

SECTION 02735 - MANHOLES AND PRECAST SEWAGE STRUCTURES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish all labor, material, and equipment necessary to construct manholes for sanitary sewers, including steps, frames and covers, together with all appurtenances as shown and detailed on the Drawings and specified herein. Manhole materials shall be precast concrete, or high density polyethylene (HDPE), as detailed on the Contract Drawings. An internal flexible rubber frame seal and where necessary, an interlocking extension or extensions, shall be used to seal the entire chimney of all sanitary manholes. The seal and extension or extensions shall extend from the frame down to the top of the cone.
- B. When and where detailed or specified, the Contractor shall furnish all labor, material, and equipment necessary to construct wetwells and valve vaults for sanitary sewer collection system or sewage treatment pump stations, including steps, cast-in place hatches, and all appurtenances as shown and detailed on the Drawings and specified herein. Wetwell and valve vault materials shall be precast concrete, or high density polyethylene (HDPE), as detailed on the Contract Drawings.

1.02 RELATED WORK

- A. Section 02731 - Gravity Sewers.
- B. Section 02732 - Sewage Force Mains
- C. Division 3 - Concrete.

1.03 DEFINITIONS

- A. Standard Manhole: Any manhole that is greater than 4 feet in depth, as measured from the invert of the manhole base at its center to the bottom of the manhole frame. A standard manhole will terminate with a manhole cone with ring and lid.
- B. Shallow Manhole: Any manhole that is 4 feet or less in depth, as measured in the preceding sentence. A shallow manhole will terminate in a flat top with ring and lid.

- C. Manhole Chimney: The cylindrical variable height portion of a manhole structure used to support and adjust the finished grade of the manhole frame. The chimney extends from the top of the cone to the base of the manhole frame.
- D. Manhole Cone: That portion of a manhole structure which slopes upward and inward from the barrel of the manhole to the required chimney or frame diameter.
- E. Wetwell: A pump station sewage containing structure constructed of pre-cast concrete components which could be used for large diameter manholes. A wetwell will terminate in a flat top with a hatch and lid cast into the cover.
- F. Valve vault: A pump station valve protection structure constructed of pre-cast concrete components which could be used for manholes. A valve vault will terminate in a flat top with a hatch and lid cast into the cover.

PART 2 - PRODUCTS

2.01 CONCRETE MANHOLES - GENERAL

- A. Manholes shall conform, in shape, size, dimensions, materials, and other respects, to the details indicated on the Drawings.
 - 1. All 4-foot diameter concrete manholes shall have precast reinforced concrete developed bases. Invert channels shall be factory constructed when the base is made. Sloping invert channels shall be constructed whenever the difference between the inlet and outlet elevation is 2 feet or less. The inverts of the developed bases shall conform accurately to the size of the adjoining pipes. Side inverts shall be curved and main inverts (where direction changes) shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerlines of adjoining pipelines. Concrete Manholes with diameters greater than 4 feet shall have cast-in-place or plastic formed inverts which shall be installed after construction of the manhole.
 - 2. The concrete manhole walls (barrels and cones) shall be precast concrete sections. The top of the cone shall be built of reinforced concrete adjustment rings to permit adjustment of the frame to meet the finished surface. Minimum strength of the concrete for the precast sections shall be 4,000 psi at the time of shipment.
 - 3. The base section shall be monolithic for 4-foot diameter manholes. Manholes with a diameter of 5 feet or larger shall have a base slab.
 - 4. Manhole frames and covers shall be the standard frame and cover as indicated on the Drawings and specified hereinafter in this Section.

- B. Manholes shall be manufactured by Sherman Dixie Concrete Industries, or approved equivalent.

2.02 CONCRETE WETWELLS AND VALVE VAULTS - GENERAL

- A. Wetwells and valve vaults shall conform, in shape, size, dimensions, materials, and other respects, to the details indicated on the Drawings.
 - 1. Concrete wetwells shall have cast-in-place inverts. Invert slopes shall be as depicted on the drawings or as required by the pump manufacturer.
 - 2. The concrete wetwell and valve vault walls (barrels) shall be precast concrete sections. The tops of both structures shall be flat, with frames and hatches cast into the slab sections. Minimum strength of the concrete for the precast sections shall be 4,000 psi at the time of shipment.
 - 3. The base section shall be monolithic for 4-foot diameter wetwells and valve vault structures. Wetwells and valve vault structures with diameters of 5 feet or larger shall have a base slab.
- B. Precast components for wetwells and valve vaults shall be manufactured by Sherman Dixie Concrete Industries, or approved equivalent.

2.03 PRECAST CONCRETE SECTIONS

- A. Precast concrete sections and appurtenances shall conform to the ASTM Standard Specifications for Precast Reinforced Concrete Manhole Sections, Designation C478, latest revision, with the following exceptions and additional requirements.
 - 1. The wall sections shall be not less than 5 inches thick.
 - 2. Only Type II cement shall be used except as otherwise specified.
- B. Joints between sections shall be made watertight through the use of rubber O-ring gaskets or rubber profile gaskets such as Forsheda 138. Gaskets shall conform to the ASTM Standard C-443, latest revision. Rope mastic or butyl mastic sealant shall not be allowed except as sealant between the cone section, any adjusting sections or rings, and the frame casting.

2.04 MANHOLES FRAMES AND COVERS

- A. The Contractor shall furnish all cast-iron manhole frames and covers conforming to the details shown on the Drawings, or as specified.
 - 1. The castings shall be of good quality, strong, tough, evengrained cast iron, smooth, free from scale, lumps, blisters, sandholes, and defects of

every nature which would render them unfit for the service for which they are intended. Contact surfaces of covers and frame seats shall be machined to prevent rocking of covers.

2. All castings shall be thoroughly cleaned and subject to a careful hammer inspection.
3. Castings shall be at least Class 25 conforming to the ASTM Standard Specifications for Gray Iron Casting, Designation A48, latest revision.
4. Unless otherwise specified or detailed, manhole covers shall be 22-3/4 inches in diameter, weighing not less than 350 pounds per frame and cover. Manhole covers shall set neatly in the rings, with contact edges machined for even bearing and tops flush with ring edge. They shall have sufficient corrugations to prevent slipperiness. The covers shall have two (2) pick holes about 1-1/4 inches wide and 2 inches deep with 3/8-inch undercut all around. Covers shall not be perforated.
5. All covers shall be marked in large letters "SANITARY SEWER" in the center.

- B. Frames and covers shall be J.R. Hoe and Sons, Mc-350, or approved equivalent.

2.05 MANHOLE STEPS (CONCRETE MANHOLES)

Manholes steps shall be the polypropylene plastic type reinforced with a deformed steel rod. The steps shall be of the size and configuration as shown on the Drawings. Steps shall line up over the downstream invert of the manhole. The steps shall be embedded into the manhole wall a minimum of 3-3/8 inches. Steps shall be uniformly spaced at 12-inch to 16-inch intervals.

2.06 PIPE CONNECTOR SYSTEM

- A. All holes for pipe connections in manhole and wetwell barrels and bases shall have a factory-installed flexible rubber pipe connector system to prevent infiltration. The pipe connector system shall conform to the latest revision of ASTM-C923.
- B. For manholes of 12 feet or less in depth, without the presence of ground water, the pipe connector system shall be A-Lok Manhole Pipe Seal as manufactured by A-Lok Corporation, Trenton, NJ; Contour Seal or Kor-N-Seal as manufactured by National Pollution Control Systems, Inc., Nashua, NH; PSX as manufactured by Press-Seal Gasket Corporation, or an approved equivalent.

- C. For manholes of 12 feet or greater in depth, or when ground water is present, the pipe connector system shall be A-Lok Manhole Pipe Seal as manufactured by A-Lok Corporation, Trenton, NJ, or an approved equivalent.

2.07 HDPE MANHOLES

PE manholes shall conform, in shape, size, dimensions, and other respects, to the details shown or indicated on the drawings.

1. PE manholes shall be manufactured from high density, high molecular weight polyethylene and have a PPI listing as a PE 340R material. Using ASTM D 3350, the pipe resin shall be a cell classification of 34 54 34 C.
2. Pipe connections to HDPE manholes shall be as described elsewhere in this specification, or as approved by the Engineer.
3. All HDPE manholes shall be fabricated to be installed with precast concrete anchors and anti-flotation rings. The manhole manufacturer shall determine the type, location and size of anchors and/or antiflotation rings if the manhole is fully submerged in ground water.
4. HDPE manholes shall be one piece construction for heights beneath the traffic cones of 12 feet or less.
5. HDPE manholes shall be "topped" with a cone-shaped traffic cap manufactured from the same materials as the manhole. Except in non-traffic areas, the manhole top elevation shall be 3 to 5 inches above existing grade.
6. Frames and Lids for HDPE manholes shall be as described elsewhere in this specification, or as approved by the Engineer.
7. HDPE manholes shall be manufactured without lifting holes and ladders or steps, unless specifically detailed on the Drawings.

- B. HDPE manholes shall be manufactured by Phillips Driscopipe or an approved equivalent.

2.08 HDPE WETWELLS AND VALVE VAULTS

- A. HDPE wetwells and valve vaults shall conform, in shape, size, dimensions, and other respects, to the details shown or indicated on the drawings.
 1. HDPE wetwells and valve vaults shall be manufactured from high density, high molecular weight polyethylene and have a PPI listing as a PE 340R material. Using ASTM D 3350, the pipe resin shall be a cell classification of 34 54 34 C.
 2. Pipe connections to HDPE wetwells and valve vaults shall be as described elsewhere in this specification, or as approved by the Engineer.

3. All HDPE wetwells and valve vaults shall be fabricated to be installed with precast concrete anchors and anti-flotation rings. The manufacturer shall determine the type, location and size of anchors and/or antiflotation rings if the manhole is fully submerged in ground water.
 4. HDPE wetwells and valve vaults shall be constructed in not more than one piece for heights of 12 feet or less.
 5. HDPE wetwells and valve vaults shall be "topped" with pre-cast or cast-in-place flat tops, reinforced as detailed on the Drawings. Except in traffic areas, the wetwell and valve vault top elevations shall be 2 to 5 inches above existing grade.
 6. HDPE wetwells and valve vaults shall be manufactured without lifting holes or ladders, unless specifically detailed on the Drawings.
- B. HDPE wetwells and valve vaults shall be manufactured by Phillips Driscopipe or an approved equivalent.

2.09 POLYETHYLENE DIAPHRAGM MANHOLE FRAME INSERTS

- A. Polyethylene diaphragm manhole frame inserts shall be installed in all manholes or those manholes which are susceptible to inflow as indicated on the Drawings.
1. Polyethylene diaphragm manhole frame inserts shall be manufactured from corrosion-proof material suitable for atmospheres containing hydrogen sulfide and diluted sulfuric acid.
 2. The body of the manhole insert shall be made of high density polyethylene copolymer material meeting ASTM Specification D 1248, Class A, Category 5, Type III (the insert shall have a minimum impact brittleness temperature of -180 degrees Fahrenheit). The thickness shall be a uniform 1/8 inch or greater. The manhole frame insert shall be manufactured to dimensions as shown on the Drawings to allow easy installation within the manhole frame.
 3. Insert gaskets shall be made of closed cell neoprene. The gasket shall have a pressure sensitive adhesive on one side and shall be placed under the weight bearing surface of the insert by the manufacturer. The adhesive shall be compatible with the manhole insert material so as to form a long-lasting bond in either wet or dry conditions.
 4. A lift strap shall be attached to the rising edge of the bowl insert. The lift strap shall be made of 1 inch wide woven polypropylene web and shall be seared on all cut ends to prevent unraveling. The lift strap shall be attached to the manhole insert by means of a stainless steel rivet. Placement of the lift strap shall provide easy visual location.
 5. Standard ventilation shall be by means of vent hole on the side wall of the manhole frame insert approximately 3/4-inches below the lip. The

vent hole will allow a maximum release of 10 gallons per 24 hours when the insert is full.

6. The manhole frame insert shall be manufactured to fit the manhole frame rim upon which the manhole cover rests. The Contractor is responsible for obtaining specific measurements of each manhole cover to insure a proper fit. The manhole frame shall be cleaned of all dirt, scale and debris before placing the manhole frame insert on the rim.
- B. The polyethylene diaphragm manhole inserts shall be as provided by any manufacturer approved by the Engineer.

2.10 MANHOLE FRAME SEAL

- A. Manhole frame seals shall consist of a flexible internal rubber sleeve and extension and stainless steel compression bands, all conforming to the following requirements:
1. Rubber Sleeve and Extension - The flexible rubber sleeve, extensions and wedge strips shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C-923, with a minimum 1500 psi tensile strength, maximum 18% compression set and a hardness (durometer) of 48"5.
 2. The sleeve shall be either double or triple pleated, with a minimum unexpanded vertical height of 8 inches and 10 inches respectively and a minimum thickness of 3/16 inches. The top and bottom section of the sleeve shall contain an integrally formed expansion band recess and multiple sealing fins.
 3. The top section of the extension shall have a minimum thickness of 3/32 inches and shall be shaped to fit into the bottom band recess of the sleeve under the bottom chimney seal band and the remainder of the extension shall have a minimum thickness of 3/16 inches. The bottom section of the extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of the rubber sleeve.
 4. Any splice used to fabricate the sleeve and extension shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180 degree bend with no visible separation.
 5. The continuous wedge strip used to adapt the rubber sleeve to sloping surfaces shall have the slope differential needed to provide a vertical band recess surface, be shaped to fit into the band recess and have an integral band restraint. The length of the wedge strip shall be such that, when its ends are butted together, it will cover the entire inside circumference of that band recess needing slope adjustment.
 6. The expansion bands used to compress the sleeve against the manhole shall be integrally formed from 16 gauge stainless steel conforming to ASTM A-240 Type 304, with no welded attachments and shall have a

minimum width of 1: inches. The bands shall have a minimum adjustment range of 2 diameter inches and the mechanism used to expand the band shall have the capacity to develop the pressures necessary to make a watertight seal. The band shall be permanently held in this expanded position with a positive locking mechanism, any studs and nuts used for this mechanism shall be stainless steel conforming to ASTM F-923 and 594, Type 304.

- B. Manhole frame seals shall be manufactured by Cretex Specialty Products or approved equivalent.

2.11 CLEANOUTS

- A. Cleanouts shall be extended to finish grade and capped with a clean-out plug in accordance with details and at locations shown on the Drawings.
 - 1. Pipe shall be the same as the gravity sewer line in which the cleanout is located.
 - 2. A 4-inch thick concrete pad, 2 feet 0-inches square, with the cleanout lid section, shall be provided around each cleanout.

2.12 DROP CONNECTIONS

Drop connections shall be installed in the manhole as shown on the Drawings.

PART 3 - EXECUTION

3.01 FABRICATION - PRECAST SECTIONS

- A. Manhole and valve vault sections shall contain manhole steps accurately positioned and embedded in the concrete when the section is cast. Wet well sections shall contain no manhole steps.
- B. Sections shall be cured in an enclosed curing area and shall attain a strength of 4,000 psi prior to shipment.
- C. No more than two (2) lift holes or inserts may be cast or drilled in each section.
- D. Flat slab tops shall have a minimum thickness of 6 inches and reinforcement in accordance with ASTM C478.
- E. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the precast sections.

F. Acceptance of the sections will be on the basis of material tests and inspection of the completed product and test cylinders if requested by the Engineer.

G. Cones shall be precast sections of similar construction.

3.02 SETTING PRECAST SECTIONS

A. Precast reinforced concrete sections shall be set so as to be vertical and with sections and steps, where required, in true alignment.

B. Rubber gaskets shall be installed in all section joints in accordance with the manufacturer's recommendations.

C. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs made specifically for this purpose.

3.03 SETTING MANHOLE FRAMES AND COVERS

A. Manhole frames shall be set with the tops conforming to the required elevations set forth hereinbefore. Frames shall be set concentric with the top of the concrete and in a full bead of butyl mastic sealant so that the space between the top of the manhole and the bottom flange of the frame shall be completely watertight.

B. Manhole covers shall be left in place in the frames on completion of other work at the manholes.

3.04 INSTALLATION OF MANHOLE FRAME SEAL

A. The Contractor shall measure the manhole to determine the information required on the manufacturer's Sizing and Ordering procedure.

1. All sealing surfaces shall be reasonably smooth, clean and free of any form offsets or excessive honeycomb. The top internal portions of the cone shall have a minimum 3-inch high vertical surface. The preparation of this vertical surface when none exists shall be in accordance with the frame seal manufacturer's instructions.

2. The internal frame seals and extensions shall be installed in accordance with the manufacturer's instructions. The Contractor shall have a manufacturer's recommended expansion tool and all other equipment/tools necessary to install the frame seals.

3. Manhole frame seals shall be visually inspected after installation to ensure that the seal is properly positioned, tight against the manhole and frame surfaces, that no voids or leakage points exist and that the bands are securely locked in place. Any seals failing this inspection

shall be reworked as necessary and reinspected at no additional cost to the Owner.

3.05 ADJUSTING MANHOLE FRAMES AND COVERS TO GRADE

- A. Unless otherwise shown on the Drawings, the top of the precast concrete eccentric cone of a standard manhole or the top of the flat slab of a shallow manhole shall terminate not less than 4 inches below existing grade in an unpaved non-traffic area (except in a residential yard) and not less than 13 inches below existing grade in a paved or unpaved traffic area and in a residential yard. The frame and lid shall be adjusted to the required final grade as described hereinafter.
- B. Only clean adjusting sections shall be used. Each adjusting section shall be laid in a bead of butyl mastic sealant and shall be thoroughly bonded.
- C. When a manhole is located in an unpaved non-traffic area (other than a residential yard), the frame and cover shall be adjusted to a final elevation of 3 inches to 5 inches above the existing grade at the center of the cover. If field changes have resulted in the installed manhole invert elevation being lower than the invert elevation shown on the Drawings, the adjustment to the required final elevation of 3 inches to 5 inches above existing grade shall be accomplished by the use of precast concrete adjusting rings. If field changes have resulted in the completed manhole invert being higher than the invert shown on the Drawings and the top of the frame and cover being higher than 5 inches above the existing grade, then the Contractor shall substitute, at no additional cost to the Owner, a shorter barrel section on the manhole so that the frame and lid may be adjusted to the proper final elevation through the use of precast concrete adjusting rings.
- D. When a manhole is located in a bituminous, concrete, or crushed stone traffic area, or in a residential yard, the frame and cover shall be adjusted to the grade of the surrounding area by the use of precast concrete rings. The adjusted frame and lid shall conform to the elevation and slope of the surrounding area. If field changes have resulted in the completed manhole invert being higher than the invert shown on the Drawings and the top of the eccentric cone, when used, or the top of the flat slab, when used, being less than the height of the frame and lid below the grade of the surrounding area, then the Contractor shall substitute, at no additional cost to the Owner, a shorter barrel section on the manhole so that the frame and lid may be adjusted to the proper final elevation through the use of precast concrete adjusting rings.

- E. The Contractor shall coordinate elevations of manhole covers in paved streets with the Owner. If resurfacing of the street in which sewers are laid is expected within twelve (12) months, covers shall be set 1-1/2 inches above the existing pavement surface in anticipation of the resurfacing operations.

3.06 VACUUM TESTING OF MANHOLES AND PRECAST SEWAGE STRUCTURES

- A. Manholes shall be tested in accordance with ASTM 1244, after installation with all connections in place. The vacuum test method is intended to demonstrate the condition of manholes prior to backfill. It may also be used to test manholes after backfilling; however, testing should be correlated with the connector supplier.
- B. Where groundwater is present in the excavation and trenches, the Contractor shall take any necessary steps (including construction of a piezometric tube adjacent to the manhole) to determine the depth of groundwater above the invert of the manhole at the time of testing, at no additional cost to the Owner. Information concerning groundwater levels above the invert shall be used to determine the amount of vacuum applied during the test.
- C. A vacuum test for manholes **shall** include testing of the joint seal between the cast iron frame and the concrete cone, top slab, and any grade rings. Where a hatch and cover are provided in the top of a precast sewage structure, the Contractor shall provide a means of establishing a seal over the hatch, unless the Drawings and notes indicate that the hatch is to be tested for vacuum.
- D. Prior to the test, the following items shall be complete:
 - 1. Lift holes, if any, shall be plugged with an approved, non-shrink grout prior to testing.
 - 2. Drop connections, if any, shall be installed prior to testing.
- E. Testing Procedure:
 - 1. Temporarily plug, with the plugs being braced to prevent the plugs or pipes from being drawn into the manhole, all pipes entering the manhole at least eight inches into the sewer pipe(s). The plug must be inflated at a location past the manhole/pipe gasket.
 - 2. The test head shall be placed on the top of the conical, over the manway opening in a flat top, or (in the case of a wetwell or valve vault) over such adapter as may be required, and inflated in accordance with the manufacturer's recommendations.

3. A vacuum of 10 inches of mercury shall be drawn on the manhole, or such lesser amount of vacuum that the combined vacuum and positive external head pressure from groundwater does not exceed the recommended pressure ratings for the pipe connector system. The vacuum shall be measured by a test gauge which shall be liquid filled, having a 3.5 inch diameter face, reading from zero to thirty inches of mercury.
4. The indicated vacuum (as determined under the preceding paragraph) shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop 1 inch of mercury.
5. The manhole shall be considered to pass the vacuum test if the time for the vacuum reading to drop 1 inch of mercury meets or exceeds the values indicated in the following table:

Minimum Test times for Various Manhole Diameters (seconds)									
Depth	Diameter (inches)								
(ft.)	30	33	36	42	48	54	60	66	72
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	28	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	58	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	69	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

6. If a manhole fails the vacuum test, the manhole shall be repaired with a non-shrinkable grout or other suitable material based on the material of which the manhole is constructed and retested, as stated above.
7. Failure of this vacuum test shall not preclude acceptance by appropriate water infiltration or exfiltration testing, or such other means as may be accepted by the Engineer.
8. All temporary plugs and braces shall be removed after each test.

END OF SECTION 02735

Division 3 - Concrete

SECTION 03310 - CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 - GENERAL

1.01 WORK INCLUDED

The work in this section shall include all formwork, shoring, bracing, anchorage, concrete reinforcement and accessories for cast-in-place concrete.

1.02 GENERAL REQUIREMENT

All concrete construction shall conform to all applicable requirements of ACI 301, ACI 318 and ACI 350 R, except as modified by the supplemental requirements specified herein.

1.03 RELATED WORK

- A. Section 02222 - Excavation.
- B. Section 03100 - Concrete Formwork.
- C. Section 03370 - Concrete Curing.
- D. Section 04200 - Unit Masonry.
- E. Section 05500 - Miscellaneous Metals, Fasteners, and Special Finishes.

1.04 REFERENCES

- A. The Contractor shall obtain and have available in the field office at all times the following references:
 - 1. Specifications for Structural Concrete for Building ACI 301 (latest revision).
 - 2. Field Reference Manual: Specifications for Structural Concrete for Buildings ACI Sp-15.
 - 3. Manual of Standard Practice - CRSI (latest revision).
 - 4. Placing Reinforcing Bars - CRSI (latest revision).
 - 5. Building Code Requirements for Reinforced Concrete ACI 318.
 - 6. Environmental Engineering Concrete Structures ACI 350R.
- B. The following standard shall also apply to this work:
 - 1. ASTM C-143.
 - 2. ASTM C-150.

3. ASTM C-33.
4. ASTM C-260.
5. ASTM C-494.
6. ASTM A-615.
7. ASTM D-638.
8. ASTM D-695.
9. ASTM D-570.
10. ASTM D-1252.
11. ASNI A-116.1.
12. ASTM A-120.
13. ASTM C-94.
14. ASTM D-2146.
15. Federal Specifications FF-S-325.

1.05 SUBMITTALS

- A. The Contractor shall submit the following data to the Engineer for review:
 1. Proposed mix designs, test results, plotted curves and all other substantiating data as required by ACI 301.
 2. Mix designs for all mixes proposed or required to be used, including all mixes containing admixtures.
 3. A certified copy of the control records of the proposed production facility establishing the standard deviation as defined in ACI 301.
- B. Certification attesting that admixtures equal or exceed the physical requirements of ASTM C-494 for Type A admixture and when required, for Type D admixture.
- C. Notarized certifications by the manufacturer that epoxy bonding adhesive meets the specification contained herein.
- D. Drawings showing locations of all proposed construction joints.
- E. Shop drawing for reinforcing steel showing bar schedules, location, and splices.

1.06 QUALITY ASSURANCE

- A. Consistency:
 1. Concrete shall be of such consistency that it can be worked readily into all parts of the forms and around embedded work, without permitting the materials to segregate, or free water to collect on the surface. Consistency shall be measured by the ASTM Standard Test Method for Slump of Portland Cement Concrete, Designation C143. The consistency of concrete shall be as given in Table I, of the standard.

2. Slump tests shall be made in the field by the Contractor.

B. Compression Tests:

1. During the progress of the work, at least one set of four compression test cylinders shall be made for each 50 cubic yards of concrete or major fraction thereof, and not less than one such set for each type of concrete for each days' pouring. Cylinders made in the field shall be made and cured in accordance with ASTM Standard Method of Making and Curing Concrete Test Specimens in the Field, Designation C31, except that wherever possible molds shall be left on cylinders until they have reached the laboratory.
2. One (1) cylinder of each set shall be broken in accordance with ASTM C-39 at seven (7) days and two (2) at twenty-eight (28) days. Two (2) copies of these test results shall be submitted to the Engineer on the same day of the tests. The remaining cylinder shall be reserved for future testing if required.
3. On evidence of these tests, any concrete that fails to meet the specified strength requirements shall be strengthened or replaced as directed by the Engineer at the Contractor's expense.

C. Inserts in Concrete by Other Trades:

1. All trades shall be notified, at the proper time, to install items to be embedded in concrete.
2. All castings, inserts, conduits, and other metalwork shall be accurately built into or encased in the concrete by the Contractor as directed and all necessary precautions shall be taken to prevent the metalwork from being displaced or deformed.
3. Anchor bolts shall be set by means of substantial templates.
4. The Contractor shall build into new concrete against which facing brick or tile is to be laid, suitable, acceptable, non-corrodible metal, dovetail grooves for ties for securing the brickwork to the concrete.

D. Testing:

1. All testing shall be in accordance with provisions of ACI 301.
2. Testing services listed in ACI 301 shall be performed by a testing agency acceptable to the Engineer. Testing services to meet the requirements of ACI shall be paid for by the Contractor at his expense. Test shall be made for each 50 cubic yards of concrete and/or each day concrete is placed.

E. Additional Requirements:

1. Unless otherwise directed by the Engineer, the vertical surfaces of all footings shall be formed. Excavations and reinforcement for all footings shall have been inspected by the Engineer before any concrete is placed.
2. The installation of underground and embedded items shall be inspected before slabs are placed. Pipes and conduits shall be installed below the concrete unless otherwise indicated. Fill required to raise the subgrade shall be placed as specified in Division 2. Unless shown otherwise, porous fill not less than 6 inches in compacted thickness shall be installed under all slabs, tank bottoms, and foundations. The fill shall be leveled and uniformly compacted to a reasonably true and even surface. The surfaces shall be clean, free from frost, ice, mud and water. Where indicated, waterproof paper, polyethylene sheeting of nominal 4-mil minimum thickness, or polyethylene coated burlap shall be laid over surfaces receiving concrete.

F. Hot Weather Requirements: Placing of concrete under conditions of high temperatures, low humidity or wind shall be done in accordance with the American Concrete Institute "Hot Weather Concreting" (ACI 305R).

G. Cold Weather Requirements: Cold weather concreting procedures and precautions shall conform with American Concrete Institute "Cold Weather Concreting" (ACI 306R).

PART 2 - PRODUCTS

2.01 Contractor shall supply concrete only from an approved ready mixed concrete supplier.

2.02 CONCRETE MIX WITHOUT FLY ASH

Structural concrete of the various classes required shall be proportioned by ACI 301, in addition to the limitation herein listed, to produce the following minimum 28-day compressive strengths:

A. Selection of Proportions for Class A Concrete:

1. 4,500 psi compressive for strength at 28 days.
2. Type II cement plus water reducing, dispersing agent and air. Type IP cement may be used in place of Type II.
3. Maximum water/cement plus water reducing dispersing agent ratio = 0.42.
4. Minimum cement content = 564 pounds (6.0 bags)/cubic yards concrete.

5. Nominal maximum size coarse aggregate = No. 67 (3/4-inch maximum) or No. 57 (1-inch maximum).
6. Air content = 6 percent plus or minus 2 percent by volume.
7. Slump = 2 inches to 3 inches in accordance with ASTM C-143.

B. Selection of proportions for Class B concrete:

1. 3,000 psi compressive strength at 28 days.
2. Type I cement plus water reducing dispersing agent and air.
3. Maximum (water)/(cement plus water reducing dispersing agent) ratio = 0.50.
4. Minimum cement content = 432 pounds (4.5 bags)/cubic yards concrete.
5. Nominal maximum size coarse aggregate = No. 67 (3/4-inch maximum) or No. 57 (1-inch maximum).
6. Air content = 6 percent plus or minus 2 percent by volume.
7. Slump = 3 inches to 4 inches in accordance with ASTM C-143.

2.03 OPTIONAL CONCRETE MIX USING FLY ASH

A. Selection of Proportions for Class A Concrete:

1. 4,500 psi compressive for strength at 28 days.
2. Type II cement plus water reducing dispersing agent and air.
3. Maximum (water)/(cement plus water reducing dispersing agent) ratio = 0.42.
4. Minimum cement content = 517 pounds (5.5 bags)/cubic yards concrete.
5. Maximum Fly Ash Content = 71 pounds/cubic yards
6. Nominal maximum size coarse aggregate = No. 67 (3/4-inch maximum) or No. 57 (1-inch maximum).
7. Air content = 6 percent plus or minus 2 percent by volume.
8. Slump = 2 inches to 3 inches in accordance with ASTM C-143.

B. Selection of Proportions for Class B Concrete:

1. 3,000 psi compressive strength at 28 days.
2. Type II cement plus water reducing dispersing agent and air.
3. Maximum (water)/(cement plus water reducing dispersing agent) ratio = 0.50.
4. Minimum cement content = 376 pounds (4.0 bags)/cubic yards concrete.
5. Maximum Fly Ash Content = 94 pounds/cubic yards.
6. Nominal maximum size coarse aggregate = No. 67 (3/4-inch maximum) or No. 57 (1-inch maximum).
7. Air content = 6 percent plus or minus 2 percent by volume.
8. Slump = 3 inches to 4 inches in accordance with ASTM C-143.

C. Applicable Standards:

1. ANSI C 311, "Standard Methods of Sampling and Testing Fly Ash for Use as an Admixture in Portland Cement Concrete".
2. ANSI C 618, "Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete".

D. Concrete shall be used as follows:

1. Class A concrete for all concrete work except as noted below.
2. Class B concrete for fill concrete, thrust blocks, drilled piers, and where indicated on the Drawings.

E. All testing shall be or have been performed by an approved independent testing laboratory.

F. Cement for exposed concrete shall have a uniform color classification.

G. Type II cement conforming to ASTM C-150 shall be used in all structural concrete. The alkali content shall not exceed 0.6 percent calculated as sodium oxide. Type IP Cement may be used in place of Type II cement, for mix designs not using fly ash.

H. Coarse aggregate shall conform to all requirements of ASTM C-33.

I. Manufactured sand shall not be used as fine aggregate in concrete.

2.04 FLY ASH CONCRETE

A. In the absence of a verified and acceptable history of fly ash concrete mixes, the following procedure is required to establish the quality of the concrete mix.

B. Trial batches must be made starting thirty (30) days ahead of initial concrete pour. Four (4) mixes shall be designed and produced at no cost to the Owner or the Engineer as follows:

1. Mix using Type II cement with water reducing admixture for normal temperatures (Class A).
2. Mix using Type II cement with water reducing admixture for cold weather temperatures (Class A).
3. Mix using Type II cement with water reducing admixture for hot weather temperatures (Class A).
4. Mix using Type II cement with water reducing admixture for normal weather temperatures (Class B).

- C. Four (4) test cylinders shall be cast for each of the four (4) mixes. Two (2) cylinders shall be broken at 7 days, and two (2) cylinders shall be broken at 28 days, for each of the four (4) mixes. The trial batch design report shall include strength breaks at 7 days and 28 days, air content, etc.
- D. The water-reducing, cement dispersing admixture (such as Master Builders Pozzolith 344-N, Nox-Crete Plastiflow, Plastocrete 161 by SIKKA Chemical Company, or approved equivalent) used in fly ash concrete, shall be a normal, accelerated, or retarded hardening admixture. The admixture shall be used at optimum dosage to offset the slow strength development and setting characteristics of the fly ash. Only those brands of admixture that can provide readily available field service on short notice to provide field services, inspection, and assistance, will be acceptable.
- E. Recent mill reports shall be submitted prior to the use of fly ash concrete, with continuing reports on a regular basis during the project. Maximum loss on ignition (LOI) shall be 6 percent.
- F. Tests for air content shall be made twice a day at the jobsite prior to placement, for all mixes containing fly ash.

2.05 ADMIXTURES

- A. An air entraining admixture shall be used on all concrete and shall be the neutralized vinsol resin type such as Master Builders MB-VR, or Euclid Chemical Co. AIR-MIX or equivalent. The admixture shall meet the requirements of ASTM C-260. Certification attesting to the percent of effective solids and compliance of the material with ASTM C-260 shall be furnished, if requested.
- B. A water reducing, set controlling admixture (non-lignin type) shall be used in all concrete. The admixture shall be a combination of polyhydroxylated polymers including catalysts and components to produce the required setting time based on job site conditions, specified early strength development, finishing characteristics required, and surface texture, as determined by the Engineer.
- C. Certification shall be furnished attesting that the admixture exceeds the physical requirements of ASTM C-494, Type A, water reducing and normal setting admixture, and when required, for ASTM C-494, Type D, water reducing and retarding admixture when used with local materials with which the subject concrete is composed.

- D. The admixture manufacturer, when requested, shall provide a qualified concrete technician employed by the manufacturer to assist in proportioning concrete for optimum use. He also will be available when requested to advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing job conditions.
- E. The use of admixtures to retard setting of the concrete during hot weather, to accelerate setting during cold weather, and to reduce water content without impairing workability will be permitted if the following conditions are met.
- F. The admixture shall conform to ASTM C-494 except that the durability factor for concrete containing the admixture shall be at least 100 percent of control, the water content a maximum of 90 percent of control and length change shall not be greater than control, as defined in ASTM C-494.
- G. Where the Contractor finds it impractical to employ fully the recommended procedures for hot weather concreting, the Engineer may at his discretion require the use of a set retardant admixture for mass concrete greater than 2.5 feet thick and for all concrete whenever the temperature at the time concrete is cast exceeds 80 degrees F. The admixture shall be selected by the Contractor subject to the review of the Engineer. The admixture and concrete containing the admixture shall meet all the requirements of these Specifications. Preliminary tests of this concrete shall be required at the Contractor's expense.
- H. Admixtures shall be used in concrete design mixes in the same manner and proportions as in the field so that the effects of the admixtures are included in preliminary tests submitted to the Engineer for review prior to the start of construction.
- I. When more than one admixture is used, all admixtures shall be compatible. They should preferably be by the same manufacturer.
- J. Calcium chloride will not be permitted as an admixture in any concrete.

2.06 WATER

The water for concrete shall be potable water. Site added mix water, where allowed, shall also be potable.

2.07 AGGREGATES

- A. Fine aggregates shall be natural sand having clean, hard, uncoated grains, free from injurious amounts of clay, dust, organic matter or other deleterious substances, and shall conform to ASTM C-33.

- B. Coarse aggregates shall be crushed stone having clean, hard, uncoated particles, and shall be free from injurious amounts of soft, friable, thin, elongated or laminated pieces. Shale may not be used as aggregate. Coarse aggregates shall conform to ASTM C-33 and shall not exceed the following maximum sizes:
 - 1. 3/4-inch for slabs, beams, girders, and walls.
 - 2. 1-inch for all other concrete.

2.08 TESTING AGGREGATES AND DETERMINING PROPORTIONS

- A. No concrete shall be used in the work until the materials and mix design have been accepted by the Engineer.
- B. The conformity of aggregates to the specifications hereinbefore given shall be demonstrated and determined by tests per ASTM C-33 made with representative samples of the materials to be used on the work.
- C. The actual proportions of cement, aggregates, admixtures and water necessary to produce concrete conforming to the requirements set forth shall be determined by making test cylinders using representative samples of the materials to be used in the work. A set of four (4) standard 6-inch cylinders shall be made and cured per ASTM C-31. Two (2) shall be tested at 7 days and two (2) at 28 days per ASTM C-39. The slump shall not be less than the greatest slump expected to be used in the work.
- D. Reports on the tests and a statement of the proportions proposed for the concrete mixture, shall be submitted in triplicate to the Engineer for review as soon as possible, but not less than five (5) days prior to the proposed beginning of the concrete work. If the Contractor furnishes in writing, similar, reliable detailed information from an acceptable source, and of date not more than four (4) months prior to the time when concrete will be used on this project, the above requirements for laboratory tests may be modified by the Engineer. Such data shall derive from mixtures containing constituents, including the admixtures where used, of the same types and from the same sources as will be used on this project.
- E. The Engineer shall have the right to make check tests of aggregates and concrete, using the same materials, and to order changes as may be necessary to meet the specified requirements.
- F. The Contractor may request permission to add water at the job site, and when the addition of water is permitted by the Engineer, the quantity added shall be the responsibility of the Contractor and in no case shall the total water per bag of cement exceed that determined by the designed mix.

- G. All concrete exposed to weather, such as foundations, walls, exterior steps and retaining walls, etc. shall be air entrained.
- H. If concrete of the required characteristics is not being produced as the work progresses, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure concrete of the specified quality. The Contractor shall make such changes at his own expense and no extra compensation will be allowed because of such changes.

2.09 MIXING

All central plant and rolling stock equipment and methods shall conform to the Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of the National Ready Mixed Concrete Assn., as well as the ACI Standards for Measuring, Mixing and Placing Concrete (ACI 614), and with Sections 7 to 14, inclusive, of the ASTM Standard Specification for Ready Mixed Concrete, Designation C94-78a, insofar as applicable.

2.10 WATERSTOPS

See Section 03251 - Expansion and Contraction Joints.

PART 3 - EXECUTION

3.01 PLACING AND COMPACTING CONCRETE

- A. At least 20 hours before the Contractor proposes to make any placement of concrete, he shall notify the Engineer of his intention and planned procedure. Unless otherwise permitted, the work shall be so executed that a section begun on any day shall be completed during daylight of the same day.
- B. Ready mixed concrete shall be transported to the site in watertight agitator or mixer trucks. The quantity of concrete to be mixed or delivered in any one batch shall not exceed the rated capacity of the mixer or agitator for the respective conditions as stated on the nameplates.
- C. Central mixed concrete shall be plant mixed a minimum of 1-1/2 minutes per batch, and then shall be truck mixed or agitated a minimum of 8 minutes. Agitation shall begin immediately after the premixed concrete is placed in the truck and shall continue without interruption until discharge. For transit mixed concrete, the major portion of the mixing water shall be added and mixing started immediately after the truck is charged.

- D. The amount of water initially added shall be recorded on the delivery slip for the Engineer's information, no additional water shall be added, either in transit or at the site, except as directed. Mixing (at mixing speed) shall be continued for at least 10 minutes followed by agitation without interruption until discharge. Concrete shall be discharged at the site within 1-1/2 hours after water was first added to the mix, and shall be mixed at least 5 minutes after all water has been added.
- E. Concrete which has become compacted or segregated during transportation to or on the site of the work shall be satisfactorily remixed just prior to being placed in the forms.
- F. Partially hardened concrete shall not be deposited in the forms. The retempering of concrete which has partially hardened (that is, the remixing of concrete with or without additional cement, aggregate, or water) will not be permitted.
- G. The concrete shall be mixed only in the quantity required for immediate use. Concrete that has developed an initial set shall not be used. The Contractor shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required.
- H. The temperature of the concrete mixture immediately before placement shall be between 50 degrees F and 90 degrees F.
- I. Concrete mixed in stationary mixers and transported by nonagitating equipment shall be placed in the forms within 45 minutes from the time ingredients are charged into the mixing drum. Concrete that is truck mixed or transported in truck mixers or truck agitators shall be delivered to the site of the work and discharge completed in the forms within the time specified in paragraph 10.7 of ASTM C-94, except that when the concrete temperature exceeds 85 degrees F, the time shall be reduced to 30 minutes. Transmit mixed concrete that is completely mixed at the site of concrete placement or batched cement and aggregates transported to mixers shall be placed in the forms within 1-1/2 hours after cement has been added. Concrete shall be placed in the forms within 15 minutes after discharge from the mixer at the job site.
- J. If concrete is placed by pumping, no aluminum shall be used in any parts of the pumping system which contact or might contaminate the concrete. Aluminum chutes and conveyors shall not be used.

- K. No concrete shall be placed until the subgrade has been accepted in accordance with the requirements of Section 01400, Quality Control, nor shall it be placed on frozen subgrade or in water. Placement of concrete shall not be scheduled until the forms, , reinforcing, and preliminary work have been accepted. No concrete shall be placed until all materials to be built into the concrete have been set and have been accepted by the various trades and by the Engineer. All such materials shall be thoroughly clean and free from rust, scale, oil, or any other foreign matter.
- L. Forms and excavations shall be free from water and all dirt, debris, and foreign matter when concrete is placed. Except as otherwise directed, wood forms and embedded wood called for or allowed shall be thoroughly wetted just prior to placement of concrete.
- M. Concrete placed at air temperatures below 40 degrees F shall have a minimum temperature of 50 degrees F and a maximum of 70 degrees F when placed.
- N. Chutes for conveying concrete shall be metal or metal lined and of such size, design, and slope as to ensure a continuous flow of concrete without segregation. The slope of chutes shall have approximately the same slope. The discharge end of the chute shall be provided with a baffle, or if required, a spout and the end of the chute. The spout shall be kept as close as practicable to, but in no event more than 5 feet above the surface of the fresh concrete. When the operation is intermittent, the chute shall discharge into a hopper.
- O. In thin sections of considerable height (such as walls and columns), concrete shall be placed in such manner as will prevent segregation and accumulations of hardened concrete on the forms or reinforcement above the mass of concrete being placed. To achieve this end, suitable hoppers spouts with restricted outlets, etc. shall be used as required or permitted unless the forms are provided with suitable openings.
- P. Chutes, hoppers, spouts, etc. shall be thoroughly cleaned before and after each run and the water and debris shall not be discharged inside the form.
- Q. For any one placement, concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams and planes of weakness within the section, and so as to maintain until the completion of the unit, an approximately horizontal plastic surface.
- R. No wooden spreaders shall be left in the concrete.

- S. During and immediately after being deposited, concrete shall be thoroughly compacted by means of suitable tools and methods, such as internal type mechanical vibrators operating at not less than 5,000 rpm. or other tool spading to produce the required density and quality of finish. Vibration shall be done only by experienced operators and shall be carried in such manner and only long enough to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents, "pumping" of air, or other objectionable results.
- T. The concrete shall be thoroughly rodded and tamped about embedded materials so as to secure proper adhesion and prevent leakage. Care shall be taken to prevent the displacement of such materials during concreting.
- U. The distance between construction joints shall not exceed 25 feet for all concrete construction and not less than 48 hours shall elapse between casting of adjoining units unless these requirements are waived by the Engineer. Provision shall be made for jointing successive units as indicated or required. Where joints are not shown on the Drawings, they are required to be made at a spacing of approximately 25 feet. Additional construction joints required to satisfy the 25 foot spacing requirement shall be located by the Contractor subject to the review of the Engineer. The Contractor shall submit for review Drawings separate from the steel reinforcing Drawings, showing the location of all proposed construction joints. All construction joints shall be prepared for bonding as specified in ACI Standard 301. Joints in walls and columns shall be maintained level.
- V. Formwork for beam soffits and slabs and other parts that support the weight of concrete shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified or permitted.

3.02 BONDING CONCRETE AT CONSTRUCTION JOINTS

- A. In order to secure full bond at construction joints, the surface of the concrete previously placed (including vertical, inclined, and substantially horizontal areas) shall be thoroughly cleaned of foreign materials and laitance, if any, and then roughened.
- B. The previously placed concrete at the joint shall be free of standing water.
- C. Waterstops shall be used on all construction joints below water level.

3.03 CURING AND PROTECTION

- A. All concrete, particularly slabs and including finished surfaces, shall be treated immediately after concreting or cement finishing is completed, to provide continuous moist curing for at least seven days, regardless of the adjacent air temperature. Walls and vertical surfaces may be covered with continuously saturated burlap, or kept moist by other acceptable means. Horizontal surfaces, slabs, etc., shall be ponded to a depth of 1/2-inch wherever practicable, or kept continuously wet by the use of lawn sprinklers, a complete covering of continuously saturated burlap, or by other acceptable means.
- B. For at least seven days after having been placed, all concrete shall be so protected that the temperature at the surface will not fall below 45 degrees F. **The methods of protecting the concrete shall be subject to the review of the Engineer.**
- C. No manure, salt, or other chemicals shall be used for protection.
- D. The above mentioned 7-day periods may be reduced to 3 days in each case if high-early-strength cement is allowed to be used in the concrete.
- E. Wherever practicable, finished slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.04 TRIMMING AND REPAIRS

- A. The Contractor shall use suitable forms, mixture of concrete, and workmanship so that concrete surfaces, when exposed, will not require patching. Concrete which, in the opinion of the Engineer has excessive honeycomb, aggregate pockets, or depressions will be rejected and the Contractor shall, at his own expense remove the entire section containing such defects and replace it with acceptable concrete.
- B. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties shall be filled and surface defects which do not impair structural strength shall be repaired.
- C. Defective concrete shall be cut perpendicular to the surface until sound concrete is reached, but not less than 1-inch deep. The remaining concrete shall be thoroughly roughened and cleaned. Concrete around the cavity or the form tie recess shall be thoroughly wetted and promptly painted with a 1/16-inch brush coat of neat cement mixed to the consistency of thick paint. The hole shall then be filled with mortar.

- D. Mortar shall be 1:1-1/2 cement and sand mix with sufficient white cement, or fine limestone screening in lieu of sand, to produce a surface matching the adjoining work. Cement and sand shall be from the same sources as in the parent concrete.
- E. Mortar in patches shall be applied so that after partial set it can be compressed and rubbed to produce a finish flush and uniform in texture with the adjoining work. All patches shall be warm-moist cured as above specified.
- F. The use of mortar patching as above specified shall be confined to the repair of small defects in relatively green concrete. If substantial repairs are required, the defective portions shall be cut out to sound concrete and the defective concrete replaced by means of a cement gun, or the structure shall be taken down and rebuilt, all as the Engineer may decide or direct.

3.05 FINISHES

- A. Exposed to View Concrete Surfaces:
 - 1. All concrete exposed to view in the completed structure shall be produced using materials and workmanship to such quality that only nominal finishing will be required. The provisions of ACI shall apply to all exposed to view concrete surfaces (limited to 1 foot below grade and 1 foot below the minimum liquid level for structures that will contain liquids).
 - 2. Forms for exposed concrete surfaces shall be exterior grade, high density overlay plywood, steel, or wood forms with smooth tempered hard board form liners.
 - 3. Forms shall be coated with Nox-Crete Form Coating Release Agent, Debond Form Coating by L & M Construction Chemicals, Inc. or an approved equivalent, before initial pour and between subsequent pours, in accordance with the manufacturer's printed instructions. Form boards shall not be wet with water prior to placing concrete.
 - 4. Recessed joints in concrete shall be formed using lacquer coated wooden battens or forms, milled to indicated profiles. Battens and corner strips shall be carefully inspected before concrete is placed and damaged pieces replaced.
 - 5. Chamfer strips shall be 1-inch radius with leg, polyvinyl chloride strips by Gateway Building Products, Saf-T-Grip Specialties Cor., Vinylex Corp., or equivalent.
 - 6. Particular attention is directed to the requirements of ACI 301. Form panels shall be provided in the maximum sizes compatible with the form joints. Wherever practicable, form joints shall occur at recessed joints. All form joints in exterior exposed to view surfaces shall be carefully caulked with an approved nonstaining caulking compound. Joints shall not be taped. Form oil or other material which will impart a stain to the concrete shall not be allowed to contact concrete surfaces.

7. Care shall be taken to prevent chipping of corners or other damage to concrete when forms are removed. Exposed corners and other surfaces which may be damaged by ensuing operations shall be protected from damage by boxing, corner boards or other approved means until construction is completed.
 8. Form ties shall remain in the walls and shall be equipped with a waterseal to prevent passage of water through the walls. Particular care shall be taken to bend tie wire ends away from exposed faces of beams, slabs and columns. In no case shall ends to tie wires project toward or touch formwork. Minimum set back of form ties shall be 1 inch from faces of wall. The hole left by removal of tie ends shall be sealed and grouted as per ACI and in accordance with procedure described hereinafter. Form ties will be permitted to fall within as cast areas of **architecturally treated wall surfaces; this does not apply to walls receiving textured decorative waterproof masonry coating.**
 9. All formed exposed to view concrete shall be prepared as required, then rubbed and coated with Thoroseal or other Engineer approved product. The manufacturer's recommendations for surface preparation, application procedures and rates, and temperature and moisture conditions shall be followed. Exterior vertical surfaces shall be finished to one foot below grade. Interior exposed to view vertical surfaces of dry pits shall be finished full height, interior vertical surfaces of liquid containers shall be finished to one foot below the minimum liquid level that will occur during normal operations.
 10. Slope all slabs to prevent water pocketing.
- B. All vertical surfaces below minimum liquid level in liquid containing structures shall have a smooth form finish.
 - C. All smooth form concrete vertical surfaces shall be true plane within 1/4-inch in 10 feet as determined by a 10 foot straight edge place anywhere on the surface in any direction. Abrupt irregularities shall not exceed 1/8-inch.
 - D. Basin, flume, conduit and tank floors shall have a "troweled" finish unless shown otherwise on Drawings.
 - E. Weirs and overflow surfaces shall be given a troweled finish.
 - F. Exterior platforms, steps and landings shall be given a broom finish. Broom finish shall be applied to surfaces which have been steel troweled to an even smooth finish. The troweled surface shall then be broomed with a fiber bristle brush in the direction transverse to that of the main traffic.
 - G. Walking surfaces of slabs shall have a troweled finish unless shown otherwise on Drawings.

- H. Patching of holes due to removal of tie ends and other repairable defective areas shall be as follows: Entire contact area of hole shall be coated with two part moisture insensitive epoxy bonding compound in accordance with manufacturer's specifications, and prior to placing of freshly mixed patching mortar. Patching mortar shall be mixed and placed in general accordance with ACI.
- I. Nox-Crete Harbeton, L & M Construction Chemicals Chem Hard, or an approved equivalent shall be applied to all exposed concrete floors in occupied spaces. The floors shall be thoroughly cured, cleaned, and perfectly dry with all work above them completed. The hardener shall be applied evenly and freely and in conformance with manufacturer's instructions, using not less than three (3) coats, allowing 24 hours between coats. One gallon of hardener shall cover not more than 100 square feet. After the final coat is completed and dry, surplus hardener shall be removed from the surface of the concrete by scrubbing and mopping with water.

3.06 CONCRETE WALKS AND CURBS:

- A. Subgrade shall be true and well compacted at the required grades. Spongy and otherwise unsuitable material shall have been removed and replaced with properly compacted, approved material. Concrete walks shall be placed upon 4-inch crushed stone fill unless noted otherwise on the Drawings.
- B. Concrete walks shall be not less than 4 inches in thickness. Walks shall have contraction joints every 5 linear feet in each direction, formed in the fresh concrete by cutting a groove in the top surface of the slab to a depth of at least one-fourth the slab thickness with a jointing tool. Transverse expansion joints shall be installed at driveways, and opposite expansion joints in adjacent curbs. Where curbs are not adjacent, transverse expansion joints shall be installed at intervals of approximately 40 feet. Sidewalks shall receive a broomed finish. Scoring shall be in a transverse direction. Edges of the sidewalks and joints shall be edged with a tool having a radius not greater than 1/6-inch. Sidewalks adjacent to curbs shall have a slope of 1/4-inch per foot toward the curb. Sidewalks not adjacent to curbs shall have a transverse slope of 1/4-inch per foot or shall be crowned as directed by the Engineer. The surface of the concrete shall show no variation in cross section in excess of 1/4-inch in 5 feet. Concrete walks shall be reinforced with 6 x 6 - W1.4 x W1.4 welded wire fabric unless noted otherwise on the Drawings.

- C. Concrete curbs shall be constructed to the section indicated on the Drawings, and all horizontal and vertical curves shall be incorporated as indicated or required. Forms shall be steel or as approved by the Engineer. At the option of the Contractor, the curbs may be precast or cast-in-place. Cast-in-place curbs shall be divided into Sections 8 to 10 feet in length using steel divider plates. The divider plates shall extend through the concrete and shall be removed. Precast curbs shall be finished smooth. Dividers shall be installed where the curb crosses pipe trenches or other insecure area. Transverse expansion joints shall be installed at all curb returns and at intervals of approximately 40 feet.

3.07 WATERTIGHTNESS

- A. The structures which are intended to contain liquids and/or will be subjected to exterior hydrostatic pressures shall be so constructed that when completed and tested, there shall be no loss of water and no wet spots shall show.
- B. As soon as practicable after the completion of the structures, the Contractor shall fill such structures with water and if leakages develop or wet spots show, the Contractor shall empty such structures and correct the leakage in an approved manner. Any cracks which appear in the concrete shall be dug out and suitably repaired. Temporary bulkheads over pipe openings in walls shall be provided as required for the testing.
- C. After repairs, if any are required, the structures shall be tested again and further repaired if necessary until satisfactory results are obtained. All work in connection with these tests and repairs shall be at the expense of the Contractor.
- D. Waterstops shall be placed in all locations as indicated on the Drawings and as may be required to assure the watertightness of all containers of liquids. Special shop fabricated ells, tees and crosses shall be provided at junctions. Waterstops shall be extended at least 6 inches beyond end of placement in order to provide splice length for subsequent placement. In slabs and tank bottoms, waterstops shall be turned up to be made continuous with waterstops at bottom of walls or in walls. All joints between adjacent, continuing, and intersecting sections of waterstop including butt joints, tee joints, and other angled joints shall be heat fused to form a watertight seal. Waterstops shall not be lapped. Waterstops shall be secured in place to maintain proper position during placement of concrete. Care shall be taken to avoid folding while concrete is being placed and to prevent voids in the concrete surrounding the waterstop. All materials shall be installed in accordance with the manufacturer's recommendations.
- E. Joints between pipe (except cast iron wall pipe) and cast-in-place concrete walls shall be sealed as required by the Drawings.

- F. The top surface of all concrete decks (except slabs on grade) shall be coated with Sikagard-70 water-repellant penetrating sealer as manufactured by the Sika Corporation, Nox-Crete Stifel, or another approved equivalent. The manufacturer's recommendations shall be followed in all areas of application.

3.08 GROUTING BASE PLATES, BEARING PLATES AND MACHINE BASES

- A. Column base plates, bearing plates for beams and similar structural members, machinery and equipment bases shall, after being plumbed and properly positioned, be provided with full bearing on epoxy nonshrink grout, as described in Section 03610, Precision Grouting. Concrete surfaces shall be rough, clean, free of oil, grease and laitance and shall be moistened thoroughly immediately before grout is placed. Metal surfaces shall be clean and free of oil, grease and rust. **Mixing and placing shall be in conformance with the material manufacturer's printed instructions.**
- B. Grout fill which is formed in place by using rotating equipment as a screed, such as for clarifiers and similar types of equipment, shall be mixed in proportions and consistencies as required by the manufacturer or supplier of the equipment.

3.09 EQUIPMENT PADS

Unless otherwise shown or directed, all equipment and items such as lockers, motor control centers, etc., shall be installed on concrete bases. The bases shall be constructed to the dimensions shown on the Drawings or as required to meet plan elevations. Where no specific plan elevations are required, the bases shall be 6 inches thick and shall extend 3 inches outside the equipment base. In general, the concrete bases shall be placed up to 1-inch below the base. The equipment shall then be properly shimmed to grade and the 1-inch void filled with nonshrink epoxy grout as described in Section 03610, Precision Grouting.

END OF SECTION 03310

SECTION 03610 - PRECISION GROUTING

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide all labor, material, equipment and services required for grouting of equipment, machinery, structural steel, handrails, anchor bolts and other items or work for which grouting is specified or required. All unnecessary holes, openings and cracks in existing concrete shall be filled and patched.

1.02 DESCRIPTION OF WORK

- A. Provide labor and materials to set anchor bolts and provide high-strength, precision support of machine bases and soleplates, including supporting equipment subject to thermal movement and repetitive dynamic loading by means of a non-shrink, ready-to-use, precision grout material.

1.03 RELATED WORK

- A. Section 03310 - Structural Concrete.
- B. Review all divisions and sections for equipment, machinery and other items to be grouted.

1.04 QUALITY ASSURANCE

Comply with the following codes, standards, test and recommended practices for foundation concrete as apply to precision grouting:

- A. ACI 347 "Recommended Practice for Concrete Formwork".
- B. ASTM C 309 "Standard Specifications for Liquid Membrane Forming Compounds for Curing Concrete".
- C. Manufacturer's Information on Use of Grout: Attached to each bag of grout.

1.05 SUBMITTALS

- A. Manufacturer's data of grout to be used shall be submitted to Engineer for review in accordance with the requirements of the General Conditions and Section 01300.

PART 2 - PRODUCTS

2.01 GROUT

- A. Precision-support grout shall consist of a non-shrink, ready-to-use, precision grout material; proportioned, pre-mixed and packaged at the factory; delivered to the job site to place with only the addition of water; forming, placing and curing as stipulated by the manufacturer.
- B. Grouts which depend upon aluminum powders, chemicals, or other agents which produce gas for expansion are not acceptable.
- C. Precision-support grout shall also meet the following requirements:
 - 1. Free of gas producing agents.
 - 2. Free of oxidizing catalysts.
 - 3. Free of inorganic accelerators, including chlorides.

2.02 WATER

Water shall be suitable for drinking.

PART 3 - EXECUTION

3.01 PREPARATION FOR GROUTING

- A. Remove laitance down to sound concrete.
- B. Surface to receive grout shall be rough and reasonably level.
- C. Surface shall be properly cured. **DO NOT USE CURING COMPOUNDS.**
- D. Clean surface of oil, grease, dirt, and loose particles.
- E. Clean bolt holes, bolts and underside of equipment base.
- F. Install per manufacturer's recommendations.

3.02 FORMWORK

- A. Formwork shall be compatible with proposed method of placing grout. Design for rapid, continuous and complete filling of space to be grouted.
- B. Build strong, tight forms braced so they will not leak or buckle under weight of fluid grout.

3.03 FINISHING AND CURING

- A. Follow manufacturer's printed instructions for the brand and type of grout being used.
- B. The grout shall meet the following compressive strength standards:

	Plastic Mix	Flowable Mix
1 day	4,000 psi	2,000 psi
3 days	6,000 psi	3,000 psi
7 days	8,000 psi	5,000 psi
28 days	10,000 psi	7,000 psi

END OF SECTION 03610

Division 4 - Masonry

SECTION 04200 - UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide unit masonry for walls and partitions:
1. Concrete masonry bearing walls and non-bearing partitions.
 2. Building in of precast or stone lintels and sills.
 3. Freestanding masonry walls (garden walls, site walls) and retaining walls.
 4. Repair and remodeling at existing construction.

1.02 SUBMITTALS

Submit for approval samples, product data, 4 foot by 4 foot mock-ups, test reports.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete Block: Normal weight, ASTM C 140 and C 90, Type 1; 7-5/8-inch by 15-5/8-inch face size. Special shapes as required.
- B. Facing Block: Normal weight, low-absorption concrete block; Foster Masonry Products or approved equivalent. Size, style, color, and surface texture as selected.
- C. Precast Concrete Coping, Wall Caps and Sills: 4,000 psi; light sandblast finish.
- D. Mortar: ASTM C 270, portland cement-lime mortar using Type S cement ASTM C91 above grade and Type M cement ASTM C91 below grade; other types as required by application. Inorganic oxide mortar pigments, color as selected; Davis, Solomon Grind-Chem or approved equivalent.

- E. Reinforcing:
1. Ties and Reinforcing: Hot-dipped galvanized, ASTM A 153.
 2. Horizontal Reinforcing: Welded truss type, 9 gage wire with deformed side rods.
 3. Brick to Concrete Masonry Ties: Two piece horizontal reinforcing with 3/16-inch diameter, tab-type, adjustable drop ties.
 4. Masonry to Concrete Ties: 24 gage steel dovetail slots, fillers, and 1 inch wide, 16 gage corrugated galvanized steel anchors, length as required.
 5. Masonry to Steel Ties: 3/16-inch diameter, 2 piece steel wire ties for lateral restraint, and horizontal and vertical movement.
 6. Brick to Metal Stud Ties: 3/16-inch diameter vee ties with drip, 12 gage wall slot; Hohmann & Barnard DW-10 or approved equivalent.
 7. Reinforcing Bars: Deformed bars, ASTM A 615, Grade 60.
- F. Through-wall Flashing: Plastic membrane "Plasta Seal" manufactured by Phoenix Building Products or approved equivalent; 0.030-inch thick; joints of plastic membrane sheeting shall be in accordance with manufacturer's recommendations.
- G. Waterproofing: Two (2) 10.0 mil coats of coal tar for a minimum DFT of 20.0 mils; coal tar shall be surface prepared and applied in accordance with manufacturer's recommendations; coal tar shall be equivalent to Tnemec Hi-Build Tnemecol (46-465) or Kop-coat Bitumastic Super Service Black.
- H. Miscellaneous Materials:
1. Weep baffle at base of cavity: Clean, rounded gravel.
 2. Drainage: Open head joints or rope wicks as indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with PCA "Recommended Practices for Laying Concrete Block" and BIA Tech Notes 11, 11A, 11B, 11C, 11D, and 11E, and NCMA TEK Bulletins.
- B. Weather Protection: Cold weather; heat mortar water and sand, enclose walls and provide temporary heat as recommended by BIA Tech Notes 1, 1A, 1B, and 1C. Hot weather; use mortar within 1-1/2 hours after mixing for ambient 80 degrees F or above.
- C. Tolerances: From dimensions and locations in Contract Documents for plumb, level and alignment, plus or minus 1/8-inch in 20 feet.

- D. Fire Rating: Where indicated, provide assemblies identical to tested assemblies and accepted by authorities having jurisdiction.
- E. Bond: Lay exposed face brick in running bond except at areas of special coursing, patterns and bonding as indicated on Drawings.
- F. Joints: Maintain uniform width; tool concave. Provide full bed, head and collar joints except at weepholes; keep cavity clean at cavity walls.
- G. Weepholes: Provide fully open head joints at 24 inches o.c. for brick at 32 inches o.c. for block above all ledges, flashings and lintels. Fill cavity 8 inches high with weep baffle material.
- H. Through-wall Flashing: Install flashing membrane at the base of each wall and at lintels.
- I. Waterproofing: Apply waterproofing on the exterior side of interior block.
- J. Install steel lintels and provide reinforced masonry lintels where indicated.
- K. Coordinate installation of flashings; prepare masonry surfaces smooth and bed flashings in mortar.
- L. Ties and Horizontal Reinforcing: Comply with codes; space ties not more than 24 inch o.c. vertically and horizontally.
- M. Provide expansion joints no greater than 30 feet o.c. at approved locations.
- N. Remove and replace damaged units. Enlarge holes in mortar and re-point. Prepare joints to receive sealants. Clean brick using bucket and brush method; comply with BIA Tech Note 20. Clean concrete masonry by dry brushing; comply with NCMA TEK No. 28.

END OF SECTION 04200

Division 5 - Metals

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide structural steel for building construction including sub-framing units which are part of the general framing system. Include anchors, bases, bearing plates, bracing, lintels when part of structural framing, and detail fittings.
- B. Modify existing structural steel systems and components to accommodate remodeling and new work.

1.02 SUBMITTALS

Submit for approval shop drawings, product data, test reports.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Provide products of acceptable manufacturers. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel shapes, plates and bars: ASTM A 36, or ASTM A 572, Grade 50.
- B. Steel pipe: ASTM A 53.
- C. Anchor bolts: ASTM A 307.
- D. High strength threaded fasteners: ASTM A 325.
- E. Non-metallic shrinkage resistant grout; Euclid Euco NS, L&M Crystex, Sonneborn Sonnegrout or approved equal. Compressive strength suited for project requirements.
- F. Shop finish for structural steel in accordance to Section 09800.
- G. Galvanized shapes, including lintels: Hot dip galvanized ASTM A 123.
- H. Welding: AWS D1.1.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with AISC codes and specifications, and with AWS "Structural Welding Code".
- B. Employ a registered engineer to check elevations and plumb and level tolerances; certify that installed work is within AISC Standards. Owner may engage testing/inspection agency to inspect welded and bolted connections.
- C. Architecturally exposed steel: Fabricate with special care using materials carefully selected for best appearance. Store materials off ground and keep clean. **Cut, fit and assemble work with surfaces smooth, square and with complete contact at joints. Set all cambers up. Weld all work continuously; grind smooth and flush to make seams invisible after priming. Prepare surfaces to comply with SSPC-SP6; apply prime coat within 24 hours after cleaning.**
- D. Touch-up field welds and abraded areas in accordance with Section 09800.

END OF SECTION 05120

SECTION 05500 - MISCELLANEOUS METALS, FASTENERS,
SPECIAL FINISHES

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide all labor, materials, equipment and service necessary for fabrication and erection of structural steel and aluminum and for fabrication and installation of miscellaneous non-ferrous metals as shown on the Drawings and not specifically included under other sections of these Specifications.

- A. Erection.
- B. Shop and Erection Drawings.
- C. Shop Painting.
- D. Galvanizing.
- E. Aluminum Work Protection.
- F. Cleaning Aluminum Work.
- G. Miscellaneous Items.
- H. Loose Lintels.
- I. Sleeves and Inserts.
- J. Aluminum Pipe Railing.
- K. Aluminum Stairs.
- L. Ladders.
- M. Ship Ladders.
- N. Plate Covers and Frames.
- O. Guard Chains.
- P. Lifting Hooks.
- Q. Sand Trap Grating and Frame.

- R. Cast Iron Wheel Guard.
- S. Cast Aluminum Nosings.
- T. Floor Hatches and Frames.
- U. Access Doors.

1.02 RELATED WORK

- A. Section 04200 - Unit Masonry.
- B. Section 05530 - Aluminum Grating.

1.03 REFERENCES

All work under this Section shall be governed by:

- A. Specifications for the design, fabrication and erection of structural steel for buildings - American Institute of Steel Construction, current edition.
- B. Aluminum Construction Manual, Section 1, Specifications for Aluminum Structures - the Aluminum Association.
- C. All welding shall conform to the latest code of the American Welding Society.
- D. ASTM A-276.
- E. ASTM A-325.
- F. ASTM F-593, 294.
- G. Federal Specification FF-S-325.
- H. ASTM A-48.
- I. Federal Specification TT-V-51F.
- J. ANSI B94.12.
- K. ASTM A-12, A-153, A-384, A-563 and A-780.
- L. SSPC SP-1, SP-2, SP3, SP-7.

1.04 SUBMITTALS

- A. As required by the Specifications, the Contractor shall submit for review completely detailed and certified shop and erection drawings of the miscellaneous metal work. All coatings or other protection against corrosion to be applied at the shop or in the field shall be indicated on these drawings. The shop drawings for aluminum work shall show the alloys and tempers to be used, and the finish, if any to be applied.
- B. Shop drawings, giving complete information necessary for fabrication, layout and installation of metal work shall be submitted to the Engineer for review prior to fabrication.
- C. Preparation of shop drawings for fabricated metal items shall be coordinated by the Contractor with the manufacturers of various equipment in order to comply with details, locations, openings, and arrangements required by the manufacturers.
- D. Field measurements shall be made to verify all dimensions in the field which may affect installation of work before shop drawings are made and/or fabrication is performed.

1.05 QUALITY ASSURANCE

- A. The design, detail and workmanship of steel plates and structural steel shall conform to the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
- B. Where welding is permitted or required, it shall conform to the current requirements of the American Welding Society for the type of work in question.
- C. Aluminum work shall be fabricated in a shop where the quality of work is in accordance with the highest standards for work of this type. All work shall be executed by mechanics skilled in the fabrication of aluminum, and shall be true to detail with sharp, clean profiles, fitted with proper joints and intersections and with finishes as specified.
- D. All miscellaneous metal work shall be formed to shape and size with sharp lines and angles. Shearing and punching shall leave clean true lines and surfaces.

1.06 RESPONSIBILITY FOR DIMENSIONS

The general design and dimensions of the miscellaneous metal work are indicated on the Drawings, but the Contractor shall be responsible for the correctness of the details and dimensions of the finished articles. He shall verify conditions at the job before fabrication and coordinate the work with that of all other trades to prevent interference.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel plates and structural steel shapes shall conform to ASTM Standard Specification for Structural Steel, Designation A36.
- B. Sheet steel shall be cold rolled or hot rolled carbon sheet steel conforming to ASTM Standard Specification for Steel, Carbon, Cold Rolled Sheet, Commercial Quality, Designation A36 or ASTM Standard Specification for Steel, Carbon (0.15 maximum, percent), Hot Rolled Sheet and Strip, Commercial Quality, Designation A569, as appropriate.
- C. Steel pipe shall conform to ASTM Standard Specifications for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless, Designation A53.
- D. Stainless steel shall be Type 304 unless otherwise indicated or specified.
- E. Aluminum work shall be fabricated of plates, rolled or extruded shapes, sheets or casting conforming (unless otherwise permitted or indicated) to the following alloy and temper designations of the Aluminum Association:
 - 1. Structural rolled or extruded shapes 6061-T6.
 - 2. Extruded shapes 6063-T5.
 - 3. Plates 6061-T6.
 - 4. Gratings (bearing bars) 6061-T6 (crimp bars) 6063-T6.
 - 5. Castings 214.
 - 6. Sheets 3003-F.
 - 7. Bolts and nuts 2024-T4.
 - 8. Pipe Railing 6063-T6.
- F. The Contractor shall furnish the Engineer with mill certificates and a signed statement from the fabricator that all aluminum work furnished is of the proper alloys, as specified above.

2.02 STEEL

- A. Structural steel shall conform to the requirements of ASTM A-36. Structural tubing, where used, shall conform to the requirements of ASTM A-500, Grade B, and the ends of the tubing shall be properly sealed to protect the internal surfaces. Steel anchor bolts shall be ASTM A-36 hot rolled threaded rod or bar stock, except where stainless steel is indicated on the Drawings.
- B. Structural steel members as required shall conform to ASTM Standard shapes.
- C. Base and bearing plates shall be provided where necessary to provide maximum bearing value of not more than 200 psi on solid concrete masonry units not more than 750 psi on concrete and shall be grouted in place.
- D. Steel lintels shall be provided for all square head openings in masonry where shown and where other lintels are not indicated on the Drawings. Lengths of bearing at each end of lintels shall be not less than 1 inch per foot of span, but in no case less than 8 inches shall be increased or the lintels shall be fitted with bearing plates as required to provide unit pressures in pounds per square inch of not more than 200 on solid concrete masonry units and 625 on concrete. All new steel lintels shall be hot-dipped galvanized. Finish coats are specified in Division 9 - Finishes.

2.03 SHOP PAINTING

Painting of miscellaneous ferrous metal work is specified under Division 9.

2.04 GALVANIZING

Items of miscellaneous iron work and steel work indicated on the Drawings or specified to be galvanized shall be zinc coated by the hot dip process in conformity with ASTM Standard Specification for Zinc (hot galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip, Designation A123-78; or ASTM Standard Specifications for Zinc Coating (hot-dip) on Iron and Steel Hardware, Designation A153-78, as appropriate. Galvanizing is specified under Article 3.04, "Hot-Dip Galvanizing".

2.05 ALUMINUM

All structural and miscellaneous aluminum shall be Alloy 6061 (Alloy 6063 for extrusions), Temper T6, unless otherwise noted, indicated or accepted by the Engineer. Where welding is necessary in fabrication, it shall be done in conformance with Section 7 "Welded Construction" of Specification for Aluminum Structures, referenced hereinbefore.

2.06 ALUMINUM WORK PROTECTION

- A. Aluminum surfaces which after erection would otherwise be in contact with concrete or brick masonry or with mortar, shall be protected from contact therewith by a coat of bitumastic super service black manufactured by the Koppers Company, Inc., Pittsburgh, PA; Tarmastic 100 manufactured by Porter Coating Division, Porter Paint Company, Louisville, KY; 450 Heavy Tnemecol manufactured by Tnemec Company, North Kansas City, MO; or an acceptable equivalent product. Areas where the paint has been damaged by abrasion or other cause shall be cleaned and repainted as directed so that the aluminum will have a complete protective paint film when brought into contact with the material against which it is being protected. Before application of coating, the surface shall be cleaned of all dirt, heavy deposits of grease or oil, and other foreign substances and shall be immersed in or swabbed with an acceptable solvent. Next the surfaces shall be rinsed with clear water and thoroughly dried.
- B. The Contractor's attention is directed to the requirements of the Specifications in regard to protection against electrolysis where aluminum is to be used in conjunction with dissimilar metals.
- C. Where a shop coating of methacrylate lacquer has been specified on aluminum work to protect the surface from stain, the protective coating of lacquer worn off during handling or erection shall be replaced in the field by a new coating of lacquer of the same type.
- D. During construction, care shall be taken to prevent damage to the aluminum work from splashing or the accumulation of paint, concrete, mortar, or other similar materials.

2.07 STAINLESS STEEL

Stainless steel shapes shall be ANSI Type 304 or 316 in accordance with ASTM A-276. Miscellaneous bar stock products such as pipe straps shall be 400 Series stainless steel. Anchor bolts, nuts and washers shall be ANSI Series 300 stainless steel.

2.08 FASTENERS

- A. Bolts, Nuts and Washers:
 - 1. Structural bolts shall be high strength ASTM A-325, Type 1, galvanized and galvanized ASTM A-325 hardened flat washers and galvanized ASTM A-325 hex nuts. Galvanized bolts, nuts and washers shall be centrifugally spun after galvanizing. Nuts shall have threads tapped oversize after galvanizing. All stainless steel bolts, nuts and washers shall be ANSI

Type 300 Series stainless steel in accordance with ASTM F-593, with ASTM F-594 nuts. All bolts shall have hexagonal heads.

2. Anchors and bolts including nuts and washers shall be provided where necessary for securing the work in place. Sizes, types and spacings of anchors and bolts not indicated or specified otherwise shall be as necessary for their purposes. Anchor bolts and anchors for the erection of structural steel shall be galvanized. Anchored bolts, nuts, and washers for all other uses including, but not limited to, underwater use and for the installation of equipment, piping, pumps and motors shall be stainless steel Type 304.

B. Expansion Anchors (In Concrete):

1. Expansion anchors shall be of two (2) types:
 - a. Stainless steel wedge type.
 - b. Self drilling plated type with stainless steel bolt and stainless steel washer.

Type of expansion anchor desired shall be noted on Drawings

2. Stainless steel wedge type anchors shall be ITW Ramset/Red Head or approved equal of Type 303 stainless steel. Anchors shall meet or exceed latest Government GSA Federal Specifications FF-S-325, Group II, Type 4, Class 1. Anchor shall be used with 300 series stainless steel bolt and washer.
3. Self drilling plated anchors shall be ITW Ramset/Red Head or approved equal. Anchors shall meet or exceed latest Government GSA Federal Specification FF-S-325, Group III, Type 1. Self-drilling anchors shall be electro-deposited zinc plated and chromate dipped, to meet or exceed the requirements of the latest Federal Specification QQ-Z-325, Type II, Class 3. Cutting teeth shall have minimum hardness of 82 Rockwell A scale.
4. Stainless steel expansion anchors shall be installed in accordance with manufacturer's recommendations.
5. Self-drilling expansion anchors shall be installed in accordance with manufacturer's recommendations. To insure full development strength, all self-drilling expansion anchors shall be expanded over the plug in the final set, by using a bolt screwed into the female threads and impacted by hand with a suitable hammer. The final set shall not be accomplished by using the drilling tool.
6. After installation, pull-out tests by the anchor manufacturer's representative may be requested by the Engineer. If so, the Engineer's Resident Representative will stipulate the number and location of the tests.

2.09 ALUMINUM LADDERS

- A. Aluminum ladders shall be furnished and installed at the locations shown on the Contract Drawings.
- B. The ladders shall be constructed with side rails of 2-1/2 inches by 1/2-inch flat bar and brackets of 3 inches by 1/2-inch flat bar with rungs of 1 inch diameter bars, shouldered, driven through the side rails and peened. Maximum bracket support spacing shall be 5 feet - 0 inches on centers. The brackets shall be welded to the side rails. Rung spacing shall be 12 inches on centers. In general, the ladders shall extend to within 6 inches of the access opening. Ladders shall be constructed of 6061-T6 aluminum. Wedge type expansion anchors shall be used to attach aluminum ladders to walls as indicated on Contract Drawings.

2.10 MISCELLANEOUS ITEMS

Items of miscellaneous metal work not particularly specified hereinafter shall be of the shape, size, material and details indicated on the Drawings or suitable for the purpose intended.

2.11 LOOSE LINTELS

The Contractor shall furnish all loose lintels as indicated on the Drawings or required by the work. The loose lintels shall be fabricated from structural steel shapes and plates. All loose lintels shall be hot-dip galvanized after fabrication.

2.12 SLEEVES AND INSERTS

The Contractor's attention is directed to the requirements of the Specifications regarding sleeves and inserts.

2.13 ALUMINUM PIPE RAILING

- A. The aluminum pipe railing shall be the product of company normally engaged in the manufacture of pipe railing. Railing shall be shop assembled in lengths not to exceed 24 feet for field erection.
- B. Handrails and stair rails shall be designed to withstand a 200-pound concentrated load applied in any direction at any point on the top rail. Handrails and stair rails shall also be designed to withstand a load of 50 lbs/ft. applied horizontally to the top rail. The 200-pound load will not be applied simultaneously with the 50 lbs/ft. load. In addition, the handrails shall be designed to withstand a load of 100 lbs/ft. applied vertically downward to the top rail and simultaneously with the 50 lbs/ft. horizontal load. The 100 lbs/ft. vertical load does not apply to stair rails.

- C. The manufacturer shall submit calculations to the Engineer for approval. Testing of base castings or base extrusions by an independent lab or manufacturer's lab (if manufacturer's lab meets the requirements of the Aluminum Association) will be an acceptable substitute for calculations. Calculations will be required for approval of all other design aspects.
- D. Post spacing shall be a maximum of 6 feet 0 inches. Posts and railings shall be a minimum of 1-1/2 inches Schedule 40 aluminum pipe alloy 6063-T6, ASTM-B-429 or ASTM-B-221. The handrail manufacturer shall show that their posts are of adequate strength to meet the loading requirements. If the manufacturer's posts are not of adequate strength, the manufacturer may reduce the post spacing or add reinforcing dowels or may do both in order to meet loading requirements.
- E. The handrail shall be made of pipes joined together with component fittings. Samples of all components, bases, toe plate and pipe must be submitted for approval. Components that are glued or pop riveted at the joints will not be acceptable. All components must be mechanically fastened with stainless steel hardware. Handrail and components shall be Thompson Fabricating Company or approved equal.
- F. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.
- G. The midrail at a corner return shall be able to withstand a 200-pound load without loosening.
- H. Expansion bolts shall be spaced 10 diameters apart and 5-diameter edge distance for no reduction in pullout strength. A safety factor of four shall be used on expansion bolt pullout values published by the manufacturer. Expansion bolts shall be stainless steel type 303 wedge bolts.
- I. Toe plate shall conform to OSHA standards. Toe plate shall be a minimum of 4 inches high and shall be an extrusion that attaches to the posts with clamps which will allow for expansion and contraction between posts. Toe plates shall be set 1/4-inch above the walking surface. Toe plates shall be provided on handrails as required by OSHA and/or as shown on Drawings. Toe plates shall be shipped loose in stock lengths with pre-manufactured corners for field installation.
- J. Openings in the railing shall be guarded by a self-closing gate. Safety chains shall not be used unless specifically shown on the Drawings.
- K. Finish shall be Aluminum Association M10-C22-A41 (215-R1). The pipe shall be plastic wrapped. The plastic wrap is to be removed after erection.

- L. Aluminum surfaces in contact with concrete, grout or dissimilar metals will be protected with a coat of bituminous paint, mylar isolators or other approved material.

2.14 ALUMINUM STAIRS

- A. The aluminum stairs shall have structural aluminum channel stringers and supports, aluminum tread plate treads and platforms and sheet aluminum risers as indicated on the Drawings and in the details.
- B. The treads shall be aluminum grating (see Section 05530). The treads shall be supported by and attached to 1-1/4 inch by 3/16 inch aluminum carrier angles bolted to the stringers. The treads shall be the widths indicated.
- C. All platforms shall be fabricated of 1/4-inches thick aluminum tread plate and shall be supported on the edges by structural aluminum angles and at the mid-spans by structural aluminum tees.
- D. The aluminum tread plate for treads and platforms shall have an acceptable nonskid pattern surface.
- E. The Contractor shall provide all structural aluminum angle hangers, struts, rod hangers, closure plates and brackets indicated or necessary to complete the stairs as indicated.

2.15 PLATE COVERS AND FRAMES

- A. The plate covers and frames shall be of the sizes indicated on the Drawings. The frames shall be aluminum angles of the sizes indicated with welded strap anchors for securing the frames in the concrete. The frames shall have mitered corners with welded joints ground smooth where exposed.
- B. The covers shall be 1/4-inch thick aluminum tread plate having an acceptable nonskid surface and reinforced with aluminum bars welded to the underside of the cover in accordance with the details. Plate covers shall be capable of supporting a uniform superimposed load of 100 psf for the span with a deflection of less than 1/4-inch based on an allowable fiber stress of 16,000 psi. The covers shall be made to fit neatly and accurately in the frames.
- C. Hinged covers shall be furnished with heavy duty stainless steel, plain bearing hinges with stainless steel pins. The hinges shall be fastened to the covers and frames with stainless steel machine screws. The hinged covers shall be provided with flush lift handles fabricated from 1/2-inch diameter aluminum rod, alloy 6061-T6511.

- D. A single leaf of hinged plate covers shall be no greater than 3 feet square in size.
- E. Removable plate covers shall have 1-inch diameter finger holes to facilitate removal. All edges of holes cut in the plate covers shall be ground smooth.
- F. Removable plate covers shall be no greater than 14 square feet in size with the longer dimension no greater than 7 feet.
- G. Gasket plate covers shall have continuous compressible neoprene seals between the cover and frame at the perimeter. The covers shall be secured to the frames with countersunk, flathead, stainless steel machine screws spaced approximately 6 inches on centers.

PART 3 - EXECUTION

3.01 ANCHORAGE ITEMS

The Contractor shall furnish all bolts, nuts, shims, pins, screws, straps, nails and other anchors which may be required by the Drawings or job conditions to secure all items permanently in place whether or not specifically called for or shown on the Drawings.

3.02 FABRICATION AND INSTALLATION OF METAL WORK

- A. General: All metal items shall be accurately fabricated and erected with exposed joints close fitting. All joints shall be of such character and so assembled that they will be as strong and rigid as adjoining sections. Joints shall be located where least conspicuous. Items shall have smooth finished surfaces except where otherwise shown or specified.
- B. Built-in Items: Members or parts to be built-in with masonry or concrete shall be in a form affording a suitable anchorage or shall be provided with approved anchors, expansion shields or other approved means of securing members.
- C. Dissimilar Metals: Ferrous and non-ferrous metals shall be insulated at all contacts with felt washer, strips or sheets, bitumastic paints, or other acceptable means. All aluminum surfaces in contact with concrete shall be coated with two (2) coats of Federal Specification TT-V51F Asphalt Varnish, or approved equal.
- D. Connections:
 - 1. All required anchors, couplings, bolts, and nuts required to support miscellaneous metal work shall be furnished and installed as required.

2. Weights of connections and accessories shall be adequate to safely sustain and withstand stresses and strains to which they will be normally subjected.
3. Connections shall be bolted except where welding is called for in the Drawings. Bolts shall be 3/4-inch diameter unless noted or required otherwise.

E. Expansion Anchors:

1. Expansion anchors shall be installed in holes drilled into concrete with carbide tipped drill bits conforming to ANSI B94.12-1977, using a rotary impact hammer for 1/2-inch and 3/8-inch anchors. Hole depth shall equal or exceed the anchor manufacturer's minimum recommended embedment. Should hole depth equal anchor manufacturer's minimum recommended embedment, hole shall be cleaned out by air pressure. The minimum hole depth shall be per anchor manufacturer's recommendations. Contractor shall assure hole is perpendicular and conforms in size to anchor manufacturer's recommendation.
2. Washer and nut shall be assembled on anchor so that the top of the nut is flush with the top of the anchor. Then the anchor shall be driven into the hole through the work until the washer bears against the work. The anchor shall be expanded in accordance with the manufacturer's recommendations.
3. General: Provide stainless steel fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.
4. Bolts and Nuts: Regular hexagon head type, stainless steel, Grade A.
5. Lag Bolts: Stainless steel.
6. Machine Screws: Stainless steel.
7. Wood Screws: Stainless steel.
8. Plain Washers: Stainless steel.
9. Masonry Anchorage Devices: Stainless steel.
10. Toggle Bolts: Stainless steel.
11. Lock Washers: Stainless steel.

3.03 WELDING

Welding procedures, welders and welding operators, both for shop and field welding, shall be qualified and certified in accordance with the requirements of AWS D1.1 "Welding in Building Construction" of the American Welding Society. Manufacturer's and fabricator's shop drawings shall clearly show complete information and Contractor shall perform all field welding in conformance with this information regarding location, type, size and length of all welds, all in accordance with AWS A2.0 "Standard Welding Symbols" of the American Welding Society. Special conditions shall be fully explained by notes and details.

3.04 HOT-DIP GALVANIZING

- A. All fabrication, galvanizing and repair shall comply with ASTM Standards as they apply in accordance with the publication "ASTM Standards for Materials Hot-Dip Galvanized after Fabrication, 1981" issued by American Hot-Dip Galvanizers Association, Inc. In particular, the following specific standards shall apply to work under this contract: ASTM A-123, A-153, A-384, A-385, A-563 and A-780.
- B. Items to be galvanized shall be fabricated in accordance with ASTM A-385-80.
- C. Galvanizing for fabricated steel items shall conform to ASTM A-123-78 and shall be done after fabrication. Steel assemblies shall be subject to safe guarding from warpage and distortion during galvanizing per ASTM A-384-76.
- D. Galvanizing for structural steel fasteners and hardware shall conform to ASTM A-153-80. Galvanized bolts, nuts and washers shall be centrifugally spun after galvanizing. Nuts shall have threads tapped oversize, after galvanizing, in accordance with ASTM A-563-80.
- E. Upon field erection, any damage measuring more than 1/10-inch wide shall be repaired with a zinc-based solder or zinc-rich paint in accordance with ASTM A-780-80. Marred, damaged, or uncoated areas 4 square inches and less shall be patched with a zinc-based solder to a thickness of 5 milligrams; areas greater than 4 square inches shall be patched with an organic zinc-rich paint to a dry film, Devcon Z, LPS Instant Cold Galvanized; or approved equal. The resident project representative shall determine the extent of damage which would require recoating.
- F. Items subject to distortion during transit, such as thin, curved members, etc., shall be stacked on edge and/or blocked to prevent radius change or other distortion while in transit to and from the galvanizing plant.

3.05 PAINTING

Painting of miscellaneous ferrous metal work is specified under Division 9.

3.06 MISCELLANEOUS METAL FABRICATIONS

- A. Rough Hardware:
 - 1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 5.2. Fabricate

items to sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

B. Miscellaneous Steel Trim:

1. Provide shapes and sizes for profiles shown. Except as otherwise indicated, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work.
2. Galvanize miscellaneous steel trim where indicated.

END OF SECTION 05500

Divisions 6 through 7 - Not Used

Division 8 - Doors and Windows

SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide and install steel doors.
- B. Provide and install hollow metal door frames.

1.02 SUBMITTALS

Submit for approval samples, shop drawings, product data.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Doors: 1-3/4" thick flush doors.
 - 1. Doors: SDI-100 grade II, heavy-duty, model 3 or 4 seamless construction, 18 gage ASTM A 366 or A 568 cold-rolled steel.
- B. Frames: Cold-rolled steel sheet, gage as follows:
 - 1. Frames: 16 gage up to 5' wide, 14 gage over 5' wide.
 - 2. Frame construction: Fully welded, mitered corners.
- C. Louvers: Sightproof, stationary type, 24 gage cold rolled steel in 20 gage frame.
- D. Finish: Rust-inhibiting primer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fabricate work to be rigid, neat and free from seams, defects, dents, warp, buckle, and exposed fasteners. Install doors and frames in compliance with SDI-100, NFPA 80, and requirements of authorities having jurisdiction.
- B. Hardware: Prepare doors and frames to receive hardware on final schedule. Provide for 3 silencers on single door frames; 2 on double door frames.
- C. Shop Finish: Clean, treat and prime paint all work with rust-inhibiting primer comparable with finish paint specified in Division 9. Provide asphalt emulsion sound deadening coating on concealed frame interiors.
- D. Touch-up damaged coatings and leave ready to receive finish painting.

END OF SECTION 08110

SECTION 08222 - FIBERGLASS REINFORCED DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes the following:
 - 1. Fiberglass Reinforced Plastic (FRP) Doors.
 - 2. Fiberglass Resin Transfer Molded Door Frames.

1.02 RELATED SECTIONS

- A. Related sections include the following:
 - 1. Division 1 - General Requirements.
 - 2. Division 8 - Finish Hardware.
 - 3. Division 8 - Glazing.

1.03 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Door Assembly: ASTM C 518 Standard test method for steady state thermal transmission properties by means of the heat flow meter apparatus.
 - 2. Laminate Properties:
 - a. ASTM D 638 - Tensile Strength = 15,000 PSI.
 - b. ASTM D 790 - Flexural Strength = 39,000 PSI.
 - c. ASTM D 2583 - Barcol Hardness = 57.
 - d. ASTM D 256 - Impact Resistance = 15.75.
 - e. ASTM D 792 - Density/Specific Gravity of Laminate.
 - f. ASTM D 1761 - Mechanical Fasteners.
 - g. ASTM E 84 - Surface Burning Characteristics.
 - h. ASTM G 155 - Gelcoat Xenon Arc light exposure test.
 - i. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
 - 3. Core Properties:
 - a. ASTM C 177 Thermal Properties
 - b. ASTM C 1622 Density/Specific Gravity
 - c. ASTM E 84 Surface Burning Characteristics

d. WDMA TM-10 and TM-5 Firestop ASTM E 152 U.L. 10(b)

B. Qualifications:

1. **Manufacturer Qualifications:** A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein with a minimum of five years documented experience and with a record of successful in-service performance for the applications as required for this project.
2. **Installer Qualifications:** An experienced installer who has completed fiberglass door and frame installations similar in material, design, and extent to those indicated and who work has resulted in construction with a record of successful in-service performance.
3. **Source Limitations: Obtain fiberglass reinforced plastic doors and frames through the source fabricated from a single manufacturer, including fire rated fiberglass frames.**
4. **Source Limitations: Hardware and accessories for all FRP doors as specified in Section 08700 shall be installed by the fiberglass door and frame manufacturer.**
5. **Source Limitations: Glass for windows in doors shall be installed by door and frame manufacturer in accordance with related section, Division 8, Glazing.**

1.04 SUBMITTALS

A. Product technical data including:

1. Acknowledgment that products submitted meet requirements of standards referenced.
2. Manufacturer shall provide certificate of compliance with current local and federal regulations as it applies to the manufacturing process.
3. Manufacturer's installation instructions.
4. Schedule of doors and frames indicating the specific reference numbers as used on drawings, door type, frame type, size, handling and applicable hardware.
5. Details of core and edge construction. Include factory-construction specifications.
6. Certification of manufacturer's qualifications.

B. Submittal drawings for customer approval shall be submitted prior to manufacture and will include the following information and formatting:

1. Summary door schedule indicating the specific reference numbers as used on owner's drawings, with columns noting door type, frame type, size, handling, accessories, and hardware.

2. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
 3. Drawing showing dimensional location of each hardware item and size of each door.
 4. Individual part drawing and specification for each hardware item and FRP part or product.
 5. Construction and mounting detail for each frame type.
- C. Samples: Provide one 21" x 18" completely assembled (hinged) door and frame corner section, with faces and edges representing typical color and finish. One edge should be exposed for view of interior door and frame composition. Sample should include six inch light opening as well as standard cutouts for hinges and strike plates.
- D. Operation and Maintenance Manuals:
1. Include recommended methods and frequency for maintaining optimum condition of fiberglass doors and frames under anticipated traffic and use conditions.
 2. Include one set of final as built drawings with the same requirements as mentioned in Section B above.
 3. Include certificate of warranty for door and frame listing specific door registration numbers.
 4. Include hardware data sheets and hardware manufacturer's warranties.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Each door and frame should be delivered individually crated for protection from damage in cardboard containers, clearly marked with project information, door location, specific reference number as shown on drawings, and shipping information. Each crate should contain all fasteners necessary for installation as well as complete installation instructions.
- B. Doors should be stored in the original container out of inclement weather for protection against the elements.
- C. Handle doors pursuant to the manufacturer's recommendations as posted on outside of crate.

1.06 WARRANTY

- A. Warranty all fiberglass doors and frames for a period of 25 years against failure due to corrosion. Additionally, warranty all fiberglass doors and frames on materials and workmanship for a period of 10 years, including warp, separation or delamination, and expansion of the core.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Chem-Pruf Door Co., Ltd., Brownsville, Texas 78523.
2. Corrim Company, Oshkosh, Wisconsin 54901.
3. Engineer approved equivalent product.

2.02 FRP Doors:

- A. Doors shall be made of fiberglass reinforced plastic (FRP) using chemically proven resins resistant to contaminants typically found in the environment for which these specifications are written. Doors shall be 1¾ inch thick and of flush construction, having no seams or cracks. All doors up to 4'0 x 8'0 shall have equal diagonal measurements with a maximum tolerance of +/- 1/32 inch.
- B. Door plates shall be +/- 0.125 inch thick, molded in one continuous piece, starting with a 25 mil gelcoat of the color specified, integrally molded with at least two layers of 1.5 ounce per square foot fiberglass mat and one layer of 13 ounce per square yard unidirectional roving. This will yield a plate weight of 0.97 lbs. Per square foot at a ratio of 30/70 glass to resin.
- C. Stiles and rails shall be constructed starting from the outside toward the inside, of a 25 mil gelcoat of the color specified followed by a matrix of at least three layers of 1.5 ounce per square foot of fiberglass mat. The stile and rail shall be molded in one continuous piece to a u-shaped configuration and to the exact dimensions of the door. In this manner there will be no miter joints or disparate materials used to form the one-piece stile and rail.
- D. Core material shall be 2 psf expanded polyurethane foam, which completely fills all voids between the door plates.
- E. Internal Reinforcement shall be of sufficient amount to adequately support required hardware and function of same.
- F. Finish of door and frame shall be identical in color and texture. At time of manufacture, 25 mil of resin-rich gelcoat must be integrally molded into both the door and frame. Secondary painting to achieve color is not acceptable.

- G. Window openings shall be provided for at time of manufacture and shall be completely sealed so that the interior of all of the door is not exposed to the environment. Fiberglass retainers which hold the glazing in place shall be resin transfer molded with a profile that drains away from glazing. The retainers must match the color, texture and finish of the door plates. Glass shall be furnished and installed by door and frame manufacturer.
- H. Louver openings shall be sealed in the same manner as the window openings. Louvers are to be solid fiberglass inverted "V" vanes and shall match the color, texture and finish of the door plates.
- I. Transoms shall be identical to the doors in construction, materials, thickness and reinforcement.

2.03 FRAMES

- A. Frames shall be fiberglass and manufactured using the resin transfer method in closed rigid molds to assure uniformity in color and size. Beginning with a minimum 25 mil gelcoat and a minimum of two layers continuous strand fiberglass mat saturated with resin, the frame will be one-piece construction with molded stop. All frame profiles up to ¾" will be solid fiberglass. All frame profiles greater than ¾" shall have a core material of 2 psf polyurethane foam. Metal frames or pultruded fiberglass frames will not be acceptable.
- B. Finish of frame shall be identical in color and texture to the door. 25 mil resin rich gelcoat will be integrally molded into the frame at time of manufacture. Secondary painting to achieve color is not acceptable.
- C. Jamb/Header connection shall be coped by CNC for tight fit.
- D. Internal Reinforcement shall be continuous within the structure to allow for mounting of specific hardware. Material shall be completely non-organic with a minimum hinge screw holding value of 656 lbs. Frame screw holding value to accommodate screws shall be minimum of 1,000 lbs. per screw. Documented strength of frame screw holding value after third insert must be submitted. Dissimilar materials, such as steel, will be deemed unacceptable as reinforcement for hardware attachment.
- E. Mortises for hardware shall be accurately machined by CNC to hold dimensions to +/- 0.010 inch in all three axis
- F. Hinge pockets shall be accurately machined by CNC to facilitate heavy duty hinges at all hinge location, using spacers when standard weight hinges are used.

2.04 HARDWARE

- A. See Section 08700.
- B. Due to the special nature of the material in this section, all related hardware as specified must be installed by the door and frame manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION CONDITIONS

- A. Verification of Conditions:
 - 1. Openings are correctly prepared to receive doors and frames.
 - 2. Openings are correct size and depth in accordance with shop drawings or submittals.
- B. Installer's Examination:
 - 1. Contractor shall have the installer examine conditions under which construction activities of this section are to be performed and submit a written report if conditions are unacceptable.
 - 2. Transmit two copies of the installer's report to the Engineer within 24 hours of receipt.
 - 3. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.

3.02 INSTALLATION

- A. Install door-opening assemblies in accordance with shop drawings and manufacturer's printed installation instruction, using installation methods and materials specified in installation instructions.
- B. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.
- C. Site tolerances: Maintain plumb and level tolerance specified in manufacturer's printed installation instructions.
- D. Fire labeled doors and frames must be installed in strict accordance with manufacturer's instruction and the latest revision.

3.03 ADJUSTING

- A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.
- B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.04 CLEANING

Cleaning surfaces of door opening assemblies and exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.05 PROTECTION OF INSTALLED PRODUCTS

Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION 08222

SECTION 08330 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of insulated overhead coiling doors is shown on the Drawings and in the schedules.
- B. Provide complete operating door assemblies including door curtains, guides, counterbalance mechanism, hardware, chain hoist operator, electric operator, and installation accessories.

1.03 QUALITY ASSURANCE

- A. Furnish each overhead coiling door as a complete unit produced by one (1) manufacturer, including hardware, accessories, mounting and installation components.
- B. Unless otherwise acceptable to Engineer, furnish overhead coiling door units by one (1) manufacturer for entire project.
- C. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
- D. Coordinate the work of this section with masonry sections of these Specifications for installation of inserts and anchorage devices.
- E. Wind Loading: Design and reinforce overhead coiling doors to withstand a 60 lb. per square foot wind loading pressure unless otherwise indicated.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door. Include operating instructions and maintenance information.

- B. Shop Drawings: Submit shop drawings for special components and installations which are not fully dimensioned or detailed on manufacturer's data sheets.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, provide products of one of the following or an approved equivalent:

- A. Kinnear Div., Harsco Corp.
- B. Mahon Rolling Door Div., RCM Corp.
- C. North American Door, Div. of Jim Walters
- D. Overhead Door Corp.
- E. Southwestern Steel Rolling Door Co.

2.02 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtain: Fabricate insulated overhead coiling door curtain of interlocking slats designed to withstand required wind loading, of continuous length for width of door without splices. Material to be as indicated on the Drawings. Unless otherwise indicated, provide slats of material gage recommended by door manufacturer for size and type of door required, and as follows:
 - 1. Furnish manufacturer's standard insulated flat slats; fully weatherstripped. Each slat shall enclose a glass fiber reinforced polyisocyanurate foam plastic core to produce an R-value of 6 when tested in accordance with ASTM C-236.
 - 2. Endlocks: Malleable castings secured to curtain slats with rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.
 - 3. Bottom Bar: Consisting of two (2) angles, each not less than 1-1/2-inch 1-1/2-inch x 1/8-inch thick, material to suit type of curtain slats.
 - 4. Provide a replaceable gasket of flexible vinyl or neoprene between angles as a weather seal and cushion bumper for manually operated doors unless shown as an overlapping joint.
 - 5. Curtain Jamb Guides: Fabricate curtain jamb guides of angles, or channels and angles with sufficient depth and strength to retain curtain loading. Slot bolt holes for track adjustment.

6. Secure continuous wall angle to wall framing by 3/8-inch (minimum) bolts at not more than 30 inches o.c., unless closer spacing recommended by door manufacturer. Extend wall angles above door opening head to support coil brackets, unless otherwise shown. Place anchor bolts on exterior wall guides so they are concealed when door is in closed position. Provide removable stops on guides to prevent over-travel of curtain, and continuous bar for holding windlocks, if any. Provide closure between door and exterior wall at the head and jambs.
- B. **Weather Seals:** Provide vinyl or neoprene weatherstripping for exterior exposed doors except where otherwise noted. At door heads, use 1/8-inch thick continuous sheet secured to inside of curtain coil hood. At door jambs, use 1/8-inch thick continuous strip secured to exterior side of jamb guide.
 - C. **Door Locks:** Provide slide bolts at bottom rail of overhead doors, one (1) side only.

2.03 COUNTERBALANCING MECHANISM

- A. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a shaft and mounted in a spring barrel and connected to the door curtain with the required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. **Counterbalance Barrel:** Fabricate spring barrel of sufficient diameter and wall thickness (materials same type as door) to support roll-up of curtain without distortion of slats and limit barrel deflection to not more than 0.03-inch per foot of span under full load.
- C. Provide spring balance of one or more oil-tempered, heat-treated helical torsion spring. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast barrel plugs to secure ends of springs to barrel and shaft.
- D. Fabricate torsion rod for counterbalance shaft of case-hardened steel, or required size to hold fixed spring ends and carry torsional load.
- E. **Brackets:** Provide mounting brackets of manufacturer's standard design, either cast iron or cold-rolled steel plate with bell mouth guide groove for curtain.

- F. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head, and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface mounted hoods, and any portion of between jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
- G. Fabricate hoods for doors of materials of the same type as the door.

2.04 PAINTING

Shop clean and prime ferrous metal (non-galvanized) surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's **standard rust inhibitive primer**. **Do not paint galvanized, aluminum or stainless steel surfaces unless noted otherwise.**

2.05. ELECTRIC DOOR OPERATORS

- A. General: Furnish electric door operator assembly of size and capacity recommended and provided by door manufacturer; complete with electric motor and factory prewired motor controls, gear reduction unit, solenoid operated brake, remote control stations, control devices, conduit and wiring from controls to motor and central stations, and accessories required for proper operation.
- B. Provide hand-operate disconnect or a mechanism for automatically engaging a sprocket and chain operator and releasing brake for emergency manual operation. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged. Provide chain hoist operator with S.S. hand chain.
- C. Design operator so that motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
- D. Door Operator Type: Provide wall or bracket-mounted door operator units consisting of electric motor, worm gear drive from motor to reduction gear box, chain or worm gear drive from reduction box to gear wheel mounted on counterbalance shaft, and a disconnect release from manual operation. Provide motor and drive assembly of horsepower and design as determined by door manufacturer for size of door required.
- E. Electric Motors: Provide high starting torque, reversible, constant duty, Class A insulated electric motors with overload protection, sized to move door in **either direction, from any position, at not less than 0.66 feet nor more than 1.0 foot per second.**

- F. Coordinate wiring requirements and current characteristics of motors with building electrical system (480v, 3 phase, 60 Hz unless noted otherwise).
- G. Furnish open-drip-proof type motor and controller with NEMA Type I enclosure unless a NEMA Type 4x is indicated on the Drawings.
- H. Furnish totally enclosed, nonventilated type motors, fitted with plugged drain, and controller with NEMA Type 4x enclosure, for exterior applications and where indicated.
- I. **Automatic Reversing Control:** Furnish each door with automatic safety switch, extending full width of door bottom, and located within neoprene or rubber astragal mounted to bottom door rail. Contact with switch before fully closing **will immediately stop downward travel and reverse direction to fully opened position.** Connect to control circuit through retracting safety cord and reel, or self-coiling cable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment support in accordance with final shop drawings, manufacturer's instructions, and as specified herein.
- B. Upon completion of installation including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting weathertight for entire perimeter.

END OF SECTION 08330

SECTION 08520 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 00700 - General Conditions.
- B. Division 1 - General Requirements.

1.02 SCOPE OF WORK

Provide heavy-duty commercial AAMA grade and performance class HC40 aluminum windows.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum window units that comply with performance requirements specified, as demonstrated by testing manufacturer's corresponding stock systems.
- B. Design Requirements: Comply with structural performance, air infiltration, and water penetration requirements indicated in AAMA 101 for type, grade and performance class of window units required.

1.04 SUBMITTALS

- A. General: Submit manufacturer's data in accordance with Section 01300 for each window type required.
- B. Certification: Provide certification by a recognized independent testing laboratory or agency showing that each type, grade, and size of window unit complies with performance requirements.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed installation of aluminum windows similar in design and extent to those required for the project and whose work has resulted in construction with a record of successful in-service performance.
- B. Standards: Requirements for aluminum windows, terminology and standards of performance, and fabrication workmanship are those specified and recommended in AAMA 101 and applicable general recommendations published by AAMA.

- C. **Single-Source Responsibility:** Provide aluminum window units from one source and produced by a single manufacturer.
- D. **Design Concept:** The Drawings indicate the size, profiles, and dimensional requirements of the aluminum window types required.

1.06 PROJECT CONDITIONS

Field Measurements: Check actual window openings by accurate field measurement before fabrication. Show measurements on final shop drawings.

1.07 WARRANTY

- A. **Aluminum Window Warranty:** Submit a written warranty, executed by the window manufacturer, agreeing to repair or replace window units that fail in materials or workmanship within the specified warranty period.
- B. **Warranty Period:** Three (3) years after the date of substantial completion and acceptance by the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. **Manufacturers:** Provide products from one of the following manufacturers or approved equal:
 - 1. Capitol Products Corporation.
 - 2. Desco Windows.
 - 3. EFCO Corporation.
 - 4. Kawneer Company, Inc.

2.02 MATERIALS

- A. Provide aluminum extrusions alloy and temper recommended by the window manufacturer for the strength, corrosion resistance, and application of the required finish, but not less than 22,000 psi ultimate tensile strength and not less than 0.125-inch thick at any location for main frame and sash members.
- B. Provide aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by the manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components of window units.

1. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125-inch thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads or provide standard noncorrosive pressed-in splined grommet nuts.
 2. Exposed Fasteners: Except where unavoidable for application of hardware, do not use exposed fasteners. For application of hardware, use fasteners that match the finish of the member or hardware being fastened, as appropriate.
- C. Anchors, Clips, and Window Accessories: Fabricate anchors, clips and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel or iron complying with the requirements of ASTM B 633.
- D. Compression-Type Glazing Strips and Weatherstripping: Provide compressible stripping for glazing and weatherstripping such as molded EPDM or neoprene gaskets complying with AAMA SG-1 or with ASTM D 2000 designation 2BC415 to 3BC620, or molded PVC gaskets complying with ASTM D 2287, or molded expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4. Also, comply with Section 08810.
- E. Sealant: For sealants required within fabricated window units, provide type recommended by the manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating. Comply with Division 7, Section "Joint Sealants" of these Specifications for selection and installation of sealants.

2.03 HARDWARE

General: Provide the manufacturer's standard hardware fabricated from aluminum, stainless steel, or other corrosion-resistant material, compatible with aluminum and of sufficient strength to perform the function for which it is intended.

2.04 ACCESSORIES

General: Provide the manufacturer's standard accessories that comply with indicated standards.

2.05 FABRICATION

- A. General: Fabricate aluminum window units to comply with indicated standards. Include a complete system for assembly of components and anchorage of window units.
1. Provide units that are reglazable without dismantling sash or ventilator framing.

- B. Thermal-Break Construction: Fabricate window units with an integral concealed low-conductance thermal barrier, located between exterior materials and window member exposed on the interior, in a manner that eliminates direct metal-to-metal contact.
 - 1. Provide thermal-break construction that has been in use for not less than three (3) years, has been tested to demonstrate resistance to thermal conductance and condensation, and has been tested to show adequate strength and security of glass retention.
 - 2. Weepholes: Provide weepholes and internal passage to conduct infiltrating water to the exterior.

- C. Preglazed Fabrication: Preglaze window units at the factory where possible and practical for applications indicated. Comply with glass and glazing requirements of the "Glass and Glazing" section of these Specifications and AAMA 101.

2.06 FINISHES

Finish shall be anodized in accordance with NAAM No. AA10C 22A31 (color to be selected by Owner).

PART 3 - EXECUTION

3.01 INSPECTION

Inspect openings before beginning installation. Verify that rough or masonry opening is correct and the sill plate is level.

3.02 INSTALLATION

- A. Comply with manufacturer's recommendations for installation of window units.
- B. Set window units plumb, level, and true to line, without warp or rack of frames. Provide proper support and anchor securely in place.
 - 1. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with the requirements specified under paragraph "Dissimilar Materials" in the Appendix to AAMA 101.
- C. Set sill members and other members in a bed of compound or with joint fillers or gaskets to provide weathertight construction. Refer to the "Joint Sealer" sections of Division 7 for compounds, fillers, and gaskets to be installed

concurrently with window units. Coordinate installation with wall flashings and other components of the Work.

3.03 CLEANING

- A. Clean aluminum surfaces promptly after installation of units. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt, and other substances.
- B. Clean glass of preglazed units promptly after installation of units.

3.04 PROTECTION

Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure window units will be free of damage or deterioration.

END OF SECTION 08520

Division 9 - Finishes

SECTION 09851 - CHEMICAL RESISTANT CONCRETE COATING SYSTEM

PART 1 - GENERAL

1.01 GENERAL

This section covers workmanship, materials, and quality requirements for coating and lining the interior of new concrete structures. Provide and apply materials as specified and as indicated on drawings.

1.02 RELATED WORK

- A. Section 02735 - Manholes and Pre-Cast Sewage Structures
- B. Division 3 - Cast-in-Place Structural Concrete

1.03 REFERENCES

- A. ICRI (International Concrete Restoration Institute): Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
- B. NACE International: Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings.
- C. National Association of Pipe Fabricators: NAPF 500-03-04 Abrasive Blast Cleaning.
- D. SSPC (The Society for Protective Coatings): SSPC-SP13 - Surface Preparation of Concrete, SSPC-SP5 - White Metal Blast Cleaning

1.04 QUALITY ASSURANCE

- A. Requirements:
 - 1. Use only products of approved manufacturers. Use products of one manufacturer in any one chemical resistant coating system with compatible materials. Provide same material product for touch-up as for original material.
 - 2. Make available all locations and phases of the work for access by the Engineer or other personnel designated by the Engineer. The Contractor shall provide ventilation and means to safely access the coating work areas for inspection.

3. Conduct work so that the chemical resistant coating system is installed as specified herein. Inspect work continually to ensure that the system is installed as specified. The Contractor shall provide for independent verification that the work has been performed in accordance with the specifications. The independent verifier is subject to acceptance by the Owner and Engineer.
4. Employ only tradespeople who have experience performing chemical resistant coating work of similar size and complexity as the work specified in this Section. **Applicators must be acceptable to the manufacturer of the chemical resistant coating system.**

1.05 SUBMITTALS

- A. Submit the following prior to commencing with any phase of the work covered by this Section:
 1. Manufacturer's current printed recommendations and product data sheets for all coating system products supplied under this section including performance criteria, surface preparation and applications, volatile organic compound (VOC) data, and safety requirements.
 2. Material Safety Data Sheets (MSDS) for any materials brought on-site including all chemical resistant coating system materials, solvents, and abrasive blast media.
 3. Storage requirements including temperature, humidity, and ventilation for resurfacing system materials.
 4. Manufacturer's requirements, including application procedures for resurfacing materials, shall be in writing and shall be followed in detail. All safety precautions recommended by the manufacturer shall be strictly adhered to at all times when work is in progress.
 5. Submit daily reports that contain the following information: substrate conditions, ambient conditions, application procedures, work completed and location thereof. Mark-up drawings that show location of work.

1.06 DELIVERY AND STORAGE

Materials shall be stored in accordance with Manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.

- A. Deliver all materials to the jobsite in their original, unopened containers. Each container shall bear the Manufacturer's name and label.
 1. Labels on all material containers must show the following information:
 - a. Name or title of product.

- b. Manufacturer's name.
 - c. Generic type of material.
 - d. Manufacturer's batch number and date of manufacture.
 - e. Application and mixing instructions.
 - f. Hazardous material identification label.
 - g. Shelf life date.
 - h. Storage requirements.
2. All containers shall be clearly marked indicating any personnel safety hazards associated with the use of or exposure to the materials.
 3. Chemical resistant coating material storage and mixing areas shall be designated by the Engineer.
 4. Do not use or retain contaminated, outdated, prematurely opened, diluted materials, or materials which have exceeded their shelf life.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Materials named are those that have been evaluated for the specific service. The following products are named:
 1. Products of the Tnemec Company, Inc.; Series 201, EpoxoPrime; Series 434, Perma-Shield H₂S; Series 436, Perma-Shield H₂S FR; and Series 435, Perma-Glaze; used as a coating system.
 2. Products of Sherwin-Williams Company, Inc.; Corobond Conductive Epoxy; Cor-Cote SC with Type SC Aggregate; and Cor-Cote SC; used as a coating system.
 3. Products of Tamms Industries; Dural Epoxy Primer; DuralTex 1805 (also specialty formulation packaged as Aquaguard 1800); and Duralkote 240 (also specialty formulation packaged as Aquaguard 1801); used as a coating system.
- B. Equivalent materials of other manufacturers may be submitted for review for acceptability by the Engineer. As part of the proof of quality, certified test reports from a nationally known, reputable and independent testing laboratory conducting comparative tests between the products named and the products proposed for substitution. Comparison tests shall be conducted for exposure to liquid and gaseous phases, on a continuous (not intermittent) basis
- C. Submittals for substitution shall also include manufacturer's literature for each product giving name, a unique product identifier, generic type, descriptive information, solids by volume and recommended dry film thickness. In addition, a list of five projects shall be submitted in which each product has been used and rendered satisfactory service.

- D. Certified data indicating material costs for the proposed substitution and the named materials shall be provided. Any material savings shall be passed to the Owner in the form of a contract dollar reduction.

2.02 MATERIALS

A. Chemical Resistant Coating Systems:

1. Materials specified herein are the only approved standard coating systems unless an "or equivalent" is approved in writing by the Engineer in accordance with this document.
2. The following list specifies the material requirements for new concrete surface systems (heavy exposure). The approved products are as follows:
 - a. Tnemec System:
 - (1) Primer: Series 201 Epoxoprime.
 - (2) Concrete Base Coat: Series 436 Perma-Shield H₂S FR.
 - (3) Topcoat/Gelcoat: Series 435 Perma-Glaze.
 - (4) Total system thickness shall be not less than 130 mils.
 - b. Sherwin-Williams System:
 - (1) Primer: Corobond Conductive Epoxy Primer.
 - (2) Concrete Base Coat: Cor-Cote SC w/Type SC Aggregate.
 - (3) Topcoat: Cor-Cote SC.
 - (4) Total system thickness shall be not less than 155 mils.
 - c. Tamms System:
 - (1) Primer: Dural Epoxy Primer.
 - (2) Concrete Base Coat: Duraltex 1805.
 - (3) Topcoat: Duralkoat 240.
 - (4) Total system thickness shall be not less than 100 mils.
3. The following list specifies the material requirements for new concrete surface systems (moderate exposure). The approved products are as follows:
 - a. Tnemec System:
 - (1) Primer: Series 201 Epoxoprime.
 - (2) Concrete Base Coat: Series 435 Perma-Glaze.
 - (3) Topcoat/Gelcoat: Series 435 Perma-Glaze.
 - (4) Total system thickness shall be not less than 45 mils.

- b. Sherwin-Williams System:
 - (1) Primer: Corobond Conductive Epoxy Primer.
 - (2) Concrete Base Coat: Cor-Cote SC.
 - (3) Topcoat: Cor-Cote SC.
 - (4) Total system thickness shall be not less than 45 mils.

- 4. The following list specifies the material requirements for rehabilitated concrete surface systems. The approved products are as follows:
 - a. Tnemec System:
 - (1) Primer: Series 201 EpoxoPrime.
 - (2) Concrete Base Coat: Series 434 Perma-Shield H2S.
 - (3) Topcoat/gelcoat: Series 435 Perma-Glaze.
 - (4) Total system thickness shall be not less than 150 mils.

 - b. Sherwin-Williams System:
 - (1) Primer: Corobond Conductive EpoxoPrime.
 - (2) Concrete Base Coat: CorCote SC with Type SC aggregate.
 - (3) Topcoat: CorCote SC.
 - (4) Total system thickness shall be not less than 155 mils..

 - c. Tamms System:
 - (1) Primer: Dural Epoxy Primer.
 - (2) Concrete Base Coat: Duraltex 1805.
 - (3) Topcoat: Duralkoat 240.
 - (4) Total system thickness shall be not less than 100 mils.

- B. Sealants: Polysulfide Caulk - Thiokol 2235SL Industrial Polysulfide Joint Sealant, or equivalent.

PART 3 - EXECUTION

3.01 GENERAL

A. Environmental Requirements:

1. Comply with the Manufacturer's recommendations as to environmental conditions under which resurfacing system materials can be applied.
2. Do not apply chemical resistant coating system materials when dust is in work site.
3. The Contractor shall provide all temporary lighting during the work.

- B. Protection:
1. Cover or otherwise protect finish work or other surfaces not being coated or resurfaced.
 2. Erect and maintain protective tarpaulins, enclosures and/or maskings to contain debris (such as dust or airborne particles resulting from surface preparation) generated during any and all work activities. This includes, but is not limited to, the use of dust/debris collection apparatus as required.
- C. Initial Inspection of Surfaces to be Coated: It is the responsibility of the Contractor to inspect and report unacceptable concrete substrate surface conditions to the Engineer prior to the commencement of surface preparation activities. **Unacceptable surface conditions are defined as the presence of cracked surfaces or concrete deteriorated to a depth of greater than 1" or otherwise unable to withstand surface preparation as specified herein.**
- D. Exterior Below Grade Coating: Those structures specified to receive a **interior** chemical resistant coating system shall receive an application of the following system to the exterior of any of the concrete structure that is below grade:
1. System: Coal tar epoxy.
 2. Surface Preparation: SSPC-SP 13, abrasive blast. Verify surface profile. Coating system - Coal Tar Epoxy; dry film thickness of 14.0 to 20.0 mils.

3.02 SURFACE PREPARATION REQUIREMENTS

- A. General:
1. All phases of surface preparation work specified herein must be inspected by the Engineer before the Contractor proceeds with the subsequent phase of surface preparation.
 2. Oil and grease shall be removed before mechanical cleaning is started via an alkaline-based emulsifying detergent.
 3. All specified surface preparation shall be performed in accordance with the latest version of the SSPC, NACE, ICRI and other standards referenced in this section.
 4. Where necessary after chemical resistant coating installation, prepare concrete joint and install sealant in accordance with sealant manufacturer's instructions.
- B. Abrasive Blast Cleaning:
1. Concrete surfaces shall be abraded to produce a minimum surface profile of a CSP-5 as noted in ICRI Guideline 03732. This preparation will be

followed by cleaning to remove all dust, dirt or friable substances leaving clean, dust free surfaces for resurfacing as detailed in SSPC-SP 13/NACE No. 6).

2. The air used for blast cleaning shall be free of oil and moisture to not cause contamination of the surfaces to be resurfaced.

3.03 APPLICATION REQUIREMENTS

A. General:

1. Areas not to be coated shall be masked using painter's masking tape or other protective materials.
2. Ensure straight, even termination of base/topcoat materials on wall edges **and flush with embedded steel.**
3. The Contractor shall strictly comply with the minimum and maximum re-coat limitation times and related temperature range restrictions between successive lifts for all products, as per manufacturer's stated requirements.
4. All equipment and procedures used for chemical resistant coating system application shall be as recommended by the manufacturer.
5. The Contractor shall comply with the manufacturer's most recent written instructions with respect to the following:
 - a. Mixing of all materials.
 - b. Protection and handling of all materials.
 - c. Minimum ambient and substrate temperatures, substrate moisture content, relative humidity, and dew point.
 - d. Application.
 - e. Final Curing.
 - f. Use of Proper Application Equipment.
6. Curing of Chemical Resistant Coating System: The applied coating system shall be protected from damage during curing and shall be cured as recommended by the manufacturer. Ambient conditions shall be controlled by the Contractor during curing to ensure that the minimum air temperature and minimum relative humidity stipulated by the manufacturer are maintained.

B. Chemical Resistant Coating:

1. **General Note:** The Contractor is advised that with all thick-film, quick curing materials applied to concrete surfaces, outgassing of the concrete may occur. Possible remedies include applying materials when the temperature of the concrete surfaces is descending, or applying thin (1/16-inch or less) layers of the specified surfacing material. Other remedies may exist, and may be submitted for the Engineer's review.

2. Fill all voids, bugholes and other surface imperfections with suitable epoxy mortar, compatible with the coating system.
3. Apply primer for chemical resistant coating system.
4. Within the recoat window of the primer, apply chemical resistant base coat to all floor areas and walls scheduled to be coated. Application may be either by trowel or spray. If spray-applied, material shall be finish-troweled and finish-rolled (Reference manufacturers application guides for explicit instructions).
5. Within recoat window of base coat, apply chemical resistant topcoat to all floor areas and walls scheduled to be coated.

3.04 FIELD QUALITY CONTROL INSPECTION AND TESTING

- A. Inspection by Engineer or others does not limit the Contractor's responsibilities for quality control inspection and testing as specified herein or as required by the manufacturer's instructions.
- B. Perform the quality control procedures listed below in conjunction with the requirements of this Section.
 1. Inspect all materials upon receipt to ensure that all are supplied by the manufacturer.
 2. Provide specified storage conditions for the chemical resistant coating system materials, solvents, and abrasives.
 3. Inspect and record findings for the degree of cleanliness of substrates used. The pH of the concrete substrate will be measured using pH indicating papers. Acceptable pH values shall be between 8.0 and 11.0 as measured by a full-range (1-12) color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum).
 4. Inspect and record substrate profile (anchor pattern). Surfaces shall be abraded, as a minimum, equal to the roughness of CSP-5 ICRI Guideline 03732.
 5. Measure and record ambient air temperature once every four hours of each shift using a thermometer and measure and record substrate temperature once every four hours using a surface thermometer.
 6. Measure and record relative humidity every two hours of each shift using a sling psychrometer, or other approved relative humidity measuring device or instrument.
 7. Provide correct mixing of resurfacing materials in accordance with the manufacturer's instructions.
 8. Inspect and record that the "pot life" of resurfacing materials is not exceeded during installation.
 9. Verify curing of the resurfacing materials in accordance with the manufacturer's instructions.
 10. Upon full cure, the installed chemical resistant coating system may be checked by high voltage spark detection in accordance with NACE

RP0188-90, and the manufacturer's printed application guide to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner and rechecked.

11. Upon completion of the chemical resistant coating system installation, the lined area shall be cleaned and prepared to permit close visual inspection by the Engineer or the Engineer's representative. Any and all deficiencies or defective work (not in compliance with this section or related sections) will be marked for repair or removal/replacement by the Contractor at no additional cost to the Owner.

3.08 FINAL INSPECTION

- A. Perform a final inspection to determine whether the resurfacing system work meets the requirements of the specifications. The Engineer and the Engineer's representative will conduct final inspection with the Contractor.
- B. Rework required on any holidays or any other inadequacies found by the Engineer or the Engineer's representative in the quality of the coating work shall be marked. Such areas shall be recleaned and reworked by the Contractor according to these specifications and the manufacturer's recommendations at no additional cost to the Owner.
- C. The Contractor is ultimately responsible for the quality performance of the applied materials and workmanship. Inspections by the Engineer or the Engineer's representative do not limit this responsibility.

3.09 CLEANUP

Upon completion of work, the Contractor shall remove surplus materials, equipment, protective coverings, and accumulated rubbish, and thoroughly clean all surfaces and repair any work-related damage. The surrounding surface areas including roadways and all other surfaces shall be restored to their pre-project condition.

END OF SECTION 09851

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, equipment and services required to do all painting (excluding items covered under Section 09800, Special Coatings), including preparation, priming and protection of finished surfaces. An extensive and comprehensive painting job will be required and shall include all surfaces which normally are painted.
- B. The intent of these Specifications is to obtain the material and workmanship necessary to produce an adequate, and acceptable job, and is intended to describe the requirements for both shop and field painting.
- C. The intent of this Specification Section is to include all items which are to receive painting and have not been included in Section 09800 - Special Coatings.

1.02 RELATED WORK

- A. Division 1 - General Requirements.
- B. Division 5 - Metals.
- C. Section 07900 - Joint Sealers.
- D. Section 09800 - Special Coatings.
- E. Wherever detailed painting requirements are covered under an equipment or product specification, the Specifications in Section 09800 govern with respect to surface preparation, paint materials, coats, thicknesses and coverage.

1.03 REQUIREMENTS

- A. It is the intent of this Specification Section that the Contractor shall provide all architectural coatings and all other work obviously required or noted to be painted unless otherwise specified (see also Article 2.01). The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications as stated herein. All interior surfaces and equipment which have been previously painted shall be repainted or recoated following the proper surface preparation.

- B. The Contractor shall review and examine all Divisions and Sections of these Specifications for any additional painting requirements and/or additional surfaces or items to be painted.
- C. Apply specified finish coats of paint to all pre-primed work and complete finishing system for unprimed work required to be painted.
- D. Backprime, with specified interior first coat material all surfaces of finish trim which will be concealed after installation.
- E. Apply specified finish coats of paint to all prepainted surfaces which are judged by the Engineer as requiring only a finish coat. Otherwise, the complete system (as given in Article 2.01) shall be administered.

1.04 ITEMS NOT REQUIRING FIELD PAINTING

- A. Prefinished items except as directed by the Engineer.
- B. Plain copper and stainless steel.
- C. Aluminum except where otherwise designated and required to prevent corrosion at contact with dissimilar materials.
- D. Finish hardware.
- E. Concealed from view items (except where required for color coding) and surfaces, except as specified herein or where previously painted.

1.05 DEFINITIONS

- A. The term "paint" as used herein includes enamels, epoxy, paints, sealers, fillers, emulsions, and other coatings.
- B. MDMTPC = Minimum dry mil thickness per coat.
- C. MDFFT = Minimum dry film thickness.
- D. SSPC = Society for Protective Coatings.

1.06 SUBMITTALS

- A. **Manufacturer Name:** Contractor shall submit manufacturer's name and brands of coating materials proposed to be used for painting on this project in accordance with Section 01300.

B. Materials List:

1. Before any materials are delivered to the project site, submit to the Engineer a complete list of all materials proposed to be furnished including quantities, types and descriptions of paint for each part of the project. Material list shall make reference to the specified paint systems and the paint schedule for each paint product proposed to be used. In cases where paint materials other than those described in the Specifications are proposed, a materials list will not be considered as acceptance of such substitute materials; further data will be required as specified herein.
2. Two (2) copies of the full range of colors available in each of the proposed products shall be submitted with the materials list.

C. Manufacturer's Data:

1. Example of past performance of paints under similar conditions (case histories).
2. Types of paint.
3. Percentage of solids by volume.
4. Recommended usage.
5. Current recommended method of application published by manufacturer, (Data Sheet and Material Safety Data Sheets).

D. Color Samples:

1. Where standard stock chart colors are not satisfactory, furnish color samples. All tinting and matching shall be the satisfaction of the Engineer.
2. Color samples shall be provided to the Engineer's office.

E. Experience Records:

1. Shortly after the award of the Contract, the Contractor shall submit experience records of the paint applicator and that of the paint manufacturer.
2. The Contractor shall submit a list of not less than five (5) utility or industrial installations which he has painted during the last five (5) years. This list shall include the names of the owners, the installations painted, responsible officials, architects or engineers of record for the project.
3. Applicators and/or manufacturers whose submissions indicate, in the judgement of the Engineer, that they have not had the experiences required to perform the Work will not be acceptable.

1.07 QUALITY ASSURANCE

- A. Qualification of Painters: All painting shall be done by qualified, skilled, experienced craftsmen. In the acceptance or rejection of completed painting, no allowance will be made for lack of skills on the part of the craftsmen.
- B. Paint Labels: Labels on paint containers shall include the following:
 - 1. Manufacturer's name.
 - 2. Generic type of paint.
 - 3. Manufacturer's stock number.
 - 4. Color.
 - 5. Instructions for thinning where applicable.
- C. Field Quality Control: Paint film thickness shall be subject to measurement by the Engineer with elecometer, wet film gauge, low or high voltage meter, and/or applicable measuring instruments acceptable to the Engineer. If dry film thickness is found to be less than specified, or coverage is not uniform, the Contractor shall apply additional paint to correct thickness or appearance at no additional cost to the Owner.
- D. Compatibility:
 - 1. The Contractor shall be responsible for the compatibility of all paints used in the Work. A compatible paint will be considered a paint which precludes adverse effects related to bonding, drying delamination, scaling, lifting, and bleeding.
 - 2. In cases where shop-applied primers and coatings on materials and equipment furnished by suppliers are products different from those described in the Specifications, the Contractor shall verify compatibility with the specified field-applied coating system.
 - 3. Where thinning is necessary, only the products of the manufacturer furnishing the paint, and products for thinning purposes only, will be allowed.
- E. Thickness and Spreading Rates:
 - 1. Minimum dry mil thicknesses per coat (MDMTPC) and/or spreading rates in square feet per gallon shall be governed by the manufacturer's current data sheets or literature containing recommendations or instructions regarding these values. These recommended dry mil thickness and/or spreading rate values will be considered requirements to be met same as if set out herein these Specifications and Contract Documents and must be included with material list submittals before Engineer grants approval to use any paint materials. Do not exceed manufacturer's recommended coverage rates.

2. The number of coats to be applied are specified herein and shall govern. Where the total dry film thickness is specified, this thickness shall govern over the MDMTPC.
- F. Technical Services: The Contractor shall provide assurance that a qualified representative of the paint manufacturer makes periodic visits to the project site during painting to verify proper application procedures, quality and progress of work.

1.08 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Delivery: All materials shall be brought to the project site in the original sealed and labeled containers of the paint manufacturer. All labels shall be legible and intact at time of use.
- B. Manufacturer's Instructions: Paint manufacturer's written instructions for proper surface preparation, mixing, thinning, application and drying shall be furnished with the paint, and strictly followed.
- C. Storage of Materials:
1. Store only acceptable materials on project site.
 2. Store only in a suitable and designated area restricted to the storage of paint materials and related equipment.
 3. Comply with all applicable health and fire regulations regarding the storage of paint materials.
 4. Storage of material shall comply with the manufacturer's specifications; however, storage shall be at a minimum temperature of 50 degrees F.
- D. Protection of Materials:
1. Take all necessary precautions to ensure the safe storage and use of paint materials and the prompt and safe disposal of waste.
 2. Painting wastes shall be properly deposited in containers made for this purpose. Do not use plumbing fixtures for disposing paints wastes.
 3. Take all necessary precautions to protect paint materials before, during and after application and to protect the finished work.
- E. Replacement: In the event of damage to paint materials, immediately make all replacements necessary to the approval of the Engineer and at no additional cost to the Owner.
- F. Product delivery, handling and storage shall be in accordance with Part 1 of this Specification.

1.09 JOB CONDITIONS

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which painting systems can be applied.
2. Do not apply finish in areas where dust and/or mist is being generated.

B. Climatic Conditions: Paint shall not be applied if:

1. The ambient temperature or temperature of the surface to be painted is below 50 degrees F or below the temperature recommended by the paint manufacturer.
2. **The relative humidity is above 85 percent.**
3. The relative humidity is such that the paint will not dry properly in accordance with the manufacturer's instructions.

C. Protection:

1. Protect with drop cloths, masking or other acceptable means all surfaces which could be damaged in function or appearance by paint, including surfaces not being painted concurrently and surfaces not to be painted.
2. Hardware, accessories, fixtures and similar items shall be removed and replaced after completion of painting.
3. Spray painting will not be permitted when it will cause damage to adjacent or otherwise located surfaces.
4. All paint splatters on glass shall be wiped off immediately.

1.10 ACCEPTABLE MANUFACTURERS

The paints listed are products of the Sherwin-Williams Company or other manufacturer's (where indicated) and are specified as a "standard of quality" only. Similar architectural paints and painting systems may be substituted as appropriate, subject to approval by the Engineer and to the provisions contained herein.

PART 2 - PRODUCTS

2.01 PAINT SYSTEMS

A. General:

1. All paints of a specific system shall be by one (1) manufacturer.
2. "Lift" tests may be requested by the Engineer on various surfaces to be painted to assure bonding compatibility.

3. Paints containing lead, or other "dangerous" materials, that surpass federal maximum levels shall not be allowed. Oil shall be pure boiled linseed oil.

B. Paint Systems: See Paint Schedule Table below.

PAINT SCHEDULE

Sys. No.	Description	Primer Coat Material	Intermediate Coat Material	Finish Coat Material
Arch 1	Interior Concrete Block (office type areas)	Heavy Duty Block Filler	DTM Acrylic	DTM Acrylic
Arch 2	Decorative Epoxy/ Quartz Floor	201 Eopoxoprime (Tnemec)	222 Decotread (Tnemec)	222 Decotread (Tnemec)
Arch 3	Interior Wood (painted)	Wall & Wood Primer		DTM Acrylic
Arch 4	Interior Wood (painted)	Wall & Wood Primer	Wood Classics Varnish	Wood Classics Varnish
Arch 5	Exterior Wood (painted)	Industrial Enamel		Industrial Enamel
Arch 6	Exterior Wood (stained opaque)	3651 Primecoat (Glidden)	9420 Endurance (Glidden)	9420 Endurance (Glidden)
Arch 7	Exterior Wood (stained)	9721 Endurance Oil (Glidden)		9721 Endurance Oil (Glidden)
Arch 8	Interior Gypsum Board	Prep-Rite 200 Primer	DTM Acrylic	DTM Acrylic

2.02 COLORS

A. The manufacturer shall be able to furnish all paints for exposed surfaces in a wide range of colors and lighter and darker shades of these colors from which the Engineer may select the colors required on the various surfaces, if not included in the following codes (also note, the below listed may be included in the requirements of Section 09800):

1. Safety Color Codes: Comply with Occupational Safety and Health Administration Standards, as applicable, regarding safety color codes.
2. Piping Color Codes: Colors for process pipe coding shall be in accordance with the latest edition of Recommended Standards for Water Works and/or Recommended Standards for Wastewater Facilities or as selected by the Engineer. Pumps, meters, valves, etc., shall be painted the same color as the line in which they are a part.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine surfaces scheduled to receive paint and/or coating finishes for conditions that will adversely affect application, permanence or quality of

work and which cannot be put into an acceptable condition through surface preparation.

- B. Do not proceed with surface preparation or painting application until conditions are suitable.
- C. If surfaces are not thoroughly dry or if they cannot be put in proper condition to receive paint by customary cleaning methods, the painting applicators shall notify the Contractor in writing, requesting necessary corrections.
- D. Review the specified or approved painting systems and bring any questions or doubts as to the proper performance in writing to the Engineer at least 15 calendar days prior to commencing work. Otherwise, the Contractor shall assume the responsibility for providing the desired results.

3.02 ACCEPTANCE OF SURFACES

The commencement of painting work in any area or space will be construed as acceptance of the surface as being satisfactory.

3.03 SURFACE PREPARATION

A. General:

- 1. All surfaces shall be thoroughly cleaned and free of dust, dirt, rust, mill scale, loose paint, or oily materials. No painting shall be done until surface is inspected by the Engineer or his designates.
- 2. Surfaces shall be primed and/or treated, as specified, as soon after completion of surface preparation as practical, but in any event before any event before any visible or detrimental corrosion or contamination can occur. A prepared surface, which becomes corroded or contaminated, shall be re-prepared before treating and/or priming.

B. Concrete and Masonry:

- 1. All concrete and masonry surfaces shall be cleaned and scrubbed clean with soap and water.
- 2. Concrete floors to be painted shall be etched with a 10 percent solution of muriatic acid. If the concrete surface is exceedingly dense, a greater strength acid or a second etching will be required. After etching for a minimum of 30 minutes, wash thoroughly with water to remove all traces of acid. Allow to thoroughly dry at least 72 hours.

C. Wood Surfaces: Wood surfaces shall be thoroughly cleaned of all extraneous matter and all cracks, nail holes, and other defects properly filled and smoothed. Wood trim shall be sanded to fine finish and wiped clean of dust.

3.04 SHOP PRIMING

- A. The requirements Specification Section 09800 will govern over this Specification Section requirements.
- B. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used.
- C. The Contractor shall coordinate all paint materials supplied in the shop and field.

3.05 THINNING

Thinning shall be done strictly in accordance with the paint manufacturer's instructions and only upon notifications to the Engineer. When thinning is acceptable, coats of paint shall be applied as needed to build up to the specified dry film thickness.

3.06 APPLICATION

- A. On masonry, the application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded.
- B. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.
- C. Evenly brush out each finish coat and permit to dry per manufacturer's recommendation before applying any subsequent coats.
- D. All paints and coatings shall be maintained at minimum manufacturer's application temperature before applying.
- E. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with No. 00 sandpaper or equivalent to remove defects and provide a smooth even surface.
- F. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weathering shall be prime coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.
- G. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be maintained at the conditions recommended by manufacturer by heating and ventilating, if necessary, until each coat of paint has hardened. Any defective paint shall be removed and the surface repainted.

- H. Apply one (1) coat of metal primer and one (1) coat of flat black metal enamel, to the surfaces of all duct work behind grilles, for a distance of 18 inches.
- I. Perform all required back-priming work before items are installed.

3.07 REINSTALLATION OF REMOVED ITEMS

Following completion of painting in each space, promptly reinstall all items removed for painting, using only workmen skilled in the particular trade.

3.08 CLEANING

- A. During the progress of Work, do not allow the accumulation of empty containers or other excess items except in areas specifically reserved for that purpose.
- B. Take all precautions to prevent accidental spillage of paint materials. In the event of spilling, immediately remove all spilled materials and the waste and other equipment used to clean-up the spill, and wash surfaces to their original undamaged condition.
- C. Touch-up and restore finish where damaged.
- D. Remove all trash and accumulated materials of a painting nature from premises at the completion of the Work.
- E. Paint spots, oil or stains upon adjacent surfaces shall be removed. Any damage to Work of other trades or equipment caused from painting shall be made good at no expense to the Owner.
- F. Do not mar surface finish of items being cleaned.
- G. Leave entire job clean (including paint storage space) and acceptable to the Engineer.

3.09 FINAL INSPECTION

- A. Protect all painted surfaces against damage until the date of final acceptance of the Work.
- B. The Engineer will conduct a final inspection of all painting work and the Contractor will be required to repaint or retouch any areas or surfaces found deficient in complying with these Specifications.

END OF SECTION 09900

Division 10 - Not Used

Division 11 - Equipment

SECTION 11214 - VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish, install and test barrel booster type vertical turbine pumps complete with drive motor and all appurtenances as indicated on the Drawings and as specified herein. These Specifications direct attention to certain features of the pumping unit but do not cover all the details of their design. The equipment furnished shall be designed, constructed and installed in conformity with accepted high quality standards. All components of the vertical turbine pump including the pump, drive motor, bearings, shafting, coupling, accessories, appurtenances and all associated equipment shall be compatible.
- B. The pumps as indicated in this section of the work herein specified include:
 - 1. Pump.
 - 2. Motor.
 - 3. Discharge head.
 - 4. Mounting base, anchors, and seals.
 - 5. Shafting, bearings, and couplings.
 - 6. Lifting attachments, lubricators, and drainage connections.
 - 7. All accessories and appurtenances.
 - 8. Installation.
 - 9. Adjustment and start-up.

1.02 RELATED WORK

- A. Section 09900 - Painting.
- B. Division 16 - Electrical.

1.03 REFERENCES

- A. ANSI B58.1-71 - Deep Well Vertical Turbine Pumps.
- B. ASA - Applicable specifications.
- C. NEMA Standards - Weather Protected Enclosure, Type I.

1.04 SUBMITTALS

Descriptive literature, catalog cuts, dimension prints, shop drawings, and installation, operation and maintenance instructions shall be submitted to the

Engineer for review before shipment. The data shown on the shop drawings shall be complete with respect to dimensions, materials of construction, wiring diagrams, and the like, to enable the Engineer to review the information as required. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the Drawings may have from the requirements of these Specifications.

Contractor shall submit the following information in shop drawings to the Engineer for review.

A. Pump Data:

1. Rated capacity, in gallons per minute.
2. Rated head (including column friction), in feet.
3. Speed, in revolutions per minute.
4. Pump efficiency (including shaft and column friction losses) at rated capacity, in percent.
5. Pump horsepower (including shaft and column friction losses) at rated capacity, in horsepower.
6. Minimum submergence required over suction inlet, in feet.
7. Total pump downthrust, in pounds.
8. Impeller shaft diameter, in inches.
9. Lineshaft diameter, in inches.
10. Column pipe diameter (nominal), in inches.
11. Length of column, in feet.
12. Weight of pump, less driver, in pounds.

B. Motor Data:

1. Manufacturer.
2. Motor rating, in horsepower.
3. Full load speed, in revolutions per minute.
4. Type.
5. Type of thrust bearing.
6. Downthrust capacity, in pounds.
7. Voltage.
8. Cycles, in hertz.
9. Phases, in number.
10. Weight of motor, in pounds.
11. Weight of pump and motor, in pounds.

1.05 GUARANTEE

The Contractor shall guarantee that the materials and workmanship of the equipment and installation shall be free from defects for a period of not less than one (1) year from the date of acceptance by the Engineer and Owner.

The Contractor shall guarantee and warrant that the pumps will operate satisfactorily and continuously in accordance with the pump schedule. If the pump fails to operate satisfactorily the manufacturer shall promptly adjust, regulate, repair or replace the pump unit, at the Contractor's expense, to maintain the guaranteed capacities, efficiencies and performances.

PART 2 - PRODUCTS

2.01 MANUFACTURER

The pumping units shall be provided by a single manufacturer with a minimum of five (5) year's experience in designing and manufacturing pumping equipment of similar type, size and capacity.

The manufacturer shall have the ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. Upon request, the Contractor shall submit evidence of the proposed manufacturer's ability to promptly fill replacement orders.

The pumps shall be manufactured by Peerless Sterling, Fairbanks Morse, Ingersoll-Dresser or approved equal.

2.02 PUMP

- A. **Type:** The Contractor shall furnish and install open lineshaft, product lubricated, vertical turbine pumps as indicated by the Drawings and described herein.
- B. **Discharge Head:** The pumps shall be supplied with above slab type discharge constructed of durable cast or ductile iron having flanged discharge opening with Class 125 ANSI flanges. The top diameter of the discharge head shall be of such diameter as to match the diameter of the motor base. Tapped drain opening shall be provided in the discharge head. Discharge shall be below the motor base. Discharge port shall be fitted with the appropriate supports and gussets for restraint as shown on the Drawings and approved by the pump manufacturer.
- C. **Sole Plate:** A sole plate of adequate thickness shall be supplied with each pump. Plate shall be of proper size to support and anchor the motor pedestal. It shall be milled and machined to allow for a smooth level mating surface to the head.
- D. **Pump Bowls:** Bowl assemblies shall consist of a suction bell, one or more intermediate bowls and discharge bowl. Pump bowls shall be accurately aligned with machined registers and shall be finished smooth. The bowls and all guide passages shall be designed and finished to reduce friction losses to a minimum. Water passages shall be lined with smooth vitreous porcelain enamel. Bowls shall be bolted to each other, to the suction bell assembly, and

column assembly by machined heavy flanges. The bowl and its bearing housing shall be in one piece and integrally bored for positive alignment. The bowl and suction bell bearings shall be bronze, ASTM B144-932 (SAE660). The suction bell bearing shall be permanently grease packed for optimum bearing life and protection.

Bowls shall be constructed of close grain cast iron having a minimum tensile strength of 30,000 psi. The bowls shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated capacity or 1-1/2 time shutoff head, whichever is greater.

Each bowl shall be fitted with a lateral bowl seal ring to prevent slippage of water between bowl and impeller. Intermediate bowls are to be constructed by using a bronze bearing and a neoprene bearing to support the impeller shaft. **Bowls of lesser construction shall not be considered equal.**

- E. **Impellers:** Semi-open or enclosed impeller(s) shall be furnished. The impeller(s) shall be keyed or taper locked to the bowl shaft to provide mechanical reliability and ease of maintenance. Impeller(s) shall be cast in one piece, constructed of bronze (ASTM B584 Alloy), and statically and dynamically balanced. Impeller adjustment shall be provided at the top of the head shaft by means of a bronze adjusting nut of ASTM B584 which shall be positively locked in position. The impellers shall be adjustable by means of a top shaft nut at the top of the motor.
- F. **Pump Shaft:** The pump impeller shaft shall be turned and polished 416 stainless steel. It shall be supported by bearings above and below each impeller. Bearings are to be lubricated by the water being pumped and shall be of bronze. The size of the shaft shall be no less than that determined by ANSI/AWWA Specifications E101, Section A4.3 paragraph 4.3.3. and shall be ample to transmit the horsepower required by the pump. Mechanical seals shall be furnished. Hollow shafts are not acceptable.
- G. **Lineshaft:** The lineshafts shall be turned 416 stainless steel of a size that conforms to the requirements of ANSI Standard Specifications for Deep Well Vertical Turbine Pumps, Number B58.1-1971. The shaft shall be furnished in interchangeable sections having a nominal length of not over 5 feet. The butting faces shall be machined square to the axis of the shaft. Shafting shall have flame sprayed stainless steel journals at the bearing points. The lineshafts shall be coupled with stainless steel couplings.
- H. **Lineshaft Bearings:** The bearings shall be designed for vertical pump service to be lubricated by the liquid being pumped. They shall be mounted in bearing retainers which shall be held in position in the column by means of the flanges. The bearings shall be spaced at intervals of not more than 5 feet. Lineshaft bearing shall be constructed of carbonite.

- I. Discharge Column Pipe: Column pipe shall be flanged and size such that the friction loss will not exceed 5 feet per 100 feet based on rated pump capacity. The minimum wall thickness of the discharge column pipe shall be 0.375 inches. The pipe shall be furnished in interchangeable sections having a maximum length of 5 feet. All bolting and hardware shall be stainless steel.
- J. Strainer: A stainless steel strainer shall be provided for the Raw Water pumps having a net inlet area equal to at least four times the suction pipe area. The maximum opening size shall not be more than 75 percent of the minimum opening of the water passage through the bowl or impeller.
- K. Pump Schedule:

Pump Station	Pump Type	Number Required	Capacity GPM	TDH Feet	Min. Eff.	Max Speed R.P.M.	H.P.	Discharge Size (In.)	Stages
High Service	Vertical Turbine	2	2,150	440	84%	1,775	300	10	5
Backwash	Vertical Turbine	1	4,200	32	77%	1,185	60	14	1

2.03 MOTORS

The motor for driving the pump shall be of the reduced voltage starting, vertical shaft, squirrel cage induction type and shall comply with applicable ASA specifications. Motor shall be furnished with an enclosure conforming to NEMA standards for Weather Protected Type I. The connection to the pump shaft shall be through a non-reverse ratchet type coupling or self-release coupling in the motor. The motor shall be of the proper size to drive the pump continuously and be non-overloading over the entire operating range of the pump. Motors shall be fitted with bearing temperature monitors, winding thermistors and a lower steady bearing. The motors shall be premium efficiency in design with a minimum rating of 93%. The motor shall be designated for 40 degrees C ambient conditions. The motor shall be 3 phase, 60 Hz, and of the voltage specified on the Drawings.

A thrust bearing of ample capacity to carry the weight of all rotating parts plus the hydraulic thrust shall be incorporated into the motor as an integral part of it. The bearing shall be of such size that the average life rating is no less than five (5) year's continuous operation. Thrust bearings shall conform to L10 life requirements.

The motor shall be manufactured by U.S. Electric Motors or General Electric.

2.04 MISCELLANEOUS

- A. Nameplates and other data plates shall be stainless steel, suitably secured to the pump.
- B. Parts Numbering: Parts shall be completely identified with a numerical system (no alphabetical letters) to facilitate parts inventory control. Each part shall be properly identified by a separate number, and those parts which are identical shall have the same number to effect minimum spare parts inventory.
- C. Spare Parts: The Contractor shall furnish the following spare parts for each pump supplied:
 - 1. One (1) set of impellers for each pump and a separate 316 stainless steel **pump shaft and set of impeller locks.**
 - 2. One (1) set of bowl bearings.
 - 3. One (1) set of lateral bowl seals.
 - 4. One (1) set of mechanical seal replacement material.
 - 5. One (1) spider bearing for each section of line shaft.
 - 6. One (1) head pump shaft.
 - 7. One-year supply of all lubricants required for all pumps and their accessories.

PART 3 - EXECUTION

3.01 SHOP TESTS

- A. The pumps shall be fully tested (witnessed) at the manufacturer's works before shipment at their rated speed, capacity, and head, and at such other conditions of head and capacity to establish that each has met all guarantees on the characteristic curves submitted. Pump test shall be performed utilizing factory calibrated motors to guarantee pump efficiencies. Five certified copies of the results of these tests are to be sent to the Engineer. Also included with the test curves shall be a certified bill of material list depicting quality of construction. Such tests shall be accomplished at the manufacturer's facility prior to shipment.
- B. The pumping units will be accepted upon the basis of the certified copies of the shop test, subject to a four hour field test of each unit. This test will be for the purpose of determining if each pumping unit will operate under installed conditions within a reasonable degree of correlation with the shop tests.
- C. The equipment supplier shall give at least two (2) week's notice to the Owner when the tests are to be accomplished so that the Owner may have a representative present at the said tests.

3.02 FIELD ACCEPTANCE TESTS

- A. After installation of the pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's representative, each pump shall be given a running test in the presence of the Engineer during which it shall determine its ability to operate without vibration or overheating, and to deliver its rated capacity under the specified conditions.
- B. During the drawdown and field tests, observations shall be made of head, capacity, and motor input. All defects or defective equipment revealed by or noted during the tests shall be corrected or replaced promptly at the expense of the Contractor, and if necessary, the tests shall be repeated until results acceptable to the Engineer are obtained. The Contractor shall furnish all labor, piping, equipment, and materials necessary for conducting the tests.
- C. All adjustments necessary to place the equipment in satisfactory working order shall be made at the time of the above tests.
- D. If sufficient water is NOT available for the test, the Contractor shall provide water for testing, if so directed.
- E. In the event that the Contractor is unable to demonstrate to the satisfaction of the Engineer that the units will satisfactorily perform the service required and that they will operate free from undue noise and vibration, the pumping units may be rejected. The Contractor shall then remove and replace the equipment at his own expense.
- F. The field verification and/or drawdown tests shall include measuring or determining the following items:
 - 1. Flow rate.
 - 2. Total head on the pump.
 - 3. Power input.
 - 4. Static head on the pump.
- G. On those pumps or set of pumps that have a flow meter in the discharge line, the flow meter may be used to determine the pump flow rate once its accuracy has been verified in the field.
- H. All field measurements for pump rate shall be made within 2 gallons per minute. Readings on all instruments shall be made at 2 minute intervals for the length of the test. The readings shall be averaged to calculate the power draw of the motor, the actual flow pumped, and the static and total dynamic head on the pumps.

- I. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.
- J. For all pumping units, the Contractor shall furnish the services of accredited representatives of the pump manufacturer who shall supervise the installation, adjustment, and field tests of each pumping unit and give instructions to the operating personnel. As one condition necessary to acceptance of any pumping unit, the Contractor shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

3.03 PUMP GAUGES

Pump pressure gauges shall be provided for all pumps to be installed under this section. Gauges shall have 4-1/2-inch white face dial with black figures. Gauges shall be provided with threaded bottom connections, gauge cocks and arranged for pipe mounting. Provide shut-off valve and union on each pressure gauge stem. Gauges shall be Ashcroft, Marsh or approved equal.

3.04 INSTALLATION

All pump equipment shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION 11214

Division 12 - Not Used

Division 13 - Special Construction

SECTION 13222 - FILTER UNDERDRAIN SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide and install as described herein and as shown on the Drawings, filter underdrain systems. Work shall include all equipment, material and labor required to complete the necessary filter underdrain systems.

1.02 RELATED WORK

- A. Division 3 - Concrete.
- B. Section 13223 - Filter Disinfection.
- C. Section 13226 - Filter Media.

1.03 SUBMITTALS

- A. The manufacturer of the filter underdrain system shall submit to the Engineer for review the test records from an independent hydraulic laboratory that demonstrates the equalization of backwash flow from the underdrains at conditions at least equivalent to the pattern shown on the Drawings.
- B. The manufacturer shall also submit samples of the following components for review and approval by the Engineer. The Engineer's approval shall be received prior to product shipment.
 - 1. One (1) lateral block.
 - 2. One (1) center flume block.
 - 3. One (1) end flume block.
 - 4. One (1) "U" anchor rod.
 - 5. One (1) section of IMS cap material.
- C. The underdrain manufacturer and installation contractor shall have a minimum of five (5) year's experience on similar designs and installations of filter underdrain systems.

1.04 REFERENCES

- A. ASTM-C-112.
- B. ASTM-C-497.
- C. ASTM-C-67.

PART 2 - MATERIALS

2.01 Underdrain

- A. The underdrain system for the filters shall be a dual parallel lateral type with a media support cap whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be so arranged that the feeder (or primary) chamber is adjacent and connected to a compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of water. All internal orifices shall be integrally molded to provide a smooth bore orifice. The primary chamber should provide at least 30 square inches of cross sectional area per block to reduce flow velocity during backwash.
- B. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall not be less than 7/32 inch diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch. The top of each orifice shall be encircled by a depression approximately 3/8 inch x 3/4 inch, which shall act to prevent the gravel support media from resting directly on the thereby blocking the dispersion orifice.
- C. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of water coverage which direct flow vertically for effective penetration and cleaning of the media.
- D. A water recovery channel with return holes shall be incorporated into the top of the underdrain block to ensure uniform and flow from the top deck orifices.
- E. The secondary chambers of the underdrain shall be baffled.
- F. The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces.
- G. The block size and weight shall permit ease of handling and installation. The block nominal dimensions shall be 8 inches high by 11 inches wide by 48 inches long. The weight of the block shall be approximately 19 pounds.
- H. When subjected to a flow rate of 20 gpm/sf of filter area the headloss through an underdrain lateral 40 feet long shall not exceed 36 inches water column when the water temperature is approximately 60° F. This does not include head losses for special feed arrangements.

- I. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches water column at a backwash flow rate of 20 gpm/sf of filter area when the water temperature is approximately 60° F.
- J. The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be gasketed, bell and spigot type with internal alignment tab for proper joint alignment, and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and receptors for ease of assembly and installation of the laterals.
- K. A media support cap shall be constructed of HDPE plastic beads sintered together and sealed to the top of the underdrain. The pore size and pore volume shall be sufficient to prevent the media from obstructing or passing through the underdrain. The Cap shall replace the need for support gravel and shall not increase the underdrain height by more than 1 inch. The cap shall be attached to the underdrain at the factory by type 316 stainless steel self tapping screws and sealed with caulking.

2.02 REQUIREMENTS

- A. The filter underdrain system shall be designed to operate under the following conditions:

Number of filters	4
Filter Size, sq. ft.	210
Filtration Rate, Design, gpm per sq. ft. (one filter out of service)	3.41
Water only Backwash Rate, gpm per sq. ft.	20

- B. All material used in contact with the water shall meet National Sanitation Foundation (NSF) Standard 61.

PART 3 - INSTALLATION

- A. The underdrain system shall be a standard product of a filter manufacturer who has been actively providing dual-parallel lateral underdrain equipment for at least 10 years. Upon request, the filter manufacturer will provide the Engineer with a list of installation of underdrain.

- B. The filter manufacturer shall, at their own facilities, if requested by the Engineer, set up a test lateral run of equal length to that required by the project and provide an opportunity for the Engineer and/or Owner to visit the facility to witness a full scale demonstration of the headloss and flow distribution during backwash.
- C. The Contractor shall provide the services of the manufacturer's technical representative for not less than 4 working days to inspect and supervise the installation and testing of the filter underdrain system in 2 trips.
- D. The Contractor shall install the filter underdrain system in strict accordance with: (1) the manufacturer's written instructions and recommendations and the manufacturer's installation drawings; (2) the oral and written directions provided the manufacturer's technical representative who is supervising and **observing the work; and (3) any additional requirements specified herein.**
- E. Care shall be exercised in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the drawing provided. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions.
- F. The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the Contractor. After joining, aligning and setting the blocks, and the bed grout is set-p, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so that the entire bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least 3 full days before functional testing.
- G. The Contractor shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the work shall be protected with heavy visqueen or other suitable material to **maintain the cleanliness of the underdrain system.** Such protection shall be maintained until the media is installed.

END OF SECTION 13222

SECTION 13223 - FILTER DISINFECTION

PART 1 - GENERAL

1.01 SCOPE

Provide labor, materials and equipment necessary to disinfect the filters prior to placing the filters in service.

1.02 RELATED WORK

- A. Section 13222 - Filter Underdrain System.
- B. Section 13225 - Filter Washwater Troughs.
- B. Section 13226 - Filter Media.

1.03 REFERENCES

Kentucky State Board of Health; Water Treatment Plant Regulations.

PART 2 - PRODUCTS

2.01 DISINFECTION SOLUTION

Only products approved for the disinfection of water shall be used to disinfect each filter interior prior to placing it in service. The disinfection solution shall be made using either calcium or sodium hypochlorite and applied as specified.

PART 3 - INSTALLATION

3.01 DISINFECTION PROCEDURE

- A. Extreme care is necessary in using chlorine.
- B. The interior of each filter shall be manually cleaned to remove any loose dirt or debris from the surface.
- C. The filter shall be backwashed. A chlorine solution of calcium or sodium hypochlorite shall be applied to the filter in order to provide a 50 parts per million (ppm) chlorine solution and be determined by a residual chlorine test on each filter.

- D. The 50 ppm chlorine solution shall travel through the filter by opening the filter effluent piping for a minimum of five (5) minutes. The filter effluent shall be closed and the water in the filter be brought back to the high water elevation. The chlorine residual shall be a minimum of 50 ppm at this point.
- E. The filter shall remain closed in the condition described in 3.01, D, for 24 hours. At the end of 24 hours, the chlorine residual shall not be less than 25 ppm. If the chlorine residual does decrease below 25 ppm, the disinfection shall be repeated. If the chlorine residual is over 25 ppm, the filter shall be thoroughly backwashed to remove all traces of the disinfection solution and then returned to service.

END OF SECTION 13223

SECTION 13225 - FILTER WASHWATER TROUGHS

PART 1 - GENERAL

1.01 WORK INCLUDED

Furnish and install filter washwater troughs for each filter including all materials, equipment and labor required for a complete installation in each filter.

1.02 RELATED WORK

- A. Division 3 - Concrete.
- B. Section 13223 - Filter Disinfection.

1.03 REFERENCES

ASTM Test Methods: D638; D570; D790; D2583.

PART 2 - PRODUCTS

2.01 DESIGN

- A. Trough carryoff capacity shall be 2,100 gallons per minute each with a free board of at least 2 inches.
- B. The troughs shall be designed to support, within the stress and deflection limitations, the gravity, buoyant and lateral loads described as follows:
 - 1. The downward vertical loads shall include the weight of the trough and attachments, such as weir plates and spreader bars in addition to the weight of water in the trough and any additional loads shall be considered.
 - 2. The buoyant load shall act vertically upward. Its magnitude shall be equal to the weight of the displaced water when the filter is filled from below with the trough empty. The line of action passes through the centroid of the submerged cross-sectional area.
 - 3. The lateral loads acting against the trough side walls which are induced by differential water levels on either side of the trough wall. The maximum differential load occurs when the trough is empty and the tank is full or when the trough is full and the tank empty.

- C. Troughs shall accommodate temperature-induced stresses resulting from differences in coefficients of thermal expansion (contraction) between the trough and the tank/support materials. Troughs shall accommodate an expansion (contraction) of $\frac{1}{8}$ inch per 20 feet of trough over range of -10° F to 100° F without exceeding deflection or strain limits.
- D. The trough system shall be designed to resist torsional oscillations induced by the flow of water over the trough edges.
- E. Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to the unsupported length of trough in inches divided by 1,000. The maximum allowable deflection shall be $\frac{3}{16}$ inches. Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to the trough depth in inches divided by 100. Maximum allowable bottom deflection shall be $\frac{3}{16}$ inches. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to the trough width in inches divided by 100. The maximum allowable bottom deflection shall be $\frac{3}{16}$ inches.
- F. Troughs shall be designed so that the maximum wall stress under the most severe loading condition is less than or equal to 1,500 pounds per square inch (psi).

2.02 MATERIALS

- A. Resin shall be a commercial grade, polyester thermosetting resin which has been found acceptable for the service conditions.
- B. Fillers shall not be contained in the resin with the exception of a thixotropic agent, which can be used for viscosity control if there is no interference with laminate quality or chemical resistance. Pigments, dyes or colorants, determined by a minimum of five (5) years of acceptable service conditions, that will not fade or chalk from the original color standard. Ultraviolet protection in the form of pigmentation or ultraviolet absorbers shall be included in the resin. When metal reinforcements are used, each shall be free of rust, oil and any foreign matter and encapsulated with a minimum of $\frac{1}{8}$ -inch thick laminate. Glass reinforcement shall consist of chemically bonded surface mat and shopped strand or chopped strand mat. The surface mat shall be Type C, 10 to 20 mils thick with a silane finish and a styrene soluble binder. The glass content shall not exceed 20 percent by weight. Chopped strands shall be Type E glass with a silane finish and styrene-soluble binder.

2.03 QUALITY

- A. Inner surface of the trough shall be smooth and resin rich. Outer surface shall be reasonably smooth with no glass fibers exposed. Laminations shall be dense without voids, dry spots, cracks or crazes. Air bubbles shall be held to a minimum.
- B. Inner surface of the trough shall be reinforced with a glass surfacing mat. This shall be followed with a chopped strand glass laminate with a maximum 2 ounces per square foot in a minimum of two (2) layers. Void content of the complete laminate shall not exceed 2.5 percent of laminate volume.
- C. Top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8 inch measured when the trough is not loaded. Length of a trough section shall have a tolerance of plus or minus 1/8 inch per 10 feet of length. Laminate thickness tolerance shall be plus 1/8 inch minus 0.
- D. Thickness at supports such as saddles shall be a minimum of 1.5 times nominal trough thickness.
- E. End flanges and blind ends shall be a minimum of 1.5 times the nominal trough thickness.
- F. An integrally molded water stop shall be provided on the trough when the trough is grouted into and/or passes through a wall.
- G. ABS spreaders (1-inch diameter) shall be bolted between trough walls on approximate 2-foot centers.
- H. Mechanical and physical properties shall conform to those listed in Table 1.

TABLE 1
FILTER WASHWATER TROUGHS
LAMINATE MECHANICAL AND PHYSICAL PROPERTIES
(73°F)

Item	ASTM Test Method	3/16-inch	1/4-inch
Ultimate Tensile Strength (PSI x 10 ³ min.)	D638	11	12
Flexural Strength (PSI x 10 ³ min.)	D790	16	19
Flexural Modulus of Elasticity (PSI x 10 ⁶ min.)	D790	0.9	0.9
Barcol Hardness (Min.)	D2583	35	35
Water Absorption (% Max.)	D570	0.2	0.2

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All trough mounting brackets, hardware and stabilizers shall be Type 18-8 stainless steel and supplied by the trough manufacturer.
- B. Troughs shall be protected during on-site storage and installation from contamination.

END OF SECTION 13225

SECTION 13226 - FILTER MEDIA

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide all labor, materials, equipment and services required to furnish and install filter media and support gravel shown on the Drawings and described herein.

1.02 RELATED WORK

- A. Section 13222 - Filter Underdrain System.
- B. Section 13223 - Filter Disinfection.
- C. Section 13225 - Filter Washwater Troughs

1.03 REFERENCES

AWWA Specification B100, latest edition.

1.04 SUBMITTALS

Submit shop drawings to the Engineer for review.

1.05 QUALITY ASSURANCE

- A. Filter media and filter underdrains shall be furnished by a single supplier.
- B. Material shall be of a quality that meets or exceeds the requirement of AWWA Specification B100 (latest edition).
- C. Samples of each gradation of support gravel and media representative of that to be furnished shall be submitted to a licensed and recognized laboratory for a complete analysis. Analyses shall be made within the six (6) months prior to the beginning of construction and five (5) copies submitted to the Engineer for approval prior to product shipment.

PART 2 - PRODUCTS

2.01 SUPPORT GRAVEL

The support gravel shall consist of a minimum of 3 inches of clean, durable and rounded particles with the gradations shown in the Gravel Schedule.

2.01 FILTER SAND

The filter sand shall be composed of hard, durable, clean silicious particles free of mica. The average specific gravity, effective size, and uniformity coefficient shall be as indicated by the Filter Media Schedule.

2.02 FILTER ANTHRACITE

The filter anthracite shall be graded, hard and durable anthracite coal particles. The anthracite shall have a minimum specific gravity uniformity coefficient, effective size and hardness shall be as indicated by the Filter Media Schedule. The anthracite shall be free of iron, sulphides, clay, shale, extraneous dirt and excessive dust.

2.03 FILTER MEDIA SCHEDULE

The filter media and support gravel shall have physical characteristics as noted in the Filter Media Schedule. Each layer shall be placed in accordance with the manufacturer's recommendations to the depth indicated.

The filter media shall be furnished by the filter equipment manufacturer and shall be shipped in bags for installation by the Contractor. The media shall be installed under the technical direction of the filter equipment manufacturer.

FILTER MEDIA SCHEDULE
(Existing Filters No. 1 through No. 4)

Bed Designation	Effective Size	Uniformity Coefficient	Specific Gravity	Hardness (MOH scale)	Depth (inches)
Anthracite	0.90-1.05 mm	1.3 or less	1.60±	2.7 or more	24
Sand	0.45-0.55 mm	1.4 or less	2.60+	---	12

GRAVEL SCHEDULE

Gravel Sizes	Air Scour Depth (inches)	Hydraulic Depth (inches)
1/4 x 1/8	2	3

FILTER MEDIA SCHEDULE

Bed Designation	Effective Size	Uniformity Coefficient	Specific Gravity	Hardness (MOH scale)	Depth (inches)
Anthracite		1.3 or less	1.60 ₊	2.7 or more	24
Sand	0.45-0.55 mm	1.4 or less	2.60 ₊	---	12
Gravel:					
(top layer)	1/4" x 1/8"	---	---	---	3

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The filter media shall be installed in accordance with the supplier's detailed instructions. The supplier shall provide supervision of the installation to insure proper compliance with procedures by the contractors.
- B. After the filter sand is placed, the filter shall be backwashed and the top of the sand bed shall be lightly scraped to remove any fines and debris. The finished sand depth shall be as indicated by the Filter Media Schedule following the scraping procedure.
- C. After the filter anthracite is placed, the filter shall be backwashed and the top of the filter anthracite shall be lightly scraped to remove any fines and debris. The finished filter anthracite depth shall be as indicated by the Filter Media Schedule following the scraping procedure.

END OF SECTION 13226

Division 14 - Not Used

Division 15 - Mechanical

SECTION 15060 - PIPING SUPPORT SYSTEMS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip) Galvanized Coatings on Iron and Steel Products.
 - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
2. Building Officials and Code Administrators (BOCA): Basic Building Code.
3. International Conference of Building Officials (ICBO): Uniform Building Code.
4. Manufacturers' Standardization Society (MSS):
 - a. SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. SP 69, Pipe Hangers and Supports - Selection and Application.
 - c. SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.

1.02 DEFINITIONS

Wetted or Submerged: Submerged, less than 1' above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Shop Drawings:

1. Drawings of piping support system, locating each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

B. **Contract Closeout Submittals:** Maintenance information on piping support system.

1.04 QUALIFICATIONS

In any seismic zone greater than 1, piping support systems shall be designed and Shop Drawings prepared and sealed by a registered professional engineer in the state where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Seismic Load: Seismic performance category forces with seismic loads in accordance with local codes.
2. Design, size, and locate piping support systems throughout facility, **whether shown or not.**
3. Supports shown are only where specific types and locations are required. Additional pipe supports may be required.
4. Meet requirements of MSS SP 58, MSS SP 69, and MS SP 89, or as modified by this section.

B. Pipe Support Systems:

1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.
2. Maximum Support Spacing and Minimum Rod Size:
 - a. Mild steel or ductile iron piping (note that this spacing may require the use of higher load pipe clamps and more than a single point anchor point in concrete):

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1" and smaller	6 feet	1/4"
1½" thru 2½"	8 feet	1/4"
3" and 4"	10 feet	3/8"
6"	12 feet	3/8"
8"	12 feet	½"
10" and 12"	14 feet	5/8"
14"	16 feet	3/4"
16" and 18"	16 feet	7/8"
20"	18 feet	1"
24"	18 feet	1-1/4"
30" and larger	As shown on Drawings	As shown on Drawings

b. Copper Piping:

- (1) Maximum Support Spacing: 2 feet less per size than listed for steel pipe, with 1 inch and smaller pipe supported every 5 feet.
- (2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.

c. Plastic and Fiberglass Piping:

- (1) Maximum Support Spacing: As recommended by manufacturer for flow temperature in pipe.
- (2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.

d. Stainless Steel Piping:

SST Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1" thru 4"	8 feet	1/4"
6"	8 feet	3/8"
8" and 10"	10 feet	1/2"
12"	10 feet	1/2"
14" and 16"	12 feet	5/8"
18" and 20"	14 feet	3/4"
24"	14 feet	7/8"

C. Framing Support System:

1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
2. Column Members: Size in accordance with manufacturer's recommended method.
3. Support Loads: Calculation using weight of pipes filled with water.
4. Maximum Spans:
 - a. Steel and Ductile Iron Pipe, 3" Diameter and Larger: 10-foot centers, unless otherwise shown.
 - b. Other Pipelines and Special Situations: May require supplementary hangers and supports.
5. Electrical Conduit Support: Include in design of framing support system.

D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

- E. Vertical Sway Bracing: 10' maximum centers, or as shown.
- F. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 - PRODUCTS

2.01 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.
- B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.
- C. Materials: In accordance with Tables 1 and 2, attached as supplements to this section.

2.02 HANGERS

- A. Type: MSS SP 58 and SP 69, Type 1 or 6.
 - 1. Anvil: Figure 104 or 260.
 - 2. B-Line: Figure B3171 or B3100.
 - 3. Or equivalent.
- B. Hinged Split-ring Pipe Clamp: MSS SP 58 and SP 69, Type 6 or 12.
 - 1. Anvil: Figure 104.
 - 2. B-Line: Figure B3171H.
 - 3. Or equivalent.
- C. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.
- D. Attachments:
 - 1. I-Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.
 - 2. Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.03 SADDLE SUPPORTS

- A. Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
 - 1. Nonadjustable Saddle: MSS SP 58 and SP 69, Type 37 with U-bolt.
 - a. Anvil: Figure 259.
 - b. B-Line: Figure B3090.
 - c. Or equivalent.
 - 2. Adjustable Saddle: MSS SP 58 and SP 69, Type 38 without clamp.
 - a. Anvil: Figure 264.
 - b. B-Line: Figure B3093.
 - c. Or equivalent.

2.04 WALL BRACKETS

- A. Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).
 - 1. Anvil: Figure 199.
 - 2. B-Line: Figure B3067.
 - 3. Or equivalent.
- B. One-Hole Clamp: Anvil: Figure 126.
- C. Channel Type:
 - 1. Unistrut.
 - 2. B-Line: Strut System.
 - 3. Aickinstrut (FRP).
 - 4. Or equivalent.

2.05 PIPE CLAMPS

- A. Riser Clamp: MSS SP 58 and SP 69, Type 8.
 - 1. Anvil: Figure 261.
 - 2. B-Line: Figure B3373.
 - 3. Or equivalent.

2.06 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 12-gauge, 1-5/8" wide minimum steel, 1½" wide, minimum FRP.
- B. Members and Connections: Design for all loads with safety factor of 5.

C. Manufacturers:

1. B-Line: Strut System.
2. Unistrut.
3. Aickinstrut (FRP System).
4. Or equivalent.

2.07 ACCESSORIES

A. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58 and SP 69, Type 40.
2. Manufacturers and Products:
 - a. Anvil: Figure 167.
 - b. B-Line: Figure B3151.
 - c. Or equivalent.

B. Welding Insulation Saddles:

1. Type: MSS SP 58 and SP 69, Type 39.
2. Manufacturers and Products:
 - a. Anvil: Figures Series 160.
 - b. B-Line: Figure Series B3160.
 - c. Or equivalent.

C. Vibration Isolation Pads:

1. Type: Neoprene Waffle.
2. Manufacturers and Products:
 - a. Mason Industries: Type W.
 - b. Or equivalent.

2.08 INTERMEDIATE PIPE GUIDES

B. Piping 6" and Smaller:

1. Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8" clearance.
2. Manufacturers and Products:
 - a. Anvil: Figure 103.
 - b. B-Line: B3148 or B3180.
 - c. Or equivalent.

C. Piping 8" and Larger:

1. Type: Specially formed U-bolts with double nuts to provide 1/4" minimum clearance around pipe.
2. U-Bolts Stock Size:
 - a. 8" Pipe: 5/8".
 - b. 10" Pipe: 3/4".
 - c. 12" thru 16" Pipe: 7/8".
 - d. 18" thru 30" Pipe: 1".

2.09 PIPE ALIGNMENT GUIDES

A. Type:

1. Piping 8" and Smaller: Spider or sleeve type.
2. Piping 10" and Larger: Roller type.

B. Manufacturers:

1. Flexonics.
2. Anvil.
3. B-Line.
4. Or equivalent.

2.10 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturers and Products:

1. B-Line: Figure B3147 or B3147B.
2. Or equivalent.

2.11 ANCHORING SYSTEMS

Size: Sized by equipment manufacturer, but not less than 1/2" minimum diameter and as specified in Section 05500 - Miscellaneous Metals, Fasteners, Special Finishes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise.
2. Support piping connections to equipment by pipe support and not by equipment.
3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
4. Support no pipe from pipe above it.
5. **Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.**
6. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
7. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
8. Install lateral supports for seismic loads at all changes in direction.
9. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
10. Repair mounting surfaces to original condition after attachments are made.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:

- a. Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.
- b. Grouped Pipes: Trapeze hanger systems.
- c. Furnish galvanized steel protection shield and oversized hangers for insulation pipe.
- d. Furnish precut sections of rigid insulation with vapor barrier at hangers for insulated pipe.

2. Horizontal Piping Supported from Walls:

- a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
- b. **Stacked Piping:**
 - (1) Wall mounted framing system and clips acceptable for piping smaller than 3" minimal diameter.
 - (2) Piping clamps that resist axial movement of pipe through support not acceptable.

- c. Wall mounted piping clips not acceptable for insulated piping.
3. Horizontal Piping Supported from Floors:
- a. Stanchion Type:
 - (1) Pedestal type; adjustable with stanchion, saddles, and anchoring flange.
 - (2) Use yoked saddles for piping whose centerline elevation is 18" or greater above floor and for exterior installations.
 - (3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
 - b. Floor Mounted Channel Supports:
 - (1) Use for piping smaller than 3" nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
 - (2) Attach channel framing to floors with anchor bolts.
 - (3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles: Use for piping larger than 3" along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
5. Standard Attachments:
- a. To Concrete Ceilings: Concrete inserts.
 - b. To Steel Beams: I-beam clamp or welded attachments.
 - c. To Wooden Beams: Lag screws and angle clips to members no less than 2½" thick.
 - d. To Concrete Walls: Concrete inserts or brackets or clips angles with anchor bolts.
6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

C. Intermediate and Pipe Alignment Guides:

- 1. Provide pipe alignment guides (or pipe supports that provide same function) at expansion joints and loops.
- 2. Guide piping on each side of expansion joint or loop at 4- and 14-pipe diameters from each joint or loop.

3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

D. Accessories:

1. Insulation Shield: Install on insulated non-steel piping. Oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.
3. vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
4. Dielectric Barrier:
 - a. **Install between carbon steel members and copper or stainless steel pipe.**
 - b. Install between stainless steel supports and non-stainless steel ferrous metal piping.
5. Electrical Isolation: Install 1/4" by 3" neoprene rubber wrap between submerged metal pipe and oversize clamps.

3.02 FIELD FINISHING

Paint atmospheric exposed surfaces not-dip galvanized steel components as specified in Section 09800 - Special Coatings.

3.03 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification:
1. Table 1: Non-chemical Areas.
 2. Table 2: Chemical Areas.

END OF SECTION 15060

Table 1 - Non-Chemical Areas

Exposure Conditions	Hanger Material
Office areas	Galvanized steel or precoated steel
Shops and warehouse areas	Galvanized steel or precoated steel
Pipe galleries	Galvanized steel or precoated steel
Headworks	Stainless steel or FRP
Process areas: high humidity or hydrogen sulfide	Stainless steel or FRP
Process areas: wetted or submerged	Stainless steel or FRP

- Notes: 1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
 2. Stainless steel to be Type 304.
 3. Galvanized steel to be per ASTM A653, Class G90, or hot-dip galvanized after fabrication to ASTM A123.
 4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2 - Chemical Areas

Exposure conditions	Hanger for Direct Exposure	Hanger for Remote Exposure
Alum	FRP	Precoated steel
Aqua Ammonia	Stainless steel	Precoated steel
Coagulants	FRP	Precoated steel or galvanized steel
Ferric Chloride	FRP	Precoated steel
Ferric Sulfate	FRP	Precoated steel
Hydrofluorsilic Acid	FRP	Precoated steel
Lime	Stainless steel; FRP, precoated steel	Stainless steel; FRP, precoated steel
Methanol	Galvanized steel	Galvanized steel
Polymers	FRP	Precoated steel
Potassium Permanganate	Precoated steel	Precoated steel
Powdered Activated Carbon	Precoated steel	Precoated steel
Sodium Carbonate	Stainless steel	Precoated steel
Sodium Hydroxide	Stainless steel	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel
Sulfuric Acid	Stainless steel	Precoated steel

- Notes: 1. Direct exposure includes entire area within containment area; area within 20" of chemical pumps or chemical mixing stations; or as specified.
 2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
 3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
 4. Stainless steel to be Type 304.
 5. Galvanized steel to be per ASTM A653, Class G90, or hot-dip galvanized after fabrication to ASTM A123.
 6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 15065 - CHEMICAL PIPING, VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish, install, and test all chemical piping, hoses, valves, fittings and appurtenances as herein specified. The locations where various types of pipe shall be used shall be as indicated on the Drawings and as herein specified.
- B. The Contractor, at no additional cost to the Owner, shall do all work required by and in accordance with applicable state and local codes; shall arrange for all permits, inspections and tests required by these codes; and shall do everything necessary to provide complete systems which will be ready for use without further expense to the Owner.
- C. The Contractor shall thoroughly familiarize himself, his workmen and his subcontractors with the hazards associated with the chemicals specified herein and used at the water pollution control plant, and he shall take all necessary safety precautions.
- D. Chemical drain piping shown on plumbing sheets is specified under Section 15400 - Plumbing.

1.02 RELATED WORK

Section 11240 - Chemical Feeding Equipment.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Insofar as possible, all materials shall conform, and all piping shall be fabricated, installed and tested in accordance with the provisions of the "American Standard Code for Pressure Piping, Chemical Plant Petroleum Refinery Piping," ANSI B31.3-1976 and Addenda B31.3a-1978, as published by the American Society of Mechanical Engineers, New York, New York 10017.
- B. All bolting shall be cadmium plated carbon steel in accordance with the hereinafter listed ASTM A307, Grade B, and nuts shall be cadmium plated carbon steel in accordance with the hereinafter listed ASTM A194, Grade 2.

C. All pipe and fittings shall conform to the following Specifications and Standards as applicable, unless otherwise indicated or specified.

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- a. A53-79 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- b. A182-70A Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged fittings, and Valves and Parts for High-Temperature Service.
- c. A194-79 Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High Temperature Service.
- d. A307-78 Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners.
- e. A312-79a Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
- f. A403-79 Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- g. D1785 Specifications for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40 and 80.
- h. D2464-76 Threaded Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80.
- i. D2467-76a Socket-Type Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80.
- j. F439-77 Specification for Socket-Type Chlorinated Poly (Vinyl Chloride)(CPVC) Plastic Pipe, Schedules 40 and 80.
- k. F441-77 Specification for Chlorinated Poly (Vinyl Chloride)(CPVC) Plastic Pipe, Schedules 40 and 80.
- l. F493-79 Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride)(CPVC) Plastic Pipe and Fittings.

2. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- a. B16.5-199 AN Standard for Steel Pipe Flanges and Flanged Fittings.
- b. B16.9-1978 AN Standard for Factory-Made Wrought Steel Buttwelding Fittings.
- c. B16.11-1973 AN Standard for Forged Steel Fittings, Socket-Welding and Threaded.

3. MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVES AND FITTINGS INDUSTRY (MSS)

- a. MSS Standard Practice SP-43 (Fitting Dimensions).
- b. MSS Standard Practice SP-56 (Hangers and Supports).
- c. MSS Standard Practice SP-69 (Selection of Hangers and Supports).

2.02 CHEMICAL FEEDING SYSTEMS

- A. Pipe and Fittings: Insofar as possible, all fittings shall be solvent socket weld type PVC Schedule 80. Schedule 40 fittings shall not be used.
- B. Screwed Connections: Screwed connections are permissible only where system components are not available in socket weld or flanged configurations, and only as follows:
 - 1. Metal male threads shall not be screwed into plastic threads. Such connections shall be made using flat faced flanges of each material.
 - 2. Plastic components requiring screwed connections shall be fitted with short one-end threaded PVC pipe nipples, and then connected to the system with socket weld PVC unions or flanges.
 - 3. The Contractor shall take every precaution not to overtighten or crack threaded components. Screwed joints shall be made up using Teflon taps and shall be tightened no more than one and one-half turns past hand tight. If a leaktight joining cannot be made in this manner, the joining shall be made over using a new pipe nipple. In no case shall PVC cement or overtightening be used to seal or backweld a leaky joint.
- C. Gaskets: PVC flanges shall be jointed with full-face Viton or hypalon gaskets, of 50 to 60 Shore "A" Durometer, and shall be 1/8-inch thick. All gaskets shall be machine made or die stamped and shall have inside and outside edges concentric. Bolt holes shall be oversized to prevent crimping of the gasket when installed. Gaskets shall be resistant to deterioration for piping chemical use.
- D. Use of Other Plastic Components:
 - 1. In the event that certain system components are composed of plastics other than PVC, and are not available in flanged configuration, if acceptable to the Engineer, they shall be provided in screwed configuration and fitted with short one-end threaded PVC nipples, and then connected to the system with socket weld PVC unions or flanges.
 - 2. All such other plastics shall have strength and heat distortion resistance equal to or greater than PVC at 150° F.
- E. Valves:
 - 1. PVC valves shall be made of Type IV, Grade 1, chlorinated polyvinylchloride and shall be rated for at least 125 psig nonshock service at 75° F. PVC valves shall be Type 1, Grade 1 and 20 percent glass filled.
 - 2. Valves shall have socket or flanged ends to suit the pipe connections hereinbefore specified and shall be of the types indicated on the drawings.

3. Valves shall be anchored as specified hereinafter to prevent torque stress on the piping when opening and closing valves.
4. Ball valves shall have double union ends to permit removal of the valve without disconnecting the pipeline and shall be of the type which will not leak when the downstream union end is disconnected. Viton "O" ring seals shall be used with Teflon seats. Ball valves shall be installed with the flow arrow pointed in the direction of downstream piping. During installation, the valve handle shall be oriented for ease of operation by rotating the valve body about its axis prior to tightening the ends.
5. Buried valves shall be provided with operating rods to the ground surface. Rods shall be installed in valve boxes as specified in Section 02640.
6. Check valves shall be double union type with PVC ball and Viton "O" ring seals.
7. **Diaphragm valves shall be Saunders Patent weir type valves with Hypalon diaphragm, rising stem and PVC body. Diaphragm valves shall have sealed bonnets to prevent leakage if damage to the diaphragm should occur.**

F. Miscellaneous Fittings and Valves:

1. Union fittings shall be PVC, Schedule 80, with socket weld ends and Viton "O" rings.
2. All sample and blowdown valves shall be furnished with outlet piping which shall terminate 6 inches above the floor slab, but in no event shall such piping be less than a 2-inch long nipple.
3. Vacuum breakers shall be designed to seal against pressure and to vent when under vacuum. Vacuum breakers shall have PVC bodies and molded normally closed diaphragm seals.
4. Pressure relief valves shall be constructed of Type 1, Grade 1 PVC with a solid Teflon Shaft. Three seals shall be constructed of Viton. Relief pressure shall be able to be manually set and shall be from 5 to 100 psig. Valve shall be Plast-O-Matic, model RVT or equal.
5. Quick disconnect hose fittings and all hoses shall be as specified hereinafter under "Chemical Hose".

- G. All underground plastic piping shall have a colored metallic tape laid 2 feet above the pipe. The tape shall have the word "Caution" printed on it and shall identify the pipe use. Product shall be Seton Name Plate Corp., New Haven, CT, No. 210 or equal.

2.03 CHEMICAL HOSE

- A. Hose for carrying chemical solutions and slurries shall be two-ply, with helical steel wire, 3/16-inch Hypalon tube and rubber cover, suction and discharge hose, of sizes as indicated on the drawings, suitable for 100 psi service. Hoses shall be made by Gates Rubber Co., Denver, CO; B.F. Goodrich, Akron, OH; Goodyear Tire & Rubber Co., Akron, OH; or be acceptable equivalent products.
- B. Hoses shall be reasonably flexible and lightweight, therefore four-ply hoses will not be acceptable.
- C. Hose sections shall not exceed 20 feet in length and shall be as necessary for the hose lines indicated on the Drawings. Hose ends shall be fitted with shank type, **polypropylene quick disconnect couplings**. Couplings shall be of the cam and groove type, sized the same as the lines to which they are connected. All couplings furnished shall be compatible with all other couplings of equal line size. Couplings shall be Viton or Hypalon gaskets.

2.04 HANGERS, SUPPORTS AND WALL SLEEVES

- A. All piping shall be provided with the necessary hangers, anchors, and supports as specified herein and as indicated on the Drawings. Piping shall not be supported by the equipment to which it is connected.
- B. The pipe supports shall be complete with all accessories such as clamps, bolts, nuts, washers, rods, intermediate structural steel members when necessary, etc.
- C. All piping hanger components shall be designed for the maximum pressures and temperatures developed under all operating and test conditions as indicated.
- D. Pipe hanger and support designs and construction shall conform to the Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Standard Practice SP-58, and where details are not provided on the Drawings or in the Specifications, the selection and applications shall conform to the MSS Standard Practice SP-69. Where hangers and supports are identified on the Drawings or in the Specifications by a Type number, this number refers to units identified in the above Standard Practice bulletins.
- E. Anchors for PVC pipe shall have compressible rubber gaskets between the pipe and metal anchor to prevent damage to the pipe.

- F. Wall sleeve seals for pipes passing through structure walls below grade shall be compressions type units consisting of molded rubber links with bolt holes, elongated backup washers, nuts and bolts. When assembled around the pipe and inserted in the wall sleeve, tightening the bolts shall expand the rubber against the pipe and sleeve.

2.05 PRESSURE GAUGES

- A. Pressure gauges shall be provided as specified and as indicated on the Drawings. They shall have a black turret-type case and shall be 4-1/2 inch nominal diameter with stainless steel or phosphor bronze Bourdon tubes, 1/2-inch. NPT male bottom connection, stainless steel rack and pinion movement, microadjustment for calibration, white dials and black figures, threaded ring case with an integral wall separating the dial face from the Bourdon tube, with blowout plug in the rear of the case and clear acrylic plastic lens.
- B. Gauges specified to have diaphragm seals shall have phosphor bronze Bourdon tubes. All other gauges shall have Type 316 stainless steel Bourdon tubes.
- C. Where specified, gauges shall be provided with protective diaphragm attachment, factory-mounted. Diaphragm housings shall be constructed such that the diaphragm is held between two halves of the housing and the assembly is secured by four through-bolts with nuts. Diaphragms shall be Viton fluoroelastomer. Diaphragm housings for lime slurry service shall be 1-1/2 inch screwed end; all other diaphragm housings shall be 1/2-inch screwed end; all lower housings shall be of the same materials as the piping system to which they are connected. Diaphragms shall be fitted with the manufacturer's standard fluid. For systems in contact with chemicals used to treat potable water supplies, the diaphragms shall be filled with propylene glycol or other FDA approved fluid. All diaphragm housings shall be equipped with 1/4-inch. NPT flushings connections, suitably plugged. Plugs shall be the same material as the lower housing.
- D. All gauges shall be installed with nipples no shorter than 2-inches and equipped with a shutoff valve of the type indicated on the Drawings. Nipples and valves shall be of the same materials as the piping system to which they are connected. Gauges shall be support as specified herein.
- E. All gauges that do not have diaphragm seals shall be equipped with the manufacturer's standard pressure snubbers.
- F. The ranges of the gauges shall be suitable for the range of pressure that can occur during operation.

2.06 WATER PRESSURE REGULATORS

- A. Water pressure regulators shall be installed where and as indicated on the Drawings. Sizes and flows shall be as indicated on the Drawings.
- B. Regulators shall be self contained units operated by internal spring loaded diaphragms or pistons. Regulators shall have bronze bodies and spring chambers, bronze or brass trim, stainless steel or bronze body seat, Buna-N seat disk, and Buna-N reinforced diaphragms. Large size regulators shall have spring-opposed bronze piston where not available in the diaphragm configuration.
- C. Regulators shall be constructed such that all repair may be performed with the valve in-line. A top adjusting screw shall be provided to set the downstream pressure.
- D. Regulators shall be sized for the required flows with an inlet pressure of 85 psig and an outlet pressure of 50 psig. Pressure variation at the outlet shall not be greater than 15 psig at maximum required flows.

2.07 PRESSURE RELIEF VALVES

- A. Pressure relief valves shall be installed where and as indicated on the Drawings. Sizes shall match the piping where installed, and flow rates shall be as indicated for the system metering pumps.
- B. An adjusting screw or handle shall be provided to set the relief pressure, and shall be provided with a locking mechanism to prevent inadvertent changes in the setting.
- C. Drain piping from the discharge of the relief valves shall be provided and routed to the locations indicated on the drawings. Drain piping shall not be less than 1.5 times the cross-sectional area of the supply piping to the pressure relief valves.
- D. Pressure relief valves shall be as manufactured by Primary Fluid Systems, Inc., or approved equivalent.

2.08 BACK PRESSURE VALVES

- A. Back pressure (anti-siphon) valves shall be installed where and as indicated on the Drawings.
- B. An adjusting screw or handle shall be provided to set the system pressure, and shall be provided with a locking mechanism to prevent inadvertent changes in the setting.

- C. Back pressure valves shall be as manufactured by Primary Fluid Systems, Inc., or approved equivalent.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING AND HOSES

Unless otherwise specified, installation of piping and hoses shall be as follows:

A. General:

1. All piping and hoses shall be installed in a neat and workmanlike manner. Piping shall be installed to accurate lines and grades, and shall be supported by hangers of the type and spacing hereinafter specified.
2. Wherever possible, piping shall be installed parallel to the other building walls. The exact location of each pipe shall be determined in the field in respect to piping and equipment installed.
3. Pipes shall not run through, directly over, or in front of electrical switchboards, power panels, etc.
4. All piping shall be free to expand and contract with an allowance of at least 3/4 inch per 100 feet.
5. Piping shall be installed to provide not less than 3-inch clearance from walls, ceilings, floors, and other piping systems of electric conduits, etc. This clearance shall be the outside surface of pipe or flange, whichever is greater.
6. All piping shall pitch toward low points.

B. Joints, Connections, and Fittings:

1. Before assembly, all dirt and chips shall be removed from inside the pipe and fittings and from the threads.
2. After being cut to final lengths, the ends of pipe shall be reamed to remove burrs.
3. Threads of all screwed joints shall be clean cut and of proper taper. Screwed joints shall be made up with Teflon tape applied to the male threads only.
4. All valves shall be installed and oriented such that valve handles are easily accessible for operation.
5. All valves, fittings and appurtenances shall be installed such that flow arrows cast into the bodies or painted thereon are facing in the direction of flow and easily visible when operating.
6. Socket joints in PVC pipe and fittings shall be tried for fit before application of the primer or solvent cement.
7. Materials shall be used, mixed, applied, cured and installed in strict accordance with the manufacturer's current printed recommendations.

8. The Contractor shall conform to the manufacturer's recommendations concerning the cleanliness and temperature to be maintained before, during and after the application of PVC primer and cement, and amount to be applied, and the set time required.
9. The Contractor shall use PVC cement and primer in the smallest containers available from the manufacturer in order to avoid drying out and evaporation of the solvent systems used.
10. The Contractor shall conform to the manufacturer's recommendations for square smooth pipe cuts and the need to protect the pipe from nicks, scratches and cracking. Tapered plugs shall be inserted into the pipe when threading to prevent the die from distorting or gouging the pipe wall. Pipe strap wrenches shall be used for tightening. Stillson-type wrenches shall not be used. If any PVC pipe is damaged, the damaged section shall be cut out. Manufacturer's recommendations shall be closely followed regarding the length of tapered pipe threads.
11. Flanged joints shall be made with bolts, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same AN Standard as the flanges. Bolts and nuts shall be Grade B, conforming to ASTM A307. Bolts studs and studs shall be of the same quality as machine bolts. Before the flanges pieces are assembled, rust-resistant coating shall be removed from machined surfaces, gaskets shall be thoroughly cleaned, and all brush and other defects shall be carefully smoothed. Flanged joints shall be made up tight, care being taken to prevent undue strain upon valves or other pieces of equipment.
12. Final connections to all equipment shall be made with flanges.
13. Cleanouts shall be installed in piping at ends of branches, at points where direction of flow changes, and at convenient points in long runs of pipe.
14. All automatic devices shall be adjusted for proper operation.
15. Isolation or service valves shall be provided in all branch, subbranch and equipment connections whether or not indicated on the drawings.
16. Joints which are required to be backed off shall be entirely disjointed, the threads of both the pipe and fittings wiped clean, new Teflon tape applied, and the connection reassembled.

C. Hangers and Supports:

1. The Drawings do not generally indicate locations or types of hangers; however, the Contractor shall provide complete support systems as necessary to allow satisfactory operation of each system. Where piping supports or accessories are indicated, the information is supplied to indicate typical provisions for systems involving more critical consideration due to expansion, thrust or other conditions. The Contractor shall adapt the indicated typical conditions as necessary to suit the actual system requirements.
2. All necessary piping supports shall be provided to install the piping at the lines and grades indicated on the Drawings or specified. The supports

shall be secured to the building structure so as to provide for expansion and contraction, prevent vibration and to prevent transmitting forces to equipment from the piping systems which are in excess of the allowable limits of the equipment.

3. Where several pipes are parallel, multiple or trapeze hangers may be used.
4. Hangers shall be secured to the building structure with expansion type anchors.
5. Except as otherwise permitted, all hangers shall have provisions for vertical adjustment after installation.
6. Hangers shall be located on all systems so as to provide at least one hanger immediately adjacent to each change of direction, offset, and additional hangers shall be provided wherever concentrated loads occur **in the piping system from the installation of in-line equipment.**
7. All pressure gages equipped with diaphragms or supported by shutoff valves shall be supported by brackets clamped to the pipeline. In-line equipment of substantial weight shall be supported independently of the pipeline.
8. Additional guides or supports shall be provided at offsets in piping as necessary to prevent deflection of pipe axis due to expansion or pressure forces except where right angle bends are utilized to compensate for expansion.
9. Hangers and support spacing for steel pipe shall not exceed 6 feet. Horizontal runs of PVC pipe and hose shall be continuously supported in light-weight epoxy-coated steel angle or channel shapes except where otherwise indicated on the Drawings.
10. For all pipe and hose, vertical runs shall be supported with clamps at a maximum spacing of 6 feet. on centers. Where hoses are hung vertically from PVC piping, such hoses shall be independently supported. Hangers shall be of a type to give broad support to the pipe and permit free axial movement. Where temporary supports are used, they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Where necessary, and particularly for PVC piping, suitable provisions shall be made for expansion.

3.02 TESTING

- A. After installation, and in the presence of the Engineer, all pipelines shall be tested for watertightness in an acceptable manner. For these tests, the Contractor shall furnish suitable testing plugs or caps, all necessary pressure pumps, pipe connections, test fluids, gages, other equipment and all labor required.
- B. Gages shall be recently calibrated. All instrumentation and appurtenant equipment which is incapable of withstanding the test pressures shall be removed from the lines, or shall be valved off.

- C. All equipment and property damaged by the testing procedure shall be cleaned, repaired to the satisfaction of the Engineer or replaced by the Contractor, all at no additional cost to the Owner.
- D. All piping shall be cleaned in a manner acceptable to the Engineer prior to testing. Generally, compressed air shall not be used for this testing procedure. Water at ambient temperatures shall be used for testing all lines.
- E. Prior to testing, the Contractor shall walk the line to be tested to visually inspect the lines for obviously improper valve settings, loose fittings, disconnected equipment, etc., and he shall correct these items before beginning the test procedures.
- F. **The Contractor shall take proper provisions to assure complete venting of all entrapped air when filling the system with the water used for testing. Special care shall be taken with plastic piping systems to insure removing all air from the system. If a slow buildup or fluctuation of pressure in a completely liquid-filled system is noted, the pressure shall be immediately released and the line re-bled to remove the entrapped air.**
- G. All piping to be so tested shall be purged of air and water-filled, and the liquid shall be pressurized using a hand-operated hydraulic pump unless other suitable means are submitted to the Engineer for review and accepted. Upon reaching the test pressure, the piping system with test gages shall be valved off and disconnected from the pressure source, and pressure shall be observed for a period of 2 hours. No leakage or pressure decay shall be permitted during the test period.
- H. Where feasible, the test pressure shall be at least 100 psi or 1-1/2 times the normal operating pressure, whichever is greater.
- I. Should leaks be found, faulty joints shall be repaired, even to the extent of disassembling and remaking the joint, and all defective pipe and fittings shall be removed and replaced in a manner satisfactory to the Engineer.
- J. Chemical sealants, tape or cements shall not be used to repair leaks. Leaks in PVC piping shall be repaired as specified and conforming to the manufacturer's current printed recommendations. Cemented PVC socket weld fittings and screwed nipples with improperly cut threads shall not be reused, nor shall threaded PVC pipe and fittings be overtightened or sealed with chemical sealants. Leaks shall not be repaired by backwelding.
- K. Wherever possible each piping system shall be tested as it is completed in order to uncover faulty materials or workmanship.
- L. Lines shall not be painted until the line has passed the leakage tests.

- M. The Contractor shall pass through all gravity flow PVC pipe rated at less than 200 psi and installed underground, under its own momentum, a wooden ball of a diameter one inch less than the nominal diameter of the pipe. All pipes that do not pass the wooden ball shall be replaced or repaired so that they do pass the ball, at no cost to the Owner.

END OF SECTION 15065

Division 16 - Electrical