cured as specified for concrete and shall contain soft steel wires embedded therein for fastening to the reinforcing.

D. Details of concrete reinforcement not shown on drawings shall be in accordance with CRSI Manual of Standard Practice.

2.3 REINFORCING BAR COUPLERS

Reinforcing bar couplers shall be internally threaded to receive future threaded reinforcing bars or couplers. The couplers shall be cold-forged to the reinforcing bars or shall be internally threaded to receive threaded reinforcing bars. The ends of the reinforcing bars shall be upset before threading. Reinforcing bars not upset before threading may be used provided the bar size is increased one bar size. The entire assembly shall be capable of developing, in tension and compression, at least 125 percent of the specified yield strength of the bar. Provide plastic screw-caps to protect internal coupler threads. The couplers shall be of Lenton or equal.

2.4 PATCHING GROUT (Dry Pack)

Patching grout shall consist of neat Portland cement, water, and sand passing a No. 8 sieve. The ratio of cement to sand shall be one part Portland cement to two parts sand. Add sufficient water to form a damp formable consistency.

2.5 FORM RELEASE

Form release shall be non-staining and in accordance with Corps of Engineers Specification CE 204 Section 3.03K. Burke Release #1 V.O.C. manufactured by Edoco, or equal.

2.6 NONSHRINK GROUT

Nonshrink grout shall conform to the ASTM-C1107 for Nonshrink Grout, and to these specifications. Use a nongas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be Masterflow 713, as manufactured by Master Builders Company, Cleveland, OH, Upcon by Upco Co., Cleveland, OH, or equal.

2.7 EPOXY GROUT

See Section 03071 for material requirements.

2.8 JOINT SEALANT

Joint sealant shall be a single component, gray, nonstaining, nonsagging, gun-grade polyurethane sealant, and shall meet ASTM C920 for vertical and horizontal joints and, in addition, is

recommended by the manufacturer for continuous immersion in water. Sealant shall be MasterSeal NP1 by BASF, Sikaflex-1a by Sika Corporation, or equal.

2.9 BACKING ROD FOR EXPANSION JOINTS

Backing rod shall be an extruded closed-cell polyethylene foam rod compatible with joint sealant and as recommended by sealant manufacturer.

The rod shall be ¼-inch larger in diameter than the joint width. Where possible, provide full length sections for the joint and minimize splices. Apply backing rod and bond breaker tape in expansion joints.

2.10 BOND BREAKER TAPE

Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.11 EXPANSION JOINT FILLERS (Walkways and Sidewalks)

Asphalt impregnated, premolded type, ASTM D1751, ½-inch by depth of slab minus ½-inch.

2.12 PREMOLDED JOINT FILLER

Joint filler shall be preformed, non-extruded type constructed of closed-cell neoprene conforming to ASTM D1752, Type I, as manufactured by W. R. Grace Company of Cambridge, MA; W. R. Meadows, Inc., Elgin, IL; or equal.

2.13 STEEL EXPANSION JOINT DOWELS

Steel expansion joint dowels shall conform to one of the following:

A. Epoxy coated steel bar dowels with a 12-mil coating thickness. Steel bar dowels shall conform to ASTM A36 or ASTM A615, plain rounds, Grade 60. Epoxy coating shall be in conformance with ASTM A775; or,

B. Stainless-steel bar dowels conforming to ASTM A276, Type 302.

2.14 EXPANDED POLYSTYRENE FILLER BLOCK

Expanded polystyrene filler blocks for future construction and expansion joints shall be Styrofoam SM brand as manufactured by Dow Chemical Company, or equal.

2.15 PREFORMED CONTROL JOINT

Preformed control joint shall be a one-piece, flexible, PVC joint former, such as Kold-Seal Zip-Per Strip KSF-150-50-50, manufactured by Vinylex, Corp., Knoxville, Tennessee, or a one-piece steel strip with preformed groove, such as Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, CA, or equal. Provide the preformed control joint material in full length unspliced pieces.

2.16 PVC WATERSTOPS

Waterstops shall be extruded from a PVC compound and shall be lock-rib, center-bulb or flat-strip type as manufactured by Greenstreak, Specon, Inc., JPSpecialties, Inc., or equal. Waterstop shall comply with Corps of Engineers Specification CRD-C-572. Waterstops shall be of the dimensions and profile as shown in the drawings.

Waterstops shall be extruded from virgin elastomeric PVC compound, resistant to chemical action with Portland cement, alkalies, acids, and not affected by mildew or fungi. It shall show no effect when immersed for 10 days in a 10% solution of sulfuric or hydrochloric acid, saturated lime solution or salt water. Waterstops shall be such that any cross section will be dense, homogeneous, and free from porosity and other imperfections. Waterstops shall be symmetrical in shape. When tested in accordance with Federal Standard No. 601, the material shall meet the following minimum requirements:

Minimum Requirement	ASTM Specification
Tensile Strength, 2000 psi	D638
Shore hardness A15, 60-80	D2240
Ultimate elongation, 300%	D638
Water absorption, 0.15	D570
Specific gravity, 1.3	D792
Stiffness in flexure, 700 psi	D747
Low temperature brittleness, -35 degrees F	D746
Tear Resistance, 300 lb/in	D624

2.17 BENTONITE WATERSTOPS

Where identified on the pipe penetration drawings, bentonite waterstops shall be bentonite strips,

Volclay “Water Stop-RX”, or equal. Bentonite waterstops shall not be used for structural construction joints unless approved by the Engineer.

2.18 FLOOR HARDENER

Liqui-Hard by W.R. Meadows; Lapidolith by Sonneborn Building Products, Division of Contech, Inc., Minneapolis, Minnesota, or equal. Hardener shall be compatible with curing method used.

2.19 ADHESIVE ANCHORS

Anchors called out on Contract Drawings as epoxy anchor, adhesive anchor or chemical anchors shall be stainless steel threaded rods, nuts, and washers (per respective ICC-ES reports) or Grade 60 rebar for epoxy dowels in two component resin adhesive. Adhesive shall be Simpson Set-XP Epoxy, HILTI RE 500-V3, or equal. Adhesive anchors shall meet the cracked section requirements of CBC 2019 and be suitable for submerged and corrosive environments.

2.20 STRUCTURAL ANCHORS

A. Anchors called out on the Contract Drawings as expansion anchors (EA), expansion bolt (EB), or wedge anchor (WA) shall be stainless steel ITW Redhead Trubolt+, HILTI Kwikbolt TZ, or equal.

B. Adhesive anchors may be substituted for structural anchors if approved by the Engineer.

2.21 CURING MATERIALS

A. Sheet Materials: ASTM C171, 4 mil polyethylene film or waterproof paper.

B. Spray Applied Membrane Forming Liquids: Meet or exceed requirements of ASTM C309, Type 1-D, Class B, except that the loss of water, when tested, shall be not more than 0.15 kilograms per square meter in 24 hours, nor more than 0.45 kilograms per square meter in 72 hours. Shall be a water-base, resin cure with fugitive dye, meeting California Air Regulation Board requirements. Products by Burke, W.R. Meadows, Inc., or equal.

Material shall only be allowed on concrete not scheduled to be coated.

C. Burlap Mats: Burlap mats shall conform to AASHTO M182.

2.22 FORM TIES

A. Notify Engineer 48 hours prior to placement of concrete. Concrete shall not be placed until Engineer has reviewed and approved the placement of all reinforcing steel.

B. Locate form ties on exposed surfaces in a uniform pattern or as indicated on the drawings. Construct form ties so that the ties remain embedded in the concrete except for a removable portion at each end and do not leave an open hole through the concrete. Form ties shall have conical or spherical type inserts with a maximum diameter of 1 inch. Construct form ties so that no metal is within 1 inch of the concrete surface when the forms, inserts, and tie ends are removed. Do not use wire ties. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.

C. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1 inch and sufficient dimensions to permit patching of the tie hole.

D. Ties for water-holding structures or dry structures with access, such as basements or pipe galleries that are below finish grade shall have an integral steel waterstop that is tightly and continuously welded to the tie. The waterstop shall be at least two times larger in the area than the tie cross-sectional area and shall be oriented perpendicular to the tie and symmetrical about the center of the tie. Construct the ties to provide a positive means of preventing rotation or disturbance of the center portion of the tie during removal of the ends.

E. Tapered form ties are allowed for dry structures only that are above finish grade and shall be tapered through-bolts at least 1 inch in diameter at the smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size.

2.23 BONDING AGENT

See Section 03071 for material requirements.

2.24 CONCRETE GROUT

Grout shall have a minimum compressive strength of 4000 psi at 28 days and shall consist of Portland cement, fine aggregate, coarse aggregate, and air entraining agent, and water which shall conform to the requirements of Section 90 of the Standard Specifications, as modified herein. Grout shall contain a minimum of seven sacks (658 pounds of Portland cement) per cubic yard. Maximum slump shall be four (4) inches. Coarse aggregate shall be 3/8-inch pea gravel. Grading shall be set forth in Section 90 of the Standard Specifications.

PART 3 EXECUTION

3.1 SAFETY REGULATIONS

Comply with all applicable safety regulations including the requirements of "The Construction Safety Orders" of the State of California and the provisions of OSHA.

3.2 CONCRETE MIX COMPOSITION

A. Concrete Composition: Concrete shall consist of Portland cement, fine aggregate, coarse aggregate, an air entraining agent, and water which shall conform to the requirements of Section 90 of the Standard Specifications, and as modified herein.

B. Submittal of Proposed Mix Design

1. The proposed mix design, with samples of rock aggregate and any admixtures to be used, shall be submitted in accordance with Section 01300.

2. Samples of fine and coarse aggregate and any admixtures to be uses in concrete, shall be submitted along with the concrete mix design submittal.

3. The grading or proportioning of the fine and coarse aggregates in the mix shall be changed whenever necessary or desirable, in the opinion of the Engineer, to secure the required economy, workability, density, impermeability or strength, and no additional compensation because of such changes shall be allowed.

C. Concrete Designations: Concrete will be designated as shown in the table below and subsequent sections.

Type of Use	Concrete Class	Maximum Aggregate Size (inches)	Minimum Compression Strength at 28 Days (psi)	Slump (inches)	Max. Water Cementitious Ratio (by weight)	Entrained Air Required (%)
LIQUID CONTAINING STRUCTURES:						
Slabs & Footings on grade	1	1 ½	4000	3 max	0.45	4-½ ± 1-½
Vertical Wall Sections and Columns	1	1	4000	4 max	0.45	4-½ ± 1-½
Mass Concrete and Unformed Slopes	1	1	4000	2 max	0.45	4-½ ± 1-½
OTHER STRUCTURAL CONCRETE:						

Interior and Exterior Slabs, Footings, Caissons, and Pipe Encasements	1	1 ½	4000	3 max	0.45	3 ± 1-½
Vertical Wall Sections and Columns	1	1	4000	4 max	0.45	3 ±1-½
Curbs, Gutters, Sidewalks, Mowing Strips, Fence Posts	3	1	2500	4 max	0.55	3 ±1-½
Thrust Blocks, Concrete Fill	4	1	2000	4 max	0.60	-----
Concrete Lined Channels	2	¾"	3000	3 ½	0.60	5 + 1

D. Concrete Class:

1. Class 1 concrete shall contain a minimum of 675 pounds of cementitious material per cubic yard.
2. Class 2 concrete shall contain a minimum of 590 pounds of cementitious material per cubic yard.
3. Class 3 concrete shall contain a minimum of 505 pounds of cementitious material per cubic yard.
4. Class 4 concrete shall contain a minimum of 420 pounds of cementitious material per cubic yard.
5. Fiberous reinforced concrete shall contain a minimum of 590 pounds of cementitious material per cubic yard. Cementitious material shall be as defined in Section 90 of Standard Specifications.

E. Concrete Compressive Strength

1. Whenever the 28-day compressive strength shown on the plans is 3,500 pounds per square inch or greater, the concrete shall be considered to be designated by compressive strength.
2. When the concrete is designated by compressive strength the mix proportions shall be determined and concrete shall be furnished which contains not less than 675 pounds and not more than 800 pounds of cementitious material per cubic yard of concrete and which conforms to the strengths shown on the plans or as specified.
3. Batch proportions shall be adjusted as necessary to produce concrete having the specified cement factor.

F. Fly Ash: The Contractor may at his option substitute up to 15 percent by weight of fly ash for the cementitious material required herein except where high early strength is specified or where the use of fly ash is prohibited.

G. Aggregate Sizing

1. Coarse aggregate maximum grading shall be as specified in the table above. Grading shall be as set forth in Section 90 of the Standard Specifications.

2. Where the spacing of reinforcing bars is such as to result in minimum clearances, or in other locations where in the opinion of the Engineer difficulties may be experienced in pouring concrete with 1½-inch maximum size aggregate, concrete with 1-inch maximum size aggregate shall be used. In this event the air content shall be increased by ½ %.

3.3 MEASURING MATERIALS

Materials shall be measured by weighing except as otherwise specified or where other methods are specifically authorized by the Engineer. Scales shall be approved by the Engineer and have been certified by the local Sealer of Weights and Measures within one year of use. Each size of aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. Cement in standard packages (sacks) need not be weighed, but bulk cement and fractional packages shall be weighed.

3.4 CONCRETE MIXING AND DELIVERY

A. All concrete shall be machine mixed at the site, or delivered to the site by transit mixers under conditions approved by the Engineer.

B. No concrete shall be placed in the work after it has started to set. No concrete can be placed more than one hour after it has been mixed.

C. If transit mix is used, the rate of delivery, haul time, mixing time and hopper capacity shall be such that all mixed concrete delivered shall be placed in the forms within one hour from the time of introduction of cement and water to the mixer. All concrete shall be kept continuously agitated until discharged in the hopper at the job site.

D. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C94 and Chapter 7 of ACI 301. Plant equipment and facilities shall conform to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.

E. Trucks rejected based on time limit or required test(s) failure shall not return with new concrete to the jobsite within three hours unless approved by the Engineer.

3.5 CONCRETE HANDLING AND PLACEMENT

A. Excavations and Formwork

1. Excavations shall be kept free from water while concrete is being placed, cured and finished therein. Fresh concrete shall be protected at all times from running water.

2. The order of placing concrete in all parts of the work shall be acceptable to the Engineer. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 14 days before the contiguous unit or units are placed.

3. Before placing concrete, all form work shall be cleaned of dirt and construction debris, water-drained, reinforcement securely and properly fastened in its correct position, forms at construction joints re-tightened, all ducts, sleeves, hangers, pipes, conduits, bolts, wires, etc., installed.

4. No concrete shall be placed before the forms and all work that is to be embedded have been set and observed by the Engineer.

5. All formwork and scaffolding shall comply to OSHA safety standards as given in Section 3.1.

B. Concrete Placement

1. Notify Engineer 48 hours prior to placement of concrete. Concrete shall not be placed until Engineer has reviewed and approved the placement of all reinforcing.

2. The working schedule and schedule of placement shall be as shown on the plans and worked out in conjunction with the Engineer. The schedule shall be worked out prior to commencement of work, and shall be rigidly adhered to.

3. Concrete shall be conveyed from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent the separation or loss of the materials. The concrete shall be deposited in the forms as nearly as practicable in its final position to avoid rehandling. Use of vibrators for extensive shifting of the mass of fresh concrete will not be permitted.

4. Concrete shall be placed and consolidated by methods that will not cause segregation of the aggregates and will result in a dense homogeneous concrete which is free of voids and rock pockets. All concrete shall be used while fresh and before it has taken an initial set. Retempering any partially hardened concrete with additional water will not be permitted.

5. Surfaces on which concrete is to be placed shall be dampened with water immediately before placing concrete.

6. Concrete shall not be deposited on frozen or ice-coated ground nor on ice-coated forms, reinforcing steel, embedded items or construction joints.

7. Where pavement or surfacing is to be placed around or adjacent to manholes or drainage inlets which will be located within traffic lanes, such structures shall not be constructed to final grade until after the pavement or surfacing has been placed around these locations.

8. Where a schedule for placing concrete is shown on the plans no deviation will be permitted there from unless approved in writing by the Engineer.

9. Mixed concrete, after being deposited, shall be consolidated until all voids are filled and free mortar appears on the surface. The concrete shall be placed as nearly as possible in its final position and the use of vibrators for extensive shifting of the mass of fresh concrete, will not be permitted.

10. Except for concrete used in cast-in-place piles, fresh concrete shall not be permitted to fall from a height greater than 4 feet without the use of adjustable length pipes, tubes or double belting placed to prevent segregation of the concrete. Double belting shall not be used unless the thickness of the member is less than 16 inches.

11. In vertical sections, concrete shall be deposited continuously in horizontal layers of 24 inches maximum depth so as to maintain a horizontal plastic surface until the completion of the unit. No concrete shall be deposited on concrete which has hardened sufficiently to cause the formation of seams and planes of weakness within the section.

12. Concrete for horizontal members or sections shall not be placed until the concrete in the supporting vertical members or sections is no longer plastic and has been in place at least two hours.

13. In all slabs, concrete shall be deposited in a continuous or monolithic operation to the full thickness of the slab. Each batch shall be dumped against previously placed concrete and not away from it, and shall not be dumped in separate piles and then worked together.

14. The concrete in each integral part of the structure shall be placed continuously, and work will not be allowed to commence on any such part unless sufficiently inspected and approved material for the concrete is on hand, and forces and equipment are sufficient to complete the part without interruption in the placing of the concrete.

C. Concrete Vibrating

1. Consolidate concrete by means of high frequency internal vibrators within 15 minutes after it is deposited in the forms. The vibrators shall not be attached to or held against the forms or the reinforcing steel. The vibrating shall be done with care and in such manner that displacement of reinforcement, ducts, and embedded items is avoided.

2. All concrete shall be consolidated by vibration so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness.

3. Internal vibrators used shall be the largest size and the most powerful that can be properly used in the work, as described in Table 5.1.4 of ACI 309. They shall be operated by competent workmen. Use of vibrators to transport concrete within forms shall not be allowed. The vibrator shall be inserted vertically at uniform spacing over the entire area of the placement. The distance between insertions shall

generally be about 1½ times the radius of action, or such that the area visibly affected by the vibrator overlaps the adjacent just-vibrated area by a few inches. In slabs, the vibrator shall be sloped toward the horizontal as necessary to operate in a fully embedded position.

4. The vibrator shall penetrate rapidly to the bottom of the layer, and at least 6 inches into the preceding layer if there is such. At each insertion, the vibrator shall be held stationary for a time sufficient to consolidate the concrete but not cause segregation, generally from 5 to 15 seconds. The vibrator shall then be withdrawn slowly, at the rate of approximately 3 inches per second.

5. A spare vibrator in good working condition shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented if necessary by spading to work the coarse aggregate back from the formed surface.

6. The use of external vibrators for consolidating concrete will be permitted when, in the opinion of the Engineer, the concrete is inaccessible for adequate consolidation provided the forms are constructed sufficiently rigid to resist displacement or damage from external vibration.

D. Cold Weather Requirements

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306 and the following paragraphs.

2. When the temperature of the surrounding atmosphere is 40 degrees F or is likely to fall below this temperature, use heated mixing water not to exceed 140 degrees F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.

3. When placed in the forms during cold weather (as defined in ACI 306), maintain concrete temperature at not less than 55 degrees F for the first five days after placing, and above 35 degrees F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.

4. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

E. Hot Weather Requirements

1. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 305 and the following paragraphs.

2. When the weather is such that the temperature of the concrete as placed would exceed 90 degrees F, use ice or other means of cooling the concrete during mixing

and transportation so that the temperature of the concrete as placed will not exceed 90 degrees F.

3. Take precautions when placing concrete during hot, dry weather to eliminate early setting of concrete. This includes protection of reinforcing from direct sunlight to prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.

4. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

3.6 BONDING TO EXISTING CONCRETE

See Section 03072.

3.7 FORMWORK

A. Arrange formwork construction to allow for proper sequencing and removal without damage. Use orderly and symmetrical panel arrangement with minimum number of joints. Before proceeding, secure approval of formwork and procedures.

B. Lumber, prefabricated wood panels, metal, or plastic-lined panels shall be sound and free from any defects that will mar or detract from the surface of the finished concrete. Construct forms sufficiently tight to prevent loss of mortar. Design forms to withstand vibrator action. Treat forms with a nonstaining material to eliminate absorption of water and to act as a form release agent.

C. Thoroughly remove all dirt, mortar, and foreign matter before each use. Where the bottom of the form is inaccessible from within, provide access panels to permit thorough removal of extraneous material before placing concrete.

D. Kerf wood forms inserted for architectural treatment to accommodate swelling without pressure on the concrete.

E. Chamfer all exposed horizontal and vertical edges or other corners ¾-inch, both interior and exterior of structures.

F. Earth trench forms for walls and footings below existing and final grades may be used, if approved after inspection of the trenches, provided the sides are clean, even, vertical, true, and provided the bottoms are level, clean, and without fill, and the width is increased two (2) inches.

G. Where tolerances are not shown elsewhere, permissible deviations from established lines, grades, and dimensions are listed below:

1. Variation from the Plumb

    a. In the lines and surfaces of columns, piers, walls and in any other vertical members: in 10 feet, ¼-inch; in any story or 20 feet maximum, 3/8-inch; in 40 feet or more, ¾-inch.

    b. For exposed corners and other conspicuous lines: in any bay or 20 feet maximum, ¼-inch; in 40 feet or more, ½-inch.

2. Variation from the Level or from the Grades Shown

    a. In floors, ceilings, and beam soffits: in 10 feet, ¼-inch; in any bay or 20 feet maximum, 3/8-inch; in 40 feet or more, ¾-inch; in floors to receive tile, maximum of 1/8" in 10 feet.

    b. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines: in any bay or 20 feet maximum, ¼-inch; in 40 feet or more, ½-inch.

3. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions: In any bay or 20 feet maximum, ½-inch; in 40 feet or more, 1 inch.

4. Variation in tank, channel or structural lines in 10 feet, ¼-inch; in 20 feet, 3/8 inch; in 40 feet or more, ½-inch.

5. Variation in the sizes and locations of sleeves, floor openings and wall openings: ¼-inch.

6. Variation in cross-sectional dimensions of columns, beams and piers, and in the thickness of slabs and walls: minus, ¼-inch; plus, 3/8-inch.

7. Footings

    a. Variation in Dimensions in Plan: Minus, ½-inch; plus, 2-inch.

    b. Misplacement or Eccentricity: 2 percent of the footing width in the direction of misplacement but not more than 2 inches.

    c. Misplacement or Eccentricity of Footings Supporting Masonry Or Concrete: ½-inch.

    d. Reduction in Thickness: Minus 5 percent of specified thickness.

8. Variation in Steps

    a. In a Flight of Stairs: rise, 1/8-inch; tread, ¼-inch.

    b. In Consecutive Steps: rise, 1/16-inch; tread, 1/8-inch.

9. Variation from established lines and grades in sidewalks, plazas, outdoor concrete slabs, curb and gutter sections: in 10 feet, ¼-inch; in 1 foot, 1/8-inch.

H. Where tolerances are not met, the Owner's Representative may require removal and replacement at no cost to the Owner.

3.8 REINFORCEMENT

A. Design: The reinforcement design shown on drawings shows only the necessary information for detailing the reinforcement and preparing placing and bending details. Prior to starting concrete work, submitted detailed shop drawings shall be approved by the Engineer.

B. Bending: In accordance with CRSI Manual of Standard Practice, Chapter 7.

C. Placement: Place reinforcement accurately as shown. Adequately secure metal reinforcement in position by concrete or metal chairs and spacers, in accordance with CRSI Manual of Standard Practice, Chapter 8. Distance between the steel and the surface, as shown; otherwise, in accordance with Chapter 8.

D. Splices: Locate splices of reinforcement as shown. For any splices not shown, assume Class B splice. Stagger splice in adjacent horizontal bars, with 5-feet stagger distance. Lap adjacent sheets of wire mesh a minimum of 6 inches and wire securely.

E. Inspection: After reinforcement has been placed, it shall be inspected and approved before placing concrete.

F. Conditions of Surfaces: At time concrete is placed, notify Engineer 48 hours prior to placement of concrete. Concrete shall not be places until Engineer has reviewed and approved the placement of all reinforcing steel.

G. Welding Reinforcement: Do not weld reinforcing steel unless specifically approved by the Engineer. Welding to be in accordance with ASTM A706.

3.9 JOINTS AND EMBEDDED ITEMS

A. Construction Joint

1. Obtain approval for joints not shown and locate them where they least impair the strength of the structure. Unless otherwise shown on the drawings, joints in walls and columns shall be at the underside of floors, slabs or beams, and at the top of footings or floor slabs. Place beams at the same time as slabs. At least two hours shall elapse after depositing concrete in columns or walls before depositing concrete in supported beams or slabs. As the new concrete is placed, vibration in tops of columns and walls is desirable. Make joints perpendicular to the main reinforcement.

2. All horizontal construction joints in walls shall have a continuous wood screed strip at the outer face of joint to form a true line. Screeds shall be removed and the reglet thoroughly cleaned out before pouring the next portion of wall.

3. Continue all reinforcing steel and mesh across construction joints. Lap slices shall be located outside all construction joints.

4. Construction joints shall be made rough and all laitance removed from the surface by chipping the entire surface, sandblasting with coarse silica sand, or hosing the surface 4 to 6 hours after the pour with a fine spray, exposing solidly embedded clean aggregate.

5. Forms and reinforcing shall likewise be cleaned of drippings, debris, etc., by means of compressed air. Surfaces of the hardened concrete shall be cleaned to the satisfaction of the Engineer and wet as required before placing of new concrete. Just before starting the new pour, all free water shall be removed and the horizontal surfaces shall be covered with at least a 4-inch thickness of concrete composed of cement and fine aggregate, omitting the coarse aggregate.

B. Expansion Joints

1. Install expansion joint fillers to ½-inch below slab.

2. Where shown, load transfer dowels shall consist of plain bars with one half coated with an approved antibond coating. The coated half shall be sleeved. No other reinforcement or metal shall extend continuously through the joint.

C. Waterstops

1. The design and location of waterstops shall be as shown on the drawings and in these specifications. Each piece of premolded waterstop shall be of maximum practicable length to minimize the number of end joints.

2. PVC waterstops shall be properly heat spliced at the ends and intersections to ensure continuity. Construct forms for construction joints in such a manner as to prevent injury to waterstops. Allow at least 10 minutes before pulling or straining the new splice in any way. The finished splices shall provide a cross section that is dense and free of porosity with tensile strength of not less than 80% of the unspliced materials.

3. Install waterstops in strict conformance with manufacturers recommendations.

4. Hold PVC waterstops securely in position with continuous No. 3 rebar secured to waterstops and hog rings at 12" max on center. Secure continuous rebar to each mat of reinforcing with tie wire at 12" on center. Install waterstops in construction and expansion joints in hydraulic structures or where shown in the drawings.

5. If joint is not watertight after construction, one or both of the following shall be done to provide a watertight joint:

   a. Grouting of the joint by drilling grout holes to the center of the structure unit and forcing epoxy grout into the joint under pressure.

   b. Cutting of a bevel groove on the water side of the joint. The groove shall be ½ to ¾-inch in width and depth and shall be caulked with epoxy joint sealer in accordance with manufacturer's instructions.

D. Other Embedded Items

1. Prior to concreting, place all required sleeves, inserts, anchor bolts and embedded items.

2. Give all trades whose work is related to the concrete ample notice and opportunity to introduce embedded items before concrete is placed.

3. Position expansion joint material, waterstops, and embedded items accurately and support them against displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material to prevent the entry of concrete.

E. Pipes and Wall Spools Cast in Concrete

1. Install wall spools (i.e. bell ring inserts), wall flanges, and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall spools or anchors to the reinforcing steel.

2. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement will occur during construction.

3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.

F. Additional Reinforcement Around Openings: Place additional reinforcement around pipe or openings as indicated in the drawings

3.10 FORM REMOVAL

Carefully remove forms to ensure the complete safety of the structure. All supporting forms or shoring shall remain in place for a minimum of 10 days or until members have acquired the 28-days compressive strength to support their weight and imposed loads safely.

3.11 CONSTRUCTION LOADS ON STRUCTURAL SLABS

No construction materials and equipment shall be allowed on structural slabs until the concrete has reached the 28-day compressive strength.

3.12 REPAIRING AND PATCHING

A. Clean, thoroughly dampen and patch all tie holes and all repairable defects immediately after form removal.

B. All honeycombed and other defective concrete shall be removed to sound concrete with edges perpendicular to the surface. Surface imperfections greater than 3/8 inch in any dimension shall be removed and the affected areas neatly patched. Dampen the area to be patched and an area at least 6 inches wide surrounding it to prevent absorption of water from the patching mortar. Mix patching grout to the consistency of thick cream and brush it well into the surface.

C. Make the patching mortar of the same material and approximately the same proportions as used for the concrete, omitting the coarse aggregate. The resultant mortar shall consist of not more than 1 part cement to 2½ parts sand by damp loose volume.

D. Do not use more mixing water than necessary for handling and placing. Mix the patching mortar in advance and allow to stand with frequent manipulation with a trowel, without adding water, until it has reached the stiffest consistency that will permit placing.

E. After surface water has evaporated from the area to be patched, brush the patching grout well into the surface. When the patching grout begins to lose the water sheen, apply the premixed patching mortar. The mortar shall be thoroughly consolidated into place and struck off to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, leave the patch undisturbed for at least 1 hour before finishing it. Keep the patched area damp for 7 days. Do not use metal tools in finishing a patch in a formed wall which will be exposed.

F. Tie Holes: Clean thoroughly by mechanical abrading, dampen, then fill solid with patching mortar. Mortar shall match color of concrete. Fill tie holes prior to finishing.

3.13 FINISHES FOR SURFACES

A. Finish 1: Beams, columns, and exterior walls not exposed to water or view: Repair defective concrete, fill depressions deeper than ½ inch, and fill tie holes.

B. Finish 2: Exterior and interior walls, beams, and columns exposed to water, unless such items are to be coated: Repair defective concrete, remove fins, fill depressions ¼ inch or deeper, and fill tie holes.

C. Finish 3: Walls, beams, and columns of structures or buildings exposed to view and to 1 foot below water level or finished grade; underside of formed floors or slabs (EXCEPT - surfaces which are to be coated): In addition to Finish 2, fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and one and one-half parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.

D. Finish 4: Exterior and interior surfaces to be coated: Repair defective concrete, remove fins, fill depressions 1/16 inch or deeper, fill tie holes, remove mortar spatter, and remove bulges higher than 1/16 inch. Surface shall be trowelled, sacked, and brush blasted.

E. Finish 5: Slabs and floors to be covered with concrete or grout: Screed to grade without special finish.

F. Finish 6: Slabs and floors not water bearing: Repair defective concrete, remove fins, fill depressions ¼ inch or deeper, and fill tie holes.

G. Finish 7: Slabs and floors which are water bearing; Slab surfaces on which mechanical equipment moves; Slab surfaces to receive hardener: Steel trowel finish, free from trowel marks and all irregularities.

H. Finish 8: Slabs and floors of structures or buildings exposed to view: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.

I. Finish 9: Slabs and floors at slopes greater than 10% and stairs: Steel trowel finish without local depressions or high points. Apply a coarse broom finish. Leave broom lines parallel to the direction of slope drainage.

J. Finish 10: Exposed stairs and landings and slabs designated for non-slip finish: Areas to have non-slip finish shall incorporate 25 pounds per 100 square feet of aluminum oxide grains into the surface. Immediately before floating begins, sprinkle two-thirds of the abrasive evenly over the surface and float. After embedment, sprinkle the remaining one-third at right angles to the previous application. Apply more heavily in areas not sufficiently covered by the first application, and float again immediately. Complete finishing as specified under Trowelled Finish.

K. Finish 11: Exposed edges (EXCEPT – edges normally covered with earth): Provide chamfer or beveled edges per this Section.

L. Finish 12: Top of walls, beams, and similar unformed surfaces: Strike smooth and float in accordance with Finish 4.

3.14 SLAB FINISHING

A. Screeding: After concrete has been thoroughly consolidated, screed slabs to the desired elevation and contours by means of accurately placed edge forms and intermediate screed strips.

B. Floated Finish

1. Place, consolidate, strike off, and level concrete, but do not work it further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently.

2. During or after the first floating, check planeness of surface with a 10-foot straightedge applied at not less than two different angles, and then cut down all high spots and fill all low spots to achieve a true plane within ¼-inch in 10 feet.

3. Refloat slab immediately to a uniform sandy texture.

C. Troweled Finish: Float finish slab as described above, then steel trowel by machine or by hand. Additional trowellings shall be done by hand after the surface has hardened sufficiently. Final trowelling shall produce a ringing sound from the trowel and the finished surface shall be free of trowel marks, uniform in texture, and appearance shall be planed to the tolerance specified under Floated Finish. Trowelled finish shall occur at tank floors (except where grout topping or fillets will follow), troughs, channels, clear wells, and all building floor slabs.

D. Coarse Broom Finish: Immediately after floating, give slabs for exterior walkways and exterior stoops a coarse transverse scored texture by drawing a broom across the surface.

3.15 FLOOR HARDENER

A. All building floors not scheduled for floor covering, Non-slip Floor Finish, or Broom finish shall receive hardener (Finish 7).

B. Apply hardener after floors have cured, in accordance with the manufacturer's recommendations.

C. Floors shall receive three applications of hardener, mixed and applied as specified for heavy duty floors as shown on contract drawings.

3.16 CURING AND PROTECTION

A. General: Beginning immediately after placement, protect concrete from drying, excessively hot and cold temperatures and mechanical injury. Keep moisture loss to a minimum until cement has hydrated and concrete is hard. Keep concrete constantly moist during the curing period. Follow color admixture manufacturer's recommendations for integrally colored concrete.

B. Curing

1. Formed Surfaces: Keep forms wet. Cool metal forms exposed to the sun with water. If curing compound is used, apply in accordance with manufacturer's instructions. Curing compound shall not be used on any wall/slab scheduled to be coated.

2. Slabs: Immediately after finishing, apply one of the materials specified in Section 2.22 entitled Curing Materials, but use membrane forming liquid only with Engineer's approval.

3. Duration of Curing: 7 days minimum.

C. Protection

1. In cold weather, maintain the moisture conditions but also, by heating or covering, maintain the temperature of the concrete between 50 degrees F and 70 degrees F for entire curing period.

2. In hot weather take immediate steps to protect newly finished concrete from drying effects of wind and sun, and maintain temperature of the air surrounding the concrete uniform within 5 degrees F in any one hour or 50 degrees F in any 24 hour period.

3. During curing period, protect concrete from mechanical damage, loading, shock and vibration.

3.17 CONSTRUCTION OF CONCRETE FILLETS, TOPPING, AND EQUIPMENT PADS

A. Concrete fillets, topping and equipment pads shall be placed as soon as possible after completion of the curing period of the tank walls and structural floors. Contact surfaces shall be thoroughly cleaned to the degree recommended by the bonding agent manufacturer.

B. Bonding agent shall be accurately and thoroughly mixed and applied at the manufacturer's recommended coverage rate. Mix only the amount which can be used prior to expiration of the pot life. Concrete shall be immediately placed over the fresh surface before setting of the agent. Bonding agent which sets up prior to placing concrete shall be recoated with a fresh coat.

C. Concrete fillets, topping, and equipment pads shall be accurately screeded to the slopes and elevations shown and steel trowel finished. Cure concrete as specified for slabs above. Set equipment anchor bolts in pad to accommodate equipment furnished.

3.18 BACKFILL AGAINST STRUCTURES

A. Backfill against concrete structures shall be allowed only when the concrete has reached the specified 28-day compressive strength or as approved by the Engineer. Where backfill is to be place on both sides of the wall, or against more than one wall of a structure, place the backfill uniformly on both sides of the wall or walls.

B. Do not backfill until structure has passed leakage testing.

C. Do not backfill the walls of structures that are laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

3.19 NONSHRINK GROUT

Use nonshrink grout to fill sleeves and voids under equipment bases. Grout shall be mixed and used in accordance with manufacturer's recommendations. Exposed edges shall be smooth, straight and even.

3.20 EPOXY GROUT

See Section 03071 for requirements.

3.21 CONCRETE GROUT

Concrete grout shall be used as a filler material to form shapes and profiles over concrete surfaces as shown on the drawings.

3.22 ADHESIVE ANCHORS

Install in strict conformance to manufacturer's printed instructions. Do not cut or damage existing reinforcing bars. Where reinforcing bars are encountered, move anchor location or core hole as approved by the Engineer.

3.23 LEAKAGE TESTING OF HYDRAULIC STRUCTURES

A. General

1. Prior to backfilling the structure and the application of water-proofing coatings, hydrostatically test reinforced concrete structures which will contain water or fluid to determine that they conform to Section B herein and are free of detectable leaks. Do not start leak testing until all of the following conditions are met:

    a. Structure or structural materials have achieved their maximum specified design strength.

    b. Cure time, defined above within subsection 3.16, has elapsed

    c. Do not hydrostatically test walls which are to be restrained or laterally supported by slabs until slab concrete has obtained the specified compressive strength.

    d. If a water test is desired for sequencing purposes on an incomplete structure, the Contractor shall immediately notify the Engineer. Such a request may not be allowed and is at the discretion of the Engineer. If the request is approved by the Engineer, the test cannot take place until the following conditions are met:

1) a duration of 14 days minimum has elapsed or the cure time has been reached, whichever is greater

2) the structure or structural materials have achieved their maximum specified design strength

3) Engineer's defined site specific requirements, defined during request review.

2. Prior to testing, clean exposed surfaces by thoroughly hosing and removing surface laitance and loose matter from walls and slabs. Remove wash water and debris from the structures by means other than washing through plant piping.

B. Leakage Test Procedure

1. All liquid containing structures (new or modified existing) shall be leak tested. Fill hydraulic structures to be subjected to leakage tests with potable water to the normal operating liquid level line not less than 2 feet below top of walls. Filling shall be at a uniform rate over a 24-hour period with continuous monitoring. For structures with adjacent bays, fill all bays simultaneously. Empty adjacent bays alternately. Repair any running leaks which appear during filling before continuing.

2. After the structure has been kept full for 48 hours, it will be assumed for the purposes of the test that the absorption of moisture by the concrete in the structure is complete. Then close all valves and gates to the structure and measure the change in water surface each day for a five-day period.

3. During the test period, examine exposed portions of the structure, and mark visible leaks or damp spots. A damp spot is defined as an area which seeps sufficient moisture to dampen a paper towel when pressed against it. Repair visible leaks or damp spots after dewatering. Additionally, if the drop in water surface in the 24-hour period exceeds 1/10 of 1% of the normal volume of liquid contained in the structure, the leakage shall be considered excessive.

4. The determination of surface moisture evaporation shall be aided with a 24-inch deep, white colored, watertight container with not less than 10 square feet of surface area exposure. Position container to experience environmental conditions similar to the structure being tested. Subtract the water loss due to evaporation from the measured water loss in the structure to determine the water loss due to leakage.

5. If the leakage is excessive, drain the structure, repair leaks and damp spots, and refill the structure and again test for leakage. Continue this process until the drop in water surface in a 24-hour period meets the test requirements and visible leaks and damp spots are eliminated.

6. If an underdrain system is present, inspect the manholes of the underdrain system for evidence of leaks in the floor slabs. If leaking is indicated, locate and repair.

7. If the leakage is detected and location is unknown, use the following procedures. All water-bearing structures must be seeded. Seed the floor slab of each hydraulic structure with one sack of cement per 1,000 square foot surface area. Seeding shall take place after the test filling has reached 18 inches in depth. Detect leaks in

construction and expansion joints with the aid of a diver. Stir cementious deposits flowing toward leaks and repair where the defect is located.

8. Repair flowing leaks whether leakage exceeds the allowable leakage or not.

9. Repairs and additional filling and testing shall be made by the Contractor at no additional cost to the Owner.

10. Use Form A, attached to this specification.

C. Repair of Defects

1. Do not repair defects until concrete has been reviewed by the Owner's Representative.

2. Surface Defects: Repair surface defects that are smaller than 1 foot across in any direction and are less than ½ inch in depth. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8 inch deep, thoroughly dampen the surface, work into the surface a bonding grout, fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.

3. Severe Defects: Repair severe defects that are larger than surface defects but do not appear to affect the structural integrity of the structure. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface, sandblast the surface, coat the sandblasted surface with an approved epoxy bonding compound, place nonshrink grout as specified herein, match the finish on the adjacent concrete, and cure as specified.

4. Major Defects: If the defects are serious or affect the structural integrity of the structure or if patching does not satisfactorily restore the quality and appearance to the surface, the Engineer may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section at no additional cost to the Owner.

D. Repair of Cracks in Concrete

1. Repair leaking concrete cracks that are 1/10 inch or less in width by epoxy pressure injection.

a. Preparation: Insert and anchor a one-way polyethylene valve or pipe nipple in holes drilled into crack. Position them every 6- to 18-inches on center depending on the width of crack. Maintain a slow, steady pressure rather than a rapid buildup of pressure. When grouting material reaches the next tube, stop off the present position and follow the same procedure on the next position.

b. Upon completion of the epoxy grouting, remove the epoxy gel used to hold the valve or nipple by applying a direct flame to the epoxy and scraping it off. Fill the holes with the same material as used for patching the surface.

c. While the valves or nipples are installed first, the grouting operation shall not commence until after the patch work has been completed and has sufficiently cured.

2. Repair cracks in concrete structures that are wider than 1/10 inch in width by cutting out t square edged and uniformly aligned joining 3/8 inch wide by 3/4 inch deep, preparing exposed surfaces of the joining, priming the join, and applying polyurethane join sealant in accordance with this section.

3. If the cracks are serious or affect the structural integrity or function of the element, the Engineer may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section at no additional cost to the Owner.

4. After repairing visible leaks, damp spots or leaking concrete cracks, retest the structure.

3.24 CONCRETE TESTING

Concrete testing shall be performed by the Owner, at Owner's expense, in accordance with the following:

A. Test reports shall be sent to the Engineer with copies to the Contractor.

B. Concrete which fails to meet strength, slump, air or shrinkage requirements may be rejected by the Engineer before, during, or after placement.

C. One set of four concrete test cylinders shall be taken for every 50 cubic yards or fraction thereof of each concrete mix design placed each day. The Engineer has the option to direct the required test specimens to be taken as he deems necessary to insure the concrete meets the specification.

D. Specimens shall be taken, cured, and tested for compressive strength in accordance with ASTM C31, ASTM C39, and ASTM C172, respectively.

E. Test one cylinder at 7 days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.

F. Determine the concrete slump by ASTM C143 with each strength test sampling and as required to establish consistency.

G. Determine air content of the concrete using ASTM C231 to verify the percentage of air in the concrete immediately prior to depositing in the forms.

H. Determine drying shrinkage in accordance with ASTM C157, as modified by SEAOC, at 7, 14, 21, and 28 days of drying after the wet cure period. A minimum of three sets of three shrinkage bars shall be fast over the project duration. The Engineer has the option to increase or decrease the testing frequency as he deems necessary to insure the concrete meets the specification. Shrinkage bars of 28 days drying age shall not exceed 0.045 percent for laboratory cast and 0.058 percent for field cast.

I. The average value of concrete strength tests shall be equal to or greater than the specified 28-day strength. No test shall be less than 90% of the specified 28-day strength.

J. If the 28-day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Owner and in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 90% of the specified minimum compressive strength or if any single core is less than 75% of the minimum specified compressive strength, the concrete will be considered defective. The Owner may require additional coring, nondestructive load testing, or repair of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor at no extra cost to the Owner.

3.25 DAMAGED OR DEFECTIVE CONCRETE

Remove damaged or defective concrete before completion and acceptance of the work and replace with acceptable concrete, at no additional cost to the Owner.

3.26 SAMPLE HYDRAULIC STRUCTURE LEAKAGE LEAK TEST FORM A

Contractor _____Project_____

Structure: _____Test #_____

Work to be Performed	Date	Quantity Water (gal)	Visible Leaks (Y/N)	Water Level Height	Pan Evaporation Reading	% loss	Contractor Initial	Construct. Manager Initial

Notes:_____
_____
_____
_____
_____

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SECTION 03110

CONTROLLED LOW STRENGTH MATERIAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Controlled Low Strength Material (CLSM).

B. Related Sections:

1. Section 03100 - Concrete.

1.2 REFERENCES

American Society of Testing and Materials (ASTM):

A. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

B. C33 - Standard Specification for Concrete Aggregates.

C. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

D. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

E. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

F. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

G. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

H. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m3))

1.3 SYSTEM DESCRIPTION

Performance Requirements:

A. Total Calculated Air Content: Not be less than 8.0 percent nor greater than 12.0 percent.

B. Minimum Unconfined Compressive Strength: Not less than 50 pounds per square inch measured at 28 days.

C. Maximum Unconfined Compressive Strength: Not greater than 150 pounds per square inch measured at 28 days.

D. Wet Density: No greater than 132 pounds per cubic foot.

1.4 SUBMITTALS

A. Product Data: Submit data completely describing products.

B. Sieve Analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate. Resubmit at any time there is a significant change in grading of materials.

C. Mix: Submit full details, including mix design calculations for mix proposed for use.

D. Trial Batch Test Data:

1. Submit data for each test cylinder.
2. Submit data that identifies mix and slump for each test cylinder.

E. Cement Mill Tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

F. Pozzolan Certificate of Compliance: Identify source of pozzolan and certify compliance with requirements of ASTM C 618.

PART 2 MATERIALS

2.1 MATERIALS

A. Portland Cement: Type II modified portland cement as specified in Section 03100.

B. Fly Ash: As specified in Section 03100.

C. Water: As specified in Section 03100.

D. Admixture: Air entraining admixture in accordance with ASTM C260.

E. Fine Aggregate: Concrete sand that does not need to be in accordance with ASTM C33. No more than 12 percent of fine aggregate shall pass a No. 200 sieve, and no plastic fines shall be present.

F. Coarse Aggregate: Pea gravel no larger than 3/8 inch.

2.2 MIXES

Suggested Design Mix

Material	Weight	Specific Gravity	Absolute Volume Cubic Foot
Cement	30 pounds	3.15	0.15
Fly Ash	300 pounds	2.30	2.09
Water	283 pounds	1.00	4.54
Coarse Aggregate	1,465 pounds	2.68	8.76
Fine Aggregate	1,465 pounds	2.68	8.76
Admixture	4-6 ounces		2.70
TOTAL	3,543 pounds		27.00

2.3 SOURCE QUALITY CONTROL

A. Trial Batch:

1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.

2. Prepare trial batches using specified cementitious materials and aggregates proposed to be used for the Work.

3. Prepare trial batch with sufficient quantity to determine slump, workability, consistency, and to provide sufficient test cylinders.

B. Test Cylinders:

1. Prepare test cylinders in accordance with ASTM C31 with the following exceptions:

   a. Fill the concrete test cylinders to overflowing and tap sides lightly to settle the mix.

b. Do not rod the concrete mix.

c. Strike off the excess material.

2. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

3. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

4. The test cylinders may be capped with standard sulfur compound or neoprene pads:

a. Perform the capping carefully to prevent premature fractures.

b. Use neoprene pads a minimum of 1/2 inch thick, and 1/2 inch larger in diameter than the test cylinders.

c. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.

C. Compression Test 8 Test Cylinders: Test 4 test cylinders at 3 days and 4 at 28 days in accordance with ASTM C39 except as modified herein:

1. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

D. If the trial batch tests do not meet the Specifications for strength or density, revise and resubmit the mix design, and prepare additional trial batch and tests. Repeat until an acceptable trial batch is produced that meets the Specifications.

1. All the trial batches and acceptability of materials shall be paid by the Contractor.

2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

E. Determine Slump in Accordance with ASTM C143 with the Following Exceptions:

1. Do not rod the concrete material.

2. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.

PART 3 EXECUTION

3.1 INSTALLATION

A. Prior to placement, soils located below controlled low strength material placement shall be scarified to a depth of 8 inches, uniform moisture conditioned to or above the optimum

moisture content, and compacted to a minimum of 95 percent relative compaction in accordance with ASTM D1557.

B. Place controlled low strength material by any method which preserves the quality of the material in terms of compressive strength and density:

1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent lateral load due to the weight of the next lift of CLSM.

2. The basic requirement for placement equipment and placement methods is the maintenance of its fluid properties.

3. Transport and place material so that it flows easily around, beneath, or through walls, pipes, conduits, or other structures.

4. Use a slump of the placed material greater than 9 inches, and sufficient to allow the material to flow freely during placement:

   a. After trial batch testing and acceptance, maintain slump developed during testing during construction at all times within plus or minus 1 inch.

5. Use a slump, consistency, workability, flow characteristics, and pumpability (where required) such that when placed, the material is self-compacting, self densifying, and has sufficient plasticity that compaction or mechanical vibration is not required.

3.2 FIELD QUALITY CONTROL

A. General:

1. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Engineer in preparing said specimens.

2. Be responsible for the care of and providing curing condition for the test specimens.

B. Tests by Owner:

1. During the progress of construction, the Owner will have tests made to determine whether the controlled low strength material, as being produced, complies with the requirements specified hereinbefore. Test cylinders will be made and delivered to the laboratory by the Engineer and the testing expense will be borne by the Owner.

2. Test Cylinders:

   a. Prepare test cylinders in accordance with ASTM C31 with the following exceptions:

      1) Fill the concrete test cylinders to overflowing and tap sides lightly to settle the mix.

2) Do not rod the concrete mix.

3) Strike off the excess material.

b. Place the cylinders in a safe location away from the construction activities. Keep the cylinders moist by covering with wet burlap, or equivalent. Do not sprinkle water directly on the cylinders.

c. After 2 days, place the cylinders in a protective container for transport to the laboratory for testing. The concrete test cylinders are fragile and shall be handled carefully. The container may be a box with a Styrofoam or similar lining that will limit the jarring and bumping of the cylinders.

d. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.

e. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

f. The test cylinders may be capped with standard sulfur compound or neoprene pads:

1) Perform the capping carefully to prevent premature fractures.

2) Use neoprene pads a minimum of 1/2 inch thick, and 1/2 inch larger in diameter than the test cylinders.

3) Do not perform initial compression test until the cylinders reach a minimum age of 3 days.

3. Not less than 3 cylinder specimens will be tested for each 150 cubic yards of controlled low strength material and not less than 3 specimens for each half day's placement:

a. Test 1 cylinder at 3 days and 2 at 28 days in accordance with ASTM C39 except as modified herein.

b. The compression strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

4. The Owner will test the air content of the controlled low strength material. Test will be made immediately after discharge from the mixer in accordance with ASTM C231.

C. Tests by Contractor:

1. Test the slump of controlled low strength material using a slump cone in accordance with ASTM C143 with the following exceptions:

a. Do not rod the concrete material.

b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.

2. Test the slump at the beginning of each placement, as often as necessary to keep the slump within the specified range, and when requested to do so by the Engineer

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SECTION 03480

PRECAST UTILITY VAULTS AND CATCH BASINS

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of furnishing and installing precast concrete utility vaults with covers for flow meters, process equipment and other shown services, and also catch basins, all as shown on the contract drawings or specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 01610: Seismic Design Criteria

C. Section 01615: Wind Design Criteria

D. Section 02200: Earthwork

E. Section 02623: Filter Fabric

F. Section 08310: Access Hatches

1.3 SUBMITTALS

A. In accordance with Section 01300, submit manufacturer's literature and drawings showing complete layout, dimensions, design loadings, materials of construction, etc.

B. For all precast items which are manufactured, the Contractor shall also submit a list of the design criteria used by the manufacturer.

C. The Contractor shall submit approved ICBO reports for all lifting inserts, showing allowable design loads on the inserts.

D. Verification of compressive strength shall be submitted in accordance with Section 01300. Such verification may be laboratory trial batch test results with a minimum of three test cylinders or a series of production compression tests with a minimum of 20 sets of test data which fall within the evaluation and acceptance criteria specified herein. Such tests must have been made within the previous two years on the identical concrete mix submitted.

E. For vaults larger than 4'-0" in any dimension, drawings and calculations shall be signed by a Civil or Structural Engineer registered in California. Loads and design criteria shall be as shown on the contract drawings, specification sections 01610 and 01615, and project Geotechnical Reports. Calculations shall be based on the soil pressures provided in the Geotechnical Reports and specification section 01610.

1.4 QUALITY ASSURANCE

Test methods and criteria for evaluation and acceptance of concrete shall be as specified in Section 03100, "Concrete".

PART 2 MATERIALS

2.1 VAULT AND CATCH BASIN DESIGN AND MANUFACTURE

A. Design Loads: Design loads shall consist of live load, dead load, impact load, hydrostatic load, and other loads that may occur.

1. Live loads shall be for HS20-44, or as required per AASHTO Standard Specifications for Highway Bridges with revisions.
2. Design wheel loads shall be sixteen (16) kips.
3. Earth loads shall include a 2-foot soil surcharge.

B. Forms: All forms used in placing concrete shall be sufficiently designed and braced to maintain alignment under pressures of concrete placement.

C. Concrete:

1. Aggregates used in the concrete mix either coarse or fine, excluding light-weight aggregates, shall conform to specifications as outlined by ASTM C33.
2. All light-weight aggregates, fine or coarse, shall conform to specifications as outlined by ASTM C33.
3. Both types of aggregates shall be properly graded and free of any deleterious substances so as to produce a homogeneous concrete mix when blended with cement.

D. Cement: The cement shall be Type II low alkali portland cement and shall meet ASTM C150 Type II standards.

E. Compressive Strength: Sufficient cement content per Section 03100 shall be used per batch so as to produce a minimum strength of 4000 psi at 28 days or other strength by design when required.

F. Batching: A central batching facility shall be used to assure accurate weighing and mixing of materials to obtain a suitable concrete mix.

G. Placing: Concrete shall be made by properly proportioned parts of sand, aggregate and cement with sufficient water to produce a concrete mix of uniform quality and slump. Handling from the mixer or the transport vehicle to the forms for deposit will be in a continuous manner, as rapidly as practicable without segregation or loss of ingredients, until the unit or segment pouring is completed. Compaction by either external or internal mechanical vibration shall be used during the placement of the concrete mix.

H. Curing: Concrete while still in the forms may be steam cured after an initial set has taken place. Steam temperature shall not exceed 160°F, nor raised from normal ambient temperature at a rate exceeding 40°F per hour. Steam curing shall be considered complete after sufficient time has elapsed to produce adequate strength to withstand any structural strain that may be subjected during the form stripping operation. Additional curing may be applied by means of water spraying or membrane curing compound to reach the ultimate strength requirements.

I. Reinforcing Steel: All reinforcing steel, including welded wire mesh, shall be of the size and in the location required for design loads and conforming to ASTM A185. All reinforcing shall be sufficiently tied to withstand any displacement during the pouring operation. All bars shall be intermediate grade, or as specified, billet steel conforming to ASTM A615.

J. Preformed Joint Sealant: The joint sealing compound shall be Quik-Seal, a preformed, cold applied, ready to use plastic joint sealing compound as supplied by Quikset Utility Vaults, Santa Ana, California; Ram-Neck by K.T. Syder Company; or approved equal.

2.2 UTILITY VAULTS

A. Dimensions as shown on the drawings, minimum size shall be 24” x 30”. Open bottom or enclosed with drain or without, as shown or required for service intended.

B. Vault Cover: Designed for HS-20 traffic loading. Unless otherwise noted on the drawings or scheduled in Specification Section 08310, provide galvanized steel, bolt down, drag off, unless shown to be hinged with spring assist, on the drawings or specified.

1. Manufacturers: Brooks Products, Inc., Stockton, CA; Jensen Precast, Sparks, NV; Utility Vault Co.; or equal.

2. Hinged Spring Assist Vault Cover: Where shown on the drawings, vaults shall be provided with spring or torsion assisted two-piece galvanized steel or aluminum covers. Covers shall be designed for HS-20 traffic loading and equipped with heavy forged brass hinges with stainless steel pins including automatic hold open arm with release handle, compression spring operators for ease of operation and to act as a check in retarding downward motion covers. Hardware shall be zinc plated and chromate sealed. Factory finish shall be a "Mill finish with bituminous coating applied to exterior of the frame". Cover shall be Bilco Model JD-H-20, Halliday Products Series 2HW, or approved equal.

3. Identification: All covers shall have identification marker detailing the contents with 1" bead weld letters (i.e. "water", "sewer", "electrical", chemical").

C. Internal Ladder: The Utility Vault shall be furnished with an internal aluminum ladder to provide easy access. The ladder rungs shall have a non-slip traction surface and internal stainless steel safety bar. The ladder shall meet or exceed OSHA General Industry Standards, Part 1910.27 for "Fixed Ladders". If the ladder depth is over 15' (as shown on the drawings), install a safety rail with harness and pull up access pole. For ladders less than 15' depth, install a head hazard deflector plate. For ladders over 24', install a safety cage and safety rail with harness and pull up access pole. Ladders shall be compliant with OSHA §1910.27 and 1926.1053.

2.3 CATCH BASINS

A. Unless otherwise noted, catch basins shall be 3' x 3' x 6" wall thickness with bottom. Catch basins shall have progressive webbed knock-outs to provide maximum flexibility and permitting pipe of any size shall be neatly and quickly grouted at the job site. All reinforcing steel shall meet ASTM specifications.

B. Catch Basin Grating: Unless otherwise noted on the drawings provide cast iron or galvanized steel grating, HS-20 traffic loading.

C. Manufacturers: Christy Concrete Products, Inc.; Jensen; or equal.

PART 3 EXECUTION

3.1 INSTALLATION

Vaults shall be installed as shown on the Contract Drawings and as recommended by the Manufacturer. Catch basins shall be placed on 6-inch compacted class 2 aggregate base. Vaults deeper than 10 feet below grade shall be placed on 12-inches of crushed rock wrapped in an approved geotextile fabric. Vaults less than 10 feet below grade shall be placed on 12-inches of

compacted class 2 aggregate base. Install level with top at grade in roadways and two to three inches above grade outside of roadways.

3.2 PRECAST VAULT

The above-mentioned precast item shall be installed in accordance with the manufacturer's recommendations, unless otherwise required by the drawings. All joints shall be sealed by the use of preformed sealant and mortar or non-shrink grout so as to be water tight. Interior joints shall be tooled flush.

3.3 CONNECTIONS

Connections to manufactured precast items shall be made by casting sections of pipe into the items using non-shrink grout as shown on the drawings, and/or using an approved resilient connector. All such connections shall be water tight.

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SECTION 03700

CONCRETE SAW-CUTTING AND CORE-DRILLING

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of saw-cutting and/or core-drilling new openings in existing concrete.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 03100 - Concrete

1.3 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

1.4 SUBMITTALS

A. Comply with pertinent provisions of Section 01300.

B. Submit drawings and commentary showing and describing the proposed cutting procedures and proposed equipment for each type of cut.

PART 2 MATERIALS

Not used.

PART 3 EXECUTION

3.1 SAFETY REGULATIONS

A. Comply with all applicable safety regulations including the requirements of "The Construction Safety Orders" of the State of California and OSHA.

B. Provide equipment in good and safe working order, adequate to perform the work.

C. Provide necessary scaffolding, lighting, access, debris removal equipment and devices, and appropriate safety measures.

3.2 CONCRETE CUTTING

A. Perform concrete cutting as shown on the drawings and as specified herein and in accordance with the approved submittals.

B. Openings shall be cut to the dimensions shown on the drawings and shall not be over-cut. In straight-cut openings, the face opposite the saw shall be chipped to achieve the opening dimension.

3.3 PATCHING

A. Where existing reinforcing bars are cut at new opening, burn back the reinforcing bars a minimum of 1-inch below adjacent concrete.

B. Patch the resulting void at existing reinforcing bars and the surface of chipped opening surfaces with an approved epoxy grout in accordance with Section 03100 - Concrete, to achieve a smooth, uniform surface.

C. Paint the patch exposed surfaces with System K - Epoxy Paint per Section 09900.

3.4 DISPOSAL

A. Remove cut material and dispose off-site in a safe and orderly manner. Do not allow debris to accumulate on the site exposed to view.

B. Inside structures, cuttings, chippings and patching grout droppings must be removed completely. No debris shall be washed into the plant's sediment drain system.

C. Upon completion of the work of this section, the surfaces of all structures shall be clean and free of cuttings, slurry and debris.

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SECTION 03906

CONCRETE REHABILITATION AND EPOXY POLYMER LINING SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. An approved applicator (Applicator) shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a concrete rehabilitation and protective lining system for the City.

2. The extent of the protective lining and concrete rehabilitation shall be all interior surfaces of the Headworks, including walls, floors, and ceilings. See contract drawings for dimensions of interior surfaces.

3. The protective lining system components for the concrete corrosion rehabilitation work shall include:

   a. Surface treatment prior to coating application

   b. Structural reinforcement (rebar) coating

   c. Cementitous resurfacing/underlayment compounds

   d. Epoxy formulation filler compound

   e. Corrosion-resistant, moisture tolerant, epoxy monolithic protective lining

   f. Miscellaneous materials

   g. Dewatering, environmental modifying heaters and/or fans, as necessary to install materials specified herein.

B. General: Specification is written around single manufacturer responsibility (Sauereisen) for entire rehabilitation and lining system components. If submitting on equivalent products, provide written evidence from the manufactures that verify compatibility and performance guarantee statements required, in accordance with this specification, for mixing multiple manufactures components. Owner reserves the right to deny approval of any materials that do not comply with the Specifications.

C. Coordination:

1. Coordinate surface preparation of substrates to avoid later difficulty or delay in performing the Work of this Section.

2. Review Specification Section 01020 for bypass pumping and drawings for equipment, miscellaneous metals, and piping appurtenances that must be removed or protected prior to restoration work begins and coordinate the installation of items that must be installed prior to application of the protective lining system.

3. Remove all chemicals, films, loose or deteriorated concrete, laitance, compounds and other materials from substrates to receive the Work of this Section.

4. All substrate surface preparation and lining application is to be completed by manufacturer's approved Applicator.

1.2 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Engage a single surface preparation and coating installation applicator specialist (Applicator) with specific experience in the application of the type of protective lining system specified, and who is approved by the protective lining manufacturer and agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit manufacturer certification to Engineer for approval.

2. The Applicator shall be trained and approved by the protective lining materials manufacturer. Provide written documentation from the materials supplier that the applicator is trained and approved to apply all products used to complete the Work prior to commencement of any site Work.

3. The Applicator shall have performed at least three (3) wastewater treatment plant projects with coating and concrete rehabilitation systems of similar or greater complexity in the last five (5) years of similar size that demonstrate the Applicator's experience and qualification to construct this project; of which, the Applicator must demonstrate the successful completion of at least two (2) wastewater projects each with a dollar value of at least 65% of the value bid for this project. Submit contact reference information and dollar value of projects completed.

B. Performance Criteria: The surfaces to receive the protective lining system shall be capable of withstanding, under constant exposure, raw wastewater and withstand attack from hydrogen sulfide, abrasive particles, and organic acids generated by microbial sources, with no adverse effects. Products capable of only intermittent exposure resistance are not acceptable.

C. Source Quality Control: Provide each component of protective lining system produced by a single manufacturer, including recommended underlayment, fillers, repair products, base coat, and top coat materials and ensure compatibility between all elements. If submitting

multiple manufacturers, provide verification from each manufacturer that all products are compatible and that mixing manufacturers will not void warranties.

D. Statement of Application: Upon completion of the Work under this Section submit a statement to Engineer, signed by the protective lining system Applicator stating that the installed protective lining system complies with the requirements of the Specifications, and that the installation and materials comply with the manufacturer's printed recommendations related to the condition of installation and use.

E. Manufacturer:

1. Single source protective lining system components specified are as manufactured by Sauereisen, Pittsburgh, PA (412) 963-0303. Request for material substitutions to the specified products shall be made in writing to the Engineer.

2. Alternative source for lining system components are Raven Lining Systems and Sika Corporation, with compatibility and performance guarantee statements required, in accordance with this specification, for mixing multiple manufactures components.

3. The naming of a manufacturer in this specification is not an indication that the manufacturer’s standard system is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:

1. Protective lining manufacturer’s standard size finished sample of protective lining system on ¼-inch board showing the installed lining system to be expected in the finished Work. Show the full thickness, or a typical thickness when underlayment requirements will vary, of system with all components in place. The protective epoxy lining must be at full thickness. Sample submittals shall be reviewed for color, texture, and pattern only. Compliance with all other requirements is the exclusive responsibility of Applicator.

B. Shop Drawings: Submit for approval the following:

1. Copies of manufacturer's technical data sheets complete with installation instructions for protective lining system required.

2. Maintenance Manual: Copies of manufacturer's written instructions for recommended maintenance practices. Include the following information:

a. Product name and number.

b. Name, address and telephone number of manufacturer and local distributor or representative.

c. Detailed procedures for routine maintenance and cleaning.

d. Detailed procedures for repairs.

3. Test Reports: Verification from protective lining system manufacturer that all testing for physical properties has been performed in strict accordance with referenced ASTM standards. Submit spark and adhesion testing data to Engineer for approval.

C. Certificates:

1. Submit manufacturer's certifications that materials have been approved for the installation in a municipal wastewater treatment plant, in the wetwell and inlet channel of a pump station with the following known conditions:

a. Pump station has continued exposure to high levels of sulfur/H_2S gas, abrasive materials, organic acids, and liquids pH range of 6.0-9.0

b. Pump station does not have exterior waterproof coating

c. Pump station is sitting in high groundwater that is above the structures bottom elevation

d. Coating is moisture tolerant and can withstand groundwater intrusion

2. Submit manufacturer’s Materials Warranty certificate.

3. Submit certificate of Applicator’s training and manufacturer’s approval to apply all materials.

D. Applicator’s successful project completion reference list.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver material in manufacturer's original unopened and undamaged packages.

2. Clearly identify manufacturer, brand name, contents and stock number on each package.

3. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage of Materials

1. Store in original packaging under protective cover and protect from damage.

2. Store all materials at temperatures recommended by manufacturer.

3. Stack containers in accordance with manufacturer's recommendations.

C. Handling of Materials: Handle materials in such a manner as to prevent damage to products or finishes.

1.5 JOB CONDITIONS

A. Environmental Requirements: Maintain substrate temperature and air temperature before, during and after installation in accordance with protective lining manufacturer's written recommendations and instructions. If dewatering, heating, cooling, humidity control, or any other environmental modification is required for proper installation (according to manufacturer's literature), provide submittal on approach.

B. Provide adequate ventilation during application and curing periods.

1.6 WARRANTY

A. Protective Lining manufacturer shall warranty its products as free from material defects for a minimum period of three (3) year. Provide associated Warranty Certificate.

B. Applicator shall warranty the installed protective lining system as free from material and workmanship defects for a minimum period of three (3) year.

PART 2 MATERIALS

2.1 MATERIALS

A. The protective lining system shall be a multi-component protective lining system, including:

1. Concrete reinforcing steel bars (rebar) coating / primer shall be placed on all exposed rebar. Assume 700-lf of exposed bars, at no additional cost to the Owner.
2. Cementitous resurfacing/ underlayment compound that shall be placed all interior surfaces. Assume application depth is 3" across entire structure, at no additional cost to Owner.
3. Epoxy filler compound to fill all voids and bug holes in the concrete to provide a properly prepared and uniform surface for the epoxy lining.
4. 100% solids epoxy, moisture tolerant, polymer lining designed specifically for municipal wastewater exposure, at a thickness of 125 mils.
5. The applicator shall supply all accessory components such as sealers, infiltration control products or other compounds or products as recommended by the protective lining manufacturer for maximum protective lining adherence to substrate and long-term service performance.

B. Products:

1. Reinforcing steel bars (rebar) coating / primer:

Properties	Sauereisen ConoWeld No. 501
Components	2 part
Application Time at 70°F	
Working Time	20 minutes
Initial Set	6 hours
Material	100% solids epoxy
Minimum Thickness	10 mils

Rebar primer shall be applied to all exposed rebar to seal surface, prevent reinforcing steel corrosion, and promote adhesion of the subsequent resurfacing layer.

Alternative manufacturer is Sika Amatec 110 EpoCem, with compatibility and performance guarantee statements for mixing multiple manufactures components.

2. Cementitous Resurfacer:

Properties	Sauereisen F-121 Substrate Resurfacer
Components	1 part
Application Time at 70°F	
Working Time	30-45 minutes
Initial Set	7 hours
Compressive Strength (ASTM C109)	
@ 24 hours	3,900 psi
@ 7 days	5,000 psi
@ 14 days	5,500 psi
@ 28 days	7,000 psi
Shear Bond Strength (ASTM C882-91)	
@ 7 days	2,200 psi
@ 28 days	2,540 psi
Flexural Strength (ASTM C580)	1,500 psi
Tensile Strength (ASTM C307)	550 psi
Density (ASTM C905)	137 pcf
Mix Ratio (powder to water, by weight)	6.25/L
Minimum Thickness	1/8”
Assumed Average Thickness (for bidding purposes)	3”

Underlayment shall be a high strength, fast setting cement resurfacing material. Mortar shall be trowel or pump applied. Existing structures which are being rehabilitated shall receive the resurfacing compound cement within the entirety of the interior surface at a minimum 1/8" thickness (and an average thickness assumed to be 3") to fill all irregularities to provide uniform surface for the application of the epoxy corrosion resistant lining system. Ensure amount of resurfacing compound does not extend beyond the limits of the original designed floor elevations (to ensure the existing pump and pipes fit without alteration to the discharge manifold).

Alternative manufacturer is Sika Repair 224 with compatibility and performance guarantee statements for mixing multiple manufactures components. Allow Sika Repair 224 to dry for a minimum of 7 days (at 70-degrees Fahrenheit and less than 50% relative humidity) prior to applying epoxy lining.

3. Epoxy Filler Compound:

Properties	Sewergard No. 109
Color	Off White
Compressive Strength	10,000 psi
Density (ASTM C905)	87.2 pcf
Flexural Strength (ASTM C580)	4,000 psi
Modulus of Elasticity (ASTM C580)	5.2×10^4 psi
Tensile Strength (ASTM C307)	2,200 psi
Bond Strength to Concrete (ASTM D4541)	Concrete Failure
Moisture Absorption (ASTM C413)	<0.25%
Shrinkage (ASTM C531)	<0.2%
Working Time	15 minutes @ 70°F
Topcoat	3 hours @ 70°F

Filler Compound shall be an epoxy formulation specifically designed to fill small voids, irregularities and air pockets in concrete surfaces, structures. The filler compound shall provide a uniform surface for the application of epoxy monolithic protective linings. The Filler Compound shall be confirmed by the manufacturer as compatible with the protective lining.

4. Epoxy Base Coat and Sealer Coat Lining:

Properties	Sewergard No. 210X
Adhesion (ASTM D4541)	Concrete Failure
Application Time (ASTM C308 modified)	
Working Time @ 70°F	30 minutes
Bond Strength to Concrete (ASTM D7234)	Concrete Failure
Bond Strength by Slant Shear (ASTM C882 modified)	700 psi (49.2 kg/cm2)
Compressive Strength (ASTM D695)	15,500 psi (1089.9 kg/cm2)
Components	2 parts
Elongation (ASTM D638)	12.9%
Flexural Strength (ASTM D790) @ 28 days	8,000 psi (562.4 kg/cm2)
Maximum Service Temperature (dry)	150°F (65°C)
Mix Ration (by volume)	1 part A-(Hardener):3 parts b (Resin)
Modulus of Elasticity (ASTM D790)	5.1 x 104 psi
Permeability (ASTM E96)	1.32 x 10-10
Shore D (ASTM D2240)	95
Tensile Strength @ 7 Days (ASTM D638)	4,300 psi (302.3 kg/cm2)
Minimum Thickness	125 mils

Protective epoxy lining is to be moisture tolerant and capable of withstanding groundwater intrusion, as exterior of structure does not have waterproof coating and the entire structure sits below the groundwater table.

Sewergard Epoxy 210X lining is to be applied in one to two coats for a total system thickness of 125 mils dft.

Alternative manufacturer is Raven Lining Solution 405, with compatibility and performance guarantee statements for mixing multiple manufactures components.

C. Product and Manufacturer: Provide one of the following:

1. Sauereisen, Pittsburgh, PA (412) 963-0303.
2. Or equal, in accordance with this specification.

PART 3 EXECUTION

3.1 INSPECTION

The Applicator shall examine the areas and conditions under which protective lining Work is to be performed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

A. Commencement of the Work of this Section shall indicate that the substrate and other conditions of installation are acceptable to the Applicator and the Engineer and shall produce a finished product meeting the requirements of the Specifications. All defects resulting from such accepted conditions shall be corrected by Applicator at his own expense.

B. Contractor shall remove all piping, equipment and appurtenances as required to properly conduct the Work. Any piping, flap gates, slide gates, guide rails, pipe supports, grating, electronic instrumentation, or other appurtenances Contractor is unable to remove shall be protected from surface preparation and coating activities. Any damage to existing piping, equipment and appurtenances shall be repaired or replaced with new at the discretion of the Engineer. See Drawings for Notes and piping, equipment and appurtenances inside wetwell and influent channel.

C. Contractor shall provide cranes or lifting devices as required to conduct the Work. Use of the City davit crane will not be allowed.

3.2 SURFACE PREPARATION

A. Prior to rehabilitation, remove all existing pipe supports, pump guide brackets, anchors, gate frames, hatches, grating and appurtenances mounted to the structure, as shown in the Pump Station Drawings.

B. Existing Concrete Application - Existing concrete structures to receive protective lining system must be capable of withstanding imposed loads. All oil, grease and chemical contaminants must be removed from the surface of the concrete. All loose or deteriorated concrete shall be removed by mechanical means. All surfaces must be firm, free of damaged or contaminated concrete, laitance, form release agents, and standing water and they must be structurally sound as determined by Engineer. Suitable surface preparation methods include shot blasting, abrasive Blasting, or hydro-blasting. Surface preparation procedures shall be in accordance with ICRI Guideline No. 03732. Surface preparation requirement is to expose aggregate and obtain a uniform surface texture resembling an ICRI CSP # 4-6 comparators.

C. Use the following procedures where reinforcing steel with active corrosion is encountered: Sandblast reinforcing steel to remove all contaminants and rust. Abrasive blast to SSPC-SP5, white metal. Remove contaminants, the substrate must be neutralized. Determine section loss, splice new reinforcing steel where there is more than 15 percent loss as directed by the Engineer. If more than half the diameter of the reinforcing steel is exposed, chip out behind the reinforcing steel a minimum of 1/2 inch. The distance chipped behind the reinforcing steel must also equal or exceed the minimum placement depth of the

accepted material. Coat rebar with primer and allow to cure for 6 hours prior to resurfacing system is installed.

D. Use the following procedures where reinforcing steel is encountered without active corrosion: Abrasive blast to SSPC-SP5, white metal. Remove contaminants, the substrate must be neutralized. If more than half the diameter of the reinforcing steel is exposed, chip out behind the reinforcing steel a minimum of 1/2 inch. The distance chipped behind the reinforcing steel must also equal or exceed the minimum placement depth of the accepted material. Coat rebar with primer and allow to cure for 6 hours prior to resurfacing system is installed.

E. Concrete surfaces that have been resurfaced must be allowed to cure in accordance with protective lining manufacturer's recommendations prior to application of protective epoxy lining system, for a minimum of 7 hours, at conditions environmental required by manufacturer. If alternative manufacturer is selected, provide a minimum of 7-days cure time, at conditions environmental required by manufacturer.

F. Level or grind concrete substrates to protective lining system manufacturer's recommended tolerances to produce a uniform surface profile, including removal of all sharp edges, ridges or depressions.

G. Stopping Active Leaks: After surface cleaning and preparation, any visible leaks shall be reported to the Engineer. Any minor leaks not requiring other repairs by the Engineer must be sealed using Sauereisen InstaPlug No. F-180, No. F-370 Chemical Grout or approved equal prior to proceeding with protective lining system installation.

H. New Concrete (*no new concrete is used on this project*):

1. Allow any new concrete is to cure for 28 days before protective lining system is installed, unless otherwise recommended by the Applicator or protective lining systems manufacturer.
2. New Concrete Application – All voids, holes and depressions shall be filled with epoxy based filler compound material (section 2.1.B.1), re-establishing plan finished grades and surface profiles.
3. Moisture Testing:
    a. Floors - New concrete should be installed over a moisture barrier to eliminate moisture transmission through the concrete floor. Prior to the application of materials, the moisture content must be determined using a suitable Moisture Detection System per ASTM F-1869 - "Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride." One such manufacturer is Sealflex Industries, 2925 College Ave. #B4, Costa Mesa, CA (714-708-0850). An average value exceeding 3.0 lbs/1000 ft^2/24-hr period is unacceptable and shall require additional cure time, the application of a surface penetrating vapor barrier or other corrective measures. Re-test after taking corrective measure to ensure an average value below 3.0 lbs.

    b. Moisture testing for walls and overheads - Test new concrete pours/block for moisture after completing surface preparation. Utilize ASTM D-4263 "Standard

Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method." Any indication of moisture shall require additional cure time, the application of a surface penetrating vapor barrier or other corrective measures. Re-test after taking corrective measure to ensure the absence of moisture.

c. Consult protective lining system manufacturer regarding all questions and/or recommendations in reference to moisture problems or questions.

d. Expansion and construction joints shall be formed and filled as recommended by the protective lining system manufacturer.

3.3 APPLICATION

A. Protective lining systems shall be installed when ambient air and surface temperatures are between 50º and 85ºF. Store lining materials within the 60º to 85ºF range for 48 hours prior to use. Application and storage temperatures outside of this range shall require written instruction from the protective lining manufacturer.

B. Application in direct sunlight and/or with rising surface temperatures is not recommended, as this may result in blistering of the materials due to expansion of entrapped air or moisture (out-gassing) in the concrete/concrete block substrates. In such cases, it shall be necessary to postpone the application until later in the day when the temperature of the substrate is falling. Concrete surfaces that have been in direct sunlight must be shaded for at least 24 hours prior to application and remain shaded until the initial set has taken place. Consult protective lining system manufacturer for application schedule guidelines specific to temperature conditions and possible sealer application recommendations to reduce out-gassing.

C. Resurfacing/Epoxy Filler Compound Application - Cementitous resurfacing and epoxy filler compounds shall be used in accordance with this specification and in accordance with protective lining manufacturer's recommendations to provide a uniform and crack, void and bug hole free surface for epoxy lining application.

D. Epoxy Base Coat and Sealer Coat Lining –Epoxy base coat and sealer coat lining shall be applied and cured on the properly prepared surface in accordance with protective lining system manufacturer's written guidelines as outlined in product technical data sheets.

1. Epoxy base coat shall be applied to a total minimum thickness of 125 mils. Application method and equipment shall be approved by the Engineer and shall be in accordance with the protective lining system manufacturer's recommendations.

E. High Voltage Spark Testing. Contractor shall provide high voltage spark testing. Installed protective epoxy lining shall be tested for pinholes after a minimum 24-hour cure at a temperature of 70°F. Pinhole testing shall be accomplished in accordance with ASTM D-4787, using a Tinker Razor Holiday Detector, San Gabriel, CA, Model AP/W, or an approved equal device. Test voltage of 100 volts/mil of coating thickness shall be applied.

All pinholes shall be marked and repaired using manufacturer's approved Patch Kit, or other approved method. Submit spark testing data to Engineer for approval.

F. Adhesion Testing – Contractor to perform adhesion testing. Adhesion testing shall be conducted after the lining system has cured in accordance with manufacturer specification. Adhesion testing shall be in accordance with ASTM D4541-Modified herein. Affix one 3/4 inch dolly (to the host structure) on every concrete slab, wall, and ceiling with a maximum spacing of 500-sf (one on the wetwell floor, one in the influent/overflow channel floor, one on each of the four wetwell walls, one on each of the four influent/overflow channel walls, and one in the wetwell ceiling). Prior to the pull test, the tester shall utilize a scoring device to cut around the dolly and cut through the lining until the original concrete is reached. Failure due to improper adhesion of the dolly shall require retesting. The pull test in each area is to be a minimum of 200psi. Pull tests of a minimum 150psi to 200psi may be acceptable if more than 50 percent of the substrate is adhered to the back of the dolly. A test result may be disregarded by the Engineer if there is a valid non-statistical reason as specified in section 8.4 and 8.5 of ASTM D4541. If the host structure fails the minimum requirement then the Engineer and lining manufacturer shall be consulted. All voids caused by the adhesion testing are to be prepared and repaired per lining manufacturer recommendations. Submit adhesion testing data to Engineer for approval.

3.4 ADJUSTMENTS AND CLEANING

A. At the completion of the Work, Applicator shall remove all materials and debris associated with the Work of this Section.

B. Clean all surfaces not designated to receive protective coating. Restore all other work in a manner acceptable to Engineer. Re-install all removed equipment, piping supports, gates, and appurtenances.

C. All finished protective lining Work shall be protected from damage until Final Acceptance of the Work. Protective lining damaged in any manner shall be repaired or replaced at the discretion of Engineer at no additional cost to Owner.

D. Clean all protective lining as recommended by the manufacturer to provide finished Work acceptable to Owner, just prior to Final Acceptance.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of providing miscellaneous metal work shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 05120 -Structural Steel

C. Section 05140 – Structural Aluminum

D. Section 09900 - Painting

1.3 GOVERNING COVER AND STANDARDS

A. 2019 California Building Code (CBC)

B. AA - The Aluminum Association “Specifications and Guidelines for Aluminum Structures”

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

B. Perform shop and/or field welding required in connection with the work of this section in strict accordance with pertinent recommendations of the American Welding Society.

1.5 SUBMITTALS

A. In accordance with Section 01300.

B. Product data to be submitted:

1. Materials list of items proposed to be provided under this Section;
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades;
4. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting actual installation procedures used on the work.

PART 2 MATERIALS

2.1 MATERIALS

A. In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, rolled trade names, and roughness.

B. Unless noted otherwise, comply with the following standards, as pertinent.

1. Steel plates, shapes, and bars: ASTM A36.
2. Rolled W and WT shapes: ASTM A992, Grade 50
3. Steel plates to be bent or cold-formed: ASTM A283, grade C.
4. Steel tubing (hot-formed, welded, or seamless): ASTM A501.
5. Steel bars and bar-size shapes: ASTM A306, grade 65, or ASTM A36.
6. Cold-finished steel bars: ASTM A108.
7. Cold-rolled carbon steel sheets: ASTM A336.
8. Galvanized carbon steel sheets: ASTM A526, with G90 zinc coating in accordance with ASTM A525.
9. Stainless steel bars, plates, structural shapes, ASTM A276, Type 304.
10. Stainless steel sheets: AISI type 302 or 304, 24 gauge, with Number 4 finish.

11. Aluminum plates, shapes, and bars, 6061-T6 or 6063-T6 alloy, mill finish unless otherwise specified.

12. Grey iron castings: ASTM A48, Class 40.

13. Malleable iron castings: ASTM A47.

14. Steel pipe: ASTM A120, schedule 40, black finish unless otherwise noted.

15. Concrete inserts:

    a. Threaded or wedge type galvanized ferrous castings of malleable iron complying with ASTM A27.

    b. Provide required bolts, shims, and washers, hot-dip galvanized in accordance with ASTM A153.

2.2 FABRICATION

A. Except as otherwise shown on the Drawings or the approved Shop Drawings, use materials of size, thickness, and type in accordance with this Section.

B. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.

C. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item.

D. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.

E. Properly mark and match-mark materials for field assembly and for identification as to location for which intended.

F. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

G. Where finishing is required, complete the assembly, including welding of units, before start of finishing operations.

H. Provide finish surfaces of members exposed in the final structure free from markings, burrs, and other defects.

2.3 CASTINGS

A. All castings shall be sound and free from shrinkage crack, blow holes, and other defects. All fins and burnt sand must be removed. Excessive porosity and spongy surfaces will constitute causes for rejection. The Engineer shall be final judge as to whether the defects present are sufficient to cause rejection.

B. No welding or patching of defects in castings will be permitted unless authorized by the Engineer. Any such welding or patching done without the Engineer's consent shall be cause for rejection.

C. All castings shall be true to form and dimensions shown on the Drawings. After inspection and prior to shipping, all machined surfaces shall be coated with a blue rust inhibitive lacquer, or other approved material which can be easily removed, unless otherwise specified.

D. The dimensions of the finished castings shall not be less than the specified dimensions. Castings shall not be more than seven and one-half (7-1/2) percent overweight. Large castings shall be suspended and hammered over their entire area. No cracks, flaws, or other defects shall appear after such hammering.

E. Castings shall be provided with adequate continuous fillets cast in place in all re-entrant angles. The radius of curvature of the exposed surface of a fillet shall define the size of the fillet. The size of fillets shall not be less than one-half (1/2) of the thickness of the thinnest adjoined member nor less than one-half (1/2) inch.

F. Iron castings shall be dipped or painted with asphalt which will form a tough, tenacious, non-scaling coating which does not have a tendency to become brittle when cold or sticky when hot.

G. The covers and seats shall be machined so that the cover sits evenly and firmly in the frame.

2.4 CONNECTIONS

A. Provide bolts and washers of types and sizes required for completion of field erection.

B. Welded Construction: Comply with AWS Code for procedures, appearance, and quality of welds, and methods used in correcting welded work.

C. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

2.5 FASTENERS

A. General:

1. For exterior use and where built into exterior walls, provide zinc-coated fasteners, for damp locations provide stainless steel fasteners.

2. Provide fasteners of type, grade, and class required for the particular use.

B. Comply with the following standards as pertinent:

1. Bolts and Nuts: Provide hexagon-head regular type complying with ASTM A307, Grade A (Steel); ASTM A320 and A194, Grade B8 (Stainless Steel).

2. Lag bolts: Provide square-head type complying with Fed. Spec. FF-B-561.

3. Machine Screws: Provide cadmium plated steel type complying with Fed. Spec. FF-S-111; except use stainless steel for damp locations or with aluminum.

4. Washers:

a. Plain washers: Comply with Fed Spec FF-W-92, round, carbon steel.

b. Lock washers: Comply with Fed. Spec FF-W-84, helical spring type carbon steel.

5. Toggle bolts: Provide type, class, and style needed but complying with Fed. Spec. FF-B-588.

6. Anchorage devices: Provide expansion shield complying with Fed Spec FF-S-325.

2.6 HOLES FOR OTHER WORK

A. Provide holes required for securing other work to metalwork and for passage of other work as shown on the approved Shop Drawings.

B. Provide threaded nuts welded to framing and other specialty items as shown, to receive other work.

C. Cut, drill, or punch holes perpendicular to metal surfaces.

D. Do not flame cut holes or enlarge holes by burning.

E. Drill holes in bearing plates.

2.7 OTHER MATERIALS

Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

2.8 GALVANIZING

A. Shall be double hot-dip processed after fabrication, ASTM A123, A153, A386, and A525. Double dip shall be required, if necessary, to achieve required coating weight.

B. For repair of galvanizing, use galvaloy stick applied as recommended by the manufacturer.

2.9 SHOP PRIMING and FINISHES

A. General:

1. Shop prime un-galvanized steel work, except those members or portions of members to be embedded in concrete or mortar.

2. Paint embedded steel which is partially exposed on the exposed portions, and the initial 2" of embedded areas only.

B. Surface Preparation:

1. After inspection and before shipping, clean steelwork to be painted.

2. Remove loose rust, loose mill scale, and spatter, slag, and flux deposits.

3. Prepare steel in accordance Section 09900. If not specified, prepare steel in accordance with Steel Structures Painting Council SP-3, "Power Tool Cleaning."

C. Primer Painting:

1. Immediately after surface preparation, apply structural steel primer paint in accordance with Section 09900 and the manufacturer's recommendations and at a rate to provide a uniform dry film thickness.

2. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.

3. The Contractor shall be responsible for providing the required coating system per Section 09900. The Contractor shall remove shop coatings not in conformance with Section 09900. Additionally, the Contractor shall prepare any shop applied coating, which, while meeting the requirements of Section 09900, requires additional surface preparation in order to obtain a mechanical bond between coatings.

D. All stainless-steel parts, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and

uniform corrosion protection. All field welds shall be cleaned and passivated to remove iron (and prevent corrosion) in accordance with ASTM A380.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 COORDINATION

Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

3.3 INSTALLATION

A. General:

1. Set work accurately into position, plumb, level, true, and free from rack.
2. Anchor firmly into position.
3. Where field welding is required, comply with AWS recommended procedures of manual-shielded metal-arc-welding for appearance and quality of weld and for methods to be used in correcting welding work.
4. Grind exposed welds smooth, and touch-up shop prime coats.
5. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for bolted or screwed field connections.
6. Dissimilar Materials: Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint conforming to MIL-C-18480 or to TT-V-51 or a coat of zinc chromate primer conforming to TT-P-645 to prevent galvanic or corrosive action.
7. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. All bolts, anchors, supports, braces, connection and other items necessary for completion of the miscellaneous metalwork shall be provided.

B. Immediately after erection, clean the field welds, bolted connections, and abraded areas of shop priming. Paint the exposed areas with same material used for shop priming.

END OF SECTION

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SECTION 05530

GRATINGS, STAIR TREADS, AND FLOOR PLATES

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of furnishing and installing gratings, stair treads and floor plates.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 03100 - Concrete

C. Section 05120 - Structural Steel

D. Section 05500 - Metal Fabrications

1.3 QUALITY ASSURANCE

Standards:

A. AA - Aluminum Association

B. AISC - American Institute of Steel Construction

C. ASTM - American Society for Testing and Materials

D. AWS - American Welding Society

E. NAAMM - National Association of Architectural Metal Manufacturers

1.4 SUBMITTALS

A. In accordance with Section 01300.

B. Submit shop drawings prior to fabrication. Include information necessary for fabrication and erection of component parts and arrangement of gratings, frames, stair treads and floor plates. Indicate size and weight of members, type and location of shop and field connections, type, size and extent of all welds and welding sequence. Use AWS welding symbols. Approval of shop drawings will be for size and arrangement of principal and auxiliary members and strength of connections. Any errors in dimensions and quantities shown will be the responsibility of the Contractor.

C. Certificate: Furnish manufacturer's certificate that grating materials meet or exceed the requirements of this specification.

1.5 HANDLING AND STORING MATERIALS

Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. To avoid delays, deliver timely all loose items to be built into the concrete.

PART 2 MATERIALS

2.1 ALUMINUM GRATING

A. Open Mesh Grating (Type A)

1. Swage locked rectangular design (spaced approximately 1-3/16 x 4-inches on center).

2. Main bars to be 3/16-inches thick, depth as indicated in the Schedule in Part 3.02A1 of these Specifications or as indicated on the Drawings. Cross bars shall be secured to the main bars by a swaging process to prevent turning, twisting or coming loose.

3. Banding strips of the same thickness and ¼ -inch less depth as main bars shall be welded to each main bar at ends of grating sections and at openings.

4. Grating shall be IKG Borden swaged lock type "BS", 31266 Avenue 12, Madera, CA 93639; Seidelhuber No. 19S4, or equal.

B. Unpunched Plank (Type B)

1. Anti-skid surface, continuous raised longitudinal ridges.

2. Integral I-beam ribs with welded banding strips at ends of grating sections and at openings.

3. Each panel shall be provided with a recessed handle for removal.

4. For grating size, see Schedule in Part 3.02A2 of these Specifications, or as indicated on the Drawings.

5. As manufactured by IKG Borden; Seidelhuber, or equal.

2.2 GALVANIZED STEEL (OPEN MESH) GRATING (TYPE C)

A. Weldforged rectangular design (spaced approximately 1-3/16 x 4-inches on center).

B. Main bars to be 3/16-inches thick, depth as indicated in the Schedule in Part 3.02A3 of these Specifications, or as indicated on the Drawings. Cross bars to be twisted square steel and resistance welded at right angles to the main bars. No notching or cutting of bearing bars before welding is permissible.

C. Banding strips of the same depth and thickness as main bars shall be welded to each main bar at ends of grating sections and at openings.

D. Grating shall be IKG Borden, weldforged type "WB", 31266 Avenue 12, Madera, CA 94623; Seidelhuber No. 19W4, or equal.

2.3 STAINLESS STEEL (OPEN MESH) GRATING (TYPE E)

A. Weld forged rectangular design (spaced approximately 1-3/16 x 4-inches on center).

B. Main bars to be 3/16-inches thick, depth as indicated in the schedule in Part 3.02.A.3 of these specifications or as indicated on the Drawings.

C. Banding strips of the same depth and thickness as main bars shall be welded to each main bar at ends of grating sections and at openings.

D. Grating shall be 1KG Borden, weld forged type stainless type 316 “WB”, 31266 Avenue 12, Madera, CA 94623 or equal.

E. Furnish with a clean welded stainless appearance by electropolish, chemical cleaning or beadblast the finished product as needed.

2.4 GRATING FRAMES

Type 304 Stainless Steel or Fiberglass in areas exposed to chemicals and corrosive materials.

A. Embedded by welding continuous vertical bar same height as grating, to edge of 2-inch horizontal leg of 2-inch x 1½-inch structural angle, thereby providing 1-5/8-inch wide bearing area. Thickness of frame shall be ¼ -inch minimum. Provide welded-on anchors at 18-inch centers, minimum two per side, as detailed on the Drawings. 1½ -inch vertical leg

of frame below grating shall have a 5/16-inch diameter hole 24-inches on center for temporary nailing to formwork.

B. Surface Mounted Frame shall be a 2½ x 2 x ¼ -inch structural angle. Frame shall be attached as shown on the Drawings with a 5/8-inch diameter Type 304 stainless steel bolts at 15-inch centers maximum, minimum two per side.

2.5 STAIR TREADS

A. Aluminum construction, 0.065-inch thick "I-bar" webs with ¼-inch wide grooved top and bottom flanges. Cross bars shall be secured to main bars by a swaging process to prevent turning, twisting, or coming loose. Main bearing bar size shall be 1½ x 3/16-inch "I-bar" for tread lengths up to 42-inches.

B. Nosing shall be extruded corrugated aluminum, 1¼-inches wide.

C. Carrier bar shall be 3 x 3/16-inch aluminum full width of tread with one round and one slotted 7/16 -inch opening for bolts. Bolts shall be 3/8-inch diameter, galvanized steel for dry locations, stainless steel for moist locations.

D. Irving Borden type "IB" Bar, Seidelhuber type 19SI4, or equal.

2.6 SAFETY NOSING FOR CONCRETE STAIRS

A. Cast aluminum with cross-hatched and non-slip abrasive surfaces, or IKG Borden MEBAC aluminum nosings.

B. Cast aluminum exposed wearing surface to contain not less than 2 oz. per square foot of abrasive granules embedded in the top metal surface not less than 1/16" while the matrix is in a molten state. Size of non-slip granules shall range from No. 16 to No. 24.

C. Nosing shall be 4-inches wide and 5/16-inches thick minimum, with ¼-inch diameter by 1-inch long cast-on bolt anchors. Length shall be as required to terminate not more than 4-inches from each end of treads and as indicated for platforms and landings. Nosing shall be flush with the top of the traffic surfaces.

D. IKG Borden MEBAC aluminum type C-4E; American Abrasive Metals Co. "Alumalun" Style A; Wooster Products Inc. "Alumogrit" Type 101, or equal.

2.7 CHECKER PLATES

A. Aluminum diamond tread, 6061-T4 or T6 alloy. Raised pattern on one-inch centers.

B. Galvanized steel angle frame as detailed on Drawings.

C. Checker plates as manufactured by Ryerson, Emeryville, CA 94608; Aluminum Co. of America, Pittsburgh, PA 15219, or equal.

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

Before fabrication or installation, verify all dimensions of areas, spaces, spans and configurations. Provide openings for passage of pipes or other penetrations.

3.2 GRATING INSTALLATION

A. Grating sizing (Unless otherwise called out on the drawings)

1. Open Mesh Aluminum Grating (Type A)

Span	Bearing Bar Size	Wt. Lbs. Sq. Ft.
2'-6" and less	1" x 3/16"	2.6
3'-0" to 3'-6"	1¼" x 3/16"	3.2
Over 3'-6" to 4'-0"	1½" x 3/16"	3.9
Over 4'-0" to 4'-6"	1¾" x 3/16"	4.5
Over 4'-6" to 5'-0"	2" x 3/16"	5.1

2. Unpunched Aluminum Plank (Type B)

Span	Bearing Bar Size	Wt. Lbs. Sq. Ft.
2'-6" and less	1"	2.65
3'-0" to 3'-6"	1¼"	3.25
Over 3'-6" to 4'-0"	1½"	3.95
Over 4'-0 to 4'-6"	1¾"	4.55
Over 4'-6" to 5'-0"	2"	5.55
Over 5'-0" to 5'-6"	2¼"	6.25

3. Open Mesh Galvanized Steel Grating (Type C)

Span	Bearing Bar Size	Wt. Lbs. Sq. Ft.
2'-6" and less	¾" x 3/16"	5.8
3'-0" to 3'-6"	1" x 3/16"	7.5
Over 3'-6" to 4'-6"	1¼" x 3/16"	9.1

Over 4'-6" to 5'-6"	1½" x 3/16"	10.8
Over 5'-6" to 6'-0"	1¾" x 3/16"	12.5

B. Grating Sections:

1. Overall physical size of grating sections may be shown or indicated on Drawings where ease of removing an individual section has been considered. Otherwise, if not indicated on Drawings specifically, size of sections shall be such that no panel weighs more than 60 pounds.

2. Provide ¼-inch space between grating sections and frame and adjacent grating sections. Edge of grating at openings shall be banded with same size bar as bearing bar.

C. Grating Fasteners:

1. Open mesh grating.

   a. Secure each grating section to frame with stainless steel saddle clips and stainless steel self-drilling fasteners; at least four per grating section. Saddle clips shall be placed over two main bearing bars.

   b. Use galvanized saddle clips for galvanized steel grating, aluminum saddle clips for aluminum grating, Type 316 stainless steel saddle clips for stainless and fiberglass grating.

2. Plank grating.

   a. As detailed on Drawings or as recommended by Manufacturer.

D. Grating Frames and Supports

1. All gratings shall be set into angle frames set and anchored into the concrete, supported by surface mounted frames, or as detailed on the Drawings.

2. The top surfaces of all bars and panels of gratings shall be flush with the adjacent surfacings, around perimeter of grating sections and at openings.

3. Provide supports for gratings at openings as detailed on the Drawings. If detailing on the drawings is not shown contractor shall design and provide support beams for gratings at openings as needed at no cost to the Owner. If additional support beams are needed due to geometrical constraints, they are designed and provided at no cost to the Owner.

4. Use galvanized steel frames for steel gratings, aluminum frames for aluminum gratings, type 304 stainless steel frames for fiberglass gratings and Type 304 stainless steel frame for stainless steel gratings.

3.3 WORKMANSHIP

A. All fabrication shall be done to the dimensions shown or as approved. All items shall be free from any defects which mar appearance or impair strength.

B. All panels shall be absolutely flat and true to provide even, uniform, non-rattling bearing on the supports. Supports for all grating shall be provided as shown on the Drawings.

END OF SECTION

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SECTION 05570

METAL SUPPORT FRAMING

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of furnishing and installing metal support framing for piping and other equipment as shown on the drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 01610 - Seismic Design Criteria

C. Section 01615 - Wind Design Criteria

D. Section 05500 - Metal Fabrications

E. Section 15094 - Hangers and Supports

F. Division 16 - Electrical

1.3 QUALITY ASSURANCE

Standards

A. AA - Aluminum Association

B. AISC - American Institute of Steel Construction

C. ASTM - American Society for Testing and Materials

D. AWS - American Welding Society

1.4 SUBMITTALS

A. In accordance with Section 01300.

B. Provide structural calculation stamped and signed by a Structural or Civil engineer registered in the state of California for the metal support framing system. See specs 01610 and 01615 for additional information.

C. Submit shop drawings prior to fabrication. Include information necessary for fabrication and erection of component parts and arrangement of frames. Indicate size and weight of members; type and location of shop connections. Approval of shop drawings will be for size and arrangement of principal and auxiliary members and strength of members. Any errors in dimensions and quantities shown will be the responsibility of the Contractor.

D. Certificate: Furnish manufacturer's certificate that framing materials meet or exceed the requirements of this specification.

1.5 HANDLING AND STORAGE OF MATERIALS

Materials to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. To avoid delays, deliver all loose items to be built into the concrete in a timely fashion.

PART 2 MATERIALS

2.1 GENERAL

A. All parts shall be manufactured by Unistrut Corporation, Wayne, Michigan; B-Line Systems, Inc., Highland, Illinois, or equal.

B. All parts of the system shall be of one manufacturer. Parts shall be stamped with manufacturer's part number for identification.

C. The load capacities of parts, connections and assemblies shall meet or exceed those published in the latest framing manufacturer's engineering catalog and supplementary bulletins.

D. Dimensions, tolerances and physical design shall be so that the parts within the system will be interchangeable and conform to the designs set forth in the latest framing manufacturer's engineering catalog and supplementary bulletins.

E. Channels, continuous concrete inserts, and closure strips shall be 12-gauge, cold-formed from mild steel conforming to ASTM A1011, Grade C specifications.

F. Fittings shall be press formed from hot rolled, pickled and oiled steel plate conforming to ASTM A575 or steel strip conforming to ASTM A1011 Grade C specifications.

G. Gripping nuts shall be stainless steel spring mounted with serrated nuts.

H. Screws and bolts shall be stainless steel. All threads shall be Unified National Coarse, Class A.

I. Unless noted otherwise, framing channels shall be galvanized.

J. Use stainless steel or fiberglass materials in wet or corrosive areas, or as shown on the drawings.

PART 3 EXECUTION

3.1 GENERAL

See Contract Drawings for configuration and member model numbers (if shown). Supply all components to result in a complete system, whether shown, specified or not. The minimum design basis shall be Unistrut model P1000, or equal.

3.2 FIELD MEASUREMENTS

Before installation, verify all dimensions of areas, spaces, spans and configurations.

3.3 INSTALLATION

A. All frameworks and assemblies of the system shall be true, plumb, square and level and accurately located according to the Contract and Shop Drawings.

B. Cut ends of fiberglass channels shall be sealed per manufacturer's recommendations.

C. All installations shall be coordinated with other trades as required.

D. All bolted connections shall be tightened to the following torque values.

1. ¼-inch bolts 4 foot-pounds torque
2. 3/8-inch bolts 30 foot-pounds torque
3. ½-inch bolts 50 foot-pounds torque

3.4 WORKMANSHIP

All fabrication shall be done to the dimensions shown or as approved. All items shall be free from any defects which mar appearance or impair strength.

END OF SECTION

SECTION 07110

WATERPROOFING

PART 1 GENERAL

1.1 DESCRIPTION

The work of this Section consists of furnishing and installing below grade waterproofing required for this work as indicated on the Drawings or specified herein and includes, but is not necessarily limited to, below grade waterproofing.

1.2 RELATED WORK DESCRIBED ELSEWHERE

A. Section 01300: Submittals

B. Section 02225: Structure Excavation and Backfill

C. Section 09900: Painting

1.3 QUALITY ASSURANCE

A. Qualifications of Installers: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly experienced in the application of the specified products and shall direct all work performed under this Section.

B. Manufacturer's Certification: Prior to start of installation of the work of this Section, secure a visit to the job site by a representative of the manufacturer of the waterproofing materials used, who shall inspect and shall certify that the surfaces to which waterproofing is to be applied are in a condition suitable for that application.

1.4 SUBMITTALS

Materials List: Before any waterproofing materials are delivered to the job site, submit a complete list of all materials proposed to be furnished and installed under this portion of the work, making the submittal in accordance with the provisions of Section 01300 of these Specifications.

1.5 PRODUCT HANDLING, STORAGE, AND DELIVERY

A. Use all means necessary to protect waterproofing materials before, during, and after installation and to protect the installed work and materials of all other trades.

B. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Owner.

C. Deliver materials in manufacturer's original, unopened containers and rolls with labels intact and legible.

D. Deliver materials in sufficient quantity to allow continuity of work.

E. Handle rolled goods so as to prevent damage to edge of ends.

F. Select and operate material handling equipment so as not to damage existing construction.

G. Store materials on clean raised platforms with weather protective covering when stored outdoors.

H. Provide continuous protection of materials against wetting and moisture absorption.

I. Protect materials against damage by construction traffic.

J. Remove wet materials for project site.

K. Comply with fire and safety regulations.

L. Store emulsions in temperature above 45°F.

PART 2 MATERIALS

2.1 WATERPROOFING

A. General: All waterproofing shall be the specified products of the W. R. Meadows Co., MEL-ROL LM, Karnak Corp., or equal.

B. Below Grade Waterproofing: All below grade waterproofing shall be non-solvent type waterproofing, or equal, applied to at least 60-mil thickness (2 coats of 30 mils each, DFT).

C. Primer: Per manufacturer's requirements.

2.2 PROTECTION

Protect all waterproofing, horizontal and vertical, with 8-mil thickness double wrapped polyethylene encasement. The thickness shall not be less than 10 percent of the nominal thickness and shall be in sheet form. Use 10 mil vinyl tape to secure and seal the polyethylene sheet.

2.3 OTHER MATERIALS

All other materials, not specifically described but required for a complete and proper installation of waterproofing, shall be as recommended by the material supplier.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that waterproofing may be installed in strict accordance with the original design and the manufacturer's recommendations.

B. Discrepancies

1. In the event of discrepancy, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 INSTALLATION

A. Waterproof coating shall be applied below grade on outside of concrete structures listed in Section 09900 Finish Schedule and below.

B. Waterproof coating shall also be applied to the following:

1. Below grade unit masonry surfaces.
2. Backfilled side of retaining walls and planters, which occur above adjacent grade.
3. Backside of metal flashings.

C. Surface Preparation: Examine surfaces for foreign material, moisture, and unevenness, which would prevent the execution and quality of application of system as specified. Remove any paraffin or wax base non-bonding compounds. Fill all cracks, voids, joints, depressions and places around projections with cement grout to provide smooth and flush surface. Proceed with waterproofing application only after surface defects are corrected. Application of material will be considered as evidence of installer's acceptance of substrate as a proper base for waterproofing.

D. Application: Install materials in accordance with requirements of waterproofing system manufacturer. Maintain neat line at upper edge. Mask as required to prevent overrun of materials onto surfaces. Install the required protective covering over the waterproofing to prevent damage during backfill operation.

3.3 COORDINATION WITH SEALANTS

A. Where feasible, delay application of waterproof coatings until installation of sealants has been completed in joints adjoining surfaces to be coated.

B. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of waterproof coatings. Cover adjoining and nearby surfaces of aluminum and glass where there is possibility of waterproof coatings being deposited on surfaces. Cover live plant materials with drop cloths. Clean waterproof coatings from adjoining surfaces immediately after spillage. Comply with manufacturer's recommendations for cleaning.

3.4 CODES, ORDINANCES AND LAWS COMPLIANCE

In addition to the specific requirements described herein, the total scope of work required by this section includes all means, methods, labor and material required to conform to all applicable Federal, State and local codes, ordinances, laws and any other requirements applicable to the construction process, materials and the finished, completed work.

3.5 PROTECTION OF SYSTEM

Score the fiber board to mold around the round surface of the structure so that all voids are eliminated. Tape the joints with duct tape to prevent the entrance of stones and dirt during backfill operations.

END OF SECTION

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SECTION 08310

ACCESS HATCHES

PART 1 GENERAL

1.1 SUMMARY

Section includes furnishing and installing access hatches.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

1.3 SUBMITTALS

A. Product Data

B. Shop Drawings:

1. Show profiles, accessories, and dimensions.
2. Show locations of access doors.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area. Do not dump onto ground.

E. Protect access doors during shipment and storage to prevent warping, bending, and corrosion.

1.5 QUALITY ASSURANCE

A. All hatches located over submersible pumps with guide rails shall be supplied by the same manufacturer as the submersible pump for coordination.

B. All hatches not located over a submersible pump shall be supplied by the same manufacturer and as specified herein.

PART 2 MATERIALS

2.1 FLOOR ACCESS HATCH (H-20 Loading)

A. Manufacturers:

1. One of the following or equal:

a. The Bilco Co., Type JD-AL-H20 or JAL-H20.

b. Babcock-Davis Associates, Inc.

c. US Foundry

d. Syracuse Castings

e. Halliday Products

B. Style: Single or double leaf, 316SST, capable of withstanding H20 loading, channel frame, with drainage couplings. Hatches with openings greater than 36-inches in the long dimension shall be double leaf type.

C. Door Leaf: Minimum ¼ -inch 316SST diamond pattern plate.

D. Frame: ¼ -inch extended 316SST channel with bend down anchor tabs around perimeter. A continuous EPDM gasket shall be mechanically attached to the frame.

E. Hardware:

1. Hinges: Equipped with 316SST hinges with 1/4-inch diameter stainless steel pins.

2. Lock: Snap lock with removable handle mounted on door leaf.

3. Grip Handle: Provide vinyl grip handle designed to release cover for closing.

4. Operating Mechanism: Compression spring tubes designed for ease of operation and automatic hold-open arm with release handle.

5. Provide 1 ½ -inch drainage coupling located in front right corner of channel frame where drainage is not allowed within structure as scheduled.

6. Provide fall protection as scheduled.

F. Minimum access hatch size and style are shown on the drawings (nominal clear opening shown, provide additional length/width as necessary to form a complete frame).

2.2 FALL PROTECTION

A. Saf-T-Grate (install grating style fall protection on all access hatches, unless shown otherwise):

1. Grating panel(s) shall be fiberglass, molded in one piece, with load bearing bars in both directions to allow for use without continuous side support.
2. Panel shall be designed to support a 300 PSF (1464 kg/m2) live load and be high visibility safety yellow in color.
3. Torsion rod lift assistance shall be provided for ease of operation and a hold open arm shall be included to automatically lock the panel in the fully open 90 degree position.
4. A release handle shall be provided to close the grating panel and there shall be a provision to lock the panel to prevent unauthorized access.
5. Hold open arm shall be 316SST with a stainless steel release handle.
6. All other hardware, including mounting brackets, hinges, torsion rod, padlock loop, and fasteners, shall be type 316 stainless steel.
7. Manufacturer shall provide a twenty-five year warranty against defects in material and workmanship.

2.3 WARRANTY

Hatch manufacturer shall provide 25-year warranty against defects in materials and workmanship.

2.4 FINISHES

Floor Access Door Types:

A. 316SST: pickle/passivate after fabrication.

B. All hardware shall be 316 stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

Examine construction to receive access door and verify correctness of dimensions and other supporting or adjoining conditions.

3.2 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring access doors.

B. Verify dimensions, profiles, and fire-resistive rating for each opening.

Verify that location will serve portion of work to which access is required. Where proposed functional location conflicts with other work, notify the Engineer before installation.

3.3 INSTALLATION

A. Install access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

3.4 ADJUSTING

Adjust doors, frames, and hardware to operate smoothly, freely, and properly, without binding.

3.5 CLEANING

Thoroughly clean surfaces of grease, oil, or other impurities, touch-up abraded prime coat.

3.6 HATCH SCHEDULE

Location	Loading	Material	Comments
Headworks	H20	Aluminum	(a) (b) (c)

(a) Fall Protection: Saf-T-Grate Style.

(b) Provide drainage collection coupling.

(c) Re-use existing frame, all else new.

END OF SECTION

SECTION 09900

PAINTING AND FINISH SCHEDULE

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of furnishing and applying paint for architectural, structural, mechanical and miscellaneous work.

The work comprises the painting of all exposed surfaces of concrete, sheet metal, iron and steel, process equipment, electrical equipment, process piping ducts and other miscellaneous items.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 02601: Manholes and Cleanouts

C. Section 05500: Metal Fabrication

D. Section 07110: Waterproofing

E. Section 10400: Identifying Devices

1.3 SUBMITTALS

A materials list and samples shall be submitted as required by Section 01300 and as follows:

A. Materials list naming each product to be used identified by manufacturer and type number.

B. Volatile organic compound (VOC) level (gm/l) and manufacturer's certification of compliance with applicable air quality limits for each coating.

C. Manufacturer's application recommendations for each product submitted.

D. The Contractor shall submit a current chart of the Manufacturer's available colors for selection by the Engineer, forty five (45) days prior to the start of coating and painting.

Samples, when reviewed and accepted by the Engineer, shall establish the quality of the painted surface where these applications are indicated.

E. The owner shall select colors from the submittal information presented. Mechanical and piping systems may include multiple color selections in order to properly identify process facilities. The owner may choose up to two (2) colors for the exterior (field and trim) and two (2) colors for the interior (field and trim) at the Boiler Building. Submittals for architectural finishes at the Boiler Building shall be coordinated with the Submittals for the Metal Roofing System.

1.4 DEFINITION

The term "paint" as used herein includes enamels, paints, sealers, emulsions and other coatings used as prime intermediate or finish coats for protection or decoration.

1.5 COMPLIANCE WITH VOLATILE ORGANIC COMPOUND (VOC) LIMITS

All paint and coating products shall comply with the applicable limits on volatile organic compounds (VOC) as established by the United States Environmental Protection Agency and by State and local air quality regulating agencies. It shall be the Contractor's responsibility to verify compliance of all paints and coatings. In the event that any paint or coating listed herein is found to be non-compliant, the Contractor shall notify the Engineer and the Engineer will select a substitute coating or paint.

1.6 QUALITY ASSURANCE

A. General: Quality assurance procedures and practices shall be utilized to monitor all phases of surface preparation, application and inspection throughout the duration of the project. Procedures or practices not specifically defined herein may be utilized provided they meet recognized and accepted professional standards and are approved by the Engineer.

B. Workmen: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

C. Paint Coordination:

1. Review other Sections of these Specifications as required, verifying the prime coats to be used and assuring compatibility of the total coating system for the various substrata.

2. Upon request, furnish information on the characteristics of the specific finish materials to assure that compatible prime coats are used.

3. Provide barrier coats over non-compatible primers or remove the primer and re-prime as required.

4. Notify the Engineer in writing of anticipated problems in using the specified coating systems over prime-coatings supplied under other Sections.

1.7 DELIVERY AND STORAGE

A. All materials shall be brought to the job site in original sealed containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life, and special directions. They shall not be used until the Engineer has inspected contents and obtained data from information on containers or label. Materials exceeding storage life recommended by the manufacturer shall be rejected.

B. All coatings and paints shall be stored in enclosed structures to protect them from weather and excessive heat or cold. Flammable coatings or paints must be stored to conform to City, County, State and Federal safety codes for flammable coatings or paint materials. At all times coatings or paints shall be protected from freezing.

1.8 REFERENCED SPECIFICATIONS AND STANDARDS

A. Without limiting the general aspects of other requirements of these specifications, all surface preparation, coating and painting of surfaces shall conform to the applicable requirements of the National Association of Corrosion Engineers, the Society for Protective Coatings, the American Concrete Institute, the Forest Products Research Society and the Manufacturer's printed instructions.

B. The Engineer's decision shall be final as to interpretation and/or conflict between any on the reference specifications and standards contained herein.

1.9 AS COATED SUMMARY SHEET

A. Contractor shall supply a list of all coating products used on the Project, including the exact stock number and the file numbers for the color tints added and amounts for each. The Summary Sheet should also list the local paint supply location for the particular brand of coating including the Name, address, phone number, and website for each product.

B. Contractor shall provide one unbroken gallon container or kit of each color and type of paint and each type of solvent and thinner required by the Specifications. These spare paint supplies shall be stored as required in paragraph 1.7, this section, until delivery is requested by the Engineer.

PART 2 MATERIALS

2.1 PAINT AND FINISH PRODUCTS

A. Paint and coating products shall be fresh and well ground; shall not settle readily, cake, or thicken in the container; shall be broken up readily with paddle to a smooth consistency; and shall have easy application properties. Other painting materials such as linseed oil, turpentine, mineral spirits, miscellaneous thinners, varnish, and shellac shall be of the highest quality.

B. All paints and coatings shall be specifically manufactured for use on projects of this type, and shall be used on surfaces intended by the paint manufacturer. Paints and coatings shall be Tnemec, Carboline or equal. All paint and coatings shall be delivered in original containers, with seals unbroken.

C. To establish a standard of quality, several specific paint and coating products are listed in the coating System Index under 2.5, this section.

2.2 COMPATIBILITY OF SHOP AND FIELD PAINTS

To ensure a satisfactory painting job it is essential that the paints applied in the shop and in the field be mutually compatible. Where prime coats are shop applied, the Contractor shall instruct suppliers to provide compatible primers with the finish coats selected by the Contractor. In no case will primers be allowed that are not manufactured by the suppliers of the finish coats unless approved by the Engineer.

2.3 COLORS

A. Color for the various surfaces to be painted shall be selected by the Engineer. Use of different colors for the various structures or for surfaces of a single structure may be directed by the Engineer.

B. Piping, ductwork and adjacent equipment colors shall be as specified in Section 10400, identifying devices.

C. Equipment/Piping colors shall be as scheduled below:

1. All exposed equipment and piping coated, as defined below, shall be tan for all process fluids, brown for all sludge lines, and blue for all potable water.

2. Provide color chart for engineers approval.

2.4 SYSTEMS INDEX

A. System A

1. Type of Coating: Polymidoamine or Amine Cured Epoxy

2. Surface: Ferrous metals and concrete submerged or subject to submersion in non-potable water.

3. Surface Preparation: Ferrous Metals: SSPC-SP-10 Concrete: SSPC-SP-13.

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	4.0 to 5.0 mils	66HS-1211 Red	Carboguard 890
2	6.0 mils	66HS	Carboguard 890

B. System B

1. Type of Coating: Protective Coal Tar

2. Surface: Buried ferrous metals and Concrete

3. Surface Preparation: Steel - SSPC-SP6; Concrete - SSPC-SP-13

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
2	10.0 mils	46H-413	Bitumastic 300M

C. System C

1. Type of Coating: 100% Solids Epoxy (Hydropox or Plasite 4500S - See Section 02601)

2. Surface: Concrete

3. Surface Preparation: SSPC-SP-7 (for new concrete) or SSPC-SP-13 (for existing modified structures)

4. Epoxy lining shall be manufactured by Con-Tech of California, Inc. and consist of a prime and finish coat. The prime coat shall be a two component, low viscosity 100% solids, deep penetrating primer. The prime coat shall be designed for use on properly prepared porous substrates, such as concrete. The finish coat shall be a non-polluting, solvent free, two-component, 100% solids epoxy system designed as a chemical coating barrier against potable water, salt water, and raw wastewater. The finish coat shall cure at a low minimum temperature of 40°F, have a potlife of 35 minutes at room temperature, be tack free in 4 hours and cured in 3 days.

   a. Prime coat (at 150 square feet per gallon), Hydro-Prime 251 + HYDROTHIX

   b. Finish coat (DFT = 80 mils), Hydro-Pox Ct. 04-204 UHB

5. Concrete curing compound is not allowed as specified in Section 03100. Forms shall remain for a minimum of 7 days or more depending on ambient temperatures as approved by the Engineer.

6. A wet cure method for a minimum of 7 days may also be allowed as approved by the Engineer.

7. Coating shall be applied during periods of stable to declining temperatures to minimize pin-holing.

8. If sacking and brush blast is required prior to the prime coat, only a grout consisting of sand and cement is allowed. Additives that may produce a surface film compromising adhesion are prohibited.

D. System D

1. Type of Coating: Polyamidoamine or Amine Cured Epoxy, Polyurethane

2. Surface: Exterior, non-submerged metals and plastic piping, mild or severe chemical or corrosion exposure.

3. Surface Preparation: Ferrous metals: SSPC-SP-6

4. Plastic Piping and Non-Ferrous Metals: SSPC-SP-1

5. Galvanized Metal: SSPC-SP-7 (Take care not to remove Galvanized Coating)

6. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
2	5.0 mils (metals) 3.0 mils (plastics)	66HS	Carboguard 890
1	4.0 mils(metals) 3.0 mils(plastics)	1074 or 1075	Carbothane 134VOC

E. System E

1. Type of Coating: Polyamidoamine or Amine Cured Epoxy

2. Surface: Interior non-submerged metals, plastic piping, concrete, mild or severe chemical or corrosion exposure.

3. Surface Preparation: Ferrous Metals: SSPC-SP-6

4. Plastic Piping and Nonferrous Metals: SSPC-SP-1

5. Galvanized Metal: SSPC-SP-7

6. Concrete: SSPC-SP-13

7. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
2	5.0 mils (metals and concrete)	66HS	Carboguard 890
2	3.0 mils (plastics)	66HS	Carboguard 890

F. System F

1. Type of Coating: Acrylic Epoxy
2. Surface: Interior plaster and gypsum wallboard.
3. Surface Preparation: In accordance with the general surface preparation specifications in this Section.
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	1.5 mils	151-1051	Sanitile 120
2	4.0 mils	113 or 114	Sanitile 255

G. System G

1. Type of Coating: Modified Aliphatic Amine Epoxy
2. Surface: Interior masonry and concrete walls.
3. Surface Preparation: SSPC-SP-13
4. Filler: Apply filler per manufacturer's requirements to provide a "pin-hole" free surface.
5. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	60 to 80 ft^2/gal.	130	Sanitile 600
2	8.0 mils	84	Carboguard 890

H. System H

1. Type of Coating: Aliphatic polyurethane.
2. Surface: Overhead rolling doors (both sides).
3. Surface Preparation: SSPC-SP-1.
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	3.0 mils	530	Carboguard 890

1	2.0 mils	1075	Carbothane 134VOC

I. System I

1. Type of Coating: Acrylic, Semi-Gloss.
2. Surface: Interior concrete, masonry, wood, plaster, gypsum drywall, and exterior wood surfaces.
3. Surface Preparation: Clean and Dry, see sections 3.02, 3.03, 3.04.
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Coating Type	Sherwin Williams (or equal)
1	2.0 mils (1.5 mils for wood)	Interior Primer	Preprite Problock
1	3.0	Interior Coating	Duration Interior
1	1.5 – 2.0	Exterior Primer	A-100 Latex Primer
2	2.5 – 3.0	Exterior Coating	Duration or Resilience Exterior

J. System J

1. Type of Coating: Resinous Flooring
2. Surface: Concrete subject to mild chemical service.
3. Surface Preparation: Acid etch or shot blast to create profile/anchor pattern.
4. Coatings And Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	4.0 mils	203	Carboseal 780
2	12.0 mils	280	Carboseal 745
1	3.0 mils	290*	Carboseal 835

* As noted on the drawings, areas of the deck floors of the UV system shall be coated with the above system except Tnemec Series 290 shall be replaced with Series 295.

NOTE: On floor surface, broadcast clean silica sand per paint manufacturer's recommendations to form non-slip surface.

K. System K

1. Type of Coating: Polyurea Elastomer
2. Surface: Exterior Concrete

3. Surface Preparation: SSPC-SP-13

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	4.0 mils	203	Carboguard 1340WB
2	40.0 mils	400	Reactamine ET

L. System L

1. Type of Coating: High build acrylic.

2. Surface: Exterior concrete block.

3. Surface Preparation: SSPC-SP7

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	Total DFT	Tnemec Series	Carboline
2	8.0 mils	180	3359DTM Series

M. System M

1. Type of Coating: Heat resistant aluminum coatings.

2. Surface: High heat (to 750°F) equipment and piping.

3. Surface Preparation: SSPC-SP-10.

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	2.5 mils	90E92	Thermaline 4700VOC

N. System N: Emulsified Asphalt Coating (See Section 07110).

O. System O

1. Type of Coating: Aromatic elastomeric polyurethane, or epoxy.

2. Surface: Submerged ferrous metals subject to abrasion.

3. Surface Preparation: SSPC-SP-10

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline

1	4.0 to 5.0 mils	66HS -1211	N/A
2	8.0 to 12.0 mils	164	Reactamine 760

P. System P

1. Type of Coating: Polyamide Epoxy / Acrylic
2. Surface: Exterior of steel structures and tanks previously coated with alkyd enamel.
3. Surface Preparation: All surfaces damaged by construction SSPC-SP-6; all other surfaces SSPC-SP-7.
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	4.0 to 6.0 mils	66HS	Rustbond
1	2.5 to 3.0 mils	30	Carbocrylic 3359DTM

Q. System Q

1. Type of Coating: Vinyl Ester
2. Surface: Concrete and masonry subject to severe chemical service (Chemical pump areas and secondary containment areas).
3. Surface Preparation: SSPC-SP-13.
4. Surface shall be smooth to obtain a “pin hole” free surface after coating. Block filler shall be used on masonry, trowel smooth. Concrete shall be trowelled or sacked prior to coating. Filler shall be Tnemec Series 201+ Carbosil, Semstone 800 Primer + Cabosil, or equal.
5. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	6.0 mils	201	Semstone 800
1	30 mils	275	Semstone 870
1	15 mils	120	Semstone 870

NOTE: On floor surface, broadcast clean silca sand into prime coat per paint manufacturer’s recommendations to form non-slip surface.

R. System R

1. Type of Lining: Epoxy.
2. Surface: Interior of welded steel potable water storage tanks. Lining shall be NSF-61 approved for potable water service.

3. Surface Preparation: Ferrous metals: SSPC-SP-10

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	6-8 mils (primer)	V140F	Carboguard 891VOC
1	6-8 mils	V140F	Carboguard 891VOC

NOTE: Field prime all remaining unprimed, abraded or rusted areas after re-blast cleaning per SSPC-SP-10.

S. System S

1. Type of Coating: Zinc-Rich Aromatic Urethane/Polyamidoamine Epoxy.

2. Surface: Exterior of welded steel potable water storage tanks.

3. Surface Preparation: Ferrous metals: SSPC-SP-10

4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	2.5-3.5 mils (primer)	94-H2O	Carbozinc 859
1	4-6 mils	166	Carboguard 890
1	3-5 mils	1075	Carbothane 134VOC

NOTE: Field prime all remaining unprimed, abraded or rusted areas after re-blast cleaning per SSPC-SP-10.

T. System T

1. Type of Coating: Flexible Polyurethane

2. Surface: Concrete subject to mild chemical service.

3. Surface Preparation: SSPC-SP-13.

4. Surface shall be smooth to obtain a “pin hole” free surface after coating. Concrete shall be trowelled or sacked, and abrasive blasted prior to coating.

5. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	2.0-4.0 mils	203	N/A
1	50-60 mils	400	Reactamine 760

U. System U

1. Type of Coating: Fiber-reinforced modified polyamine epoxy.
2. Surface: Concrete and steel subject to hydrogen sulfide exposure.
3. Surface Preparation:
   a. Concrete: SSPC-SP-13 plus finish 4 to obtain a "pin hole" free surface after coating
   b. Steel: SSPC-SP-5
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	Total DFT	Tnemec Series	Carboline
1	50 mils	436 (steel)	Plasite 4500S
1	8 mils	201 (concrete)	*
1	70 MILS	436 FR (concrete)	Plasite 4500S

* Engineer knows of no equal.

V. System V: Fusion Epoxy .

1. Type of Coating: Fusion Epoxy – Fluidized Bed Grade
2. Surface: Fabricated steel piping manifolds and above ground welded steel piping
3. Surface Preparation: SSPC-SP10
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	Total DFT	3M Scotchkote
Shop Coat 1	16 mils	206N (steel)
Field Coat* 1	10 mils	312

* Field welds, connections and damaged areas

W. System W:

1. Type of Coating: Self-crosslinking Acrylic
2. Surface: Primed Structural Steel Members.
3. Surface Preparation: SSPC-SP-11
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Tnemec Series	Carboline
1	4 mil	115	Carbocrylic 3359DTM

X. System X:

1. Type of Coating: Semi Gloss Silicone Trim Enamel
2. Surface: Exterior Ferrous Metals.
3. Surface Preparation: SSPC-SP-6
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Coating Name	Manufacturers
1(Zinc primed metal)	4 mil	Zinc Oxide Dust Primer ("SW Galvanized Iron Primer")	ICI Paint Stores Deero-Frazee Pioneer Paint Co. PPG Industries Sherwin Williams Dunn Edwards
1 (unprimed metal)	4 mil	Zinc Chromate Alkyd Primer ("Zinc Chromate Primer")	ICI Paint Stores Deero-Frazee Pioneer Paint Co. PPG Industries Sherwin Williams Dunn Edwards
2	4 mil	Semi Gloss Silicone Alkyd Enamel	ICI Paint Stores Deero-Frazee Pioneer Paint Co. PPG Industries Sherwin Williams Dunn Edwards

NOTE: Delete Primer at Factory primed items. Provide painted finish to match adjacent surfaces at exposed roof top equipment as directed by architect. This system to cover painting of switchgear, and roof top HVAC equipment

Y. System Y:

1. Type of Coating: Semi Gloss Alkyd Enamel
2. Surface: Building Interior Including Toilet Area, Kitchens, and Paint Grade Doors.
3. Surface Preparation: In accordance with the general surface preparation specifications in this Section.
4. Coatings and Dry Film Thickness (DFT):

Minimum No. of Coats	DFT per Coat	Manufacturer
Per MFG	Per MFG	Devoe: 50801 Wonder –Tones Latex Primer and Sealer Glidden: Y-3416 Spred Primer Sealer Moore: Moore's Latex Quick Dry Prime Seal Pittsburg: 6-2 PPG Quick Drying Interior Latex Primer
Per MFG	Per MFG	Devoe: 26XX Velour Alkyd Semi-Gloss Enamel Glidden: Y-4600 Line – Spred Lustre Semi Gloss Moore: Moore's Satin Impervo Enamel

Z. System Z

1. Type of Coating: Low Solids Acrylic
2. Surface: Exterior concrete block.
3. Surface Preparation: SSPC-SP7
4. Coatings and Dry Film Thickness (DFT)

AA. System AA

1. Type of Coating: Polyamidoamine Epoxy
2. Surface: Ductile Iron Pipe
3. Surface Preparation: In accordance with the general surface preparation specifications in this Section.
4. Coatings and Dry Film Thickness (DFT)

PART 3 EXECUTION

3.1 GENERAL

A. During scheduled coating periods, daily whether reporting is required (including, but not limited to, air and surface temperature, dew point, relative humidity, rain, snow, mist, fog, and wind. Further, daily report shall include conditions that have the potential to cause dust, insects, or debris adhere to coating.) Contractor is required to obtain preauthorization from Owner's representative and Engineer prior to coating and painting; authorization shall be whether dependant. At all times, Contractor shall comply with paint manufacturer's published recommendation for environmental conditions in which paint materials can be applied and as approved by the Engineer. Additionally, see section 3.5.

B. All surface preparation, coating and painting shall conform to applicable standards of the National Association of Corrosion Engineers, the Steel Structures Painting Council, the American Concrete Institute, the Forest Products Research Society and the Manufacturer's printed instructions. Material applied prior to approval of surface by the Engineer shall be removed and re-applied to the satisfaction of the Engineer at the expense of the Contractor.

C. All work shall be performed by skilled craftsmen qualified to perform the required work in a manner comparable with the best standards of practice.

D. The Contractor shall provide a supervisor at the work site during cleaning and application operations. The supervisor shall have the authority to sign any change orders, coordinate work and make decisions pertaining to the fulfillment of the contract.

E. Dust, dirt, oil, grease or any foreign matter that will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved cleaning solvent and wiped dry with clean rags.

F. Coatings and painting systems include surface preparation, prime coating and finish coatings. Unless otherwise specified, prime coatings shall be field applied. Where prime coatings are shop applied, the Contractor shall instruct suppliers to provide the prime coat compatible with the finish coat specified. Any off-site work which does not conform to the specification is subject to rejection by the Engineer.

Shop applied prime coatings which are damaged during transportation, construction or installation shall be thoroughly cleaned and touched up in the field as directed by the Engineer. The Contractor shall use repair procedures which insure the complete protection of all adjacent primer.

The specified repair method and equipment may include wire-brushing, hand or power tool cleaning or dry air blast cleaning. In order to prevent injury to surrounding painted areas blast cleaning may require use of lower air pressure, smaller nozzle and abrasive particle sizes, short blast nozzle distance from surface, shielding and masking. If damage is too extensive, the item shall be re-cleaned and coated or painted as directed by the Engineer.

G. Previously painted surfaces: Repair surface defects. Remove grease, oil and other contaminants as specified for steel surfaces. Scrape carefully to remove deteriorated coatings. Glossy or very hard coatings should be sanded lightly to promote maximum adhesion of the subsequent coating. Surface must be thoroughly dry before coating.

H. The Contractor's coating and painting equipment shall be designed for application of materials and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Contractor's equipment shall be subject to approval by the Engineer.

I. Application of the first coat shall follow immediately after surface preparation and cleaning and within an eight-hour working day. Any cleaned areas not receiving first coat within eight-hour period shall be re-cleaned prior to application of first coat. This may include re-blasting.

J. Prior to assembly, all surfaces made inaccessible after assembly shall be prepared as specified herein and shall receive the coating or paint system specified.

3.2 SURFACE PREPARATION, METALLIC SURFACES

A. Surface preparation will be based on comparison with: ASTM D2200 "Pictorial Surface Preparation Standards for Painting Steel Surfaces", SSPC-Vis 1,: ASTM D610 "Standard Methods of Evaluating Degree of Rusting on Painted Steel Surfaces", SSPC-Vis 2,; and as described below. Anchor profile for prepared surfaces shall be measured by use of a non-destructive instrument such as a Keane-Tator Surface Profile Comparator or Testex Press-O-Film System.

To facilitate inspection the Contractor shall, on the first day of abrasive blast cleaning operations, blast clean metal panels to the standard specified. These panels shall be equivalent to the supplied plate stock which is to be coated or painted and shall have minimum measurements of 8-½-inches by 11-inches. After agreeing a specific panel meets the requirements of the specification, it shall be initialed by the Contractor and Engineer and coated with a clear non-changing finish. Panels shall be utilized for inspection purposes throughout the duration of blast cleaning operations.

B. Heavy deposits of grease or oil shall be removed with solvent oil cleaner and any chemical contamination shall be neutralized and/or flushed off prior to any other surface preparation.

C. Surfaces scheduled for Near White or Commercial Blast Cleaning shall have all welds, edges, and sharp corners ground to a 1/16-inch radius and all weld splatter removed, and sandblasted in accordance with Steel Structures Painting Council Specifications, removing mill scale, rust, dirt, paint, or other foreign matter, and shall be slightly roughened to form a suitable anchor pattern for the coating application. Do not leave blasted surfaces overnight before coating. Remove all sand from the surface by brush or industrial vacuum.

D. All other steel not scheduled for blast cleaning shall have all weld splatter removed, and rough edges and rough welds ground, and shall be cleaned by means of hand or power tools, in accordance with Steel Structures Painting Council Specification No. 2 or No. 3, removing all loose mill scale rust, dirt, paint, or other contaminants. Blast cleaning may be used if practical. The remaining mill scale, rust, and paint must be sufficiently abraded to provide for good bonding of the coating.

E. Field blast cleaning for all surfaces shall be dry method unless otherwise directed.

F. Particle size of abrasives used in blast cleaning shall be that which will produce a 2 mil (50.0 microns) surface profile or in accordance with recommendations of the manufacturer of the specified coating or paint system to be applied.

G. Abrasive used in blast cleaning operations shall be new, washed, graded and free of contaminants that would interfere with adhesion of coating or paint and shall not be reused unless specifically approved by the Engineer.

H. During blast cleaning operations, caution shall be exercised to insure that existing coatings or paints are not exposed to abrasion from blast cleaning.

I. The Contractor shall keep the area of his work in a clean condition and shall not permit blasting materials to accumulate as to constitute a nuisance or hazard to performance of work or operation of existing facilities.

J. Blast cleaned surfaces shall be cleaned prior to application of specified coatings or paints by a combination of blowing with clean dry air, brushing/brooming and/or vacuuming as directed by the Engineer.

K. All welds shall be cleaned with a suitable chemical compatible with the specified coating materials.

L. Specific Surface Preparation: Surface preparation for the specific system shall be as designated in the Systems Index, Part 2.05 of these specifications.

M. Application SSPC specifications are as follows:

1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.

2. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding, and wire-brushing.

3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by power wire-brushing, power impact tools or power sanders.

4. White Metal Blast Cleaning (SSPC-SP5): Blast cleaning to a gray-white uniform metallic color until each element of surface is free of all visible residues.

5. Commercial Blast Cleaning (SSPC-SP6): Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues.

6. Brush-Off Blast Cleaning (SSPC-SP7): Blast cleaning to remove loose rust, loose mill scale and other detrimental foreign matter to degree specified.

7. Near White Blast Cleaning (SSPC-SP10): Blast cleaning to nearly white metal cleanliness, until at least 95 percent of each element of surface area is free of all visible residues.

3.3 SURFACE PREPARATION, CONCRETE AND MASONRY

A. Concrete and masonry shall cure at least 28 days and have a moisture content prior to coating or painting below 8 percent as measured by an instrument such as a Delmhorst Model DP, unless recommended otherwise by the paint manufacturer.

B. All surfaces shall be thoroughly cleaned by abrasive blasting, wire-brushing or other approved methods, removing all traces of foreign materials. Remove all loose concrete and masonry by chipping or other approved methods to leave only a sound, firmly bonded substrate. Cracks and voids shall be repaired or filled as directed by the Engineer with approved suitable materials, mixed and applied in strict accordance with the Manufacturer's printed instructions. In general, final surface shall be smooth and free of voids, cavities, dirt, dust, oils, grease, or other contaminants.

C. Where oil or grease deposits are present, prior to above surface preparation, clean surfaces by scrubbing with a solution of one and one-half ounces (44.4 ml) tri-sodium phosphate (TSP) and one and one-half ounces (44.4 ml) of non-sudsing detergent mixed into one gallon (3.785 liters) of warm water. Surfaces shall then be flushed clean with fresh water.

D. Specific Surface Preparation: Surface preparation for the specific system shall be as designated in the Systems Index, Part 2.05 of these specifications.

3.4 SURFACE PREPARATION, WOOD AND COMPOSITION MATERIALS

A. Wood and composite materials shall have a moisture content prior to coating or painting below 15 percent as measured by an instrument such as a Delmhorst Model BD-7, unless recommended otherwise by the paint manufacturer.

B. All surfaces shall be thoroughly cleaned by use of mineral spirits, scrapers, and sandpaper or wire brushes to remove all dirt, oil, grease or other foreign substances. Finished surfaces exposed to view shall, if necessary, be made smooth by planing or sandpapering. Small, dry, seasoned knots shall be scraped, sandpapered, and thoroughly cleaned, and shall be given a thin coat of WP-578 Western Pine Association knot sealer before application of the priming coat. Large, open unseasoned knots, and all beads or streaks of pitch shall be scraped off, or if the pitch is still soft, it shall be removed with mineral spirits and the resinous area shall be thinly coated with knot sealer. After priming, all holes and imperfections shall be filled with putty or plastic wood (colored to match the finish wood), allowed to dry, and sandpapered smooth. Painting of interior wood and composite materials shall proceed insofar as practicable, only after masonry work has dried. Existing surfaces shall be cleaned of all loose or flaking paint and sandpapered as required.

C. Specific Surface Preparation: Surface preparation for the specific system shall be as designated in the Systems Index, Part 2.5 of this section.

3.5 COATING APPLICATION

A. Coating and paint application shall conform to the requirements of the Steel Structures Painting Council Paint Application Specifications SSPC-PA1, latest revision, for "Shop, Field and Maintenance Painting", and recommended practices of the National

Association of Corrosion Engineers, the American Concrete Institute, the Forest Products Research Society and the Manufacturer of the paint and coating materials.

B. Before applying any paint or finish, all surfaces shall be thoroughly cleaned and prepared for painting as herein specified. All cleaned metal shall be primed or painted, as specified, immediately after cleaning to prevent new rusting or oxidation of cleaned surfaces.

C. Protective coverings or drop cloths shall be use to protect floors, fixtures, and equipment. Care shall be exercised to avoid lapping on glass or hardware. Coatings and paints shall be sharply cut to lines. Finished surfaces shall be free from defects or blemishes.

D. Application – Environmental Conditions

1. Do not paint surfaces that exceed manufacturer specified moisture contents or when none, the following moisture contents:

   a. Plaster and Gypsum Wallboard: 12 percent.

   b. Masonry, Concrete and Concrete Block: 8 percent.

   c. Interior Located Wood: 15 percent.

   d. Concrete Floors: 7 percent.

2. Do not paint or coat:

   a. Under dusty conditions.

   b. When light on surface measures less than 15 foot-candles.

   c. When ambient or surface temperature is less than 40 degrees Fahrenheit.

   d. When relative humidity is higher than 85 percent.

   e. When surface temperature is less than 5 degrees Fahrenheit above dew point.

   f. When surface temperature exceeds the manufacturer's recommendation.

   g. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.

3. No coating work shall be done under unfavorable weather conditions to wet or damp surfaces or in rain, snow, fog or mist.

4. When it is expected the air temperature will drop below 40 degrees F or less than 5 degrees F above the dewpoint within eight hours after application of coating or paint.

   Dewpoint shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with the US Department of Commerce Weather Bureau Psychometric Tables.

   If above conditions are prevalent, coating or painting shall be delayed or postponed

until conditions are favorable, unless conditions are acceptable to the paint manufacturer for any given coating. The days coating or painting shall be completed in time to permit the film sufficient drying time to prevent damage by atmospheric conditions.

5. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensation or dew on surface of substrate, coating between coats and within curing time following application of last coat.

6. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 45 degrees Fahrenheit for 24 hours before, during and 48 hours after application of finishes.

E. All painting shall be well applied, leaving no sags, laps, brush, or other defects. Each coat must thoroughly dry before applying next coat, and all work must be carefully cut into a true line and left smooth and clean. Hardware trim and other items shall be removed as required for proper application of coatings.

All painting shall conform to the following general conditions:

1. Thickness of coating in mils shall mean the dry film thickness. The number of coats specified shall mean the minimum number of coats to be used. Additional coatings shall be required if necessary to obtain the specified film thickness.

2. No coating work shall be done under unfavorable weather conditions.

3. Prime coats shall be provided where called for as a part of the painting system. Shop prime coats shall conform to the specified painting system for the given item. It shall be the responsibility of the Contractor to coordinate work so that factory prime items are primed or painted with a coating compatible with the specified finish painting system.

4. Particular attention shall be given to all welds, edges, and corners so as to get full and adequate coverage. Damaged shop prime coats or field applied prime coats shall be carefully replaced before finish painting. Surface preparation for replacement of damaged coats shall be such as to give a clean surface for proper bonding of prime coat. Finish coatings shall not be applied until touch-up prime coat has completely dried.

5. Minimum between-coat drying items, as stated in the printed instructions of the coating manufacturer will be carefully observed.

6. Thinning shall be done only if necessary for workability of the coating material in accordance with the manufacturer's printed instructions. Use only the appropriate thinner.

7. Each coat shall be applied in a similar but different color from the preceding coat, the finish coat to be color selected by the Engineer.

3.6 SPECIAL REQUIREMENTS FOR GALVANIZED AND NON-FERROUS METALS

Where galvanized or non-ferrous metals are scheduled to be painted, the surface shall be brush blasted in accordance with SSPC-SP7 before finish is applied. Do not remove the galvanized coating. Damaged areas should be repaired with an appropriate zinc-rich primer, such as Tnemec Series 90-97.

3.7 INSPECTION

A. Inspection - General:

Concrete, plastic and wood surfaces shall be visually inspected to insure specified coverage has been attained. Where destructive testing is deemed necessary, an instrument such as a Tooke Gage shall be used. Thickness of coatings and paints on metal surfaces shall be checked with a non-destructive type thickness gauge. Coating integrity shall be tested with an approved inspection device. Holiday detection shall be performed prior to the application of aluminum or metallic finish coats. Holiday detectors shall not exceed the voltage recommended by the manufacturer of the coating system. For film thickness between 10 and 20 mils, a non-sudsing type wetting agent such as Kodak Photo-Flo shall be added to the water prior to wetting the detector sponge. All pinholes shall be marked, repaired in accordance with the manufacturer's recommendations and retested. No pinholes or other irregularities will be permitted in the final coating.

In cases of dispute concerning film thickness or holidays, the Engineer's calibrated instruments and measurements shall predominate. Wide film thickness discrepancies shall be measured and verified with a micrometer or other approved measuring instrument.

B. Inspection Devices:

The Contractor shall furnish, until final acceptance of coating and painting, inspection devices in good working condition for detection of holidays and measurement of dry-film thickness of coating and paint. The Contractor shall also furnish US Department of Commerce; National Bureau of Standards certified thickness calibration plates to test accuracy of dry-film thickness gauge and certified instrumentation to test accuracy of holiday detectors.

Dry-film thickness gauges and holiday detectors shall be made available for the Engineer's use at all times until final acceptance of application. Holiday detection devices shall be operated in the presence of the Engineer.

Acceptable devices for ferrous metal surfaces include, but are not limited to Tinker-Rasor Model M-1 holiday detector for coatings to 20 mils dry film thickness, Tinker-Rasor Models AP and AP-W holiday detectors for coatings in excess of 20 mils dry-film thickness, and Mikrotest or Positest unit for dry-film thickness gauging. Non-ferrous metal surfaces shall be checked with an instrument such as an Elcometer "Eddy Current" Tester or De Felsko Model 252. Inspection devices shall be operated in accordance with the manufacturer's instructions.

3.8 SAFETY AND HEALTH REQUIREMENTS

A. General: In accordance with requirements set forth by regulatory agencies applicable to the construction industry and Manufacturer's printed instructions and appropriate technical bulletins and manuals, the Contractor shall provide and require use of personnel protective lifesaving equipment for persons working in or about the project site.

B. Head and Face Protection and Respiratory Devices: Equipment shall include protective helmets which shall be worn by all persons in the vicinity of the work. In addition, workers engaged in or near the work during abrasive blasting shall wear eye and face protection devices and air purifying, half-mask or mouthpiece respirator with appropriate filter. Barrier creams shall be used on any exposed areas of skin.

C. Ventilation: Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Ventilation shall reduce the concentration of air contaminant to the degree a hazard does not exist. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. Sound Levels: Whenever the occupational noise exposure exceeds maximum allowable sound levels, the Contractor shall provide and require the use of approved ear protective devices.

E. Illumination: Adequate illumination shall be provided while work is in progress, including explosion-proof lights and electrical equipment. Whenever required by the Engineer, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the Engineer.

F. Temporary Ladders and Scaffolding: All temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected where requested by the Engineer to facilitate inspection and be removed by the Contractor to locations requested by the Engineer.

3.9 PRESERVATION

During construction, painter shall assume the preservation of all his work against damage by accident or otherwise, and shall leave the work clean and whole. The work will not be accepted until all of the work has been completed and all retouching has been done. All work which is rejected, or for any reason has to be done over, will be done by the Contractor at his expense.

3.10 CLEANING

During the progress of the work, all other work shall be covered and fully protected from injury or painter's finish, and care shall be exercised not to splatter paint, enamel, etc., on adjacent work. Upon completion of the work, all staging, scaffolding and containers shall be removed from the

site or destroyed in a manner approved by the Engineer. Name and data plates on equipment shall not be painted and shall be left clean and legible upon completion of the project. All damage to surfaces resulting from the work of this section shall be cleaned, repaired, or refinished to the satisfaction of the Engineer at no expense to the Agency.

3.11 SURFACES REQUIRING PAINTING

In general, the following surfaces are to be coated or painted:

A. All exposed metal surfaces and piping, interior and exterior.

B. All submerged or buried metal and some submerged concrete and masonry surfaces, as scheduled.

C. All structural and fabricated steel, including tanks and equipment and galvanized structural steel.

D. The interior of certain tanks and wet wells as specified in the schedule.

E. Exterior aboveground concrete and masonry, as scheduled.

F. The interior of certain structures as specified in the Schedule.

G. Equipment furnished without factory finish surfaces.

H. Doors, woodwork and architectural items.

I. Equipment furnished with factory finished surfaces to match pipe service color.

J. Fusion epoxy lined and coated steel piping and equipment to match pipe service color.

K. Dissimilar Materials: Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint conforming to MIL-C-18480 or to TT-V-51 or a coat of zinc chromate primer conforming to TT-P-645 to prevent galvanic or corrosive action.

3.12 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise indicated, painting is not required on surfaces in concealed areas and inaccessible areas such as furred spaces, foundation spaces, utility tunnels, pipe spaces, and on buried piping.

B. Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze, and similar finished materials will not require painting under this Section except as scheduled and defined below.

1. All stainless-steel parts/equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection. All field welds shall be cleaned and passivated to remove iron (and prevent corrosion) in accordance with ASTM A380.

C. Portions of metal embedded in concrete, except for aluminum surfaces.

D. Electrical equipment with factory applied finish.

E. Do not paint moving parts of operating units; mechanical or electrical parts such as valve operators; linkages; sensing devices; and motor shafts, unless otherwise indicated.

F. Do not paint over required labels or equipment identification, performance rating, name, or nomenclature plates.

3.13 FINISH SCHEDULE

The following is a partial schedule and does not include all surfaces that require coatings. Coat unlisted surfaces with the same coating system as similar listed surfaces. Color selection shall be made by the Owner and provided in returned Contractor's Paint Submittal.

A. System "A" Polymidoamine or Amine Cured Epoxy:

1. Exterior of all submerged piping and valves except for stainless steel piping.
2. Submerged pipe supports and hangers except for stainless steel.
3. Exterior of submerged pumps, mixers, motors and other equipment.
4. Bell rings and underside of manholes covers and frames.
5. Sump pumps including the underside of base plates.
6. Field priming of ferrous metals surfaces with defective shop prime coating or where no other prime coating is specified.
7. All other submerged iron and steel metal unless specified otherwise.

B. System “B” Protective Coal Tar: Underground pipe flanges, corrugated metal pipe couplings, flexible pipe couplings, and miscellaneous underground metals not specified to receive another protective coating system.

C. System “C” 100% Solids Epoxy: Coat all interior concrete surfaces below top of slab or wall of all structures including new flow metering manhole, and existing screenings channels and grit channels and grit basins. Fill construction joints of all structures with epoxy grout, per 03100, prior to applying System C. Apply coating prior to drilling and installing pipe and grating anchors and supports. All existing modified structures listed shall be sandblasted and cleaned prior to coating. Coat exterior of all below grade structures with System “N” to prevent excessive moisture in concrete to be coated.

D. System “D” Polyamidoamine or Amine Cured Epoxy, Polyurethane:

1. Exterior piping, valves, pipe hangers and supports, electrical conduit, and other supports except for stainless steel.
2. Valve and gate operators and stands.
3. Structural steel including galvanized steel.
4. Process equipment (not submerged) including pumps, motors, equipment guards, equipment supports and other miscellaneous metals at the Headworks except for stainless steel and aluminum.
5. Exposed PVC piping and valves.
6. Exterior electrical cabinets, boxes, and exposed conduits that are not factory painted.
7. All primed structural steel members
8. All other miscellaneous exposed metals and plastics unless specified otherwise.

E. System “E” Polyamidoamine Epoxy: Interior non-submerged piping, valves, pipe hangers and supports, and exposed interior electrical conduits, and other supports at all process areas except for stainless steel and aluminum.

F. System “F” Acrylic Epoxy: Not used.

G. System “G” Modified Aliphatic Amine Epoxy: Not used.

H. System “H” Aliphatic Polyurethane: Not used.

I. System “I” Acrylic, Semi-Gloss: Not used.

J. System “J” Resinous Flooring: Not used..

K. System “K” Polyurea Elastomer: Exterior concrete, not used unless noted on drawings.

L. System “L” High Build Acrylic: Not used..

M. System “M” Heat Resistant Aluminum Coatings: Not used..

N. System “N” Emulsified Asphalt Coating (see Section 07110): Exterior buried walls for waterproofing of all below grade structures that require coating as defined within this specification, including the influent metering manhole.

O. System “O” Aromatic Elastomeric Polyurethane, or Epoxy: Submerged ferrous metals subject to abrasion.

P. System “P” Polyamide Epoxy/Acrylic: Exterior of steel structures previously coated with alkyd enamel.

Q. System “Q” Vinyl Ester: Not used.

R. System “R” Epoxy (Interior): Not used..

S. System “S” Zinc-Rich Aromatic Urethane/Polyamidoamine Epoxy (Exterior): Not used..

T. System “T” Flexible Polyurethane: Not used..

U. System “U” Fiber-reinforced Modified Polyamine Epoxy: Not used.

V. System “V” Fusion Epoxy: Not used.

W. System “W” Self-Crosslinking Acrylic: Not used.

X. System “X” Semi Gloss Silicone Trim Enamel: Not used..

Y. System “Z” Low Solids Acrylic: Not used.

Z. System “AA” Polyamidoamine Epoxy: Ductile Iron Piping.

END OF SECTION

SECTION 10400

IDENTIFYING DEVICES

PART 1 GENERAL

1.1 SUMMARY

The work of this section consists of providing safety signs, identifying devices for buildings, structures, piping, valves, and underground warning tapes for buried utilities.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 02229 – Utility Line Marking

C. Section 15000 – Piping

D. Division 16 - Electrical

1.3 SUBMITTALS

A. In accordance with Section 01300.

B. Samples of sign materials, colors and exterior letters, along with manufacturer's literature and shop drawings.

C. Submit a complete schedule of all signs, including sign label, type, location and support.

PART 2 MATERIALS

2.1 SIGNS - GENERAL

A. Colors, legends, and layout shall conform to OSHA 1910.145 requirements.

B. Overall size of signs 10 inches x 14 inches.

C. Material: 1/8-inch-thick rigid Butyrate (BSR) or fiberglass with printed message and background sealed within a fiberglass resin, suitable for outdoor weather conditions. Seton Name Plate Corporation, New Haven, CT 06505; W.H. Brady Company, Milwaukee, WI 53201, or equal.

2.2 "DANGER" SIGNS

Two-inch high white letters "Danger" in red oval surrounded by a rectangular black field. Text wording 1½-inch high black capital letters on white field.

No. of Signs Required	Text Wording	Placement
Not Used		

2.3 "CAUTION" SIGNS

Two-inch high yellow letters “Caution” on black field. Text wording 1½-inch high black capital letters on yellow field.

No. of Signs Required	Text Wording	Placement
Not Used		

2.4 “SAFETY” SIGNS

Two-inch high red letters on white field. Text wording 1-½-inch high black capital letters on red field.

No. of Signs Required	Text Wording	Placement
Not Used		

2.5 NFPA HAZARD IDENTIFICATION SIGNS

A. Per 2010 CFC Section 2703.5 and NFPA 704.

B. 12-inches x 12-inches minimum size.

C. Letter Size: 4-3/4 inches. Letter Color: Black.

D. Sign: Aluminum for exterior application; color to comply with NFPA requirements with red, blue, yellow and white diamonds. Provide mounting spacers for uneven surfaces.

E. Contractor to verify NFPA Rating text with City of Merced Fire Department prior to submittal.

F. Provide the following signs: Hazard Identification Code per NFPA 704 Fire Diamond:

No. of Signs Required	Text Wording	Placement
Not Used		

2.6 IDENTIFICATION OF PIPING AND VALVES

A. All piping shall be properly identified per the pipe schedule in Section 15000.

1. Snap-on Markers:
   a. Brady Bradysnap-On B-915.
   b. Seton Setmark.
2. 3/4 inch high letters for 3/4 to 4 inch pipe or covering, or 5 inch high letters for 5 inch or larger pipe or cover:
3. Provide UV resistant nylon extension straps for pipes larger than are 4 inch.
4. Material: UV resistant Vinyl.
5. Provide Text and Flow Arrows.

B. All Valves shall be identified per the valve numbers on the P&ID drawings. Provide stainless steel tag with embossed text and stainless steel wire connection to valve body.

2.7 UNDERGROUND WARNING TAPE

A. Refer to Section 02229 for underground identification requirements.

PART 3 EXECUTION

3.1 MOUNTING DANGER, CAUTION, SAFETY AND CHEMICAL SIGNS

A. Install the signs at the locations designated by the Engineer.

B. Mount signs with top of the sign 5'-6" above the floor.

C. Secure with No. 10 stainless steel screws, providing expansion shields for concrete.

D. Plastic ties shall not be used for fastening.

E. Mounting holes in signs shall be oversized to allow signs to “float” free.

3.2 MOUNTING ROOM SIGNS

A. Where doors are present, mount on doors, centered between jambs, and top of signs 5'-6" above the floor.

B. Where signs can be attached to doors and walls, attach with 1/16" thick white vinyl foam tape.

3.3 IDENTIFYING DEVICES FOR PIPING AND VALVES

A. Piping and valves identification signage and markings shall be installed as specified in Section 2.6.

B. Installation of identification signage and markings shall be by Divisions 15 and 16 subcontractors.

3.4 UNDERGROUND WARNING TAPE

Underground warning tape shall be installed in accordance with the details provided in section 02229.

END OF SECTION

SECTION 11010

GENERAL MECHANICAL EQUIPMENT PROVISIONS

PART 1 GENERAL

1.1 DESCRIPTION

This section contains items that pertain to all mechanical work.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01610 - Seismic Design Criteria

B. Section 01010 - General Construction Information and Requirements

C. Section 01020 - Modifications to Existing Facilities and Order of Work

D. Section 01300 - Submittals

E. Section 03100 - Concrete

F. Section 09900 - Painting

G. Section 15080 - Piping Accessories and Appurtenances

H. Division 16 - Electrical

1.3 WORK INCLUDED

The work consists of completely installing the mechanical systems as shown on the drawings and specified in other sections.

1.4 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with all applicable codes, rules, and regulations.

B. References: Comply with referenced standards as listed in the individual sections.

C. Fees and Permits: Obtain required permits necessary to execute the work under this division.

D. All pressure vessels, safety devices and appurtenances shall comply with standards of and bear stamp of ASME.

E. All electrical devices and wiring shall comply with standards of NEC. All devices shall be UL listed and so identified.

F. Testing: All mechanical equipment shall undergo the minimum factory and field testing as specified herein and Section 01010. Additional testing requirements over and above those specified herein may be included in the individual equipment specifications. These requirements shall be considered complimentary to the minimum requirements specified herein.

1.5 DRAWINGS

Drawings are diagrammatic and show the general design, arrangement and extent of the systems. Do not scale drawings for roughing in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings as required. Coordinate work with shop drawings of other specification divisions.

1.6 SUBMITTALS: IN ACCORDANCE WITH SECTION 01300

A. Detailed submittal requirements are given in the individual sections.

B. Contractor shall investigate the capacity and space requirements of the proposed equipment before submitting shop drawings.

C. Factory test reports shall be submitted for acceptance prior to shipment of the equipment to the job site. Field test reports shall be submitted for acceptance prior to final acceptance of the equipment.

D. Factory test procedures shall be submitted to the engineer for approval prior to commencement of any factory testing.

E. Seismic and structural anchoring calculations shall be submitted to the engineer for approval prior to installation of equipment.

F. Operation and Maintenance manuals shall be submitted to the engineer for approval prior to acceptance of equipment, in accordance with specification section 01680.

1.7 WARRANTY

A supplier's written warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of one (1) year for start-up or 18 months from time of equipment shipment, whichever comes first.

1.8 PRODUCT HANDLING

Protect material, equipment, and apparatus provided under this section from damage, water and dust, both in storage and installed, until final acceptance. Provide temporary storage facilities for material and equipment. Material, equipment, or apparatus damaged because of improper storage or protection will be rejected. See Section 01640.

1.9 JOB CONDITIONS

A. Special Requirements:

1. Maintain emergency and service entrances usable to pedestrian and vehicle traffic at all times. Where trenches are cut, provide adequate bridging for traffic.

2. Coordinate shutdown of water, wastewater, or heating systems.

B. Schedule of Work: Arrange work to comply with schedule of construction. In scheduling, anticipate means of installing equipment through available openings in structure. See Section 01020.

C. Protection:

1. Completely cover motors and other moving machinery to protect from dirt, dust, and water during construction.

2. Cap all openings in pipe and ductwork to protect against entry of foreign matter.

3. Protect premises and work of other divisions from damage arising out of installation of work of this division.

4. Perform work in manner precluding unnecessary fire hazard.

1.10 SPECIAL TOOLS

At completion of project, provide one set of special tools required to operate, adjust, dismantle, or repair any equipment of this division, as specified in the individual sections for specific pieces of equipment. Special tools mean those not normally found in possession of mechanics or maintenance personnel.

PART 2 MATERIALS

2.1 GENERAL

A. All the mechanical equipment to be shipped disassembled shall be assembled in the manufacturer's shop to insure proper fitting of parts, then match-marked for erection, and disassembled for shipment.

B. Contractor shall be responsible for locating and installing sleeves, inserts, and supports as required during the stages of construction.

C. Contractor shall be responsible for making minor changes in the piping, and equipment locations due to structural obstructions or conflicts with work specified in other divisions.

2.2 FABRICATED STEEL

A. All steel members used in the fabrication of the equipment shall conform to the requirements or "Specifications for Structural Steel". ASTM A36. All stainless steel shall be Type 316 unless otherwise specified.

B. Design and fabrication of Structural Steel Members shall be in accordance with the latest edition of AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel Plates, Bars and Strip," Designation A-123, or of the ASTM Standard Specifications for Zinc Coating (Hot Dip) or Iron and Steel Hardware, Designation A153067, as appropriate for Buildings. All welding shall conform to the latest standards of the American Welding Society.

C. All parts shall be amply proportioned for all stresses which may occur during fabrication, erection, and operation.

D. All stainless-steel parts/equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.

2.3 BOLTS, NUTS, AND WASHERS

Bolts for the equipment assembly shall be hexagonal, refined bar iron, except where the equipment body is stainless steel, aluminum, or bronze alloy, the bolts shall be the same corrosion

resistant material. Nuts shall be hexagonal, of the same metal as the bolts. All threads shall be clean cut and shall conform to US Standard B1.1 for Unified Screw Threads.

2.4 NAMEPLATES

Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or drive pins. Nameplates to have ¼-inch letters with Equipment Name and number as shown on "I Series" Contract Drawings.

2.5 EQUIPMENT MOUNTS, GROUTING, AND VIBRATION ISOLATION

A. Where a steel or cast base is shown between the equipment and a concrete pedestal, it shall be painted after fabrication in conformance with applicable provisions of Section 09900. It also shall be equipped with drain pans and drain connections, where applicable.

B. All concrete plan dimensions for bases or pedestals shall be at least 6 inches larger in each dimension than the steel or cast base so that the distance between the anchor bolt and edge of concrete is at least 3 inches. Conduits, piping connections, drains, etc., shall be installed as shown on the Drawings, and/or standard mechanical details.

C. Where specified or noted in the Drawings, the equipment including the base, shall be mounted on or suspended from vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the supporting structure. Vibration isolation available internally in the equipment unit is not equivalent and shall not be provided when vibration isolation as specified herein is required. Normally provided internal vibration isolators need be replaced with rigid supports in such cases.

D. Details of the vibration isolators where required by certain units of mechanical equipment are included in the Specifications for furnishing and installing those units.

E. Furnish all necessary materials and construct suitable raised concrete foundations for all equipment installed, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.

F. In setting pumps, motors, and other items of equipment customarily grouted, make an allowance of at least one inch for grout under the equipment bases. All shims shall be removed. Unless otherwise approved, all grout shall be an approved non-shrink grout.

G. Grout shall be mixed and placed in accordance with the Manufacturer's installation instructions and/or Section 03100, whichever is more stringent. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form

so constructed as to provide a suitable chamfer around the top edge of the finished foundation.

H. Where such procedure is impracticable, the method of placing grout shall be as approved. After the grout has hardened sufficiently, all forms, hoppers and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, if necessary, given a burlap-rubbed finish, and painted with at least two coats of an approved paint.

2.6 ANCHOR BOLTS

A. Anchor bolts for all equipment and appurtenances shall be furnished and installed as specified herein and/or as shown on the Drawings. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum over-sizing of ¼-inch. Minimum anchor bolt diameter shall be 1/2 inch. All anchor bolts shall be furnished with leveling nuts, the faces of which shall be tightened against flat surfaces as shown to not less than 10 percent of the bolt's safe tensile stress.

B. Equipment manufacturer shall provide structural calculations for all equipment weighing more than 400 pounds. In addition, any equipment weighing more than 50 pounds that is hung from the structure above or from a wall shall have structural calculations. Further, all equipment taller than 5-feet shall have structural calculations. Structural calculations and details shall conform to the requirements of the CBC including Section 1613 and in accordance with contract specification Section 01610. Calculations shall be signed and stamped by a California Registered Civil or Structural Engineer.

1. All equipment inside water bearing structures shall also be designed to withstand sloshing, in accordance with ACI 350.3 and Specification Section 01610. Contractor shall provide stamped and signed calculations to verify compliance.

C. It shall be the responsibility of the equipment manufacturer to determine the number, size, and location of all anchor bolts to be set in concrete. Unless indicated otherwise on the drawings, anchor bolts, nuts, and washers shall be galvanized steel, except in wet or corrosive locations they shall be Type 316 stainless steel.

D. Obtain anchor bolt templates from the equipment manufacturer to aid in locating anchor bolts in the concrete pad.

E. No equipment shall be anchored to vertical or overhead structural elements without written approval of the Engineer.

2.7 SEISMIC CONSIDERATIONS

A. Vibration-isolated equipment shall be provided with snubbers capable of retaining the equipment in its designated locations without any material failure or deformation of the snubbers when exposed to a vertical or horizontal force at the contact surface equal to 100 percent of the operating weight of the equipment. Air gaps between retainer and equipment base shall not exceed 1/4 inch.

B. Inasmuch as most anchorage of equipment is to be made of poured-in-place concrete elements, it is imperative that types of anchorage be coordinated with the Contractor so that anchorage may be installed at time of pouring. If calculations and anchorage details are not submitted prior to pouring of concrete, the Contractor will become responsible for any strengthening of concrete elements because of superimposed seismic loading.

C. All piping, raceways, ductwork, accessories, appurtenances, etc., furnished with equipment shall be anchored to resist a lateral seismic force of 40 percent of its operating weight without excessive deflection. This force shall be considered acting at the center of gravity of the piece under consideration.

D. Piping with flexible connection and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system.

2.8 BELT DRIVES

A. V-belt with cast iron sheaves rated not less than 1-1/2 times motor horsepower.

B. Multiple V-belts shall be matched sets.

2.9 SHAFT COUPLINGS

A. Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger shall be non-lubricated type, designed for not less than 50,000 hours of operating life. Where requirements of the equipment dictate specialized features, the manufacturer may substitute the coupling normally supplied for the service.

B. Coupling sizes shall be as recommended by the manufacturer for the specific application, considering horsepower, speed of rotation, and type of service. The use of couplings as specified herein shall not relieve the Contractor of his responsibility for precision alignment of all driver-driven units as specified by the equipment manufacturer.

C. Couplings shall be of the pin and pre-loaded neoprene cylinder type, designed to accommodate shock loading, vibration and shaft misalignment or offset. Stub shafts shall be connected through collars or round flanges firmly keyed to their shafts, to neoprene cylinders held to individual flanges by through pins. Couplings with cylinders pinned to both coupling flanges will not be acceptable.

2.10 BEARINGS

A. Unless otherwise specified all equipment bearings shall be oil or grease lubricated, ball or roller anti-friction type of standard manufacturer. Bearings shall be conservatively designed to withstand all stresses of the service specified and shall be selected on the basis of a 60 degrees C ambient temperature. Each bearing, except when otherwise noted, shall be rated in accordance with the latest revisions of AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings for one of the following classes of B-10 rating life:

Class M1	8,000 hours of operation
Class M2	20,000 hours of operation
Class M3	50,000 hours of operation
Class M4	100,000 hours of operation
Class M5	200,000 hours of operation

B. Unless otherwise noted, all process-associated equipment, including motors, drivers and driven units shall have, as a minimum, bearings for Class M3 life.

C. All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type designed for use with quick hydraulic couplings attached to grease guns. All equipment shall be equipped with an identical type of grease fittings, Alemite, Zerk, or equal.

D. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gauge. To avoid work hardening or "brinelling" damage from vibration, bearings shall be removed and shipped separately, or rotors shall be locked in place to prevent movement during transport.

2.11 GUARDS

A. All exposed moving parts shall be protected with guards in accordance with the requirements of the State Division of Safety Standards.

B. Belt guards shall be fabricated of 16 gauge, expanded metal or wire screen with 70 percent free area and steel frame, covered both sides. Provide visual inspection of moving parts and insertion of tachometer without removal of guard. Provide access door in guard to permit checking of belt tension. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts.

C. Shaft guards shall be solid 16 gauge galvanized steel, inverted "U" shape trough cover over entire length of exposed horizontal shafts, and tubular shape for vertical shafts. Extend

cover to below bottom of shaft and couplings. Provide for lubrication of bearings without requiring removal of cover.

D. All equipment with exposed moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION - AUTOMATIC EQUIPMENT - MAY START AT ANY TIME". Signs shall be 10 inches by 14 inches in size and shall be constructed of corrosion-proof material with a heavy-duty porcelain enamel finish or 1/8" thick butyrate or fiberglass. Letters shall be white in a red oval on a black background. Signs shall be installed near exposed moving parts.

2.12 ELECTRIC MOTORS

A. Standards: Motors shall be built in accordance with IEEE Standards, NEMA Standard MGI, latest revision, and to the requirements specified herein. Where a conflict may exist, these specifications take precedence.

B. Type: Motors specified herein are three-phase squirrel cage for 1/2 HP and above; or single-phase types for less than 1/2 HP; or D.C. for D.C. Variable Speed Drives.

C. Rating: Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where detailed on the Electrical Drawings to be operated on a reduced voltage starters, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method. Each VFD shall be one horse power size larger than required motor size.

D. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.

E. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient unless noted otherwise.

F. Specific motor data such as HP, Service Factor, RPM, enclosure type etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.

G. Single Phase Motors: Single phase 120, 208, or 230 volt motors shall have integral thermal overload protection or shall be inherently current limited.

H. Thermostats: Where indicated or specified, winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be pre-calibrated by the manufacturer. All inverter duty motors shall be provided with winding thermostats, unless RTDs are specified. All explosion-proof motors shall be provided with winding thermostats.

I. See electrical specifications for additional details.

2.13 NAMEPLATES

The motor manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.

2.14 SUBMITTAL DATA

Submittal of motor data for acceptance shall include complete nameplate data in accordance with NEMA Standards cited above and, in addition, the following for motors 3 hp or larger:

A. Ambient temperature rating.

B. Service factor.

C. Efficiency at 1/2, 3/4 and full load.

D. Power factor at 1/2, 3/4 and full load.

E. Motor outline, dimensions and weight.

F. Descriptive bulletins, including full description of insulation system.

G. Bearing design data.

H. Special features (i.e., space heaters, temperature detectors, etc.).

I. Wiring diagrams for motor power leads, over-temperature switch, heater and moisture monitoring.

2.15 CONDENSATION HEATERS

Condensation heaters, where specified under the detailed mechanical specifications shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 V, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor lead junction box.

2.16 WINDING TEMPERATURE DETECTORS

Where specified under the detailed mechanical specifications for individual equipment or on all A.C. motors to be connected to a variable speed drive, there shall be a factory installed winding temperature detector consisting of 3 thermostats (1 per phase) wired in series, with leads terminating in the main conduit box. This device shall protect the motor against damage for overheating caused by single phase, over load, high ambient, abnormal voltage, locked rotor, frequent starts or ventilation failure. The protective device shall have normally closed contacts rated 120VAC, which opens on high motor temperature. Not less than two (2) sets of three (3) detectors shall be furnished with each motor requiring such detector with one left as a spare. Temperature detectors shall be TI Klixon 9700 series or equal.

2.17 SUBMERSIBLE TYPE1 PROTECTION DEVICES

Where specified under the detailed mechanical specifications for individual equipment, furnish and install at the motor control center (unless indicated otherwise) a solid state device that provides a warning signal when the motor oil reaches a certain level of contamination by water. The contamination level is determined by measuring the resistivity of the motor oil bath. The resistivity shall be measured using a probe (di-electrode). The probe is connected to a lead, which runs back through the motor cables to the sensing device. The sensing device shall trip an auxiliary relay at low resistance (100K ohms or lower), to provide an alarm. The submersible Type 1 protection device shall be ABS Pumps Inc., Sealminder or equal.

2.18 SUBMERSIBLE TYPE 2 PROTECTION DEVICES

Where specified under the detailed mechanical specifications for individual equipment, furnish and install at the motor control center (unless indicated otherwise) a solid state protection device for monitoring the temperature and leakage detectors installed at the equipment. The solid state device shall operate on the current sensing principal whereby a change in temperature or leakage condition shall change the resistance of the associated sensor and thus alter the current in the sensing circuit. The protection device shall contain two sets of dry contacts, one for over temperature and one for leakage. The dry contacts will change state upon occurrence of an over temperature or leakage condition so as to shutoff the equipment on over temperature and provide an alarm for leakage. The submersible Type 2 protection device shall be Flygt, ITT Industries MiniCAS or equal.

2.19 SUBMERSIBLE TYPE 3 PROTECTION DEVICES

A. Each pump shall be provided with its own self-contained control and status protection device module which shall be mounted within the motor control center (unless indicated otherwise). This module shall operate from a 24 VAC transformer furnished with module and shall provide a single point within the control system for pump sensor output processing. The protection device module shall have a manual reset so that the operator must locally restart the pump and thus be provided with local indication as to the cause of pump stoppage.

B. The protection device module shall interface for the direct connection of all pump/motor internal monitoring devices by furnishing the module with four (4) 24 VAC Relays for the following functions.

1. Stator winding over temperature protection (stops pump, local LED indication).

2. Stator leakage alarm (local LED indication and contacts for remote alarm indication).

3. Lower bearing temperature protection (adjustable, stops pump, local LED indication).

C. The submersible Type 3 protection device shall be Flygt, ITT Industries, CAS or equal.

2.20 SINGLE PHASE MOTORS

A. General: Unless otherwise specified, motors smaller than 143T (1/2 hp) frame shall be single phase, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment. Wound rotor or commutator type single-phase motors are not acceptable unless their specific characteristics are necessary for the application.

B. Voltage: Motors shall be rated for operation at 115 volts, single phase, 60 Hz. Should unusual conditions require a three-phase motor on a frame smaller than 143T, it shall be designed for 200 volts, three phase, 60 Hz, but only after written approval has been received from the Engineer.

C. Enclosure: Motors shall be totally-enclosed in conformity with NEMA Standard MG1-10.35. Small fan motors may be open type if suitably protected from moisture, dripping water and lint accumulation.

1. Locked rotor current shall not be greater than specified in NEMA Standard MG1-12.32, Design "N".

D. Bearings: Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

2.21 THREE PHASE MOTORS - FRAMES 143T THROUGH 449T

A. General: All motors 1/2 HP and larger shall be on a NEMA frame 143T or larger. Motors shall be designed and connected for operation on a 240 or 480 volt, 3 phase, 60 hertz alternating current system, as applicable. Dual voltage (230/460) rated motors are acceptable.

B. All motors shall be NEMA Design B, normal starting torque unless noted otherwise, Starting KVA/HP (Locked rotor) shall not exceed the values given in NEMA Standard

MG1-10.37. Motors shall be manufactured by US Motors, General Electric, Westinghouse, Reliance, or equal.

C. Bearings: Anti-friction motor bearings shall be designed to be re-greasable and initially shall be filled with grease suitable for ambient temperatures to 40 degrees C. Bearings shall be AFBMA Types BC or RN, heavy duty, or shall otherwise be shown to be suitable for the intended application in terms of B-10 rating life, Class M3 or better.

1. All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type as manufactured by the Alemite Division of the Stewart-Warner Corporation.

D. Insulation: Insulation systems shall be Class B or F (except as modified below) and shall be the manufacturer's premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.

E. Enclosures: Motors shall have a cast iron frame and cast iron or stamped steel conduit box. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking non-hygroscopic insulating material. A pad with drilled and tapped hole, not less than 1/4-inch diameter, shall be provided inside the conduit box for a motor frame grounding stud.

Motors weighing more than 50 pounds shall be equipped with at least one lifting lug. All hardware shall be corrosion resistant. Motors shall be delivered with manufacturer's standard paint.

The following specific features are required in addition to the preceding general specifications for the motor enclosures noted:

1. Open Drip Proof - Manufacturer’s standard design with Class B insulation, stamped steel motor lead junction boxes and 1.15 service factor (@ 40 degrees C).

2. Totally Enclosed Fan Cooled - TEFC motors shall include Class B insulation, cast iron junction box, 1.15 service factor (@ 40 degrees C) tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger), upgraded insulation by additional dips and bakes to increase moisture resistance.

3. Explosion Proof - Explosion proof motors shall include Class B insulation, 1.15 service factor (@ 40 degrees C). Tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain/drain devices for frames 324T and larger), UL label for Class 1, Division 1, Group D Hazardous areas.

4. Severe Duty - Motors shall be of the corrosion resistant type conforming to motors designated by the manufacturer as "Chemical Duty", "Mill and Chemical", "Custom Severe Duty", or similar applicable manufacturer's quality designation. Severe duty

motors shall include Class F insulation (applied at Class B rise), 1.15 service factor (@ 40 degrees C), tapped drain holes (corrosion resistant plug for frames 286T and smaller automatic breather/drain devices for frames 324T and larger), epoxy finish, upgraded insulation by additional dips and bakes to increase moisture resistance.

5. Submersible - Motors shall be housed in a watertight casing and shall have Class F insulated windings which shall be moisture resistant. Pump motors shall have cooling characteristics suitable to prevent continuous operation in a totally, partially, or non-submerged condition continuously without overheating or other damage. The power cable shall be of adequate length to allow the unit to be wired as detailed on the electrical drawings without splices.

6. Inverter Duty – Motors shall be premium efficient design with inverter grade (Class H) insulation. Each inverter duty motor shall meet NEMA MG-1, Part 31 specifications for variable frequency drive (VFD) inverter duty applications. Motors shall be US Motors 841 Plus or equal.

7. Efficiency - Unless otherwise specifically specified for a specific motor, all motors shall be high-energy efficient type. Efficiencies shall be as determined in accordance with IEEE Standard 112 and NEMA MG-1-12.59. Motors shall be US Electric Motors "Premium Efficiency"; Baldor "Super-E", or equal.

2.22 ELECTRICAL DEVICES FURNISHED WITH MECHANICAL EQUIPMENT

A. Control panels supplied with mechanical equipment shall have the control switches, indicating lights, relay logic, and dry contact SCADA interfaces as indicated for each panel on the P&ID Drawings. Unless otherwise specified or shown all electrical power, control or instrumentation devices furnished as a "package" with mechanical equipment shall conform to the latest issue and addenda to the Joint Industry Council Electrical Standards for Mass Production Equipment (EMP-1-67), applicable NEMA Standards, National Electric Code (NEC 1999), or as modified herein.

B. Panels housing electrical equipment shall be NEMA rated for area into which panel is to be installed as shown on Contract Electrical Drawings. NEMA 4X panels shall be stainless steel. NEMA 1, 12 or 3R panels shall be galvanized steel, electrostatic applied baked enamel, painted gray. Panels located in Class 1 locations shall be explosion proof.

C. Devices mounted in non-ventilated panels shall be rated for a 50 degrees C (122 °F) ambient. Panels with devices rated less than 50 degrees C shall have ventilation fans and louvers. Louver openings shall have removable metal filters. All outdoor panels shall have heaters with guards and thermostat. Fans and heaters shall be powered from panel internal 120VAC control power.

D. A main panel power disconnect device to disconnect all power within the panel shall be an integral part of the panel and shall be one of the following types:

1. A horsepower rated heavy-duty fused safety switch or circuit breaker for 480, 240, or 208 volt, 1 phase or 3 phase panels. An outer door mounted operator for each switch or breaker padlockable in the off position shall be provided.

2. Circuit breaker for 120 volt, 1 phase panels.

E. Individual motor circuit protector (magnetic only circuit breaker) or fused protection shall be provided for each motor feed from panel.

F. All panels supplied with a 480-volt power feeder shall be provided with an integrally mounted dual winding 120-volt secondary control power transformers with primary and secondary fusing. Control power transformers shall have the neutral grounded.

G. All door mounted devices shall be of a heavy-duty industrial type quality. Lights, switches and pushbuttons shall be standard 30mm diameter, NEMA 13, U.L. listed and water & oil tight. All outer door mounted devices shall have black phenolic nameplates with 3/16" (minimum) white letters fastened by device assembly or stainless steel screws.

H. All indicating lights shall be full voltage 120VAC, LED type with push to test switch and wiring. Light lens colors shall be as follows:

Open/On	Green
Closed/Off	Red
Alarm/Trouble	Amber
Power On	White

I. Control relays shall be plug-in type with clear see-through sealed housing. Provide relay energized neon lamp or LED inside relay housing.

J. Time delay relays shall be solid state, plug in type with LED timer energized indicator lights.

K. All fuse shall have visible blown fuse indicator lights.

L. Contacts for external status, alarms or equipment interlocking shall be of the isolated contact type and provided as required per individual equipment specifications or Process and Instrumentation "I-Series" Drawings. Contacts shall be rated 10 amps at 120VAC continuous pilot duty. Alarm contacts shall be of the maintained latching contact type, requiring manual reset. Reset pushbuttons shall be provided and located on outer door for latching alarms.

M. Motor starters shall be magnetic, 120VAC coil solenoid operated, NEMA rated for horsepower of supplied equipment, contactor type, with chatter-proof armatures. Each motor starter to have a normally open and a normally closed auxiliary contacts. Provide one bimetallic type thermal overload relay for each phase.

An outer door insulated mechanical reset mechanism shall be installed for each motor starter thermal overload reset.

N. Watertight gasketed conduit hubs shall be used for all conduit penetrations to outdoor panels. Conduit entries to outdoor panels shall not enter top of panels.

O. Auxiliary devices (pressure switches, flow switches, etc.) located remotely from panels but furnished under this Section shall have enclosures as specified in the individual mechanical sections, or in conformance with the NEMA area classification noted on Contract Electrical drawings.

P. Schematic (elementary) or connection wiring diagrams, and equipment material lists shall be furnished for all panels. For panels containing a complex control scheme, a written operational theory shall be cross-referenced to the schematic diagram. The wiring diagram in its "as built" form shall be fastened to the panel door when panel is delivered to jobsite. The equipment material list shall identify the actual manufacturer, manufacturer's part or model number and a cross-reference as to its location in the panel. Generic part or model numbers are not to be used in material lists.

2.23 WIRING

A. Conductors extending beyond a panel to other auxiliary equipment which is pre-wired on a skid type or package base shall be protected by galvanized rigid steel conduit. Where terminating at a motor or other similar device requiring frequent movement or which produces excessive vibration liquid tight type flexible conduit shall be used. Liquid tight conduit will be limited to three (3) feet maximum length at any termination. All pre-wired wiring shall be copper, #14 AWG minimum.

B. Input or output instrumentation level signals shall be 4-20 mA and provided as required per the individual equipment specification and Process & Instrumentation “I-Series” drawings. All signal wiring shall have copper twisted shield pairs with overall shield.

C. Separate power, control and instrumentation terminal strips shall be provided for all external panel connections. All terminal points shall have black machine printed identification numbers on white background.

D. All wires inside panels and on pre-wired packages and skids shall have wire labels at each end point. Wire labels shall be white shrink tubes with permanent ink black machine typed lettering.

2.24 PRESSURE GAUGES

Pressure gauges furnished with mechanical equipment shall be as specified in Section 15080.

2.25 TOOLS AND SPARE PARTS

A. All special tools required for exclusive operation and maintenance of respective items of equipment shall be furnished with those items of equipment by the manufacturer. This includes special tools, instruments, accessories required for proper "in-plant" adjustment, maintenance, overhaul, and operation. Tools shall be high-grade, smooth, forged, alloy tool steel.

B. All tools and spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The tools and spare parts shall be delivered and stored in a location as directed.

C. Spare parts for certain equipment provided under Divisions 11, 15, and 16 have been specified in the pertinent Sections of the Specifications. All spare parts shall be collected and stored in a designated area. In addition, an inventory listing all spare parts, the equipment they are associated with, the name and address of the supplier, and the delivered cost of each item shall be furnished. Copies of actual invoice for each item shall be furnished with inventory to substantiate the delivered.

2.26 LUBRICANTS

Provide all mechanical equipment with a sufficient supply of correct lubricant for starting, testing, and an initial 120-day operation period. All lubricants shall be of types recommended by the applicable equipment manufacturer. Subject to the approval of the equipment manufacturer's, lubricants shall be limited to the least number or types required for normal maintenance of all equipment. Not less than 90 days before the date scheduled for field testing of equipment three (3) copies of a listing indicating all lubricants for item of mechanical equipment shall be provided. Unless otherwise noted, all grease lubrication fittings shall be of an approved standard hydraulic type.

2.27 LIFTING LUGS

Lifting lugs shall be provided for all equipment weighing 50 pounds or more.

2.28 VIBRATION

A. This section specifies the maximum allowable vibration levels for all mechanical equipment over 20 horsepower. Additional requirements that may be more stringent may also be listed in individual equipment specifications. In that case, the more stringent of the two requirements shall apply. Testing of equipment at the factory and in the filed as identified in PART 3 of this specification shall demonstrate compliance with the specified vibration limits. All vibration tests shall be conducted under actual operating conditions:

1. Unfiltered readings at each unit shall have less than the following peak to peak amplitudes.

Operating Speed (revolutions per minute)	Centrifugal Blowers	Unfiltered (Overall) Peak-to-Peak Amplitude (mils)		
		Other Rotating Equipment	Non-Clog Mixed Flow Pumps	Clean Fluid Pumps
0 - 300	N/A	5.0	6.0	6.0
301 - 600	N/A	4.0	5.0	5.0
601 - 900	N/A	3.0	4.0	3.0
901 - 1,200	N/A	2.0	3.5	2.0
1,201 - 1,500	N/A	1.8	3.0	1.8
1,501 - 1,900	N/A	1.5	2.5	1.5
1,801 - 2,400	N/A	1.0	2.0	1.0
2,401 - 3,000	N/A	0.8	1.5	0.8
3,001 - 3,600	1.25	0.7	1.3	0.7
Above 3,600	1.0	0.6	1.2	0.6

2. Vibration Velocity Limits: Unless otherwise specified, equipment is not to exceed the following peak velocity limits:

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Non-Clog or Mixed Flow Pumps	0.35	0.25
Clean Fluid Pumps	0.25	0.20
Motors and Steady Bearings	0.25	0.20
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	
Other Reducers, Axial	0.10	0.10
Centrifugal Blowers	0.15	0.10

B. For all equipment, axial shaft vibration displacements (relative to casing) shall not exceed 50 percent of the maximum lateral shaft vibration displacements (relative to casing existing at any point along the shaft).

C. The above vibration responses are to include the range from 5.0 Hz to 5000 Hz and shall therefore encompass both low and high frequency responses of the subject equipment. The measurements shall be obtained with the equipment installed and operating at any capacity within the specified operating range. In addition to these maximum unfiltered readings, it is also stipulated that no narrow band spectral acceleration component, whether sub-rotational, higher harmonic or asynchronous multiple of running speed, shall exceed 40 percent of the synchronous displacement amplitude component without manufacturer's detailed verification of the origin and ultimate effect of said excitation.

Any equipment showing excessive vibration shall be corrected by the Contractor at his expense and the equipment retested.

D. The Contractor shall furnish a written report covering all the test values and data for each unit tested.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Belt Driven Equipment: Mount with motors on common steel base with adjustable motor mount.

B. Pumps: Align pump and motor. Completely fill steel and cast iron pump bases with concrete grout after properly set.

C. Install equipment so nameplates are visible.

D. Basis for equipment and material installation is the published recommendations of manufacturer. Submit such recommendations for review.

E. Pipelines and other connections to mechanical equipment shall be installed square and shall not put in strain or use the equipment for support unless it is specifically designed for it.

3.2 IDENTIFICATION

A. Provide manufacturers' nameplates on all equipment, identifying manufacturer's name, model number, size, capacity, and electrical characteristics.

B. Leave all manufacturers' nameplates clean and legible. Install all equipment so view of nameplates is not obstructed.

C. Identify all equipment with symbol number and service as shown. Identification shall be on 1-1/4 inch by 3 inch, or larger nameplates, securely fastened to equipment.

D. Provide engraved identification of function on switches and manually operable controls.

3.3 CLEANING

A. During progress of work, keep premises reasonably free of debris, cuttings, and waste material. Upon completion of work, and at other times as directed, remove all such debris from premises.

B. Clean equipment and materials. Remove foreign materials including dirt, grease, splashed paint, and plaster. Restore to original condition any finish damaged.

3.4 FACTORY QUALITY CONTROL TESTING

A. All pumps and mechanical equipment shall receive the following minimum factory testing. Additional testing requirements may be specified in the individual equipment specification sections.

B. All pumps shall be provided with manufacturer's standard factory quality control testing as modified herein.

C. All pumps greater than 5 horsepower shall receive a hydrostatic test of the pump casing at 1.5 times the pump shut off head.

D. All pumps shall be statically and dynamically balanced and shall have a certified balancing report.

E. All pumps 5 horsepower and above shall receive a standard manufacturers bench test that shall include a minimum of 5 test points defining the pump curve. Test points shall correspond to the design points given in the individual pump specification.

The remaining test points shall define the pump curve above and below the specified design conditions. In addition, pump shut off conditions shall also be tested. Test procedures shall follow appropriate sections of the Hydraulic Institute Standards in addition to the requirements in this and other Sections.

1. As a minimum, pump head, flow, power, speed, efficiency and NPSH shall be determined and recorded.

F. All pumps scheduled to be driven by variable frequency drives shall be factory tested with a minimum of 5 test points at full speed and 5 test points at each speed specified under the design conditions in the individual pump specifications. If no alternate speed conditions are specified, 5 test points shall be provided at the minimum operating speed of the pump as recommended by the Manufacturer.

G. Vertical turbine pumps shall have bowl tests only.

H. Pump Test Tolerances: In accordance with appropriate Hydraulic Institute Standards, except the following modified tolerances apply:

1. From 0 to plus 5 percent of head at the rated design point flow.

2. 0 to plus 5 percent of flow at the rated design point head.

3. No negative tolerance for the efficiency at the rated design point.

4. No positive tolerance for vibration limits. Vibration limits in Hydraulic Institute Standards do not apply, use limits specified in this Section of the Specifications.

I. All non-submersible pumps greater than 10 horsepower shall also be tested for vibration in each plane at each exposed bearing location, on the pump, and on the motor. Vibration limits shall meet the requirements specified in Section 2.28 or more stringent requirements if specified in the individual equipment specifications.

J. All non-submersible pumps and non-vertical turbine pumps greater than 15 horsepower shall also receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height (set up temporary facilities to replicate field conditions, as shown on the contract drawings, including surrounding piping and walls). Pump and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications. Pumps will need to pass the same noise test in the field, using actual installed conditions (including surrounding facilities), as described in the below the field performance testing section. If the pump does not meet noise limitations in the factory or installed field condition, manufacturer shall take immediate steps to correct the issue and limit the noise below allowable limits.

K. For all pumps, except vertical turbine pumps, the actual job motor shall be used unless an alternate means of driving the equipment is agreed to by the Engineer prior to testing.

L. All mechanical equipment shall be provided with the manufacturer's standard factory quality control tests, which shall clearly demonstrate conformance with the specifications and the specified manufactured equipment is free from defects. Standard tests shall be as modified herein.

M. All blowers for aeration or channel air systems shall be provided with a standard ASME PTC-13 (wire to air) test at the blower rated speed. Blower airflow shall be adjusted based on inlet throttling or blower speed to match the blower service specified. All blowers for aeration or channel air systems shall be provided with a hydrostatic test to 15 psig.

N. All blowers over 40 horsepower shall also be tested for vibration in each plane at each exposed bearing location, on the blower, and on the motor. Vibration limits shall meet the requirements specified in Section 2.28 or more stringent requirements if specified in the individual equipment specifications.

O. All blowers and Fans over 10 horsepower shall receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height (set up temporary facilities to replicate field conditions, as shown on the contract drawings, including

surrounding piping and walls). Blower and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications. Blowers and fans will need to pass the same noise test in the field, using actual installed conditions (including surrounding facilities), as described in the below the field performance testing section. If the blower/fan does not meet noise limitations in the factory or installed field condition, manufacturer shall take immediate steps to correct the issue and limit the noise below allowable limits.

P. All other rotating equipment greater than 40 horsepower shall be tested for vibration in each plane at each exposed bearing location, on the blower, and on the motor. Vibration limits shall meet the requirements specified in Section 2.28 or more stringent requirements if specified in the individual equipment specifications.

Q. All other rotating equipment greater than 40 horsepower shall receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height (set up temporary facilities to replicate field conditions, as shown on the contract drawings, including surrounding piping and walls). Blower and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications. Equipment will need to pass the same noise test in the field, using actual installed conditions (including surrounding facilities), as described in the below the field performance testing section. If the equipment does not meet noise limitations in the factory or installed field condition, manufacturer shall take immediate steps to correct the issue and limit the noise below allowable limits.

R. For all mechanical equipment, the actual job motor shall be used unless an alternate means of driving the equipment is agreed to by the Engineer prior to testing.

3.5 TEST WITNESSING

Factory tests shall be non-witnessed unless specified in the individual equipment specifications. When factory tests are indicated as witnessed, the costs for witnessing the tests by the Engineer, travel, and lodging costs shall be born by the Owner for the first test. All such costs for any subsequent factory re-testing required shall be born by the Contractor. The Contractor shall notify the Owner in writing a minimum of 21 calendar days prior to commencement of witnessed factory tests.

3.6 FIELD REPORTS

Submit reports for Field and Factory testing. Report features:

A. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.

B. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.

C. Include appendix with sample calculations for adjustments to raw test data and for calculated results.

D. Include appendix with the make, model and last calibration date of instrumentation used for test measurements.

E. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.7 FIELD QUALITY CONTROL TESTING

A. Temporary Facilities and Labor: Provide all necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing. With Owner's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

B. Instrumentation: Provide all necessary test instrumentation, which has been calibrated within one year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

C. Field Quality Control Tests: Schedule test date and notify Engineer at least 7 days prior to start of test. Test Measurement and Result Accuracy:

D. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments.

E. Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

3.8 FIELD TESTING

A. All pumps and mechanical equipment shall receive the following minimum field testing. Additional field testing requirements may be specified in the individual equipment specification sections.

B. Submit test plan indicating test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on Owner's existing equipment and other information relevant to the test.

C. Perform general start-up and testing procedures for the equipment as recommended by the Manufacturer's written start up instructions.

D. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested and that the manufacturer's representative has certified proper installation of the equipment.

E. All mechanical pumps and equipment shall be given an 8-hour performance test and a 5-day facility startup/operational test in accordance with Section 01670. Equipment shall be operated continuously under normal operation as intended by the Contract Documents. Operational testing shall include automatic control and instrumentation systems. Any equipment or control systems that fail to perform properly shall be corrected and retested by the Contractor. Upon completion of a satisfactory operational test, a certificate of completion shall be prepared and signed by the Owner.

F. In addition to an operational test, certain mechanical equipment and pumps shall be given a field performance test as specified herein to demonstrate the complete system as installed meets the specified performance requirements.

G. All operational and performance testing shall be completed and accepted prior to acceptance of the equipment by the Owner. Equipment warranty periods shall not begin until final acceptance of the equipment by the Owner.

3.9 FIELD PERFORMANCE TESTS FOR PUMPS

A. All pumps shall be provided with a field performance test in accordance with applicable Hydraulic Institute Standards in addition to the requirements in this and other Sections.

B. All pumps 5 horsepower and smaller shall receive a field test that shall include testing the pump at the specified design condition. Pump Flow, head, and horsepower shall be recorded.

C. All pumps greater than 5 horsepower shall receive a field test that shall include a minimum of 5 test points defining the pump curve. Test points shall correspond to the design points given in the individual pump specification. The remaining test points shall define the pump curve above and below the specified design conditions. In addition, pump shut off conditions shall also be tested. Test procedures shall follow appropriate sections of the Hydraulic Institute Standards in addition to the requirements in this and other Sections. As a minimum, pump head, flow, power, speed, efficiency and NPSH shall be determined and recorded.

D. All pumps scheduled to be driven by variable frequency drives shall be tested with a minimum of 5 test points at full speed and 5 test points at each speed specified under the design conditions in the individual pump specifications. If no alternate speed conditions are specified, 5 test points shall be provided at the minimum operating speed of the pump as recommended by the Manufacturer.

E. Vertical turbine pumps shall be tested as a complete system after assembly.

F. Pump Test Tolerances: In accordance with appropriate Hydraulic Institute Standards, except the following modified tolerances apply:

1. From 0 to plus 5 percent of head at the rated design point flow.
2. 0 to plus 5 percent of flow at the rated design point head.
3. No negative tolerance for the efficiency at the rated design point.
4. No positive tolerance for vibration limits. Vibration limits and test methods in Hydraulic Institute Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

G. All non-submersible pumps greater than 10 horsepower shall also be tested for vibration in each plane at each exposed bearing location, on the pump, and on the motor. Vibration limits shall meet the requirements specified in Section 2.28 or more stringent requirements if specified in the individual equipment specifications.

H. All non-submersible pumps greater than 15 horsepower shall also receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Pump and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

I. For all pumps, the actual job motor or driver shall be used.

J. Submit for engineering approval an alternative plan or waiver to the above listed field testing in cases where a certified pump curve has been provided by the manufacturer (as specified in the technical specifications) and there is insufficient water or appurtenances available to perform the field test. Submittal of alternative plan does not guarantee engineering acceptance.

3.10 FIELD PERFORMANCE TEST FOR MECHANICAL EQUIPMENT

A. All mechanical equipment shall be provided with a field performance tests.

B. Test all mechanical equipment at rated design conditions. Record equipment horsepower, speed, and other process performance parameters. Demonstrate compliance with the specified design conditions.

C. All equipment over 20 horsepower and shall also be tested for vibration in each plane at each exposed bearing location, on the machine, and on the motor. Vibration limits shall meet the requirements specified in Section 2.28 or more stringent requirements if specified in the individual equipment specifications.

D. All blowers and Fans over 2 horsepower and all other equipment over 20 horsepower shall receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Blower and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

E. For all mechanical equipment, the actual job motor or driver shall be used.

3.11 FIELD REPORTS

A. Submit reports for field performance testing. Report features:

B. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.

C. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.

D. Include appendix with sample calculations for adjustments to raw test data and for calculated results.

E. Include appendix with the make, model and last calibration date of instrumentation used for test measurements.

F. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.12 PRELIMINARY OPERATION

Operate any portion of installation if requested. Such operation does not constitute acceptance of the work as complete.

3.13 STARTUP SERVICE

A. Prior to startup, check auxiliary connections, lubrication, venting, controls, wiring, equipment for proper rotation, and install and properly set relief and safety valves to insure readiness of systems.

B. Start and operate all systems. All mechanical equipment and systems shall be placed in service by qualified factory authorized technicians who shall provide a written statement that the equipment has been installed and placed in service as recommended by the manufacturer. If, in the opinion of the Engineer, a start-up technician is not qualified or competent to work on a particular piece of equipment, the Contractor shall replace that person with one who is qualified and competent.

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SECTION 11334

PERFORATED PLATE SCREEN AND WASHER COMPACTOR

PART 1 GENERAL

1.1 DESCRIPTION

Scope: The work of this section consists of furnishing and installing two (2) fine screens with perforated filter panels, two (2) screenings washer/compactors and associated controls. The screening mechanism will be installed into the existing headworks. The screens and washer/compactor shall be provided by the same manufacturer. All equipment supplied shall be rated for a Class I, Division 1, Group C and D hazardous environment.

1.2 EQUIPMENT TAG NUMBER

Tag Number	Equipment Name
SCR A3111	Headworks Screen No. 1
WSH/CMP A3121	Headworks Washer/Compactor No. 1
SCR A3211	Headworks Screen No. 2
CMP A3211	Headworks Washer/Compactor No. 2

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 01680 – Operating and Maintenance Manuals

C. Section 09900 – Painting and Finish Schedule

D. Section 11010 – General Mechanical Equipment Provisions

E. Division 16 – Electrical

1.4 SUBMITTALS

A. In accordance with Specification Section 01300, the Manufacturer shall furnish shop drawings, parts lists, complete descriptive literature, catalog cut sheets, engineering and physical data, etc. as necessary to fully describe and define all items to be furnished under this specification. The submittals shall include:

1. Certified general arrangement drawings showing all important details including materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
2. A list of all deviations from drawings and specifications.
3. Descriptive literature, bulletins and/or catalogs of the equipment.
4. Complete data on motors and gear reducers.
5. Wiring diagrams and electrical schematics for all control equipment to be furnished.
6. Describe the automatic adjusting cleaner brush and secondary deflector roller.
7. Describe method of checking and adjusting drive chain tension.
8. Provide details of the area at the bottom of the screen to show how the screen will pick up large objects off the channel floor.
9. Provide details of the bottom of the screen that shows the method employed to prevent buildup of grit and small stones beneath the screen and to prevent wear on the screen elements.
10. Provide independent certified test data confirming screen capture efficiency (or SCR value) with perforated panels of the same size as specified herewith. Testing shall confirm the percentage of all material captured by the screen as documented by an independent third party laboratory (the National screen evaluation facility at Chester Lee Street in England by TRPM and Northumbrian Water). The documented report of the test which shows the result of screenings capture rate (SCR) must be provided with submittals.
11. Submit hydraulic calculations verifying each screen can handle 24.7 MGD with 34-inches of downstream water elevation and 30% blinding that results in less than 12-inches head loss, stamped and signed by a California registered professional engineer.
12. Submit seismic calculations, stamped and signed by a California registered professional engineer, in accordance with Specification Section 01610 and 01615.
13. Manufacturer's installation instructions, parts list, and operating and maintenance instructions. Provide operation and maintenance manuals in accordance with Specification Section 01680.
14. Provide startup services and training in accordance with Specification Section 01670 and 01675.

15. Electrical Information:

    a. Electrical Drawings including, but not limited to:

        1) Three line or one drawings detailing all devices associated with the power distribution system.

        2) Elementary diagrams for all relay logic, power supplies, PLC I/O and other wiring. Include ladder rung numbers and coil and contact cross referencing numbers.

        3) PLC analog and digital I/O wiring diagrams showing the wiring requirements for each instrument loop.

        4) Enclosure and elevation layout diagrams showing deadfront, front panel and backpan devices drawn to scale. Show fabrication methods and details; including material of construction, paint color, support and latching mechanisms, fans and ventilation system, and conduit entrance areas.

        5) Nameplate drawing showing dimension of nameplate lettering & format of text, color of nameplate & lettering, materials, and location.

    b. Complete catalog cuts with full description of equipment. The part or model number with options to be provided shall be clearly identified. Where more than one item or catalog number appears on a catalog cut, the specific item(s) or catalog numbers(s) proposed shall be clearly identified

    c. Bill of Material list.

    d. Programmable Logic Controller (PLC) and Operator Interface (OI). In addition to above requirements submit:

        1) PLC ladder logic program and narrative of functional description.

        2) OI graphic screen color print outs for proposed graphic screens.

        3) Electronic files of proposed PLC and OI program

1.5 QUALITY ASSURANCE

A. All equipment furnished under this Section shall:

1. Be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment;

2. Be of latest design; and,

3. Be demonstrated to the satisfaction of the owner that the quality is equal to the equipment specified herein.

4. Have a minimum of five (5) installations, of perforated plate fine screens meeting these specifications, in the United States.

5. Equipment manufacturer shall be ISO 9001 certified

6. The perforated plate screens and washer/compactors will be shipped to the site fully assembled, if possible, and dependent upon the height of the screens and washer/compactors. Some ancillary components may be removed in order to prevent damage during shipment.

7. All stainless-steel parts/equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion and to remove all embedded iron and heat tint.

    a. All stainless-steel components shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling.

    b. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel.

    c. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.

    d. Surfaces shall be subjected to a 24-hour water test or ferroxyl test to detect the presence of residual embedded iron and shall be re-treated, as needed, to remove all traces of iron contamination.

    e. All field welds shall be cleaned and passivated to remove iron (and prevent corrosion) in accordance with ASTM A380.

    f. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

8. Definitions

    a. Screen Height: The height between the operating floor and the top of the perforated plate screens.

    b. Discharge Height: The height between the operating floor and the screenings discharge.

    c. Head Loss: Total difference in elevation of the water level upstream of the upstream screening elements and downstream of the downstream return elements.

    d. Percent Blinded: Percentage of submerged area of partially blinded perforations relative to total area of non-blinded perforations.

e. Maximum Differential Head: Maximum difference in elevation of the water level upstream and downstream of the upstream screening elements that the screen will experience during emergency conditions (i.e. screen fully plugged).

f. Screenings Capture Rate (SCR) or Capture Efficiency: Percentage of all material captured by the screen as documented by the National screen evaluation facility at Chester Lee Street in England by TRPM and Northumbrian Water. The documented report of the test which shows the result of screenings capture rate (SCR) must be provided with submittals.

g. Screen Angle: Angle of screen frame incline from horizontal plane parallel with mounting floor.

B. Factory Assembly and Testing: The perforated plate screen and the washer/compactor shall be factory assembled and factory tested at the point of manufacture. A second test shall be conducted on-site after the screen and washer/compactor installation, to ensure that the screenings/washing system is installed properly and performs according to the specification. The test shall be conducted by a service representative, which is employed by the equipment manufacturer, and shall include a complete mechanical check during a 4 hour minimum test run. The U.S. testing shall be videotaped and a copy of the videotape shall be provided to the Engineer. The combined unit shall be shipped assembled for erection by the Contractor excluding the discharge piping.

1.6 DESIGN CRITERIA

A. Perforated Plate Screen:

1. Each perforated plate screen will consist of perforated filter panels, drive chain, sprockets and bearings, primary rotating self-adjusting cleaner brush, secondary deflector roller, spray wash water system, drive motors, gear reducers, anchor bolts, controls and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.

2. Solids will collect on a continuous belt of perforated panels perpendicular to the flow, elevating solids to the discharge point. The perforated filter panels shall be cleaned by means of an automatic adjusting rotating cleaner brush. Screens that do not have an automatic adjusting rotating cleaner brush shall not be allowed.

3. The perforated filter panels shall be driven by drive sprockets secured to the main drive shaft.

4. The screen shall be suitable for installation and operation in a channel with the following measurements:

   a. All channel dimensions: 42-inches wide and 108-inches deep

   b. The angle of inclination shall be 30° (lower section) and 75° (upper section) from horizontal.

5. The screen shall be capable of passing a maximum of 24.7 MGD of wastewater with a downstream water level of 34 inches. The total maximum headloss across the screen will be approximately 12 inches, based on a 30% screen blinding factor and steady state flow.

6. The screen shall be capable of operation under the following configurations and/or conditions:

Parameter	Quantity
Service:	Pumped Raw Wastewater
Channel width (inches)	42
Channel depth (inches)	108
Discharge Height (feet)	4.5 (from top of channel)
Perforated Screen opening (mm)	6
Minimum Screen Capture Ratio	85%
Spray water flow (gpm)	20
Spray water pressure (psi)	45
Peak Design Condition	
Peak hydraulic flow per screen (MGD)	24.7
Maximum design headloss (inch)[1]	12

Notes 1 Headloss based on 30% screen blinding factor and 34-inch water level downstream

B. Washer/Compactor

1. Each washer/compactor shall consist of a flange mounted gearmotor, spiral with separate thrust bearing, wash water spray system, stainless steel trough, wash zone, press zone, discharge piping, electrical controls, and all other appurtenances required or shown on the drawings.

2. Each screen shall have a coupled washer/compactor.

3. All designs shall ensure that maintenance to the mechanisms such as motors, drives and bearings are accomplished at the operating floor level without need to remove the units from their anchorage.

4. Operation: Washer/compactor is designed to be continuously run without requiring an operator.

5. The washer/compactor unit shall be furnished in type 304 stainless steel for wetted parts and all structural pieces.

6. The washer/compactor shall be capable of operation under the following configurations and/or conditions:

Parameter	Quantity
Max Capacity	177 cfh
Screenings Volume Reduction	60-85%
Weight Reduction	60-85%
Inlet Length	31.5 inches
Solid Matter of Debris	>40%
Fecal Reduction	90% (<20 mg/g BOD_5)
Wash Water	16 gpm @ 20-40 psi
Motor HP	5

1.7 ENVIRONMENTAL CONDITIONS

A. The equipment will be continuously and intermittently exposed to the following environmental conditions

1. Ambient air temperature may range from 15°F to 115°F. Relative humidity may fluctuate between 10 and 100 percent. All equipment supplied shall be rated for a Class I, Division 2, Group C and D hazardous environment.

2. The screened media will be domestic raw sewage, wastewater treatment plant mixed liquor and plant drain flows.

3. Exposures: The equipment will be subject to rainfall, wind (including dust and dirt), direct sunlight and a corrosive environment due to wastewater, splashing, hydrogen sulfide and hydrocarbon gases.

1.8 WARRANTY

A supplier's written warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of five (5) years from start-up or 66-months from time of equipment shipment, whichever comes first.

PART 2 MATERIALS

2.1 ACCEPTABLE PRODUCTS

The screening equipment shall be: SAVECO North America, Inc. FSM Perforated Filter Screen Model FRSIII 800 x 3075/6HF. The screenings washer/compactor equipment shall be: SAVECO Screw Wash Press Model SPW. All equipment shall be supplied by the screening manufacturer to ensure coordination between screen and washer/compactor. The screen and washer/compactor controls shall be fully integrated by the screen manufacturer and operate as a single unit.

2.2 MATERIALS – PERFORATED PLATE SCREENS

A. All moving wetted parts, all wetted parts on which moving parts ride, all filter belt components under guiding, bearing, or driving loads shall be 304 stainless steel, wear resistant heat treated, high tensile, wear resistant steel, or UHMW-PE as noted below:

1. The frame shall be minimum 4mm thick type 304 stainless steel.
2. The discharge chute, and all covers shall be type 304 stainless steel.
3. The primary screen and brush drive shafts shall be type 304 stainless steel.
4. The secondary rotating deflector shall be from type 304 stainless steel.
5. The lower sprocket stub shafts shall be from type 304 stainless steel.
6. The upper and lower sprockets shall be type 304 stainless steel with only the wear area hardened.
7. The middle guide transitioning the filter panels from 30 degrees to 75 degrees is a non-revolving guide from UHMW-PE.
8. The screening elements shall be one piece curved from type 304 stainless steel and will not require upstream protection using coarse bar screens. Screens that require upstream protection shall not be permitted.
9. The heavy duty roller chain will be from type 304 stainless steel with PA6 rollers.
10. The side and bottom seals shall be replaceable contoured UHMW-PE with 304 stainless steel fasteners.
11. The bottom seal between the lower end of the screen frame and the width of the filter panels shall be from Buna-N rubber and shall include a triple layer polyester brush with a 304L stainless steel adjustable holder.
12. The screening element support rails shall be 304 stainless steel with UHMW-PE wear surface or equivalent.
13. Spray bars from shall be 304 stainless steel.
14. All fasteners shall be 304 stainless steel.
15. All other appurtenances shall be of manufacturer’s standard coated material.

2.3 EQUIPMENT DESIGN FEATURES – PERFORATED PLATE SCREENS

A. General

1. The screen shall be designed to provide maximum solids filtration and thus maximize capture of debris and minimize rate of head loss increase through the screen. This shall be achieved by means of one piece perforated curved filter elements. The maximum openings shall be 6 mm. The screen will be operated intermittently by means of differential head measurement.
2. The screen shall be mounted by fastening to the top of the channel. The screen mounting system shall be constructed of 304 stainless steel and complete as required to function in accordance with the specification. Routine service, repair or replacement of damaged parts, shall be possible with the screen in the channel.
3. Unit shall be designed so that maintenance of the drive mechanism can be accomplished at operating floor level. Screen elements shall be capable of removal at the operating level without taking the screens out of the channel or effecting the continuous or intermittent rotation of the screen.
4. The screen shall be factory assembled and tested for a minimum of four hours prior to delivery and shall be delivered to the site fully assembled (other than the motor/reducer unit, discharge chute, and support legs). It shall be capable of being set in place and field erected by the contractor with minimal field assembly.
5. The influent screening system shall include a perforated plate screen and a washer/compactor system. The perforated plate screens shall be a self-contained screening system used to capture and transport wastewater debris to the washer/compactor system.
6. Influent screening system shall be designed for continuous and intermittent operation. The perforated plate screens shall be installed in the channel as shown on the Contract Drawings.
7. All components shall be amply proportioned for all stresses that may occur during manufacturing, transportation, erection, and operation.

B. Filter Screen

1. The one-piece curved screening elements shall be nominal 1/8" thick and fixed by four fasteners to the heavy-duty roller chain drive links having 7.87" pitch x 1.38" x 0.2" thick section which shall ride on 0.2-inch thick 304 stainless steel supports located on the upstream and downstream sides of the screen.
    a. Chain shall have an average ultimate design strength of 20,232 lbf (90kN).
    b. On every tenth screen panel a set of static, non-engaging 'finger' type lifters shall be attached to the lower edge of the panel, designed specifically to lift spherical and large size solids (stones, square lumber cans, bottles, rag clumps, etc.) from the bottom of the channel.

c. Screens that use lifting ledge on top of the panel thereby preventing the removal of solids from the bottom of the channel floor will not be permitted. Screens which do not support the drive chains on the downstream side will not be approved.

2. A submerged curved stainless steel plate shall be provided at the base of the screen. The base of the screen shall be fitted with a rubber seal 10mm thick directly followed by a polyester brush along the full length of the filter panel to prevent ingress of stones and grit and to prevent solids bypass.

3. Two (2) upper sprockets from ¾-inch thick type 304 stainless steel with 7.87 inch pitch. Upper sprockets shall be split to allow removal without having to remove the drive shaft.

4. Two (2) revolving ¾-inch thick lower guides with 7.87 inch pitch. Lower revolving guide bearings shall be slide bushing from bronze with a 316 stainless steel 3.15 inch stub shaft. Complete unit sealed with stainless steel cover, o-rings and v-rings seals. Grease line from stainless steel brought to operating level. Ball or roller bearings or slide bushings made of plastic or ceramic shall not be accepted as a lower sprocket bearing.

5. The middle guide shall be stationary between the 30 and 75-degree transition section. The use of rotating sprockets/guides in this area shall not be allowed.

6. To prevent deflection, the one-piece filter elements shall have a minimum thickness of 1/8" and shall be made of curved stainless steel. This is required to insure structural integrity and smooth operation. Engaging tines, fingers or engaging elements, which can bind or jam, will not be acceptable. Filter panels that are not curved shall not be acceptable. Filter panels with a flat face inclined and a horizontal ledge shall not be allowed.

7. The screening elements are to be of the engineered curved shaped so that they can be cleaned with optimum efficiency with an automatic adjusting rotating cleaner brush. Minimum diameter of rotating cleaner brush is 450 mm. The rotation direction of the brush drive must be in the opposite direction of the belt drive.

8. The rotating cleaner brush shall be nylon and have a minimum diameter of 450 mm and be self-adjusting with no manual or motorized adjuster mechanism. The motorized cleaner brush will automatically adjust as the brush wears during use. The automatic adjustment will maintain consistent cleaning efficiency at a SCR value of 85%. The distance between the cleaner brush and filter panels will be automatically controlled to ensure the distribution and magnitude of pressure is equal across the entire filter panel surface. Systems that use gas springs or struts to adjust brush shall not be permitted. Screens with rotating cleaner brushes requiring manual adjustment or adjustment with gas cylinders or a motor shall not be permitted.

9. The lifting fingers are located on each tenth filter plate. The lifting fingers must be located on the lower area of the filter element. Systems where these fingers are near the middle or top of the element are not permitted. They will be designed to remove spherical solids from the bottom of the channel, which may otherwise roll back off

the screen face and accumulate thus creating a wear problem as the screen elements are moving thru the solids as they ascend on the upstream side of the screen.

10. The screening elements must be sealed against the chain by means of special knuckle joint side plates attached to each perforated plate filter element. Maximum gaps between the screen panels and side frame is 1 mm. These side plates must be made in Stainless steel. Simple brush systems are not permitted. This is to ensure that small items are not floated past the sides of the screening elements.

11. A rotating deflector consisting of a 304 stainless steel tube roller wiper fabricated from 3.5 inches O.D. complete with 1.75 inches diameter stainless drive steel shafts at each end supported by two-hole flange bearings and auxiliary driven by screen drive unit. The roller wiper shall turn at max 20 rpm and function to seal the gap between the filter panels and discharge chute and to direct the heavier solids removed from the screen by the revolving brush cleaner into the screenings wash press inlet hopper. The rotating deflector prevents bypassing of solids into the downstream channel. Screens supplied with a brush scraper and/or a static deflector that is not self-cleaning shall not be permitted.

C. Filter Screen Panels

1. The screen filtration belt shall be provided with one piece perforated curved elements, which limits the maximum opening in any direction to the perforated opening size detailed in Paragraph 1.6.A.6. This restricted opening profile prevents long thin materials from passing through the openings. Filter panels that are not curved shall not be acceptable. Filter panels with a flat face inclined and a horizontal ledge shall not be allowed.

2. No cleaning devices which cause trash to be pushed or dropped into the interior of the filtration belt will not be allowed.

3. The individual screening elements must not exert stresses on one another and the load transmission must be exclusively via chains. Systems which involve connecting the screen elements together with other or additional attachments are therefore not permissible because of stressing. Furthermore, the elements must not be able to overlap one another, which would create spaces in which material could collect.

4. Due to the risk of high differential levels on the screen, in the event of a power failure, excess solids load condition, mechanical breakdown etc. the screen shall be designed to withstand a maximum differential head of 3.3 ft. measured from the upstream water level to the downstream water level.

5. The manufacturer shall provide calculations showing that it will meet this requirement. A test will be conducted at site, before the screen or screens are accepted, during which time the screen will be tested for a minimum period of two hours at the specified maximum differential head condition.

    a. Should the screen fail this test, for example there is bending, bowing, buckling or other significant signs of mechanical damage then the screen shall be removed at the manufacturers cost.

6. The horizontal space between each adjoining screen panels will not exceed 1 mm +/- 10% at any point between any adjacent panels. The screen manufacturer shall make a witnessed measurement of the screen panel adjoining spaces before acceptance at site and if more than 10% are greater than the dimension of the specified screen perforation the screen will not be accepted until the manufacturer has corrected the problem and a re-measurement as above confirms the specification has been met.

7. To control the buildup of biological slimes behind the screen panels, a 1-inch diameter internal spray water wash spray bar will be provided, manufactured from stainless steel with PVDF spray nozzles. The spray bar will be attached in the internal space between the rotating screen panels and the spray water will be directed to wash each screen panel as the panel moves past the spray nozzles. The spray bar will supply approximately 9 gpm per ft. width of screen panel at a pressure of 40 - 45 psi. The spray orifices will be non-plugging and suitable for use with treated effluent water. A minimum 1" NPT connection will be located on one side of the screen frame above the operating floor level and the water supply connection will include an inline strainer, manual operated ball valve, and solenoid valve suitable for attaching to the 1" NPT connection. Systems that require spray bars to assist with removing screenings from the filter panels shall not be allowed. The nozzle system for cleaning the belt must be located after the cleaning by the brush. Systems with a spray bar prior to the brush are not permitted.

D. Chain and Sprockets

1. The filter panel drive chains shall be equal in pitch to the upper and lower drive sprockets.

2. The chain for the perforated filter panels shall be roller type chain and be from material as per Paragraph 2.2.A.9. Chain shall have a maximum design operating force of 20,232 lbf. Chain shall not require lubrication.

3. Each screen shall be provided with two identical drive sprockets from material as per Paragraph 2.2.A.6. Sprocket pitch and width shall match the roller chain – 7.87-inches. The sprockets shall be mounted on a drive shaft from material as per Paragraph 2.2.A.3 mounted between grease-able bearings mounted on the external side of the frame.

4. Each screen shall be provided with a middle transition guide from material as per Paragraph 2.2.A.7. This guide shall be located on the tension side between the 30 and 75-degree transition section.

5. Chain drive shaft bearings shall be four-hole flange mounted to a stainless steel plate. The bearings shall be grease lubricated. Chain tension adjustment is achieved via the take up screws attached to the flanged mounting plate. The take screw shall be an acme thread type from type 18-8 stainless steel. The bearing casing shall be made of paint coated cast iron. Units using threaded rod shall not be allowed.

6. Chain guides shall be secured to the screen frame for the full height of travel. A guide track shall also be located at the bottom of screen to allow the chain to travel

from a downward to an upward direction. The chain guides shall accurately guide the chain and filter panels. The chain guide tracks shall be stainless steel.

E. Screen Drive Mechanism

1. Motor: 1.5 HP, 1760 rpm TEFC geardrive inverter duty motor suitable for 460/3/60 electrical supply. Overload protection shall be provided by a true power monitor electrical overload device that senses the motor power factor.

2. Gear Reducer:

   a. Helical Worm type from SEW.

   b. Hollow, shaft type.

   c. Anti-friction bearings.

   d. AGMA I rating.

3. All drive components shall be designed to operate the screen continuously under a calculated load resulting from the differential water level between the upstream and downstream sides of the screen.

4. Minimum filter panel speed shall be 13 fpm.

F. Brush Drive Mechanism

1. Motor: 2.0 HP, 1760 rpm TEFC geared motor suitable for 460/3/60 electrical supply.

2. Gear Reducer:

   a. Helical Worm type from SEW.

   b. Hollow, shaft type.

   c. Anti-friction bearings.

   d. AGMA I rating.

G. Rotating Deflector Drive Mechanism:

1. Auxiliary driven from Screen drive. Screens that require a third motor for the rotary deflector shall not be allowed.

H. Discharge Chute/Hood:

1. A discharge chute/hood shall be provided that fully encloses the discharge section of the screen. The upper section of the discharge chute/hood shall be hinged to allow complete access the screen cleaner brush. The hinged hood shall be secured with quick closing clamps and supplied with two (2) gas cylinders to aid opening and closing

2. Discharge chute shall be from type 304 stainless steel

3. Each screen discharge chute/hood shall direct screenings directly to the washer/compactor. Outlet shall extend down to the inlet of the washer/compactor and shall be designed to match the screenings washer/compactor inlet hopper with no water leaking or screenings dropping to the floor.

I. Frame Enclosures / Covers

1. The screen shall be provided with easily removable, sufficiently stiffened covers made of 18-gauge 304 stainless steel plates with edges on all sides.

2. Covers shall be provided on the upstream and downstream portion of the screen above the operating floor.

3. Covers shall be secured in place using quarter turn tool operated stainless steel cam latches.

2.4 EQUIPMENT DESIGN FEATURES – WASHER/COMPACTORS

A. General

1. The shafted screw type screenings wash press shall be a complete assembly consisting of an inlet hopper between the filter screen and wash press. The shafted screw wash press shall be designed to receive and wash screenings, then reduce the volume and water content by means of a pressing zone. The unit's washing and compacting performance will be as documented in Paragraph 1.6.B.6. After the compacting and dewatering process, the screenings shall be conveyed through the discharge transportation tube to the existing transport screw conveyor.

2. Screenings washers that use impellers and/or grinders to tear and shred fibrous screenings at the inlet to the compactor and therefore increase the amount of inert material returned to the plant shall not be allowed.

3. The screw wash press shall be designed and built to withstand maximum possible forces exerted. All structural and functional parts shall be sized to prevent deflections or vibrations that may impair the screw wash press operations. All components of the screw wash press shall be made of type 304 stainless steel except the shaft screw which shall be from high strength steel with Hardox™ 400 flights throughout. Bearings, electrical devices, sprockets, motor, and gear reducer shall be of the manufacturer's standard materials.

4. Shop Surface Preparation/Coating: All weldments shall be cleaned and passivated using a full dip passivation process to remove weld spatter, slag, and discoloration. Bearings, electrical devices, drive and wiper chains and sprockets, motor and gear reducer shall be provided with the manufacturer's standard coating system. Screen weldments not full dipped passivated, using spray on cleaning solutions, passivating welds only or bead blasting shall not be allowed.

5. The screw wash press shall discharge dewatered screenings capable of passing the EPA Paint Filter Test as described in method 9095 of the EPA publication SW-486.

B. Screw Housing

1. The screw housing shall be constructed from 8mm (0.31 inches) thick type 304 stainless steel. The screw housing shall have support beams with U-profile, thickness of 5mm on each side. The screw housing shall be designed to support all required loads.

2. The interior of the screw housing shall incorporate with minimum of six (6) anti-rotation wear bars each fabricated from Hardox® 400 special high strength alloy steel with minimum Brinnel Hardness of 400.

3. The bottom of the housing shall be provided with perforated drainage sections. Perforations shall be countersunk with maximum 6 mm in diameter. Units supplied with slotted or wedgewire drainage or compaction sections shall not be allowed. Perforations not countersunk shall not be allowed.

4. An inlet area length as specified in Paragraph 1.6.B, will receive incoming materials. A hopper constructed from type 304 stainless steel shall be provided by the manufacturer to direct solids to the inlet area of the screenings washer.

C. Shafted Screw

1. The screw will be constructed of high strength low alloy carbon steel and Hardox® 400 flights (minimum 400 Brinell), prime coated for protection during shipment. Screw OD shall be 300 mm (11.8 inches) with 12 mm (0.47 inches) thick flights welded to a minimum 100 mm (4 inches) diameter shaft. The final flight of the screw shall be supplied dual thickness 24 mm (0.94 inches) for increased wear life. Screws that do not have the final flight from dual thickness (24 mm) and all flights from Hardox® 400 will not be allowed.

2. A replaceable nylon brush reinforced with a stainless steel backer shall be attached to the screw flights in the drainage area with stainless steel clips and hardware. To reduce wear on the brush the design shall be such that the screw shall not be allowed to rest in the press housing. The screw shall be fully supported and cantilevered off the thrust bearing.

D. Thrust Bearing

1. An independent thrust bearing housing shall be flanged mounted to the drive and flanged mounted to the press body. The independent thrust bearing assembly shall be protected from the environment and located in a separately sealed area located inside the press body. The flange portion of the thrust bearing shall have a grease fitting centrally located for ease of maintenance.

2. The thrust bearing shall fully support the screw and handle the load created during compaction and reversal of the screw. The thrust bearing shall utilize an SKF roller bearing complete with double lip grease seals and O-rings. The mounting flange shall have an O-ring seal mounted in a machined groove to seal the housing against the press body. Designs that utilize the thrust bearing inside the gear reducer housing will not be acceptable.

E. Drain Pan

1. A drain pan shall be mounted to the bottom of the screw housing along the full length of the housing. The pan shall be sloped to the drain, and it shall be provided with a flushing water connection. Drain connection shall be minimum 6-inch plain ended pipe. Flush connection shall be minimum 1-inch NPT connection.

2. The pan shall be secured in place with hardware and allow for easy removal. Drain pan shall be constructed of minimum 14-gauge 304 stainless steel.

F. Wash Water Manifold

1. The screenings washer shall be provided with a minimum of two (2) separate connections for injecting wash water into the screenings.

2. Wash water spray nozzles shall be capable of utilizing the screened plant effluent without clogging or fouling.

3. The wash zone shall include a spray wash system to wash organic residue from the screenings. The wash zone spray will consist of one (1) spray header with two (2) wash water injection points at 3 o'clock and 9 o'clock, two (2) brass spray nozzles, two (2) PRV's, one (1) ball valve and one (1) solenoid valve. The system will have an output of 16 gpm at 20-40 psi. The spray connection will be 1 inch NPT.

G. Inlet Hopper

1. The inlet hopper shall be designed to accept discharge screenings from the perforated plate filter screen discharge chute. The hopper shall directly interface with the filter screen discharge with no solids or water bypass.

2. The inlet hopper shall be fabricated from minimum 12-gauge type 304 stainless steel.

H. Discharge Pipe

1. The discharge pipe shall be flanged and mounted to the press body by a minimum 17-inch diameter flange.

2. The discharge pipe shall be designed to transport the washed, dewatered, and compacted screenings to the discharge point without plugging.

3. The diameter of the discharge pipe shall increase in size to ease the transportation of the screenings.

4. For increased washing and compaction performance the discharge pipe will include a manually controlled back pressure device. The back pressure is manually generated by a stainless steel plate positioned by operating personnel. Access to the back pressure device is through a stainless steel access box fitted with a bolt in place hatch with handle. The access box is integral to the discharge pipe. Material of construction 304 stainless steel.

5. The discharge pipe elbow shall be fabricated from minimum 11-gauge type 304 stainless steel.

6. The discharge piping following the elbow shall be fabricated from minimum 12-gauge type 304 stainless steel.

7. Discharge chute shall connect to the existing transport screw conveyor. Coordinate discharge point with existing conveyor inlet points.

    a. Provide extensions as needed to accommodate discharge at 4'-2" above floor and 6'-6" from center of channel.

    b. Provide flexible rubber connection and SST band for connection between compactor discharge and existing transport screw conveyor inlet connection point.

    c. Contractor to field verify connection point dimensions prior to equipment submittal.

I. Drive Assembly

1. The gear reducer shall be a flanged mounted directly to the thrust bearing housing and the compactor frame. Gear reducer shall be a helical gear type with hollow input shaft. The unit will be provided with a cast iron frame and be designed in accordance with AGMA recommendations for Class I service based on the horsepower required to operate the wash press. Units that do not bolt the gear reducer directly to the unit's frame will not be allowed.

2. The motor shall be TEFC, 5.0 HP, 460 Volt, 3 phase, 60 Hz. The motor shall be NEMA design code B and be direct coupled to the reducer.

3. Chain drives, belt drives, and hydraulic drives will not be accepted.

2.5 PERFORATED PLATE SCREEN AND WASHER/COMPACTOR SURFACE FINISH

A. Surface Treatment of Stainless Steel Components: All stainless steel subassemblies will be pickled in an acid bath or Starblast.

1. Shop Surface Preparation/Coating: All stainless steel subassemblies will be acid passivated after welding for corrosion resistance and to provide a superior surface finish. This will be done by full dipping of weldments. After passivation, the weldments will be thoroughly rinsed with clean water and allowed to air dry.

2. Sandblasting, acid paste passivation of welds and heat affected areas only, spray-on acid solutions in lieu of dipping, glass bead blasting or grit blasting of stainless steel surfaces will not be allowed in lieu of fully submerged acid passivation.

3. See part 1.5, above, for additional information.

B. The screw and drive shaft will be finished with an enamel coating.

C. Motors and gear reducer will be manufacturer's standard finish and shall be painted the same color. The drive shaft, sprockets and gear reducers will be epoxy painted.

2.6 ELECTRICAL DEVICES– PERFORATED PLATE SCREENS and WASHER/COMPACTORS

A. Electrical Devices For Screens: All interconnecting conduit and wiring will be the responsibility of the installing contractor. In addition to the drive motors, the following electrical devices will be supplied with each perforated plate screen unit:

1. Ultrasonic Level Controller: A 120V differential level controller shall be provided in a windowed NEMA 4X polycarbonate enclosure suitable for floor mounting, to receive and interpret a 4-20mA scaled signal from an upstream and downstream transducer. The controller shall have 5 internal relays and provide an LCD display.
2. Ultrasonic Level Transducer: Two (2) ultrasonic level transducers shall be provided with type 304 stainless steel mounting brackets and expansion anchors. Each sensor shall have an PBT housing, have a range of 1-33 ft, and be supplied with a 33 ft integral cable. Sensor shall be suitable for installation in a Class 1, Division 1, Group D area.
3. Emergency Stop Local Push Button Station: A NEMA 7 emergency stop push button station will be mounted on a support stand and will have a ½-inch NPT conduit connections (electrical connection by others).
4. Motor Cut-out Switch: One (1) safety microswitch will be provided, suitable for the area classification and mounted to the hinged hood.
5. Solenoid Valve: One (1) solenoid valve shall be provided to control flow to the spray wash assembly. The brass body valve shall be 120 Volt, single phase, 60 Hz with a NEMA 4X housing.

B. Electrical Devises for Washer/Compactors: In addition to the drive motors, the following electrical devices will be supplied with each unit:

1. Intrinsically Safe Torque Switch. The washer and compactor will be equipped with a limit switches to detect over-torque conditions by sensing relative movement of the motors. The switches will have a 3.2-foot long integral cable. An intrinsically safe barrier relay will be mounted in the main control panel.
2. Alternatively, overload protection may be supplied electronically in the control panel by measuring current draw.
3. Explosion-Proof Emergency Stop Local Push Button Station. A NEMA 4X emergency stop push button, suitable for outdoor use, station will be mounted to the support stand and will have a ¾-inch NPT conduit connection to control both the washer and compactor.
4. Explosion-Proof Solenoid Valves. 120 volt, single phase, 60 HZ solenoid valves for the wash zone and flush spray washes housed in NEMA 4X enclosures will have 18-inch-long integral leads and will have 1/2 inch NPT conduit connections.

C. Control Panel

1. Each Screen and Washer/Compactor train shall have a single control panel (this project will have two control panels total to operate the two screening system trains). The panel shall be 480-volt primary U.L. listed and labeled control panel in a NEMA 4X, 316 stainless steel enclosure. Panel shall be supplied with control switches, indicating lights, relay logic, and dry contact SCADA interfaces as indicated for each panel on the Process and Instrumentation Diagrams (P&ID) contract drawings and as specified under Division 16 and 17 of the specifications. In addition, panel shall be suitable for floor mounting with the following electrical components to provide proper operation of the equipment.

    a. Main disconnect with through door interlock handle.

    b. Step down control transformer.

    c. Branch circuit protection.

    d. Screen drive motor VFD.

    e. Brush motor starter (IEC) with overloads.

    f. Compactor motor starter (IEC) with overloads.

    g. Emergency stop pushbuttons (for screen and washer/compactor).

    h. Hand-Off-Auto selector switches for screen and brush drive.

    i. Hand-Off-Auto selector switches for the screw drive, wash and flush water sprays.

    j. Open–Close–Auto switch for screen wash water solenoid valve.

    k. Power monitor shall provide overload protection for screen drive by sensing motor power factor.

    l. Hour meter for each motor.

    m. Control power on, run and fault indicating lights.

    n. Alarm reset pushbuttons.

    o. Programmable logic controller to control the equipment.

    p. Indicating lights shall be push-to-test.

    q. UL label.

    r. Communicate with SCADA (for alarms, status, and control)

2. The manufacturer shall provide a programmable logic controller (PLC) with local operator interface (OI) to monitor and control the Screen and Washer/Compactor System. The PLC shall be Allen-Bradley (AB) Compact Logix 5380 family (5069-L306ER processor or larger) with Ethernet port. The OI shall be Allen Bradley (AB) Panelview 7 with color LCD touch screen and Ethernet. The PLC

shall be provided with a 4-port hub to allow direct interface and communication with the OI and plant's SCADA system, which will operate on an "Ethernet Data Network"

a. The PLC shall be fully programmable to reflect the specifics of the Screening system (screen and washer/compactor). Setup shall provide a user-friendly graphic interface to display information

b. The Screenings System Supplier shall provide the PLC ladder logic programs and OI graphic configuration on electronic files to the City, along with all relevant PLC addresses to enable the future SCADA system to monitor the Screening system remotely.

c. The PLC shall be sized with all I/0 points necessary for a complete operating system, with an additional 20 percent I/O points of each type of I/O as spares.

d. All PLC software, including graphics, configuration and applications ladder logic programming software shall be licensed directly to and become the sole property of the City for their use on this and future City projects. Software listed as proprietary will be rejected.

e. Operator Interface shall have screens developed to allow full manual or automatic monitoring and control of the equipment supplied, including:

   1) All Alarm conditions.

   2) Timers, and setpoints.

   3) Status of all equipment

   4) Differential level.

   5) Trends for all analog inputs..

f. No passwords shall be enabled on PLC or OI software or hardware developed for this project. All electronic copies provided to Owner shall not have any password protection enabled on them or the software.

g. PLC with OI shall be mounted inside the control panel.

3. The manufacturer shall coordinate the function of the control panel with all related equipment, including screens and washer/compactors, all of which shall be controlled from the screen control panel.

4. The Contractor shall provide all wiring, conduit, disconnects, and accessory items between the control panel and the screen.

5. Manufacturer shall work with SCADA team to configure vendor provided PLC code for data transfer between vendor provided PLC and Plant SCADA system, as required for fully function system and as shown on the P&ID Contract Drawings.

6. Control panel shall have an adjustable thermostat switch to run the equipment continuously at ambient temperatures below 30^{o}F.

D. Operation, Monitoring, and Control for Each Screen

1. Screen and Brush Hand Operation: In Hand position the operator shall be able to run the screen or brush assembly by selecting the respective Hand-Off-Auto selector switch. Turning the screen selector switch to Off will stop the unit. Screen drive motor is interlocked with the brush motor. Brush motor must be on if the screen is in operation.

2. Screen Automatic Operation: When the Screen and Brush are in Auto position the screen shall be controlled by the water level sensors. Screen operation shall be started when the water level sensors monitor a certain water level difference, when the sensor senses high upstream water level, high differential, or when a certain time has passed since the last operation of the screen. When the upstream water level reaches its high-level setting or when the high differential setpoint is reached, the Screen will run in high speed. When both the high level and high differential drop below their setpoints, the screen will decrease to low speed after the high speed off delay timer has expired. Screen operation shall be stopped with an adjustable delay time after the water difference is below a certain value and after the sensor reads the correct water level, or after a certain run time has expired (if operation was started by timer).

    a. When Unit is in AUTO, and Screen, Drive and Washer/Compactor are not running, allow Plant SCADA System to initiate start operation of Unit without Unit requiring a high differential level start setpoint to be reached. Unit will then stop/start as programmed.

3. Controls shall operate the washer and compactor on a timed, liquid level control signal or continuous basis.

4. Wash Water Solenoid Valve Operation: In Hand position the wash water solenoid valve will open. In the Close position the wash water solenoid valve will close.

5. Wash Water Automatic Operation. The wash water solenoid valve will open and close via a repeat cycle timer whenever the screen is in operation.

6. Fault Conditions:

    a. Excessive motor power will trip the starter overload relays, immediately stop the drive or brush motor, and illuminate the alarm indicating light. This fault must be reset by depressing the associated motor starter overload reset internal to the control panel.

    b. Momentary drive high torque will trip the screen motor load monitor, immediately stopping the screen drive motor, and illuminate the alarm indicating light. Pushing the reset pushbutton will reset this fault.

E. Operation, Monitoring, and Control for Each Washer/Compactor

1. Hand Operation: When Hand mode is selected, the spiral will run continuously. When spray wash Hand mode is selected, the spray wash will run continuously.

2. Intermittent Automatic Operation: The control panel will be equipped to control the wash cycle and screw movement. The wash cycle and the screw movement will be controlled independently using timers and counters. The drive motor and spray wash will be controlled automatically when the selector switches are placed in the Auto position.

    a. The press motor starts after an adjustable accumulated run time from the interlocked feeding equipment.

    b. The wash water solenoid is open whenever the screw is in operation.

    c. The washing solenoid closes, and the press motor runs for an adjustable length of time, typically set at 30 seconds, to dewater and discharge the screenings.

3. Emergency Stop: The unit can be deactivated at any time by pressing either the control panel mounted or unit mounted Emergency Stop push buttons.

4. Fault Conditions: Motor overload, high motor torque, or high motor current conditions will stop the motor and illuminate the fault light.

2.7 WASHER COMPACTOR DIMENSIONS

As shown on the contract drawings.

2.8 ANCHOR BOLTS

A. Anchor Bolts: All anchor bolts shall be a type 304 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment. Seismic calculations shall be required, as specified in Specification Section 01610 and 01615.

B. Fasteners: All fasteners shall be type 304 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

C. The General Contractor shall set the anchors in accordance with the Manufacturer's instructions.

2.9 SPARE PARTS

A. The following spare parts shall be provided as the total amount of spare parts for each perforated plate screen:

1. Two (2) perforated screen panels with side sealing and without lifting fingers.

2. One (1) perforated screen panel with side sealing and with lifting fingers.

3. One (1) complete set of replacement cleaner brush elements.

4. Five (5) feet of chain with one (1) master link.

B. The following minimum spare parts shall be provided for each washer/compactor:

1. One (1) brush with mounting clips and hardware for screw.

C. Manufacturer shall recommend any additional spare parts deemed necessary based on experience with the screen in similar applications.

2.10 FACTORY ASSEMBLY, TESTING AND INSPECTION

The screen shall be factory assembled and tested for a minimum of four (4) hours prior to delivery and shall be delivered to the site fully assembled (other than the motor/reducer unit, discharge chute and supports). It shall be capable of being set in place and field erected by the Contractor with minimal field assembly.

2.11 INSTALLATION, OPERATION AND MAINTENANCE MANUAL

In addition to the normal Installation, Operation and Maintenance manuals required by contract, a spare manual will be shipped with the unit in order to allow for proper operation of equipment prior to release of all final Installation, Operation and Maintenance Manuals to the end user. Provide, in accordance with Specification Section 01680.

2.12 PAINTING

Non-stainless steel parts shall be cleaned, primed and coated in accordance with Specification Section 09900. Motors and gear reducers shall be painted the same color. Stainless steel shall be passivated after fabrication. Factory coated equipment shall be repainted in the field as specified in Specification Section 09900.

PART 3 EXECUTION

3.1 PREPARATION

A. The mounting points of the channel shall be level and parallel and of proper size.

B. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings.

3.2 LIFTING AND MOVING EQUIPMENT

A. Lifting points shall be identified on all SAVECO North America equipment. A crane of sufficient capacity must be onsite for unloading the equipment from the truck and placing in the channel for installation.

3.3 INSTALLATION

A. The equipment shall be installed in conformance with the manufacturer's instructions. The manufacturer's service technician shall thoroughly check and inspect equipment after installation, initiate testing, make necessary adjustments, and instruct owner's personnel in proper operating and maintenance procedures.

B. Equipment shall demonstrate compliance with the specifications and shall operate to the satisfaction of the Owner under actual operating conditions.

3.4 STARTUP, TRAINING, AND QUALITY CONTROL

A. The initial start-up of SAVÉCO North America equipment will be performed by an authorized SAVÉCO North America representative. The SAVÉCO North America authorized representative will verify the proper operation and installation and provide training to the equipment operators. One (1) trip for a total of two (2) days is allotted. Additional days, if required, will be paid by the Owner for a nominal rate. Sales representatives will not be deemed acceptable in lieu of a factory-employed service technician. See Specification Section 01670, 01675, and 01680.

END OF SECTION

SECTION 11343

VORTEX GRIT REMOVAL SYSTEM (BAFFLE PLATES)

PART 1 GENERAL

1.1 DESCRIPTION

Scope: The work of this section consists of furnishing and installing four (4) V-Force baffle plates into two existing vortex grit removal tanks. Each existing tank shall be fitted with both inlet and outlet baffles. The existing vortex grit removal system is complete with vortex grit removal tanks, vortex grit drives, grit pumps, grit classifier and auxiliary equipment.

1.2 EXISTING EQUIPMENT TAG NUMBERS

Tag Numbers	Equipment Name
DRV A4112	Vortex Grit Drive 1
DRV A4212	Vortex Grit Drive 2
PMP A4111	Grit Pump 1
PMP A4211	Grit Pump 1
DRV A4310	Grit Classifier

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 05500 - Metal Fabrications

C. Section 09900 - Painting

D. Section 11010 - General Mechanical Equipment Provisions

E. Division 16 - Electrical

1.4 SUBMITTALS

A. In accordance with Section 01300:

1. Submit shop drawings, parts lists, complete descriptive literature, catalog cut sheets, engineering and physical data, etc. as necessary to fully describe and define all items to be furnished under this specification.
2. Provide complete design calculations shall be submitted to show compliance with design and seismic criteria, in accordance with Section 01610.
3. Provide operation and maintenance manuals in accordance with Specification Section 01680.

1.5 QUALITY ASSURANCE

A. All equipment furnished under this Section shall:

1. Be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment;

2. Be supplied by a single manufacturer or supplier.

3. Be of the latest design; and,

4. Be demonstrated to the satisfaction of the owner that the quality is equal to the equipment specified herein.

B. Material Standards: All materials and workmanship shall meet the following referenced standards.

1. American Iron and Steel Institute (AISI): Steel Products Manual.

2. American Society for Testing and Materials (ASTM):

a. A36, Standard Specification for Carbon Structural Steel.

b. A536, Standard Specification for Ductile Iron Castings

c. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

1.6 DESCRIPTION

A. Inlet and outlet baffles shall be provided in each existing vortex grit removal tank to enhance the coanda effect and direct the grit downward to the bottom of the separation chamber as well as enhance chamber flow patterns.

1.7 WARRANTY

A. A supplier's written warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of one (1) year for start-up or 18 months from time of equipment shipment, whichever comes first.

1.8 ENVIRONMENTAL CONDITIONS

A. Exposures: The equipment will be subject to rainfall, wind (including dust and dirt), direct sunlight and a corrosive environment due to wastewater, splashing, hydrogen sulfide and hydrocarbon gases. Ambient air temperatures may range from 15°F to 115°F. Relative humidity may fluctuate between 10 and 100 percent.

PART 2 MATERIALS

2.1 MANUFACTURERS

A. The baffle plates shall be V-Force Baffles as manufactured by Smith and Loveless to match the existing Pista 360 vortex grit removal system.

B. The naming of a manufacturer in this specification is not an indication that the manufacturer's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified.

2.2 EQUIPMENT

A. V-Force Baffle: The vortex grit removal tanks shall be fitted with the V-Force Baffle, which is an integral flow control baffle for both the inlet and outlet of each tank. The V-Force Baffle shall be designed to direct the inlet flow into the main chamber of the tank in a manner ensuring the proper vortex flow and to prevent short-circuiting. The V-Force Baffle on the outlet shall direct the flow out of the tank, and to act as a "slice weir" to control the water level in the main chamber and in the inlet chamber. No additional downstream flow control device shall be required to keep the velocity between 3.5 feet per second (fps) at peak flow and 1.6 fps at minimum flow with a 10:1 turn down. The V-Force Baffle shall be constructed of 316 stainless steel. The installing Contractor shall attach the V-Force Baffle to the existing concrete structure using 5/8" anchor bolts, as shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. The equipment shall be installed in conformance with the manufacturer's instructions.

B. Equipment shall demonstrate compliance with the specifications and shall operate to the satisfaction of the Owner under actual operation conditions.

END OF SECTION

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Contract Documents and Specifications for

CITY OF MERCED
DEPARTMENT OF PUBLIC WORKS
PROJECT NUMBER 230035
MERCED WWTF PHASE VI PROJECT – HEADWORKS IMPROVEMENTS

Volume 1B

March 2023

Stantec

PROJECT NUMBER 230035

CITY OF MERCED WWTF PHASE VI PROJECT – HEADWORKS IMPROVEMENTS

LICENSEE RESPONSIBLE FOR TECHNICAL SPECIFICATIONS

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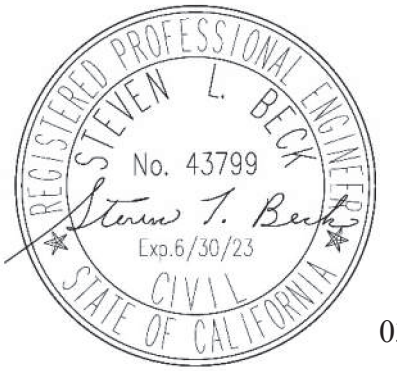

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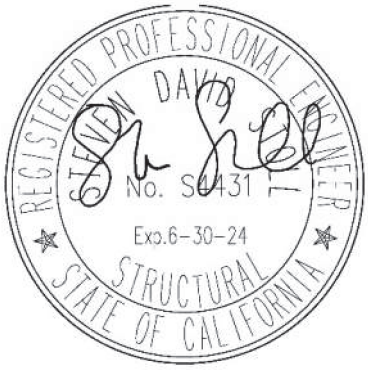

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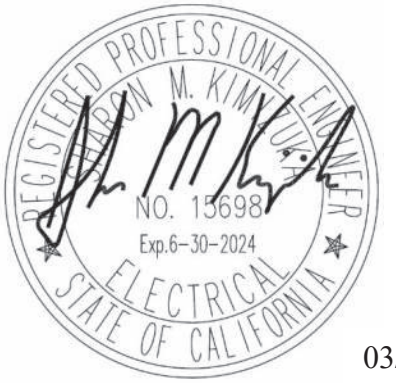

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CITY OF MERCED
DEPARTMENT OF PUBLIC WORKS

PROJECT NUMBER 230035

MERCED WWTF PHASE VI PROJECT – HEADWORKS IMPROVEMENTS

TECHNICAL SPECIFICATIONS TABLE OF CONTENTS

VOLUME 1B

SECTION 15000

MECHANICAL AND PLUMBING

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 01666 - Testing of Pipelines

C. Section 02223 - Trenching, Backfilling, and Compacting

D. Section 10400 - Identifying Devices

E. Section 15052 – Stainless Steel Piping

F. Section 15080 – Pipe Appurtenances

G. Section 15094 - Hangers and Supports

1.2 DRAWINGS

Drawings are diagrammatic and show the general design, arrangement and extent of the systems. Do not scale drawings for roughing in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings as required. Coordinate work with shop drawings of other specification divisions.

1.3 WORK INCLUDED

Perform all labor for installation and furnish all materials and equipment necessary for the installation of Air Conditioning and Plumbing Systems as indicated on the drawings and any incidental work to provide a complete and workable system, including the following related work:

A. The contractor shall provide a qualified job superintendent who shall manage and coordinate the activities of the trades and maintain the progress of the work to the satisfaction of the Architect.

B. Before beginning work, verify all dimensions at the building site and check existing conditions. Make changes which are necessary to install the work in harmony with other trades; they shall be first approved by the Engineer.

C. Follow as closely as possible, the locations of pipe, duct, and equipment indicated on the drawings. Changes which may be necessary on account of building obstructions shall be made at no extra cost to Owner. Indicated pipe sizes are a minimum and shall not be decreased in size without permission from the Engineer. No holes will be allowed in any structural members without written consent of the Engineer.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Provide all work and materials in full accordance with the latest Rules and Regulations of the following:

1. California Code of Regulations, Title 21, Title 22, & Title 24
2. Building Standards
3. The State Fire Marshal
4. National Fire Code
5. National Fire Protection Association
6. Safety Orders of the Division of Industrial Safety
7. The California Electric Code, Latest Edition
8. The California Building Code, Latest Edition
9. California Mechanical Code, Latest Edition
10. California Plumbing Code, Latest Edition
11. Other Applicable State Laws and Regulations

B. Nothing in these plans or specifications is to be construed to permit work not conforming to these Codes.

C. Furnish without extra charge any additional material and labor required to comply with these Rules and Regulations.

1.5 FEES, PERMITS, AND UTILITY SERVICES

A. Obtain all permits and pay all fees and charges of any kind required in connection with this work.

B. Arrange for utility connections and pay charges incurred, including excess service charges if any.

C. All temporary connections required to maintain services including adequate heat and cooling during the course of this contract shall be made without additional cost to the Owner. The normal function of the building must not be interrupted. Notify the Owner seven (7) days in advance before disturbing any service.

1.6 SUBMITTAL

In accordance with Section 01300.

A. Submittals shall be provided for the following items plus any additional items required in the specifications for the particular types of pipe:

1. Piping and jointing materials
2. Fittings
3. Specialties
4. Fabrication drawings of all major runs of pipe and all pipe which cannot be fabricated in the field.
5. The arrangement of piping and appurtenances proposed to serve equipment of other than the first named manufacturer.

B. Contractor shall investigate the space requirements of the proposed piping before submitting shop drawings.

1.7 PLACEMENT OF EQUIPMENT AND WORK

A. The placement of all equipment, piping, valves, etc. installed in accordance with manufacturer’s instructions.

B. Install equipment, piping, valves, etc. to provide sufficient clearance for maintenance and clearance from electrical panels whether shown on drawings or not.

C. Move equipment and/or work into spaces through openings provided or located in the spaces during construction, as required. Do disassembling and reassembling of equipment or other work necessary to accomplish this requirement without extra cost to the Owner.

1.8 SPECIAL FRAMING AND PIPE ISOLATION

Special framing, recesses, chases, and backing for work of this section is covered under other sections. Be responsible for proper placement of all pipe sleeves, hangers and supports, and location of openings for work of this section.

1.9 PAINTING

Painting in accordance with Section 09900.

1.10 MAINTENANCE AND OPERATING INSTRUCTIONS

A. Furnish 5 complete copies of operating and maintenance instructions for all equipment including typed instructions for lubrication of specific equipment, in accordance with Specification Section 01680. Provide the air balance report, as defined below. Provide in durable binder.

1.11 SYSTEM OPERATIONS

Operate the system for a period of at least one day of eight (8) hours to demonstrate fulfillment of the specifications. During this time all adjustments shall be made to the equipment so that it is placed in first-class operating condition. Instruct Owner in operating and maintenance procedures. Lubricate all equipment including motors before operation. In accordance with Specification Section 01670 and 01675.

1.12 GUARANTEE

The Contractor shall guarantee to repair or replace at his expense any defective work or material within a period of one (1) year after the acceptance of the work. This includes repair of any damage caused by leaks.

PART 2 MATERIALS

2.1 GENERAL

Provide pipe and tube, joint type, grade, size and weight indicated for service, and comply with governing regulations and industry standards.

Pipe sizes are minimum nominal inside diameter unless otherwise noted. All sizes of pipe shall be as called out on the drawings and specified herein. All pipe and fittings delivered to the job site shall be clearly marked to identify the material, class, thickness, and manufacturer. All material shall be new and free of blemishes.

Provide dielectric (insulated) fittings at all pipes of dissimilar metals, all buried valves, and all locations where buried pipeline connects to aboveground piping.

2.2 PIPES AND PIPE FITTINGS

A. Drain (D) piping above the floor (exposed):

1. Mechanical-Joint, Ductile-Iron Pipe: Thickness Class 50, cement mortar lined, and shall conform to the provisions of AWWA C151-81 and C140-80 and shall have "Tyton" type joints. Standard bituminous coating shall be applied to the outside surface of the pipe by the manufacturer. All fire hydrants shall be connected to the distribution main with ductile iron pipe running from the main to the hydrant.

    a. Mechanical-Joint, Ductile-Iron Fittings: Class 250 conforming to the requirements of ANSI A21.10 (AWWA C110-77). Fittings shall be cement mortar lined in accordance with AWWA C104-80. The inside and outside of the fittings shall be bituminous coated.

    b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts. Nuts and bolts shall conform to the provisions of ANSI Specifications B18.2.

B. Vent (V) pipe shall be stainless steel piping, in accordance with Specification Section 15052.

C. Reclaimed Water (3W):

1. For piping that is less than 4" diameter, PVC Sch.40 and fittings. PVC schedule 40 piping shall not be allowed on site for pipes that are 4" diameter or larger.

    a. PVC (less than 4" diameter): Schedule 40 Rigid polyvinyl chloride (PVC) compound, Type I Grade I, with a Cell Classification of 12454 as defined in ASTM D1784. This compound shall be white in color, and shall be approved by NSF International for use with potable water (NSF Std 61).

    b. PVC is only allowed below grade, no exposed PVC piping shall be allowed on site.

2. For all piping that is less than 4-inches diameter and above ground, use schedule 40 galvanized steel.

   a. For 2.5-inches and smaller: ASTM A53 with threaded couplings. Pipe thread dimensions and size limits shall conform to ANSI B2.1. Fittings shall be malleable iron, ASTM A197, ANSI B16.3, Class 150.

   b. For 3-inches and larger: ASTM A53, butt-welded, grooved couplings, or flanges. Fittings shall be Steel, ASTM A234, ANSI B16.9, Sch. 40, or ductile iron in accordance with Section 15062; ends to match pipe.

   c. Screwed Joint Seal: Teflon tape.

   d. Flanges: steel flanges shall be ANSI B16.5, minimum Class 150, plain face or AWWA C207, Class D. Plain faced flanges shall not be bolted to raised face flanges. Gaskets shall be full face 1/16 inch thick Garlock Multi-swell Style 3760, or approved equal. Bolts shall be 316 SST.

   e. Grooved joints: in accordance with AWWA C606. Bolts shall be 316 SST.

   f. Pipe and fittings shall be lined with liquid epoxy as specified in AWWA C210 to a minimum thickness of 16 mils in not less than two coats.

   g. Insulate as scheduled below.

D. Copper and steel pipe connection: Provide Epco dielectric unions at connections of copper pipe and steel pipe of materials.

2.3 PIPE INSULATION

A. All exposed piping 2-inches or smaller shall be insulated with insulation and jacket, as defined below.

B. Insulation Thicknesses: Provide insulation thickness in inches in accordance with the following table:

	Nominal Pipe Diameters				
Temperature Service	**1 inch and less**	**1.25 to 2 inch**	**2.5 to 4 inch**	**5 to 10 inch**	**Over 10 inch**
Above 200 degrees Fahrenheit	2.0	2.5	3.0	3.5	3.5
105 to 200 degrees Fahrenheit	1.5	1.5	1.5	2.0	2.5
40 to 60 degrees Fahrenheit	0.5	1.0	1.0	1.5	2.0
Refrigerant and Fluids Below 40 degrees Fahrenheit	1.0	1.0	1.5	2.0	2.0
Heat Traced Lines	1.0	1.0	1.0	1.5	2.0

C. Insulation

1. Insulation Material: Closed cell elastomeric insulation in tubular form.
2. Temperature Range: Minus 40 degrees Fahrenheit to plus 180 degrees Fahrenheit.
3. K Factor at 75 Degrees Fahrenheit: 0.27.
4. Fire Rating: 25 or less flame spread, smoke developed 50 or less per ASTM E84.
5. Maximum Moisture Absorption, Weight Percent: 5.0.
6. Moisture Permeability: 0.10 perm-inch.
7. Joints: Seal with adhesive to form continuous water barrier.
8. Manufacturers: One of the following or equal:
    a. Armstrong World Industries, AP Armaflex.

D. Jacket

1. Material: Aluminum, Alloy 5005; 0.016 inch (26 gauge) minimum thickness.
2. Overlap: Overlap circumferential joints 4 inches minimum; overlap longitudinal joints 1 inch minimum; longitudinal joints oriented to minimize water entry.
3. Bands: 0.5 inch wide, 0.0508 inch (16 gauge) thick Aluminum, same alloy as jacket or 0.0179 inch thick Type 304 stainless steel; install on 18 inch centers, uniformly spaced and at all fitting joints.
4. Joint Seal: Apply waterproof adhesive at joints and overlaps.
5. Fittings: Custom fit of same materials.
6. Manufacturers: One of the following or equal:
    a. Childers Products.
    b. Premetco International.

2.4 VALVES

A. Ball Valves

1. Stainless steel Ball Valves (BV) - sizes 2” and smaller: shall have full ports and screwed ends.Stainless Steel body. TFE seats and seals. Type 316 stainless steel trim. Jamesbury; Hills-McCanna “McCannaflo”, Worcester, or equal.
2. Stainless steel Ball Valves (BV) Larger than 2”:
    a. Ball: Full port, single piece, solid. Solid 316, or 17-4 PH stainless steel conforming to requirements of ASTM A 351 Grade CF8M, or ASTM A 351 Grade CB7CU.

b. Stem: Blow-out proof (when assembled) using T-shaped configuration for positive retention. 304, 316, or 17-4 PH stainless steel.

c. Body: Three-piece, vertically split, end entry. Cast 316 stainless steel conforming to requirements of ASTM A 351 Grade CF8M

d. Seat: Cartridge design consisting of a seat ring with reinforced teflon or PEEK seat insert, and body seal. Spring loaded seats to assure ball/seat contact at low pressure.

e. Stem Seat: Thrust washer packing ring, two-rings for tight seal.

f. Jamesbury; Hills-McCanna "McCannaflo", Worcester, or equal.

B. SOLENOID VALVES (SOV, SOL V)

1. ¾ inches and smaller.

2. Forged brass body, Buna "N" seals and disc or diaphragm.

3. Orifice diameter equal to or greater than pipe size.

4. Epoxy resin encapsulated, waterproof, high temperature coil, 120 volt or as indicated on the drawings, single phase, 60 cycle, explosion-proof enclosure, normally-closed design, continuous duty rated.

5. Jackes-Evans Mfg. Co. Series J; Asco No. 8210, or equal.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Dewater in accordance with Section 02140.

B. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe, coating, and lining. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. Each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Padding shall be used on car or truck stakes, skids, etc., to prevent damage to the pipe during transportation and handling. Any pipe damaged shall be replaced or repaired as approved by the Engineer at no additional cost to the Owner.

C. Each section of pipe shall be delivered in the field as near as practicable to the place where it is to be installed. Pipes shall be distributed along the side of trench opposite to the spoil bank within easy reach of the installing crew.

D. Where it is necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe. Pipe shall not be rolled or dragged on the ground. Where pipe is placed on stockpiles, it shall be neatly piled and blocked with strips between tiers.

3.2 EXCAVATING, TRENCHING, AND BACKFILL

A. Trenching and Backfill:

1. Except as otherwise noted on the plans or specified herein, all excavation and backfilling for piping shall be as specified in Section 02223, "Trenching, Backfilling, and Compacting".

2. Pipelines located in or under fill areas shall not be placed until the fill has been constructed and compacted to an elevation at least one (1) foot above the elevation of the top of the pipe.

3. All backfill other than where concrete encasement is required, for pipe lines installed under structures, slabs, footings, and paving shall be made with sand and fine gravel, thoroughly compacted in place to not less than 95% of maximum density.

B. Grades and Elevations:

1. All piping and appurtenances shall be installed in the position and to accurate lines, elevations, and grades as shown on the plans or specified herein. Where possible, piping shall be sloped to permit complete drainage. All pipelines shall be rigidly supported and braced by approved hangers, brackets, or other devices. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work. See Specification Section 15094.

2. Furnish all fittings necessary for the satisfactory alignment and arrangement of piping and all necessary unions and cleanouts.

3. An invert grade rod shall be used in laying all lines below ground.

3.3 INSTALLATION OF PIPING AND FITTINGS

A. Flexible Couplings:

1. Flexible couplings shall be installed where shown on the drawings and at such other points as may be required for ease of installation or removal of the pipe, subject to approval of the Engineer. Where necessary to prevent separation of pipe due to internal pressures, flexible couplings shall be of the type with set screws in the retainer gland or shall be provided with tie rods as approved by the Engineer. Where permanent flexibility is required, however, such as at connections to pumps or other equipment, and elsewhere as called for on the drawings, tie rods shall be the only acceptable restraining devices and shall be installed through separate mounting plates or lugs and not through flange bolt holes, in order to retain flexibility.

2. Where rubber or similar flexible couplings are called for on the Drawings, tie rods shall be provided if recommended by the manufacturer to prevent excessive elongation.

B. Flexible Joints: For pipelines extending from a concrete structure into earth, at least two flexible joints shall be provided in the earth within 3 feet of the structure face, one of which may be cast in structure with end flush with structure face. Piping beyond structure shall adequately supported by proper compaction under pipe or by supporting on firm undisturbed soil if necessary.

C. Union and Flanges:

1. In erecting the pipe, a sufficient number of screwed unions or flanged joints shall be used to allow any sections or runs of pipe to be disconnected without taking down adjacent runs. Screwed unions shall be used on pipelines two and one-half (2-1/2) inches in diameter and smaller. Flanged joints shall be employed in pipelines three (3) inches in diameter and larger.

2. All exposed piping shall be provided with rigid joints as necessary to prevent shifting or separation due to internal pressures, seismic forces, or the weight of the pipe and it's contents. Rigid joints shall include flanges, grooved couplings, screwed joints, welded joints, soldered joints, etc., unless otherwise noted on the drawings.

D. Concrete Thrust Blocks: Unless noted otherwise, concrete thrust blocks shall not be allowed, except at specific locations shown on the drawings or specifically approved by Engineer. Thrust blocks shall be poured between the pipe or fitting and undisturbed earth.

E. Concrete Wall and Slab Penetrations:

1. Hydraulic Conditions - Piping passing through concrete walls normally below liquid level shall be installed with one of the following:

a. Cut-off collar cast on ductile iron fittings or pipe, ¼-inch thick, 3-inches wide.

b. Cut-off collar welded to steel fittings or pipe, ¼-inch thick, 3-inches wide.

c. Cored, canned or sleeved hole 3-inches to 7-inches larger diameter than pipe; pack with non-shrink grout.

d. Cored, canned, or sleeved hole of suitable size to be sealed with a modular mechanical interlocking EPDM synthetic rubber links shaped to continuously fill the annular space between pipe and opening, equal to "Link-Seal" by Thunderline Corp., Wayne, MI.

2. Non-Hydraulic Conditions -

a. Piping passing through concrete walls, slabs, or footings from earth to earth shall have provision for reasonable relative movement by wrapping pipe with one-inch fiberglass entire thickness of concrete.

b. Horizontal or vertical piping passing through concrete walls, sidewalks, slabs, or footings from earth to air shall be wrapped with 3/8-inch thick, 60 durometer, rubber sheeting, secured with banding.

F. Connections to Equipment:

1. The pipework of all pumps and equipment shall be adequately supported throughout and the weight thereof shall be carried independently of the pump casings or the equipment. All pipework shall be mounted parallel with vertical and horizontal axes of reference. All sections of pipe shall be rigidly bolted or joined together after being cut accurately to length in such a manner as to relieve any and all parts of equipment of undue strain resulting from closure of flanged or other joints or connections.

2. Equipment shall be so positioned and aligned that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

G. Pipe Joints:

1. Pipe shall be cleaned of dirt and scale prior to installation and all joints swabbed clean before jointing. Ends of all pipe shall be closed or plugged at the end of each day's work or otherwise as necessary to prevent the entrance of foreign materials.

2. The Contractor shall perform all work of cutting pipe and special castings necessary to the assembly, erection and completion of the work. All pipe shall be cut and reamed to fit accurately with smooth edges.

H. Coatings for Buried Valves and Piping Accessories: All buried valves, flange assemblies, flexible connections, flange coupling adapters and similar fittings shall be coated with petrolatum wax tape. All buried nuts, bolts, washers, tie rods, and other threaded fasteners shall be Type 316 stainless steel.

3.4 DISINFECTION AND TESTING OF PIPING

Disinfect all piping in accordance with Section 01656. Test all piping to 5 psi above operating pressures, in accordance with Section 01666.

3.5 IDENTIFICATION

See Section 10400.

3.6 PIPE CLEANOUTS

Cleanouts shall be "T" or "Y" branches or trap hubs of same material as pipe in which they are placed; locate as required by code.

3.7 INSTALLATION OF PIPING

A. Upon installation of piping, close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.

B. Flush each piping thoroughly and proved clean before connection to equipment.

3.8 PIPE HANGERS

In accordance with Section 15094.

END OF SECTION

SECTION 15052

STAINLESS STEEL PIPE

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of furnishing materials and constructing therewith new stainless-steel pipe, tubing, and fittings 30-inches in diameter and smaller.

A. Pipe shall conform to ASTM A312.

B. Stainless steel tubing shall be as specified in Part 2.15.

1.2 RELATED WORK ELSEWHERE

A. Section 01300 - Submittals

B. Section 01666 - Testing of Pipelines

C. Section 02223 - Trenching, Backfilling, and Compacting

D. Section 09900 - Painting

E. Section 11010 - General Mechanical Equipment Provisions

F. Section 15010 - General Process and Onsite Utility Piping Provisions

G. Section 15080 - Piping Accessories and Appurtenances

H. Section 15094 - Hangers and Supports

1.3 QUALITY ASSURANCE

Standards, American Society for Testing and Materials (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), American Iron and Steel Institute (AISI), and American Welding Society (AWS).

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Show materials of construction, with ASTM reference and grade. Submit manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A312, A403, A774, A778. Show wall thickness of steel cylinder and fittings.

C. Submit piping layout drawings showing the location and dimensions of the pipe and fittings larger than 2.5 inches nominal diameter. Include layout lengths of valves, meters, blowers, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe.

D. Submit manufacturer's data for flange and coupling gaskets.

E. Submit certifications that welders are qualified in accordance with ANSI B31.1, Paragraph 127.5 for shop and project site welding of pipe work.

PART 2 MATERIALS

2.1 PIPE

Pipe shall conform to ASTM A312 or A778, Grade 304L or Grade 316 as indicated in the Drawings and/or Specifications. If not indicated, use Grade 304L. Pipe sizes and wall thickness shall conform to ANSI B36.19. Pipe 2.5 inches nominal diameter and smaller shall be Schedule 40S. Pipe 3 inches nominal diameter and larger shall be Schedule 10S.

2.2 FITTINGS

A. Fittings 2.5 inches and smaller shall be threaded conforming to ANSI B16.11, 3,000-pound CWP. Material for threaded fittings shall conform to ASTM A403, Class WP, same material as connecting pipe.

B. Fittings for buried or submerged pipe larger than 2.5 inches shall be butt-welded, conforming to ASTM 403, Class WP same material and wall thickness as the connecting piping, conforming to ANSI B16.9. Elbows shall be short radius.

C. Fittings for aboveground or exposed pipe larger than 2.5 inches shall be butt-welded, grooved, or flanged, conforming to ASTM A403, Class WP same material and wall thickness as the connecting piping, conforming to ANSI B16.9. Elbows shall be short radius.

2.3 JOINTS

A. Joints for pipes 2.5 inches and smaller shall be threaded, same material as specified for fittings, 3,000-pound WOG, conforming to ANSI B16.11.

B. Joints for buried pipe larger than 2.5 inches shall be butt-welded or flexible grooved, unless noted otherwise on drawings.

C. Joints for aboveground or exposed pipe larger than 2.5 inches shall be flanged or welded.

D. Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-weld joints or flanges.

2.4 THREAD LUBRICANT

Use Teflon thread lubricating compound or Teflon tape.

2.5 FLANGES

Provide stainless steel weld-neck flanges conforming to ANSI B16.5 for piping 2.5 inches and smaller to connect to flanged valves, fittings, or equipment. Provide weld-neck or slip-on flanges for piping larger than 2.5 inches. Flanges shall be Class 150 per ANSI B16.5. Material for weld-neck and slip-on flanges shall conform to ASTM A182, Grade F304 or F316 to match pipe type. Flanges shall match the connecting flanges on the adjacent fitting, valve, or piece of equipment. Flange shall be flat face.

2.6 BOLTS AND NUTS FOR FLANGES

A. Bolts and nuts for flanges shall be stainless steel conforming to ASTM A193, Grade B8M, for bolts and ASTM A194, Grade 8M, for nuts.

B. Bolts for flange insulation kits shall be stainless steel and conform to ASTM A 193, Grade B7. Nuts shall conform to ASTM A194, Grade 2H.

C. Provide stainless teel washer for each nut. Washers shall be of the same material as the nuts.

2.7 LUBRICANT FOR STAINLESS-STEEL BOLTS AND NUTS

Lubrication shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Jusk IT Husky Lube O'Seal, or equal.

2.8 GASKETS FOR FLANGES

Gaskets shall be fullface, 1/16 inch thick. Gaskets shall be acrylic or aramid fiber bound with nitrile. Gaskets shall be Garlock "Bluegard", Klinger "Klingersill C4400", or equal. Gaskets shall be suitable for a water pressure of 500 psi at a temperature of 400 degrees Fahrenheit.

2.9 WELDING:

A. Ensure that weld seams have full penetration and be free of oxidation, crevices, pits, cracks, and protrusions.

1. Weld seams without undercuts.
2. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.

B. Accomplish longitudinal welds on fittings, except elbows by the same procedures as for pipe.

C. Manually Weld Pipe Spools with Type 304L Filler Metal:

1. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
2. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

2.10 OUTLETS

A. Outlets 2.5 inches and smaller in piping 3 inches and larger shall be of the stainless steel Thredolet type, per AWWA Manual M11 (1998 edition), Figure 13-23. Outlets shall be 3,000-pound WOG stainless steel per ASTM A182, Grade F304 or F316, or ASTM A403, Grade WP304 or WP316, to match pipe. Threads shall comply with ANSI B2.1. Outlets shall be Bonney Forge Co. "Thredolet", "Allied Piping Products Co. "Branchlet", or equal.

B. For outlets 2.53 inches and smaller in piping smaller than 3 inches, use a stainless steel tee with a threaded outlet.

C. For outlets larger than 3 inches, use a stainless steel tee. Tees, crosses, laterals and wyes shall be shop fabricated from pipe, and in addition, stainless steel reinforcement collars shall be fully welded to the branch and run of the pipe as necessary to maintain the specified pressure rating.

2.11 WALL PENETRATIONS

Wall pipes shall have integral shop welded wall stops, circumferentially welded to the pipe run.

2.12 EXPANSION AND FLEXIBLE COUPLING ASSEMBLIES

Expansion and Flexible Coupling shall be provided at a minimum in the locations shown on the Contract Drawings. Couplings shall comply with the requirements of Section 15080, except that all metal parts in contact with the stainless steel piping and fitting shall also be stainless steel. Gasket material for hot air piping shall be able to withstand sustained operating temperatures up to 350°F. Flexible Coupling shall be held in place by means of an internal centering ring or centering lugs.

2.13 FINISH

After all shop operations have been completed, pipe and fittings shall be pickled and passivated in manufacturer's plant, and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed. The standard finish for 16-gage through 8-gage material shall be No. 1 or 2B per ASTM A480; 3/16-inch and heavier plate material shall be No. 1 mill finish or better per ASTM A480.

2.14 STAINLESS STEEL TUBING

A. General

1. Provide stainless steel tubing in sizes indicated on the Drawings.
2. Where not indicated on the Drawings, provide stainless steel tubing of the size required to perform the function intended.

B. Tubing

1. Stainless Steel Tubing: Seamless tubing made of Type 316 L or 304L stainless steel and conforming to ASTM A269.
2. Wall thickness adequate for test pressure specified, but not less than 0.065 inch for run tubing. Connections to actuators may be ¼-inch as required for flexibility.

C. Fittings

1. Fittings for Use with Stainless Steel Tubing: Swage ferrule design, with components made of Type 316 stainless steel.
    a. Fittings: Double acting ferrule design, providing both a primary seal and a secondary bearing force.
    b. Flare, bite, or compression type fittings are not acceptable.
2. Fittings: Manufacturers: One of the following or equal:
    a. Crawford Fitting Company, Swagelok.
    b. Hoke, Gyrolok.

c. Parker, CPI.

D. Valves: Valves for Use with Stainless Steel Tubing: Air cocks of Type 316 stainless steel.

PART 3 EXECUTION

3.1 FABRICATION/INSTALLATION REQUIREMENTS

The piping supplier during manufacturing, fabricating and handling stages, and the Contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber-lines. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes, and rinse clean.

3.2 MARKING, SHIPPING, AND STORAGE

All pipe, fittings, and fabrications shall be properly marked with type, gage, and heat number. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

3.3 INSTALLING THREADED PIPING

Ream, clean, and remove burrs from threaded piping before making up joints. Apply thread lubricant to threaded ends before installing fittings, couplings, unions, or joints.

3.4 INSTALLING FLANGED PIPING

A. Set pipe with the flange bolt holes straddling the pipe horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

B. Lubricate bolts prior to installation.

3.5 INSTALLING GROOVED-END PIPING

Install grooved-end pipe and fittings in accordance with the coupling manufacturer's recommendations and the following:

A. Clean loose scale, rust, oil, grease, and dirt from the pipe or fitting groove before installing coupling. Apply the coupling manufacturer's gasket lubricant to the gasket exterior including lips, pipe ends, and housing interiors.

B. Fasten coupling alternately and evenly until coupling halves are seated.

3.6 FABRICATION, ASSEMBLY, AND ERECTION

A. Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding.

B. Fabrication shall comply with ANSI B31.3, Chapter V.

C. Welds shall be full circumferential. The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inch)	Minimum Number of Passes for Welds
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

D. Use the shielded metal arc welding (SMAW) or the tungsten inert gas (TIG) process for welding. Use the SMAW process for any pipe. Use the TIG process only on pipe having a maximum thickness of Schedule 10S.

E. Welding preparation shall comply with ANSI B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 341.3.2A and 341.3.2B, and paragraph 341.4 for visual examination.

F. Identify welds in accordance with ANSI B31.3, paragraph 328.5.

G. Major piping assemblies shall be shop fabricated. Field welding of above ground piping shall be permitted only where indicated on the Contract Drawings or deemed necessary by the Engineer.

3.7 INSTALLING BURIED PIPE

Install in accordance with Section 02223, except as modified herewith. Pipe installed underground shall not deviate more than 1 inch from line or ¼ inch from grade. Measure for grade at the pipe invert.

3.8 INSTALLING ABOVEGROUND PIPE AND TUBING

A. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

B. Provide pipe hangars and supports as identified in the drawings.

C. Install tubing fittings in strict conformance with manufacturer's recommendations.

3.9 SUBMERGED PIPE

Install submerged aeration piping as shown on the drawings.

3.10 COATINGS

After installation, the Contractor shall paint all steel or iron flanges, couplings, and appurtenances in accordance with Section 09900. Painting of the stainless steel pipe is not required. However, the Contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

3.11 TESTING

Test air piping in accordance with Section 01666.

END OF SECTION

SECTION 15080

PIPING ACCESSORIES AND APPURTENANCES

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of providing piping accessories and appurtenances.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittal

B. Division 15: Mechanical

1.3 QUALITY ASSURANCE

A. Reference, American Society for Testing and Materials (ASTM).

B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

C. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.4 SUBMITTALS

A. Materials list and catalog data sheets naming each product to be used identified by manufacturer and type number.

B. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

PART 2 MATERIALS

2.1 FLEXIBLE COUPLINGS

A. Application

	Baker	Rockwell	Dresser
Iron pipe size O.D. pipe	200	411,521	38,90
Ductile iron	228	411, 431, 441	38, 53, 138, 153
Transition	212, 236	413, 433	162
Reducing	220, 240	415, 435	62
Flanged coupling adapter	601, 602, 603, 604	912, 913, 914, 916	127, 128

1. Rockwell International, 400 North Lexington, Pittsburg, PA 15208
2. Dresser Mfg., 41 Fisher Ave., Bradford, PA 16701
3. R.H. Baker & Co., 2929 Santa Fe Ave., Los Angeles, CA 90058, or equal.

B. Materials: Cast couplings shall be used wherever possible. Steel couplings with a minimum sleeve thickness of the connecting pipe wall or ¼-inch, whichever is greater, shall be used where cast couplings are not available.

1. Sleeve: Grey iron or steel.
2. Flanges: Malleable or ductile iron or high strength steel.
3. Bolts and Nuts: Low alloy, high strength, zinc coated when exposed, 304 stainless steel when buried, 316 stainless steel or below top of wall in water bearing structures.
4. Finish of Coupling: fusion epoxy coating.
5. Gaskets:
   a. Synthetic rubber (Rockwell grade 60, Dresser 42) High-temperature, non-asbestos gasket for service above 212°F.
   b. High Temperature Service – Gaskets on air piping or hot water piping shall be suitable for temperatures up to 300°F.

C. Wrap couplings, two feet beyond on either side, with geotextile fabric suitable to temperatures stated above.

D. Split-Sleeve couplings, with double-arched housing and O-ring gaskets may be used in lieu of sleeve-type. Couplings shall be restrained (FxF), expansion (ExE), or a combination (FxE) as required, manufactured by Victaulic Depend-O-Lok, Doraville, GA 30362.

2.2 FLANGED RUBBER FLEXIBLE CONNECTIONS

A. Rubber Expansion Hot Water, Sludge, and Air Service:

1. Manufacturers: One of the following or equal:

a. Mercer Rubber Company, Style 500.

2. Provide rubber expansion joints complete with control rods and split retaining rings.

3. Design:

a. Material: EPDM, reinforced with embedded steel rings, and a strong synthetic fabric.

b. Single Arch Expansion Joints for Air and Sludge Service,

1) Pressure Rating: Suitable for continuous operation at a pressure of at least 250 Pounds per square inch gauge.

2) Vacuum Rating: Suitable for a vacuum of 30 inches of mercury

3) Temperature Rating: Minimum continuous operation at 250°F.

4) Axial Extension: 1/2"

5) Axial Compression: 3/4"

6) Split retaining rings, stainless steel.

7) Ends of expansion joints, stainless steel 150 pound ANSI flanges with drilling to match that of the piping.

c. Dual Arch Expansion Joints for Hot Water service,

1) Pressure Rating: Suitable for continuous operation at a pressure of at least 180 Pounds per square inch gauge.

2) Vacuum Rating: Suitable for a vacuum of 30 inches of mercury

3) Temperature Rating: Minimum continuous operation at 250°F.

4) Axial Extension: 1"

5) Axial Compression: 1-1/2""

6) Split retaining rings, stainless steel.

7) Ends of expansion joints, stainless steel 150 pound ANSI flanges with drilling to match that of the piping.

B. Rubber Expansion Digester Gas and Chemical Service:

1. Manufacturers: One of the following or equal:

a. Mercer Rubber Company, Style 700.

2. Provide rubber expansion joints complete with control rods and split retaining rings.

3. Design:

   a. Material: EPDM with Teflon liner etched and permanently bonded to the expansion joint body and flange faces, reinforced with embedded steel rings, and a strong synthetic fabric.

   b. Coating: Hypalon paint to provide protection against ozone, weathering, and chemical exposure.

   c. Single Arch Expansion Joints for Digester Gas and Chemical service,

      1) Pressure Rating: Suitable for continuous operation at a pressure of at least 150 Pounds per square inch gauge.

      2) Vacuum Rating: Suitable for a vacuum of 30 inches of mercury

      3) Temperature Rating: Minimum continuous operation at 250°F.

      4) Split retaining rings, stainless steel.

      5) Ends of expansion joints, stainless steel 150 pound ANSI flanges with drilling to match that of the piping.

2.3 GROOVED COUPLINGS AND FITTINGS

A. Couplings

1. Housing shall be ductile iron conforming to ASTM A536, grade 65-45-12.

2. Gasket: ASTM D2000, one of the following, for the appropriate application:

   a. Ethylene Propylene Diene (EPDM) - Grade “E”

   b. Nitrile (Buna-N) - Grade “T”

   c. Halogenated Butyl - Grade “M”

3. Bolts and nuts: heat treated carbon steel, ASTM A449 and A183.

4. Coating:

   a. Exposed: enamel

   b. Buried: two coats Koppers, Bitumastic 50, or equal, after assembly.

5. Application:

   a. Grooved Steel Pipe (non-rigid connection): Victaulic 77 and W77, or engineer approved equal.

      1) For rigid connections through 12”, coupling housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

a) 2” through 6”: Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 107.

b) Victaulic Zero-Flex Style 07.

2) For sizes 14” through 24”, Victaulic Style W07.

b. Grooved Cast Pipe (nonrigid connection): Victaulic 31 or engineer approved equal.

B. Flange Adapters for Grooved Pipe

1. Class 125 standard drilling.

2. Housing shall be ductile iron conforming to ASTM A536, grade 65-45-12.

3. Gasket, ASTM D2000, one of the following, for the appropriate application:

a. Ethylene Propylene Diene (EPDM) - Grade “E”

b. Nitrile (Buna-N) - Grade “S” or “T”

c. Halogenated Butyl - Grade “M”

4. Coating:

a. Exposed: enamel.

b. Buried: Two coats Bitumastic 50, Koppers, or equal, after assembly.

5. Application:

a. Grooved Steel Pipe: Victaulic 741, W741, and 743 or engineer approved equal.

b. Grooved Cast Pipe: Victaulic 341 or engineer approved equal.

C. Cut and Rolled Grooves

1. Pipe sized ¾ through 24-inch may be cut grooved.

2. Roll groove pipe if wall thickness is less than minimum recommended by the manufacturer for cut-grooving.

3. Cast pipe shall have rigid radius cut grooves.

D. Collared and Shouldered Pipe

1. In accordance with manufacturer’s recommendations, Vic-Rings with Style 41 or 44 couplings as required for the application.

2. Victaulic Co., 4901 Kesslersville Road, Easton, PA 18042

2.4 TRANSITION COUPLING ADAPTOR

A. For piping connections with dissimilar outside diameter (for example, SDR to DIP), provide transition coupling.

B. The coupling shall have follower flanges and a sleeve made of cast ductile iron per ASTM A-536.

C. Flanges shall be color coded to identify general type of pipe (red for IPS size, Blue for ductile iron sizes, and gray for Cement sizes).

D. Gasket shall be Buna N and NSF 61 rated with temperature range from -20 to 180 degrees F.

E. The nuts and bolts shall be 304 SST.

F. Coat fitting with fusion epoxy.

G. Manufactured by Smith Blair Inc, model 441 Omni cast coupling, or equal.

2.5 PRESSURE GAUGES (PG)

A. Liquid filled, glycerine or silicone.

B. 2½- to 3½-inch dial, scale 20-50% greater than normal operating pressure, 270 degree movement.

C. Stainless steel case and polycarbonate window.

D. Provide gauges with Type 316 stainless steel socket and bellows or bourdon tube, depending on pressure range.

1. Where the maximum pressure is less than or equal to 15 pounds per square inch the gauge shall use bellows as the measuring element.
2. Where the maximum pressure is greater than 15 pounds per square inch, the measuring element shall be a bourdon tube.

E. 2½ percent accuracy.

F. ¼-inch NPT bottom connection.

G. Mount gauges on diaphragm seals where indicated on the Drawings.

1. Provide diaphragm seals with Type 316 stainless steel top housing, bottom housing, and bolt assemblies.

    a. Bottom housing shall be fitted with a ¼-inch flushing connection.

    b. This flushing connection shall be fitted with a Type 316 stainless steel close nipple and a brass shutoff cock.

    c. Diaphragm Seal: Removable.

        1) For pressure less than or equal to 15 pounds per square inch, provide a diaphragm seal.

        2) For pressures greater than 15 pounds per square inch, provide Type 316 stainless steel diaphragm seal.

    d. Fit diaphragm seal gauge assembly with a snubber.

    e. Snubber shall have porous metal disc sized to dampen pressure fluctuations in the filled system.

    f. Snubber shall be Stainless Steel.

    g. Snubber filter disc shall be sized to prevent the gauge from pulsating.

    h.

    i. Provide diaphragm seal gauge assemblies filled with silicone. Gauges used for chemical service shall utilize PTFE diaphragm seals and PVC gauge guard housings.

2. Pressure gauges, except gauges with diaphragm seals, shall have pulsation dampeners installed between the gauge and the shut-off valve.

3. Pulsation Dampeners shall be Stainless Steel.

H. Annular Seal Pressure Sensors

1. Pressure Sensors are to be of the full flange design, to be retained between standard ANSI B16.1 Class 125/6.5 Class 150 pipeline flanges.

2. The outside diameter of the sensor shall match the outside diameter of the mating flange.

3. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. The elastomer sensing ring shall be rigidly clamped between metal end cover flanges, and no part of the elastomeric sensing ring shall be exposed to the external face of the sensor. There shall be no dead ends or crevices and flow passage shall make the sensor self-cleaning.

4. The pressure sensing ring shall measure pressure for 360° around the full inside circumference of the pipeline. Flexible sensing ring shall have a cavity behind the ring filled with fluid to transfer pressure to the gauge.

I. Manufacturers

1. Pressure Gauges: One of the following or equal:

   a. U.S. Gauge Division of Ametek, Inc. Solfrunt Gauges, Figure Number 1931T.

   b. Dresser Industries, Inc., Ashcroft Figure Number 1379.

2. Diaphragm Seal: One of the following or equal:

   a. For pressure less than or equal to 15 pounds per square inch:

      1) Ashcroft, Type 301.

      2) Mansfield and Green, Type LG.

      3) For chemical service, Plast-O-Matic Series GGMT.

   b. For pressures greater than 15 pounds per square inch:

      1) Ashcroft, Type 101.

      2) Mansfield and Green, Type RG.

      3) For chemical service, Plast-O-Matic Series GGMT.

3. Snubber: One of the following or equal:

   a. Chemiquip, Ashcroft

4. Pulsation Dampeners: One of the following or equal:

   a. Dresser Industries, Inc., Ashcroft Figure Number 1106S.

   b. Operation and Maintenance Specialties, Charlotte, N. C., Ray Pressure Snubbers.

5. ¼-inch stainless steel cross handle cock, Ashcroft 7004; Marsh MFG, or equal.

6. Pressure Annual Seal

   a. Red Valve Series 40.

   b. Ashcroft ISO-Ring.

   c. Approved equal.

2.6 THERMOMETERS

A. Tube Type Thermometers:

1. 9 inch size with adjustable angle from temperature well.

2. Type 316 stainless steel separable sockets with extension necks on insulated pipes and where indicated on the Drawings.

3. Range indicated on the Drawings.

4. Manufacturers: One of the following or equal:

   a. H.O. Trerice Company, Series BX9.

   b. Jay Instruments Company.

2.7 LINE SIZE PRESSURE SENSORS

A. Full line size with flanged or threaded ends.

B. Carbon steel body with flexible neoprene tube and liquid cavity.

C. Rated at 200 psi with 2 percent accuracy.

D. Gauge and liquid as specified in subsection 2.11 above.

E. Red Valve Series 30 or 40, 500 No. Bell Ave., Carnegie, PA 15106; Ronningen-Petter "Iso-Spool" or "Iso-Ring", Portage, MI 49081, or equal.

2.8 FLUSHING CONNECTION

A. Cast bronze swivel inlet adapter, rocker lugs.

B. 1-inch NPT inlet, hose thread outlet.

C. DeSanno Foundry & Machine Co. No. 73, 1933 Peralta, Oakland, CA 94607; Champion No. 10, 1460 No. Naud St., Los Angeles, CA 90012, or equal.\

2.9 INDUSTRIAL HOSE

A. Each hose valve shall be supplied with a coupled 50-foot long industrial hose.

B. Hose shall be the same size (full line size) of hose valve, 1" or 1.5" diameter.

1. Hose shall be oil resistant, reinforced two ply, modified nitrile tube and cover.

2. Versigard synthetic rubber, RMA Class C. Reinforced with spiral synthetic yarn. Rated between -40 oF and 190 oF. Minimum pressure rating of 150 psi.

3. Provided with threaded end connections and spray nozzle.

4. GoodYear, Model 569-049 Sureline, or equal.

2.10 MECHANICAL RUBBER SEAL

A. Modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

B. EPDM seal element suitable for service to 250 degrees F, except seal element shall be silicone or viton suitable for 300 degrees F for aeration piping.

C. Composite pressure plates.

D. 316 stainless steel nuts and bolts.

E. Thunderline Link-Seal, or equal.

2.11 Tapping Sleeve

A. Manufacturers: One of the following or equal.

1. BTR Inc./Smith-Blair, Inc., Style 622 or 662.
2. Romac Industries, Inc., Style FTS 420.
3. Ford Metering Company, Model FTSC

B. Material

1. Tapping Sleeves: Steel construction, fusion bonded epoxy coating.
2. Bolts and Nuts: Type 304 stainless steel.
3. Nuts: Teflon coated.
4. Gaskets: EPDM.
5. Size of Tapped Boss: As indicated on the Drawings.

2.12 Tapping Valves

Tapping valve shall conform to AWWA C500. Tapping valves shall be manufactured by Mueller, or approved equal. Tapping valves shall have a Class 125, ANSI B16.1 inlet flange and a two inch (2”) square wrench nut.

2.13 PIPE SADDLES

A. Manufacturers: One of the following or equal.

1. BTR Inc./Smith-Blair, Inc., Style 317

2. Romac Industries, Inc., Style 202S

3. Ford Metering Company, Model FC202

B. Materials:

1. Pipe Saddles: Ductile iron.

2. Straps, Bolts, and Nuts: Type 304 stainless steel with Teflon coating on nuts.

3. Gaskets: EPDM

2.14 Line Stopping

Where indicated on the drawings, provide tapping sleeve, tapping valve, and line stopping equipment to temporarily stop flow in pipe.

2.15 CORPORATION STOPS

In accordance with AWWA C 800.

A. Manufacturers: One of the following or equal.

1. Ford

2. Mueller Company

2.16 CURB STOPS

A. Manufacturers: One of the following or equal.

1. Ford

2. Mueller Company

B. Description: Round way solid tee head stops.

2.17 COCKS

A. Gauge Cock:

1. Manufacturers: One of the following or equal.

2. Lunkenheimer Company, Figure 1178 or Figure 1180

B. Air Cock:

1. Manufacturers: One of the following or equal.

a. Whitey Research Tool Company, Model B-42S4

b. Hoke Inc., 7122G4B

C. Plug Cock Manufacturers:

1. One of the following or equal.

a. Lunkenheimer Company, Figure 454

D. Plug Cock Design:

1. Bronze, straightway pattern complete with lever.

2.18 FLOOR DRAIN

A. Floor Drains and Equipment Drains in Process Areas or Buildings:

1. Equipment and Floor Drains: Provide with adjustable strainer head, floor level grate, 4-inch diameter funnel extension and provided with no-hub outlet and nickel bronze top.

a. Manufacturers (one of the following or equal):

1) Josam Company, 30000-A, combination drip drain, less clamping collar.

2) Zurn Industries Inc., ZN-415 strainer.

2. Funnel Extension:

a. Manufacturers (one of the following or equal):

1) Josam Company, E-2.

2) Zurn Industries Inc., Zn-238.

2.19 CLEANOUTS

A. Floor Cleanouts (FCO) in Finished Floor Areas: Provide complete including cast-iron ferrule, countersunk plug, gas tight and watertight seal, adjustable cleanout head extension, scoriated nickel-bronze top, and securing screw.

1. Manufacturers: One of the following or equal:

a. Josam Company, 56070.

b. Zurn Industries, Inc., ZN-1400.

B. Floor Cleanouts (FCO) in Unfinished Floor Areas: Same as floor cleanouts specified for finished floor areas, except heavy duty scoriated cast-iron top suitable for heavy traffic conditions.

1. Manufacturers: One of the following or equal:
   a. Josam Company, 56040-5.
   b. Zurn Industries, Inc., Z-1400-HD.

C. Yard Cleanouts (YCO) in Asphalt or Ground Areas: Floor cleanouts in unfinished floor areas specified before, for encasement in a concrete pad as indicated on the Drawings and flush with grade.

2.20 ROOF DRAINS

A. Main Roof Drains:

1. Main Roof Drains: Provide complete, including coated cast-iron body, combined flashing collar and gravel stop, bronze dome strainer, underdeck clamp where required, and pipe of size indicated on the Drawings.
2. Manufacturers: One of the following or equal:
   a. Josam Company, Series 21520-23.
   b. Zurn Industries, Inc., ZRB-100.

B. Overflow Roof Drains: Provide same as main roof drains but with a 2 inch water dam.

1. Manufacturers: One of the following or equal:
   a. Josam Company, 26010-23.
   b. Zurn Industries, Inc., ZRB-100-89.

C. Scupper Roof Drains: Provide complete, including coated cast-iron body, coated cast-iron or bronze angle strainer, 90 degree or 45 degree threaded outlet where required, and pipe of size indicated on the Drawings.

1. Manufacturers: One of the following or equal:
   a. Josam Company, 24700.
   b. Zurn Industries, Inc., Z-187.

D. Downspout Nozzles: Provide complete, including nickel-bronze body and wall flange.

1. Pipe Size: As indicated on the Drawings.
2. Manufacturers: One of the following or equal:
   a. Josam Company, 25010-50-SF.

b. Zurn Industries, Inc., ZANB-199.

2.21 POLYETHYLENE ENCASEMENT

All buried metallic piping, specials, and fittings shall be polyethylene encased, double wrapped. 8 mils thickness, sized to pipe diameter, ANSI/AWWA-C105/A21.5. Ends taped off with vinyl pipe wrap tape 10-mil vinyl tape manufactured by Calpico Inc. (Calpico VI-10) or equal.

Polyethylene Encasement- "Clear" non-colored polyethylene film, in either tubular or sheet form. The polyethylene film shall have a minimum thickness of 8 mils and at no point shall not be less than 10 percent of the nominal thickness. Polyethylene film shall be manufactured from a Type 1, Class A raw polyethylene material conforming to "Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids" (ANSI/AWWA C-105/A21.5). Manufactured by Fee Spec's-LP378D Northtown, Fulton Enterprise Inc., Global Polymer Tech, Unisource, or equal.

PART 3 EXECUTION

3.1 FLEXIBLE COUPLINGS

A. Install where shown on Drawings and where required for ease of installation or removal of pipe, subject to approval of Engineer.

B. Pipelines 4 inches and larger extending from a concrete structure into earth shall have at least two flexible joints within 3 feet of the structure face.

C. Provide tension assemblies as specified in subsection 2.05 of this Specification where necessary to prevent separation of pipe due to internal pressures.

3.2 GROOVED COUPLINGS AND FITTINGS

A. Grooved systems may be used in lieu of flanged, welded or screwed joints for steel or cast pipe (grey or ductile) at Contractor's option, except for chemical service.

B. Install per manufacturer's directions.

C. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

3.3 Hot Tapping

A. Hot tapping piping is not permissible, unless approved by Engineer. If approved, tapping shall be done in accordance with American Petroleum Institute (API) recommended practice 2201.

END OF SECTION

SECTION 15094

HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 DESCRIPTION

The work of this section consists of providing necessary materials and installation to properly support all pipe, electrical conduit, ductwork and miscellaneous hardware.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 01610 – Seismic Design Criteria

C. Section 01615- Wind Design Criteria

D. Section 09900 – Painting and Finish Schedule

E. Section 11010 - General Mechanical Equipment Provisions

F. Section 15010 - General Process and Onsite Piping Provisions

1.3 QUALITY ASSURANCE

Standards:

A. AA - Aluminum Association

B. AISC - American Institute of Steel Construction

C. ASTM - American Society for Testing and Materials

D. AWS - American Welding Society.

1.4 SUBMITTALS

A. In accordance with Section 01300.

B. Shop Drawings: Submit certified drawings showing all details of pipe, electrical conduit, ductwork and miscellaneous support devices. Shop drawings shall include all details of construction, anchor size, hanger rod sizes, bar sizes, weld sizes, mounting dimensions and overall space requirements.

1. Submit manufacturer's literature to verify support of 5 times the weight or thrust of the piping without failure. Where standard tables are not available, provide calculations signed and stamped by a Civil or Structural Professional Engineer licensed to practice in the state where the project is located. All calculations shall be provided in English units.

2. All exposed and above grade piping shall be vibrationally isolated and restrained by a Seismic Restraint System. Provide calculations in accordance with specification sections 01610 and 01615.

a. The Typical Details provided in the construction documents for supporting mechanical equipment, electrical equipment and distributed systems (i.e. piping, conduit, ducting, other) are to be used for general guidance, minimum requirements, and layout for support systems. Design for these support systems shall be provided in the submittal. The design shall include details and calculations stamped and signed by a Civil or Structural engineer registered in the State of California.

b. Submit layout drawing(s) showing where submitted supports will be used. Layout drawings shall document how the pipe support will be used to resist lateral loads, perpendicular and parallel to the pipe, the specific height and spacing in that area, where the support will connect to flanges (e.g. pipe friction cannot be used to resist lateral loads)- to ensure the calculated maximum loads/spacing provided are appropriate (and to ensure contractor is installing correct detail in appropriate location).

3. Submit documents supporting manufacturer's published values (load capacities, max design loads, deflection from stress, etc.) in terms of how the values were obtained (independent testing laboratory, testing agency, or government agency).

C. Manufacturer's Literature: Submit manufacturer's literature for all channels, clevis hooks, straps, hanger rod, anchors, fasteners, and related material used in the utility support systems.

PART 2 MATERIALS

2.1 HANGERS AND SUPPORTS

A. Hangers and supports shall be factory fabricated units with published load limits and meet Manufacturer's Standardization Society of the Valve and Fittings Industry Standard Practice SP58.

B. Provide hanger or support as indicated on drawings, or select an appropriate hanger or support as shown on the "PIPE SUPPORT DETAILS" Drawing.

C. Hangers or supports shall be B-Line Systems, Inc.; Grinnell Corp., or equal.

2.2 FRAMING SUPPORT SYSTEMS

A. As called out on the drawings and as required to provide adequate support, use framing systems as manufactured by B-Line Systems, Highland, IL 62249; Unistrut Corporation of Wayne, MI 48184; or equal.

B. The load capacities of parts, connections and assemblies shall meet or exceed those published in the latest framing manufacturer's engineering catalog and supplementary bulletins.

C. Unless otherwise noted on the drawings, all framing members and fittings in non-corrosive or dry areas shall be hot-dipped galvanized steel. Paint entire framing support system in accordance with specification section 09900. Nuts and screws shall be electro-galvanized. All painted channels and fittings shall be carefully cleaned and phosphated. Immediately after phosphating, a uniform coat of highly effective rust inhibiting acrylic enamel paint shall be applied by the electro-deposition process and thoroughly baked. Color shall be Unistrut "Perma-Green", B-Line "Dura-Green per Federal Standard 595a, color number 14109 (dark limit V-). The resulting finish will withstand 400 hours salt spray when tested in accordance with ASTM designation B-117.

D. All framing members and fittings for humid, wet or corrosive areas shall be stainless steel or fiberglass. Cut ends of fiberglass shall be sealed per manufacturer’s recommendations. Nuts and screws shall be stainless steel, fiberglass or nylon as approved by the Engineer.

E. Continuous insert embedment channel shall be B-Line B52I; Unistrut P-3300 Series, Caine Strut No. C-3450/70, or equal.

F. For stainless steel pipe, all pipe support materials, framing members, and fittings shall be stainless steel.

2.3 CABLE TRAYS

Shall be B-Line Series 444; Unistrut tray system 3L2 Series, Globetray HDS Series, in widths as shown on the Drawings and with 18-inch rung spacing. Tray shall be supported on six-foot

maximum centers and designed to support a safe uniform allowable load of 200 pounds per lineal foot. Side rails shall be 3- or 4-inch high, 0.0747" (14 gauge) galvanized steel.

2.4 MISCELLANEOUS METAL FABRICATIONS

As specified in Section 05500, all miscellaneous metals used for hangers and supports (in non-corrosive areas) shall be hot-dip galvanized in accordance with ASTM A123 and 304 stainless steel passivated (for corrosive and wet areas). Vent holes shall be provided in closed tube type members in an unobtrusive location as required to prevent any danger of explosion during the galvanizing process.

PART 3 EXECUTION

3.1 PIPE SUPPORTS AND HANGERS

A. General

1. Pipes and ductwork shall be supported as shown on the Drawings, otherwise use appropriate type of support.

    a. The Typical Details provided in the construction documents for supporting mechanical equipment, electrical equipment and distributed systems (i.e. piping, conduit, ducting, other) are to be used for general guidance, minimum requirements, and layout for support systems. Design for these support systems shall be provided in the submittal. The design shall include details and calculations stamped and signed by a Civil or Structural engineer registered in the State of California.

2. Supports shall be used to meet all criteria herein, regardless of whether or not indicated on the drawings. No pipe shall be left unsupported whenever a change in direction of line or flow takes place. At least one support shall be provided between every two couplings. Supports shall be provided for all valves, meters, or other metallic appurtenances.

3. Securely fasten all piping to building construction with approved hangers, supports, guides, anchors and sway braces to maintain pipe alignment and prevent sagging, noise and excessive strain due to uncontrolled movement under operating conditions.

4. Relocate any hangers as necessary to correct unsatisfactory conditions that may become evident when system is put into operation.

5. Supporting of piping by wire, rope, wood or other makeshift devices will not be permitted.

6. Burning of holes in beam flanges or narrow members will not be permitted.

7. All exposed and above grade piping shall be vibrationally isolated and restrained by a Seismic Restraint System. Provide calculations in accordance with specification sections 01610 and 01615.

    a. In addition to the above listed specification requirements, sway bracing of non-resiliently supported piping shall also be designed to ensure compliance with SMACNA Guidelines for Seismic Restraint of Mechanical Systems and fire protection piping per NFPA requirements.

    b. Where supported by pipe hangers from the ceiling or where lateral displacement of pipe is probable, pipelines shall be seismically braced laterally at every 20 feet (minimum), and braced longitudinally and laterally every 40 feet (minimum) and at 90 degree bends. The minimum seismic bracing shall consist of 3/8-inch steel plate welded to pipe hanger, ½-inch diameter all threaded rod, ½-inch diameter flexible connector and eye rod inserted in the ceiling. Design shall be based on most restrictive requirement.

8. Fasten hanger rods to structural steel members with suitable beam clamps.

9. Protect pipe insulation at every hanger, support or guide of insulated piping with inserts and shields.

B. Manifolding

1. Parallel runs of piping, except for fire protection piping may be supported on trapeze hangers, spaced as required for the smallest pipe carried.

2. Piping in chases shall be supported on channel framing.

3. Channel framing shall be selected to support 5 times the weight or thrust of the piping without failure in accordance with the manufacturer's standard ratings. Submit details for approval.

    a. Where standard tables are not available, provide calculations signed and stamped by a Civil or Structural Professional Engineer licensed to practice in the state where the project is located. All calculations shall be provided in English units.

C. Support Hanger Spacing

1. Maximum spacing for horizontal piping supports shall be as follows:

Material	Size	Spacing
Steel Pipe and Stainless Steel Pipe	1” and smaller	5 feet
	1-1/4” to 2”	7 feet
	Larger than 2”	10 feet
Copper Pipe	1" and smaller	5 feet
	1-1/4" and larger	8 feet

PVC Pipe	1" and smaller	4 feet
	1-1/4" to 2"	4-1/2 feet
	2-1/2" to 3-1/2"	5 feet
	4" to 5"	6 feet
	6" and larger	7 feet
Ductile iron pipe	All sizes	8 feet
Fiberglass pipe	Less than 3"	8 feet
	3" and larger	10 feet

2. Where building structure does not permit the specified spacing the Contractor shall provide additional adequate support. Location and details shall be submitted for approval.

3.2 ELECTRICAL CONDUIT SUPPORT

See Division 16 for additional requirements, the most stringent of the listed spacing shall apply.

3.3 MISCELLANEOUS HARDWARE

Support as shown. When not shown, support as required to form a solid, rigid, strong installation satisfactory to the Engineer.

3.4 GALVANIZING TOUCH-UP

Cold Galvanize all field cut bare metal not designated to be painted.

END OF SECTION

SECTION 15110

SST FLAP GATES

1.1 GENERAL

A. This Section Covers Stainless Steel Pump Discharge Flap Gates. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

B. Gates shall be supplied with all the necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated water control gates.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

1.3 REFERENCE STANDARDS

A. ASTM - American Society for Testing and Materials.

B. AWWA - American Water Works Association.

1.4 SUBMITTALS

A. In accordance with Section 01300, submit materials list naming each product to be used identified by manufacturer and model number. Provide catalog cuts, shop drawings, or other information to fully describe and define the equipment being supplied including materials of construction.

B. Provide a structural design for seismic loads in accordance with criteria in the UBC Standards and Section 01610.

C. Provide operation and maintenance manuals in accordance with Specification Section 01680.

1.5 QUALITY ASSURANCE

All materials and equipment shall be the latest standard product of a manufacturer regularly engaged in the design and manufacturer for a period of at least five years. Gates shall be furnished with all necessary accessories for a complete installation, including hydraulic control systems. All gates shall be provided by one manufacturer.

1.6 WARRANTY

The gate manufacturer shall guarantee the equipment supplied to be free of design deficiencies and manufacturing defects for a period of Five (5) years following its being placed into service. If any design deficiencies and/or manufacturing defects are defined during the warranty period, the Manufacturer shall, at their discretion, repair or replace the "failed component(s)". If repair or replacement of a component is needed to correct a problem, the Manufacturer shall be responsible for the cost of parts and labor with no cost to the Owner. If repair or replacement of a component is needed to correct a problem, it shall be made on-site (whenever possible) and in a manner, which minimizes the time the unit is out of service and the inconvenience to the Owner. All warranty repairs are required to be completed within 30 days.

1.7 MANUFACTURERS

Gates supplied under this section shall be Model GH-39SP Stainless Steel Pump Discharge Flap Gates as manufactured by Golden Harvest Inc. or equal.

1.8 QUALITY ASSURANCE

A. The manufacturer shall have 10 years experience in the production of hydraulic control gates and have a licensed engineering staff with a minimum of 10 years of experience in the design of hydraulic control gates. The manufacturer’s shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of AWS Sections D1.1, 1.2 & 1.6.

B. The fully assembled gates shall be shop inspected, tested for operation and adjusted before shipping. There shall be no assembling or adjusting on the job site.

C. All stainless steel equipment shall be passivated after fabrication.

1.9 PERFORMANCE

A. Flap gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.10 US gallons per minute per foot of seating perimeter.

B. Flap gate is designed for use on pump discharge lines where violent slamming action will occur. A Leaf spring damper is provided to restrict over-rotation. The flap cover, body and hinge system shall be of extra heavy-duty construction. The compression seal shall be designed to act as a cushion and help dampen the slamming action of the flap cover that occurs when the pump is turned off or fails to operate.

PART 2 MATERIALS

2.1 GENERAL

A. Anchor bolts for gates shall not conflict with the concrete reinforcing bars. Contractor shall not be allowed to drill through the reinforcing steel. The gate manufacturer shall modify the gate frame as required to prevent a conflict with the bolts and reinforcing steel. All gates are rising stem unless noted otherwise.

B. All gates shall be of one manufacturer.

C. The naming of a manufacturer in this specification is not an indication that the manufacturer's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified

2.2 MATERIALS AND CONSTRUCTION

General Design. Flap gates shall be stainless steel designed to mount direct to a concrete wall, wall thimble or spigot style mounted around a pipe. Gates shall be designed and constructed to withstand the maximum seating head as shown in the gate schedule. The flap gate shall pivot from a single hinge point to allow free flow on the unseating head side.

MATERIALS TABLE:

Part	**Material**
Frame, Flap, Hinge Arms, Pins	Stainless Steel Type 304L, 316L ASTM A-240 & 276
Seals	Neoprene ASTM D-2000
Seal Retainer	UHMW-PE ASTM D4020 or Stainless-Steel T-304 / 316 ASTM 276
Hinge Bushing	Self-Lubricating Fiberglass Reinforced DIN ISO 4379
Fasteners & Hardware	Stainless Steel Type 304, 316 ASTM F593 / F594
Anchor Bolts	Stainless Steel Type 304, 316 ASTM A276
Leaf Spring	HI carbon 5160 steel or stainless-steel

2.3 FRAME SPIGOT AND FLANGE

A. The gate spigot and flange shall be constructed of stainless-steel members to form a one-piece rigid frame.

B. The spigot shall be design in such a way to place the flap at an approximate 2.5°-degree taper to allow for positive closure.

2.4 FLAP

The gate cover shall consist of stainless-steel plate reinforced to limit its deflection to L/360 of the gates span under the design head condition.

2.5 HINGES & HINGE ARMS

A. Flap gates shall be hinged at the top with a minimum two [2] hinge arms construction stainless steel plate or shapes.

B. Flap gates required to open with low differential head pressure shall be supplied dual hinge/pivot system. The upper hinge shall provide opening sensitivity adjustment.

2.6 HINGE MECHANISMS

Hinge pin and fasteners shall be machined of stainless-steel round bar. Hinge bushings shall be self-lubricating fiberglass, Gar-Max or approved equal.

2.7 RESILIENT SEAL:

Seals shall be of resilient neoprene and be attached to body with a UHMW-PE or stainless-steel retainer strip.

2.8 MOUNTING GASKET:

When required, flap gate shall be mounted with a minimum of 3/8 in. (10mm) thick neoprene gasket and sealant. Sealant shall be Bostic 915 industrial sealant or approved equal.

2.9 LEAF SPRING

Shall form 1/4” minimum material and may be a single or multiple leaf. Leaf size and number depend on the size of the flap gate.

2.10 PASSIVATION

All stainless-steel parts/equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion and to remove all embedded iron and heat tint. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection. Surfaces shall be subjected to a 24-hour water test or ferroxyl test to detect the presence of residual embedded iron and shall be re-treated, as needed, to remove all traces of iron contamination. All field welds shall be cleaned and passivated to remove iron (and prevent corrosion) in accordance with ASTM A380. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

PART 3 EXECUTION

3.1 GATE HANDLING, TRANSPORTATION AND STORAGE

A. Contractor shall exercise the following precautions with Flap Gates.

B. Handling: Avoid bending, scraping or overstressing the gates.

C. Transportation: Loading, transporting and unloading of the gates shall be conducted such that the gates are kept clean and free from damage.

D. Protection: Provide sheltered onsite storage. Provide blocking, platforms, or skids to protect the gates from contact with the ground. Protect the gates from damage from construction activities or equipment.

E. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

3.2 FIELD QUALITY CONTROL

A. Testing

1. After the gate installation and checking, run gates through at least 2 full cycles from the closed position to full open position and back to the closed position. Also operate gates with intermediate stops.

2. Provide certificate of proper installation.

B. Manufacturer's Field Services

1. Coordinate field service work with the manufacturer's representative, Owner, and Engineer prior to initiating such work.
2. Manufacturer's Representative: Furnish services of a representative experienced in installation and operation of the gates.
3. Manufacturer's representative shall perform the following services in three separate trips (minimum) as described below:
    a. Installation assistance and inspection: One man-day.
        1) Advise/observe the Contractor on the installation of the gates.
        2) Check and verify the installation of the gates is in accordance with the Drawings and manufacturer's installation instructions.
    b. Certification of installation, field testing, and start-up assistance: One man-day.
    c. Operator Training: One man-day.
    d. Each man-day consists of 8 working hours.
    e. The specified durations are the minimum required time on the job site and do not include travel time.

SECTION 15142

WALL PIPES, SEEP RINGS, AND PENETRATIONS

PART 1 GENERAL

1.1 DESCRIPTION

This section includes materials, installation, and testing of steel and cast-iron wall pipes and sleeves (including wall collars and seepage rings), and penetrations.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 03100 - Concrete

C. Section 09900 - Painting and Finish Schedule

D. Section 15010 - General Process Piping Provisions

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit detail drawings for fabricated steel or cast-iron wall and floor pipes and sleeves, wall flanges, seep rings, and sealing materials. Show dimensions and wall thicknesses.

C. Show flange sizes and the appropriate ANSI or AWWA flange dimensional standard where flanged end wall pipes or penetrations are used.

D. List coating systems to be applied, manufacturer, and dry thickness of coatings. Call out coatings where coatings are to be applied.

E. List materials of construction, with ASTM material reference and grade.

F. Submit manufacturer's instructions for installing rubber annular hydrostatic sealing devices.

G. Submit six copies of the results of the leakage test for cast-iron sleeves having shrink-fit steel collars or collar halves bottomed in a groove and steel sleeves having welded steel collars.

PART 2 MATERIALS

2.1 GENERAL

A. Use either cast-iron or fabricated steel wall sleeves when containing rubber annular hydrostatic sealing devices through which piping passes. Use only cast-iron penetrations and anchors when connecting to cast-iron and ductile-iron pipe. Use only fabricated steel penetrations and anchors when connecting to steel pipe.

B. Cast-iron flanges shall conform to ANSI B16.l, Class 125 or 250, to match the flange on the connecting pipe.

C. Steel flanges shall conform to AWWA C207, Class D. Flanges shall be flat face. Flanges shall match the flange on the connecting pipe.

D. Gaskets for flanges shall be as specified in the detail piping specification.

E. Bolts and nuts for flanges shall be as specified in the detail piping specifications with the following additions: buried or submerged service shall be 316 stainless steel, exposed service shall be galvanized.

2.2 CAST-IRON WALL FLANGES, ANCHORS, AND SLEEVES

A. Provide cast- or ductile-iron wall pipes with ends as shown in the drawings for connection to adjacent PVC and ductile-iron pipe, or for containing pipes where they pass through concrete walls, ceilings, and floor slabs. Provide seepage ring on wall pipes and sleeves passing through concrete walls and slabs which are to be watertight. Locate collars such that the collar is at the center of the wall or floor slab, unless otherwise shown in the drawings.

B. Wall pipes and sleeves shall be of the following types:

1. Pipe or sleeve with integrally cast seep ring.
2. Pipe or sleeve with steel collar halves bottomed in a groove provided in the pipe or sleeve.

3. Minimum wall thickness for pipes and sleeves having integrally cast seep rings shall be as shown in the following table:

Pipe of Sleeve Size (inches)	Minimum Wall Thickness (inches)
3	0.48
4	0.52
6	0.55
8	0.60
10	0.68
12	0.75
14	0.66
16	0.70
18	0.75
20	0.80
24 or greater	0.89

C. Minimum wall thickness of pipes or sleeves having shrink-fit collars shall be Class 52. Cut shrink-fit collars from a 1/4-inch-thick steel ring. Attach the collar to a cast-iron pipe or sleeve by heating the steel collar and allowing it to shrink over the pipe at the necessary location. Provide an epoxy bond (Keysite 740 or 742 or Scotchkote 302) between the pipe and collar. Sandblast the area of the pipe to be epoxy coated per SSPC SP-l0.

D. Wall pipes or sleeves having steel collar halves bottomed in a groove shall be ductile iron Class 54 minimum unless otherwise shown. Wall flanges shall consist of ¼-inch-thick steel seep ring halves for pipes through 24-inch and 3/8-inch-thick halves for pipe 30 inches and larger, bottomed in a groove provided on the pipe. The pipe groove shall be machine cut to a depth of 1/16 to 5/64 inch to provide a press fit for the seep ring. Seep ring halves shall be welded together after fit into groove but shall not be welded to pipe. Seep rings shall be sealed completely around the pipe with silicon sealant manufactured by Dow-Corning No. 790, General Electric Silpruf, or equal.

E. The material used in cast- or ductile-iron wall flanges, wall sleeves, and wall penetrations shall conform to ASTM A 395, A 436, A 536, A 48 (Class 35), or A 126 (Class B).

F. Pressure test at least one of each size of cast-iron pipes or sleeves having shrink-fit steel collars or collar halves installed in a groove in the pipe at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for four hours duration and shall show zero leakage.

2.3 FABRICATED STEEL WALL FLANGES, ANCHORS, AND SLEEVES

A. Provide fabricated steel wall pipes and sleeves with ends as shown in the drawings for connection to adjacent steel or concrete pipes, or for containing pipes, where they pass through concrete walls. Provide seepage ring or wall flange on wall pipes and sleeves passing through concrete walls and slabs which are to be watertight. Wall thickness shall be the same as the pipe wall thickness when connecting to steel pipe. Minimum wall thickness for sleeves containing pipes shall be standard weight per ANSI B36.10 for sleeves 72 inches and smaller and ½-inch for sleeves greater than 72 inches through 96 inches.

B. Wall flanges shall be in the form of a steel wall collar welded to the steel sleeve or penetration. Cut welded wall collars from a ¼-inch steel ring. Attach the collar to a steel wall pipe or sleeve with full circle, 3/16-inch fillet welds. Welding procedures shall be in accordance with ANSI B31.3, Chapter V.

C. Steel pipe used in fabricating wall sleeves containing pipes shall comply with ASTI4 53 (Type E or 5), Grade B; ASTI4 A 135, Grade B; ASTM A139, Grade B; or API 5L or 5LX. Wall pipes connecting to steel pipe shall be of the same material as the connecting pipe. Wall collar material shall comply with ASTM A105, A181, or A182.

D. Pressure test at least one of each size of fabricated steel wall sleeve or penetration and collar assemblies at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for four hours duration and shall show zero leakage.

2.4 RUBBER ANNULAR HYDROSTATIC SEALING DEVICES

A. Rubber annular hydrostatic sealing devices shall be of the modular mechanical type, utilizing interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe sleeve and the passing pipe. Assemble links to form a continuous rubber belt around the pipe, with a pressure plate under each bolthead and nut.

B. Materials of construction shall be as follows:

Compound	Material
Pressure Plate	Carbon
Bolts and Nuts for Links	Zinc Phosphated Carbon Steel (exposed service) 316 Stainless Steel (submerged or buried)
Sealing Element	EPDM Rubber

C. The size of the wall sleeve needed to accommodate the passing pipe shall be as recommended by the rubber annular seal manufacturer.

D. Provide centering blocks in 25% of the sealing elements on pipelines larger than 12 inches in diameter.

E. The rubber annular hydrostatic sealing devices shall be Link Seal as manufactured by Thunderline Corporation or equal.

2.5 BOLTS AND NUTS FOR FLANGED-END WALL PIPES

Use bolts and nuts as specified for the piping connected to the wall pipe. See Section 15010.

2.6 POLYETHYLENE FOAM FILLER FOR PIPE PENETRATIONS

Packing foam shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam, as manufactured by Dow Chemical Company, Midland, Michigan; or equal. The rod shall be 1/2 inch larger in diameter than the annular space.

2.7 PAINTING AND COATING

A. Coat penetrations and sleeves exposed, above ground, or in vaults and structures in accordance with Section 09900, Systems A or D unless fusion-bonded epoxy coatings are shown in the drawings or specified elsewhere.

B. Coat submerged sleeves and penetrations per Section 09900, System A unless fusion-bonded epoxy coatings are shown in the drawings or specified elsewhere.

C. Coat buried sleeves and penetrations with fusion-bonded epoxy in accordance with Section 09900.

PART 3 EXECUTION

3.1 LOCATION OF PIPES AND SLEEVES

A. Provide a wall or floor pipe where shown in the drawings and wherever piping passes through walls or floors of tanks or channels in which the water surface is above the pipe penetration.

B. Provide a floor sleeve where shown in the drawings and wherever plastic pipe, steel, or stainless-steel pipe 3 inches and smaller or stainless steel or copper tubing passes through a floor or slab. Provide a rubber annular sealing device in the annular space between the sleeve and the passing pipe or tubing.

C. Provide wall sleeves where shown in the drawings and wherever plastic pipe, steel or stainless-steel pipe 3 inches and smaller, or stainless-steel or copper tubing passes through

a wall. Provide a single rubber annular seal when the wall is 8 inches thick or less. Provide two rubber annular seals (one at each end of the sleeve) when the wall is more than 8 inches thick. Pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2 inches of elastomeric sealant on both sides of the structure.

D. Where sleeves are installed in which water or soil is on one or both sides of the channel or wall, provide two rubber annular seals (one at each end of the sleeve).

E. Where pipes pass through walls or slabs and no sleeves or wall or floor pipe with seep ring is provided, pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2 inches of elastomeric sealant on both sides of the structure.

3.2 INSTALLATION IN EXISTING CONCRETE WALLS AND SLABS

Core drill holes 2 inches larger in diameter than the diameter of the wall flange or collar. Install wall pipe and collar assembly axially aligned with the piping to which it will be connected or will contain. Pack the void space between the sleeve and concrete with grout. See Section 03100 for grouting specification.

3.3 INSTALLATION IN NEW CONCRETE WALLS AND SLABS

Install wall pipes and sleeves in walls before placing concrete. Do not allow any portion of the pipe or sleeve to touch any of the reinforcing steel. Install wall pipe or sleeve and collar assembly axially aligned with the piping to which it will be attached or will contain. Provide supports to prevent the pipe or sleeve from displacing or deforming while the concrete is being poured and is curing.

3.4 INSTALLATION IN DRY FLOORS AND SLABS

Install pipe sleeves and spools in concrete floors and slabs which do not have water over them such that the sleeve or pipe extends from the bottom of the floor or slab to 2 inches above the floor or slab unless shown otherwise in the drawings.

3.5 INSTALLATION OF WALL PIPES HAVING FLANGED END CONNECTIONS

A. Check alignment before grouting in place or pouring concrete. Realign if the sleeve is not properly aligned.

B. Install flanged end wall sleeves or penetrations with bolt holes of the end flanges straddling the horizontal and vertical centerlines of the sleeve.

C. Lubricate flange bolts with oil and graphite prior to installation.

3.6 QUALIFICATIONS OF WELDERS

Welder qualifications shall be in accordance with AWS B2.1.

3.7 INSTALLATION OF RUBBER ANNULAR HYDROSTATIC SEALING DEVICES

Install in accordance with the manufacturer's instructions.

3.8 FIELD TESTING

Check each wall penetration for leakage at the time the hydraulic structure is tested for leakage; see Section 03100. Penetrations shall show zero visible leakage.

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SECTION 16010

ELECTRICAL

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall install, ready for use, the electrical system as specified in Division 16 and shown on the Contract Drawings. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices. All components and devices shall be furnished and installed as required to provide a complete operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter.

B. If an "or equal" manufacturer is proposed by the Bidder, the cost of any required engineering redesign, and the cost of any electrical, mechanical or structural modifications to adjacent and interfacing equipment necessary to make the several parts fit together, licensing fees and additional construction and other costs resulting from the proposed "or equal" equipment shall be included in the Bid. If the proposed "or-equal" manufacturer is not accepted by the Owner after the Award of Contract, the Bidder shall furnish and install the named equipment at no additional cost to the Owner. See specification section 01300 for further information on submitting equal products.

C. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, test equipment, incidentals, and services to provide a complete and operational electrical system as shown on the Drawings, included in these Specifications, or required for fully operating facilities. See Section 16940 Appendix "A" for Device Index for mounting detail requirements to be provided for equipment listed.

D. Examine the Specification and Drawings for mechanical equipment and provide all starters, circuit breakers, switches, pushbuttons and appurtenances which are not specified to be with the mechanical equipment. Erect all electrical equipment not definitely stated to be erected by others, furnish and install conduit, wire, cable, and make connections required to place all equipment in complete operation.

E. Contract Elementary Drawings do <u>not</u> show all electrical interfaces, lockouts, etc. required for motor control. These Drawings show general layout and have made provisions for interlocks, solenoid valve control, etc. and are only typical. Contractor is responsible for examining the Contract P- Series Drawings for all motor control interfaces, temperature switches, solenoid valves, float switches and device lockout, requirements. The

Contractor's submitted elementary diagrams shall show all motor controls and interlocks for the specific piece of equipment. Provide a separate set of elementary diagrams for each similar group of equipment. It is within the Contractor's scope of work to submit elementary diagrams that not only show the MCC bucket wiring, but also include the field interlocks, motor heaters, protective devices, valve controls, etc. The Contractor's Elementary submittal Drawings shall also show field terminal block numbers for each of the field interlocks and valve controls.

F. The major areas in the Division scope of work are shown on the E & P series drawings and are designated on the Division 16 Index Specifications which include both the furnishing and installation of:

1. Replace existing Headworks Screening Unit 1 and 2. Modify existing Headworks Screening Unit 3. Add new Plant Meter Manhole Flowmeter.
2. PLC programming shall be by Contractor. OI & SCADA system configuration shall be by Contractor.
3. Conduits, and the field interconnection wiring between the equipment, pumps, MCCs, main switchboard, control panels, panelboards, field devices, etc. as shown on plans for both sites.
4. All necessary miscellaneous shut off, sample, and calibration valves to sensors.
5. Trenching, backfilling, compaction, and resurfacing for all new underground conduit routes.
6. Grounding system and equipment grounding.
7. Supply concrete pads and supports for electrical and instrumentation equipment.
8. Installation of primary devices, equipment and instruments, are not completely detailed on Contract drawing plan sheets. Contract Drawing typical installation details for installation and mounting requirements for equipment and instruments are called out in the following Division 16 indexes:
    a. 16970 – Flow Instrument Index
9. Removal and disposal of excess materials from excavation, pavement removal and demolition work.
10. Drawings EA--series are referenced as E-series.
11. Drawings PA-, and PT - series are referenced as P-series.

G. No items for panels or MCCs shall be shipped loose for later field installation in MCC, control panel, enclosures, etc. without prior written approval of the Owner. Incomplete panels or MCC arriving at the jobsite shall be returned by the Contractor to the shop to complete fabrication at no additional cost to the Owner when directed by the Owner. Panels that were shipped to site without a factory test will be returned by the Contractor to the shop to complete factory test no additional cost to the Owner.

H. Provide all necessary hardware, conduit, wiring, fittings, and devices to connect the electrical equipment provided under other Sections. The following shall be done by the Contractor at no additional cost to the Owner:

1. Provide additional devices, wiring, conduits, relays, and isolators to complete interfaces of the electrical and instrumentation system.

2. Changing normally open contacts to normally closed contacts or vice versa.

3. Adding additional relays to provide more contacts as necessary to carry out work specified.

4. Other work implied by the Contract documents.

5. Provide larger circuit breakers, starter, conduit and wire as required for the horsepower of the supplied equipment when the supplied equipment is larger than that specified, at no additional cost to the Owner or lug adapters as necessary when connecting to the wires listed in the Conduit and Wire routing schedule.

I. The following Specifications incorporate specific equipment and devices that are preferred by the Owner because of their serviceability, because of the local availability of labor, parts and materials, or because of the ability of the Owner to umbrella the equipment under existing maintenance Contracts; however, favorable alternatives proposed in writing during the submittal process will be reviewed by the Owner as to whether they are acceptable as approved equals.

J. The decision of the Engineer governs what is acceptable as a substitution or approved equal. If the Engineer considers it necessary, tests to determine equality of the proposed substitution shall be made, at the Contractor's expense, by an unbiased laboratory that is satisfactory to the Engineer. No reason will be released on why a substitution was not acceptable. No Contract extension will be granted due to the substitution being rejected.

K. All electrical equipment and materials, including installation and testing, shall conform to the applicable codes and standards listed in this and other Sections. All electrical work shall conform with the National Electric Code (NEC) 2020 issue. Nothing on the Drawings or in the Specifications shall be construed to permit work or materials not conforming to these codes and standards.

L. Electrical Contractor is encouraged to attend the pre-bid job walk and it is highly recommended Contractor shall have accomplished the following:

1. Thoroughly examine existing conditions before submitting his bid proposal to perform any work. He shall compare site conditions with data given on the plans or in these Specifications. No allowance shall be made for any additional costs incurred by the Electrical Contractor due to his failure to have examined the site or to have failed to report any discrepancies to the Owner prior to bid.

2. Verify all measurements and conditions and shall be responsible for the correctness of same. No extra compensation will be allowed because of differences between work shown on the Drawings and measurements at the site.

M. It is the Electrical Contractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations. New MCCs may be installed in areas with limited space. MCC and other equipment footprints were developed based on best available information. Contractor is responsible for any additional conduits, wires, construction costs, engineering design requirements, and appurtenances to accommodate MCCs that are larger than that shown on Contract Documents.

N. Any major deviations in location and conduit routing that the Electrical Contractor makes without the express written review or direction of the Engineer, shall be considered to have been made at the Electrical Contractor's sole responsibility. Such deviations made by the Electrical Contractor shall be reflected on the Electrical Contractor supplied "Record Drawings" and Conduit Schedule. The Owner will reimburse the Electrical Engineer and the Owner and then will deduct an amount equal to this reimbursement from the Electrical Contractor's contract for all engineering, drafting, and clerical expenses associated with updating the Record Drawings and Conduit Schedule due to any major unauthorized changes.

O. The term "Engineer" used throughout this Division 16 is the "City of Merced Engineer or their designated Engineer representative." The term "Owner" in Division 16 is the City of Merced. When "Contractor" is listed in these documents without further definition, such as "Electrical Contractor," it is to mean the "Prime or General Contractor."

P. All control panels, control stations and instrument enclosures shall be a listed approved assembly and labeled by an approved testing shop. This is to be an entire assembly (a complete unit) to include all components and enclosures as an assembly, controls. etc.

Q. The Contractor shall field verify all existing conditions, equipment, wires, conduit, etc., as required to complete the project.

1.2 CODES AND STANDARDS

A. All electrical/instrumentation equipment and materials, including installation and testing, shall conform to the following applicable codes and standards:

1.	ANSI	American National Standards Institute, Inc.
2.	EIA	Electronics Industries Association
3.	ETL	Electrical Testing Laboratories
4.	FM	Factory Mutual
5.	GO128	General Order No. 128, Rules for Construction of Underground Electrical Supply and Communication Systems, Public Utilities Commission of the State of California
6.	IEEE	Institute of Electrical and Electronics Engineers
7.	ICEA	Insulated Power Cable Engineers' Association

8.	ISA	International Society for Measurements & Control Standards (formerly Instrument Society of America)
9.	NEC	National Electric Code, 2020 Edition
10.	NEMA	National Electrical Manufacturers Association
11.	NETA	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, International Electrical Testing Association
12.	NESC	National Electrical Safety Code
13.	NFPA 820	National Fire Protection Agency, Standard for Fire Protection in Wastewater and Collection Facilities
14.	OSHA	Occupational Safety and Health Act Standards
15.	UL	Underwriter's Laboratories, Inc.

B. The revisions of these codes and standards in effect on the date of issuance of the Contract Documents shall apply.

C. Codes and standards referenced shall be considered minimum acceptable work.

D. In instances where two or more codes are at variance, the most restrictive requirements shall apply.

E. Nothing on the Drawings or in the Specifications shall be construed to permit work or materials not conforming to the preceding codes and standards.

F. All work shall also be performed in accordance with the State, County or City standards, and local Utility codes.

G. The Contractor shall furnish without extra charge any additional material and labor which may be required for compliance with these codes and standards, even though the work is not explicitly mentioned in the Specifications or shown on the Contract E- Series Drawings.

H. Amperage listed on the single-line Drawings for motors are per NEC Table 430.250 and may not necessarily match that of the equipment supplied. It is the electrical system supplier and Contractor's responsibility to furnish equipment sized for the motors supplied for this project at no additional cost.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. The following are covered in other sections in the Contract documents and are part of Division 16:

1. Section 16010 – Electrical.
2. Section 16011 – Electrical and Instrumentation Submittals and Drawing Requirements.
3. Section 16012 – Electrical and Instrumentation Operations and Maintenance Data.
4. Section 16013 – Electrical and Instrumentation Spare Parts.
5. Section 16020 – Seismic Restraint for Electrical Equipment.
6. Section 16110 – Conduits.
7. Section 16115 – Duct Banks, Vaults, and Pull Boxes.
8. Section 16120 – Wire, Fuses, and Terminal Blocks.
9. Section 16140 – Wiring Devices.
10. Section 16144 – Nameplates.
11. Section 16190 – Supporting Devices.
12. Section 16450 – Grounding.
13. Section 16605 – Electrical System Analysis.
14. Section 16620 – Electrical and Instrumentation Field Tests.
15. Section 16900 – Electrical and Instrumentation Training.
16. Section 16912 – PLC Firmware and Programming Software.
17. Section 16913 – PLC Applications Programming.
18. Section 16914 – PLC I/O List.
19. Section 16915 – PLC Control Strategies
20. Section 16940 – Instrumentation.
21. Section 16970 – Flow Instruments.

B. The contents of this Section apply to all "electrical and instrumentation" equipment suppliers and manufacturers doing work listed in following sections:

1. Section 01300 - Submittal Procedure.
2. Division 11.
3. Division 15.

1.4 ELECTRICAL CONTRACTOR QUALIFICATIONS

A. It is the intent of this Division that the complete responsibility for management and installation of the electrical and instrumentation required for this project be by the Electrical Contractor. This responsibility includes, but is not limited to, supervision and coordination of work performed by the System Supplier. Uncertified electricians shall not perform electrical work for which certification is required.

B. Contractor shall submit the proposed Electrical Sub-Contractor and System Supplier with bid documents that will be used on this project.

C. The Electrical Contractor shall meet the following minimum qualifications:

1. Has a current C-10 Electrical Contractor's License.
2. Has regularly engaged in similar electrical Contracting for the municipal water and wastewater industry.
3. Has performed work of similar or greater complexity on at least five previous projects under one company name which is the present company name.
4. Has all persons performing work as electricians certified by the California Apprenticeship Council per California Labor Code Section 3099.
5. The Electrical Contractor certification per Section 01012 – Certification of Electrical Sub-Contractor Experiences and Qualifications.

1.5 SYSTEM SUPPLIER QUALIFICATIONS

A. General:

1. All switchboards, panels, MCCs, panelboards, panelboard transformers and PLC hardware, shall be supplied by one system supplier. All panels and instrumentation listed for Division 16 in all Division 16 appendix Indexes shall be supplied by the same System Supplier. This includes, but not limited to, all work necessary to select, furnish, supervise installation, calibrate, program, and place into operation all transmitters, instruments, controllers, alarm equipment, monitoring equipment, and accessories as specified herein. The system supplier shall not subcontract any portions of the equipment provisioning with the exception of fire and security alarm systems without written approval of Owner.

2. The system supplier shall have an on-staff project engineer with prior experience on similar sized projects. This project engineer shall coordinate the technical aspects of this project and prepare the submittals and drawings. This project engineer's name, address, and phone number shall be provided within the first week after notice to proceed. The system supplier project engineer shall attend all coordination meetings and be on-site when requested by the Owner's Resident Engineer.

B. The System Supplier certification per Section 01013 – Certification of System Supplier Experiences and Qualifications.

1.6 CONTRACT DOCUMENTS

A. The Contract Drawings and Specifications are intended to be descriptive of the type of electrical system to be provided; any minor details missing in either shall not relieve the Contractor from the obligations there under to install in correct detail any and all materials necessary for a complete operational system at no additional cost.

B. The Contract Drawings are generally diagrammatic; exact locations of electrical products shall be verified in the field with the Owner's Resident Engineer. Except where special details on Drawings are used to illustrate the method of installation of a particular piece or type of equipment or materials, the more restrictive of the two shall take precedence in the event of conflict.

C. The Contract Electrical elementary, elevation and one-line diagrams are the basis of the electrical system to be provided and are for reference only. It is the Contractor's responsibility to adjust and make minor revisions to the diagrams as necessary for an operational system at no additional cost to the Owner. Additional isolators, relays, wiring, terminal blocks, etc., shall be provided for an operational system at no additional cost to the Owner. Contractor shall also modify starter size, breaker size, etc. at no additional cost to the Owner, if such changes are the direct result of the equipment selected by the Contractor.

D. Location at facilities of new equipment, inserts, anchors, panels, pull boxes, conduits, stub-ups, and fittings for the electrical system are to be determined by the Contractor and Engineer at time of installation. Contractor shall make minor adjustments to locations of electrical equipment required by conditions and coordination with other trades at no additional cost. Minor adjustments are defined as those adjustments required due to equipment size changes or variations between different equipment suppliers.

E. The Conduit and Wire Routing Schedule, wire fill, and number of conduits are based on the best information available. It is the Contractor's responsibility to modify the conduit schedule based upon Shop Drawings for the actual equipment. Such modifications in conduit sizes and numbers of conductors shall be at no additional cost to the Owner and shall be approved by Owner, if such changes are the direct result of the equipment selected by the Contractor. A copy of the Conduit and Wire Routing Schedule and Electrical plans showing conduit routing shall be updated weekly by the Contractor. Progress payments will be withheld if during monthly checks it is found that the contractor fails to maintain the Conduit Schedule updates.

F. Electrical and instrumentation, conduit and wire lengths shown on circuit Drawings are approximate and do not show changes in elevation or vertical risers. The Contractor is responsible for determining actual lengths for bidding and installation purposes.

G. All equipment shall be installed and located so that it can be readily accessed for operation and maintenance. The Engineer reserves the right to require minor changes in location of equipment, without incurring any additional costs. These minor changes are changes which would provide adequate clearance and work areas in front of and around equipment.

H. Where conduits are shown as "home runs" on the Contract Drawings or stated to be furnished, but not explicitly shown as part of the scope of work, the Contractor shall provide all fittings, boxes, wiring, etc., as required for completion of the raceway system in compliance with the NEC and the applicable Specifications in this Section.

I. No changes from the Contract Drawings or Specifications shall be made without written approval of the Engineer. Should there be a need to deviate from the Contract documents, submit written details and reasons for all changes to the Engineer for review within thirty days after the award of the contract.

J. The resolution of conflicting interpretation of the Contract documents shall be as determined by the Engineer.

K. The Electrical Contractor shall maintain a separate set of neatly hand-printed or typed and accurately marked set of Record Documents, consisting of spreadsheets, specifications and full size blue-line Electrical (E-Series) and Instrumentation (P-Series) Contract Drawings. These documents are to be used specifically for recording the as built locations and layout of all electrical and instrumentation equipment, routing of raceways, vaults, junction and pull boxes, and other diagram or document changes. These Record documents shall be kept up-to-date during the progress of the job, with all "change orders," submittal modifications, and construction changes shown and stamped with "As-Built" at end of job. These Record documents shall not be used for daily construction use and shall not contain any mark-ups that are unrelated to as-built corrections. Updated drawings are to be submitted with pay estimates to show progress of revisions, changes which affects pay request.

1. The following lists the record documents that shall be submitted as "as-built" by the Electrical Contractor:

    a. E-Series Drawings.

    b. Panelboard schedules.

    c. Conduit and Wire Routing Schedule.

        1) A copy of the Conduit and Wire Routing Schedule and Electrical Contract Drawings showing conduit routing shall be updated weekly by the Contractor.

        2) Progress payments will be withheld if during monthly checks it is found that the Contractor fails to maintain the Conduit Schedule updates.

    d. Lighting and Fixture Schedule.

    e. Duct banks and their routing with offset measurement and indicated changes in depths.

2. The following lists the record documents that shall be submitted as "as-built" by System Supplier to be maintained by Electrical Contractor:

    a. P-Series Drawings

    b. Section 16914 PLC I/O List

    c. Instrumentation Indexes

3. Record documents shall be kept current weekly with all change orders, submittal modifications, and construction changes shown. Record Documents shall be subject to the inspection by the Engineer at all times, progress payments or portions thereof may be withheld if Record Documents are not accurate or current.

4. When documents are changed, they shall be marked with erasable colored pencils using the following coloring scheme:

    a. Additions – red

    b. Deletions – green

    c. Comments - blue

    d. Dimensions – black

5. Show the following on the Electrical (E-Series) Record Contract Drawings by dimension from readily obtained base lines:

    a. Exact location, type and function of electrical and instrumentation equipment and devices.

    b. Precise routing and locations of underground conduits, ductbanks, vaults, pullboxes, junction boxes, etc. that make-up the raceway system.

c. Show the dimensions, location and routing of electrical work which will become permanently concealed.

d. Show complete routing and size of any significant revisions to the systems shown.

6. Prior to acceptance of the work, the Contractor shall deliver to the Engineer one set of record full-size Electrical and Instrumentation series Record Contract Drawings and spreadsheets neatly marked and accurately showing the information required above.

1.7 SUBMITTAL AND DRAWING REQUIREMENTS

Provide electrical and instrumentation submittals per Section 16011 - Electrical and Instrumentation Submittal Requirements and Section 01300 - Submittal Procedure.

1.8 COORDINATION

A. The Contractor shall coordinate the electrical work with the other trades, code authorities, utilities, and the Engineer, with due regard to their work, towards promotion of rapid completion of the project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provisions, then the Contractor shall bear expense of such changes as necessary to be made in the work of others.

B. The Contractor shall examine the architectural, mechanical, structural, electrical, and instrumentation equipment provided under other Sections of this Contract in order to determine the exact routing and final terminations for all conduits and cables. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interferences, and the physical location of wire terminations on equipment. Conduits shall be stubbed up as close as possible to equipment terminals.

C. Manufacturer's directions and instructions shall be followed in all cases when they have more restrictive requirements than that shown on the Contract Drawings or have stipulations in order to meet warranty requirements.

D. The Contractor shall schedule a minimum of two (2) mandatory coordination meetings during the initial and submittal phase of the project. The meetings shall be held at the jobsite and include, as a minimum, attendance by the Owner's Resident Engineer, Prime Contractor, Electrical Contractor, System Supplier Engineer, and Design Engineer.

1. The first meeting shall be held in advance of the first comprehensive submittal and no later than 21 days after Contract award. The purpose of the meeting shall be for the Electrical Contractor and System Supplier to summarize their understanding of the project, discuss any proposed substitutions or alternatives, review the project schedule, explain format of Drawings, and discuss any other topics deemed necessary for project coordination.

2. The second meeting shall be held after the review of the first comprehensive System Supplier submittal has been completed by the Owner. The purpose of the meeting is to discuss comments made on the submittal package, to update the project schedule, and coordinate the testing, training, and installation phases of the project.

E. The electrical and instrumentation modifications and additions are to be made after parts of the Plant are operational. The Contractor shall schedule all the required work with the City, including each shutdown period. Each shutdown shall be implemented to minimize disruption of the existing operations. The work to be provided under this Contract shall not disrupt any of the Plant operations without prior approval.

1. The Contractor shall limit all unscheduled shutdown periods to less than 1 hour and only with prior approval of the City.

2. Carry out scheduled shut downs only after the time, date, and sequence of work proposed to be accomplished during shutdown has been favorably reviewed by the City. Submit shutdown plans at least 2 days in advance of when the scheduled shutdown is to occur.

3. The City reserves the right to delay, change, or modify any shutdown at any time, at no additional cost to the City, when the risk of such a shutdown would jeopardize the operation of the system.

F. The Contractor shall cease work at any particular point, temporarily, and transfer his operations to such portions of work as directed, when in the judgment of the Owner it is necessary to do so.

G. Prior to commencing construction, the Electrical Contractor shall arrange a conference with the Prime Contractor, System Supplier and Owner's Resident Engineer as well as all major equipment suppliers, and shall verify types, sizes, locations, controls and installation requirements of all proposed equipment. He shall, in writing, inform the Owner's Resident Engineer that all phases of coordination of this equipment have been covered and if there are any unusual conditions, they shall be enumerated at this time.

1.9 SUPERVISION

A. The Contractor shall schedule all activities, manage all technical aspects of the project, coordinate submittal and Drawings, and attend all project meetings associated with this Section.

B. The Contractor shall supervise all work in this Section, including the Electrical Contractor's general construction work, and System Supplier's work, from the beginning to completion and final acceptance.

C. The Contractor shall supervise and coordinate all work in this Section to ensure that each phase of the project, submittal, delivery, installation, and acceptance testing, warranty, etc., is completed within the allowable scheduled time frame.

D. The Contractor shall be responsible for obtaining, preparing, completing, and furnishing all paper work for this Section including that of the Electrical Contractor and the System Supplier, which shall include transmittals, submittals, forms, documents, manuals, instructions, and procedures.

1.10 INSPECTIONS

A. All work or materials covered by the Contract documents shall be subject to inspection at any and all times by the Engineer. If any material does not conform to the Contract documents, or does not have an "approved" or "approved as noted" submittal status; then the Contractor shall, within three days after being notified by the Engineer, remove the unacceptable material from the premises; and if said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be done by the Contractor.

B. The Contractor shall give the Owner 10 working days' notice of the dates and time for inspection. Date of inspection shall be as agreed upon by both the Contractor and Owner

C. Work shall not be closed in or covered over before inspection and approval by the Owner's Resident Engineer. All costs associated with uncovering and making repairs where non-inspected work has been performed shall be borne by the Contractor.

D. The Contractor shall cooperate with the Owner and provide assistance for the inspection of the electrical system under this Contract. The Contractor shall remove covers, provide access, operate equipment, and perform other reasonable work which, in the opinion of the Engineer, will be necessary to determine the quality and adequacy of the work.

E. Before request for final inspection is made, the Contractor shall submit to the Owner in writing, a statement that the Contractor has made his own thorough inspection of the entire project enumerating punch list items not complete and that the installation and testing is complete and in conformance with the requirements of this Division.

F. The Owner may arrange for a facility inspection by Cal-OSHA Consultation Service at any time. The Contractor shall make the necessary corrections to bring all work in conformance with Cal-OSHA requirements, all at no additional cost to the Owner.

G. Contractor will be responsible for any additional cost for overtime, weekend overtime or differential time expenses for inspection of defective work that has to be re-inspected.

1.11 JOB CONDITIONS

A. The Contractor shall make all arrangements and pay the costs thereof for temporary services required during construction of the project, such as temporary electrical power and

telephone service. Upon completion of the project, remove all temporary services, equipment, material, and wiring from the site as the property of the Contractor.

B. The Contractor shall provide adequate protection for all equipment and materials during shipment, storage, and construction. Equipment and materials shall be completely covered with two layers of plastic and set on cribbing six inches above grade so that they are protected from weather, wind, dust, water, or construction operations. Equipment shall not be stored outdoors without the approval of the Owner. Where equipment is stored or installed in moist areas, such as unheated buildings, provide an acceptable means to prevent moisture damage, such as a uniformly distributed heat source to prevent condensation.

C. The elevation of the project site is approximately 150 feet above sea level. All equipment shall be derated as recommended by the manufacturer or in accordance with ANSI C37.30.

D. The normal, unconditioned ambient temperature range of the job site will vary between 10° to 110 °F. All equipment shall be rated to operate at continuous full load under these temperature ranges. Any additional provisions for cooling or heating shall be provided to meet these requirements at no additional cost.

E. Corrosion Protection:

1. The Contractor is specifically cautioned that the treatment plant ambient air contains airborne contaminants, including but not limited to, the corrosive gasses: hydrogen sulfide, chlorine and ammonia. The corrosion severity level will vary according to specific locations, temperature, relative humidity, ratio of change of relative humidity, wind speed and wind direction, and may also be subject to seasonal variation.

2. Unless otherwise specified, equipment shall be installed such that no significant or detrimental corrosion shall occur over a 20 year period. Installation of 316 stainless steel NEMA 4X enclosures is acceptable to meet this requirement.

3. Class 1 Areas:

   a. Areas noted as Class 1, Div 1 or 2 areas may contain gases or vapors that are hazardous. The Contractor shall take all precautions to maintain personnel safety by always having working gas monitors present in Class 1 areas or by other methods.

   b. All Electrical construction in Class 1, Div 1 or 2 areas shall be installed as follows:

      1) Explosion proof.

      2) Intrinsically safe.

1.12 OPERATION AND MAINTENANCE MANUALS

Operation and maintenance manuals covering instructions and maintenance for each type of equipment shall be furnished per Section 16012 – Electrical and Instrumentation Operations and Maintenance Data.

1.13 AREA CLASSIFICATION

Where equipment ratings are not specifically called out on the drawings or schedules, they shall be supplied with the following ratings:

A. Wet environments requiring NEMA 4X enclosures and construction:

1. Indoors in water corrosive or chemical exposed areas.
2. All equipment mounted outdoors.

B. Dry heated areas requiring NEMA 12 enclosures and construction:

1. Indoor equipment not in water corrosive or chemical exposed areas.

C. Seismic Classification:

1. The site is within Seismic Zone 3. All electrical equipment and construction techniques must be designed and braced per Section 16020 Seismic Restraint for Electrical Equipment.

D. Locations requiring Class 1, Division 1 rating:

1. Septage receiving station.
2. Headworks screening area.
3. All wetwells of submersible sewage or wastewater pumps.

E. Locations requiring Class 1, Division 2 rating:

1. Grit pumps, basins and classifier.
2. Aerobic Digesters.
3. Influent pump station.

1.14 CHANGE ORDER PRICING

A. All change order pricing by Contractor or System Supplier shall be broken out into the following minimum categories:

1. Labor per hour, listed per discipline, i.e. Engineer, Drafter, Estimator, Programmer, Secretarial, Electrician, etc.
2. Materials and equipment itemized per component and quantity.
3. Conduit and wiring size, lengths and costs per foot for material only.
4. Rentals, travel, per diem, etc.
5. Tax.
6. Shipping.
7. Insurance.
8. Overhead and profit.

B. Lump sum change order pricing is not acceptable.

C. If Contractor or System Supplier refuses to provide a change order with broken out pricing, the Engineer reserves the right to obtain independent estimates from other Contractors or System Suppliers. The Contractor or System Supplier, who refused to provide the change order with broken out pricing, will be charged for the preparation of the independent estimates.

PART 2 MATERIALS

2.1 QUALITY

A. It is the intent of the Contract Specifications and Drawings to secure the highest quality of all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product. Provide the manufacturer's latest design that conforms to these Specifications.

B. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed, braced, and anchored, and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for

long, trouble-free service. Light duty, fragile, and competitive grade devices which in the opinion of the Engineer are of doubtful durability shall not be used.

C. Products that are specified by manufacturer, trade name, or catalog number, establish a standard of quality and do not prohibit the use of approved equal of other manufacturers. However, all provided products specified or not, must be favorably reviewed and approved by the Engineer prior to installation.

D. Underwriter's Laboratories (UL) listing is required for any installed equipment; this includes substituted equipment when such a listing is available for any named equipment.

E. When required by the Contract Specifications or requested by the Engineer, the Contractor shall submit equipment or material samples for test or evaluation. The samples shall be furnished with information as to their source and prepared in such quantities and sizes as may be required for proper examination and testing, with all freight and charges prepaid. All samples shall be submitted before shipment of the equipment or material to the job site and in ample time to permit the making of proper tests, analyses, examinations, rejections, and resubmissions before incorporated into the work.

F. It is the System Supplier's responsibility to visit the jobsite to collect and document existing equipment and MCC device part numbers in order for all similar new equipment to match existing.

2.2 COMPONENTS

A. Switches and Lights

1. General:

a. Water and oil tight as defined by NEMA 13, UL listed.

b. Standard 30 mm diameter, with round plastic clamp ring.

c. Manufacturers:

1) Switches shall be Allen Bradley 800T.

2) Cutler-Hammer E34 Series.

3) Approved equal.

4) Devices to be mounted or supplied for existing MCCs, switchgear, and control panels shall match the style of existing devices.

2. Hand Switch (HS):

a. Selector switches for hand-off-auto (HOA) applications shall have the hand position to the left, off in center, and auto in the right position.

b. On/Off selector switches shall have the On position to the right.

3. Hand Control (HC):

    a. Pushbutton caps shall be colors shown on Contract Drawings or approved in submittals.

4. Indicating Lights:

    a. Full voltage LED type.

    b. Round plastic lens and miniature bayonet lamp base.

    c. Manufacturer's standard legend plates shall be provided.

    d. Indicating light type and color of lens shall be as shown on the Drawings or specified in the Contract documents.

    e. Indicating lights designated "PTT" shall be provided with a push-to-test switch and wiring.

B. Relays and Timers:

1. General: Relays and timers shall be provided with N.O. or N.C. contacts as shown on the Contract Drawings. All spare contacts shown shall be provided. A minimum of two isolated form C contacts shall be provided on each timer or relay. Contacts shall be rated 10 amps minimum at 120 VAC, 60 Hz unless otherwise stated. Supply power or coil voltage shall be 120 VAC unless otherwise shown on the Contract Drawings or when relay is utilized in 24VDC control circuits. Relays and timers shall be designed for continuous duty. All relays shall be UL listed. The following is a summary of abbreviations associated with relays and timers:

    a. CR - control relay.

    b. PFR - power fail relay.

    c. TR - time delay relay.

    d. TDOE - time delay on energization.

    e. TDOD - time delay on de-energization.

2. Control relays (CR) shall be plug-in type with clear see-through sealed or enclosed housing to exclude dust. Sockets for plug-in relays shall be standard industrial type blade 8 or 11 pin with barrier pressure screw terminals. Provide IDEC Type RH, Potter and Brumfield, or approved equal. Provide relay energized neon lamp or LED (inside relay case).

3. The power fail relay (PFR) shall continuously monitor the three phases for power loss, low voltage, phase loss, and phase reversal. The power fail monitor shall have a drop-out voltage adjustment, an adjustable delay on make time delay (0.2 to 8.0 minutes) and a status indicating LED. Power fail relays shall be Diversified SLJ, Time Mark, or approved equal.

4. Time delay relays (TR) shall be solid state plug-in relays with a timer adjustable over the multi-time range 1 second to 10 minutes and from 1 minute to 10 hours unless

other ranges are indicated or required. Provide LED timer energized indicator lamp. Sockets for plug-in timers shall be standard industrial type blade 8 or 11 pin with barriered pressure screw terminals. Time delay relays shall be IDEC RTE, Potter and Brumfield, or approved equal.

5. Provide and install all moisture or temperature protection relays when required for equipment or motor/pump warranty conditions including any additional conduits for low voltage signal wiring. Submitted drawings shall include the wiring and terminations for all of these relays.

6. The motor controls shall be controlled by an Allan-Bradley 1760 Pico controller or approved equal. Provide additional modules to meet intent of Contract Drawings. The Pico controller I/O shall be wired to match wiring shown on Contract drawings. Pico controller shall have built in keypad, LCD display and real-time clock. Contractor shall be responsible for programming PICO and obtaining software required to program PICO.

2.3 ELECTRICAL ENCLOSURES AND BOXES

A. Enclosures to be NEMA rated per Indexes with fast access door latches. Enclosure construction shall be 14 gauge (minimum) with continuously welded seams. Outer door shall have provisions for locking enclosure with standard padlock. Provide full height white backpan in each box. Provide larger enclosure as required to accommodate the supplied equipment at no additional cost to the Owner.

B. Provide accessories consisting of breaker to disconnect incoming power, heater, fan, louvers, and thermostats. Provide metal data pocket within each enclosure and box to hold as-built drawings.

C. Panels listed as stainless steel shall be 316 stainless steel.

D. Provide copper ground bus per Section 16450.

E. All metal panel doors shall be installed with ground straps.

F. Panels shall be provided with engraved nameplate identifying name of panel, voltage and location of power source feeding it (i.e. MCC-100, Panelboard LP-1, etc.).

G. Enclosure shall be Hoffman, Rittal or approved equal.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards outlined in Division 16 or in these plans and specifications.

B. The Contractor shall employ personnel that are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. The Contractor shall ensure that all equipment and materials fit properly in his installations.

D. The Contractor shall perform any required work to correct that in the opinion of the Engineer are improper installations at no additional expense to the Owner.

E. The Engineer reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

F. All cutting and notching shall be laid out carefully in advance. Do not notch any structural member or building surface without specific approval in writing from the Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to new condition using skilled craftsmen of the trades involved, at no additional cost to the Owner.

G. Keep the premises free from accumulation of waste material or rubbish on a daily basis. Upon daily completion of work, remove waste materials, scraps, and debris from the premises and from the interior and exterior of all devices and equipment.

H. All equipment installed by the Contractor shall be in accordance with the Drawings and the manufacturer's recommendations and instructions and shall operate to the Engineer's satisfaction. Follow all manufacturers' instructions for handling, receiving, installation, and pre-check requirements prior to energization. After energization, follow manufacturer's instructions for programming, set-up and calibration of equipment. The Contractor shall be responsible for and shall correct by repair or replacement, at his own expense, equipment which in the opinion of the Engineer, has been caused by faulty mechanical or electrical assembly by the Contractor. Necessary tests to demonstrate that the electrical and mechanical operation of the equipment is satisfactory and meets the requirements of these Specifications shall be made by the Contractor at no additional cost to the Owner.

I. The Contractor shall vacuum clean the interior of all motor control centers, panelboards, junction boxes and other enclosures supplied under this project containing electrical

equipment to remove all dirt, metal chips, stripped insulation, etc., from the enclosure. This cleaning shall be done prior to energizing the device initially and a second time immediately prior to the final acceptance inspection.

3.2 CONSTRUCTION METHODS, GENERAL

A. All wiring shall be neatly bundled and laced with plastic tie-wraps, anchored in place by screw attached retainer. Where space is available, such as in electrical cabinets, all wiring shall be run in slotted plastic wireways or channels with dust covers. Wireways or channels shall be sized such that the wire fill does not exceed 50%. Wires carrying 100 volts and above shall be physically separated from lower voltage wiring by using separate bundles or wireways with sufficient distance to minimize the introduction of noise, crossing only at 90 degree angles. Retainers shall be Panduit High Bond Adhesive back mounts SGABM series, or approved equal.

B. Where wiring crosses hinged surfaces, provide a "U" shaped hinge loop protected by plastic spiral wrap. The hinge loop shall be of sufficient length to permit opening and closing the door without stressing any of the terminations or connections.

C. Wireways, retainers, and other devices shall be screw-mounted with round-head 316 stainless steel screws. Glue or sticky back attachment of any type or style shall not be used.

D. All devices and wiring shall be installed and permanently labeled and secured in accordance with Section 16144 and Section 16120.

E. All components associated with a particular compartment's or enclosure's function shall be mounted in that compartment or enclosure.

F. Spacing and clearance of components shall be in accordance with UL, JIC, and NEC standards.

G. Wires shall not be spliced except where shown. Devices with pigtails, except lighting fixtures, shall be connected at terminal blocks. Equipment delivered with spliced wires shall be rejected and the Contractor required to replace all such wiring, at no additional cost to the Owner.

H. Where splices are allowed or approved by the Engineer they shall conform with the following:

1. Splices of #10 and smaller, including fixture taps, shall be made with nylon self-insulated twist on wire joints; T & B, or approved equal.

2. Splices of #8 and larger shall be double crimped splices, or approved equal, insulated with heat shrink tubing, or approved equal.

3. Splices in underground pullboxes shall be insulated and moisture sealed with 3M "Scotchcast" cast resin splice kits. Kits used shall have a date marking for shelf life that is not expired.

4. Wire splicing devices shall be sized according to manufacturer's recommendations.

5. Tape on splices shall not be allowed.

6. Splices for motor leads shall be made with 3M DB series splice kit, or approved equal.

I. Tapes shall conform to the requirements of UL 510 and be rated: 105 °C, 600V, flame retardant, hot and cold weather resistant. Vinyl plastic electrical tape shall be 7 mil black. Phase tape shall be 7 mil vinyl plastic, color coded as specified; 3M 33 + or equal. Electrical insulation putty shall be rubber based, elastic putty in tape form; 3M or equal. Varnished cambric shall not be used.

J. Connections to terminals shall be as follows:

1. Use connector or socket type terminals furnished with component.

2. Connections to binding post screw, stud, or bolt use:

a. For #10 and smaller wire, T & B "Sta-Kon," Buchanan "Termend" or approved equal, self-insulated locking forked tongue lug.

b. For #8 to #4/0 wire, T & B "Locktite," Burndy QA, or approved equal, lug of shape best suited.

3. Use ratchet type crimping tool which does not release until proper crimp pressure has been applied.

4. Connections for all terminals shall be made with insulation stripped per manufacturer's instructions.

K. Equipment shall be wired and piped by the manufacturer or supplier. Major field modifications or changes are not allowed without the written "change order" authority by the Engineer. When field changes are made, the components, materials, wiring, labeling, and construction methods shall be identical to that of the original supplied equipment. Contractor's cost to replace or rework the equipment to match original manufacturer or supplier methods shall be done at no additional cost to the Owner.

L. Mating fittings, bulkhead fittings, plugs, connectors, etc., required to field interface to the equipment and panels shall be provided by the supplier when the equipment is delivered.

M. All electrical and instrumentation Drawings associated with the equipment shall be provided with the equipment when it is delivered to the job site. Drawings for each piece of equipment shall be placed in clear plastic packets of sufficient strength that will not tear or stretch from drawing removal and insertion. All Drawings shall also be provided in a digital electronic format.

N. Vertical motors, horizontal motors and all motors shall have make-up connections per Contract Drawings.

O. All wire and cable lugs shall be copper; aluminum or aluminum alloy lugs shall not be allowed. The Electrical Contractor shall supply all lugs to match the quantity and size of wire listed in the Conduit and Wire Routing Schedule.

3.3 EQUIPMENT FABRICATION, GENERAL

A. Panel cutouts for devices (i.e., indicating lights, switches) shall be cut, punched, or drilled and smoothly finished with rounded edges. Exposed metal from cutouts that are made after the final paint finish has been applied shall be touched up with a matching paint prior to installing device. Do not paint nameplates, labels, tags, switches, receptacles, conductors, etc.

B. All doors shall be fully gasketed with non-shrinkable, water and flame resistant material.

C. Bolts and screws for mounting devices on doors shall be as specified by the manufacturer; otherwise they shall have a flush head which blends into the device or door surface. No bolt or screw holding nuts shall be used on the external surface of the door.

D. No fastening devices shall project through the outer surfaces of equipment except as designated by the manufacturer and approved by the Engineer.

E. Each component within the equipment shall be securely mounted on an interior subpanel or backpan and arranged for easy servicing, such that all adjustments and component removal can be accomplished without removing or disturbing other components. Mounting bolts and screws shall be front located for easy access and removal without special tools. Access behind the sub panel or backpan shall not be required for removing any component.

F. A copper ground bus shall be provided in each enclosure or cabinet. It shall have provisions for connecting a minimum of ten grounding conductors. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall be sized as shown on plans or in accordance with NEC Table 250.120, whichever is larger.

G. Minimum wire bending space at terminals and minimum width of wiring gutters shall comply with NEC Tables 312.6 (a) and (b).

H. Wire shall not be installed with smaller sizes than those shown in NEC Article 310 for each circuit amperage rating.

I. Future device and component mounting space shall be provided on the door, backpan, and subpanel where detailed on the Drawings. Where no detail is shown, provide a minimum of 15 percent usable future space.

J. Doors shall swing freely to a minimum of 90° and close with proper alignment.

K. All control, power, and signal wires inside enclosures shall be run in separate plastic wireways. Wireways shall not be filled over 50% capacity.

L. All electrical panels shall be labeled with the KAIC rating and meet the minimum Contract Document design rating; SSCR labeling is not accepted as an equivalent.

M. All vents shall be provided with removable metal filter.

N. A ground bus shall be provided in each enclosure or cabinet. It shall have provisions for connecting a minimum of ten grounding conductors. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall be sized as shown on plans or in accordance with NEC Table 250.122, whichever is larger.

3.4 DELIVERY

A. Contractor shall inspect each electrical and instrumentation item delivered to the jobsite and ensure that it is undamaged, meets specification and submittal.

B. Contractor shall unpack each item for inspection within two (2) days of arrival.

C. Complete written inventory shall be produced by Contractor and submitted to Owner within (2) days after arrival on jobsite for record keeping prior to any payment for the item.

3.5 DAMAGED PRODUCTS

Damage products will not be accepted. All damaged products shall be replaced with new products.

3.6 FASTENERS

A. Fasteners for securing equipment to walls, floors, and the like shall be 316 stainless steel. The minimum size fastener shall be 1/2-inch diameter. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads required.

B. Concrete pad with stainless steel anchor bolts shall be provided for each Field Control Station and instrument support.

C. Anchor Methods:

1. Hollow Masonry: Sleeve type anchors.
2. Solid Masonry: Sleeve type anchors or epoxy anchors bolts.

3. Metal Surfaces: Machine screws, bolts, or welded studs.

4. Concrete Surfaces: Wedge or expansion anchors.

5. Structural Steel: Right angle, parallel and edge type rigid metal clamps. Do not weld or drill structural steel.

D. Equipment Mounting:

1. The Contractor shall be responsible for furnishing and setting all anchor bolts required to install his equipment.

2. Electrical equipment shall be unistrut "stand off" mounted a minimum of ½ - inch from the wall in a manner so that the rear of the equipment is freely exposed to air circulation.

3. Unistrut material shall be 316 stainless steel in NEMA 4X areas and galvanized in non-NEMA 4X areas unless called out specifically in details. Provide and install all unistrut face and bracing for secure mounting with a maximum ¼" deflection.

4. All equipment enclosures shall be of the NEMA classification noted on the electrical plan Drawings for the area in which the device will be mounted.

5. Reinforced concrete pad with 316 stainless steel anchor bolts shall be provided for each electrical freestanding equipment.

E. Dissimilar metals such as aluminum, stainless steel, steel, galvanized steel between enclosures, devices, etc. and mounting surfaces shall be isolated from each other using insulated tape or nonmetal spacers. Tape and spacers used shall be specifically manufactured for this application.

3.7 INSTALLATION, GENERAL

A. System:

1. Install all products per manufacturer's recommendations and the Drawings.

2. Provide relays, signal converters, isolators, boosters, and other miscellaneous devices as required.

3. Change normally open contacts to normally closed contacts or vice versa.

4. Add additional relays to provide more contacts as necessary.

5. Keep a copy of the manufacturer's installation instructions on the jobsite available for review at all times prior to and during the installation of the associated equipment.

B. Panels and Enclosures:

1. Install panels and enclosures at the location shown on the Drawings or approved by the Engineer.

2. Install level and plumb.

3. Seal all enclosure openings to prevent entrance of insects and rodents.

4. All conduits entering outdoor panels and enclosures shall use watertight hubs. These hubs shall be located on sides or bottom only. Top entry of outdoor panels or enclosures is not allowed unless specifically shown on plans.

5. Provide larger motor termination boxes as required to accommodate conduit and wires.

6. Additional condulets with terminal blocks shall be supplied for wire termination to devices with leads instead of terminals (i.e. solenoid valves, level probe, etc.).

7. Terminate all status, control, and analog I/O wiring on terminal blocks, including spares. Provide additional relay, DIN rails, terminal blocks and side panels as required.

8. Seal around bottom edge of all pad mounted enclosures to prevent entrance of insects, rodents, dirt, debris, etc.

9. Clearance about electrical equipment shall meet the minimum requirements of NEC 110.26.

10. Provide supporting devices per Section 16190.

11. All panels and enclosures shall be delivered with as-built drawings in clear plastic packets within each panel and enclosure.

C. Conduits and Ducts:

1. Install all conduits and ducts per Section 16110, Section 16115 and Section 16190.

2. Special “Soft–Jaw” type pipe clamps shall be used to prevent damage to PVC-coated conduit while field threading and cutting to length.

D. Wiring, Grounding, and Shielding:

1. Wiring inside and outside equipment shall be installed per Section 16120.

2. It is important to observe good grounding and shielding practices in the generally noisy environment in this application. The shield of shielded cables shall be terminated to ground at one end only, the originating panel end. The shield at the other end shall be encased in an insulated material to isolate it from ground.

3. Special cables shall be provided when required by manufacturer or necessary to correct noise or distortion interference at no additional cost to Owner.

4. Field wiring shall not begin until interconnection drawings have been submitted by the Contractor and approved by the Engineer, per Section 16011.

E. Cutting and Patching:

1. The Contractor shall do all cutting and patching required to install their work. Any cutting which may impair the structure shall require prior approval by the Engineer. Cutting and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after cutting and patching.

F. Seals:

1. Seal around all conduits, wires, and cables penetrating between walls, ceilings, and floors in all buildings with a fire stop material. Seal shall be made at both ends of the conduit with a fire stop putty. Seal shall have a minimum two hour rating. Fire stop sealing shall be International Protective Coatings Flamesafe, or approved equal.

2. Seal around conduits entering outside to inside structures and around bottom of free standing enclosures to maintain watertight integrity of structure.

3. Place conduit type seal in each underground conduit riser into panels and enclosures to prevent entrance of insects and rodents.

4. Seal around bottom edge of all pad mounted enclosures to prevent entrance of insects, rodents, dirt, debris, etc.

G. Housekeeping Pads:

1. Concrete housekeeping pads are required for all free standing electrical equipment. Housekeeping pads shall be 3-1/2" inches above surrounding finished floor or grade unless otherwise shown and shall be 4 (minimum) inches larger in width and depth around equipment.

2. Housekeeping pads shall be installed for future units as shown on the Contract Drawings.

3. Housekeeping pad shall be high quality Class "A" concrete with rebar crossway network per Contract Drawings. The minimum size rebar allowed is #3. Concrete shall be precisely leveled so that equipment set in place will not require shimming.

H. Cleaning and Touch up:

1. Prior to start-up and the completion of the work, all parts of the installation, including all equipment, exposed conduit, and fittings shall be cleaned and given touch up by Contractor as follows:

   a. Remove all grease and metal cuttings.

   b. Any discoloration or other damage to parts of the building, the finish, or the furnishings, shall be repaired.

   c. Thoroughly clean any of his exposed work requiring same.

d. Vacuum and clean the inside of all MCC and electrical and instrumentation enclosures prior to applying power and at end of project before final acceptance.

e. Clean all above and below ground pull boxes, junction boxes, and vaults from all foreign debris prior to final acceptance.

f. Paint all scratched or blemished surfaces with the necessary coats of quick drying paint to match existing color, texture, and thickness. This shall include all prime painted electrical equipment, including but not limited to enclosures, panels, poles, boxes, devices, etc.

g. Remove all decals and lettering from both sides of support plates.

h. Repair damage to factory finishes with repair products recommended by Manufacturer.

i. Repair damage to PVC or paint finishes with matching touchup coating recommended by Manufacturer.

3.8 SAFETY LOCKOUTS

A. Contractor shall provide safety lockout tags on the breakers for all MCCs and Panelboards and other electrical enclosures. Safety tags shall not be the same as those used by the Owner. All padlocks used for this purpose shall be keyed differently from any of the Owner's padlocks. Padlocks shall remain in place by the Contractor until operation of the portion of work is turned over to the Owner with the responsibilities noted on the acceptance form.

B. The following is the procedure for transferring each portion of work over to the Owner prior to completion of the entire project:

1. Contractor shall inform the Owner when a portion of the work is complete, ready for inspection and available to be placed into operation.

2. The Owner will schedule the inspection and substantiate that the work is complete and operational.

3. The Contractor will correct any deficiencies.

4. The Owner will prepare a Partial Utilization form in which that portion of the project will be turned over the Owner with the responsibilities noted on the acceptance form. The Contractor then shall remove his safety lockouts and tags.

C. Safety lockout tags shall be rigid vinyl with write-on surface and brass grommet. Safety tags shall be secured in place with material of sufficient strength to prevent accidental removal or displacement. Safety lockout tags shall be Panduit Write-on Safety Tags, model PVT-98 or approved equal

3.9 TESTING

A. Factory testing shall be as specified in Section 16610.

B. Field Tests shall be as specified in Section 16620.

3.10 TRAINING

Training shall be as specified in Section 16900.

3.11 SPARE PARTS

Spare parts shall be provided as specified in Section 16013.

3.12 WARRANTY

A. The Contractor shall warrant all electrical and instrumentation equipment and software supplied under this scope of work for a period of one (1) year from date of final acceptance. Standard published warranties of equipment which exceed the preceding specified length of time shall be honored by the manufacturer or supplier.

B. The Contractor shall provide all labor and material to troubleshoot, replace, or repair any hardware or software that fails or operates improperly during the warranty period, at no additional cost to the Owner.

C. The System Supplier shall have a staff of experienced personnel available to provide service on a two (2) working day notice during the warranty period. Such personnel shall be capable of fully testing, programming and diagnosing the hardware and software delivered; and of implementing corrective measures.

D. If the System Supplier fails to respond in two (2) working days, the Owner at its option will proceed to have the warranty work completed by other resources; the total cost for these other resources shall be reimbursed in full by the Contractor. The use of other resources, as stated above, shall not change or relieve the Contractor or supplier from fulfilling the remainder of the warranty requirements.

E. Each time the Supplier's repair person responds to a system malfunction during the warranty period, he or she must contact the designated Owner maintenance supervisor for scheduling of the work, access to the jobsite, and permission to make repairs. Operation of facilities necessary to test equipment shall only be performed by or under the direction of the Owner Staff. The Owner reserves the right at its sole discretion to deny operations requested by the Supplier. A written description of all warranty work performed shall be documented on a field service report to be given to Owner prior to the repair person leaving job site each day. This field service report shall detail and clearly state problem, corrective

actions taken, additional work that needs to be done, data, repair person name and company.

F. Prior to "final acceptance," the Contractor shall furnish to the Engineer a listing of warranty information for all manufacturers of materials, instruments, and equipment used on the project. The listing shall include the following:

1. Manufacturer's name, service contact person, phone number, and address.
2. Material and equipment description, equipment number, part number, serial number, and model number.
3. Manufacturer's warranty expiration date.
4. Copies of receipts/proof of purchase.

3.13 FINAL ACCEPTANCE

A. Final acceptance will be given by the Owner after the equipment has passed the "final acceptance trial period," each deficiency has been corrected, final documentation has been provided, and all the requirements of design documents have been fulfilled.

B. At the end of the project, following the completion of all of the field tests, and prior to final acceptance, the Supplier shall:

1. Remove all temporary services, equipment, material, and wiring from the site.
2. Verify Service equipment has been legibly marked in field with the maximum available fault current per NEC 110.24 (A). Field marking shall include date the fault current calculation was performed and be weather & UV rated. Service equipment shall not be hand labeled.
3. Two sets of all keys for locks supplied on this project. Submit each key with matching duplicate. Wire all keys for each lock securely together. Tag and plainly mark with lock number or equipment identification, and indicate physical location, such as panel or switch number.
4. Verify that as-installed drawings, in reinforced clear plastic pockets, have been placed in all new or modified panels.
5. Resubmit all Electrical System Analysis studies with all calculations rerun, data and graphs updated to reflect as-left conditions. Provide new Arc Flash labels to reflect as-constructed equipment and as-left circuit breaker settings.
6. Provide the following final documentation to the Owner:
    a. A listing of warranty information.
    b. Operations and Maintenance Manual – Each "operation and maintenance" manual shall be modified or supplemented by the Supplier to reflect all field changes and as-built conditions.

c. Full size record drawings, neatly marked and accurately showing the information required herein.

d. Two (2) disk copies of all final documentation to reflect as-built conditions.

e. Four (4) USB drives with copies of all final documentation to reflect as-built conditions. USB to include drawings in both PDF & DWG Format; SCADA Program for PLC and associated equipment; all configuration files for radios, instrumentation, etc.

f. At least one set of manuals, all software, disks and required programming cables shall be turned over to the Owner's SCADA/Electrical division.

END OF SECTION

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SECTION 16011

ELECTRICAL AND INSTRUMENTATION SUBMITTALS AND DRAWING REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

Work specified under Section 01300.

1.2 RELATED SECTIONS

These Electrical Submittals and Drawing Requirements apply to all Sections of Division 16.

1.3 SUBMITTAL AND DRAWING REQUIREMENTS

General:

A. The Contractor shall ensure all equipment suppliers provide the submittal documentation required in Section 01300 and this Section. Submittals shall be complete, neat, orderly, and indexed. The Contractor shall check all submittals required under this Division for the correct number of copies, adequate identification, correctness, and compliance with the Contract Specifications and Drawings, and initial all copies certifying compliance.

B. Submittals shall also include all other information as may reasonably be required, in the opinion of the Engineer, to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the Contract Documents. Additional submittal requirements are specified in each individual Section of the Specifications.

C. The Contractor shall coordinate each submittal with the work so that the project will not be delayed. This coordination shall include scheduling the different categories of submittals, so that one will not be delayed for lack of coordination of another. No extension of time will be allowed because of failure to properly schedule submittals.

D. The Contractor shall provide a Submittal Check List, as shown in Appendix "A," for each submittal item. Note, submittal checklist in Appendix is typical and does not limit the extent of the submittals required.

E. No submittal documents shall be labeled as proprietary. Labeling documents as proprietary will be sufficient cause for rejection of entire submittal. The Owner reserves the right to copy or duplicate any and all portions of the documents provided for the project including copyrighted documents as desired.

F. Submittals shall be provided in binders as specified herein. The Owner reserves the right to reject submittals that fail to be organized as described herein.

G. Identify all submittals by submittal number on letter of transmittal. Submittals shall be numbered consecutively and resubmittals shall have a letter suffix. For example:

1. 1st submittal: 1
2. 1st resubmittal: 1A
3. 2nd resubmittal: 1B, etc.

H. All submittals required for Division 16 shall be submitted in quantity specified per Section 01300.

I. Submit a "Submittal Organization Plan and Schedule" for approval prior to the submission of any other submittals. This organization plan and schedule shall list all the submittals required under Division 16 and have a column filled in for proposed submittal date; and additional columns for entry of actual submittal date and date submittal approved. Submittal dates shall be spread out in a sequence meeting approval of Engineer to provide adequate review time and follow sequence of work. If contents of proposed schedule and submittal organization would not provide for a complete and timely review, compile submittal organization and schedule as directed by the Engineer. The schedule shall be updated and resubmitted as requested by the Engineer.

J. All catalog cuts and drawings for Division 16 listed materials for a major piece of equipment such as an MCC, shall be in one submittal package regardless of supplier of the various components. Catalog cuts shall be submitted grouped together by material and not scattered throughout the submittal intermingled with other material cut sheets (i.e. do not submit cut sheet for specific size conduit followed by cut sheet for specific size wire, and then cut sheet for different size conduit and different size wire. Group conduits together, group wires together, etc.).

K. Each submittal page shall be sequentially numbered and stamped with the date prepared. New pages added or pages replaced in any resubmittal shall have a later revised date than those used in original submittal and page numbering.

L. The decision of the Owner governs what is acceptable as a substitution. If the Owner considers it necessary, tests to determine equality of the proposed substitution shall be made, at the Contractor's expense, by an unbiased laboratory satisfactory to the Owner. Equality will be judged on the basis of the following:

1. Conformance with description or performance required.
2. Equal in quality.
3. Comparable in operation and maintenance.
4. Equal in longevity and service under conditions of climate and usage for given application.
5. Conformance with space allocations.
6. Comparable in appearance and artistic effect.
7. Compatible with mechanical and electrical construction of related work without necessitating changes in detail.

M. For each resubmittal, provide a copy of submittal comments and a separate letter, on Company letterhead, identifying how each submittal comment has been addressed in the resubmittal.

1.4 ELECTRICAL CONTRACTOR SUBMITTALS

A. Submittals include, but are not limited to, product data, samples, requests for substitutions, descriptive data, certificates, methods, schedules, marked-up Record Contract Drawings manufacturer's installation and other instructions, operations and maintenance manuals, and miscellaneous work related items.

B. Shop documents and Drawings shall be submitted for all devices and components in the electrical system provided by Electrical Contractor. The following items shall be submitted for approval under separate submittals:

1. Electrical components such as:
    a. Wire, cable and conduit labels.
    b. Nameplates and tags.
    c. Terminal blocks.
    d. Connectors and tapes.
    e. Conduit, raceways, wireways, and fittings.
    f. Ground system components.
    g. Pull, junction, and device boxes.

h. Enclosures and panels.

i. Miscellaneous wiring devices such as receptacles, switches, cover plates, etc.

j. Support and mounting methods.

k. Vaults.

2. Lighting and Fixtures, per Section 16500.

3. Conduit layout diagrams drawn to scale utilizing AutoCAD, with all conduit tags and size listed, shall be submitted and approved prior to underground conduits being installed. Conduits, duct bank and enclosure entries shall be drawn to scale. The following conduit layout diagrams shall be prepared and submitted by Electrical Contractor for approval.

   a. Diagrams for conduit stub-up locations into the bottom of:

      1) All Panels and Enclosures with 10 or more conduit entries.

      2) All new MCCs.

      3) Power Transformers.

   b. Diagrams for conduit cross sections for:

      1) All concrete duct banks.

      2) Each conduit run between all vaults and pull boxes shown on Contract Drawings.

      3) Pullbox and Vault side entries.

      4) Power Transformers.

4. Device and panel supports as specified in Section 16190.

5. Nameplates for equipment supplied by Electrical Contractor per Section 16144.

6. Seismic calculations per Section 16020.

7. Electrical system analysis per Section 16605.

8. Factory Test procedures per Section 16610.

9. Field Test procedures per Section 16620.

10. Training manuals per Section 16900.

11. Operation and maintenance manuals per Section 16012.

12. Record as-built Contract documents at end of project.

1.5 SYSTEM SUPPLIER SUBMITTALS

A. Submittals include, but are not limited to, product data, shop Drawings, test procedures, test results, annotated software program listings, disk copies of CAD generated Drawings, samples, requests for substitutions, descriptive data, certificates, methods, schedules, marked-up Contract Drawings and Specifications, manufacturer's installation and other instructions, operations and maintenance manuals, and other miscellaneous work related items.

B. Drawings shall be drawn using AutoCAD in a professional manner provided both on paper hardcopy and electronic form of CD or with each submittal. Each Drawing title shall contain an English Title, equipment number, and Drawing type to which Drawing pertains (i.e. Influent Pump No. 1 P1001 Elementary Diagram). Standard preprinted Drawings simply marked to indicate applicability to the Contract will not be acceptable. Drawings shall be prepared in a professional manner and shall have borders and a title block identifying the project, system, Drawing Number, AutoCAD file name, project engineer, date, revisions, and type of Drawing. Drawings shall be no smaller than 11" x 17" and printed with a laser jet printer or plotted in ink on vellum. The lettering shall be legible and no smaller than 0.075 inch in height. Drawings shall be prepared in the electrical diagram drafting format and detail as shown on the Contract "E" and "P" Series Drawings.

C. Drawings that are "B" sized shall be submitted in a folder that securely holds 11" x 17" Drawings. Drawings shall not be folded. Folder shall be clearly marked with System Supplier Company name, Submittal number, Specification Section reference, project name, and Electrical Contractor. "C" or "D" sized shall be folded and inserted into a clear plastic pocket with the title block visible. Drawings reduced from 11" x 17" to 8-1/2" x 11" or 8-1/2" x 14" in size shall not be acceptable.

D. Documents and Drawings shall be submitted for all devices and components in the electrical and instrumentation system. The following items shall be submitted for approval under separate submittals:

1. Motor control centers with all associated components.
2. PLC hardware.
3. Transformers and Panelboards.
4. Miscellaneous material:
    a. Wire, cable, and wire labels.
    b. Nameplates and tags.
    c. Terminal blocks and fuses.
    d. Miscellaneous devices.
5. Control panels and Enclosures with all associated components.
6. Instrumentation.

7. Instrument and vendor software and program documentation.
8. Operation and maintenance manuals.
9. Electrical System Analysis
10. Factory Test procedures.
11. Field Test procedures.
12. Training manuals.

E. System Supplier to submit Record as-built documents at end of project.

1.6 TESTING SUBMITTALS

A. The Contractor shall provide separate typed procedures and test forms detailing all of the factory and field tests. Test forms shall be setup to allow record entry of the results of each test. Each test procedure shall detail the requirements of Owner personnel to assist in operation of the site in order to conduct the tests. The Contractor shall provide sign-off forms for each test similar to those shown in Section 16610 and 16620 appendices. Each form shall include space for recording the following:

1. Test Procedure.
2. Test date.
3. Equipment tag number and description.
4. Test acceptance criteria.
5. Results of test.
6. Calibration test equipment description, part number and calibration date.
7. Check-off/sign-off for pass/fail including telephone numbers:
    a. Contractor.
    b. Engineer's Representative.
    c. Manufacturer's Representative.

B. Submit for approval the test procedures and test forms to the Owner at least three weeks prior to the start of testing. Testing shall not commence until the test procedures have been reviewed and approved by the Owner.

C. Along with each test procedure submittal, the Contractor shall state the name of the person to perform the test, qualification of person, company affiliation, resume listing past similar testing experience. If the Owner determines the person submitted is not qualified, then the Contractor shall resubmit an alternate. Test shall only be performed by the testing person approved by the Owner for the specific test.

D. Submit testing, start-up and operational testing schedule at the request of the Owner/Owner's Representative.

PART 2 MATERIALS

2.1 GENERAL

A. Submittals shall be neatly and orderly placed in binders. All copies shall be clear and legible. Provide originals when copies are not legible.

B. Each submittal shall include a copy of the appropriate Division specification sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the Contractor, each deviation shall be underlined and denoted by a unique number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. The submittal shall be accompanied by a detailed, written justification for each numbered item explaining variance or non-compliance with specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations from the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no review.

C. Each submittal for major equipment, such as MCCs shall be complete with all related drawings, catalog cuts, and other related submittal requirements in one package. Submittal deemed incomplete by Owner will be returned without review.

D. A copy of the Contract Document elementary diagrams and process and instrumentation (P & ID) diagrams relating to the submitted equipment, with require conformed plans and specifications that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required". Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no review being done.

E. All interconnects, loop, one-line and elementary diagrams shall be prepared by one System Supplier (except where noted otherwise). The Contractor shall submit for approval the proposed Drawing format for each type of Drawing or diagram specified. The Contractor shall not go into production with the Drawings or diagrams for this project until the Engineer has given written approval of the submitted proposed drawing format submittal.

2.2 ELECTRICAL CONTRACTOR SUBMITTAL DOCUMENTS

A. Each submittal shall be bound in a three hole-punched binder, which is sized such that when all material is inserted, the binder is not over 3/4 full. Spiral ring type binders are not acceptable.

B. Each binder shall be appropriately labeled on the front cover with the project name, Contract number, equipment supplier's name, Specification Section(s), and major material contained therein.

C. An index shall be provided on the inside front cover. This index shall itemize the contents of each tab and subtab section. Also list the project name, Contract number, and equipment supplier's name, address, phone number, and contact person on the index page.

D. Complete Material's list shall be provided as the first tabbed section. The Contractor shall provide Material list providing name of project, location of equipment, Specification Section, quantity, description, manufacturer, and full part number.

E. Shop documents, Drawings, and bill of materials shall be grouped under separate tabs. Shop documents shall be ordered in the same sequence as their corresponding Contract specification subsection. Dividers for each section shall be heavy duty with reinforced binding holes and permanent plastic labeled index tabs.

F. Failure to provide submittals with heavy duty permanent plastic labeled index tabs may be grounds for immediate rejection without review.

2.3 SYSTEM SUPPLIER SUBMITTAL DOCUMENTS

A. Each submittal shall be bound in a three ring binder, which is sized such that when all material is inserted the binder is not over 3/4 full. Binder construction shall allow easy removal of any page without complete manual disassembly. Spiral ring type binders are not acceptable.

1. Each binder shall be appropriately labeled on the outside spine and front cover with the project name, Contract number, equipment supplier's name, Specification Section(s), and major material contained therein.

2. An index shall be provided on the inside front cover. This index shall itemize the contents of each tab and subtab section. Also list the project name, Contract number and equipment supplier's name, address, phone number, and contact person on the index page.

3. The order of tabbed section in shop document submittal shall be as follows:

Tab	Contents
I	EXCEPTIONS/CLARIFICATIONS
II	BILL OF MATERIALS
III	PANEL EQUIPMENT SHOP DOCUMENTS
IV	FIELD EQUIPMENT SHOP DOCUMENTS
V	CONTRACT SPECIFICATIONS AND DRAWINGS
VI	NAMEPLATES

4. Dividers for each section shall be heavy duty with reinforced binding holes and permanent plastic labeled index tabs.

5. The following shall be submitted as separate submittal binders:

   a. PLC software program and documentation.

      1) Listing of all setpoints with proposed initial numeric entry values and corresponding Engineering Units for control strategies.

      2) Listing of all digital and analog registers, bits, timers etc., their respective description and full addresses.

      3) Complete commented ladder logic program.

      4) See Sections 16911 and 16915 for further submittal requirements.

   b. Drawings:

      1) A Drawing Index shall be provided that lists each Drawing title and drawing number. Each Drawing title and number shall be unique. The index shall not include drawings listed as "This Page Intentionally Left Blank."

      2) Drawings shall be submitted in a separate hole-punched binder that covers the entire 11 inch by 17 inch length of the Drawing:

         a) Shop Drawings with less than 15 sheets total in the submittal, shall be provided in an 11½-inch by 17½-inch reinforced folder.

         b) All Interconnection Drawings or Shop Drawings of 15 sheets or more shall be provided in separate three-ring binder to allow drawings to be easily removed. Binder shall be Cardinal D-Ring Easy Open Ledger Binder with locking D-Rings or approved equal.

         c) Failure to provide drawing submittal in correct binder format may be grounds for immediate rejection without review.

      3) Drawings shall not be folded. Blank pages shall not be placed in drawings set.

4) Drawings shall be hard tabbed into separate sections as follows:

a) One-line or three-line diagrams.

b) Loop diagrams.

c) Elementary diagrams.

d) Elevation diagrams.

e) Fabrication diagrams.

f) Interconnect diagrams (PDF version is not acceptable).

g) PLC I/O card wiring diagrams.

6. The following shall be submitted as a separate submittal binders:

a. Drawings:

1) The index shall not include drawings listed as "This Page Intentionally Left Blank." A Drawing Index shall be provided that lists each Drawing title and drawing number. Each Drawing title and number shall be unique.

2) Drawings shall be submitted in a separate hole-punched binder that covers the entire 11" X 17" length of the Drawing

a) Shop Drawings with less than 20 sheets total in the submittal, shall be provided in an 11½-inch by 17½-inch reinforced folder.

b) All Interconnection Drawings or Shop Drawings of 20 sheets or more shall be provided in separate three-ring binder to allow drawings to be easily removed. Binder shall be Cardinal D-Ring Easy Open Ledger Binder with locking D-Rings or approved equal.

c) Failure to provide drawing submittal in correct binder format may be grounds for immediate rejection without review.

3) Drawings shall not be folded. Blank pages shall not be placed in drawings set.

4) Drawings shall be tabbed into separate sections as follows:

a) One line or three line diagrams

b) Loop diagrams

c) Elementary diagrams

d) Elevation diagrams

e) Fabrication diagrams

f) Interconnect diagrams

g) PLC I/O card primary diagrams

B. The System Supplier submittals shall include but not be limited to data sheets and Drawings for each product together with the technical bulletin or brochure. The instrumentation submittals shall be clearly copied from originals. No FAX copies of documents are allowed. Color copies shall be provided when black and white copies do not show adequate clarity. The system supplier submittals shall include:

1. Catalog Cuts: Complete catalog cuts with full description of equipment. General sales literature will not be acceptable. The part or model number with options to be provided shall be clearly identified. Where more than one item or catalog number appears on a catalog cut, the specific item(s) or catalog numbers(s) proposed shall be clearly identified. Each catalog cut sheet shall be identified with the applicable Section and subsection numbers. The catalog cuts shall be placed in numerical Specification Subsection and paragraph order in the submittal for easy reference. (i.e. Section 16950-2.03 devices before Section 16950-2.04, etc.) Catalog cuts shall include:

    a. Product (item) name used herein and on the Contract Drawings.

    b. The manufacturer's model or other designation.

    c. Tag name/number per the P & ID Drawings, schedules and indexes.

    d. Complete documentation with full description of operation.

    e. Equipment technical specifications, ratings, and listings.

    f. Location of assembly at which it is installed.

    g. Input/output characteristics.

    h. Range, size, and graduations as required.

    i. Physical size with dimensions and mounting details.

    j. Quantity and quality requirements for electric power, air, and/or water supply.

    k. Materials of components in contact with or otherwise exposed to the process.

    l. Calibration, performance, or accuracy curves.

    m. Specifications

2. Equipment Record Sheets shall be provided to subtab all shop documents for each individual piece of equipment. Equipment Record or Instrument Sheets shall be bright yellow or blue for easy identification. Equipment Record Sheets shall be similar in format to the one shown in Appendix "A". Instrument Data Sheets shall be standard ISA 20 forms.

    a. The Equipment Record Sheets or Instrument Data shall have the following information preceding their corresponding catalog cuts:

        1) Product identification; name used herein and on the Contract Drawings.

        2) The Manufacturer's model number, part number, or other designation. This shall include the specific numbers of all proposed options.

3) Tag name/number per the P & ID Drawings or schedules.

4) Location of assembly at which it is installed.

5) Range, span, engineering units, input, and output characteristics.

6) Contract Specification Subsection number.

3. Tab I: Exceptions/Clarifications:

a. Itemize all exceptions and clarifications.

b. All exceptions taken from the Drawings and specifications shall be documented with justifications. When noting the exception, list which Drawings or which Specification Subsection number the exception is taken.

c. All exceptions taken from the Drawings and specifications shall be documented with justifications. When noting the exception, list which Drawings or which Specification Subsection number the exception is taken.

d. Clarification requests shall list which Drawing or Specification Subsection number the clarification is required for.

e. Requests for information (RFIs) shall not be included in submittals. RFIs shall be submitted separately, with its individual submittal number.

4. Tab II: Bill Of Materials:

a. Bill of Materials: Complete Materials list shall be provided similar in format to the Bill of Material shown in Appendix "A". Generic names or part numbers used by a distributor or Systems House are not acceptable; originating manufacturer's name and part number shall be listed. In addition the "Material Listing Form" shown in Appendix "A" shall be filled in and submitted for all Control Panels. A separate Bill of Material Listings shall be provided for:

1) MCCs

2) Switchgear, Switchboard, Panelboards, and Transformers

3) Control Panel

4) Power Transformer

5) Miscellaneous Devices

6) Disconnect Enclosure

7) Type of Field Instrumentation (i.e. 16950 series level instruments only in one submittal)

8) Spare Parts

5. Tab III and IV: Equipment:

a. Include catalog cuts and Equipment Record Sheet for each submittal item as specified herein.

b. Field equipment shop documents, panel equipment shop documents, and Bill of Materials shall be grouped under separate tabs. Shop documents shall be ordered in the same sequence as their corresponding Contract Specification Subsection.

6. Tab V: Contract Specifications and Drawings:

   a. The following Contract documents shall be provided in submittal.

   b. Copy of checked (✓) specifications as specified herein.

   c. Copy of P & ID and elementary diagrams marked to show changes requested.

7. Tab VI: Nameplates

   a. Submit full-size Drawing of all nameplates and tags, per Section 16144 - Nameplates, to be used on project. The Engineer has the right to adjust nameplate engraving titles during submittals at no additional cost to the Owner. Submittal to include the following:

      1) Dimensions of nameplate.

      2) Exact lettering and font for each nameplate.

      3) Color of nameplate.

      4) Color of lettering.

      5) Materials of construction.

      6) Method and materials for attachment.

      7) Drawing showing location and mounting arrangements of nameplates on each MCC, Switchboard, panel and enclosure.

8. Drawings:

   a. Drawings shall be provided with minimum drafting details as illustrated on Contract Drawings. Diagrams shall carry a uniform and coordinated set of wire colors, wire numbers, and terminal block numbers. Provide a symbol list identifying symbols used. The Drawings shall include:

      1) Electrical one line or three line diagrams detailing all devices associated with the power distribution system. The following applicable information or data shall be shown on the one-line diagram: location, size, interrupt KAIC. and amperage rating of bus; size and amperage rating of wire or cable; breaker ratings, number of poles, and frame sizes; auto-transfer switch; utility metering, voltage, amperage, number of wires and phases; ground size and connections; neutral size and connections; protective devices; fuse size and type; distribution transformers; panelboards; starters; contactor size and overload range; motor full load amperage of submitted motor and horsepower; rating for miscellaneous loads; etc. Submit a list of all equipment motor voltage, phase and full load amps provided for this project for verification of accuracy of submitted one line Drawings.

2) Analog and digital I/O loop diagrams showing the wiring requirements for each instrument loop. Graphic symbols shall conform with ISA S5.4 Drawing standards. A loop diagram shall be furnished for each analog and digital I/O process. Loop diagrams shall include the following as a minimum:

   a) The loop diagram shall be drawn with sufficient detail to express control philosophy. The diagram shall show all components and accessories of the instrument loop, highlighting special safety and other requirements. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and for maintaining or troubleshooting that system.

   b) A separate Drawing shall be prepared for each analog card. Each analog input and output shall be arranged on the diagram in the same order as the physical arrangement of the card terminations. Example format is shown on "E"-Series Contract Drawing.

   c) Each digital input and output shall be arranged on the diagram in the same order as the physical arrangement of the card terminations. All termination points on the diagram shall be shown with the actual equipment identification, device, and relay terminal number or letter. A separate Drawing shall be prepared for each digital input and digital output card. Example format is shown on "E"-Series Contract Drawing.

   d) All devices or items on the diagram shall have clear labeling and identification.

   e) All termination points on the diagram shall be shown with the actual equipment identification terminal number or letter. This identification of termination includes terminal blocks, junction boxes, field devices, panel devices, computer I/O points, etc.

   f) Energy sources - electrical power, air supply, pneumatic and hydraulic fluid supply, designating voltage, current, pressure, etc., shall be shown in detail on the diagram. Input and output signals (e.g., 1-5 VDC, 4-20 mA DC, 3-15 psig, etc.), power and instrument supplies to devices (e.g., 120 VAC, 24 VDC, 80 psig, etc.) shall be shown.

   g) Engineering units shall be shown on the diagram.

   h) Care shall be taken to prevent overcrowding on the diagram and space shall be provided for future additions.

   i) Each wire label and color code shall be shown. Signal and DC polarities shall be shown.

   j) All spare wires, cables, and termination points shall be shown. All jumpers, grounding, shielding, power supply details shall be shown.

3) Elementary diagrams shall be provided for all relay logic, power supplies, and other wiring not shown on the loop diagrams. All elementary diagrams shall be drawn in ladder logic EMP/EGP format and standards, similar to those shown on the E-Series elementary diagrams showing ladder rung numbers and coil and contact cross referencing numbers. All loop diagrams shall be drawn per ISA standards. The elementary diagram shall be drawn between vertical lines which represent the source of control power. Show control devices between on the right-hand side. Show contacts between the coils and the left vertical line.

   a) Where the internal wiring diagrams of subassemblies are furnished on separate sheets, show as a rectangle in the elementary diagram with all external points identified and cross-referenced to the separate sheets of the control circuit. Show coils and contacts internal to the subassemblies in the rectangle connected to their terminal points.

      (1) Exception No. 1: Where relay and electronic circuits are mixed, diagrams may be drawn between horizontal lines which represent the source of control power.

      (2) Exception No. 2: Overload relay contacts may be connected to the right of the coil (common) if the conductors between such contacts and the coils of the magnetic devices do not extend beyond the control enclosure.

   b) For clarity, show control device symbols in the order in which the controls are positioned on the diagram.

   c) Use a cross-referencing system for each relay coil so that associated contacts may be readily located on the diagram. Where a relay contact appears on a sheet separate from the one on which the coil is shown, describe the purpose of the contact on the same sheet.

   d) Show spare contacts.

   e) Show limit, pressure, floats, flow, temperature sensitive, and similar switch symbols on the elementary diagram with all utilities turned off (electric power, air, gas, oil, water, lubrication, etc.) and with the equipment at its normal starting position.

   f) Show contacts of multiple contact devices, e.g., selector switches, on the line of the elementary diagram where they are connected in a circuit. Indicate a mechanical connection between the multiple contacts by a dotted line or arrow. This does not apply to control relays, starters, or contactors.

   g) Additional charts or diagrams may be used to indicate the position of multiple contact devices such as drum, cam, and selector switches.

h) Show the purpose or function of all switches adjacent to the symbols.

i) Describe the purpose or function of controls such as relays, starters, contactors, solenoids, subassemblies, and timers on the diagram adjacent to their respective symbols. Show the number of positions of the solenoid valve adjacent to the valve solenoid symbol.

j) Show values of capacitors and resistors on the diagram.

k) Descriptive terms for command and status functions shall be in the present or past tense. For example, Raise Transfer-Transfer Raised; Advance Transfer-Transfer Advanced. Do not use terms such as "Transfer Up."

l) Show field wiring as dashed lines.

4) Elevation diagrams shall be provided that show the front, side, and top view and shall be drawn to scale and dimensioned. Detail all devices, protrusions, penetrations, doors, cutouts, wireways, latching mechanism, etc., on or in the panel to indicate device clearances. Show the actual physical size or each device (i.e., indicating lights, hour meters, switches, push buttons, annunciators, indicators, controllers, breaker diagram. Nameplates, with cross-reference numbers to the elevation schedule shall be shown at the location of mounting. The top view shall detail conduit entrance clearance areas and mounting base bolt locations for floor mounted equipment.

a) "Exterior" panel elevation diagrams, drawn to scale, shall be provided for control panels, and any equipment that has devices mounted on the face of the enclosure.

b) "Interior" enclosure layout panel elevation diagrams shall be provided for the enclosures specified. Diagram format shall conform with JIC, EMP, or EGP panel layout Drawing standards. Backpan and sidepan layout shall be shown in detail, showing the location of all devices, wireways, gutters, relays, power supplies, terminal blocks, etc., drawn to scale. Spare panel space shall be dimensioned to indicate area for expansion. Show fabrication methods and details; including material of construction, paint color, support and latching mechanisms, fans and ventilation system, and conduit entrance areas.

5) Fabrication Diagrams shall be provided for each switchboard, MCC, panel, enclosure, and electrical custom built equipment. Sufficient detail shall be provided on the fabrication diagrams to determine size, weight, material hinge, and hasp locations, method of locking, gauge and type of steel or plastic, metal preparation, paint method, color, construction methods, weld location and type, fabrication and assembly, mounting details, conduit entrance clearance areas, and other information to show the enclosure is suitable for the application. All diagrams shall be scaled. Overall dimensions and minimum clearances shall be shown. Available conduit stub-up areas shall be shown on a base plan.

6) Interconnection diagrams shall show, for each piece of equipment, all wiring between all devices, panels, cabinets, terminal boxes, control equipment, motor control centers and any other devices and equipment. An interconnection diagram shall be furnished for each electrical and instrumentation system, even if one was not shown explicitly on the Contract Drawings. Interconnection diagrams shall be prepared for all conduits listed in the Conduit and Wire Routing Schedule in Section 16111, with the exception of conduits for lights and receptacles which are not required to have interconnect drawings. Each interconnection diagram shall show the following as a minimum:

   a) Interconnect drawings shall be prepared for all equipment by the System Supplier with the exception of the video surveillance, Telephone and Security Alarm Systems which may be produce their own interconnect drawings.

   b) The diagrams shall be utilized by the electrician during all phases of installation and connection of all conductors to ensure coordination of equipment interconnects.

   c) The diagrams shall show wiring as field labeled at the end of the project when as-builts are submitted.

   d) Each wire labeling code as actually installed shall be shown. The wiring labeling code for each end of the same wire must be identical.

   e) All device and equipment labeling codes shall be shown.

   f) Interconnection diagrams shall be of the continuous line type with identified lines. Diagrams of the wireless or wire schedule type are not acceptable. Bundled wires shall be shown as a single line with the direction of entry/exit of individual wires clearly shown.

   g) All terminations points on the diagram shall be shown with the actual equipment identification terminal number or letter. This identification of terminations includes terminal blocks, junction boxes, all devices, computer I/O points, etc.

   h) Diagrams shall include raceway numbers, raceway size, raceway type, cable numbers, wire color code, and wire numbers.

i) Each wire size, and cable size and color code shall be shown. Each conduit with the conduit label and conduit size and wire fill shall be shown. Wire and cable routing through conduits, wireways, manholes, handholes, junction boxes, terminal boxes and other electrical enclosures shall be shown with the appropriate equipment labels. All spare wires, cable, and termination points shall be shown. Cable shields shall be shown.

j) Labeling codes for terminal blocks, terminals, wires, cables, panels, cabinets, instruments, devices, and equipment shall be shown. Place "øA", "øB", and "øC" label next to each breaker to identify phase connected to.

k) Schematic symbols shall be used for field devices, showing electrical contacts. Signal and DC circuit polarities shall be shown.

l) The diagrams shall show all other Contract and Supplier Drawing numbers, for reference, that are associated with each device that is interconnected.

m) Attached to each interconnect, a copy of all the support documents used in preparing interconnects shall be submitted. This includes current issues of panel schematics, elementary diagrams, panelboard schedules, conduit schedules, one-line diagrams, connection diagrams, terminal block diagrams, submittals, contract drawings, vendor drawings and all other data used to develop the interconnection diagram, as noted in the "Reference Documents" corner of interconnect drawings.

n) Do not show the same wires or jumpers, or panel wiring on both the connection and interconnection diagrams. All jumper, shielding, and grounding termination details not shown on the connection diagrams shall be shown on the interconnection diagrams.

o) Interconnection diagrams shall be submitted and approved by Owner for each electrical and instrumentation system.

p) Field wiring shall not start before the interconnection Drawing has been submitted by the Contractor and approved by the Owner.

q) The Contractor shall not pull in any wires into conduits that do not have approved interconnects. If the Contractor pulls in wire without Owner approval of associated Interconnect Drawings, the Contractor will not be reimbursed for labor for re-pulling in wires even if there was an error in wire fill or sizing.

r) If the Contractor pulls in wire without Owner approval of associated Interconnect Drawings, then all progress payments related to field wiring for that particular area of work will be withheld until approved Interconnect Drawings are in use.

s) All interconnection diagrams shall be prepared by a System Supplier under the supervision of or by a State of California Registered Electrical Engineer and shall bear that Engineer's professional stamp and signature for all Interconnection Drawings submitted for approval including as-builts and those used in the field installation. Engineer's stamp missing from interconnection drawings will be sufficient grounds to reject entire interconnection drawing submittal without review.

t) Failure to provide backup references or signed and stamped drawings may be grounds for immediate rejection.

u) Example format of Interconnection diagram is shown on Contract "E"-Series Drawings or may be obtained from the Engineer.

v) Interconnection Drawings shall use bundled wire format as shown on example interconnect Contract Drawing. Interconnect drawings submitted with wiring of a single conduit run separated onto multiple interconnect drawings will be rejected without review. A single conduit run with wiring shown on separate interconnect drawings will be allowed only after written approval is given by the Engineer for each conduit run prior to submitting the associated interconnect drawings.

w) Only field wiring between switchboards, MCCs, Panelboards, Control Panels, and other electrical and instrumentation devices or equipment shall be shown on interconnection drawings. No internal panel wiring shall be shown on interconnect drawings except jumper or other wiring to be installed in field by Electrical Contractor.

x) Interconnect Drawings along with the corresponding support documents shall be submitted in a separate submittal package. Interconnect drawings submitted with non- interconnect drawing packages will be rejected. The latest support documents shall be obtained by System Supplier from Contractor for all non-Division 16 instruments, panels, and equipment, and included with interconnect drawing submittal. Support documents shall have their submittal number marked in upper right hand corner.

y) Provide a notes section on each interconnect drawing. In the notes section, list any variances from the Contract conduit schedule necessary for completing the interconnections. Change orders regarding wire fill, conduit schedule and errors in plans regarding conduits and wires will not be processed until interconnect drawings have been received for such work.

z) The field electrician shall mark-up all interconnection diagrams during installation to show accurate as-built wiring, conduits runs, terminations, etc. If interconnection drawings are not properly as-built, the Contractor will have cost deducted from the Contract for the Owner to field verify and prepare as-built interconnection drawings amount. The amount of the deduction shall be determined on a time and material basis. The cost of such work shall be $150.00 per hour plus expenses.

aa) Interconnects shall include list of all applicable reference drawings, request for clarifications, field instructions and change orders. All deletions and additions of equipment, conduits, wire, and cables shall be clearly shown. Clearly state why termination data is not available. Statements should point to applicable area and be placed in a bold box.

bb) The System Supplier shall be responsible to collect all information necessary to complete each interconnection drawing. This includes making field trips to collect all terminal connection data for new and existing, MCCs, switchboards, panelboards, instruments, equipment and electrical panels.

cc) An index of drawings shall be provided with each Interconnection submittal listing the unique drawing number and the description of the interconnect drawing (e.g. Drawing 4321-IC1004 Pump 1004 Interconnect Drawing).

dd) Provide conduit and interconnect drawing cross reference indexes. Interconnect Conduit Index shall list all conduits listed in the Conduit & Wire Routing schedule and its associated Interconnection Drawing number. An Interconnection Drawing Index shall list all Interconnection drawings and the conduits shown on that specific drawing. These two indexes shall be at the front of all interconnection drawing submittals.

ee) Interconnection submittals that contain more than two motor control panels/centers shall have heavy duty dividers with permanent plastic labeled index tabs separating each group of drawings.

PART 3 EXECUTION

3.1 SUBMITTAL REQUIREMENTS

A. Within 30 calendar days after Contract award the Contractor, Electrical Contractor, System Supplier, Resident Construction Manager and Engineer shall meet to ensure that all parties are in agreement regarding submittals and Contract objective toward the electrical, instrumentation, and control submittal process.

B. Within 90 calendar days after Contract award the Contractor shall furnish to the Engineer all first stage submittals required for the project.

C. Submit shop drawings for review at least 45 days before reviewed drawings will be required for commencing the work.

D. Resubmittals shall address all comments by the Engineer. Partial resubmittals may be returned without review at the discretion of the Engineer. The Contractor shall be responsible for the Engineer's review cost for each resubmittal in excess of the second resubmittal. These costs will be back-charged to the Contractor and will be deducted from his progress payments.

E. No material or equipment shall be allowed at the job site until the submittal for such items has been reviewed by the Engineer and marked "no exceptions taken" or "make corrections noted".

F. The Contractor shall include in writing on the Submittal Check Sheet (see Appendix "A") any proposed departures from the Contract documents, and the reasons therefore. Incorporate no such departures into the work without prior written approval of the Engineer. The approval of departures which substantially deviates from the Contract Documents shall be evidenced by a "change order" directive by the Engineer. Any cost differential associated with this change order must be negotiated with the Engineer to amend the Contract to reflect the costs or savings.

G. Exceptions to the Specifications or Drawings shall be clearly defined by the equipment supplier. Submittal data shall contain sufficient details so a proper evaluation may be made by the Engineer.

H. The equipment specifications have been prepared on the basis of the equipment first named in the Specifications. The Contractor shall note that the second named equipment, if given, is considered acceptable and equal equipment, but in some cases additional design, options, or modifications may be required to meet Specifications all at no additional cost to the Owner.

I. The decision of the Engineer governs what is acceptable as a substitution. If the Engineer considers it necessary, tests to determine equality of the proposed substitution shall be made, at the Contractor's expense, by an unbiased laboratory that is satisfactory to the Engineer.

J. Electronic PDF version of submittals shall be provided with table of contents regardless of hard copy format of submittal. PDF shall be "bookmarked" at each index, subtab, transmittal letter, copy of appropriate check marked Specification Section, bill of materials, copy of submittal comments (for resubmittals), Contractor's response to submittal comments (for resubmittals), logical division in submittal, drawings, etc. Bookmarks shall be descriptive of actual document, tab, etc. Failure to bookmark PDF or broken bookmarks may be grounds for immediate rejection without review. Bookmarks shall not be out of order; the English description shall match that listed in the Submittal's Table of Contents.

K. Electronic submissions of submittals may be provided for submittals less than 40 pages and without drawings. Submittals equal to or over 40 pages or those that contain drawings shall be provided in a hardcopy format. Drawings shall be printed at 11 inches by 17 inches. Hardcopy submittals shall be provided in binders as specified herein. The Owner reserves the right to reject submittals that fail to be organized as described herein.

3.2 DRAWINGS AND DATA SUBMITTAL PROCESS

A. General: Submittal data shall be grouped and submitted in three separate stages. Each stage submitted shall be substantially complete. Individual Drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications indicated on the Drawings shall be referenced where applicable. Each submittal shall contain the submittal check list.

B. First Stage Submittals: The first stage submittals shall include the following items:

1. A detailed list of any exceptions, functional differences or discrepancies between the Supplier's proposed system and the Contract requirements.
2. Product catalog cut sheets on all hardware items. Clearly marked to show the applicable model number, optional features, and intended service of each device.
3. A brief, concise description of the system proposed, including major hardware and software components, field services and training.
4. A system configuration Drawing in block diagram or schematic format showing the principal items of equipment being furnished and their interrelationship with new and existing system components.
5. Drawings showing floor or desktop space requirements for all equipment items. Drawings shall include space requirements for door swings and maintenance access. Provide dimensioned foot prints of all MCCs and other enclosures.
6. Environmental and power requirements for each equipment item.

7. Standard field termination Drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

8. Bill of Materials and Material Listing forms.

9. Proposed drawing and diagram format for each type of drawing or diagram specified.

10. Equipment Record Sheets.

11. Electrical System Analysis.

C. Second Stage Submittals: Before any equipment is released for shipment to the jobsite or before factory testing is scheduled, the following data shall be submitted.

1. At the Supplier's option, the stage one and stage two submittals may be combined.

2. Detailed, functional descriptions of all software modules required per the Contract documents and furnished as part of the Supplier's standard system. Software module descriptions shall be marked with the applicable specification paragraph.

3. System one line, elementary, loop and interconnection Drawings for all wiring between components of the system furnished and for interconnection wiring between the related equipment and the equipment furnished. Drawings shall show complete circuits and indicate all connections. If panel terminal designations, interdevice connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised Drawings shall be resubmitted prior to shipment of the equipment to the jobsite.

4. Elevation and Fabrication diagrams with nameplate schedules.

5. Process input/output listings showing point names, numbers, and addresses.

6. Factory Test Procedures.

D. Third Stage Submittal - The following information shall be provided as part of the third stage submittals:

1. Field Test Procedures.

2. Documentation on training course content, schedule, instructor's qualifications and recommended prerequisites for all training activities specified herein.

3. The System Supplier shall furnish complete documentation on all software provided with the systems specified herein. Software documentation shall consist of the following principal items:

a. User reference manuals for all standard system and application software provided.

b. User reference manuals for all operation systems.

c. Written as-built reference documentation for any special software provided specifically for this Contract.

E. Operation and Maintenance Manuals shall be furnished for all equipment per Section 16012.

3.3 FIELD REPORTS

System Supplier to submit written report to Engineer at conclusion of each site visit, prior to leaving job site. Report to include copies of all pertinent operating and test data obtained during visit, onsite personnel names, company, time, dates, and description of all work performed.

APPENDIX "A"

Bill of Material

Submittal Check Sheet

Material Listing Form

Equipment Record Sheet

BILL OF MATERIAL

PROJECT: _____ **DATE** / /

LOCATION: _____ **PAGE** _____

SPECIFICATION SECTION	QTY	DESCRIPTION	MFG.	PART NUMBER	TAG No.

SUBMITTAL CHECK SHEET

EQUIP NAME: _____ **DATE** / /

SUBMITTED BY: _____ **PAGE** _____

EQUIPMENT No.: _____ **SUBMITTAL No.** _____

SUBMITTAL STATUS CHECK				LIST OF ITEMS INCLUDED IN THIS SUBMITTAL	PER SPEC SECTION
I	F	N	P		
				CATALOG CUTS & DOCUMENTS:	
				BILL OF MATERIALS	
				SEISMIC CALCULATIONS	
				NAMEPLATE SCHEDULE	
				GENERATOR DATA	
				PANELBOARD DATA	
				VFD STARTER DATA	
				SPECIAL CALCULATIONS	
				SHORT CIRCUIT & COORDINATION STUDY	
				TEST SCHEDULE	
				TESTING PROCEDURES	
				TEST FORMS	
				FIELD TEST REPORT	
				QUALIFICATIONS OF TESTING PERSONNEL	
				TRAINING PLAN	
				TRAINING MANUALS	
				SOFTWARE DOCUMENTATION & PROGRAM	
				CALIBRATION SHEETS	
				OPERATING INSTRUCTIONS (O&M INFORMATION)	
				DRAWINGS:	
				ELECTRICAL ONE LINE DIAGRAMS	
				MOUNTING DETAILS	
				ANALOG / DIGITAL I/O LOOP DRAWINGS	
				ELEMENTARY DRAWINGS	
				ENCLOSURE LAYOUT DIAGRAMS	
				INTERCONNECTION DIAGRAMS	
				FABRICATION DRAWINGS	
				LIGHTING CONNECTION DIAGRAM	
				LIGHTING POLE ARRANGEMENT DRAWING	
				LIGHTING POLE & FIXTURE OUTLINE DRAWING	
				LIGHTING POLAR PLOTS	
				PLC BLOCK DIAGRAM	
				AS-BUILT PLUS DISK FILES	

LIST OF DEVIATIONS FROM SPECIFICATIONS & DRAWINGS:

SUBMITTAL STATUS CHECK ABBR.:

I => INCLUDED IN THIS SUBMITTAL **N =>** SUBMITTAL NOT REQUIRED

F => TO BE INCLUDED IN FUTURE SUBMITTAL **P =>** PREVIOUSLY SUBMITTED

MATERIAL LISTING FORM
FOR CONTROL PANELS

Description	Mfg.	Model No.	Quantity at Location			
			CP-1	CP-2	CP-3	

EQUIPMENT RECORD SHEET
ELECTRICAL AND INSTRUMENTATION

PROJECT: **DATE:**

DESCRIPTION	LOCATION	
SPEC	DATE INST	WEIGHT
MFR	MFR CONTACT	
MFR ADDRESS		PHONE
LOCAL REP		
LOCAL REP ADDRESS		PHONE

ELECTRICAL DATA

DESCRIPTION	OPTIONS
PART #	SIGNAL IN
MODEL #	SIGNAL OUT
TYPE	POWER SUPPLY
MATERIAL	NEMA RATING
COLOR	MISCELLANEOUS
CALIBRATION EQUIP	CALIBRATION DATE

CALIBRATION DATA

EQUIP # OR TAG	RANGE	ENG UNITS	SPAN

MAINTENANCE

DESCRIPTION	FREQUENCY						
	D	W	M	Q	S	A	OTHERS

END OF SECTION

SECTION 16012

ELECTRICAL AND INSTRUMENTATION OPERATIONS AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

A. Compile product data and related information appropriate for Owner's operation and maintenance of products furnished under the Contract.

B. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent Sections of Specifications for products furnished under the Contract.

C. Instruct Owner's personnel in the maintenance of products furnished under the Contract and in the operation of equipment and systems.

D. Product data for equipment provided by Owner is not a part of this Contract.

E. Quantity of O&M manuals required is specified in Section 01680.

1.2 REFERENCES

Related requirements specified in Division 16

1.3 QUALITY ASSURANCE

Preparation of data shall be done by Contractor's personnel:

A. Trained and experienced in operation and maintenance of the described products and authorized by the original equipment manufacturer to provide materials for the specified equipment.

B. Completely familiar with requirements of this Section.

C. Skilled as a technical writer to the extent required to communicate essential data to operating personnel.

D. Skilled as a draftsman competent to prepare required Drawings.

1.4 SUBMITTALS

A. Prepare data in the form of an instructional manual for use by Owner's personnel.

B. Format:

1. Size: 8½-inch by 11-inch. (Except Drawings)

2. Text:

a. Manufacturer's printed data properly edited for project. Cross out all data that does not apply to the equipment to be furnished.

b. All documents shall be machine typed; hand written documents are not acceptable. All documents shall be legible and original size, documents that cannot be read or have been reduced will be returned for correction.

3. Drawings:

a. Provide in separate reinforced punched binder to allow drawings to be easily removed.

b. For 11-inch by 17-inch Shop Drawings with less than 20 sheets total in the submittal, provide in an 11½-inch by 17½-inch reinforced punched folder.

c. For 11-inch by 17-inch all Interconnection Drawings or Shop Drawings of 30 sheets or more, provide in separate three-ring binder to allow drawings to be easily removed. Binder shall be Cardinal D-Ring Easy Open Ledger Binder or approved equal.

d. Drawings shall not be folded. 11"x17" drawing shall not be reduced for O&M manuals.

e. Drawings larger than 11-inch by 17-inch to be placed in an 8½-inch by 11-inch envelope bound in text.

f. Suitably identified on Drawing binder.

g. Referenced clearly with index of drawings by title and drawing numbers.

4. Binders: Commercial quality, permanent, all white in color, three-ring, durable, cleanable plastic covers with inserts, full height and width, front, back, and spine, with full-page sheet lifters, as manufactured by "K&M Company, 2-inch with pocket D-Ring View Binders," "Manufacturer No. 79792." Model VS11-20, Wilson Jones D-Ring Binders, or approved equal. All binders shall be 2-inch size.

5. Folder: Commercial quality, permanent. Two-hole "Sandwich" type.

6. Indexing: The manuals shall be fully indexed by use of "Avery Side Tab Legal Index Exhibit Dividers LGT5S1-25," "Avery Number AVY11370," Wilson Jones Commercial Indexes with pre-printed tabs, or approved equal.

7. Cover and Spine:

   a. The cover sheet format inserted in the front of the view binder shall be as stated above herein.

   b. The spine format inserted in the spine of the view binder shall list:

      1) Volume X of X.

      2) Operation and Maintenance Manual.

      3) Supplier Name

      4) Project Name.

      5) Binder Contents

8. Numbering: Number all pages within the O&M manual. The number shall be located ½-inch from the bottom, centered on each page. The system used within each tabbed section shall be the tab section-page number sequentially numbered (i.e., 1-1, 1-2, 1-3, and so on).

9. All of these sets of O&M manuals shall be made up of "original" (no copies or reproductions) documents. No photo or fax copies are allowed of standard published manuals available from manufacturers.

10. Electronic PDF version of O&M manual.

    a. Version format shall follow the hard copy submittal of the O&M, including index, equipment record sheet, warranty information, theory of operation, maintenance instruction, etc.

    b. PDF shall be “bookmarked” at each index, subtab, transmittal letter, equipment record sheet, warranty information, theory of operation, maintenance instruction, etc.

    c. Bookmarks shall be descriptive of actual document, tab, etc. Bookmarks shall not be out of order or misspelled; the English description shall match that listed in the Submittal’s Table of Contents.

    d. Failure to bookmark PDF may be grounds for immediate rejection without review.

C. Review:

1. Submittals that are not fully indexed and tabbed with sequentially numbered pages shall be returned without review.

2. The Engineer has allowed for up to and including two (2) reviews of each submittal. The Engineer shall be reimbursed for all reviews after the first two reviews by the Owner and the Owner will deduct the amount of the reimbursement from the Contractor's Contract. The Engineer's reimbursement shall be on a time and expense basis and the current billing rate of the Engineer. The Engineer shall be the sole source for determining the suitability of any submittal.

3. Electronic submissions of submittals may be provided for submittals less than 40 pages and without drawings. Submittals equal to or over 40 pages or those that contain drawings shall be provided in a hardcopy format. Hardcopy submittals shall be provided in binders as specified herein. The Owner reserves the right to reject submittals that fail to be organized as described herein.

D. O&M manual shall be properly completed, submitted, and approved prior to the personnel training.

1.5 CONTENT OF MANUALS

A. Product of Data:

1. Include only those sheets which are pertinent to the specific product.

2. Annotate each sheet to:

a. Clearly identify the specific project or part installed.

b. Clearly identify the data applicable to the installation.

c. Cross-out references to inapplicable information.

B. Drawings:

1. Supplement product data with Drawings as necessary to clearly illustrate:

a. Relations of component parts of equipment and systems. Include individual parts list with exploded views for all equipment.

b. Control and flow diagrams.

2. Coordinate Drawings with information in project Contract documents to assure correct illustration of completed installation.

3. Do not use project Contract documents as maintenance Drawings.

4. "As Constructed" set of submittal shop documents, data sheets, and drawings for all items in the electrical system as specified in Section 16011 – Electrical Submittal and Drawing Requirements.

C. Written text as required to supplement product data for the particular installation:

1. Organize in a consistent format under separate headings for different procedures.

2. Provide a logical sequence of instructions for each procedure.

D. Provide the index and information layout in the operation and maintenance manual for each unit of equipment, and system, including electrical, and electronic items as follows:

1. Cover sheet including the following:

a. Volume __ of __.

b. Operation and Maintenance Manual.

c. Project title.

d. Owner project number.

e. Manufacturer:

1) Manufacturer's name.

2) Full address.

f. Date.

2. Document Index: Neatly typewritten document index for each volume, arranged as indicated in Appendix "A." Master Table of Contents shall be placed in Volume 1 itemizing all of the information included in the O&Ms and the corresponding volume location of that information.

3. Equipment Record Sheet:

a. Equipment record sheet as specified in Section 16011.

b. A complete list of items supplied, including model and serial numbers, ranges, options, and other pertinent data necessary for ordering replacement parts.

c. Name and location of nearest parts supplier for all equipment.

4. Warranty:

a. Provide copy of warranty as specified in Section 16010. Include procedures in the event of failure.

b. Provide copy of substantial completion with corresponding warranty duties.

5. Theory of Operation.

    a. Description. Provide description of units and components' parts function, normal operating characteristics, and limiting conditions.

        1) Include general descriptive bulletins, brochures, or catalog sheets to describe the equipment.

        2) Performance curves, engineering data and tests.

6. Operating Instructions: Complete, detailed, written description of the operating sequence for all control system and operations in all modes. The description shall be specifically prepared for this work, and shall be fully referenced to control diagrams and system components:

    a. Recommended step-by-step startup, adjustment, calibration and break-in operating instructions.

    b. Routine and normal operating instructions. Include summer and winter operating instructions as applicable. Also include special operating instructions.

    c. Recommended step-by-step regulation, control, stopping, and shut-down instructions.

    d. No photocopies are allowed of standard published manuals available from manufacturers.

    e. Recommended step-by-step Emergency Instructions.

    f. Current and desired control settings.

7. Maintenance Instructions:

    a. Lubrication schedule and list of lubrication required.

    b. Detailed service, maintenance and operation instructions for each item supplied. Preventative maintenance to include routine operation, alignment, adjusting, and checking. Include illustrations, assembly drawings, and diagrams required for maintenance. Preventative maintenance procedure and schedule for all equipment over a five-year cycle.

    c. Corrective maintenance to include disassembly, repair, overhaul and reassembly.

    d. Schematic diagrams of all electronic devices shall be included. A complete parts list with stock numbers shall be provided on the components that make up the assembly.

    e. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

    f. No photocopies are allowed of standard published manuals available from manufacturers.

g. Include Maintenance Program data entry forms.

h. Original manuals (no copies) shall be provided for all instruments and PLC components.

8. Shipping and Installation:

   a. Receiving and handling.

   b. Long-term storage, and short-term storage.

   c. Complete step-by-step installation instructions of all components.

9. Safety Procedures:

   a. Manufacturer's safety procedures for operating and maintaining all equipment and materials used.

10. List of recommended spare parts:

    a. Original manufacturer's parts list with manufacturer's current prices. Include complete nomenclature and commercial numbers of replaceable parts.

    b. Predicted life of parts subject to warranty.

    c. Items recommended to be stocked as spare parts.

    d. Complete nomenclature and commercial number of all replaceable parts.

11. Test Data:

    a. Include all completed and signed test data and forms from factory and field testing.

12. Troubleshooting instructions.

13. Equipment catalogue sheets and submittals.

    a. Include copy of all approved submittals.

14. Drawings:

    a. All Electrical and Instrumentation Drawings to include:

       1) As-built set of all required Drawings per Section 16011 for the project.

       2) As-built drawings shall be signed and stamped by a registered Electrical Engineer in the State of California.

15. Complete software ladder logic printouts including English descriptions of control operation.

16. Record of all settings or parameters for all programmable devices.

17. At the end of the project these manuals shall be updated to show "as-built" or "as-installed" conditions.

18. Provide to the Owner four (4) each USB drives with lanyards containing all documents in both PDF format and unlocked AutoCAD - DWG format, latest version:

    a. As-built Contract electrical and instrumentation drawings prepared for this project.

    b. As-built set of all required Drawings per Section 16011 for the project.

    c. As-built sets of other computer generated documents prepared for this project, including PLC ladder logic files, and Bill of Materials prepared for this project.

    d. Electronic PDF version of O&M manual. Version format shall follow the hard copy submittal of the O&M, including index, equipment record sheet, warranty information, theory of operation, maintenance instruction, etc. PDF shall be "bookmarked" to at each index and subtab listed in O&M. Bookmarks shall be descriptive of actual document, tab, etc. Bookmarks shall not be out of order; the English description shall match that listed in the Submittal's Table of Contents

    e. Storage devices shall contain the ladder logic program files with all support files.

    f. These files shall be the property of the Owner, for its use on this and future projects.

    g. Label drives with site name using clear plastic with black machine printed lettering as produced by a KROY or similar machine. The size of the nameplate tape shall be with 3/8-inch lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on the USB drive using the adhesion of the tape.

PART 2 MATERIALS

Not used.

PART 3 EXECUTION

Not used.

APPENDIX "A"

Operation and Maintenance Manual Document Index

OPERATION AND MAINTENANCE MANUAL
DOCUMENT INDEX

END OF SECTION

SECTION 16013

ELECTRICAL AND INSTRUMENTATION SPARE PARTS

PART 1 GENERAL

1.1 GENERAL

A. The Contractor shall provide all spare parts and expendables prior to start-up. All parts shall be sealed in plastic bags and delivered to the site in a heavy-duty plastic storage bag.

B. The Contractor shall recommend for stocking, as spare parts, any replacement parts that are not manufacturer's normal stock items and would not be readily available if a failure occurred. The Contractor shall supply to the Owner a list of any additional Manufacturer's recommended spare parts that should be purchased and stocked by the Owner.

1.2 SECTION INCLUDES

Work specified under Section 01300.

PART 2 MATERIALS

2.1 SPARE PARTS

The following spare parts shall be provided to the Owner as part of this Contract:

A. Instrumentation:

1. Expendables - 2-year supply of expendables required for calibration and operation of instruments.

2. Four (4) surge protection terminals of each type.

B. Control Panels:

1. Five (5) fuses for each type and size of control and analog fuses.

2. Two (2) fuse holders of each type and size.

PART 3 EXECUTION

3.1 DELIVERY

A. An itemized shipping list prepared by Contractor shall be transmitted with all spare parts. The Owner and Contractor shall initial and date each item on shipping list during verification of receipt of spare parts by Owner.

B. Spare parts shall be packaged for safe shipping and storage and clearly labeled on exterior of package with part name and number and the corresponding equipment tagname.

END OF SECTION

SECTION 16020

SEISMIC RESTRAINT FOR ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

Work Included - Seismic restraint for new electrical equipment.

1.2 RELATED WORK.

The provisions of Section 16010 of these Specifications shall apply, unless otherwise specified.

1.3 SUBMITTALS

A. Provide data and Drawings for all materials furnished under this Section with the content and format as specified Section 16011.

B. Submit seismic anchoring calculations with equipment submittals. Calculations shall be performed, signed and stamped by a licensed civil or structural engineer registered in the State of California.

C. Submit equipment anchoring methods. Include anchoring locations; anchor types, sizes and materials; and minimum anchor embedment depths. All anchors shall be stainless steel.

D. Seismic anchoring calculations and equipment anchoring requirements are required for all:

1. MCCs
2. Switchboards
3. Field Control Stations
4. Panelboards and transformers
5. Control Panels
6. Electrical and instrumentation enclosures
7. Light Pole Bases

8. Rod and Trapeze Conduit Supports

9. Pad mounted transformers

10. Wall mounted equipment over 400 pounds

PART 2 MATERIALS

2.1 SEISMIC ANCHORING AND RESTRAINTS

Equipment Anchors: Securely anchor electrical equipment to wall or floor of structure with 316 stainless steel anchoring. Anchoring shall be designed in accordance with Specification Sections 01610 and 01615.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment anchors and supports in accordance with the seismic calculations and manufacturer's recommendations. Properly torque all bolts to the required values.

B. Install all supports in plumb vertical position. Any support installed that is not plumb shall be removed and reinstalled by the Contractor at no additional cost to the Owner.

C. Floor mounted equipment such as MCCs, switchboards, enclosures, panels, etc. shall be secured to concrete with bolts through the front and back frames at bottom of enclosures. Securing enclosures at the top in place of bolts at bottom back is not allowed without prior approval.

END OF SECTION

SECTION 16110

CONDUITS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This Specification Section covers the furnishing, installing and testing of all conduits, cable tray, fittings, and supports as specified herein, as shown on the Drawings, and as required for a complete electrical installation. Conduits shall be as listed in Section 16111 Conduit Schedule.

B. The provisions of Section 16010 of these Specifications shall apply, unless otherwise specified in this Section.

C. The conduit system shall consist of the types and sizes as required and shall include all rigid steel conduit, flexible conduit, non-metallic conduit, wireway, and accessories as required for the embedded and exposed raceway systems.

1.2 SUBMITTALS

A. Provide data and Drawings for all materials furnished under this Section with the content and format as specified Section 16011.

B. Submittals for the Conduit materials and equipment shall include, but shall not be limited to, the following:

1. Catalog cuts showing manufacturer, catalog numbers, dimensions, weights and material for all raceway and accessories.
2. Dimensioned "as-built" Drawings of Contract Electrical plans.
3. Marked up "as-built" Conduit and Wire Routing Schedule.

1.3 QUALITY ASSURANCE

A. Materials shall be of a manufacturer that has been fabricating and assembling specified raceway systems in his current facility for a minimum of two (2) years.

B. All materials selected for the manufacture of the hardware shall be the best available for the purpose for which they are used, considering strength, ductility, durability, and the best engineering practice.

C. All like parts shall be interchangeable.

PART 2 MATERIALS

2.1 REFERENCE STANDARDS

A. Conduits supplied under this Contract shall be designed, manufactured, and tested in accordance with the latest version of the following standards.

B. American National Standards Institute (ANSI) Publications:

C33.92	Flexible Liquidtight Metal Conduit
C80.1	Rigid Steel Conduit
C80.4	Rigid Steel Conduit Fittings

C. National Electrical Manufacturer's Association (NEMA):

FB 1	Fittings and Supports for Conduit Cable Assemblies
TC-2 and TC-3	Non-metallic Conduit and Fittings
RN 1	Rigid Steel Conduit PVC jacketed

D. Underwriters Laboratories, Inc.:

UL-514A	Metallic Outlet Boxes, Electrical
UL-870	Wireways, Auxiliary Gutters and Associated Fittings
UL-6	Rigid Metal Electrical Conduit
UL 651	Schedule 40 and 80 Rigid PVC Conduit

2.2 CONDUIT AND CONDUIT FITTINGS

A. General:

1. Conduit, fittings, and raceway materials shall be manufactured in accordance with UL and ANSI standards and shall be UL labeled for the application.

2. The Contractor shall use special conduit, raceways, wireways, construction methods, and materials as shown on the Contract Drawings and "Conduit and Wire Routing Schedule" located in Section 16111; which shall take precedence over any general methods and materials specified in this Section.

3. Continuation of conduit runs, not specifically called out in Conduit and Wire Routing Schedule, especially "flex" conduits, shall be provided with wires listed in Conduit and Wire Routing Schedule of previous runs.

B. Material for the conduit system shall conform to the following:

1. Galvanized Rigid Steel Conduit:

a. Rigid steel conduit, couplings, bends and nipples shall be in accordance with ANSI C80.1 and UL-6.

b. Hotdip galvanized inside and outside after fabrication and then coated with a zinc bichromate finish.

c. Minimum trade size - three-quarters inch (¾") unless otherwise shown on Contract Drawings.

d. Galvanized rigid steel factory elbows for NEMA 1 areas 90 degree transitions. NEMA 4X area transitions shall be GRS-PVC factory ells.

e. EMT or IMC is not considered an equivalent to GRS.

f. GRS conduit is allowed only when specifically called out in the "Conduit and Wire Routing Schedule."

2. Flexible Liquidtight Metal Conduit: (FLEX):

a. Flexible liquidtight metal conduit shall be in accordance with ANSI C33.92 and shall be galvanized steel core with a copper bonding conductor between the spiral segments and an extruded synthetic jacket overall to insure a liquid-tight conduit. Flexible metallic conduit shall be fabricated from galvanized interlocked steep strip. Liquid-tight flexible metallic conduit shall have an extruded polyvinylchloride covering of the flexible steel conduit and shall be in accordance with NEC 350.120. The conduit shall be Anamet Sealtight Flexible conduit, or approved equal.

b. FLEX conduits shall meet the minimum requirements of NEC Code Table Annex 3 C3 "Maximum Number of Conductors and Fixture Wires in Flexible Metallic Conduit" and Table C3A "Maximum Number of Compact Conductors and Fixture Wires in Flexible Metallic Conduit."

c. Minimum trade size - one-half inch (½") unless otherwise shown on Contract Drawings.

d. Flexible conduit lengths shall not be greater than 36 inches for conduits 1½" or smaller (½" minimum) and 48 inches for conduits 2" or larger.

e. Flexible metallic conduit shall not be considered as a ground conductor, Contractor shall install a separate wire for equipment bonding.

f. Non-metallic flexible conduit shall not be used except when connecting from PVC-40 or PVC-80 conduits to equipment.

g. Flexible conduit shall only be installed in exposed or accessible locations.

h. Install flexible conduit in a manner that will minimize stress on connectors per NEC 350.24.

i. Flex connectors shall be PVC coated when connected to GRS-PVC conduits, or when located in NEMA 4X area.

3. Rigid Galvanized Steel Conduit PVC Bonded (GRS-PVC): Conduit shall conform to the requirements of NEMA RN1, Type A40. GRS-PVC conduit shall be rigid galvanized steel conduit to which an epoxy acrylic primer and a 40 mil thick UV rated polyvinyl chloride coating has been bonded. The interior of all GRS-PVC conduits and fittings shall be coated with a two part chemically cured urethane coating at a 2 mil minimum thickness. Bond strength shall exceed the tensile strength of the plastic coat. Furnish Perma Cote Supreme, Robroy Industries, or approved equal.

   a. Minimum trade size – three-quarters inch (¾") unless otherwise shown on Contract Drawings.

   b. Provide PVC coated galvanized rigid steel factory elbows for 45 or 90 degree transitions.

   c. All fittings used with plastic coated conduit shall be similarly coated with not less than 40 mils of polyvinyl chloride and shall be provided with Type #316 stainless steel hardware.

   d. For factory coated conduit, use overlapping PVC sleeves. Sleeves shall extend beyond end of fitting minimum distance equal to nominal diameter of conduit, and shall fit tightly over conduit coating to form a watertight joint. Joints and fittings shall be made tight with strap wrenches.

   e. All damage to PVC jacket shall be repaired with four separate applications of PVC paint. Finished patch shall be 0.040-inch minimum thickness. PVC coating patching material shall be as provided by the Manufacturer.

   f. Support channel and pipe straps shall be PVC coated. Exposed metal bolts/nuts, all-thread rod shall be 316 stainless steel.

   g. GRS-PVC conduits shall be used for all underground conduits except service entrance conduits.

4. Rigid Polyvinyl Chloride (PVC) Conduit: PVC conduit shall be manufactured in accordance with UL 651. PVC conduit shall be Schedule 40 or Schedule 80 high impact polyvinyl chloride, UL listed for direct burial.

   a. Minimum trade size - one inch (1") unless otherwise shown on Contract Drawings.

   b. PVC fittings shall have solvent-weld-type conduit connections.

   c. PVC conduit is not suitable for above grade installation except where specifically called out in Conduit and Wire Routing Schedule.

5. Electrical Metallic Tubing (EMT):

   a. EMT shall be galvanized thinwall conduit conforming to UL 797.

   b. Minimum trade size - three-quarters inch (¾") unless otherwise shown on Contract Drawings.

   c. Couplings and connectors for EMT shall be galvanized or cadmium plated and shall be of the compression type requiring the tightening of a nut on a gland ring.

   d. Rolled steel, zinc coated outside with zinc-coating or other approved corrosion-resistant coating on the inside.

   e. EMT conduits may be used as follows when listed on plans or in the Conduit and Wire Routing Schedule:

      1) Conduit runs on walls and ceilings inside buildings more than 8 feet above the floor. EMT can be used below 8 feet, but not lower than 1 foot above the floor when EMT originates from above and conduit does not penetrate the floor. EMT Conduit may not be used in normal exposed locations lower than 8 feet above the floor when conduits penetrate the floor.

      2) Concealed in drywall partitions.

   f. EMT conduits shall not be used:

      1) When other types of conduit material are specifically called out in the Conduit and Wire Routing Schedule.

      2) Any location subject to physical damage.

      3) Normal exposed locations lower than 8 feet above the floor when conduits penetrate the floor.

      4) In boiler rooms.

      5) Wetwell, outdoor or corrosive locations.

6. Fittings:

   a. GRS Fittings:

      1) Fittings for GRS conduits shall be threaded type. Set-screw type and compression-type are not acceptable. Fittings shall conform to the requirements of ANSI C80.4.

   b. Flex Fittings:

      1) NEMA 1 or 12 locations shall have cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat.

2) NEMA 4X rated areas shall have PVC coated flex fittings and connectors.

3) Fittings, for Class 1 locations only, shall have insulted throats, liquidtight, oil tight, suitable for outdoors and Class I, Div 2 locations.

c. GRS-PVC Fittings:

1) GRS-PVC fittings shall be hot dipped galvanized steel or galvanized cast ferrous metal with a PVC 40 mils thick coating. Provide threaded-type fittings, couplings, and connectors; set-screw type and compression-type are not acceptable. Fittings shall be Robroy Liquitite, Perma-Cote, or approved equal coated fittings.

d. EMT Fittings:

1) Couplings shall be rain tight compression type Appleton 93T Series, Efcor 760 Series, or approved equal.

2) Connectors shall be rain tight compression type with insulated throat Appleton 84T Series, Efcor 750B Series, or approved equal.

C. Conduit Type by Installation: Provide conduits as listed in "Conduit and Wire Routing Schedule" or as shown on Contract Drawings. Conduits not covered by in "Conduit and Wire Routing Schedule" or Contract Drawings shall be GRS-PVC except where EMT is allowed.

2.3 WIREWAY

A. Provide screw cover and hinged wireway only.

B. Wireways shall be constructed in accordance with Underwriter's Laboratories Standards UL 870 for Wireways, Auxiliary Gutters and Associated Fittings. Every component including lengths, connectors, and fittings shall be UL listed.

C. Wireways shall be suitable for "lay-in" of conductors. All screws installed toward the inside shall be protected by spring nuts or otherwise guarded to prevent wire insulation damage.

D. Wireways shall be EMP-1 Sectional flanged oil-tight type with hinged covers and shall be 8 inches by 8 inches in cross Section unless otherwise specified. New wireways that extend existing wireways shall be of the same manufacturer and type.

E. Non-Corrosive Areas: Wireways shall be coated with a rust-inhibiting, phosphatizing coating and gray baked enamel finish. All hardware shall be plated to prevent corrosion.

F. Corrosive or NEMA 4X Areas: Wireways shall be NEMA 4X 316 stainless steel. Non-Metallic wireways may be used when approved by Engineer in writing.

2.4 CONDUIT SEAL

Conduit seal shall provide high adhesion and moisture protection. Seal shall absorb cable-filling material and be re-enterable. Conduit seal shall be 3M #442 High Gel re-enterable encapsulant, or approved equal.

2.5 WARNING TAPE

Bury plastic tape shall be colored for particular underground service, 3-inch minimum width, utilize tape made of material resistant to corrosive soil. Tape shall have aluminum backing to facilitate locating it underground using a non-ferrous locator. Use red tape for “Electric” service and orange tape for “Communication” service. Tape shall have printed wording listing type of service. Tape shall have aluminum backing to locate using non-ferrous locator. Bury detectable warning tape shall be Seton, Blackburn, Griffolyn Co., Terra-Tape, Brady, or equivalent.

2.6 CABLE TRAY

A. MANUFACTURE

1. Subject to compliance with these specifications, cable tray and cable channel systems shall be as manufactured by Cooper B-Line Inc. model 166-P-06-24-144 with dividers as shown, or engineer approved equal.

B. CABLE TRAY SECTIONS AND COMPONENTS

1. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

2. Materials and Finish: Material and finish specifications for each tray type are as follows:

3. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.

C. TYPE OF TRAY SYSTEM

1. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails..

2. Tray Sizes shall have 4 inch minimum usable load depth, or as noted on the drawing.

3. Trays shall span and be supported 12 feet on center.

4. Tray widths shall be 24 inches or as shown on drawings.

5. All fittings must have a minimum radius of 24 inches.

6. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.

7. Barrier Strips: Shall be placed as specified on all cable trays having control cables and be fastened into the tray with self-drilling screws.

8. All Cable trays shall have removable flanged covers installed.

9. Outdoor cable trays shall have enclosed bottom and shall be weather tight.

10. Provide all necessary fasteners and supports. Fasteners and supports shall be galvanized steel.

11. All cable trays shall be continuously grounded per manufacturer details.

PART 3 EXECUTION

3.1 CONDUIT AND RACEWAY INSTALLATION

A. Conduit and Raceway Requirements:

1. Install an accessible raceway and conduit system for connection of all boxes, panelboards, cabinets, equipment, etc.

2. All conduit and raceway shall be the size and type as shown on Conduit and Wire Routing Schedule except as follows:

   a. All exposed conduits in NEMA 4X areas (except for indoor corrosive areas) and outdoor locations shall be GRS-PVC.

   b. All exposed conduits in NEMA 12 areas shall be GRS.

   c. All exposed conduits in indoor NEMA 4X corrosive areas shall be PVC-80.

3. All conduit and raceway shall be the type as shown on Conduit and Wire Routing Schedule. In no case shall the conduit size be smaller than that shown.

4. Conduits connected to boxes, cabinets, etc., outdoors, exposed to weather or in areas subject to excessive moisture shall be fitted with watertight sealing hubs of steel or malleable iron with sealing ring and insulated throat, Myers hub, Thomas and Betts 370 Series, or approved equal.

5. Malleable iron threaded grounding bushing, with insulated throat and set screw solderless lugs, Appleton GIB-XXXSL series shall be placed on the end of all rigid conduits. A ground bare copper wire shall bind each bushing to the enclosure ground bus.

6. Spare conduits shall be installed as that type of conduit.

7. Matching Existing Facilities:

    a. When new conduit are added to areas which are already painted, the conduit and its supports shall be painted to match the existing facilities.

    b. Where new conduit is used to replace existing conduit, the existing conduit and supports shall be removed, resulting blemishes shall be patched and repainted to match original conditions.

    c. If existing conduits are to be reused and rerouted, resulting blemishes shall be corrected in the same manner.

    d. Mandrel or conduit piston shall be pulled through the entire existing conduit run to prove the length contains no blockages or obstructions. Mandrelling shall be witness by the Owner

    e. Install new conduit tags for reused conduits at all transition boxes and endpoints. Conduit & Wire Routing Schedule shall be updated as these modifications take place.

8. Contractor is to remove and waste all unused wire associated with existing conduits reused for new work.

9. When existing conduits have new wire pulled to existing equipment, the Contractor is responsible for reconnecting all terminations to the equipment.

10. Contractor to remove and waste all conduit and wire associated with removal or demolition of equipment.

11. Equipment to be replaced with new shall have new flex conduits installed and wire reconnected by Contractor.

12. Painted to match adjoining surface.

13. After complete installation of 2 inch and larger conduit runs, snake conduits with conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace conduits through which mandrel will not pass.

14. Clean and ensure that new and existing conduit runs are not crushed or creased. Verify internal dimensions of existing conduit prior to installation of conductors. Verify that no foreign objects or obstructions are present in conduit prior to installing conductors.

15. Install conduit system to provide firm mechanical assemblies with electrical conductivity throughout.

B. Exposed Conduit:

1. All exposed conduits shall be run in straight lines parallel to column lines, walls or beams. Where conduits are grouped, the bends and fittings shall be installed so as to present an orderly appearance. Unnecessary bending or offsets shall be avoided. Conduits shall be kept at least 12 inches away from heating devices or similar equipment.

2. Supports for exposed conduit shall be in accordance with Title 24, CAC.

3. Securing and supporting of liquidtight metal conduit shall be in accordance with NEC 350.30.

4. Support rigid conduits at 8 feet intervals and PVC conduits at 4 feet intervals. Support all conduits within 1 foot of boxes or changes in direction. Use riser supports with clamps for vertical conduit risers.

5. For single conduit runs, use pipe straps or suspend from ceiling with single conduit hangers. Single hole malleable iron clamps with backplates may be used for horizontal runs on vertical surfaces. Perforated strap (plumber's tape), not acceptable.

6. For multiple conduit runs, group conduits together and support from ceiling by means of trapeze hangers. Wall brackets or unistrut supports shall be used for conduit runs on vertical surfaces. Clamp each conduit to trapeze or support, using conduit clamp.

7. Fasten hanger rods to structural steel members with beam clamps or to concrete inserts set flush with surface. Install reinforcing rod through opening in concrete insert.

8. Exposed conduit shall be supported rigidly in place. All exposed conduit shall include, where required, the drilling of holes in the bottom or sides of enclosures. The Contractor shall thoroughly examine work prior to drilling to avoid drilling into components within enclosures.

C. Conduits in Concrete Slabs:

1. Conduits may be installed in structural slabs, or in slabs on grade, having the following minimum thickness: 4” thick for conduits greater than ¾”.

2. Maintain a minimum of two-inches of clearance between conduits and any reinforcement bars. In structural slabs, place conduits carefully between upper and lower layers of steel. In pre-stressed concrete slab construction, place conduits in center of slab and do not support from pre-stressed steel.

3. Space conduits to maintain structural integrity of slabs.

4. Place conduits running parallel to slab supports (beams, columns, walls, etc.) not less than 12" from such supports.

5. Where floor slab is in direct contact with earth or fill, rigid steel conduit may be embedded in concrete blister below bottom of slab with 2-inch minimum of concrete cover.

6. Runs of conduit to be embedded in concrete shall be rigidly supported in their proper positions while concrete is being placed. Place conduit separators every 4 feet on centers and securely anchor to prevent movement. Ends of conduits shall be plugged or capped during construction to prevent the entrance of concrete or other foreign matter. Connections shall be checked for tightness before being embedded.

D. Underground Conduits:

1. Buried conduit shall be placed at least 24 inches below grade and be located to avoid interference with other underground piping, foundations, etc. Conduit for Telephone and Power Utilities shall be set to depth as required by Utility engineered drawings and not less than 36" below grade.

2. Conduits placed in concrete which is in contact with earth or water shall be adequately separated from the earth or water by at least 3" of concrete. Concrete encasement shall extend 4" above finished grade or into housekeeping pad at completion of each run.

3. Install expansion couplings in conduit runs crossing expansion or contraction joints in concrete. Expansion couplings shall be zinc coated and watertight.

4. Where other piping systems are encountered or being installed along a raceway route, maintain a 12-inch-minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch-minimum separation between raceways and other systems in parallel runs. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the Owner's Representative for instructions before further work is done.

5. Underground conduits not encased shall have a minimum 4" sand bedding completely encircling the conduits.

6. Duct taping conduits together is not acceptable. Conduits, installed into concrete pads, shall be installed with a minimum of 2” distance between conduits to allow installation of bushings.

E. Raceway Identification:

1. All conduits and raceways listed in Conduit and Wire Routing Schedule shall have conduit tags at both terminations of each conduit. All conduits and raceways listed in Conduit and Raceway Schedule shall be provided with conduit tags with tag numbers listed in schedule. All spare conduits shall be labeled. Spare conduits that have prefix "X" with a conduit quantity greater than one shall have a unique conduit postfix number assigned to each conduit; i.e., if conduit quantity is 3 for conduit route X0001, then label conduits as X0001A, X0001B, X0001C, etc.

2. All exposed conduit inside buildings entering/leaving panels and enclosures shall conduit tags composed of tag tiles with tag holder where allowed by space. Tag holder shall be secured to conduit using nylon cable ties on both ends. Tag tiles shall be Almetek Type EZ-V, or approved equal. Tag holder shall be Almetek Type TH, or approved equal.

3. Conduit terminating in walls shall be identified by stenciling the conduit number on the wall directly under the conduit.

4. When there is no space available to use tag ties, such as in Motor Control Centers with underground feed or for conduits outside of buildings, then the tag material shall be rigid laminated red phenolic with white lettering. The size of the tag shall be 2" diameter. No letters are allowed smaller than 7/16". Tags shall be heat and UV resistant, stain-proof, electrically non-conductive and non-corroding. Securely fasten tags in place using UV rated plastic ty-wraps. Engrave the tags, on both sides, with the conduit number. Labeling shall be neatly installed for visibility and shall be clearly legible. Conduit tags shall be Brady Custom B-1, or approved equal.

5. Prior to encasement, concealment, backfilling of conduits, temporary conduit labels shall be provided at each end of conduit. Temporary conduit labels shall be provided on conduits when it leaves an open transition point, junction boxes, terminal boxes, pullboxes, vaults, and manholes, etc. Temporary conduit labels shall have ½-inch (minimum) lettering at all transition points. After encasement and concealment temporary conduit labels shall be placed at each exposed end.

6. Each conduit listed in Conduit and Wire Routing Schedule shall have permanent tags where it enters an open transition point, junction boxes, terminal boxes, pullboxes, vaults, and manholes. Where limited conduit length is exposed, use a ½" washer attached with non-metallic tie wraps and having the conduit ID clearly labeled on both sides with black permanent ink.

7. All existing conduits listed in Conduit and Wire Routing Schedule reused for new work shall have new conduit tags installed at all transition boxes and endpoints. Conduit and Wire Routing Schedule shall be updated as these modifications take place.

F. Workmanship and Installation Requirements:

1. Where field changes are required, every precaution shall be taken to insure that the change is coordinated with other conduit, structural, plumbing, and piping work. Information shall be obtained regarding the completed raceway runs to insure that there will be no interference when the raceway run is extended or revised. A complete record of such changes shall be made on the Record Contract Drawings.

2. Conduits shall be cut square, threaded and reamed to remove sharp or rough edges and burrs. Conduit joints and connections shall be made waterproof and rustproof by application of a non-insulating thread compound, such as white lead or graphite, and zinc sealing material. Each threaded joint shall be thoroughly cleaned to remove cutting oil before the compound is applied.

3. All bends and offsets, where required, shall either be made with factory made bends or shall be field bends made with a conduit bender designed specifically for use with the type of conduit to be bent. Elbows and bends for conduits shall be formed in the field and shall be reasonably free from flattened surfaces, indentations, or kinks. Avoid field bends and offsets where possible. Heating of conduit to facilitate bending shall not be acceptable. Metallic conduits shall be bent cold to prevent damage to the protective coating. All bending shall be gradual and be done smoothly to permit the pulling on insulated electrical wires and cables without incurring damage to the insulation or sheath. Radius of curvature shall be not less than that permitted by NEC.

4. Conduit shall be rigidly secured to panels and other electrical equipment terminal boxes with locknuts and bushings in such a manner that each system shall be electrically continuous throughout.

5. Flexible liquidtight metal conduit shall be used to provide flexible connections between the rigid system and motor conduit boxes or other equipment subject to vibration.

6. To reduce damage to the zinc coating, only strap type wrenches shall be used. All wrench marks, field cut threads, and all other places where the zinc coating is damaged, shall be repaired with zinc-rich galvanizing repair compound.

7. Raceway shall be installed with necessary fittings and supports.

8. Contractor shall limit the number of directional changes of the conduit to total no more than the equivalent of 270 degrees in any run between pull points. Where required for ease of pulling and as necessary to meet code, the Contractor shall supply and install junction or pullboxes, even though not shown on Drawings, at no additional cost to the Owner.

9. Conduit runs between two vaults, pull or junction boxes shall be limited to a maximum of 300 feet, or less 50 feet for every 90 degrees of conduit change in direction.

10. Install and equip conduits and fittings installed outdoors or in other wet locations, entering equipment from bottom unless necessary to enter from side, so as to prevent water from entering the equipment. Top entry of conduits into enclosures located outdoors or in other wet locations is not allowed.

11. Spare or Future Conduits:

    a. Provide a braided yellow polypropylene pull ropes, ¼" minimum size.

    b. Provide a waterproof label on each end of the pull cords to indicate the destination of the other end.

    c. Provide caps on conduit ends to prevent entrance of dirt or insects.

    d. Label conduits as specified herein.

12. Contractor shall neatly bundle all new and reused wires with ty-wraps.

13. Conduit stubs for future use shall be capped with coupling, nipple, and plug.

14. Conduit between vibrating equipment and outlet boxes or conduits shall be liquid tight flexible electrical conduits.

15. Whenever possible, make bends for exposed conduit stub-ups completely below the surface. Make stubs vertical and arrange neatly.

16. Where conduits turn up in accessible floor areas or under removable partitions, install coupling flush with finish floor surface (exclusive of floor covering). Provide flush threaded plug in this coupling where conduit is not to be extended.

17. For flush mounted panels, run empty conduits from panel to accessible spaces above. Install a minimum of one ¾" conduit for every 3 single pole spare circuit breakers or spaces, or fraction thereof.

18. Running Threads: Do not use running threads. Where such device is needed, use raintight unions or concrete tight couplings.

19. The entire electrical raceway system shall be bonded and form a continuous metallic electrical conductor from service point to every box and shall be terminated with ground bushings connected to the ground bus. Conduits entering enclosures shall be fitted with insulated grounding bushing. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC Code.

20. Connection to steel conduit from PVC shall be made with approved threaded adapters.

21. All conduits which are installed shall be capped during construction to prevent the entrance of foreign material.

22. Secure hangers, brackets, conduit straps, supports and electrical equipment by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard preset inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; wood screws on wood construction. Wood or fiber plugs or concrete nails, not acceptable.

23. Special "Soft–Jaw" type pipe clamps shall be used to prevent damage to PVC-coated conduit while field threading and cutting to length.

G. Raceway shall be installed with necessary Warning Tapes:

1. Bury warning tapes approximately 12 inches above all underground concrete-encased duct banks and other conduit runs over 100' in length. Align parallel to and within 3 inches of the centerline of the conduit or duct bank.

H. Cutting and Patching:

1. The Contractor shall do all core drilling, cutting, and patching required to install his work at no additional cost to the Owner. Core drilling, cutting, and patching is considered standard work to be done at existing facilities, therefore, this work is not specifically called out on Drawings. Any core drilling or cutting which may impair

the structure shall require prior approval by the Engineer. Core drilling, cutting, and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after core drilling, cutting, and patching and made watertight.

I. Seals:

1. Seal around all conduits, wires, and cables penetrating between panels, any other boxes that house electrical and instrumentation components, walls, ceilings, and floors in all buildings with a fire stop material. Seal shall be made at both ends of the conduit with a fire stop putty. Seal shall have a minimum two hour rating. Fire stop sealing shall be International Protective Coatings Flamesafe, or approved equal.

2. Conduit entrances: Seal each conduit entrance from below grade into the MCC and other electrical enclosures with plugging compound sealant to prevent the entrance of insects and rodents. Conduits between the enclosures shall be sealed with plugging compound sealant on each end. Plugging compound sealant shall be PRC-DeSoto (formerly Courtaulds) Aerospace Semco PR-868 or approved equal.

3. Seal all conduits to prevent water traveling through conduits into buildings, junction boxes, underground facilities, electrical enclosures, panels, instruments.

4. Install conduit drain boxes and plug conduit interior to form an effective barrier to keep out water traveling into equipment or instrumentation from conduit installed higher than equipment or instrumentation.

5. Conduit entrances in the bottom of MCCs, power distribution panels, switchboards, and enclosures shall project into the enclosure a minimum of two inches to prevent water from entering conduits.

J. Excavation and Back Filling:

1. At all times during the excavation and backfilling, the Contractor shall provide barricades, fences, guard rails, etc., to safeguard authorized personnel, and the general public from excavated trenches. Where Access is Deemed Necessary by the Owner, the Contractor shall provide trench plates to allow said access over excavated areas (traffic of all types).

2. Excavations: Provide the excavation for Utility power and telephone services, electrical, and instrumentation equipment foundations and trenches for conduits and ductbanks as necessary. Backfill and surface all areas in accordance with other Contract Sections. Excavations shall be in accordance with other Contract Sections.

   a. Underground conduits outside of structures, excluding utility conduits, shall have a minimum cover of 24 inches. Utility power and telephone conduits shall have a minimum cover of 36 inches.

   b. Trenches for all conduits below floor slabs and underground shall be excavated to the required depths. Conduits under floor slabs shall have trenches no deeper than is required to properly contain bends within walls.

c. All trenching and underground work shall be closely coordinated with the Owner and Engineer. Contractor shall be responsible for locating, and avoiding disruption of, all existing underground facilities such as gas lines, water lines, sewer, fire protection lines, and existing underground electrical facilities. Any damage caused by the Contractor must be repaired at the Contractor's cost, to the satisfaction of the Owner.

d. All trenching shall be done as to minimize disruption to normal plant or construction operations. All open trenches shall be suitably marked and/or protected to avoid any accidents or injuries to workers or plant personnel.

e. Where new electrical ducts intersect existing facilities, at essentially the same depth, Contractor shall gradually divert the electrical facilities down, under, and back up around the existing facilities.

f. All excavations shall be backfilled and resurfaced to match surfaces prior to and adjacent to excavation.

3. Back filling shall be done only after conduits have been inspected by Owner. Excavation and back fill of lines and conduits shall conform to the requirements of the Earthwork Section of these Specifications, unless modified on plans.

   a. Backfill, Non-Paved Areas: Use native backfill, compacted in 6 inch layers to 90 percent relative compaction. Final backfill elevation shall match existing.

   b. Backfill, Paved Areas:

      1) Use clean imported sand rated for use under paved areas.

      2) Imported sand shall be free from organic material, trash, debris and rubbish.

      3) Compact trench backfill by manual methods. Water flooding or jetting is not permitted.

4. Repave any area that was paved prior to excavation. Backfill and surface all areas as shown on the Drawings or where not shown to the original condition that was present prior to the excavation.

3.2 WARRANTY

Provide warranty as specified in Electrical Section 16010 - Warranty.

END OF SECTION

SECTION 16115

DUCT BANKS, VAULTS AND PULL BOXES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall install, ready for use, the duct banks, vaults, and pull boxes as specified herein. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices. All components and devices shall be furnished and installed as required to provide duct banks, vaults and pull boxes for accomplishing the functions and meeting the performance set forth hereinafter at no additional cost to the Owner.

B. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, test equipment, incidentals, and services to provide duct banks, vaults, and pull boxes as shown on the Drawings, included in these Specifications as recommended by suppliers, or required for complete installation.

C. This section scope of work includes providing and installing:

1. Duct banks, pull boxes, vaults, and associated hardware.
2. All necessary hardware, fittings, and devices to connect the electrical equipment and grounding system provided under other Sections.
3. Trenching and backfilling.

1.2 RELATED WORK

Junction boxes to be per Section 16140 – Wiring Devices.

1.3 SUBMITTALS AND DRAWINGS

A. Provide submittals and Drawings as specified in Electrical Section 16011.

B. Submit for approval, calculation verifying pull box and vault size and layout of duct banks.

C. Submit for approval, each rack cable and wire support layout proposed for each vault prior to installation.

PART 2 MATERIALS

2.1 GENERAL

A. The Contractor shall use special construction methods, and materials as shown on the Contract Drawings, which shall take precedence over any general methods and materials specified in this Section.

B. The location of pull boxes, vaults, and duct banks are shown on Contract drawing at their approximate location. The Contractor shall relocate theses pullboxes, vaults, and duct banks to avoid conflict with other underground utilities at no additional cost to Owner.

2.2 DUCT BANKS

Duct banks, materials, and installation shall meet all requirements of the NEC and the following minimum Specifications:

A. Concrete shall conform to ASTM C150, with 7-day 2500 PSI compressive strength and minimum cement content of 55%. Use a color additive for identification purposes: Brick red "Colorfull," as manufactured by Owl Manufacturing Company, Arcadia, California; coral red "Chromix C-22," as manufactured by L.M. Scofield Company, Los Angeles, California or equivalent. Add the color additive while the concrete is being mixed, using the quantity per cubic yard of concrete recommended by the color additive Manufacturer for the class of concrete indicated.

2.3 PULL BOXES AND VAULTS

A. General:

1. Box dimensions shall be the minimum size as shown on Contract Drawings and in accordance with size, quantity of conductors, and conduit clearances per NEC article 314 requirements.

2. A copper ground bus shall be provided in each pullbox and vault. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall be sized as shown on plans or in accordance with NEC Table 250-122, whichever is larger.

B. Aboveground Pull Boxes:

1. Surface Mounted Pull Boxes:

a. Pull boxes in "damp", "wet" or NEMA 4X locations shall be stainless steel, with the exception of "corrosive" locations. Accessories and hardware shall be stainless steel.

b. Non-metallic pull boxes shall be used in "corrosive" locations, unless noted otherwise. Non-metallic pull boxes shall be molded PVC or hot compressed reinforced fiberglass. Conduit connections shall be made with solvent cement fittings or other watertight non-metallic fittings. Accessories and hardware shall be stainless steel.

c. Pull boxes in NEMA 12 or 3R areas shall be galvanized steel (unless specifically called out on Contract drawings) and painted to match surrounding surfaces or as designated by Engineer.

d. Pull boxes larger than 20" H by 16" W shall have hinges access covers.

e. Covers shall be attached with stainless steel screws. No devices, screws, rivets, or bolts shall protrude through the exterior surface unless specifically shown on the Drawings.

f. Boxes shall be Circle AW, Hoffman, or approved equal.

2.4 UNDERGROUND PULL BOXES AND VAULTS

A. Underground pull boxes and vaults, where shown or required by length of conduit runs, shall be prefabricated 3000PSI reinforced steel concrete type with the minimum size shown on the Drawings. Provide larger pull boxes/vaults when necessary to allow for adequate pull area or to accommodate the number of conduits entering box. Extension sections shall be provided as necessary to reach the depth of underground conduits.

B. Pullboxes shall have diamond plate galvanized steel full H/20 loading rated traffic covers with galvanized steel hold down bolts and hardware.

C. Vaults shall be precast concrete with traffic rated covers designed for full H/20 loading. Vaults shall have recessed checker plate, galvanized, ¼" (minimum) steel cover. Dimensions shall be as specified on the Drawings. Vaults shall be constructed of 3000 psi reinforced steel concrete.

D. Underground vaults shall be provided with end hinged, torsion spring opening assist type cover assemblies. Provide single leaf assemblies for 2 by 3 feet opening. Provide double leaf assemblies for pullboxes and vaults with openings larger than 2 by 3 feet.

E. Underground pullboxes, vaults and handholes shall be Utility Vault, Christy Concrete Products, Brooks, or approved equal.

2.5 PULL BOX AND VAULT IDENTIFICATION

A. Underground Pull Box and Vault Cover Identification: engrave or bead weld vault and pull box covers with minimum thickness of ¼".

B. Aboveground Pull Box Cover Identification: stainless steel screw attached phenolic nameplates with 1/2" letters meeting the requirements of Section 16144 Nameplates.

C. Identification to indicate services contained within each pull box as shown on Contract E-series Drawings.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards specified in Section 16010 - Electrical.

B. The Supplier shall employ personnel that are skilled and experienced in the installation of duct banks, vaults, and pull boxes. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all vaults and pull boxes fit properly in their installations.

D. Perform any required work to correct that in the opinion of the Engineer are improper installations at no additional expense to the Owner.

3.2 INSTALLATION

A. General:

1. Install all products per Electrical 16010 - Installation, General.

2. Keep boxes, vaults, and other openings closed at all times when not being accessed to prevent entry of foreign matter. Cover to protect them against dirt, paint, water, chemical, or mechanical damage before and during construction period. Restore to original condition damaged products prior to final acceptance.

3. Duct banks and raceways shall not leak water into dry interiors. This applies to duct banks and raceways entering structures, vaults, basements, tunnels, and buildings. Replace defective sections with new duct banks and raceways which leak water into dry spaces.

4. Place non-shrink grout between conduits and void in sides of underground pull boxes and vaults.

B. Duct Banks:

1. Direct burial of conduit shall not be permitted where concrete duct banks are required. Minimum size of conduit in duct banks interconnecting vaults shall be 1 inch.

2. Conduit material for exposed transition from underground to above ground shall be Contract Drawing E44 detail "G."

3. All ducts shall be inspected by the Owner prior to pouring concrete. The Owner will inspect for backfill compaction, drainage slope, spacers, flotation ties and conduit condition, joints, and end bells. Concrete shall not be poured until this inspection is complete.

4. Conduit placed in concrete which is in contact with the earth shall be separated from the earth by at least 4 inches of concrete. Clearances equal to the nominal conduit diameter, but not less than 1½ inches, shall be maintained between conduits. Clearances of less than 1½ inches at conduit crossing and terminating locations may be acceptable with Owner written approval.

5. Expansion fittings shall be provided whenever embedded conduit crosses building expansion joints, between two adjacent structures, and between a duct bank and structure.

6. Plastic conduit spacers shall be located 5 feet on centers. Plastic spacers shall be of the type manufactured specifically for spacing conduits in duct banks. The spacers shall be secured to the conduits by wire ties. The duct bank shall be securely anchored to prevent conduit flotation while the concrete is being placed. Conduit runs shall be watertight. Spacing for spacers shall be as recommended by manufacturer for size of conduit. Spacers shall be interlocking and rated for concrete encasement. Concrete duct bank spacers shall be Underground Devices Wunpeece or approved equal.

7. The ends of conduits shall be protected from damage during construction by using plastic plugs.

8. Conduits shall be thoroughly swabbed inside immediately upon completion of pouring concrete. After the concrete has set, but before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. The mandrel shall be lead covered or painted white to indicate any protrusion on the inside of the conduit. The protrusion shall be removed or the conduit Section replaced.

9. Duct banks shall maintain a steady slope between the high point of the duct bank to the vault or pull box. Maintain a grade of at least 1 inch per 100 feet, either from one vault or pull box to the next or from a high point between them, depending on the surface contour. Slope duct banks downward away from buildings to pull boxes or vaults.

10. Conduits entering vaults and pull boxes shall have end bells with conduit tags.

11. Conduits tags shall be provided and installed as specified in Section 16110 – Conduits in all pull boxes and vaults.

12. The entire electrical raceway system shall be bonded and form a continuous metallic electrical conductor from service point to every box. Metallic conduits shall be terminated with ground bushings connected to the ground bus or to next section of conduit run.

13. Where other non-electrical systems are encountered or being installed along a duct bank route, maintain a 12-inch-minimum vertical separation between duct bank and other systems at crossings. Maintain a 12-inch-minimum separation between duct banks and other non-electrical systems in parallel runs. Do not place duct banks over valves or couplings in other piping systems. Refer conflicts with these requirements to the Owner's Representative for instructions before further work is done.

14. Conduit Separation in Duct Banks: "E," "XE," "L," "XL," "P" and "XP" prefixed conduit groups shall be separated a minimum of 12" from all other conduit groups.

15. Concrete encasement shall extend continuously to 4" above finished grade or into housekeeping pad at completion of each run; except for fiberglass pull boxes, where duct bank to stop at horizontal and space above filled with pea gravel.

C. Pull Boxes and Vaults Installation:

1. Pull boxes and vaults shall be installed accurately to match the surrounding building outline, pavement or sidewalk grade. Set pullboxes parallel or perpendicular with adjacent structures.

2. Size pull boxes and vaults to meet National Electrical Code requirements and to provide sufficient room for the future conduits and cables indicated on the Drawings at no additional cost to Owner.

3. Contractor shall limit the number of directional changes of the conduit to total no more than 270 degrees in any run between pull points. Where required for ease of pulling and as necessary to meet Code, the Contractor shall supply and install junction, vaults, or pullboxes, even though not shown on Drawings, at no additional cost to the Owner.

4. Conduit runs between two vaults, pull, or junction boxes shall be limited to a maximum of 300 feet, or less 50 feet for every 90 degrees of change in direction.

5. Set underground pull boxes and vaults level on a crushed rock base with a minimum 18 inches thick with horizontal dimensions same as bottom of pull box plus 8 inches minimum all around. Crushed rock shall be 3/4 inch maximum size, 1/4" minimum size.

6. Install covers flush within finished paved or concrete surfaces. In unfinished areas, install covers one inch (1") above finished grade. In areas where a snow plow would access, install covers ½" below grade.

7. In pullboxes and vaults separate power "E, L, P, XE, XL, and XP" wiring to one side within and all other wiring to opposite side in bundles. In vault, these separate bundles are to be supported on plastic cable supports rated for the bundle loading.

D. Vault Installation:

1. Vaults shall be set plumb. Vault covers, unless otherwise shown on Contract Drawings, shall be set at grade.

2. Seal vault joints located between box upper section, extensions and bottom with joint sealing compound to make watertight.

3. Provide plastic cable racks for all cables passing through each vault. No wires or cables are permitted to lie on bottom of the vault. Conductors of different voltages or types shall be suspended from different "saddles" on different sides. Cable racks shall be U.L. listed and suitable for mounting in vault. Design of saddle shall be capture type such that cables shall not be required to be tied to rack. Provide number of cable racks and sizes as required for each vault. Cable racks shall be Underground Devices Saddle Rack or approved equal.

E. Pull Boxes and Vaults Entry: Conduits entering underground pull boxes and vaults shall be horizontal, except when required otherwise by Power and Telephone Utility Standards. Conduits shall not enter through the concrete bottom of boxes, or vaults, except for vaults or boxes with bottoms shown at or above grade.

F. Provide Excavation and Back Filling per requirements of Section 16110-Conduits.

G. Openings:

1. Leave no unused opening in any pull box or vault. Install close-up plugs as required to seal openings.

H. Cleaning:

1. Prior to project completion, clean out debris from all pullboxes and vaults.

2. Remove dirt from vaults with concrete bottoms.

3.3 WARRANTY

Provide warranty as specified in Electrical Section 16010 - Warranty.

END OF SECTION

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SECTION 16120

WIRES, FUSES, AND TERMINAL BLOCKS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall assemble, ready for use, the electrical and instrumentation system with wires, fuses, and terminal blocks as specified herein.

B. Furnish all required labor, materials, tools, test equipment, incidentals, and services to provide a complete and operational electrical and instrumentation system with wire and electrical devices as shown on the Drawings, included in these Specifications or required for fully operating facilities.

C. Work includes that specified in Section 16010 - Electrical.

1.2 SUBMITTALS AND DRAWINGS

Descriptive literature for all materials furnished under this Section shall be submitted in accordance with Electrical Section 16011.

1.3 QUALITY ASSURANCE

A. All materials selected for the manufacture of the hardware shall be the best available for the purpose for which they are used, considering strength, ductility, durability and the best engineering practice.

B. Conductors shall be less than 12 months old.

C. All like parts shall be interchangeable.

PART 2 MATERIALS

2.1 WIRING AND ELECTRICAL DEVICES

A. General:

1. The Electrical Contractor and the electrical and instrumentation system suppliers shall provide and install wiring and devices as specified herein and per Division 16 requirements.

B. Low Voltage Wire and Cable:

1. General: Low voltage conductors shall be used for power, control, lighting and miscellaneous circuits. This Section applies to all wires or conductors used internally for all electrical equipment or externally for field wiring. Wire shall be new, plainly marked with UL label, gauge, voltage, type of insulation, and Manufacturer's name.

2. Low voltage wire shall conform with the following:

   a. NEMA standards WC70 and UL requirements.

   b. Class B stranding. Solid conductors may be used for lighting and receptacle circuits.

   c. Conductors shall be copper with a minimum of 98% conductivity.

   d. Insulation type for conductors smaller than #6 AWG shall be moisture and heat resistant thermoplastic NEC Type THHN/THWN, rated 90 °C in dry locations and 75 °C in wet locations, or approved equal. Conductors #6 AWG and larger shall be XHHW insulation rated 90 °C in dry locations and 75 °C in wet locations.

   e. Insulation of all conductors shall be rated 600 volt or higher.

   f. Field wire minimum AWG sizes:

      1) #12 for wires used for individual conductor circuits 480 volts and above, except for PLC I/O which may be size listed in Conduit and Wire Routing Schedule.

      2) #14 for wires used for individual conductor circuits below 480 volt.

   g. Non-field or equipment wire minimum AWG sizes if properly protected by fuse or breaker:

      1) #14 for wires used for individual conductor circuits 100 volt and above, except for PLC I/O wiring which may be #16.

      2) #18 for wires used for individual conductor circuits below 100 volt.

C. Color Code:

1. The color code of all wire shall conform with the following table:

DESCRIPTION	PHASE/CODE LETTER	FIELD WIRE WIRE OR TAPE COLOR	NON-FIELD WIRE COLOR
480 V, 3 PHASE	A	BROWN	BROWN
	B	ORANGE	ORANGE
	C	YELLOW	YELLOW
240 V or 208 V, 3P	A	BLACK	-
	B	RED (ORANGE if high leg)	-
	C	BLUE	-
240 / 120 V, 1 P	L1	BLACK	BLACK
	L2	RED	-
12V POSITIVE	12P	DARK BLUE	DARK BLUE
12V NEGATIVE	12N	BLACK/RED STRIPE	BLACK/RED STRIPE
24V POSITIVE	24P	PINK	PINK
24V NEGATIVE	24N	BLACK/WHITE STRIPE	BLACK/WHITE STRIPE
AC CONTROL		VIOLET	RED (YELLOW FOR FOREIGN CIRCUITS)
DC CONTROL		LIGHT BLUE	LIGHT BLUE
NEUTRAL	N	WHITE	WHITE
GROUND	G	GREEN	GREEN
SHIELDED PAIR	+	WHITE OR CLEAR	WHITE OR CLEAR
	-	BLACK	BLACK

2. No other colors shall be used without prior written approval of the Owner.

3. The same color shall be connected to the same phase throughout the panel.

4. All wires shall be properly fused or protected by a breaker at the amperage rating allowed by the NEC.

5. Phase color insulation shall be provided for complete length of #8 wire or smaller, colored phase tape is <u>not</u> allowed on #8 and smaller wire.

6. Neutral used for AC Control shall be white.

D. Instrument Cable:

1. All 4-20mA and 1-5VDC inside instrument and control panel cables shall conform with the following:

   a. Signal wiring shall be shielded twisted pair with #18 AWG tinned copper stranded conductors and shield drain conductor.

b. Conductor insulation shall be polyethylene rated 600VAC, 90° C and outer jacket shall be PVC.

c. A metal foil shield shall completely surround the signal conductors.

d. Multiple pair cables with individually shielded pairs may be used only with prior written approval of the Engineer.

2. All field 4-20mA instrument cables and cables shall conform with the following:

a. Signal wiring shall be shielded twisted pair with a minimum #16 AWG, tinned copper stranded conductors and shield drain conductor.

b. Conductor insulation shall be polyethylene rated 600VAC, 90° C and outer jacket shall be PVC and be "Tray Cable" rated.

c. A metal foil shield shall completely surround the signal conductors.

d. Multiple pair cables with individually shielded pairs may be used only with prior approval written of the Engineer.

3. Instrument Cables shall be Okonite, Okoseal-N Type P-OS, Belden, or approved equal. Note, multi-pair T.S.PR. Cables may be reduced in size to that listed in Conduit and Wire Routing Schedule.

E. Special Purpose Wiring:

1. Manufacturer Supplied Cables (MNFR CBL): Cables and wiring for special systems shall be provided by the manufacturer with the equipment and installed per the manufacturer's recommendations.

2. CAT 6 Cable

a. Underground (UG) buried CAT 5 communication cable meet the following requirements:

b. CAT 6 communication cable in underground (UG) conduit shall meet the following requirements:

1) TIA/EIA-568-B Category 6 Specifications.

2) #24 AWG solid bare copper conductor, 4 or 25 pair shielded twisted pair per “Conduit & Wire Routing Schedule.”

3) Rated for direct burial application.

4) Insulation: Solid Polyolefin, 600v.

5) Filling compound: 80°C extended thermoplastic rubber.

6) Outer Jacket: Water and UV resistant polyethylene.

7) Electrically continuous aluminum shield.

c. Indoor CAT 6 communication cable shall meet the following requirements:

1) TIA/EIA-568-B Category 6 specifications.

2) #24 AWG solid bare copper conductor, 4 twisted pairs.

3) Thermoplastic Dielectric type, 600v.

4) Shielded bulk cable.

5) UL listed.

6) Non-plenum usage rated when routed in conduit.

7) Plenum usage rated when routed in plenum spaces.

3. Vinyl Nylon Tray Cable (VNTC)

a. Cables shall have type THHN or THWN conductors. Individual conductors are bare annealed copper covered with polyvinyl chloride (PVC) insulation over which a nylon (polyamide) or UL listed equal jacket is applied.

b. The overall jacket shall consists of a heat, moisture, ultra violet and sunlight resistant PVC. Jacket shall be flame-retardant per Underwriter's Laboratory Subject 1277, 90 degrees Celsius temperature rating, rip cord laid longitudinally under jacket to facilitate removal.

c. Single Pair or Triad Shielding:

1) Group Shielding: Minimum 1.35 mil double-faced aluminum/synthetic polymer-backed tape overlapped to provide 100 percent coverage.

2) Drain Wire: 7-strand tinned copper drain wire, 2 sizes smaller than conductor.

d. Multiple Pair or Triad Shielding:

1) Group Shield: 1.35 mil aluminum-polyester tape overlapped to provide 100 percent coverage and a 7-strand tinned copper drain wire, 2 sizes smaller than conductor. Completely isolate group shields from each other.

2) Cable Shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage and a 7-strand tinned copper drain wire, same size as conductors.

e. Approved for cable tray installation in accordance with the National Electrical Code

F. Wire Marking:

1. Wire identification: All wire terminations including field interconnect as well as wiring interior MCC cubicles, switchboard, panels, equipment, junction panels and boxes shall be identified with machine printed labels. Hand lettered labels are not acceptable and shall be replaced at the Contractor's expense. The wire identification code for all field interconnect and panel interior wiring, shall be similar to the designations shown on the Contract example drawings.

2. Wire Labels: The labels shall be machine printed with indelible ink, heat shrink type capable of accepting a minimum of 23 machine printed characters per sleeve label by Brady "Bradysleeve" or equal. Labeling shall be neatly installed for visibility and shall be clearly legible. Each wire and conductor shall be labeled with wire label as shown on approved loop, elementary and interconnect Drawings. Labels shall not be wrap-around or snap-on type.

3. Where there is insufficient space for labels on locally interconnected neutral wires such as jumpers between adjacent auxiliary relay coil neutral terminals, these labels may be omitted. "Locally" is defined as wires no longer than 8".

4. Wire labels for lighting and receptacles shall be installed and consist of the panelboard and circuit number (i.e., Panelboard "LP1," circuit breaker #3 would have wire label line "LP1-L3" and neutral "LP1-N3").

5. All control and signal wiring terminations shall have the correct wire label applied prior to making connection.

6. Numerically identify every conductor within each multi-pair and triad tray cable.

G. Pulling Compound:

1. Use only cable pulling compound which is approved by the manufacturer of the cable as being compatible with cable insulation and jacket materials.

H. Distribution:

1. Panel Power:

a. All electrical and instrumentation panels shall be equipped with a main power disconnect circuit breaker and power distribution circuit breakers. The main power disconnect breaker shall disconnect all power to panel. Distribution circuit breakers shall be single pole. The circuit breakers shall be mounted on a standard DIN rail, and shall be Allen - Bradley Channel Mounting Type, or equal.

b. For each power distribution circuit breaker, a neutral return terminal block shall be installed at the bottom of the breaker rail.

2. Analog Signals:

   a. Analog signal transmission between electric or electronic instruments shall be 4-20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Provide isolated current amplifiers wherever the loop load resistance exceeds the current signal transmitter's rating. Associated shunt resistors shall be located on rail-mounted terminal blocks. Exposed resistor leads shall be insulated with heat-shrink tubing.

   b. Each analog loop source shall be individually fused at the panel analog interface terminal block. Each analog loop shall be provided with a separate fuse, positive terminal, negative terminal and ground terminal at each Control panel

   c. Signal transmission from remote or field electric and electronic devices shall be 4-20 mA. Nonstandard transmission methods such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission.

3. Terminal Blocks and Fuses:

   a. General:

      1) Each terminal block shall have a unique identifying alphanumeric code. Terminal numbers shall be assigned starting lowest number at one end, incrementing in sequence top to bottom or left to right (i.e., 1,2,3,4....).

      2) Numbers shall be assigned to all blocks except grounding blocks. Fuse blocks shall be assigned unique tag numbers such as FU1, FU2. No two fuses in a common enclosure shall be assigned the same tag number. Fuse blocks shall also be provided with markers identifying the current rating of the fuse.

      3) A plastic marking tab shall be provided to label each individual terminal block. Each tab shall have a unique number/letter for each terminal which is identical to the "elementary" and "loop" diagram wire designation. Numbers on tabs shall be machine printed and 1/8-inch high.

      4) Terminal blocks shall be physically separated into groups by the level of signal and voltage served. Power and control wiring above 100 volts shall have a separate group of terminal blocks from terminal blocks for wiring below 100 volts, intermixing of these two types of wiring on the same group of terminal blocks is not allowed.

      5) As a minimum, provide a ground terminal or connection point for the power system grounding conductor for each terminal block group.

6) Terminate field wiring on the "field side" of the terminal blocks. Do not connect internal panel wiring to the "field side" of the terminal blocks. Do not connect field wiring to the "panel side" of the terminal block.

7) Provide a separate terminal block for every two neutral terminals or as coordinated with the interconnect diagrams.

8) Terminal blocks shall be, DIN rail, and 600V rated.

9) Provide terminal blocks with "follower" plates which compress the wires and have wire guide tangs for ease of maintenance. Terminal blocks which compress the wires with direct screw compression are unacceptable.

10) All power, control and instrument wires entering and leaving a compartment shall terminate on terminal blocks.

b. MCC – Motor Starter Cubicles Terminal Blocks:

1) MCC cubicle terminal blocks shall be pull-apart, as supplied standard by MCC manufacturer.

2) Fuse blocks shall be per MCC manufacturer or Connectron NDN-F1 with PF-1 fuse puller.

c. Control/Signal – Control and Signal Panel Terminal Blocks, (Excluding Motor Starter Cubicles):

1) Power Distribution, 120 VAC

a) Terminal Blocks: Compression -clamp, black bodies, 600 volt rating, Entrelec M4/6 or approved equal.

b) Fuse Blocks: Compression Clamp, black bodies, 600 volt rating, with fuse blown indicator, Entrelec ML 10/13.SFL or approved equal.

2) Control Circuits, Analog and Digital

a) Terminal Blocks: Compression-clamp, grey bodies, 600 volt rating, Entrelec M4/6 or approved equal.

b) Fuse Blocks: Compression Clamp, grey bodies, 600 volt rating, Entrelec M 4/8.SF or approved equal.

c) Provide a separate fuse and neutral terminal block for each PLC input or output card.

d) The configuration of analog and discrete input/output terminals and associated accessories shall be submitted for approval by the Owner. Colored marking tabs inserted into terminal blocks shall be Entrelec or approved equal. Color coding for all MCC Control Compartment or Panel Section terminal tabs shall be:

Description	Color	TB Code Letter
Digital Inputs	Red	R
Digital Outputs	Yellow	Y
Analog Inputs	Blue	B
Analog Outputs	Orange	O
Distribution / Fuses	Grey	A
Ground	Green	G
Neutral	White	W

3) Analog input and output terminal blocks, in addition to terminal block numbering, shall have "+," "-" and ground prefabricated symbol plastic terminal label inserts.

4) No more than two field wires are to be inserted in any single terminal block.

5) All PLC spare I/O points including spares shall be wired to terminal blocks.

d. Miscellaneous - Terminal Blocks, for locations other than MCC cubicles and Control/Signal Panels:

1) Provide terminal blocks rate a minimum of 20 amps at 600VAC.

2) Terminal blocks shall be Buchanan 500 series, or approved equal.

e. Fuse Sizes:

1) Fuses used in circuits 200 VAC and above shall be time-delay type FNQ, or approved equal, 13/32" x 1½" and have an interrupting rating of 10,000 AIC at 500 VAC. Fuse holders shall be of the barrier type and rated 600 VAC.

2) Fuses used in 120 VAC shall be time-delay type MDL or approved equal, ¼" x 1¼", and have a rating of 250 VAC. Fuse-holders shall be of the terminal block type, and shall be rail-mounted. Fuses shall have neon or LED blown fuse indicators.

3) Fuses used in signal and 24 VDC circuits shall be fast acting type, or approved equal, 5mm x 20mm, and have an rating of 250 VAC. Fuse holders shall be of the terminal block type, and shall be rail mounted.

4) Fuses shall be sized in conformance with the NEC.

I. Splices:

1. No splices are allowed with exceptions as stated in Electrical Section 16010 - Construction Methods, General.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the Codes and Standards specified in Section 16010 - Electrical.

B. The Supplier shall employ personnel that are skilled and experienced in the installation and wiring of electrical enclosure panels, devices, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. Perform any required work to correct that in the opinion of the Engineer are improper installations at no additional expense to the Owner.

3.2 INSTALLATION

A. System:

1. Install all products per Electrical Section 16010 - Installation, General.
2. All panels and enclosures shall be completely factory wired and tested before shipment.
3. Lace tie with cord, minimum length 2', each wire bundle entering any enclosure, vault, pull box, cable tray or any other enclosure. Place label with conduit number associated with wire on each of these bundles when there is no place to attach label to conduit. Labels for each cord shall be similar to the engraved circular tag type specified in Section 16110 or approved equal.
4. Pulling lubricant shall be used when installing all wire in conduits.

B. Wiring Methods:

1. Wiring Separation: Wires carrying 100 volts and above shall be physically separated from lower voltage wiring by using separate bundles or wire ways with sufficient distance to minimize the introduction of noise, crossing only at 90 degree angles.

2. Harness: All wiring shall be neatly bundled and laced with plastic tie-wraps, anchored in place by screw attached retainer. Where space is available, all wiring shall be run in slotted plastic wire ways or channels with dust covers. Wire ways or channels shall be sized such that the wire fill does not exceed 60%. Tie-wraps shall be T&B TY-RAP, or approved equal. Wiring inside of conduit, plastic wire duct, duct bank Sections or corrugated loom tubing is not to be wire tied or taped together.

3. Hinge Loops: Where wiring crosses hinged surfaces, provide a "U" shaped hinge loop protected by black head stabilized corrugated loom tubing as manufactured by Panduit # CLT100N-C630, or approved equal. The hinge loop shall be of sufficient length to permit opening and closing of the door without stressing any of the terminations or connections. Corrugated flexible wire duct shall be Graybar T25N, or approved equal.

4. Retainers: Wire ways, retainers, and other devices shall be screw-mounted with round-head 316 stainless steel screws or mechanically mounted by push-in or snap-in attachments. Glue or sticky back attachment of any type or style shall not be used. Retainers shall be T&B TC series, or approved equal.

5. Routing:

    a. Wires shall be routed in slotted plastic wire-ways with snap covers. Wires carrying VAC shall be separated as much as possible from other wires and signal cables, and shall be routed only in wireways for VAC. If the power wiring has to cross the signal wiring, the crossing shall be as close to a right angle as possible. Wireways for signal and VDC wiring shall be used separate from all VAC wireways. Routing of VAC wiring in combined ducts shall not be allowed. Wires and cable shall be routed along the shortest route between termination points, excepting routes which would result in routing VAC and other wires and cables in the same duct. Wires and cables shall have sufficient length to allow slack and to avoid any strain or tension in the wire or cable. Wires and cables shall be placed in the wireways in a straight, neat and organized fashion and shall not be kinked, tangled, or twisted together. Additional wire ducting shall be provided for use by the Electrical Subcontractor for routing field wires to their landing points in the each electrical enclosure and control panel.

    b. Wiring that cannot be routed in wireways, shall be neatly bundled, treed, and laced with plastic ties. Wiring across door hinges shall be carefully made up and supported to avoid straining and chafing of the conductors or from putting any strain on their terminals.

    c. Exposed Tie-Wraps: Plastic tie-wraps used in all outdoor or exposed applications shall be sun resistant UV rated for outdoor usage.

6. Terminations: Single wire and cable conductors shall be terminated according to the requirements of the terminal device.

    a. For screw terminals, appropriately sized locking forked spade lugs shall be used. Lugs shall be crimp on type that form gas tight connections. All crimping shall be done using a calibrated crimping tool made specifically for the lug type and size being crimped.

    b. On shielded cables, the drain wire shall be covered with heat shrunk insulating tubing along its full bare length between the cable jacket and the terminal lug or terminal pressure plate. To insulate the foil or braid shielding use heat shrink tubing sized for the wire and shrunk into place with the properly sized heat gun.

    c. Minimum distance between terminal blocks and relays or other terminations and wireways shall be 2".

    d. The wire label codes for each end of the same wire shall be identical.

7. Spare Terminals: Provide a minimum of 20% spare terminals in all MCC cubicles, electrical and instrumentation enclosures, and instrumentation/control panels.

3.3 WARRANTY

Provide warranty as specified in Electrical Section 16010 - Warranty.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall install, ready for use, the receptacles, plugs, switches, boxes and appurtenances specified herein. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices. All components and devices shall be furnished and installed as required to provide a complete operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter at no additional cost to the Owner.

B. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, test equipment, incidentals, and services to provide a complete and operational wiring devices as shown on the Drawings, included in these Specifications, or required for fully operating facilities.

C. Work includes that specified in Division 16.

D. The wiring devices scope of work includes:

1. Provide and install miscellaneous wiring devices, conduits, field interconnection wiring, and associated hardware.

2. Provide all necessary hardware, fittings, and devices to connect the electrical equipment provided under other Sections.

1.2 SUBMITTALS AND DRAWINGS

Provide submittals and Drawings as specified in Electrical Section 16011.

PART 2 MATERIALS

2.1 WIRING DEVICES

A. General: Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA area rating.

B. Boxes:

1. Box dimensions shall be in accordance with size, quantity of conductors, and conduit clearances per NEC Article 314 requirements.

2. Boxes shall be located and placed according to Owner requirements.

3. All terminal and junction boxes shall be labeled identifying them by number shown on Contract Drawings engraved with ½" letters on nameplates meeting the requirements of section 16144 Nameplates.

4. Non-Weatherproof Boxes:

   a. Recessed boxes shall be flush with wall. Boxes for fixtures shall not be less than four (4) inches square or diameter. Boxes for switches and receptacles shall be two and one-eight inch (2-1/8) deep. Provide plaster rings or box cover adapters for the wall surface finish.

   b. Surface boxes shall be cast ferrous, deep FD type.

5. Weatherproof Boxes:

   a. Boxes located in NEMA 4X areas shall be 316 stainless steel type rated NEMA 4X.

   b. PVC-coated cast ferrous boxes may be used in place of stainless steel boxes, except where boxes contain devices on cover. Boxes shall be deep, FD type. Single gang boxes shall have cast hubs.

6. Explosion-proof Boxes:

   a. Boxes shall be rated for Class 1, DIV 1 or 2 and weatherproof locations.

C. Switches:

1. General purpose switches shall be manufactured in accordance with UL 20. Switches shall be single pole, rated 20 amps, at 277 VAC. Bodies shall be of ivory phenolic compound supported by mounting strap having plaster ears. Switches shall have copper alloy contact arm with silver cadmium oxide contacts. Switches shall have slotted terminal screws and a separate green grounding screw. Furnish Hubbell 1221, Leviton, or approved equal.

2. Special purpose switches shall be provided with the amperage, voltage, and configuration as shown on the Drawings. Switches used as motor disconnects for single phase motors shall be horsepower rated.

D. Receptacles:

1. General purpose receptacles shall be duplex and rated 20 amps, at 120 VAC, 2 pole, 3 wire grounding, NEMA 5-20R configuration, Specification grade, and side wired to screw terminals. Face color shall be brown in industrial areas and white or ivory in finished areas. General purpose receptacles shall be Bryant, Hubbell, or approved equal.

2. GFI (ground fault circuit interrupting) receptacles shall be "Specification grade". GFI receptacles shall be duplex, 20A, 120V, with "test" and "reset" buttons with shallow design for mounting and standard screw terminals for direct wiring. Receptacles shall be designed, manufactured, and tested to prevent nuisance tripping from voltage spikes, RFI, EMI, or electronic component failures. Chaining multiple receptacles from one GFI unit is not acceptable. GFI receptacles shall be Arrow-Hart, Leviton, or approved equal.

3. Four in One receptacles (4 each 20A-125V receptacles in one housing, shall mount on a single gang box without additional adapters). Four in One receptacles shall be Leviton 21254, Hubbell, or approved equal.

E. Device Plates and Covers:

1. Non-Weatherproof general purpose device plates and covers shall be stainless steel. Plates or covers shall be attached with stainless steel screws. Exception: Device plates and covers within reach of sinks and other wet areas shall have beige plastic covers with plastic screws.

2. Device plates and covers for cast metal boxes shall be same material as the box.

3. PVC coated cast boxes shall have PVC coated cast covers.

4. Weatherproof switch, outlet, and receptacle boxes shall be fitted with cast aluminum gasketed cover rated for wet locations. Each receptacle access cover shall have a gasketed spring door to maintain the weatherproof integrity with plug inserted in accordance with NEC 406.8 for unattended locations. Screws and hinge springs shall be stainless steel. Final decision of type of access cover for specific location shall be per Engineer. Weatherproof access covers shall be Hubbell, Tay Mac, Crouse-Hinds, or approved equal.

5. Receptacle and light switch plates shall be stamped or engraved as specified in Section 16144 Nameplates.

F. Communication Jacks:

1. Communications Jacks shall consist of CAT 5 wall plate and device box mounted at locations shown on Contract drawings. Communications Jacks shall be Leviton Quickport or approved equal as follows:

a. All communication modules shall be UL listed, meet FCC Part 68 requirements, and fully comply with NEC Article 800.

b. Modules shall be high-impact, self-extinguishing plastic rated UL 94V-0.

c. Contacts shall be spring wire with phosphor bronze plated with 50 micro-inches hard gold over 100 micro-inches nickel. Jacks shall be applicable for CAT 5 wire applications.

d. Device box shall be as specified herein. Wall plates and jacks shall be provided as follows:

1) Four-port Wall plate shall be field configurable and flush-mounted. Wall plate shall house any combination of four (4) 8-conductor keyed jacks. Jacks shall be able to be interchangeable depending on application.

2) Single-port wall plate shall have a 8-Conductor keyed jacks and shall be individually terminated using insulation displacement connectors with punchdown caps for installation.

3) Color of jacks shall be as follows:

a) Telephone network => Ivory

b) Spare => Brown

c) Data => White

d) Spare => Black

e. Wall plates shall be mounted on a 2" by 4" (minimum) device box.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards specified in Section 16010 - Electrical.

B. The Supplier shall employ personnel that are skilled and experienced in the installation of receptacles, plugs, switches, appurtenances, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. Perform any required work to correct that in the opinion of the Engineer are improper installations at no additional expense to the Owner.

3.2 INSTALLATION

A. System:

1. Install all products per Electrical Section 16010 - Installation, General.

2. Keep boxes, and other openings closed during construction to prevent entry of foreign matter. Cover devices and boxes to protect them against dirt, paint, water, chemical, or mechanical damage before and during construction period. Restore to original condition apparatus or equipment damaged prior to final acceptance. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.

3. All receptacles shall be tested by Electrical Contractor in presence of Owner for correct connections utilizing a plug-in ground, line and neutral test light plug.

4. Boxes shall be relocated at no additional cost to Owner as directed by Engineer when a conflict occurs in the box placement shown on Contract drawings and other building appurtenances.

B. Device Mounting Heights:

1. Mounting heights of fixtures and devices shall be as follows unless otherwise indicated or when height has to be adjusted to be over or under counter tops.

a.	Wall switches	=>	48 inches
b.	Convenience outlets	=>	18 inches finished areas 24 inches non-finished areas
c.	Telephone outlets	=>	54 inches
d.	Bracket fixtures	=>	7 feet 6 inches
e.	Counter top outlets	=>	12 inches above countertop

C. Cutting and Patching:

1. The Contractor shall do all cutting and patching required to install his work. Any cutting which may impair the structure shall require prior written approval by the Engineer. Cutting and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after cutting and patching.

D. Boxes:

1. Leave no unused opening in any box. Install close-up plugs as required to seal openings.

2. All spare and/or empty conduits shall terminate in a device box.

3. Use stainless steel boxes when box must support door mounted devices.

4. In NEMA 4X areas boxes are to be spaced ¼-inch minimum from walls using stainless steel, nylon or plastic spacers. Regular steel washers are not considered an approved spacer.

3.3 WARRANTY

Provide warranty as specified in Electrical Section 16010 - Warranty.

END OF SECTION

SECTION 16144

NAMEPLATES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Contractor shall provide nameplates for all instruments, panels, enclosures, devices, and equipment.

B. All nameplates shall be of the identical style, color, and material throughout the system.

C. Work includes that specified in Division 16.

D. Provide and install nameplates as specified herein.

1.2 SUBMITTALS AND DRAWINGS

A. Provide submittals and Drawings as specified in Electrical Section 16011.

B. Submit schedule of all nameplates to be used on project. Submittal to include the following drawn with AutoCAD or equivalent printout:

1. Dimension of nameplate.
2. Exact lettering, text size and font for each nameplate.
3. Color of nameplate.
4. Color of lettering.
5. Materials of construction.
6. Method and materials for attachment.
7. Drawing showing location of nameplate on each panel and enclosure.

PART 2 MATERIALS

2.1 NAMEPLATES AND TAGS

A. Equipment Exterior Nameplates: Nameplate material shall be rigid laminated black phenolic with beveled edges and white lettering, except for caution, warning, and danger nameplates the color shall be red with white lettering. The size of the nameplate shall be as shown on the Drawings. No letters are allowed smaller than 3/16". All phenolic nameplates located outdoors shall be UV resistant. Securely fasten nameplates in place using two stainless steel screws if the nameplate is not an integral part of the device. Epoxy cement or glued on nameplates will not be acceptable.

1. Each major piece of electrical equipment shall have a manufacturer's nameplate showing the Contract specified name and number designation, the manufacturer's name, model designation, part number, serial number, and pertinent ratings such as voltage, amperage, # of phases, range, calibration, etc.

2. For each device with a specific identity (pushbutton, indicator, field control station, disconnect switches, etc.) mounted on the exterior or deadfront of a piece of equipment, provide a nameplate with the "Equipment Name and Equipment Number" inscription as shown in the Contract Documents. Where no inscription is indicated in the Contract Documents, furnish nameplates with an appropriate inscription providing the name and number of device.

3. For all receptacles and switches, provide a faceplate engraved or stamped with the panelboard and circuit number it is fed from. Also, include on faceplate or on a separate nameplate for each light switch identification use such as "Outside Building Lights," "Perimeter Lights," "MCC Room," etc.

4. All field instruments and devices shall be labeled with designation shown on P&ID diagrams.

5. All transformers and panelboards shall have nameplates with ½" high letters and be engraved with designations as shown on one-line Drawings.

6. All disconnect switches shall have nameplates with ½" high letters and be engraved with designations as shown on one-line drawings or as directed by Owner.

7. Service entrance equipment shall have engraved nameplate with 1/2” letters (red with white lettering) indicating type and location of standby generator per NEC 702.7 (A).

8. Service entrance equipment shall have engraved nameplate for generator grounding per NEC 702.7(B).

9. Service Equipment Label: Per NEC 110.24 (A) Service equipment shall be legibly marked in field with the maximum available fault current. Field marking shall include date the fault current calculation was performed and be weather & UV rated. Service equipment shall not be hand labeled.

10. Generator receptacles and generator lug panels shall have engraved nameplate with ½" letters (red with white lettering) per NEC 702.7.(C).

B. Equipment Interior Nameplates: Nameplate material shall be clear plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have red lettering. The size of the nameplate tape shall be no smaller than ½" in height with 3/8" lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. Add additional clear adhesive to hold the nameplate securely in place when necessary. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a nameplate located above the device with the inscription as shown in the Contract Documents. Where no inscription is indicated in the Contract documents, furnish nameplates with an appropriate inscription providing the name and number of device used on the Submittal Drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the submittal. Nameplates shall not be attached to wireway covers or to removable devices.

C. Equipment Tags: The Contractor shall attach a tag to the equipment (including instruments) with the same inscriptions as specified above in paragraph A. The tag shall be made from stainless steel material and the size of the nameplate shall be no smaller than 3/8"h x 2"w with 3/16" machine printed or engraved lettering unless otherwise approved by the Engineer. The tag shall be attached to the equipment with stainless steel wire of the type normally used for this purpose. SST wire must be crimp connected. Twisting ends together is not acceptable.

D. Engrave or machine print the tags with inscriptions as approved by the Engineer in the nameplate submittal.

E. Provide temporary labels for all instruments and devices immediately when installed. Temporary labels shall be provided with 1/2" letters minimum and labeled with P&ID tag number.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards specified in Section 16010 - Electrical.

B. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Perform any required work to correct improper installations or nameplates at no additional expense to the Owner.

D. Nameplates shall be readily visible and not painted over.

E. Damaged nameplates shall be immediately replaced.

F. Phenolic nameplates that are glued on shall be replaced with stainless steel screw attached nameplates.

3.2 INSTALLATION

A. Install all products per Electrical Section 16010 - Installation, General.

B. Securely fasten nameplates in place using two stainless steel screws if the nameplate is not an integral part of the device. Epoxy cement or glued on nameplates will not be acceptable.

C. All nameplates shall be in place prior to the start of any field test.

D. Epoxy cement or glued on nameplates will be acceptable only for NEMA 4X enclosures.

3.3 SPARE PARTS

The Contractor shall include in his bid price the following to be designated during testing and start-up by the Engineer or Owner:

A. Five (5) additional engraved 1-1/8" x 3-5/8" nameplates with 1/4" letters.

B. Five (5) additional engraved ring type nameplates.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall install, ready for use, the supporting devices as specified herein. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices. All components and devices shall be furnished and installed as required to provide a complete operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter at no additional cost to the Owner.

B. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, incidentals, and services to provide supporting devices as shown on the Drawings, included in these Specifications, or required for fully operating facilities.

C. Work includes that specified in Division 16.

D. The supporting devices scope of work includes:

1. Provide all necessary hardware, supporting devices, and devices to support and align raceways, cabinets, boxes, fixtures, and other appurtenances in an approved manner and as herein specified.

2. The location of field control stations on Drawings is tentative. During construction the Owner will direct the Contractor as to the exact position and direction of orientation at no additional cost to the Owner.

E. The Electrical Contractor shall supply and install all supporting devices listed under column "DWG REF DET MOUNTING" that references "E" Series Contract Drawings in all Division 16 indexes.

1.2 SUBMITTALS AND DRAWINGS

A. Provide Submittals and Drawings as specified in Section 16011.

B. Submit detailed fabrication Drawings showing material of construction for each type of support.

C. Submit seismic and anchoring calculations that show that each support meets the seismic requirements of Seismic restraint under Section 16020.

D. Submit dimensioned supporting device drawings for each type of enclosure, instrument, and panel. The mounting tab locations for device mounting shall be clearly shown and dimensioned.

PART 2 MATERIALS

2.1 SUPPORTING DEVICES

A. General: Materials and installation shall meet all requirements of the NEC, and meet the minimum following Specifications.

1. Inserts, hangers, brackets and miscellaneous supports for electrical equipment and conduits must be designed with minimum safety factor of 4, based on ultimate strength of material used. For empty conduits, include weight of 4 Type XHHW copper wires of maximum permissible size.

2. Secure hangers, brackets, conduit straps, supports and electrical equipment as specified in Electrical Section 16010 - Fasteners.

3. Power driven or velocity driven inserts may be used where their use does not affect finished appearance of work, but may not be used on structures in tension. They may not be used in pre-stressed slabs, beams, purlins, or in precast members.

4. All concrete embedded bolts shall be 316 stainless steel.

5. Support channels steel shall conform to the requirements of ASTM A570. These shall be nominal 1 5/8" x 1 5/8" roll formed low carbon 12-gauge galvanized steel in dry areas and 316 stainless steel NEMA 4X areas (fiberglass in "corrosive areas" when supporting fiberglass boxes). One side of the channel shall have a continuous slot with in-turned lips. Double strut shall be two of these welded back to back.

B. Mounting, support, or bracing bolts shall not be used as an attachment point for ground conductors. Attachment of the grounding conductor to equipment or enclosures shall be by connectors specifically provided for grounding.

C. Conduit Supports:

1. Single Conduit Hangers: 3/8" minimum diameter 316 stainless steel rod or anchor.

2. Trapeze Hangers: Channel, with 1/2" minimum diameter 316 stainless steel rods.

3. Supports for Indoors in Non-Corrosive/Dry Locations:

   a. Hangers, channels, clamps, supports and rods; galvanized steel.

   b. Conduit straps and single hole clamps; galvanized.

   c. Steel bolts, screws, nuts and washers; galvanized.

   d. Paint surfaces to match adjacent finishes.

4. Supports for Outdoors, Corrosive/Wet, and NEMA 4X Locations:

   a. Hangers, channels, clamps, supports and rods; 316 stainless steel. Fiberglass may be used when approved in writing by Engineer.

   b. Conduit straps and single hole clamps; 316 stainless steel or PVC-coated galvanized steel with PVC coated backplates.

   c. Bolts, screws, nuts and washers; shall be 316 stainless steel.

5. All supports shall be braced at 10-foot intervals, minimum.

D. Equipment and Device Supports:

1. Equipment and device supports shall be similar to that detailed on the Contract E-series Drawing "Miscellaneous Electrical Details."

2. In wet and/or corrosive environments, all metal brackets and fasteners shall be 316 stainless steel.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards specified in Section 16010 - Electrical.

B. The Supplier shall employ personnel that are skilled and experienced in the installation of support devices and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. The Contractor shall perform any required work to correct that in the opinion of the Engineer are improper installations at no additional expense to the Owner.

3.2 INSTALLATION

A. System:

1. Install all products per Electrical Section 16010 - Installation, General.

2. Restore to original condition apparatus or equipment damaged prior to final acceptance. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.

B. Conduit Supports Installation - Conduits shall be secured using approved manufactured supports, connectors, and securing devices. Conduits shall be supported independently of one another.

1. Single Runs: Conduit straps or ring bolt type hangers with specialty spring clips. Do not use plumbers perforated straps.

2. Multiple Runs: Unistrut conduit rack with 25 percent spare capacity.

3. Provide additional supports where obviously required or as directed by Engineer.

C. Equipment and Device Supports: Install plumb and level. Install anchors as listed in the approved seismic calculation submittals. Provide grout bases around all floor supports.

3.3 WARRANTY

Provide warranty as specified in Electrical Section 16010 - Warranty.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall install, ready for use, the grounding system as specified herein. This document describes the function of the grounding system and particular components, but does not necessarily describe all necessary devices. All components and devices shall be furnished and installed as required to provide a complete grounding system for accomplishing the functions and meeting the performance set forth hereinafter at no additional cost to the Owner.

B. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, test equipment, incidentals, and services to provide a complete grounding system as shown on the Drawings or included in these Specifications.

C. The grounding system scope of work includes:

1. Provide and install miscellaneous trenching, grounding system wiring, and associated hardware.

2. Related work specified in Division 16.

1.2 SUBMITTALS AND DRAWINGS

A. Submittals and Drawings

1. Provide Submittals and Drawings as specified in Section 16011 for all grounding system components.

PART 2 MATERIALS

2.1 SERVICE GROUNDING

A. The ground ring shall consist of bare wire laid in a grid as detailed on the Contract E-Series Drawings. Bond ring to building steel frames and to metal water pipe within 5 feet of pipe entrance to building when available.

B. Network ground bond wires shall be connected from the UFFER ground to locations shown on Contract Drawings. The network ground bonding wires shall be bare copper sized as shown on Contract Drawings.

C. The system neutral shall be connected to the system's grounding conductor at only a single point in the system. This connection shall be made by a removable bonding jumper sized in accordance with the applicable provisions of the National Electrical Code. The grounding of the system neutral shall be in the enclosure that houses the service entrance main breaker.

D. Ground grid and bond wires shall be AWG bare copper as manufactured by Southwire or approve equal. Ground grid and bond wires shall be sized as shown on the Plans or in accordance with NEC Table 250.66, whichever is greater.

E. All grid and bond wire connections shall be made with U.L. approved material and methods. Ground clamps and connectors shall be made of cast bronze.

2.2 RACEWAY, EQUIPMENT AND ENCLOSURE GROUNDING

A. All raceway systems, supports, enclosures, panels, motor frames, and equipment housings shall be permanently and effectively grounded.

B. Ground clamps shall be bolt-on cast bronze type as manufactured by ILSCO type AGC, O-Z Gedney type GRC, or approved equal.

C. Grounding conductors shall be sized as shown on the Plans or in accordance with NEC Table 250.122, whichever is greater.

D. Bonding wires shall be installed on ends all metallic conduits with grounding bushings, expansion joints, and for continuity of raceways transitions. Bonding wires shall be solid bare copper sized and installed per NEC 250.102. Bonding wires at endpoints shall be connected to enclosure ground bus or equipment grounding lug. No aluminum fittings, bushings and lugs shall be used.

E. All equipment and devices shall be grounded in a manner that satisfies the requirements of the National Electrical Code.

F. One side of neutral of the secondary on all transformers shall be grounded to the ground bus or ground bond wire.

G. All receptacles shall have their grounding contact connected to a grounding conductor.

H. Branch circuit grounding conductors for receptacles or other electrical loads shall be arranged such that the removal of a lighting fixture, receptacle, or other load does not interrupt the ground continuity to any other part of the circuit.

I. All metallic light fixture enclosures and ballasts shall be grounded.

J. Attachment of the grounding conductor to equipment or enclosures shall be by connectors specifically provided for grounding. Mounting, support, or bracing bolts shall not be used as an attachment point for ground conductors.

K. The negative side of all DC power supplies shall be grounded.

L. Each ground bus shall be copper. Screw type fasteners shall be provided on all ground buses for connection of grounding conductors. Ground bus shall be a Challenger GB Series, ILSCO CAN Series, or approved equal.

2.3 ENCLOSURE GROUND BUS

A. Each electrical, control and instrumentation enclosure shall be provided with a copper grounding bus bar, mounted on the inside of the enclosure. The grounding bar shall be mounted on non-insulated standoffs so that a good electrical connection is made between the ground bar and the cabinet through the mounting.

B. The bus bar shall be sized to meet the panel grounding requirements of NEC, and for connection of a minimum of 10 groundings conductors.

C. Each ground bus shall be copper and UL recognized. Screw type fasteners shall be provided on all ground buses for connection of grounding conductors. Ground bus shall have a minimum of 10 taps, and be rated for copper conductors. Ground bus shall be an ILSCO CAN Series, or approved equal.

D. Aluminum ground bus and lugs are not acceptable.

2.4 GROUND RODS

A. The ground rod shall consist of not less than 10 continuous feet of 3/4 inch copper coated electroplated high grade carbon steel. The ground rod shall be a NEHRING type NCC 3410, or approved equal. The ground rod shall extend up for visible connection of a UL approved "ground clamp" to the ground bus.

B. Provide 14 inch diameter, 9-inch nominal throat, concrete ground rod boxes, minimum 12 inches deep, with a cast-iron traffic cover embossed or engraved "GROUND." Ground rod boxes to be as manufactured by BES Concrete Products or approve equal.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards specified in Section 16010 - Electrical.

B. The Supplier shall employ personnel that are skilled and experienced in the installation grounding system, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. The Contractor shall perform any required work to correct that in the opinion of the Engineer are improper installations at no additional expense to the Owner.

E. All grounding system components installed by the Contractor shall be in accordance with the Drawings, NEC, and the manufacturer's recommendations and instructions.

3.2 INSTALLATION

A. System:

1. Install all products per Electrical 16010 – Installation.
2. Ground rods that are unable to be driven vertically into the earth shall be installed per NEC 250.53(G) at a 45 degree angle or buried 30 inches below grade.
3. Install additional ground rods as required to meet NEC 250.53.
4. Provide a separate grounding conductor in each raceway, securely grounded to equipment at each end of raceway.
5. Bond metal piping and building structure metal frames to grounding electrode per NEC.
6. Contractor shall not conceal or cover any ground connections until the Engineer or Owner has established that every grounding connection conforms to the Contract Drawings and Specifications and has given the Contractor written confirmation.

7. Grounding details shown on plans are minimum. If additional equipment, such as ground rods, clamps, conductors, etc., is required per NEC, Title 24, CAC, furnish and install same without additional cost to Owner.

B. Connections:

1. Use U.L. approved ground clamps specifically designed for grounding purposes. Strap metal is not acceptable for grounding or bonding.

2. Exposed connections to ground buses, raceways, and small pipes shall be made by means of U.L. approved grounding clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A, or approved equal.

3. All buried, ground rod, large pipe, and steel plate or frame ground bond connections shall be made by welding process equal to Cadweld.

C. Electrical Equipment Grounding:

1. Metal conduits shall be bonded together to the enclosure ground bus.

2. Lightning arresters or suppressors shall be directly connected to the ground system using copper conductors sized per manufacturer's literature.

3. Transformer secondary neutrals shall be directly connected to the ground system using copper conductors sized as per NEC.

4. All motors shall be grounded by bonding the grounding conductor within the raceway to the motor frame. Motors as shown on Electrical Plans shall also have a supplemental grounding conductor bonded to the ground grid in the immediate area of the motor.

5. Each enclosure containing metallic components shall be grounded to the ground grid per NEC 250.4(A) (1) ~ (5).

6. A ground bus shall be provided in each enclosure or cabinet. It shall have provisions for connecting a minimum of ten grounding conductors. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall be sized as shown on Contract Drawings or in accordance with NEC Table 250.122, whichever is larger.

7. Each panelboard shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall be equal to panelboard neutral bus amp rating and shall have adequate quantity of lugs. No more than two grounding conductors shall be installed per lug.

D. Excavation and Back Filling:

1. Trenches for all bare copper ground bond wires shall be excavated to a minimum depth of 30".

2. Back filling shall be done only after grounding system has been inspected. Excavation and back fill of grounding system shall conform to the requirements of the Earthwork Section of these Specifications.

3. At all times during the installation of the grounding system, the Contractor shall provide barricades, fences, guard rails, etc., to safeguard all personnel, including small children, from excavated trenches.

E. Cutting and Patching:

1. The Contractor shall do all cutting and patching required to install his work. Any cutting which may impair the structure shall require prior written approval by the Engineer. Cutting and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after cutting and patching.

3.3 FIELD TEST

Provide field testing on grounding system as specified in Section 16620.

3.4 WARRANTY

Provide warranty as specified in Electrical Section 16010 – Warranty.

END OF SECTION

SECTION 16605

ELECTRICAL SYSTEM ANALYSIS

PART 1 GENERAL

1.1 SUBMITTALS

A. Provide the following submittals per Section 16011 for all switchboards, switchgear and MCCs, including existing:

1. Short Circuit and Load Flow Study.
2. Protective Device Coordination.
3. Arc Flash Study.
4. Harmonic Analysis.

B. Short Circuit, Load Flow, and Protective Device Coordination Studies shall be prepared, stamped and signed by a professional Electrical Engineer registered in the State of California and in accordance with NFPA 70E, IEEE 242 and IEEE 399.

C. Exceptions / Clarifications

1. Itemize all exceptions and clarifications to the Contract Documents in a letter (located in the front of the submittal) on company letterhead.
2. Exceptions that are noted in the study, but not listed on the Exceptions/Clarifications letter, will be considered as non-responsive and not accepted as changes to the Contract Documents.
3. All exceptions taken from the Drawings and specifications shall be documented with justifications. When noting the exception, list which Drawings or which Specification Subsection number the exception is taken.
4. Clarification requests shall list which Drawing or Specification Subsection number the clarification is required for.

D. Provide two (2) DVDs at the completion of the project. One DVD will contain the as-built set of studies, reports, settings, etc. The other DVD will contain the original source format of input data used for the PC based computer software. Provide all setup information used for the computer based study and report.

E. For each resubmittal, provide a copy of submittal comments and a separate letter, on Company letterhead, identifying how each submittal comment has been addressed in the resubmittal.

F. When submittals are provided in PDF format, utilize the "Bookmark" feature of the Adobe Acrobat and clearly bookmark locations in the report to locations identified in the Report's Table of Contents. Bookmarks shall not be out of order; the English description shall match that listed in the Report's Table of Contents.

1.2 SEQUENCING AND SCHEDULING

A. It is the people performing the electrical system analysis responsibility to collect and field verify all data (i.e. existing breaker relay types, settings, and feeder wire sizes. This includes obtaining all data from the serving utility for this project; Merced Irrigation District (MID) and Pacific Gas and Electric (PG&E).

B. Contractor shall provide letter certifying the inspection and verification of existing equipment and distances used in study.

C. A complete Protective Device Coordination Study shall be submitted within 60 days after approval of Short Circuit and Load Flow Study.

D. The Short Circuit, Load Flow, Protective Device Coordination and Arc Flash Studies shall be updated prior to Project Completion. Utilize characteristics of as-installed equipment and materials. The protective device coordination study shall be submitted and approved prior to start of field breaker test per Section 16620.

E. Complete protective device coordination study listing all device settings shall be utilized during start-up of electrical equipment.

F. When previous electrical system analysis studies are available and provided to the Contractor, it is the Contractor's responsibility to verify the accuracy of the data used and to update it to match existing conditions.

PART 2 MATERIALS

2.1 GENERAL

A. Equipment and component titles used in the Studies shall be identical to the equipment and component titles shown on the Drawings.

B. Perform Studies using PC based computer software. State program name and version in report.

C. Perform complete fault calculations for each Utility and Generator source. Equipment shall not be grouped as a single large load; they shall be treated as individual loads. When generators are incorporated into the system, develop two separate networks: one with utility only (no generator attached) and one with generator only (no utility attached).

D. Utilize proposed load data for the Study obtained from submittals, Utility Company and field verifications.

E. Complete protective device coordination study listing all device settings shall be utilized during start-up of electrical equipment.

F. Provide unique page numbers for every sheet in all Studies. Unique page numbers to be manually placed by Study Company after printout if study report doesn't assign page numbers.

G. One line diagrams

1. Shall be readable on 11" x 17" paper. One line diagrams shall be redrawn in AutoCAD on multiple sheets if necessary or as requested by Owner.

2. Buses and branches shall have descriptive names matching one line diagram or existing system (i.e. not Bus-0084).

3. Automatic transfer switches (ATSs), Main Switchboards (MSBs), shall not have multiple node buses.

4. Primary and secondary for transformers, Variable Frequency Drives (VFDs), etc. shall be changed to node buses.

2.2 SHORT CIRCUIT AND LOAD FLOW STUDY

A. Include in Short Circuit and Load Flow study the following containing:

1. Cable impedances based on copper conductors.

2. Bus impedances based on copper bus bars.

3. Transformer impedances based on tolerances specified in ANSI C57.12.00.

4. Input data including motor loads, wire lengths, and sizes.

5. Utility data:

    a. Impedance of Utility source.

    b. Primary voltage of Utility source.

    c. Fault information from Utility Company:

        1) Three phase bolted fault.
        2) X/R ratio (positive sequence).
        3) Line to ground fault.
        4) X/R ratio (zero sequence).

6. Voltage drop and current flow at each node and load in system.

B. Calculate Short Circuit interrupting duties for an assumed three-phase bolted fault and line-to-ground fault at each of the following locations:

1. Main Switchgear.

2. All Switchboards.

3. All Motor Control Centers (MCCs).

4. All panelboards.

5. All 480V, 3 phase motor and equipment loads 10HP and larger.

6. All 3 phase transformer secondaries.

C. Verify:

1. Equipment and protective devices are applied within their ratings.

2. Adequacy of switchboard, panelboard and MCC bus bars to withstand Short Circuit stresses.

3. Adequacy of transformer windings to withstand Short Circuit stresses and over-current.

4. Cable sizes for ability to withstand normal and fault load currents.

D. Provide the following in the Short Circuit and Load Flow study report:

1. Calculation methods and assumptions.

2. Input data.

3. Short Circuit and Load Flow data.

    a. Impedances.

    b. X to R ratios.

    c. Asymmetry factors.

d. Motor contributions.

e. Short Circuit kVA.

f. Symmetrical and asymmetrical line-to-line and line-to-ground fault currents.

g. Device evaluation including rating of equipment.

h. Bus evaluation including rating of equipment.

i. Source data, from Electric Utility Company.

j. Load flow amperage and voltage at each load and node of system.

4. Tabulations of calculated quantities.

5. Results, conclusions, and recommendations.

6. One line diagram of distribution system.

7. Impedance diagram showing the resistances and reactances for all cables of the distribution system.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Provide Protective Device Coordination drawings for each section of distribution system that includes the following:

1. Graphically diagram displaying coordination time-current curves on conventional log-log curve sheets. Each time-current curve shall have a unique identifier label. This identifier shall be used in the tabulated settings spreadsheet and on the associated one-line diagram.

2. Time-current curves shall include the following curves (minimum):

a. Utility relays (phase & ground) and high voltage switchgear relays (phase and ground).

b. All upstream protective devices and breakers.

c. All mechanical overloads.

d. MCP breaker and associated motor or equipment load. Duplicates of the same sized protective device and motor size may be omitted (i.e., when there are 3 pumps for same application).

e. All transformers and associated primary and secondary protection.

f. Unique identifier for each protective device.

g. Provide separate TCC for phase and ground curves.

h. TCC for Ground curves shall include the transformer magnetizing inrush currents for all transformers downstream of the circuit breaker. Ground shall clear the inrush currents.

3. One-line diagram that applies to specific portion of distribution system associated with time-current curves. One-line diagram shall include the following:

    a. Location of each device.

    b. Power and voltage ratings, primary and secondary transformers amperages.

    c. All significant circuit elements such as transformers, cables, breakers, fuses, relays, etc. with their corresponding amperage ratings.

    d. Tag of each branch and node (shall be the same tags used in Short Circuit and Load Flow study).

    e. Mechanical overload and contactor.

    f. English description, equipment name, HP, and full load amp rating of motors and other 3 phase loads.

    g. Terminate device characteristic curves at a point reflecting maximum fault current to which device is exposed as calculated in short circuit study.

B. Characteristics plotted on time current curves shall include:

1. Protective current relays.

2. Fuses including manufacturer's minimum melts, total clearing, tolerance, and damage bands.

3. Circuit breaker trip devices, including manufacturer's tolerance bands.

4. Transformer full-load currents at 100% and 600%.

5. Motor and equipment full load currents.

6. Transformer magnetizing inrush currents.

7. Transformer damage curves.

8. ANSI transformer withstand parameters.

9. Fault currents.

10. Ground fault protective device settings.

11. Other electronic protective devices.

C. Provide the following recommended settings for all protective devices in spreadsheet format in the Protective Device Coordination study report:

1. Relay settings including CT values.

2. Circuit Breakers adjustments:

   a. Long Delay Pickup and Time.

   b. Short Time Pickup and Time.

   c. Instantaneous Pickup and Time.

   d. Ground Pickup and Time.

3. Programmable settings for all electronic devices. Settings for non-current relay settings shall also be provided.

4. Settings shall be given both in amps and seconds as well as the corresponding physical setting (i.e. 30A and setting B on MCP) for device.

5. Identify breaker and protective device associated with each curve by manufacturer type, function and part number.

2.4 HARMONIC STUDY

A. Perform a harmonic analysis study in accordance with the latest version of IEEE 519 unless otherwise specified in contract documents.

B. The total harmonic distortion (THD) at the point of common coupling (PCC) shall be predicted through computer modeling of the distribution system and connected AC drives. PCC shall be considered as the main breaker of all MCCs and switchboards. Contractor shall calculate TDD and THD at each PCC.

C. Do not exceed harmonic voltage and current distortion limits at PCC for general system applications, as recommended and defined by IEEE 519, unless specified otherwise in contract drawings.

D. If the calculations determine that the harmonic distortion levels are higher than the voltage and current specified, the drive manufacturer shall provide line reactors, isolation transformers, multi-pulse drives or trap filters to meet the intent of IEEE 519.

2.5 ARC FLASH HAZARD STUDY

A. General:

1. Arc flash boundary and incident energy shall be calculated, using a PC computer program, at all significant locations in the electrical network, including switchgears, switchboards, MCCs, transformers, etc. where work could be performed on energized equipment.

2. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

3. Document method of calculation.

4. Do not include the motor contribution of motors fed by VFDs in the arc flash hazard study.

B. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary and considering incident energy of 1.2 cal/cm2.

C. Study shall include the following:

1. All significant locations in 12KV, 480 volt, 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

2. Incident energy and flash protection boundary calculations in spreadsheet format in the Arc Flash Hazard study report.

3. Provide the following incident energy and flash protection boundary calculations in spreadsheet format in the Arc Flash Hazard study report (values shall be calculated for all electrical equipment in the power distribution system):

   a. Arcing fault magnitude

   b. Device clearing time

   c. Duration of arc

   d. Boundary for:

      1) Arc flash limited shock approach

      2) Limited shock approach

      3) Restricted shock approach

   e. Working distance

   f. Incident energy at 18 inches (in cal/sq.-cm)

   g. Recommendations for arc flash energy reduction for each location having more than 8 cal/sq.-cm. Provide preliminary cost estimate for implementing recommendations.

4. Provide recommendations for the Personal Protective Equipment (PPE) that the Owner should maintain on site for the level of hazard.

5. Provide recommendations for safety label design that should be posted on electrical equipment.

6. Spreadsheet summarizing incident energy and flash protection boundary list Arc Flash Boundary in inches on label. No fractional distance in feet.

2.6 STUDY REPORTS

A. Written reports submitted for approval shall contain:

1. Scope of Studies performed.
2. Explanation of bus and branch numbering system.
3. Report calculations, tabulations and spreadsheets.
4. Selected equipment deficiencies.
5. Results of Short Circuit, Load Flow, Coordination and Arc Flash Studies.
6. Comments or suggestions regarding:
    a. Changes and additions to equipment wire and cable sizes, ratings, and/or characteristics.
    b. Circuit protective devices and breakers improperly rated for overload or fault conditions.
    c. Arc flash protective equipment and safety labels.
7. Tabulation spreadsheet for all protective device and breaker settings with the following column entries:

Device Code	Description	MFR	Type	Plug Trip	Frame	KAIC	Long Time		Short Time		Inst	Ground	
							Amps	Time	Amps	Time	Amps	Amps	Time

8. Stamped, signed and dated by Electrical Engineer registered in the State of California who performed the analysis.

B. Reports are to be updated to reflect as-built conditions and placed in O&M manual per Section 16012 requirements.

PART 3 EXECUTION

3.1 GENERAL

A. Make minor modifications to equipment settings as required to accomplish conformance with the Short Circuit, Load Flow, and Protective Device Coordination Studies.

B. Notify Engineer in writing of any required major equipment modifications.

3.2 FIELD TESTS

A. Provide field testing of breakers and protective equipment as specified in Section 16620 – Electrical and Instrumentation Field Tests.

B. Adjust breaker, relay, and protective device settings according to values established by coordination Study.

3.3 ARC FLASH WARNING LABELS

A. All Arc Flash warning labels shall meet NEC requirements, OSHA standards and NFPA recommendations.

B. Provide and install 4 in. x 6 in. thermal transfer type labels of high adhesion polyester for each work location analyzed and as required by the NEC for flash protection on power distribution equipment.

C. Each label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following machine printed information:

1. Location designation
2. Nominal voltage
3. Arc Flash boundary
4. Available incident energy and working distance (in inches)
5. Minimum arc rating of clothing
6. Site specific level of PPE
7. Engineering report number, revision number and issue date
8. Company preparing report and contact phone number.

D. Labels shall not be hand labeled.

E. Labels shall be submitted for approval. No labels shall be installed without prior approval by Owner or Owner representative.

F. For all areas, Contractor shall post the following:

1. Working distances
2. Shock hazard voltage
3. Shock Approach Boundaries:
    a. Limited
    b. Restricted

G. Provide Arc Flash labels for the each of the following pieces of equipment:

1. 480V and applicable 208V panelboards
2. MCCs
3. Switchboard
4. Switchgears
5. Control Panels
6. All electrical equipment with an incident energy level greater than 1.2 Cal/cm2.
7. Provide separate labels at each circuit breaker that has arc flash reduction switches indicating the appropriate values when the switch is enabled.

3.4 ARC FLASH TRAINING

Provide Arc Flash Training per Section 16900.

END OF SECTION

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SECTION 16620

ELECTRICAL AND INSTRUMENTATION FIELD TESTS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This Section specifies the field testing of electrical and instrumentation materials, equipment and systems as specified in this Section and in each Section of Division 16. All equipment provided under Division 16 shall be tested as specified herein. The Electrical Contractor shall be present and assist the System Supplier and testing firm in testing all equipment. The Electrical Contractor shall be on site while the System Supplier and testing firm are performing field tests in order to correct any wiring problems.

B. The Electrical Contractor, System Supplier and the testing firm shall provide all labor, tools, material, power, and technical supervision to perform the specified tests and inspections.

C. Prior to start of any field testing, the Field Test Procedures, Interconnection Drawings and Preliminary Operation and Maintenance Manuals shall have been submitted by the Contractor and approved by the Engineer.

D. All field tests shall be documented in writing by the person performing the test on test forms similar to those shown in Appendix "A", and signed by the Owner as satisfactorily completed.

1. Contractor shall fill in the associated Field Test Forms, prior to the start of any field test, with all of the equipment information required on the Equipment Data Forms for the specific area being tested.

2. The testing firm, Electrical Contractor or System Supplier performing tests shall keep a detailed log of all tests that failed or did not meet Specifications, including date of occurrence and correction.

1.2 RELATED SECTIONS

Additional testing requirements may be found in Division 16.

1.3 PROJECT SUBMITTALS

A. Provide field test procedure submittals in format as specified in Section 16011.

B. A copy of the completed test forms shall also be placed in the O&M manual as specified in Section 16012. Test forms submitted without witness signatures will be rejected and re-testing shall be performed at Contractor's expense.

C. Test procedures shall be submitted in separate binders for approval as follows:

1. Pre-Energization Field Tests by third party testing firm.
2. Powered Field Tests by third party testing firm.
3. Field tests by Contractor.
4. Field tests by System Supplier.

PART 2 MATERIALS

2.1 DEFECTS

Contractor shall notify the Owner of any material or workmanship found defective within 24 hours of discovery. All defective equipment shall be replaced with new equipment at no additional expense to Owner.

2.2 TEST EQUIPMENT

A. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, name of calibration laboratory and technician, and date re-calibration is required.

B. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, name of calibration laboratory and technician, and date re-calibration is required.

C. All test equipment to be used as part of field testing shall be listed in the submittal field testing forms.

D. On each day, prior to start of field test, confirm with resident engineer

2.3 TESTING FIRM

A. The Electrical Contractor shall engage and pay for the services of an approved qualified third party independent testing company for the purpose of performing inspections and all tests as specified except for those listed below in paragraph B. The independent testing firm shall not be affiliated in any way with the System Supplier or Electrical Contractor. Submit detailed field test procedures and test forms along with the name of company to perform tests and resumes of person to perform tests. Testing firm shall have been actively engaged in the type of electrical and instrumentation testing specified in this Division for the past three years (minimum).

B. The following field tests may be performed by:

1. Electrical Contractor:
    a. Torque Connections.
    b. Wire Insulation and Continuity Tests.
    c. Phase Rotation Tests.
    d. Motor Tests.
    e. Start-up and Operational Tests.
2. System Supplier:
    a. Instrumentation Tests.
    b. Start-up and Operational Tests.
    c. Program Parameter Record.
    d. Fiber System Tests.

PART 3 EXECUTION

3.1 TESTING

A. General Requirements:

1. It is the intent of these tests to ensure that all equipment is operational within industry and manufacturer's tolerances and is installed in accordance with design plans and Specifications.
2. All tests shall be witnessed by the Engineer and/or Owner. The person performing tests shall fill in two sets of test forms. One set of these test forms shall be given to the Engineer and/or Owner the day of the test. Test forms that are not signed by the Engineer or the Owner on the day of the test will require repeating of the test at no additional cost to the Owner or extension of the Contract time.