Resolution 591-2014

Contract 324-2014

# CONTRACT DOCUMENTS AND SPECIFICATIONS

## FOR

## Town Branch Wet Weather Storage Facility

### Wastewater System Improvements
### Division of Water Quality
### Lexington Fayette Urban County Government

### Remedial Measures Plan ID No.G2-TB-1

### LFUCG Bid No.137-2014

### Date: AUGUST 2014

### Volume 2 of 2


PREPARED BY:

GRW Engineers, Inc
801 Corporate Drive
Lexington, KY 40503
(859) 223-3999


Edition: Conformance Set

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Conformance Set

# DIVISION 3

# CONCRETE

## SECTION 03100 - CONCRETE FORMWORK

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03200 - Reinforcing Steel

B. Section 03250 - Concrete Accessories

C. Section 03290 - Joints in Concrete

D. Section 03300 - Cast-in-Place Concrete

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Kentucky Building Code
2. ACI 318 - Building Code Requirements for Structural Concrete
3. ACI 301 - Specifications for Structural Concrete for Buildings
4. ACI 347 - Recommended Practice for Concrete Formwork
5. U.S. Product Standard for Concrete Forms, Class I, PS 1
6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

### 1.04 SUBMITTALS

A. Product data: Manufacturer's data on proposed form release agent and on proposed formwork system including form ties.

B. Shop Drawings: Submit drawings that detail formwork locations, elevations, dimensions, shapes and sections, openings, support conditions, and erection instructions.

### 1.05 QUALITY ASSURANCE

A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

## PART 2 - PRODUCTS

### 2.01 FORMS AND FALSEWORK

A. All forms shall be smooth surface forms unless otherwise specified.

B. Wood materials for concrete forms and falsework shall conform to the following requirements:

1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.

C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

### 2.02 FORMWORK ACCESSORIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

### 2.03 FORMWORK LINERS

A. Formwork liners for construction of fluted wall treatment shall be prefabricated plastic liners as manufactured by Greenstreak, Interform Company, of Symons Corporation.

B. Liners shall be fiberglass or ABS (acrylonitrile – butadiene – styrene) of such configuration as to obtain the fluted pattern shown or indicated on the Drawings.

C. For purposes of designating type and quality of material required, form liners shall be pattern 361 trapezoidal liners as manufactured by Greenstreak.

D. Preparation of forming materials, sealing of joints to prevent grout leakage and form release treatment (if required) shall be in strict compliance with the manufacturer's printed instructions and recommendations.

## PART 3 - EXECUTION

### 3.01 FORM DESIGN

A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.

B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

### 3.02 CONSTRUCTION

A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.

B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.

C. Forms shall be true to line and grade, and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.

D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form.

E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.

G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.

H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.

I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered; set screeds to a like camber to maintain the proper concrete thickness.

J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

## 3.03 TOLERANCES

A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.

B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.

C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

D. Regardless of the tolerances specified, no portion of the building shall extend beyond the legal boundary of the building.

## 3.04 FORM ACCESSORIES

A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.

B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to wastewater or enclosed surfaces above the wastewater, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

## 3.05 APPLICATION - FORM RELEASE AGENT

A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

## 3.06 INSERTS AND EMBEDDED ITEMS

A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

## 3.07 FORM CLEANING AND REUSE

A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

## 3.08 FORM REMOVAL AND SHORING

A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

| | Ambient Temperature (°F.) During Concrete Placement | | | | |
|---|---|---|---|---|---|
| | Over 95° | 70°-95° | 60°-70° | 50°-60° | Below 50° |
| Walls | 5 days | 2 days | 2 days | 3 days | Do not remove |
| Columns | 7 days | 2 days | 3 days | 4 days | until directed by |
| Beam Soffits | 10 days | 7 days | 7 days | 7 days | Engineer (7 days |
| Elevated Slabs | 12 days | 7 days | 7 days | 7 days | minimum) |

C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.

D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

## 3.09 RESHORING

A. When reshoring is permitted or required the operations shall be planned in advance and subjected to approval by the Engineer.

B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.

C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.

D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.

E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

END OF SECTION

## SECTION 03200 - REINFORCING STEEL

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03250 - Concrete Accessories

C. Section 03300 - Cast-in-Place Concrete

D. Section 03400 – Precast Prestressed Concrete

### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Kentucky Building Code
2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice
3. ACI SP66 - ACI Detailing Manual
4. ACI 315 - Details and Detailing of Concrete Reinforcing
5. ACI 318 - Building Code Requirements for Structural Concrete
6. ASTM A 185 - Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcing
7. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing
8. ASTM C 881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

### 1.04 SUBMITTALS

A. Steel Reinforcement Shop Drawings: Submit drawings that detail fabrication, bending, and bar placement. Include bar sizes, lengths, materials, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing and supports for concrete reinforcement. Shop drawings shall conform to the ACI detailing manual SP-66.

B. Mill test certificates - 3 copies of each.

C. Description of the reinforcing steel manufacturer's marking pattern.

D. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.

E. Proposed supports for each type of reinforcing.

F. Request to use splices not shown on the Drawings.

G. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.

H. Request for placement of column dowels without the use of templates.

I. Request and procedure to field bend or straighten partially embedded reinforcing.

## 1.05 QUALITY ASSURANCE

A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.

# PART 2 - PRODUCTS

## 2.01 REINFORCING STEEL

A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type and grade.

B. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.

C. Field welding of reinforcing steel will not be allowed.

D. Use of coiled reinforcing steel will not be allowed.

## 2.02 ACCESSORIES

A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers and other devices to position reinforcing during concrete placement. Slab bolsters shall have gray plastic-coated legs.

B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

## 2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.

C. Hot-forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.

## 2.04 DOWEL ADHESIVE SYSTEM

A. Epoxy Bonding Adhesive: Where shown on the Drawings, reinforcing bars anchored into hardened concrete with an epoxy bonding adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions. Adhesive shall meet ASTM C881, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and reinforcing bar. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. The embedment depth of the bar shall be per manufacturer's recommendations, so as to provide a minimum allowable bond strength that is equal to 125 percent of the yield strength of the bar, unless noted otherwise on the Drawings. The adhesive system shall be "Epcon System C6 or G5" as manufactured by ITW Redhead . "SET Epoxy-Tie" or "SET-XP" as manufactured by Simpson Strong-Tie Co. or "PE-1000 SD" and "T308" by Powers Fasteners. Engineer's approval is required for use of this system in locations other than those shown on the Drawings. **Fast-set epoxy formulations shall not be acceptable.**

B. Where identified on the Contract Drawings or for installation of concrete where anchorage failure could present a life-threatening hazard, the adhesive system shall be "PE-1000 SD" by Powers Fasteners, "SET-XP" by Simpson Strong-Tie Co. or "Epcon System G5" as manufactured by ITW Redhead. Alternate adhesive systems shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories, must comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. Installation of adhesive system shall be per manufacturer's recommendations and as required in Item A above.

# PART 3 - EXECUTION

## 3.01 TEMPERATURE REINFORCING

A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 12 inches.

## 3.02 FABRICATION

A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.

B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.

C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved by the Engineer to be bent in the field. Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.

## 3.03 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle steel reinforcement and anchor rods to prevent bending and damage.

B. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.

C. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.

D. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

E. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

## 3.04 PLACING

A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.

B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8 inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.

E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.

F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings or authorized in writing by the Engineer. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.

I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations. A representative of the manufacturer must be on site when required by the Engineer. At least 25 percent of the dowels installed shall be proof tested to 1.33 times the allowable load specified by the manufacturer, or as indicated on the Drawings. If the dowels are required to have a hook at the end to be embedded in the new work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate the testing.

## 3.05 SPLICING

A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.

B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.

C. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer.

D. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

## 3.06 INSPECTION

A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.

END OF SECTION

## SECTION 03250 - CONCRETE ACCESSORIES

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, epoxy bonding agent, and concrete anchors.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03290 - Joints in Concrete

C. Section 03300 - Cast-in-Place Concrete

D. Section 07900 - Joint Sealers

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1 Federal Specification TT-S-00227 E (3)

| | | |
|---|---|---|
| 2. | ASTM C881 | Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |
| 3. | ASTM D412 | Standard Tests for Rubber Properties in Tension |
| 4. | ASTM D 624 | Standard Test Method for Rubber Property - Tear Resistance |
| 5. | ASTM D 638 | Standard Test Method for Tensile Properties of Plastics |
| 6. | ASTM D1751 | Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types) |
| 7. | ASTM D 1752 | Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |

### 1.04 SUBMITTALS

A. Submit the following:.

1. Manufacturer's literature on all products specified herein including material certifications.

2. Proposed system for supporting PVC waterstops in position during concrete placement.

3. Samples of products if requested by the Engineer.

## PART 2 - PRODUCTS

### 2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

A. PVC waterstops for construction joints shall be flat ribbed type, 4 inches wide with a minimum thickness at any point of 3/8 inches.

B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.

C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The waterstop material shall have an off-white, milky color.

1. The waterstops shall be of size shown on Drawings, complete with fittings as required such as unions, vertical tees, vertical ells, flat crosses, flat ells, flat tees, etc.

2. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572.

D. The required minimum physical characteristics for this material are:

1. Tensile strength - 1,750 psi (ASTM D-638).

2. Ultimate elongation - not less than 280% (ASTM D-638).

E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.

F. PVC waterstops shall be as manufactured by DuraJoint, Vinylex Corp., Greenstreak, Inc.

G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

### 2.02 WATERSTOP ADHESIVE

A. Adhesive between waterstops and existing concrete shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

### 2.03 JOINT SEALANTS

A. Joint sealants shall comply with Section 07900, Joint Sealers.

### 2.04 EXPANSION JOINT MATERIAL

A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:

1. Type I - Sponge rubber, conforming to ASTM D1752, Type I.

2. Type II - Cork, conforming to ASTM D1752, Type II.

3. Type III - Self-expanding cork, conforming to ASTM D1752, Type III.

4. Type IV - Bituminous fiber, conforming to ASTM Designation D1751.

## 2.05 EXPANSION JOINT SEAL

A. Expansion Joint Seal System shall consist of a preformed neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive and pressurized during the adhesive cure time.

B. The expansion joint system shall be Hydrozo/Jeene Structural Sealing joint system by Hydrozo/Jeene, Inc, or equal.

## 2.06 CONTRACTION JOINT INSERTS

A. Contraction joint inserts shall be ZipCap Control Joint former by Greenstreak Plastic Products.

## 2.07 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, Concresive LV1 by BASF Construction Chemicals.

## 2.08 CONCRETE ANCHORS

A. Mechanical Anchors:

1. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt" or "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Powerstud SD-1" or "Powerstud SD-2" by Powers Fasteners.

2. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Wedge-Bolt +" by Powers Fasteners. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

3. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by Powers Fasteners.

4. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by Powers Fasteners

B. Adhesive Anchors:

1. Adhesive anchors shall be "Epcon G5" by ITW Redhead, "HIT HY-150 Max SD" by Hilti, Inc., "SET-XP" by Simpson Strong-Tie Co., or "Powers 1000+" by Powers Fasteners.

2. Adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in

accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

C. Concrete Anchor Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.

2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

3. Nuts, washers, and other hardware shall be of a material to match the anchors.

## PART 3 - EXECUTION

### 3.01 PVC WATERSTOPS

A. PVC waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.

B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.

C. Waterstops shall be securely wired into place to maintain proper position during placement of fresh concrete, as shown on the Drawings. Care shall be taken in the installation of the waterstop and the placing of the concrete to avoid "folding" while concrete is being placed, and to prevent voids in the concrete surrounding the waterstop.

D. Special shop fabricated ells, tees and crosses shall be provided at junctions.

E. Waterstops shall be extended at least 6 inches beyond end of placement in order to provide splice length for subsequent placement.

F. In slabs and tank bottoms, water stops shall be turned up to be made continuous with waterstops at bottom of walls or in walls.

G. Splices in PVC waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures.

H. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.

I. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:

1. Tensile strength not less than 80 percent of parent material.
2. Overlapped (not spliced) Waterstop.
3. Misalignment of Waterstop geometry at any point greater than 1/16 inch.
4. Visible porosity or charred or burnt material in weld area.
5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

## 3.02 WATERSTOP ADHESIVE

A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.

B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

## 3.03 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.

B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.

C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.

E. Type 1 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.

F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.

G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

## 3.04 EXPANSION JOINT SEAL

A. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

## 3.05 CONTRACTION JOINT INSERTS

A. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.

B. For contraction joints in walls, inserts shall be secured in place prior to casting wall.

C. Inserts shall be installed true to line at the locations of all contraction joints as shown on the Drawings.

D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.

E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

## 3.06 EPOXY BONDING AGENT

A. The Contractor shall use an epoxy bonding agent for bonding all fresh concrete to existing concrete as shown on the Drawings.

B. Bonding surface shall be clean, sound and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.

C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.

D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

## 3.07 ANCHOR INSTALLATION

A. Concrete Anchors

1. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.

2. The Contractor shall verify that all concrete anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Concrete anchors shall not be used in place of anchor bolts without Engineer's approval.

4. All stainless steel threads shall be coated with antiseize lubricant.

5. Concrete at time of anchor installation shall be a minimum age of 21 days.

6. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.

7. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. No cored holes shall be allowed unless specifically approved by the Engineer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a

wire brush prior to installation of adhesive and threaded rod/bolt unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. Wipe rod free from oil that may be present from shipping or handling.

C. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.

2. All stainless steel bolts shall be coated with antiseize lubricant.

END OF SECTION

## SECTION 03290 - JOINTS IN CONCRETE

## PART 1 -- GENERAL

### 1.01 REQUIREMENTS

A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.

B. Types of joints in concrete shall be as follows:

1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.

2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.

3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03250 - Concrete Accessories

C. Section 03300 - Cast-in-Place Concrete

D. Section 07900 - Joint Sealers

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings

2. ACI 318 - Building Code Requirements for Structural Concrete

3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

### 1.04 SUBMITTALS

A. Submit the following:

1. Layout drawings showing location and type of all joints to be placed in each structure.

2. Details of proposed joints in each structure.

## PART 2 - MATERIALS

### 2.01 MATERIALS

A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Sealers.

## PART 3 - EXECUTION

### 3.01 CONSTRUCTION JOINTS

A. Construction joints shall be constructed as indicated on the Drawings. Contractor shall submit layout drawings of the joints and their locations to Engineer for approval.

B. Construction joints shall be positioned so as not to adversely affect the structural performance.

C. Construction joint locations not indicated on the structural drawings shall be approved by the Structural Engineer.

D. All corners and tees shall be part of a continuous placement unless indicated otherwise. Should a construction joint be required, the joint shall not be located closer than five feet from a corner or tee unless indicated otherwise.

E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.

F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

### 3.02 EXPANSION JOINTS

A. Expansion joints shall be constructed as indicated on the Drawings.

B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

### 3.03 CONTRACTION JOINTS

A. Contraction joints shall be constructed as indicated on the Drawings.

B. Contraction joints shall be formed with contraction joint inserts as specified in Section 03250, Concrete Accessories.

C. Sawcutting of contraction joints in lieu of forming will not be allowed unless otherwise noted on the Drawings. Where sawcutting is allowed, joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.

D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

## 3.04 JOINT PREPARATION

A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.

C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.

D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

END OF SECTION

## SECTION 03300 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. Provide all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.

B. All water holding structures shall be tested for leakage by the Contractor. The contractor shall provide at his own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests. Each unit shall be tested separately and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source. Wastewater treated effluent is acceptable.

C. The requirements in this section shall apply to the following types of concrete:

1. Class A Concrete: Normal weight structural concrete to be used in all structures, sidewalks and pavements, except where noted otherwise in the Contract Documents. All concrete shall be Class A concrete unless another class is specifically called for on Contract Documents or specified herein.

2. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03200 - Reinforcing Steel

C. Section 03250 - Concrete Accessories

D. Section 03290 - Joints in Concrete

E. Section 03350 - Concrete Finishes

F. Section 03370 - Concrete Curing

G. Section 03600 – Grout

H. Section 01300 - Submittals

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Kentucky Building Code

| | |
|---|---|
| 2. ACI 214 | Recommended Practice for Evaluation of Strength Test Results of Concrete |
| 3. ACI 301 | Specifications for Structural Concrete for Buildings |
| 4. ACI 304 | Guide for Measuring, Mixing, Transporting, and Placing Concrete |
| 5. ACI 305 | Hot Weather Concreting |
| 6. ACI 306 | Cold Weather Concreting |
| 7. ACI 309 | Recommended Practice for Consolidation of Concrete |
| 8. ACI 318 | Building Code Requirements for Structural Concrete |
| 9. ACI 350 | Code Requirements for Environmental Engineering Concrete Structures |
| 10. ACI 350.1 | Specification for Tightness Testing of Environmental Engineering Concrete Structures |
| 11. ASTM C 31 | Standard Methods of Making and Curing Concrete Test Specimens in the Field |
| 12. ASTM C 33 | Standard Specification for Concrete Aggregates |
| 13. ASTM C 39 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| 14. ASTM C42 | Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| 15. ASTM C 88 | Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate |
| 16. ASTM C 94 | Standard Specification for Ready-Mixed Concrete |
| 17. ASTM C 114 | Standard Test Method for Chemical Analysis of Hydraulic Cement |
| 18. ASTM C 136 | Standard Method for Sieve Analysis of Fine and Coarse Aggregate |
| 19. ASTM C 138 | Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete |
| 20. ASTM C 143 | Standard Test Method for Slump of Portland Cement Concrete |
| 21. ASTM C 150 | Standard Specification for Portland Cement |
| 22. ASTM C 172 | Standard Method of Sampling Fresh Concrete |
| 23. ASTM C 192 | Standard Method of Making and Curing Concrete Test Specimens in the Laboratory |
| 24. ASTM C 231 | Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| 25. ASTM C 260 | Standard Specification for Air-Entraining Admixtures for Concrete |
| 26. ASTM C 295 | Standard Guide for Petrographic Examination of Aggregates for Concrete |

27. ASTM C 457 — Standard Recommended Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete

28. ASTM C 494 — Standard Specification for Chemical Admixtures For Concrete

29. ASTM C 595 — Standard Specification for Blended Hydraulic Cements

30. ASTM C 618 — Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete

31. ASTM C1077 — Recommended Practice for Labs Testing Concrete

32. ASTM C 1567 — Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

## 1.04 SUBMITTALS

A. Submit the following:

1. Product Data: For each type of product indicated.

2. Design Mixtures: For each class of concrete specified herein. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Indicate amounts of mixing water to be withheld for later addition at Project site.

3. Slab and Wall Layout Plan: Layout plan specifically detailing methods and sequences of concrete placements for concrete slabs and walls. Include proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations.

4. Concrete placement schedule and procedures.

5. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

    a. Cementitious Materials.

    b. Aggregates: Test results showing compliance with required standards, i.e., sieve analysis, aggregate soundness tests, petrographic analysis, alkali-aggregate reactivity per ASTM C1260, mortar bar expansion testing per ASTM C 1567, etc. Submit Certification of Compliance KYTC Form TC64-764 for freeze-thaw resistant concrete aggregate.

    c. Admixtures: Include the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review by the Engineer.

    d. Curing Compounds.

    e. Trial Batches: For each of the preliminary concrete mix designs and shall include slump (ASTM C143), air content (ASTM C231), unit weight (ASTM C138) and compressive strength tests.

6. Manufacturer Certification: Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities".

7. Delivery and Batching Detail Tickets: For each and every concrete delivery to the Project site. Copies shall be immediately provided to the Resident Project Representative.

8. Certified current (less than 1 year old) chemical analysis of fly ash to be used.

9. Field experience.

10. Testing schedule.

11. Testing procedures for structures to be leak tested.

12. Testing report upon completion of leak testing. Report shall include test summary, test data and calculations.

## 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products that complies with ASTM C94/C94M requirements for production facilities and equipment.

B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

C. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.

D. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.

E. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a testing laboratory employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

# PART 2 - PRODUCTS

## 2.01 HYDRAULIC CEMENT

A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided fly ash is also included in the mix. Type III may only be used upon Engineer's approval.

2. When potentially reactive aggregates are to be used in concrete mix, cement shall meet the following requirements:

a. For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of NA2O plus 0.658 times the percentage of K2O) shall not exceed 0.40%.

b. For concrete mixed with Portland Cement and an appropriate amount of fly ash the total alkalis in the Portland Cement (calculated as the percentage of $NA_2O$ plus 0.658 times the percentage of $K_2O$) shall not exceed 0.85%.

3. When non-reactive are used in concrete mix, total alkalies in the cement shall not exceed 1.0%.

4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

B. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

C. Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

## 2.02 FLY ASH

A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618.

B. For fly ash to be used in the production of type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.

C. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the provisions of Article 2.05.G.2.

D. For concrete to be used in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash in the concrete mix, is mandatory.

## 2.03 WATER

A. Water used for mixing concrete shall be clear, potable and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts and other impurities.

B. Water shall not contain more than 100 PPM chloride.

C. Water shall not contain more than 500 PPM dissolved solids.

D. Water shall have a pH in the range of 4.5 to 8.5.

## 2.04 AGGREGATES

A. All aggregates used in normal weight concrete shall conform to ASTM C 33.

B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.

C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.

D. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.

E. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using magnesium sulfate.

F. Non-reactive aggregates shall meet the following requirements:

1. Fine and coarse aggregates shall be tested and evaluated for alkali-aggregate reactivity in accordance with ASTM C1260. The fine and coarse aggregates shall be evaluated separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing shall have a measured expansion less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of 0.08 percent or greater, the aggregate shall be rejected or additional testing using ASTM C1260 and ASTM C1567 shall be performed. The additional testing using ASTM C1260 and ASTM C1567 shall be performed using the low alkali Portland cement in combination with Class F fly ash. Class F fly ash shall be used in the range of 25 to 40 percent of the total cementitious material by mass.

2. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

   a. Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.

   b. Chert or chalcedony, 3.0%, maximum.

   c. Tridymite or cristobalite, 1.0%, maximum.

   d. Opal, 0.5%, maximum.

   e. Natural volcanic glass in volcanic rocks, 3.0%, maximum.

3. Proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

G. All aggregates shall be considered reactive unless they meet the requirements above for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.

H. Contractor shall submit KYTC form TC 64-764, certifying that all aggregates used for this Project meet the Kentucky Transportation Cabinet's requirements for freeze-thaw resistance.

I. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

## 2.05 ADMIXTURES

A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be obtained and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.

B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall confirm to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.

1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are "Eucon Series" by the Euclid Chemical Company, "Pozzolith Series" by BASF, and "Plastocrete Series" by Sika Corporation.

2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at either the batch plant or at the job site and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are "Eucon 37" or Plastol 5000 by the Euclid Chemical Company, "Rheobuild 1000 or Glenium Series" by BASF, and "Daracem 100 or Advaflow Series" by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E, and shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are "Accelguard 80/90 or NCA" by the Euclid Chemical Company and "Daraset" by W.R. Grace.

4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more than 0.05% chloride ions. Acceptable products are "Eucon NR or Eucon Retarder 100" by the Euclid Chemical Company, "Pozzolith Retarder" by BASF, and "Plastiment" by Sika Corporation.

C. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.

*D. Structures 1, 2, 3, 6 & 7 will require Xypex C-1000 RED cementitious crystalline admixture at a dosage of 3.5% by weight of cement.*[ADD1]

## 2.06 CONCRETE MIX DESIGN

A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete

strength results shall be from concrete mixed with all of the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.

B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, and fly ash contained in the mix.

1. Compressive Strength (28-Day)

| | | |
|---|---|---|
| a. | Concrete Class A | 4,500 psi (minimum)<br>6,500 psi (maximum) |
| b. | Class B | 3,000 psi (minimum) |

2. Maximum water/cementitious materials ratio, by weight

| | | |
|---|---|---|
| a. | Concrete Class A | 0.42 |
| b. | Class B | 0.50 |

3. Slump range — 4" nominal unless high range water reducing admixture is used.
3" maximum before addition of high range water reducing admixture.

4. Air Content

| | | |
|---|---|---|
| a. | Class A | 6% ±1.5% |
| b. | Class B | 3% Max |

## PART 3 -- EXECUTION

### 3.01 TRIAL MIXES

A. When trial mixes are used to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350, an independent testing laboratory designated by the Contractor and acceptable to the Engineer shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

B. An independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. _____, Product _____." If the average 28-day compressive strength

of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

## 3.02 PRODUCTION OF CONCRETE

A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready mix plant or from a site mixed plant. In selecting the source for concrete production the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.

B. Ready-Mixed Concrete

1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.

2. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.

6. Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:

   a. Date and truck number

   b. Ticket number

   c. Mix designation of concrete

d. Cubic yards of concrete

e. Cement brand, type and weight in pounds

f. Weight in pounds of fine aggregate (sand)

g. Weight in pounds of coarse aggregate (stone)

h. Air entraining agent, brand, and weight in pounds and ounces

i. Other admixtures, brand, and weight in pounds and ounces

j. Water, in gallons, stored in attached tank

k. Water, in gallons, maximum that can be added without exceeding design water/cement ratio

l. Water, in gallons, actually used (by truck driver)

m. Time of loading

n. Time of delivery to job (by truck driver)

7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.

8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within ±0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.

2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

| | |
|---|---|
| a. Cement, fly ash | ± 1 percent |
| b. Water | ± 1 percent |
| c. Aggregates | ± 2 percent |
| d. Admixtures | ± 3 percent |

3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and

of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.

5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.

7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.

8. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.

9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.

10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.

12. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.

13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

## 3.03 CONCRETE PLACEMENT

A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.

B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.

C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture shall be placed with a slump not less than 8

inches for the initial placement at the base of the wall. This concrete shall be worked well into the irregularities of the hard surface.

D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.

E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cement ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.

F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.09 of this Section.

G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise by Engineer.

H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.

I. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.

K. When placing concrete which is to be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.

L. Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.

M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.

N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.

O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed.

P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.

Q. To prevent featheredges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.

R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.

S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

## 3.04 PLACING FLOOR SLABS ON GRADE

A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the Engineer.

B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50°F long enough to remove all frost from the subgrade.

C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.

D. Thirty-pound felt paper shall be provided between edges of slab-on-grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.

E. Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03290 - Joints in Concrete.

F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with the requirements of Section 03350 - Concrete Finishes.

## 3.07 ORDER OF PLACING CONCRETE

A. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

## 3.08 CONCRETE WORK IN COLD WEATHER

A. Cold weather concreting procedures shall conform to the requirements of ACI 306.

B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F, unless otherwise approved by the Engineer.

C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water is heated to a temperature in excess of 100°F. in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement forms and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

## 3.09 CONCRETE WORK IN HOT WEATHER

A. Hot weather concreting procedures shall conform to the requirements of ACI 305.

B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand an in position prior to each placing operation.

C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.

D. The temperature of the concrete mix when placed shall not exceed 90°F.

E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.

F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater

than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.

G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

## 3.10 QUALITY CONTROL

A. Field Testing of Concrete

1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the testing firm's personnel as required for concrete testing.

2. Concrete for testing shall be supplied by ~~the Contractor at no additional cost to~~ the Owner, and the Contractor shall provide assistance to the testing laboratory in obtaining samples. The Contractor shall dispose of and clean up all excess material.[ADD#4]

B. Consistency

1. The consistency of the concrete will be checked by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material or labor costs due to such eventualities.

2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary and each time compressive strength samples are taken.

3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the Testing Agency in accordance with ASTM C 138.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content in accordance with ASTM C 231.

2. Air content tests will be performed as deemed necessary and each time compressive strength samples are taken.

3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.

2. In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.

3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The Testing Agency will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.

4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.

5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.

6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.

2. The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.

   a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix.

   b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.

   c. No more than 10% of the compressive tests have strengths greater than the maximum strength specified.

3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.

4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, paragraph H shall be performed.

5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:

   a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.

   b. Maintain or add temporary structural support as required.

   c. Correct the mix for the next concrete placement operation, if required to remedy the situation.

6. All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.

G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.

H. Additional Tests

1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.

2. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

   a. Three cores shall be taken for each sample in which the strength requirements were not met.

   b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by an independent testing laboratory to be selected by the Engineer.

   c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.

   d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.

   e. The diameter of core specimens should be at least 3 times the maximum nominal size of the course aggregate used in the concrete, but must be at least 2-inches in diameter.

   f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.

   g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.

   h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.

3. In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage an independent test laboratory to be selected by the Engineer, to obtain and test samples for air content in accordance with ASTM Specification C 457.

4. Concrete placed with compressive strengths greater than the maximum strength specified shall be removed and replaced or repaired as deemed necessary by the Engineer.

## 3.11 WATERTIGHTNESS TESTING OF CONCRETE STRUCTURES

A. TEST PREPARATION

1. The design capability of the structure to withstand testing shall be verified for the pressures to be applied. Another type of test shall not be substituted for hydrostatic tightness testing without approval of the Engineer.

2. The structure shall not be tested before all elements of the structure which resist any portion of the retained liquid pressure are in place and the concrete has attained its specified compressive strength.

3. Unless otherwise specified, coatings shall not be applied until after the hydrostatic tightness testing is complete. Liners that are mechanically locked to the surface during the placement of the concrete shall be installed before the hydrostatic tightness testing. Interior liners shall be visually examined for deficiencies (pinholes, tears and partially fused splices) and must pass integrity testing. Deficiencies shall be prepared.

4. Clean the exposed concrete surfaces of the structure, including the floor, of all foreign material and debris. Prior to testing, standing water in or outside of the structure that would interfere with the inspection of the exposed concrete surfaces of the structure shall be removed.

5. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired before filling the containment structure with water.

6. All openings, fittings, and pipe penetrations in the structure shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired prior to testing. All structural penetrations and inlet/outlets shall be securely sealed to prevent the loss of water from the structure during the test. All structural penetrations shall be monitored before and during the test to determine the water tightness of these appurtenances. If the structure is to be filled using the inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving through this pipe once the structure is filled to the test level. Leakage at these inlet/outlets shall be repaired prior to testing. No allowance shall be made in test measurements for uncorrected known points of leakage

7. The flow from any underdrain system, if a system is provided, shall be monitored during this same period, and any increase in flow shall be recorded and considered for information as a part of the hydrostatic tightness testing.

8. The ground water level shall be brought to a level below the top of the base slab and kept at that elevation or at a lower elevation during the test.

9. No backfill shall be placed against the walls or on the wall footings of the structure to be tested unless otherwise specified.

10. Potable water will not be utilized for testing unless paid for by the Contractor. Sewage shall not be utilized for testing. The WWTP treated effluent may be utilized as the source. The Contractor may pump, at this expense, to the basin, for testing water.

B. PROCEDURE

1. The initial filling of a new structure should not exceed a rate of 4 ft/h. Filling shall be continued until the water surface is at the design maximum liquid level, or either 1 in. below any fixed overflow level in covered containment structure or 4 in. in open structure, whichever is lower.

2. The exterior surfaces of the structure shall be inspected during the period of filling the structure. If any flow of water is observed from the structure exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired prior to testing.

3. Watertightness Test - Part 1: Qualitative Criteria

   a. The water shall be kept at the test level for at least 3 days prior to Part 2 of the testing.

   b. The exterior surfaces of the structure shall be observed in both the early mornings and later afternoons during the 3-day period before Part 2 of the test. If any water is observed on the structure exterior surfaces, including joints, repaired honeycombed areas and cracks, where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the test.

   c. Wet areas on top of wall footing shall not be cause to fail Part 1 of the test unless the water can be observed to be flowing.

   d. Part 2 of the test may begin prior to completion of repairs for Part 1. However, all defects causing the failure of Part 1 shall be repaired before the structure is accepted.

4. Watertightness Test - Part 2: Quantitative Criteria

   a. The test measurements shall not be scheduled for a period when the forecast is for a difference of more than 35°F between the ambient temperature readings at the times of the initial and final level measurements of the water surface. The test shall also not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed.

   b. The vertical distance to the water surface shall be measured to within 1/16 in. from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals. Measurements taken at the same time of day will reduce the probability of temperature difference.

   c. Measurements shall be taken at two locations, 180° apart, which will minimize the effect of differential settlement. Measurements shall be taken at the same locations to reduce the probability of measurement differences.

   d. The test period shall be at least the theoretical time required to lower the water surface 3/8 in. assuming a loss of water at 0.050% of the water volume per 24-hour period. The test period shall not be longer than five days.

   e. The water temperature shall be recorded at a depth of 18 in. below the water surface at the start and end of the test.

   f. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open structures and the water level in the container recorded at 24-hour intervals. Determination of evaporation by a

shallow pan-type measuring device is not acceptable due to possible heating of the bottom of the shallow pan resulting in accelerated evaporation.

C. EVALUATION

1. The containment structure shall continue to be observed in both the early mornings and late afternoons to verify compliance with Part 1 of the test during Part 2.

2. At the end of the test period, the water surface shall be recorded to within 1/16-in at the location of original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.

3. The allowable loss of water for tightness tests shall not exceed 0.050% of the test water volume in 24 hours.

4. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature based on the change recorded in the water level from the open container. If the loss exceeds the allowable loss, the structure shall be considered to have failed the test.

5. During Part 2 of the test, observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failed test. The structure shall also be considered to have failed the test if moisture can be transferred from the exterior surface to a dry hand. Dampness or wetness on top of a footing shall not be considered as a failure test.

D. RETESTING

1. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.

2. The Contractor shall be permitted to immediately retest when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage. The structure shall only be retested after the most probable areas of leakage are repaired.

3. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.

4. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed.

E. NOTIFICATION BY ENGINEER

1. If any leaks, in excess of the specified amount, are not remedied by the Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the General Contractor.

## 3.12 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may

have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed by the Engineer.

C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed by the Engineer. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed by the Engineer.

D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed by the Engineer. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an epoxy injection system approved by the Engineer. Non-structural cracks shall be repaired using a hydrophilic resin pressure injected grout system approved by the Engineer, unless other means of repair are deemed necessary and approved by the Engineer. Extensive repair or replacement will be considered for concrete placed having compressive strengths greater than maximum strength specified. All repair work shall be performed at no additional cost to the Owner.

E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed by the Engineer as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be directed by the Engineer.

END OF SECTION

## SECTION 03350 - CONCRETE FINISHES

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03300 - Cast-in-Place Concrete

C. Section 03600 - Grout

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings

2. ACI 318 - Building Code Requirements for Structural Concrete

### 1.04 SUBMITTALS

A. Submit the following:

1. Product Data: Manufacturer's literature on all products specified herein.

## PART 2 - PRODUCTS

### 2.01 CONCRETE FLOOR SEALER

A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals.

### 2.02 CONCRETE LIQUID/SEALER DENSIFIER

A. Concrete liquid sealer/densifier shall be a high performance, deeply penetrating concrete densifier. Product shall be odorless, colorless, VOC-compliant, non-yellowing siliconate based solution designed to harden, dustproof and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The product must contain a minimum solids content of 20% of which 50% is siliconate. Acceptable products are Diamond Hard by the Euclid Chemical Company and Seal Hard by L&M Construction Chemicals. Liquid sealer/densifier shall be applied in strict accordance with directions of manufacturer and specifications.

## 2.05 NON-SLIP AGGREGATE

A. Shake-on aggregate for non-slip floors shall be non-metallic. Shake-on aggregate shall be Frictex NS by BASF Construction Chemicals, A-H Acox by Anti-Hydro, or Non-Slip by the Euclid Chemical Company.

# PART 3 - EXECUTION

## 3.01 FINISHES ON FORMED CONCRETE SURFACES

A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.

1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.

3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type I finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities require it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

## 3.02 SLAB AND FLOOR FINISHES

A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.

1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a stiff brush or rake prior to final set.

2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "C" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "D" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.

6. Type "E" – Fine Broom Finish: This finish shall be provided on the pretopped precast by the Manufacturer.

## 3.03 CONCRETE SEALERS

A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.

B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.

C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.

D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.

E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

## 3.04 FINISHES ON EQUIPMENT PADS

A. Formed surfaces of equipment pads shall receive a Type III finish.

B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "C" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

## 3.05 CONCRETE FINISH SCHEDULE

| Item | Type of Finish |
|---|---|
| Concrete surfaces indicated to receive textured coating (as noted on Drawings and in Section 09800, Special Coatings) | I |
| Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures. | II |
| Exterior concrete walls below grade | I |
| Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere. | II |
| All interior exposed concrete walls and vertical surfaces | III |
| Interior exposed ceiling, including beams | III |
| All interior finish floors of buildings and structures and walking surfaces. | C |
| Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather | D |
| Precast concrete form panels, hollow core planks, double tees | E |

END OF SECTION

## SECTION 03370 - CONCRETE CURING

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03300 - Cast-In-Place Concrete

C. Section 03350 - Concrete Finishes

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete
3. ACI 305 - Hot Weather Concreting
4. ACI 306 - Cold Weather Concreting
5. ACI 308 - Standard Practice for Curing Concrete
6. ASTM C171 - Standard Specifications for Sheet Materials for Curing Concrete
7. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
8. Federal Specification TT-C-800

### 1.04 SUBMITTALS

A. Submit the following:

1. Proposed procedures for protection of concrete under wet weather placement conditions.
2. Proposed normal procedures for protection and curing of concrete.
3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.

4. Proposed method of measuring concrete surface temperature changes.

5. Manufacturer's literature and material certification for proposed curing compounds.

## PART 2 - PRODUCTS

### 2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m$^2$ when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals, and Cure & Seal 30 Plus by Symons Corporation.

B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

### 2.02 EVAPORATION REDUCER

A. Evaporation reducer shall be BASF, "Confilm", or Euclid Chemical "Euco-Bar".

## PART 3 - EXECUTION

### 3.01 PROTECTION AND CURING

A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.

B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.

C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.

D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.

1. Ponding or continuous fogging or sprinkling.

2. Application of mats or fabric kept continuously wet.

3. Continuous application of steam (under 150°F).

4. Application of sheet materials conforming to ASTM C171.

5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.

E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.

F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

## 3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.

B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.

C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.

D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

## 3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.

B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.

C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.

D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least four (4) additional days using one of the methods listed in paragraph 3.01D.

E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

## 3.04 USE OF CURING COMPOUND

A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.

B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.

C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

## 3.05. EARLY TERMINATION OF CURING

A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:

1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.

2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

END OF SECTION

## SECTION 03400 – PRECAST PRESTRESSED CONCRETE

## PART 1 – GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and services required to furnish and install all precast prestressed hollow core slabs and double tees as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Cast-in-Place Concrete: Section 03300.

### 1.03 REFERENCES SPECIFICATIONS, CODES, AND STANDARDS:

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Kentucky Building Code
2. ACI 301 — Specifications for Structural Concrete for Buildings
3. ACI 306.1 — Standard Specification for Cold Weather Concreting
4. ACI 318 — Building Code Requirements for Structural Concrete
5. ASTM A123 — Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
6. ASTM A153 — Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
7. ASTM A780 — Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
8. ASTM C42/42M — Standard Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
9. AWS D.1/D.1M — Structural Welding Code – Steel
10. AWS D1.4 — Structural Welding Code – Reinforcing Steel
11. PCI MNL 116 — Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
12. PCI MNL 120 — PCI Design Handbook – Precast and Prestressed Concrete
13. PCI MNL 135 — Tolerance Manual for Precast and Prestressed Concrete Construction
14. PCI TR-6 — Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants

## 1.04 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance – Loads: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated. In addition, elements shall be adequately reinforced to resist all handling and erection stresses.

C. Structural Performance – Deflections: Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements.

2. Limit short-time lateral load deflection to span/240. Limit long-time total load deflection net of camber to span/180.

## 1.05 SUBMITTALS:

A. Submit the following:

1. Product Data: For each type of product indicated.

2. Design Mixtures: For each precast concrete mixture. Include compressive strength and water absorption tests.

3. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Include erection instructions. All shop drawings shall bear the seal of a professional engineer licensed in the state in which the Project is located and who was directly responsible for their preparation.

a. Indicate any exceptions to the structural criteria on the contract drawings.

b. Include layout of all precast elements with all locations and dimensions indicated. Indicate joints, reveals, and extent and location of each surface finish.

c. Include details of all precast-to-precast and precast-to-structure connections. Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.

d. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.

e. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.

f. Include and locate openings larger than by 10 inches.

g. Indicate location of each precast structural concrete unit by same identification mark placed on panel.

h. Indicate relationship of precast structural concrete units to adjacent materials.

i. Indicate estimated camber for precast double tees.

j. Indicate shim and bearing pad sizes and grouting sequence.

k. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

4. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data and calculations signed and sealed by the qualified professional engineer licensed in the state in which the Project is located and who was directly responsible for their preparation.

5. Precast member shop detail drawings (shop tickets) shall be submitted for record after approval of the erection drawings. The shop detail drawings shall indicate the as-manufactured configuration of each member.

6. Qualification Data: For manufacturer.

7. Material Certificates: For the following, from manufacturer:

a. Cementitious materials.

b. Reinforcing materials and prestressing tendons.

c. Admixtures.

d. Bearing pads.

e. Structural-steel shapes and hollow structural sections.

f. Proprietary connection hardware.

8. Material Test Reports: For aggregates.

9. Source quality-control reports.

## 1.06 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Participates in PCI's Plant Certification program and is designated a PCI-certified plant as follows:

a. Group C, Category C3 - Prestressed Straight Strand Structural Members; Category C4 - Prestressed Deflected Strand Structural Members.

B. Installer Qualifications: A precast concrete erector with a history of successful completion of erection of similar components in similar structures for the last three years.

C. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

E. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D.1.1M, "Structural Welding Code - Steel."

2. AWS D1.4, "Structural Welding Code - Reinforcing Steel."

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.

2. Place adequate dunnage of even thickness between each unit.

3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.

D. Lift and support units only at designated points shown on Shop Drawings.

## 1.08 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

## 1.09 WORK OF OTHER TRADES

A. All inserts, welded plates, sleeves and other items for the Work of other trades shall be installed.

# PART 2 – PRODUCTS

## 2.01 FABRICATION

A. Concrete: Concrete for structural precast elements shall conform to PCI MNL 120 and shall be durable for the environment that the structure will be located in.

B. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design

requirements. Steel embedded items shall be accurately positioned for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement. All cast-in items that will have surfaces not covered by concrete shall be hot-dipped galvanized in accordance with ASTM A 153 or ASTM A 123 as required.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

C. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, clamps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction. All loose hardware items that will have surfaces not covered by concrete shall be hot-dipped galvanized in accordance with ASTM A 153 or ASTM A 123 as required. Provide elastomeric bearing pads as required. Do not use cotton duck bearing pads.

D. Cast-in slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

E. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.

F. Reinforcement: Comply with recommendations in PCI MNL 116 for specifying, fabricating, placing, and supporting reinforcement.

G. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.

H. Prestress tendons for precast structural concrete units in compliance with PCI MNL 116.

1. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.

2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.

4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

5. Protect strand ends and anchorages with a minimum of 1-inch-thick, nonmetallic, nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.

I. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

J. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.

K. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."

L. Comply with ACI 306.1 procedures for cold-weather concrete placement.

M. Comply with PCI MNL 116 procedures for hot-weather concrete placement.

N. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.

O. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

P. Discard and replace precast structural concrete units that do not comply with requirements, at contractor's sole cost, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

## 2.02 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.

## 2.03 COMMERCIAL FINISHES

A. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.

B. Fine broom finish unformed surfaces not exposed in the completed structure. Consolidate concrete, bring to proper level with straightedge, float, broom with a fine broom to a smooth, uniform finish.

## 2.04 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.

1. Test and inspect self-consolidating concrete according to PCI TR-6.

C. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength according to the strength specified in the manufacturer's design.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.

1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect/Engineer.

2. Cores will be tested in an air-dry condition or, if units will be wet under service conditions, test cores after immersion in water in a wet condition.

3. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.

4. Test results will be made in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:

a. Project identification name and number.

b. Date when tests were performed.

c. Name of precast concrete fabricator.

d. Name of concrete testing agency.

e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups.

## PART 3 – EXECUTION

### 3.01 FABRICATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place, building structural framing has attained minimum allowable design compressive strength or until supporting steel or other structure is complete.

## 3.02 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.

2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted without approval of the Architect/Engineer.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units without written approval of precast manufacturer's engineer and Architect.

F. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.

2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil-thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.

3. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.

4. Remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.

H. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard

enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.

1. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Promptly remove grout material from exposed surfaces that it is not supposed to be on before it affects finishes or hardens.
5. Keep grouted joints damp for not less than 24 hours after initial set.

## 3.03 ERECTION TOLERANCES

A. Erect precast structural concrete units square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize excessive camber variations between adjacent members as determined by Architect by jacking, loading, or other method recommended by manufacturer and approved by Architect/Engineer.

## 3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.

B. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements at Contractors sole cost.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

## 3.05 REPAIRS

A. Repair precast structural concrete units if permitted by Architect/Engineer.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect/Engineer.

## 3.05 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.

2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

## SECTION 03410 - PRECAST MODULAR BLOCK RETAINING WALL

## PART 1 – GENERAL

### 1.01 SUMMARY

A. This Section includes furnishing all materials and labor required for the design and construction of a precast concrete modular block (PMB) retaining wall with or without geosynthetic reinforcement. Precast modular concrete (large block) retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 400 pounds per unit.

B. Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for construction of a precast modular block (PMB) retaining wall structure *and integral guardrail*[ADD#4] in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project site plans.

### 1.02 REFERENCES

A. Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document.

B. Definitions:

1. Precast Modular Block (PMB) Unit – "wet cast" concrete modular block retaining wall facing unit.

2. Geotextile – a geosynthetic fabric manufactured for use as a separation and filtration medium between dissimilar soil materials.

3. Geogrid – a geosynthetic material comprised of a regular network of tensile elements manufactured in a mesh-like configuration of consistent aperture openings. When connected to the PMB facing units and placed in horizontal layers in compacted fill, the geogrid prevents lateral deformation of the retaining wall face and provides effective tensile reinforcement to the contiguous reinforced fill material.

4. Drainage Aggregate – clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction requirements immediately adjacent to and behind the precast modular block units.

5. Unit Core Fill – clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, the same material used for drainage aggregate as defined above.

6. Foundation Zone – soil zone immediately beneath the leveling pad and the reinforced zone.

7. Retained Zone – soil zone immediately behind the drainage aggregate and/or wall infill.

8. Reinforced Zone – soil fill zone within which successive horizontal layers of geogrid soil reinforcement have been placed to provide stability for the retaining wall face. The reinforced zone exists only for retaining wall sections that utilize geosynthetic soil reinforcement for stability.

9. Reinforced Fill – soil fill placed within the reinforced zone.

10. Leveling Pad – flat surface upon which the bottom course of precast modular blocks are placed. The leveling pad may be constructed with crushed stone or cast-in-place concrete. A leveling pad is not a structural footing.

11. Wall Infill – the fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures.

C. Reference Standards

1. Design

   a. AASHTO LRFD Bridge Design Specifications, 2012.
   b. Minimum Design Loads for Buildings and Other Structures – ASCE/SEI 7-10.
   c. International Building Code, 2009 Edition.
   d. FHWA-NHI-10-024 Volume I and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
   e. FHWA-NHI-10-025 Volume II and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.

2. Precast Modular Block Units

   a. AASHTO M 194 – Standard Specification for Chemical Admixtures for Concrete.
   b. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
   c. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
   d. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. ASTM C140 – Standard Test Method of Sampling and Testing Concrete Masonry Units.
   f. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
   g. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
   h. ASTM C666 – Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing.
   i. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
   j. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.

k. ASTM C1262 – Standard Test Method for Evaluating Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units.
l. ASTM C1372 – Standard Specification for Dry-Cast Segmental Retaining Wall Units.
m. ASTM C1611 – Standard Test Method for Slump Flow of Self-Consolidating Concrete.
n. ASTM D6638 – Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks).
o. ASTM D6916 – Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks).

3. Geosynthetics

a. AASHTO M 288 – Geotextile Specification for Highway Applications.
b. ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics Diaphragm Bursting Strength Tester Method.
c. ASTM D4354 – Standard Practice for Sampling of Geosynthetics for Testing.
d. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles
e. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
f. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
g. ASTM D4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
h. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
i. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile.
j. ASTM D4759 – Standard Practice for Determining Specification Conformance of Geosynthetics.
k. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
l. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
m. ASTM D5262 – Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.
n. ASTM D5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
o. ASTM D5818 – Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics.
p. ASTM D6241 – Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
q. ASTM D6637 – Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
r. ASTM D6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.

s. ASTM D6992 – Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

4. Soils

a. AASHTO M 145 – AASHTO Soil Classification System.
b. AASHTO T 104 – Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
c. AASHTO T 267 – Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition.
d. ASTM C33 – Standard Specification for Concrete Aggregates.
e. ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.
f. ASTM D448 – Standard Classification for Sizes of Aggregates for Road and Bridge Construction.
g. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (12,400 ft-lbf/ft (2,700 kN-m/m)).
h. ASTM D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base and Surface Courses.
i. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
j. ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. (56,000 ft-lbf/ft (2,700 kN-m/m)).
k. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
l. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
m. ASTM D3080 – Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.
n. ASTM D4254 – Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
o. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
p. ASTM D4767- Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils.
q. ASTM D4972 – Standard Test Method for pH of Soils.
r. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Aggregate by Nuclear Methods (Shallow Depth).
s. ASTM G51 – Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing.
t. ASTM G57 – Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.

5. Drainage Pipe:

a. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
b. ASTM F2648 – Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

## 1.04 SUBMITTALS

A. Product Data. The General Contractor shall submit the retaining wall product information to the Owner for review and approval. See Specification Section 1300, Submittals. The submittal package shall include technical specifications and product data from the manufacturer for the following:

1. Precast Modular Block System brochure.

2. Precast Modular Block concrete test results specified in paragraph 2.01, subparagraph B of this section as follows:

   a. 28-day compressive strength
   b. Air content
   c. Water/Cement Ratio of Concrete Mixture
   d. Slump or Slump Flow (as applicable)

3. Drainage Pipe.

4. Geotextile.

B. Installer Qualification Data. The General Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the Retaining Wall Installation Contractor, per paragraph 1.07, subparagraph A of this section.

C. Retaining Wall Design Calculations and Construction Shop Drawings. This submittal shall include the following:

1. Signed, sealed and dated drawings and engineering calculations prepared in accordance with these specifications. The Drawings shall be sealed by a professional engineer, licensed to practice in the State where the project is located.

2. Qualifications Statement of Experience of the Retaining Wall Design Engineer as specified in paragraph 1.07, subparagraph B of this section

3. Certificate of Insurance of the Retaining Wall Design Engineer as specified in paragraph 1.06, subparagraph B of this section.

## 1.05 CONSTRUCTION SHOP DRAWING PREPARATION

A. The Retaining Wall Design Engineer shall coordinate the retaining wall construction shop drawing preparation with the project Engineer and Owner.

B. The Retaining Wall Design Engineer shall provide the Owner a certificate of professional liability insurance verifying the minimum coverage limits of $1 million per claim and $1 million aggregate.

C. Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local design or building code requirements exceed these specifications, the local requirements shall also be satisfied.

D. The precast modular block design, except as noted herein, shall be based upon AASHTO Load and Resistance Factor Design (LRFD) methodology as referenced in paragraph 1.03, subparagraph C.1.

E. Soil Shear Parameters. The Retaining Wall Design Engineer shall prepare the construction shop drawings based upon soil shear strength parameters from the available project data and the recommendations of the project Geotechnical Engineer. If insufficient data exists to develop the retaining wall design, the Retaining Wall Design Engineer shall communicate the specific deficiency of the project information or data to the Owner in writing.

F. Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.

G. Global Stability.

1. Overall (global) stability of mechanically stabilized earth retaining wall structures shall be evaluated in accordance with principals of limit equilibrium analysis as set forth in FHWA-NHI-10-024 Volume I and FHWA-NHI-10-025 Volume II GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes as referenced in paragraph 1.03, subparagraph C.1. The minimum static factor of safety shall be 1.4. The minimum seismic factor of safety shall be suitable for Seismic design Category B of the Kentucky Building Code.

2. Overall (global) stability of gravity walls shall be evaluated in accordance with AASHTO LRFD Bridge Design Specifications, 2012, Section 11.11.4.6 and 11.6.2.3.

H. Seismic Stability. Seismic loading shall be evaluated in accordance with AASHTO Load and Resistance Factor Design (LRFD) methodology as referenced in paragraph 1.03, subparagraph C.1.

## 1.06 QUALITY ASSURANCE

A. Retaining Wall Installation Contractor Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the Retaining Wall Installation Contractor shall document compliance with the following:

1. Experience.

a. Construction experience with a minimum of 10,000 square feet of the proposed precast modular block retaining wall system.
b. Construction of at least three (3) precast modular block (large block) retaining wall structures within the past three (3) years.
c. Construction of at least 5,000 square feet of precast modular block (large block) retaining walls within the past two (2) years.

2. Retaining Wall Installation Contractor experience documentation for each qualifying project shall include:

   a. Project name and location
   b. Date (month and year) of construction completion
   c. Contact information of Owner or General Contractor
   d. Type (trade name) of precast modular block system built
   e. Maximum height of the wall constructed
   f. Face area of the wall constructed

3. In lieu of the requirements set forth in items 1 and 2 above, the Retaining Wall Installation Contractor must submit similar information to that outlined above as necessary to demonstrate basic competence to construct precast modular block walls and must be a certified Precast Modular Block Retaining Wall Installation Contractor as demonstrated by satisfactory completion of the Precast Modular Block Retaining Wall Installation Training Program.

4. The Owner reserves the right to reject the design services of any Retaining Wall Installation Contractor who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

B. Retaining Wall Design Engineer Qualifications and Statement of Experience. When the General Contractor furnishes the retaining wall design for the Owner's review and approval as part of a design/build contract, the Retaining Wall Design Engineer shall submit a written statement affirming that he or she has the following minimum qualifications and experience.

1. The Retaining Wall Design Engineer shall be licensed to practice in the state or province where the project is located.

2. The Retaining Wall Design Engineer shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.

3. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project, that the design considers all the requirements listed in paragraph 1.06 and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.

4. The Retaining Wall Design Engineer shall affirm in writing that he or she has designed a minimum of 10,000 total square feet of earth retaining walls in each of the preceding three (3) years.

C. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

## 1.07 QUALITY CONTROL

A. The Owner shall review all submittals for materials, design, Retaining Wall Design Engineer qualifications and the Retaining Wall Installation Contractor qualifications.

B. The Retaining Wall Installation Contractor shall inspect the on-site grades and excavations prior to construction and notify the Retaining Wall Design Engineer and General Contractor if on-site conditions differ from the elevations and grading conditions depicted in the retaining wall construction shop drawings.

## 1.08 DELIVERY, STORAGE AND HANDLING

A. The Retaining Wall Installation Contractor shall inspect the materials upon delivery to ensure that the proper type, grade and color of materials have been delivered.

B. The Retaining Wall Installation Contractor shall store and handle all materials in accordance with the manufacturer's recommendations as specified herein and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the work.

C. Geosynthetics

1. All geosynthetic materials shall be handled in accordance with ASTM D4873. The materials should be stored off the ground and protected from precipitation, sunlight, dirt and physical damage.

D. Precast Modular Blocks

1. Precast modular blocks shall be stored in an area with positive drainage away from the blocks. Be careful to protect the block from mud and excessive chipping and breakage. Precast modular blocks shall not be stacked more than 2 units high in the storage area.

E. Drainage Aggregate and Backfill Stockpiles

1. Drainage aggregate or backfill material shall not be piled over unstable slopes or areas of the project site with buried utilities.

2. Drainage aggregate and/or reinforced fill material shall not be staged where it may become mixed with or contaminated by poor draining fine-grained soils such as clay or silt.

# PART 2 – MATERIALS

## 2.01 PRECAST MODULAR BLOCK RETAINING WALL UNITS

A. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the

published quality control standards of the proprietary precast modular block system licensor for the previous two (2) years. If the manufacturer has been producing retaining wall units of this precast modular block system for less than two (2) years, quality control compliance documentation for other concrete products may be submitted in addition to documents for the precast modular block system.

B. The Owner reserves the right to grant in-state preference to manufacturers of precast modular block retaining wall systems approved under this section and to reject products furnished by out-of-state manufacturers solely on this basis.

C. Concrete used in the production of the precast modular block units shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the following:

1. Minimum 28-day compressive strength of 4,000 psi.

2. Shall be free of water soluble chlorides and chloride based accelerator admixtures.

3. Maximum water/cement ratio of 0.50 for mild climate areas and 0.45 for moderate or severe climate areas as defined in ASTM C94 and ACI 211.1 Section 6.3.3.

4. Air-entrainment in conformance ASTM C94 Table 1.

5. Maximum slump of 5 inches +/- 1½ inches per ASTM C143 for conventional concrete mix designs.

6. Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 18 inches and 32 inches as tested in accordance with ASTM C1611.

D. Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the table below and be produced to the dimensional tolerances shown as measured in accordance with ASTM C140.

| Block Type | Dimension | Nominal Value | Tolerance |
|---|---|---|---|
| 28" Block | Height | 18 inches | +/- 3/16 inch |
| | Length | 46-1/8 inches | +/- 1/2 inch |
| | Width | 28 inches | minus 1" |
| 41" Block | Height | 18 inches | +/- 3/16 inch |
| | Length | 46-1/8 inches | +/- 1/2 inch |
| | Width | 40-1/2 inches | +/- 1 inch |
| 60" Block | Height | 18 inches | +/- 3/16 inch |
| | Length | 46-1/8 inches | +/- 1/2 inch |
| | Width | 60 inches | +/- 1 inch |

E. Individual block units shall have a nominal height of 18 inches.

F. With the exception of half-block units, corner units and other special application units, the precast modular block units shall have two (2), circular dome shear knobs that are 10 inches maximum in diameter and 4 inches maximum in height. The shear knobs shall

fully index into a continuous shear channel in the bottom of the block course above. Peak interlock shear between any two (2) vertically stacked precast modular block units measured in accordance with ASTM D6916 shall exceed 1,850 lbs./ft at a minimum normal load of 500 lbs./ft., 6,650 lbs./ft at a minimum normal load of 4,000 lbs./ft, and an ultimate peak interface shear capacity in excess of 10,000 lbs./ft. Test specimen blocks tested under ASTM D6916 shall be actual, full-scale production blocks of known compressive strength. The interface shear capacity reported shall be corrected for a 4,000 psi concrete compressive strength.

G. The 28" Block and 41" Block precast modular block units shall be cast with a continuous vertical core slot that will allow a 12 inch wide strip of continuous geogrid reinforcement to pass completely through the block. When installed in this manner, the geogrid reinforcement shall form a non-normal load dependent, positive connection between the block unit and the reinforcement strip. The continuous vertical core slot shall have a nominal width of 12.5 inches. The 60" precast modular block units may be furnished with or without the continuous vertical core slot. Alternative precast modular blocks with hollow cores or void space submitted for preapproval under this specification, shall provide an interface shear capacity test report in accordance with section 2.01.F above without the inclusion of unit core infill aggregate.

H. Without field cutting or special modification, the precast modular block units shall be capable of achieving a minimum radius of 14 ft. – 6 in.

I. The precast modular block units shall be manufactured with an integrally cast shear key, lip or knob(s) with the option for individual horizontal unit-to-unit set-back for subsequent block courses resulting in a maximum face batter of 26.6 degrees, 5.1 degrees, 1.2 degrees or 0 degrees as measured from vertical.

J. The precast modular block unit face texture shall be "Ledgestone" or equal approximating the appearance of stacked, cut field stones. The face texture shall exhibit minimum relief of 3 to 5 inches. Each textured block facing unit shall be a minimum of 5.75 square feet with a unique texture pattern that repeats with a maximum frequency of once in any 50 square feet of wall face. The block unit face texture shall be manufactured with ~~a custom color blend selected by the Owner from the manufacturer's full range of color options.~~ *Lexington Limestone stock color scheme or equal.*[ADD#1]

K. All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall or create an unsatisfactory appearance as determined by the Owner. Acceptable cracks or chips observed during construction shall be within the guidelines outlined in ASTM C1372.

L. Preapproved Manufacturers.

1. Manufacturers of Redi-Rock PC (Positive Connection) Retaining Wall Block Units or equal.

## 2.02 GEOGRID REINFORCEMENT

A. Geogrid reinforcement shall be a woven or knitted PVC coated geogrid manufactured from high-tenacity PET polyester fiber with an average molecular weight greater than

25,000 ($M_n$ > 25,0000) and a carboxyl end group less than 30 (CEG < 30). The geogrid shall be furnished in nominal, prefabricated roll widths of 12 inches +/- ½ inch. The geogrid rolls shall be certified for width, product integrity, and minimum average roll strength by the geogrid manufacturer.

B. The ultimate tensile strength ($T_{ult}$) of the geogrid reinforcement shall be measured in accordance with ASTM D6637.

C. Geogrid – Soil Friction Properties

1. Friction factor, F*, shall be equal to 2/3 Tan $\phi$, where $\phi$ is the effective angle of internal friction of the reinforced fill soil.

2. Linear Scale Correction Factor, $\alpha$, shall equal 0.8.

D. Long-Term Tensile Strength ($T_{al}$) of the geogrid reinforcement shall be calculated in accordance with Section 3.5.2 of FHWA-NHI-10-024 and as provided in this specification.

1. The creep reduction factor ($RF_{CR}$) shall be determined in accordance with Appendix D of FHWA-NHI-10-025 for a minimum 75 year design life.

2. Minimum installation damage reduction factor ($RF_{ID}$) shall be 1.10. The value of $RF_{ID}$ shall be based upon documented full-scale tests in a soil that is comparable to the material proposed for use as reinforced backfill in accordance with ASTM D5818.

3. Minimum durability reduction factor ($RF_D$) shall be 1.15 for a soil pH range of 5 to 8 and 1.3 for a soil pH range of 4.5 to 5 and 8 to 9.

E. Connection between the PMB retaining wall unit and the geogrid reinforcement shall be determined from short-term testing per the requirements of FHWA NHI-10-025, Appendix B.4 for a minimum 75-year design life.

F. The minimum value of $T_{al}$ for geogrid used in design of a reinforced precast modular block retaining wall shall be 2,000 lbs./ft. or greater.

G. The minimum length of geogrid reinforcement shall be the greater of the following:

1. 0.7 times the wall design height, H.

2. 6 feet.

3. The length required by design to meet internal stability requirements, soil bearing pressure requirements and constructability requirements.

H. Constructability Requirements. Geogrid design embedment length shall be measured from the back of the precast modular block facing unit and shall be constant over the entire height of the retaining wall.

I. Geogrid shall be positively connected to every precast modular block unit. Design coverage ratio, Rc, as calculated in accordance with AASHTO LRFD Bridge Design Specifications Figure 11.10.6.4.1-2 shall not exceed 0.50.

J. Preapproved Geogrid Reinforcement Products.
Miragrid XT Geogrids as manufactured by TenCate Geosynthetics of Pendergrass, Georgia.

K. Substitutions.
No substitutions of geogrid reinforcement products shall be allowed.

## 2.03 GEOTEXTILE

A. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the reinforced backfill when the wall is reinforced and between the drainage aggregate and the retained soil when the wall is designed as a gravity structure. Additionally, the nonwoven geotextile fabric shall be placed in the v-shaped joint between adjacent block units on the same course and at any other locations noted in the design drawings prepared by the Retaining Wall Design Engineer. The nonwoven geotextile fabric shall be a needle-punched, polypropylene material with a minimum nominal weight of 4 oz./sq. yd. The geotextile shall meet the minimum requirements of AASHTO M288-06 Class 3 for elongation greater than 50% and the following properties:

| **Mechanical Property** | **Test Method** | **Unit** | **Minimum Average Roll Value (MARV)** | |
|---|---|---|---|---|
| | | | **MD** | **CD** |
| Grab Tensile | ASTM D4632 | lbs. | 115 | 115 |
| Puncture Resistance | ASTM D4833 | lbs. | 45 | 45 |
| Trapezoid Tear Strength | ASTM D4533 | lbs. | 45 | 45 |
| Apparent Opening Size | ASTM D4751 | U.S. Sieve | 70 | |
| Flow Rate | ASTM D4491 | gal./min./ft$^2$ | 120 | |

B. Preapproved Geotextile Products

1. Mirafi 140N
2. Propex Geotex 451
3. Skaps GT-142
4. Thrace-Linq 140EX
5. Carthage Mills FX-40HS
6. Stratatex ST 142

## 2.04 DRAINAGE AGGREGATE AND WALL INFILL

A. Drainage aggregate and wall infill shall be a durable crushed stone with the following particle-size distribution requirements per ASTM D422:

| US Standard Sieve Size | Percent Passing |
|---|---|
| 1-½ inch | 100 |
| 1 inch | 95 - 100 |
| ¾ inch | 90 - 100 |
| ½ inch | 20 - 100 |
| 3/8 inch | 0 - 70 |
| No. 4 | 0 - 25 |
| No. 8 | 0 - 10 |
| No. 16 | 0 - 5 |

## 2.05 REINFORCED FILL

A. Material used as reinforced backfill material in the reinforced zone (if applicable) shall be a granular soil meeting the requirements of USCS soil type GW, GP, SW or SP per ASTM D2487 or alternatively by AASHTO Group Classification A-1-a or A-3 per AASHTO M 145. The backfill shall exhibit a minimum effective internal angle of friction, $\phi$ = 34 degrees at a maximum 2% shear strain and meet the following particle-size distribution requirements per ASTM D422.

| US Standard Sieve Size | Percent Passing |
|---|---|
| 1-½ inch | 100 |
| No. 4 | 0 – 100 |
| No. 40 | 0 - 60 |
| No. 100 | 0 - 10 |
| No. 200 | 0 - 5 |

B. The reinforced backfill material shall be free of sod, peat, roots or other organic or deleterious matter including, but not limited to, ice, snow or frozen soils. Materials passing the No. 40 sieve shall have a liquid limit less than 25 and plasticity index less than 6 per ASTM D4318. Organic content in the backfill material shall be less than 1% per AASHTO T-267 and the pH of the backfill material shall be between 5 and 8.

C. Soundness. The reinforced backfill material shall exhibit a magnesium sulfate soundness loss of less than 30% after four (4) cycles, or sodium sulfate of less than 15% after five (5) cycles as measured in accordance with AASHTO T-104.

D. Reinforced backfill shall not be comprised of crushed or recycled concrete, recycled asphalt, bottom ash, shale or any other material that may degrade, creep or experience a loss in shear strength or a change in pH over time.

## 2.06 LEVELING PAD

A. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the Retaining Wall Design Engineer.

B. Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in section 2.05 or preapproved alternate material.

C. Concrete used for construction of an unreinforced concrete leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi.

## 2.07 DRAINAGE

A. Drainage Pipe

1. Drainage collection pipe shall be a 4 inch diameter, 3-hole perforated, HDPE pipe with a minimum pipe stiffness of 22 psi per ASTM D2412.

2. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.

3. The type of drainage pipe and fittings selected by the Retaining Wall Installation Contractor in accordance with these specifications and the retaining wall design drawings shall remain consistent within each retaining wall structure.

## *2.08 GUARDRAIL*

*A. The retaining wall shall have an integral guardrail as detailed on Sheet C-0-506 across the entire length of wall.*[ADD#4]

## PART 3 – EXECUTION

## 3.01 GENERAL

A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer's requirements.

B. The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.

C. New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.

D. The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.

E. All work shall be inspected by the Inspection Engineer as directed by the Owner.

## 3.02 EXAMINATION

A. Prior to construction, the General Contractor, Grading Contractor, Retaining Wall Installation Contractor and Inspection Engineer shall examine the areas in which the retaining wall will be constructed to evaluate compliance with the requirements for installation tolerances, worker safety and any site conditions affecting performance of the completed structure. Installation shall proceed only after unsatisfactory conditions have been corrected.

## 3.03 PREPARATION

A. Fill Soil.

1. The Inspection Engineer shall verify that reinforced backfill placed in the reinforced soil zone satisfies the criteria of this section.

2. The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the Retaining Wall Design Engineer as shown on the construction drawings.

B. Excavation.

1. The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.

2. Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the Retaining Wall Design Engineer and "Division 31, Section 31 20 00 – Earthmoving" of these project specifications.

3. Embankment excavations shall be bench cut as directed by the project Geotechnical Engineer and inspected by the Inspection Engineer for compliance.

C. Foundation Preparation.

1. Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed. Additional foundation soils found to be unsatisfactory beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits are consistent with the requirements of the project Geotechnical Engineer and that all soil fill material is properly compacted according project specifications. The Inspection Engineer shall document the volume of undercut and replacement.

2. Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.

   a. The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. The Inspection Engineer shall immediately stop work and notify the Owner if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.

   b. The Inspection Engineer shall verify that the foundation soil exhibits sufficient allowable bearing capacity according the requirements indicated on the retaining wall construction shop drawings per the requirement of paragraph 1.06 I of this section.

D. Leveling Pad.

1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions shown on the retaining wall construction drawings and extend to the limits indicated.

2. Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 9 inches. The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 lbs. of centrifugal force and to the satisfaction of the Inspection Engineer.

3. Unreinforced Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The Retaining Wall Installation Contractor shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.

## 3.04 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION

A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer's recommendations and these specifications, these specifications shall prevail.

B. Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.

C. Precast Modular Block Installation

1. The first course of block units shall be placed with the front face edges tightly abutted together on the prepared leveling pad at the locations and elevations shown on the construction drawings. The Retaining Wall Installation Contractor shall take special care to ensure that the bottom course of block units are in full

contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.

2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks to a minimum distance of 12 inches behind the block unit.
3. Drainage aggregate shall be placed in 9 inch maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 2,000 lbs. of centrifugal force.

4. Unit core fill shall be placed in the precast modular block unit vertical core slot. If geogrid is to be installed through the block, the geogrid shall be kept taut and in full contact with the back of the vertical core slot prior to placement of the unit core fill. Care shall be taken when placing unit core fill to keep material from between the geogrid and the back of the vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.

5. Base course blocks for gravity wall designs (without geogrid reinforcement) may be furnished without vertical core slots. If so, disregard item 4 above, for the base course blocks in this application.

6. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the retained soil (gravity wall design) or between the drainage aggregate and the reinforced fill (reinforced wall design) as required on the retaining wall construction drawings.

7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90 degree corner units, the shear channel of the upper block shall be fully engaged with the shear knobs of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Geogrid, drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.

8. The elevation of retained fill shall not be less than 1 block course (18 inches) below the elevation of the reinforced backfill throughout the construction of the retaining wall. This requirement shall not apply to unreinforced, gravity wall designs.

9. If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.

D. Geogrid Reinforcement Installation (if required)

1. Geogrid reinforcement shall be installed at the locations and elevations shown on the construction drawings on level fill compacted to the requirements of this specification.

2. Continuous 12 inch strips of geogrid reinforcement shall be passed completely through the vertical core slot of the precast modular block unit and extended to the embedment length shown on the construction plans. The strips shall be staked or anchored as necessary to maintain a taut condition.

3. Reinforcement length (L) of the geogrid reinforcement is measured from the back of the precast modular block unit. The cut length ($L_c$) is two times the reinforcement length plus additional length through the block facing unit. The cut length (ft.) is calculated as follows:

   **$L_c$ = 2*L + 3 ft. (28-inch block unit)**
   **$L_c$ = 2*L + 5 ft. (41-inch block unit)**

4. The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths of 12 inches +/- ½ inch. No field cutting of the geogrid to width shall be allowed.

5. Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 5 mph once a minimum of 9 inches of compacted fill has been placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.

E. Construction Tolerance. Allowable construction tolerance of the retaining wall shall be as follows:

1. Deviation from the design batter and horizontal alignment, when measured along a 10 ft. straight wall section, shall not exceed ¾ inch.

2. Deviation from the overall design batter shall not exceed ½ inch per 10 feet of wall height.

3. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be ½ inch.

4. The base of the precast modular block wall excavation shall be within 2 inches of the staked elevations, unless otherwise approved by the Inspection Engineer.

5. Differential vertical settlement of the face shall not exceed 1 foot along any 200 feet of wall length.

6. The maximum allowable vertical displacement of the face in any precast modular block joint shall be ½ inch.

7. The wall face shall be placed within 2 inches of the horizontal location staked.

8. The geogrid reinforcement strips shall be continuous, oriented perpendicular to the wall face and located horizontally and vertically within 1 inch of the locations shown on the construction drawings.

## 3.05 WALL INFILL AND REINFORCED BACKFILL PLACEMENT

A. Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:

1. 95% of maximum dry density at ± 2% optimum moisture content per ASTM D698 standard proctor or 80% relative density per ASTM D4254.

B. Compactive effort within 4 feet of the wall face should be accomplished with walk-behind compactors. Compaction in this zone shall be within 93% of maximum dry density as measured in accordance with ASTM D698 standard proctor or 75% relative density per ASTM D 4254. Heavy equipment should not be operated within 4 feet of the wall face.

C. Within 18 inches of a pavement section, soil shall be compacted to within 98% of the maximum dry density as measured in accordance with ASTM D698 standard proctor or 85% relative density per ASTM D4254.

D. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 9 inches.

E. At the end of each work day, the Retaining Wall Installation Contractor shall grade the surface of the last lift of the granular wall infill to a 3% ± 1% slope away from the precast modular block wall face and compact it.

F. The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill/wall backfill.

## 3.06 OBSTRUCTIONS IN THE INFILL AND REINFORCED FILL ZONE

A. The Retaining Wall Installation Contractor shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.

B. Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be constructed until the Retaining Wall Design Engineer can provide a written description of the required procedures for construction of the wall section in question.

## 3.07 COMPLETION

A. For walls supporting unpaved areas, a minimum of 12 inches of compacted, low-permeability fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.

B. For retaining walls with crest slopes of 5H:1V or steeper, silt fence shall be installed along the wall crest immediately following construction. The silt fence shall be located 3 to 4 feet behind the uppermost precast modular block unit. The crest slope above the wall shall be immediately seeded to establish vegetation. The General Contractor shall ensure that the seeded slope receives adequate irrigation and erosion protection to support germination and growth.

C. The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Owner of any deviations.

END OF SECTION

## SECTION 03415 – PRECAST UTILITY STRUCTURES

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all precast concrete utility structures, manholes, vaults, slabs and other precast structure appurtenances as shown on the Drawings and specified herein.

B. Delegated Design: Design utility structures, including comprehensive engineering analysis by a qualified professional engineer, licensed in the state in which the project using performance requirements and design criteria indicated.

### 1.02 SUBMITTALS

The Contractor shall submit the following data for Engineer's review in accordance with Section 013323.

A. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data, calculations, and erection drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Product Data: For each type of product indicated included but not limited to standard precast units, proprietary precast units, embedded items, and accessories.

C. Design Data: Submit calculations prepared under the direct supervision of a professional engineer supporting the structural design, including resistance to buoyancy, uplift and wheel loads in accordance with requirements and references indicated. The calculations shall be sealed by a professional engineer licensed in the state in which the project is located.

D. Test Reports: Submit test reports for the following:

1. Material certifications and/or laboratory test reports, including mill tests and all other test data, for Portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this Project.

2. Test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete or cast-in items.

3. Sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.

4. In-plant QA/QC inspection reports, upon the request of the Project Representative.

E. Shop Drawings: Submit shop drawings for standard precast units and custom-made precast units prepared under direct supervision of a professional engineer licensed in the state in which the project is located. Shop drawings shall include:

1. The criteria and loads used in the design of the precast components.

2. All materials used, their specifications and their design strengths.

3. Layout, piecemark, dimensions, reinforcing, and connection details of each precast member, including openings.

4. Details and instructions for lifting, rigging, erection, and installation of each precast component.

5. Lists and descriptions of all loose accessory materials supplied.

6. Instructions on secondary pours (in the field) when required.

7. Kentucky Professional Engineer's seal.

F. Quality Control Procedures: Submit certificate from the NPCA QC Manual that the precast concrete utility structures and vault manufacturer participates in their QA/QC program.

G. Manufacturer's Instructions.

## 1.03 QUALITY ASSURANCE

A. Manufacturer of precast concrete utility structures and vaults shall be quality certified by NCPA. Inspect manufacture of utility structures and vaults in accordance with ASTM C1037.

B. Installer of precast concrete utility structures and vaults shall have a record of at least three (3) years of successful installation of similar products on similar projects.

C. Inspection of earthwork, compaction and backfill shall be in accordance with the earthwork specifications in Division 31.

## 1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Project Representative for quality and final acceptance.

B. Store units off the ground or in a manner that will minimize potential damage.

C. Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on Shop Drawings.

# PART 2 - PRODUCTS

## 2.01 PRECAST STRUCTURES FOR UTILITY STRUCTURES AND VAULTS

A. Circular precast utility structures and vaults shall conform to ASTM C478. Non-circular vaults and structures shall conform to ASTM C857. Access hatch and pipe penetrations shall be cast in the top slab.

B. Manhole frames and covers shall have a clear opening of 22 inches and shall be made of cast iron conforming to ASTM A48/A48M Class 30. Casting shall be smooth, clean and free from blisters, blowholes and shrinkage. Castings shall be dipped twice in a

preparation of asphalt or coal tar and oil applied at a temperature of not less than 144 degrees F and not more than 155 degrees F so as to form a tenacious coating.

C. Structural design of precast concrete utility structures and vaults is hereby delegated. A licensed professional engineer in the State of the Project shall approve all designs.

D. All precast concrete structures shall be designed to resist the lateral soil pressures and fluid pressures in accordance with ASTM C857.

E. All precast concrete structures have integral flanges at the base to engage enough soil resistance to resist the buoyant force from full submergence.

F. All precast concrete structures shall be designed to support HL-93 or HS25-44 wheel loads in accordance with the AASTHO HB-17 anywhere on the top surface of the structure.

G. Joints: Joints shall be watertight and shall be sealed with one of the following:

1. Rubber gaskets conforming to ASTM C443.

2. Pre-formed flexible butyl type joint sealant conforming to AASHTO M198.

a. Hamilton Kent "Kent Seal No. 2"

b. K.T. Snyder Company "Rub'r Nek"

c. Press Seal Gasket "E Z Stik"

H. Corrosion Control: Follow recommendations outlined in ACPA 01-110 when hydrogen sulfide is indicated as a potential problem. See the geotechnical report.

## PART 3 - EXECUTION

### 3.01 FABRICATION

A. Fabricate precast concrete utility structures and vaults in accordance with NPCA QC Manual.

### 3.02 INSTALLATION

A. Install precast concrete utility structures and vaults in accordance with ASTM C891 and the manufacturer's instructions.

B. Lift precast components at designated lifting points in accordance with the manufacturer's instructions and other applicable safety standards.

C. Precast concrete utility structures and vaults shall bear on a minimum 4 inch thick bedding / base / drainage course of free-draining granular material. See Division 31 for bedding / base / drainage course materials.

D. Do no bear precast concrete utility structures and vaults on uneven subgrade or grade with high points from rock pinnacles or boulders or rock ledges.

E. Install precast concrete utility structures and vaults in proper location, with the proper alignment and level.

F. Backfill around the precast concrete utility structures and vaults in accordance with Division 31 specifications.

## 3.03 JOINTS

A. Joints shall be sealed with an approved sealant as specified in Part 2, and shall be mortared or grouted.

B. When making joints with mastic compound prime and seal all joints with primer supplied with the joint compound.

C. Joints shall be watertight.

D. Pipe Connections into Precast Structures:

1. Precast Openings:

a. Pipe shall be sealed in the precast section pipe opening with a resilient connector meeting the requirements of ASTM C923. Resilient connector shall be "Dura-Seal III" by Dura-Tech, Dayton, Ohio; "A-Lok" by A-LOK Products, Inc.; or approved equal.

b. Resilient connector shall be cast integrally into the wall of the precast section at the time of manufacture. There shall be no mortar placed around the connector on the outside of the manhole and no mortar shall be placed around the top half of the connector on the inside of the manhole when completing the invert work.

2. Cored Openings:

a. Pipe shall be sealed in cored precast section pipe opening with a resilient mechanical connector meeting the requirements of ASTM C923. Resilient connector shall be "NPC Kor-N-Seal I" (with stainless steel wedge) by Trelleborg Pipe Seals Milford, Inc.; "PSX: Direct Drive" by Press-Seal Gasket Corporations; interlocking link pipe seal; or approved equal. All fasteners and hardware shall be Type 304 stainless steel.

b. There shall be no mortar placed around the connector on the outside of the structure and no mortar shall be placed around the top half of the connector on the inside of the structure when completing the invert work.

## 3.04 LEAKAGE TESTING

A. Leakage tests shall be made and observed by the Project Representative's representative for all precast utility structures and vault structures. The test shall be the watertightness (exfiltration) test as described herein.

B. After each structure has been assembled in place, including wall piping, all lifting holds shall be filled with an approved non-shrink, non-metallic grout. Upon completion, each precast structure shall be tested to determine watertightness. The leakage test shall be made prior to placing any fill material and prior to application of interior/exterior wall coatings if specified. If the groundwater table has been allowed to rise above the bottom of the utility structures or vault, it shall be lowered for the duration of the test. All pipes and other openings into the structures shall be suitably plugged and the plugs braced to prevent blow out.

C. The tank shall be filled with potable water to the maximum level. The test shall consist of measuring the liquid level over the next 24 hours to determine if any change has occurred. If a change is observed and exceeds the maximum allowance, the test shall be extended

to a total of five days. If at the end of five days the average daily change has not exceeded the maximum allowance, the test shall be considered satisfactory.

D. The liquid volume loss for a period of 24 hours shall not exceed one-twentieth of one percent of the tank capacity, 0.0005 x tank volume. If the liquid volume loss exceeds this amount, it shall be considered excessive, and the tank shall be repaired and retested.

E. Damp spots will not be permitted at any location on the structure wall. Damp spots are defined as spots where moisture can be picked up on a dry hand. All such areas shall be repaired as necessary.

F. Damp spots or standing water on the footing may occur upon tank filling and are permissible within the allowable volume loss. Measurable flow in this area is not permissible and must be corrected.

G. It shall be the Contractor's responsibility to uncover the structure as necessary and to disassemble, reconstruct, or replace it as directed by the Project Representative. The structure shall then be retested.

H. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the Project Representative that the water table is below the bottom of the utility structures throughout the test.

## 3.05 CLEAN UP

A. Upon completion of installation of the precast structures and appurtenances, the Contactor shall remove all debris and surplus construction materials resulting from the Work. The Contractor shall grade the ground around and adjacent to the construction area in a uniform and neat manner to the final grade lines.

END OF SECTION

## SECTION 03600-PRECISION GROUTING

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. 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.

B. The object of these Specifications is to obtain grout which can be mixed to a flowable consistency (i.e., thinner than plastic consistency), placed in leakproof forms, with a minimum of strapping, without bleed water exceeding Specification requirements. The requirement of 24 hour presoak of existing concrete is of prime importance and must be adhered to. Trade name of grout shall be submitted to Engineer for review well in advance of preparation for grouting.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-place Concrete is included in Section 03300.

B. Review all divisions and sections for equipment, machinery, and other items to be grouted.

### 1.03 DESCRIPTION OF WORK

A. High strength, precision support of machine bases and soleplates, setting anchor bolts, including equipment subject to thermal movement and repetitive dynamic loading.

B. Work includes providing a non-shrink, ready-to-use, fluid 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 specified in this section.

### 1.04 QUALITY ASSURANCE

Comply with the following codes, standards, tests and recommended practices for foundation concrete as applies to precision grouting.

A. ACI 304R-85 " Guide for Measuring, Mixing, Transporting and Placing Concrete."

B. ACI 305R-77 (Revised 1982) "Recommended Practice for Hot Weather Concreting."

C. ACI 306R-78 (Revised 1983) "Recommended Practice for Cold Weather Concreting."

D. ACI 347-78 "Recommended Practice for Concrete Formwork."

E. ASTM C 309-74 "Standard Specifications for Liquid Membrance Forming Compounds for Curing Concrete."

F. Manufacturer's Information Use of Grout: Attached to each bag of grout.

G. Corps of Engineers CRD C-79 Method of Test for Flow of Grout Mixtures (Flow-Cone method).

H. ASTM C 109-73 "Tentative Method of Test for Compressive Strength of Hydraulic Cement Mortars."

## 1.05 SUBMITTALS

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

B. Purchase Orders: Furnish copies of purchase orders relating to materials in this Section to the Engineer prior to delivery.

## PART 2 - PRODUCTS

## 2.01 GROUT

A. Precision-support grout shall consist of a cementitious system; special graded and processed ferrous metallic internal reinforcing aggregate, carefully graded natural fine aggregate and additional technical components.

B. Grouts which depend upon aluminum powders, chemicals or other agents which produce gas for expansion are not acceptable.

1. Free of gas producing agents.

2. Free of oxidizing catalysts.

3. Free of inorganic accelerators, including chlorides.

C. Provide Performance Characteristics when mixed to fluid consistency, 25 to 30 seconds (Flow Cone Method CRD C-79), as follows:

1. No visible bleeding and/or settlement up to 2 hours on 1/4 to 2 gal. grout poured into gallon can, covered with glass plate to prevent evaporation. Grout shall meet the requirements of Paragraph 4.1 of Corps of Engineers CRD C 588-76.

2. Maintain firm, full contact with underside of 4'x 4' x 2" steel plate firmly bolted to supports at quarter points at 1, 7 and 14 days, evidenced by tapping of plate and visual observation after stripping. Grout shall be cured in accordance with manufacturer's printed instructions.

3. Provide strengths as specified in Paragraph 3.05 (2" x 2" cubes). Prepare specimens and test in accordance with ASTM C 109-73.

## 2.02 MEMBRANE CURING COMPOUND

A. Membrane forming curing compound shall be in accordance with ASTM C 309-74.

## 2.03 WATER

A. 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 wet cured. DO NOT USE CURING COMPOUNDS. (See Section 03300).

D. Clean surface of oil, grease, dirt, and loose particles.

E. Clean bolt holes, bolts and underside of bed plate.

F. Saturate concrete including bolt holes for 24 hours prior to grouting. Blow out excess water with oil free compressed air, or siphon prior to grouting.

## 3.02 FORMWORK

Formwork shall be compatible with proposed method of placing grout. Design for rapid, continuous and complete filling of space to be grouted.

A. Build strong, tight forms braced so they will not leak or buckle under weight of fluid grout. On placing side, slant form at 45o angle and pour grout directly on slanted face. On other sides, place form 2" or more from base of bed plate and 1" or more higher than underside of the plate.

B. Caulk forms with grouting material being used on inside or a sand-cement mortar outside to prevent leakage and loss of "head." Use expanded polystyrene or other means to caulk between foundation and portions of the bed plate and equipment to seal off areas where grout is not desired.

## 3.03 PREPARATION OF GROUT

Preparation of grout shall be in paddle-type mortar mixer suitable mechanical mixer. DO NOT MIX BY HAND.

A. Mix grout adjacent to area being grouted, have sufficient manpower and equipment available for rapid and continuous mixing and placing. DO NOT ADD CEMENT, SAND OR PEA GRAVEL ADDITIVES.

B. Avoid a consistency that produces bleeding. Mix materials for a minimum of 3 minutes and place immediately. DO NOT RETEMPER. DO NOT USE MIXING WATER ABOVE 80°F. (27°C.).

## 3.04 PLACING

Placing of grout shall be at a temperature of 65-75 degrees F. (18-24 degrees C.) for foundation, bed plate and grout material. Maintain for 24 hours following installation, hereafter above 40 degrees F. (4 degrees C.) until strength exceed 4,000 psi (280 kg/cm$^2$.) DO NOT USE COKE-FIRED SALAMANDERS.

A. Place grout quickly and continuously; avoid surface of overworking material and segregation. DO NOT VIBRATE GROUT. DO NOT OVERWORK GROUT.

B. Field service representative of the manufacturer shall be available during initial planning for installation to suggest recommended procedures and at start of placement for further suggestions.

1. A minimum of three (3) days notice shall be given by the Contractor to the manufacturer prior to use of the product.

## 3.05 FINISHING AND CURING

Follow manufacturer's printed instructions for the brand and type of grout being used.

A. The grout shall meet the following strengths:

| | 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

# DIVISION 5

# METALS

## SECTION 05500 - METAL FABRICATIONS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the metal fabrications as shown on the Drawings and specified herein.

B. Metal fabrications include items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to Work of this Section.

### 1.03 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, anchor details and installation instructions for products used in miscellaneous metal fabrications, including paint products and grout.

B. Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include member locations, plans, elevations, dimensions, shapes and sections, support conditions, and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others. Detail all loose and cast-in hardware. All shop drawings shall bear the seal of a professional engineer licensed in the state in which the Project is located and who was directly responsible for their preparation.

### 1.04 QUALITY ASSURANCE

A. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

A. Ferrous Metals: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.

1. Wide Flange Shapes: ASTM A 992.

2. Steel Plates, Channels, S-shapes and Bars: ASTM A 36.

3. Steel Tubing: Cold formed, ASTM A 500; or hot rolled, ASTM A 501.

4. Structural Steel Sheet: Hot-rolled, ASTM A 570; or cold-rolled ASTM A 611, Class 1, of grade required for design loading.

5. Steel Pipe: ASTM A 53; Type and grade (if applicable) as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (schedule 40), unless otherwise indicated.

B. Stainless Steel: All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise. All connections for stainless steel fabrications shall use Type 304 or Type 316 stainless steel fasteners. Fasteners shall be of the same allow type as the structural members.

1. Plates and Sheets: ASTM A 167 or A 666 Grade A.

2. Structural Shapes: ASTM A 276.

3. Fasteners (Bolts, etc): ASTM F593.

C. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

D. Grout: Non-Shrink Non-Metallic Grout, Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with CE CRD-C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this Section.

E. Fasteners:

General: Provide zinc-coated fasteners for exterior use or where built into exterior walls, unless noted otherwise. Select fasteners for the type, grade and class required.

1. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.

2. Lag Bolts: Square head type, FS FF-B-561.

3. Machine Screens: Cadmium plated steel, FS FF-S-92.

4. Wood Screws: Flat head carbon steel, FS FF-S-111.

5. Plain Washers: Round, carbon steel, FS FF-W-92.

6. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required.

7. Lock Washers: Helical spring type carbon steel, FS FF-W-84.

F. Paint:

1. Shop Primer for Ferrous Metal: Manufacturer's or Fabricator's standard, fast-curing, lead-free, "universal" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field-applied topcoats prolonged exposure; complying with performance requirements of FS TT-P-645.

2. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, complying with the Military Specifications MIL-P-21035 (Ships) or SSPC-Paint-20.

## 2.02 FABRICATION, GENERAL

A. Workmanship: Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of work.

B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

C. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

D. Form exposed connection with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts.

E. Provide for anchorage of type indicated, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

F. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

G. Galvanizing: Provide a zinc coating for those items indicated or specified to be galvanized, and conform to ASTM A 153 requirements for galvanizing iron and steel hardware.

H. Fabricate joints, which will be exposed to weather, in a manner to exclude water. Provide weep holes where water may accumulate.

I. Shop Painting: Apply shop primer to surfaces of metal fabrications except those which are galvanized or as indicated to be embedded in concrete, unless otherwise indicated, and in compliance with requirements of SSPC-PAL "Paint Application Specification No. 1" for shop painting.

J. Surface Preparation: Prepare ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

   1. Exteriors (SSPC Zone IB): SSPC-SP6 "Commercial Blast Cleaning".

   2. Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning".

## 2.03 ROUGH HARDWARE

A. 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-6 sections.

B. 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.

## 2.04 STAIR SAFETY NOSINGS

A. Step safety nosings shall be 4-inch wide, aluminum grit, crosshatched surface, complete with screws, nuts and wing anchors for anchoring to concrete, pre-drilled to admit anchor screws, Wooster WP4T Alumogrit as manufactured by Wooster Products Company, Wooster, Ohio; Style AXPF Nosing by SAFE-T-METAL Company; or equal. Nosings shall be furnished for all new interior concrete steps only.

## 2.05 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide miscellaneous steel framing and supports, which are not a part of structural steel framework, as required to complete work.

B. Fabricate miscellaneous units to sizes, shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise indicated, fabricate from structural steel shapes and plates and steel bars of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

C. Equip units with integrally welded anchors for casting into concrete. Furnish inserts if units must be installed after concrete is placed.

# PART 3 - EXECUTION

## 3.01 PREPARATION

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete construction. Coordinate delivery of such items to project site.

## 3.02 INSTALLATION

A. General Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

B. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.

C. Fit exposed connections accurately together to form tight hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

## 3.03 ADJUSTING AND CLEANING

A. Cleaning and touch-up painting of field welds, bolted connections and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 of these Specifications.

B. For galvanized surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION

## SECTION 05520 - HANDRAILS AND RAILINGS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Extent and dimensions of handrails and railings are indicated on Drawings and include miscellaneous handrails and railing systems not included in other Sections of these Specifications.

B. Type of handrails and railing systems in this Section is aluminum pipe handrails and railing systems.

C. Products furnished but not installed under this Section include inserts and anchors preset in concrete for anchorage of hand rails and railing systems.

D. Delegated Design: Design aluminum handrail, railings, support system and all anchorage of supports. Include comprehensive engineering analysis by a qualified professional engineer licensed in the state in which the Project is located, using performance requirements and design criteria indicated.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to Work of this Section.

B. Metal Fabrications: Section 05500

### 1.03 SUBMITTALS

A. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data, calculations, and erection drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Product Data: Manufacturer's technical data for products and processes used in handrails and railing systems, including finishes and grout.

C. Shop Drawings: Shop details of fabrication and installation for each type and material of handrail and railing system required including dimensions, plans, elevations, sections and section assembly, profiles of rails, fittings, connections, and anchorage and accessory items. Shop drawings shall be sealed by the qualified professional engineer responsible for their preparation.

D. Submit installation drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchorages and accessories that are to be embedded in concrete.

E. Samples: Prepare samples of each type of metal finish required on metal of same thickness and alloy indicated for final work. Where finish involves normal color and texture variations, include sample sets composed of two (2) or more units showing limits of such variations expected in completed work. Include 6" long samples of each distinctly different railing member including handrails, top rails, posts, and samples of fittings and brackets.

### 1.04 DEFINITIONS

A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

## 1.05 SYSTEM DESCRIPTION

A. Structural Performance of Handrails and Railing Systems: Design, engineer, fabricate, and install handrails and railing systems to withstand the following structural loads without exceeding the allowable design working stress of the materials for handrails, railing systems, anchors, and connections. Apply each load to produce the maximum stress in each of the respective components comprising handrails and railing systems.

1. Top Rail of Guardrail Systems: Concentrated load of 200 lbf (890 N) applied at any point and in any direction and a uniform load of 50 lbf per linear foot (730 N/m) applied horizontally and concurrently with a uniform load of 100 lbf per linear foot (1460 N/m) applied vertically downward. Concentrated and uniform loads need not be assumed to act concurrently.

2. Handrails Not Serving as Top Rails: Concentrated load of 200 lbf (890 N) applied at any point and in any direction and a uniform load of 50 lbf per linear foot (730 N/m) applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.

3. Infill Area of Guardrail Systems: Horizontal concentrated load of 200 lbf (890 N) applied to 1 sq. ft. (0.09 sq. m) at any point in the system including gates, panels, intermediate rails, balusters, or other elements composing the infill area. Loads on infill area need not be assumed to act concurrently with loads on top rails.

B. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Material for rails and gates shall be a minimum of 1-1/2" diameter Schedule 40 and for posts, a minimum of Schedule 80.

## 1.06 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain handrails and railing systems of each type and material from a single manufacturer.

B. Design Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of structural computations for handrails and railing systems to determine compliance with structural performance requirements indicated.

## 1.07 STORAGE

A. Store handrails and railing systems in clean, dry location, away from uncured concrete, protected against damage of any kind. Cover with waterproof paper, tarpaulin, or polyethylene sheeting; allow for air circulation inside the covering.

# PART 2 - PRODUCTS

## 2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide handrails and railing systems of one of the following, or an approved equal. Handrail System shall be equal to "TUFRAIL" as manufactured by Thompson Fabricating Company.

1. Thompson Fabricating Company, Inc., Birmingham, Alabama.

2. Superior Railing Company

3. Alumaguard

## 2.02 METALS

A. General: Comply with standards indicated for forms and types of metals indicated or required for handrail and railing system components.

B. Aluminum: All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein. Provide alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties of the alloy and temper designated below for each aluminum form required.

1. Structural Shapes: ASTM B308.

1. Castings: ASTM B26, B85, or B108.

1. Extruded Bars: ASTM B221 – Alloy 6061.

1. Extruded Rods, Shapes, Pipes, and Tubes: ASTM B221 – Alloy 6063.

3. Plates: ASTM B 209 – Alloy 6061.

1. Sheets: ASTM B 221 – Alloy 3003.

4. Die and Hand Forgings: ASTM B 247 – Alloy 6061-T6.

## 2.03 MISCELLANEOUS MATERIALS

A. Nonshrink Nonmetallic Grout: Pre-mixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRD C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this Section.

B. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS Specifications, and as required for color match, strength, and compatibility in fabricated items.

C. Fasteners: Use fasteners of Type 304 stainless steel for aluminum components, unless otherwise indicated. Do not use metals which are corrosive or incompatible with materials joined.

D. Provide concealed fasteners for interconnection of handrail and railing components and for their attachment to other work except where exposed fasteners are unavoidable or are the standard fastening method for handrail and railing system indicated.

E. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

F. Anchors and Inserts: Provide anchors of type, size, and material required for type of loading and installation condition shown, as recommended by manufacturer, unless otherwise

indicated. Use nonferrous metal of hot-dipped galvanized anchors and inserts for exterior locations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

G. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel: Sherwin-Williams Zinc-Clad Galvanizing Compound #143-0255 or equal.

H. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

I. Zinc Chromate Primer for Galvanized Metals: Sherwin-Williams Galvite, B50W3 or equal; for Ferrous Metals: Sherwin-Williams KemKromik Universal, B50Z Series or equal.

## 2.04 FABRICATION

A. General: Fabricate handrails and railing systems to design, dimensions and details shown. Provide handrail and railing members in sizes and profiles indicated, with supporting posts and brackets of size and spacing shown, but not less than required to comply with requirements indicated for structural performance. Handrail systems which use fittings which are glued or pop-riveted will not be acceptable.

B. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Nonwelded Connections: Fabricate railing systems and handrails for interconnection of members by means of railing manufacturer's standard concealed mechanical fasteners and fittings unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

D. Welded Connections for Aluminum Pipe: Fabricate aluminum pipe handrails and railing systems for interconnection of members by concealed internal welds, which eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

E. Form changes in direction of railing members by bending members, insertion of prefabricated elbow fittings, radius bends, or by mitering.

F. For handrails and railing systems with nonwelded connections which are exposed to exterior or to moisture from condensation or other sources, provide weepholes or other means for evacuation of entrapped water in hollow sections of railing members.

G. Toe Boards: Where required by O.S.H.A. and where indicated on the Drawings, provide toe boards at railing systems around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details shown or, if not shown, use manufacturer's standard detail. Toe boards shall be 4" high.

H. Brackets, Flanges, Fittings and Anchors: Provide manufacturer's standard wall brackets, flanges, hinges, miscellaneous fittings and anchors for interconnection of handrail and railing members to other work, unless otherwise indicated.

I. Furnish inserts and other anchorage devices for connecting handrails and railing systems to concrete work. Fabricate anchorage devices which are capable of withstanding loadings imposed by handrails and railing systems. Coordinate anchorage devices with supporting structure.

J. For railing posts set in concrete provide preset sleeves of steel, not less than 6" long and inside dimensions not less than 2" greater than outside dimensions of post, with steel plate forming bottom closure.

K. Provide slip-fit metal sockets to receive removable railing posts. Fabricate sockets for a close fit with posts and to limit deflection of post without lateral load, measured at top, not to exceed 1/12 of post height. Design and fabricate socket covers to resist accidental dislodgement.

L. Gates: Provide gates of equal structural properties of railing system, with toe board. Hinges shall be capable of providing a swing of 180 degrees. Provide positive latching device which shall be operable from both sides of gate.

## 2.05 METAL FINISHES, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations and designations of finishes, except as otherwise indicated.

B. Class I Clear Anodized Finish: AA-M10C22A41 (medium satin directional textured mechanical finish; chemical etch, medium matte; 0.7 mil min. thick clear anodic coating) complying with AAMA 607.1.

# PART 3 - EXECUTION

## 3.01 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete construction. Coordinate delivery of such items to project site.

B. Field Measurements: Take field measurements prior to fabrication.

## 3.02 INSTALLATION, GENERAL

A. Fit exposed connections accurately together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installation of handrails and railing systems. Set work accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Do not weld, cut or abrade surfaces of handrails and railing components which have been coated or finished after fabrication, and are intended for field connection by mechanical means without further cutting or fitting.

C. Field Welding: Comply with applicable AWS Specification for procedures of manual shielded metal-arc welding, for appearance and quality, of welds made, and for methods used in correcting welding work. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent rail surfaces.

D. Corrosion Protection: Coat concealed surfaces of aluminum, which will be in contact with grout, concrete, or dissimilar metals, with a heavy coat of bituminous paint or zinc chromate primer.

E. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at 5'-0" o.c. MAX but not more than that required by design loadings.

## 3.03 ANCHORING POSTS

A. Anchor aluminum handrail posts to concrete with manufacturer's base flange assembly (3 anchors per base) for top and side mount brackets recommended for meeting the design criteria. Base flanges and side mount brackets will not be welded to the post but will be mechanically fastened so as to achieve a rigid construction without annealing the post. All connections to concrete will be made using stainless steel wedge anchors, which are to be sized and furnished by the handrail manufacturer as an integral part of their handrail system. Anchor post on new concrete shall be side mounted except where shown otherwise on the drawings.

B. Anchor posts to metal surfaces with manufacturer's standard fittings designed for this purpose unless otherwise indicated.

C. Provide removable railing sections as indicated, using slip-fit metal sockets. Accurately locate sockets to match post spacing.

## 3.04 RAILING CONNECTIONS

A. Nonwelded Connections: Use manufacturer's standard mechanical joints for permanently connecting railing components. Components that are glued or pop riveted at the joints will not be acceptable. All components must be mechanically fastened with stainless steel hardware. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic filler cement colored to match finish of handrails and railing systems.

B. Welded Connections: Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact or use manufacturer's standard fittings designed for this purpose.

## 3.05 ANCHORING RAILING ENDS

A. Anchor railing ends into concrete with manufacturer's standard fittings designed for this purpose, unless otherwise indicated.

B. Anchor railing ends to metal surfaces with manufacturer's standard fittings using concealed fasteners, unless otherwise indicated.

C. Expansion Joints: Provide expansion joints at locations indicated or, if not indicated, at intervals not to exceed 40 feet. Provide slip-joint internal sleeve extending 2" beyond joint on either side; fasten internal sleeve securely to one side, locate joint within 6" of post.

## 3.06 ATTACHMENT OF HANDRAILS TO WALLS

A. General: Secure handrails to walls with manufacturer's standard wall brackets and end fittings, unless otherwise indicated.

B. For concrete, use drilled-in expansion shields and concealed hanger bolts, unless otherwise indicated.

## 3.07 PROTECTION

A. Protect finishes of railing systems and handrails from damage during construction period by use of temporary protective coverings approved by railing manufacturer. Remove protective covering at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items which cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units as required.

END OF SECTION

## SECTION 05530 – ALUMINUM GRATING

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install metal bar grating in accordance with the Drawings and specified herein.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

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

B. Miscellaneous Metals and Fasteners are included in Division 05.

### 1.03 SUBMITTALS

A. Submit shop drawings to the Engineer for review before fabrication.

B. Indicate areas to receive grating, grating details and dimensions, and material specifications.

C. Show anchorage details and locations.

D. Indicate coordination with equipment suppliers where openings for such equipment are required.

### 1.04 REFERENCE STANDARDS

A. Design, fabrication and installation of grating shall be in accordance with Standard Specifications and Voluntary Code of Practice in Metal Bar Grating Manual, 1979 Edition, published by National Association of Architectural Metal Manufacturers, Chicago, Illinois (ANSI A 202.1).

## PART 2 - PRODUCTS

### 2.01 DESIGN CRITERIA

A. Gratings shall meet or exceed the following design criteria:

B. Support uniform live load of 100 psf.

C. Deflection not to exceed span of bearing bars (in inches) divided by 360.

D. Maximum fiber stress: 12,000 psi.

### 2.02 BASIC DESIGN

The basic design requirements are listed below:

A. Shape: Rectangular.

B. Type Construction: Pressure locked.

C. Bar Sizes, unless otherwise shown on the Drawings:

1. Bearing Bars: 1-1/2" x 3/16".
2. Cross Bars: 1" x 1/8".

D. Maximum Bar Spacing:

1. Bearing Bars: 1-3/16" c-c.
2. Cross Bars: 4" c-c.

E. Banding Bars:

1. Same thickness as bearing bars to which they are attached.
2. At free ends: Same depth as bearing bars.
3. At supported ends: 1/8" less in depth than bearing bars.

F. Bearing and crossbars shall be flush at surface.

G. All free and supported bar ends around perimeter and around cutouts shall be banded.

H. Provide removable sections of grating with suitable end bearing where noted on the Drawings or otherwise required.

## 2.03 MATERIALS

A. Aluminum Grating:

The materials of construction shall meet the following requirements:

1. Bearing Bars: ASTM B 221, 6061-T6 or 6063-T6, aluminum.
2. Cross Bars: ASTM B 221 (extruded) or ASTM B 210 (drawn) aluminum.
3. All steel fasteners used with aluminum grating shall be galvanized.
4. Finish: Aluminum mill finish (as fabricated).
5. Anchors: Saddle clips of manufacturer's standard design, galvanized.

# PART 3 - EXECUTION

## 3.01 INSTALLATION

A. Grating shall be fabricated as indicated by shop drawings which have been revised to reflect actual field measurements.

B. Grating shall be set with full and uniform end bearing to preclude rocking; do not use wedges or shims.

C. Provide 1-inch minimum bearing with maximum erection clearance of 1/4-inch all around.

D. Anchor grating with saddle clips in accordance with manufacturer's recommendations or as detailed on the Drawings.

E. Provide cutouts for the passage of pipe, valve and equipment operators, conduit, stems and similar work; cutouts for circular obstructions shall be at least 2" larger in diameter than the obstruction.

F. Protect all surfaces of angles and frames to be in contact with concrete or dissimilar metals with two (2) coats of Fed. Spec. TT-V-51F Asphalt Varnish.

END OF SECTION

# DIVISION 6

# WOOD & PLASTIC

# SECTION 06600 - FIBERGLASS REINFORCED PLASTIC PRODUCTS AND FABRICATIONS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary to install the fiberglass reinforced plastic (FRP) grating system and supports, stair treads and stair support system, handrail and support system, ladder system and structurals as shown on the drawings and as specified herein.

### 1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

### 1.03 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain all fiberglass reinforced plastic (FRP) grating system and supports, stair treads and stair support system, handrail and support system, ladder system and structurals from a single manufacturer.

B. Design Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of structural computations for all fiberglass reinforced plastic (FRP) grating system and supports, stair treads and stair support system, handrail and support system, ladder system and structurals to determine compliance with structural performance requirements indicated.

C. The material covered by these specifications shall be furnished by a reputable and qualified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems.

D. Substitution of any component or modification of system shall be made only when approved by the Engineer.

E. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.

F. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for the work.

### 1.04 DESIGN CRITERIA

A. Delegated Design: Design gratings, grating support systems including columns and beams, handrail system and supports, ladder system and supports, and all anchorage of supports. Include comprehensive engineering analysis by a qualified professional engineer licensed in the state in which the Project is located, using performance requirements and design criteria indicated.

B. The design of FRP products including connections shall be in accordance with governing building codes and standards as applicable.

C. Design of FRP live loads on grating shall not be less than 100 pounds per sq. ft. Grating deflection at the center of a simple span not to exceed 0.25 inch. Deflection in any direction shall not be more than L/360 of span for structural members. Connections shall be designed to transfer the above loads.

## 1.05 SYSTEM PERFORMANCE REQUIREMENTS

A. STRUCTURAL PERFORMANCE

Design, engineer, fabricate, and install the following FRP fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each FRP fabrication. Each of the systems shall comply with OSHA regulations.

B. STAIR TREAD PERFORMANCE

Design stair treads capable of withstanding a uniform load of 100 lbs per sq. ft. or a concentrated load of 300 lbs on an area of 4 sq. inches located in the center of the tread, whichever produces the greater stress.

C. PLATFORMING AND STAIR PLATFORM PERFORMANCE

Design platforms and stair platforms capable of withstanding a uniform load of 100 lbs per sq. ft.

D. HANDRAILS SYSTEMS PERFORMANCE

Design top rail of handrail systems capable of withstanding a concentrated load of 200 lbs applied at any point noncurrently, vertically downward, or horizontally. Capable of withstanding a uniform load of 50 lb. per linear foot applied horizontally and concurrently with a uniform load of 100 lb. per linear foot applied vertically downward. Concentrated and uniform loads need not be assumed to act concurrently.

Design handrails not serving as top rails capable of withstanding a concentrated load of 200 lbs applied at any point and in any direction and a uniform load of 50 lb per linear foot applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.

Design infill area of guardrail systems capable of withstanding horizontal concentrated load of 200 lbs applied to 1 sq. ft. at any point in the system including gates, panels, intermediate rails, balusters, or other elements composing the infill area. Loads on infill area need not be assumed to act concurrently with loads on top rails.

E. LADDER SYSTEMS PERFORMANCE

Design ladder systems capable of withstanding a concentrated load of 500 lbs applied at any point noncurrently, vertically downward, or horizontally. Width of ladder shall be a minimum of 24" wide.

## 1.06 SUBMITTALS

A. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data, calculations, and erection drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Shop drawings of all FRP structural members, handrails, gratings, plate, ladders and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01340.

C. Detailed shop drawings shall include:

1. Dimensions of grating, ladders, handrail, and structural members.

2. Sectional assembly

3. Location and identification mark

4. Size and type of supporting frames required

5. Anchorage and accessory items.

6. Professional Engineer's seal.

D. Submit installation drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete.

E. Manufacturer's catalog data/product data showing:

1. Dimensions, spacings, anchor details, and construction of grating.

2. Design tables showing limits for span length and deflection under various uniform and concentrated toads.

3. Materials of construction.

F. Samples of each type of grating proposed shall be submitted for approval prior to placement of purchase orders.

G. In-plant QA/QC inspection reports or fabricator certification.

H. Provide three year manufacturer's limited warranty on all FRP products against defects in materials and workmanship. Submit manufacturer's sample warranty prior to commencement of the work.

## 1.07 SHIPPING AND STORAGE INSTRUCTIONS

A. All systems, sub-systems and structures shall be shop fabricated and assembled into the largest practical size suitable for transporting.

B. All materials and equipment necessary for the fabrication and installation of the grating, plate, handrails, stair treads, ladders, all support systems and structural shapes shall be

stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the Engineer, has become damaged as to be unfit for use shall be promptly removed from the site of work and the Contractor shall receive no compensation for the damaged material or its removal.

C. Store all materials and equipment necessary for the fabrication and installation of the grating, plate, handrails, stair treads, ladders, all support systems and structural shapes in a clean, dry location, away from uncured concrete, protected against damage of any kind.

D. Identify and match-mark all materials, items, and fabrications for installation and field assembly.

## PART 2- PRODUCTS

### 2.01 GENERAL

A. Materials used in the manufacture of the FRP products shall be new stock of the best quality and shall be free from all defects and imperfections that might affect the performance of the finished product.

B. All materials shall be of the kind and quality specified, and where the quality is not specified, it shall be the best of the respective kinds and suitable for the purpose intended.

C. All FRP products noted in 1.02 shall be manufactured using a pultruded process utilizing either isophthalic polyester or a vinyl ester resin with flame retardant and ultra-violet (UV) inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. The FRP shapes shall achieve a flame spread of 25 or less in accordance with ASTM test method E84. (Isophthalic polyester resin is available without flame retardant and UV inhibitor additives.)

D. After fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating to prevent intrusion of moisture.

E. FRP products exposed to weather shall contain an ultraviolet inhibitor and shall additionally receive one mil thick 1J.V. coating to shield from ultra-violet light if specified or requested.

F. All exposed surfaces shall be smooth and true to form.

### 2.02 GRATINGS AND TREADS

A. GENERAL

1. Grating shall be shipped from the manufacturer, palletized and banded with exposed edges protected by cardboard to prevent damage in shipment.

2. Each piece shall be clearly marked showing manufacturer's applicable drawing number.

B. DESIGN

1. The panels shall be 1-1/2" deep and sustain a deflection of no more than 0.25 inches under a uniform distributed load of 100 psf for the span lengths shown on the plans.

2. The baring bars shall be joined into panels by passing continuous length fiberglass pultruded cross rods through the web of each bearing bars. The pultruded cross rod assembly shall consist of two cross rod spacers that have notches cut into them at 1-1/2" inches on center to fit the distance between the web of each bearing bar. A continuous fiberglass pultruded bar shaped section shall be wedged between the two cross rod spacers mechanically locking the notches in the cross rod spacers to the web of the bearing bars. Chemical bonding shall be achieved between the cross rod spacers and the bearing web and between the bar shaped wedge and the two cross rod spacers locking the entire panel together to give a panel that resists twist and prevents internal movement of the bearing bars.

3. The top surface of all panels shall have a nonskid grit affixed to the surface by a baked epoxy resin followed by a top coat of baked epoxy resin.

4. Panels shall be fabricated to the sizes shown on the drawings.

5. Hold down clamps shall be type 316L stainless steel, a minimum of 4 each per panel.

6. Color shall be gray (OSHA safety gray)

7. All bearing bars that are to be exposed to UV shall be coated (optional) with polyurethane coating of a minimum thickness of I mil if desired.

C. FABRICATION

1. The FRP grating and stair treads shall be fabricated from bearing bars and cross rod manufactured by the pultrusion process. The glass fiber reinforcement for the bearing bars shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. A synthetic surface veil shall be the outermost layer covering the exterior surfaces.

2. Fiberglass Grating and Stair Treads

   a. Fiberglass grating and stair treads shall be made from a premium grade chemical resistant, fire retardant isophthalic polyester or fire retardant vinyl ester resin system with antimony trioxide added to meet the flame rating of 25 or less in accordance with ASTM E-84 testing and meets the self-extinguishing requirements of ASTM D-635. U. V. inhibitors are added to the resin.

3. Grating with Plate

   a. Grating shall be the same as described above in this section.

   b. Plate shall be manufactured using premium grade polyester or vinyl ester resin with fire retardant additive to meet Class I flame rating of 25 or less as tested by ASTM E-84 and meet the self-extinguishing requirements of

ASTM D-635. All plate shall contain a U. V. inhibitor.

c. Plate will be epoxy bonded to the grating, and non-skid grit will be affixed to the top surface of the assembly by a baked epoxy resin, followed by a top coat of baked epoxy resin.

4. All cut and machined edges, holes and abrasions shall be sealed with a resin compatible with the resin matrix used in the bearing bars and cross rods.

5. All panels shall be fabricated to the sizes shown on the approved shop drawing.

## 2.03 STRUCTURAL SHAPES

A. Structural shapes shall be made from a premium grade polyester or vinyl ester resin with fire retardant additives to meet Class 1 flame rating of ASTM E-84 and meet the self-extinguishing requirements of ASTM D-635. All structural shapes shall contain a U.V. inhibitor.

B. Manufactured by the pultrusion process.

Structural FRP members composition shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50% resin to glass ratio. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Continuous glass strand rovings shall be used internally for longitudinal strength. Continuous strand glass mats shall be used internally for transverse strength.

C. The following minimum mechanical properties shall apply:

**Table 1 – Fiberglass Pultruded Material Properties**
**Minimum Ultimate Coupon Properties (UN)**

| Material Properties | ASTM Test Method | PSI (Mpa) |
|---|---|---|
| **Pultruded Fiberglass Structural Shapes** | | |
| Ultimate tensile stress in longitudinal direction | D638 | 30,000 (207) |
| Ultimate compressive stress in longitudinal direction | D695 | 30,000 (207) |
| Ultimate flexural stress in longitudinal direction | D790 | 30,000 (207) |
| Ultimate short beam shear in longitudinal direction | D2344 | 4,500 (31) |
| Ultimate tensile stress in transverse direction | D638 | 7,000 (48) |
| Ultimate compressive stress in transverse direction | D695 | 15,000 (103) |
| Ultimate flexural stress in transverse direction | D790 | 10,000 (69) |
| Density (lb/in.$^3$ (kg/mm$^3$) | D792 | .060-.070 (0.00166-00194) |
| Water absorption (24-h immersion) | D570 | 0.60 Max., % by Weight |
| Barcol Hardness | D2583 | 45 |
| Coefficient of thermal 10$^{-}$6 in/in/°C | D696 | 8 |

| | | |
|---|---|---|
| Expansion,LW10$^{-6}$ in/in/°F | _____ | 4.4 |
| Thermal conductivity BTU-in/FT$^2$/hr/°F | C177 | 4 |

**Flame Retardant Properties**

| | | |
|---|---|---|
| Flame resistance | FTMS 406-2023 | 55/30 lgn.burn.sec. |
| Flammability test | D 635 | Self Extinguishing |
| Surface burning characteristics | E 84 | 25 maximum |
| Flammability class | UL 94 | VO |
| Temperature index | UL94 | 130°C |

## 2.04 HANDRAILS AND LADDERS

A. Design:

1. The FRP handrail system shall be designed to meet the configuration and loading requirements of OSHA 1910.23, with a minimum factor of safety on loading of 2.0.

B. Material:

1. The parts may be coated with an industrial grade polyurethane paint for additional U.V. protection and wear resistance. The pultruded parts shall be made with a fire retardant resin which meets the ASTM E-84 test for a flame spread of 25 or less. The resin matrix shall be polyester or vinyl ester and shall contain a UV inhibitor. The color shall be OSHA safety yellow.

2. Handrails: The rails and posts shall be 2" x 2"x 0.156" square tube manufactured by the pultrusion process. The kick plate shall be 4"x ½" (corrugated) x 0.125" thick pultruded fiberglass shape.

3. Ladders: The rungs shall be 1-1/8 inches in diameter, connected to 2-7/8 inch side rails.

4. The pultruded parts shall meet the following minimum mechanical properties:

| Properties | Test Method | Values |
|---|---|---|
| Tensile Stress | ASTM D638 | 30,000 psi |
| Tensile Modulus | ASTM D638 | 2.5 x 10$^6$ psi |
| Compressive Stress | ASTM D695 | 30,000 psi |
| Compressive Modulus | ASTM D695 | 2.5 x 10$^6$ psi |
| Flexural Stress | ASTM D790 | 30,000 psi |
| Flexural Modulus | ASTM D790 | 1.6 x 10$^6$ psi |
| Shear Stress | ASTM D2344 | 4,500 psi |
| Density | ASTM D792 | .060 - .070 lbs/in$^3$ |
| 24 Hr. Water Absorption | ASTM D570 | 0.6% max |

| | | |
|---|---|---|
| Coef. of Thermal Expansion | ASTM D696 | $4.4 \times 10^{-6}$ in/in°F |
| Flexural Stress | Full Section | 36,000 psi |
| Flexural Modulus | Full Section | $3.7 \times 10^{6}$ psi |

C. Fabrication Handrail System:

1. The fiberglass handrail system shall be fabricated into finished sections by fabricating and joining together the pultruded square tube using molded or pultruded components; epoxy bonded and connected as shown in the fabrication details. Where required by OSHA, fiberglass kick plate shall be attached to the handrail posts with nylon rivets. Handrail sections shall be fabricated to the size shown on the approved fabrication drawings and shall be piece marked with a waterproof tag.

D. For Side Mount:

1. Post shall be constructed with a square pultruded bottom plug. Length shall be sufficient to extend a minimum of one inch beyond the uppermost bolt hole to prevent cursing of post tubing. Bolt holes shall provide clearance of 1/16 inch for 1/2 inch diameter bolts/studs. Holes shall be on longitudinal center line of post, 1 inch from bottom of post (minimum) and not less than 3 inches apart on center. Posts shall be fastened with stainless steel anchor bolts or studs, 1/2 inch diameter extending no less than 2-1/4 inches into the concrete, or into a minimum thickness of 1/4 inch structural steel or pultruded fiberglass.

2. Post locations shall be no greater than 24 inches, nor less than 9 inches from horizontal or vertical change in handrail direction. Post centers shall be no greater than 72 inches apart on any straight run of rail or 48 inches apart on any inclined rail section.

E. Other Attachment Methods:

1. Base mount, embedded, and removable are also types of mounting procedures for handrail. Contact approved fabricator for detailed information on these connection types.

F. Installation of Handrail Sections:

1. The fabricated handrail sections shall be supplied complete with fittings by the FRP manufacturer. The components used to joint fabricated sections together may be shipped loose, to be exposed and riveted together in the filed by the Contractor, per the manufacturer's recommendations.

2. The fabricated handrail sections shall be installed as shown on the approved shop drawings. The handrail sections shall be accurately located, erected plumb and level. The sections shall be fastened to the structure as shown on the approved shop drawing.

## PART 3 - EXECUTION

### 3.01 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete construction. Coordinate delivery of such items to project site.

B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

## 3.02 INSTALLATION, GENERAL

A. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete inserts, toggle bolts, through-bolts, lag bolts, and other connectors as required.

B. Cutting, fitting, and placement: Perform cutting, drilling, and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or similar construction.

## 3.03 ALL FRP INSTALLATION

A. All field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer. The sealing of the edges shall prevent premature fraying at the field cut edges.

B. Install items specified as indicated and in accordance with manufacturer's instructions.

## 3.04 INSPECTION AND TESTING

A. The Engineer shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacture.

B. All labor, power, materials, equipment, and appurtenances required for testing shall be furnished by the Contractor at no cost to the Owner.

END OF SECTION

# DIVISION 7

# THERMAL & MOISTURE PROTECTION

## SECTION 07900 - JOINT SEALERS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the joint sealers in accordance with the Drawings and as specified herein.

B. The extent of each form and type of joint sealer is indicated on the drawings and includes but is not limited to, the following general locations:

1. Exterior wall joints.
2. Paving and sidewalk joints.
3. Joints at penetrations of walls, decks, and floors by piping and other services and equipment.
4. Joints between items of equipment and other construction.
5. Joints at windows, doors and louvers.

### 1.02 RELATED DOCUMENTS SPECIFIED ELSEWHERE

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

### 1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each joint sealer product required, including instruction for joint preparation and joint sealer application.

B. Certificates: Submit certificates from manufacturers of joint sealers attesting that their products comply with specification requirements and are suitable for the use indicated.

### 1.04 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer who has successfully completed within the last 3 years at least 3 joint sealer applications similar in type and size to that of this project and who will assign mechanics from these earlier applications to this project of which one will serve as lead mechanic.

B. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each different product required.

C. System Performance: Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

## 1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

## 1.06 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40 degrees F. (4.4 degrees C).

2. When joint substrates are wet due to rain, frost, condensation or other causes.

B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.

# PART 2 - PRODUCTS

## 2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Owner from manufacturer's standard colors.

## 2.02 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those for Type, Grade, Class, and Uses.

B. Two-Part Urethane Sealant: Type M; Grade NS; Class 25 - Class 50; Uses T, M, A, I, and as applicable to joint substrates indicated, O.

C. Products: Subject to compliance with requirements, provide one of the following:

1. Two Part Urethane Sealant:

"Tremco Dymeric 240FC"; Tremco, Inc.
"Sikaflex Type-2c NS"; Sika Corporation US.
"Sonolastic NP 2"; Sonneborn Building Products Division, BASF Construction Chemicals, LLC.

## 2.03 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Plastic Foam Joint-Fillers: Preformed, compressible, resilient, non-waxing, non-extruding strips of plastic foam of material and size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Provide either flexible, open cell polyurethane foam or non-gasing, closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer.

## 2.04 MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealer-substrate and field tests.

B. Cleaners for Nonporous Surfaces: Provide non-staining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. Masking Tape: Provide non-staining, non-absorbent type compatible with joint sealants and to surfaces adjacent to joints.

# PART 3 - EXECUTION

## 3.01 INSPECTION

A. Require Installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance.

B. Obtain Installer's written report listing any conditions detrimental to performance of joint sealer work.

C. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

## 3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellants; water; surface dirt and frost.

2. Clean concrete, masonry and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

3. Remove latence and form release agents from concrete.

4. Clean metal and other non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

## 3.03 INSTALLATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Installation of Sealant Backings: Install sealant backings to support sealants during application and at position required to produce optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint-fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability. Do not leave gaps between ends of joint-fillers. Do not stretch, twist, puncture or tear joint-fillers. Remove absorbent joint-fillers which have become wet prior to sealant application and replace with dry material.

F. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning of curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer. Provide concave joint configuration per Figure 6A in ASTM C 962, unless otherwise indicated.

## 3.04 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

END OF SECTION

# DIVISION 8

# WINDOWS & DOORS

## SECTION 08370 - ACCESS HATCHES

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and service required for the complete installation of the access hatches as specified herein and shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-Place Concrete: Section 03300

B. Precast Concrete: Section 03400

### 1.03 SUBMITTALS

A. Submit manufacturer's data and shop drawings for the materials specified herein. Comply with all requirements of Section 01300.

B. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein to the Engineer for review before ordering.

C. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

D. In accordance with the requirements of the General and Special Conditions and this Section, the following table includes, but is not limited to, the items required to be submitted:

| Item Description | Shop Drawings | Product Data | Schedules | Installation Data | Parts Lists | Wiring Diagram | Samples | O & M Manual | Certificates | Warranty | Report | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Access Hatches | X | X | | X | | | | | | X | | |

### 1.04 ACCEPTABLE MANUFACTURERS

A. Access hatches shall be as manufactured by the Bilco Company, New Haven, Connecticut; Babcock-Davis Associates, Inc., Arlington, Massachusetts; Milcor Division Inryco, Inc., Milwaukee, Wisconsin; Halliday Products, Orlando, FL., or equal.

## PART 2 - PRODUCTS

### 2.01 ACCESS HATCHES

A. Access hatch shall be double leaf or single leaf, as indicated on the Contract Drawings or by the Engineer, aluminum, gutter type, watertight, exterior, flush floor hatch design. Door leaves shall be 1/4 inch aluminum diamond pattern plate to withstand a live load of 300 pounds per sq. ft. Channel frames shall be 1/4 inches aluminum with an anchor flange around the perimeter. Provide 1-1/2 inch female NPT threaded aluminum drainage coupling welded under frame at right front corner for connection of drain pipe.

B. Door shall be equipped with 316 stainless steel hinges, a lockable hasp for use with a padlock, stainless steel pins, spring operator for easy operation and an automatic hold-open arm with release handle. Provide inside stainless steel snap locks with removable wrench lift handle outside. Furnish threaded aluminum plug to seal lock aperture. Hardware shall be cadmium plated.

C. Doors and frames shall be mill finish with bituminous coating applied to the exterior of the frame. Hatches shall have an odor resistant gasket.

D. Access hatches shall be furnished with a factory installed "Safe-Hatch" fall prevention system, as supplied by ITT Flygt Corporation, or equal. Safety grate shall be constructed of 6061-T6 aluminum and designed to withstand a live load of 300 pounds per sq. ft. and painted with a bright safety orange color. The grating shall completely cover the opening and be in conformance with OSHA Standard 1910.23 and controlled space entry per OSHA Standard 1910.146.

E. Contractor shall verify that identified hatch sizes are sized appropriately to allow removal of the largest piece of equipment/pump in the space.

F. All units will be set with a slight slope toward drain.

G. Furnish and install 1" diameter Schedule 80 PVC drainage pipe and fittings to gutter drainage coupling slope and route pipe to daylight or to the valve vault sump.

H. Initial series of hatches are provided on the drawings.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. Installation shall be in accordance with manufacturer's instructions.

B. Manufacturer shall guarantee against defects in material of workmanship for a period of five years.

C. Unit shall be set with slight pitch toward drain. Furnish and install 1" diameter schedule 80 PVC plastic drainage pipe and fittings to connect to gutter drainage coupling, set in concrete and run outside vault to daylight.

END OF SECTION

# DIVISION 9

# FINISHES

## SECTION 09961 - HIGH PERFORMANCE PAINTS AND COATINGS - WASTEWATER

## PART 1- GENERAL

### 1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the finishes as indicated on drawings and schedules, and as herein specified.

B. Work includes painting and finishing of interior and exterior exposed items and surfaces throughout project, except as otherwise indicated. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections of work.

C. Work includes field painting of exposed bare and covered pipes and ducts (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work, except as otherwise indicated. In addition, the Contractor shall provide for the use of deep tone colors to be applied in selected areas as wall graphics, stripes and visual accents. The areas and colors shall be selected by the Architect-Engineer and shall not exceed 15% of the total wall surface area to be painted.

D. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

E. Surfaces to be Painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect-Engineer will select these from standard colors or finishes available.

F. Following categories of work are not included as part of field- applied finish work.

1. Pre-Finished Items: Unless otherwise indicated, do not include painting when factory-finishing or installer-finishing is specified for such items as (but not limited to) toilet enclosures, prefinished partition systems, acoustic materials, architectural woodwork and casework, and finish mechanical and electrical equipment, including light fixtures, switchgear, and distribution cabinets.

2. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, and duct shafts.

3. Finished Metal Surfaces: Unless otherwise indicated, metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze and similar finished materials will not require finish painting.

4. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts will not require finish painting.

G. Following categories of work are included under other sections of these specifications.

1. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under various sections for structural steel, metal fabrications, hollow metal work and similar items.

2. Unless otherwise specified, shop priming of fabricated components such as architectural woodwork, wood casework and shop-fabricated or factory-built mechanical and electrical equipment or accessories is included under other sections of these Specifications.

H. Do not paint over any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

I. PVC plastic process piping shall not be painted, but shall be stenciled and labeled or tagged for identification surfaces. Each type of process piping using PVC pipe shall be installed using the same color pipe.

J. Repainting of existing structures, tanks, piping, and all other existing items shall not be part of this Contract unless otherwise noted or altered by this work. Areas that have been directly altered or damaged by construction shall be repainted to match existing conditions using the appropriate painting system. Repainting shall include the entire length of a system including piping, equipment, and accessories. Walls and structural items altered shall be painted for their entire length and height.

## 1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to Work of this Section.

## 1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical information including paint label analysis and application instructions for each material proposed for use. Provide MSDS sheets for each item submitted.

B. Samples: Prior to beginning work, submit color chips for surfaces to be painted. Use representative colors when preparing samples for review. Submit samples for Architect-Engineer's review of color and texture only. Provide a listing of material and application for each coat of each finish sample.

## 1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

B. Coordination of Work: Review other sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings systems for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

## 1.05 DELIVERY AND STORAGE

A. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:

1. Name or title of material.

2. Fed. Spec. number, if applicable.

3. Manufacturer's stock number, batch number, and date of manufacturer.

4. Manufacturer's name.

5. Contents by volume, for major pigment and vehicle constituents.

6. Thinning instructions.

7. Application instructions.

8. Color name and number.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage of paint in a clean condition, free of foreign materials and residue. Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

## 1.06 JOB CONDITIONS

A. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.

B. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.

C. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

D. Paint only when the surface temperature is at least 5 degrees F above the dew point, unless otherwise permitted by paint manufacturer's printed instructions.

# PART 2 - PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Tnemec Company, Inc. (Tnemec)

2. The Sherwin-Williams Company

## 2.02 MATERIALS

A. Material Quality: Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

B. Proprietary names used to designate colors or materials are not intended to imply that products of named manufacturers are required to exclusion of equivalent products of other manufacturers.

C. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.

1. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint by weight.

## PART 3 - EXECUTION

### 3.01 INSPECTION

A. Applicator must examine areas and conditions under which painting work is to be applied and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Applicator and coating manufacturer.

B. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.

C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

### 3.02 SURFACE PREPARATION

A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.

1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect-Architect-Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.

3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning per SSPC SP-1. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.

4. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.

5. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

B. Cementitious Materials: Per ASTM D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating, prepare cementitious surfaces of concrete block to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Per ASTM D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces, determine alkalinity of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and

burning of finish paint, correct this condition before application of paint. Test the surface for moisture and do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions. Concrete surfaces shall be prepared in accordance with SSPC-13 – Concrete Surface Preparation. Prepare concrete to remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall be similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.

C. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.

1. Prime, stain, or seal wood required to be job-painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling.

2. When transparent finish is required, use spar varnish for backpriming.

D. Ferrous Metals: Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, and other foreign substances by solvent cleaning per SSPC SP-1. Mechanical cleaning shall be in accordance with SSPC-SP6 Commercial Blast Cleaning specifications for non-immersion surfaces and SSPC-SP10 Near White Metal Blast Cleaning for immersion in potable or non-potable water.

E. Galvanized Surfaces: Clean free of oil and surface contaminants with non-petroleum based solvent.

F. Shop Primed Surfaces: Prepare shop-applied prime coats wherever damaged or bare as required by other sections of these Specifications. Clean and touch-up with same type shop primer.

## 3.03 MATERIALS PREPARATION

A. Mix and prepare painting materials in accordance with manufacturer's directions.

B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

## 3.04 APPLICATION

A. General: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Painting requirements, surface treatments, and finishes, are indicated in "schedules" of the contract documents and as noted in Paragraph 3.11 hereinafter.

2. Provide finish coats which are compatible with prime paints used.

3. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently- fixed equipment or furniture with prime coat only before final installation of equipment.

5. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.

6. Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.

7. Finish exterior doors on tops, bottoms and side edges same as exterior faces, unless otherwise indicated.

8. Sand lightly between each succeeding enamel or varnish coat.

9. Omit first coat (primer) on metal surfaces which have been shop-primed and touch-up painted, unless otherwise indicated.

B. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness (DFT) as indicated or, if not indicated, as recommended by coating manufacturer. Coatings to be in immersion or a severe environment shall be tested for dry film thickness. Testing shall be accomplished by methods recommended by coating manufacturer. Record DFT for each 100 square feet of surface area using the average of three readings within each 100 square feet. Additional coats of paint shall be applied where minimum DFT is not achieved.

D. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed in mechanical equipment rooms and in occupied spaces.

1. Mechanical items to be painted include, but are not limited to, the following:

   a. Piping, pipe hangers, supplementary steel and supports except galvanized surfaces.

   b. Heat exchangers.

   c. Tanks.

   d. Ductwork, insulation.

   e. Motor, mechanical equipment, and supports.

   f. Accessory items.

2. Electrical items to be painted include, but are not limited to, the following:

   a. Conduits and fittings except galvanized surfaces.

b. Switchgear.

c. Hanger and support except galvanized surfaces.

E. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn- through or other defects due to insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable. Holiday test coated steel in immersion areas in accordance with NACE International RP 0188-90.

G. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.

H. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

## 3.05 FIELD QUALITY CONTROL

A. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:

1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to project site will be taken, identified and sealed, and certified in presence of Contractor.

2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance and quantitative materials analysis.

B. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

## 3.06 CLEAN-UP AND PROTECTION

A. Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect-Architect-Engineer. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations. At completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

## 3.07 PAINTING SYSTEMS

Product names and numbers are based on Tnemec products.

A. Ferrous Metals - Structural, Tanks, Pipes and Equipment

1. Exterior, Non-Immersion

| | | Dry Mils |
|---|---|---|
| Sur. Prep.: | SSPC-SP6 Commercial Blast Cleaning | |
| 1st Coat: | 1 PurplePrime | 2.5 - 3.5 |
| 2nd Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |
| 3rd Coat: | 1074- Endura-Shield | 2.0 - 3.0 |

2. Interior, Non-Immersion

| | | |
|---|---|---|
| Sur. Prep.: | SSPC-SP6 Commercial Blast Cleaning | |
| 1st Coat: | 1 PurplePrime | 2.5 - 3.5 |
| 2nd Coat: | N 69 High-Build Epoxoline II | 4.0 - 6.0 |
| Finish Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |

3. Immersion, Potable or Non-Potable Water

| | | |
|---|---|---|
| Sur. Prep.: | SSPC-SP10 Near-White Blast Cleaning | |
| 1st Coat: | 1 PurplePrime | 2.5 - 3.5 |
| 2nd Coat: | N 69 High-Build Epoxoline II | 4.0 - 6.0 |
| 3rd Coat: | N 69 High-Build Epoxoline II | 4.0 - 6.0 |

4. Factory Primed Interior (Refer to Piping Specifications)

| | | |
|---|---|---|
| Sur. Prep.: | Surface shall be clean and dry | |
| Int. Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |
| Finish Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |

5. Factory Primed, Exterior (Refer to Piping Specifications)

| | | |
|---|---|---|
| Sur. Prep.: | Surface shall be clean and dry | |
| 1st Coat: | N69 Epoxoline II | 4.0 – 6.0 |
| 2nd Coat: | 1074- Endura-Shield | 2.0- 3.0 |

6. Primed Steel (Doors, Frames, etc.)

| | | |
|---|---|---|
| Touch up: | 1 Purpleprime | |
| 1st Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |
| 2nd Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |

7. Hydrogen Sulfide Exposed

| | | |
|---|---|---|
| Sur. Prep: | SSPC-SP5 | |
| 1st Coat: | 435 Perma-Glaze | 15.0 - 20.0 |
| 2nd Coat: | 435 Perma-Glaze | 15.0 - 20.0 |

B. Galvanized Steel - Pipe and Miscellaneous Fabrications

1. Exterior, Non-Immersion

| | | |
|---|---|---|
| Sur. Prep.: | SSPC-SP1 Solvent Cleaning and Etch | |
| 1st Coat: | N69 Epoxoline II | 2.0 - 3.0 |
| 2nd Coat: | 1074-Color Endura-Shield | 2.0 - 3.0 |

| | | Dry Mils |
|---|---|---|
| 2. Interior, Non-Immersion (Doors, Frames, etc.) | | |
| Sur. Prep.: | SSPC-SP1 Solvent Cleaning and Etch | |
| One Coat: | N69 Epoxoline II | 2.0 - 3.0 |
| 2nd Coat: | N 69 High-Build Epoxoline II | 2.0 - 3.0 |
| 3. Immersion, Potable or Non-Potable Water | | |
| Sur. Prep.: | SSPC-SP1 Solvent Cleaning followed by abrasive blast | |
| 1st Coat: | N69 Epoxoline II | 3.0 - 5.0 |
| 2nd Coat: | N69 Epoxoline II | 4.0 - 6.0 |

C. Porous Masonry - Concrete Masonry Units

| | | |
|---|---|---|
| 1. Interior | | |
| Sur. Prep.: | Surface shall be clean and dry | |
| 1st Coat: | 130 Envirofill | 80 - 100 sf/gal. |
| (Spray & Back Roll to Fill Porosity) | | |
| 2nd Coat: | 84 Ceramlon ENV | 4.0 - 6.0 |
| 3rd Coat: | 84 Ceramlon ENV | 4.0 - 6.0 |

D. Cast-In-Place Concrete

1. Concrete Walls & Precast Concrete Ceilings (Interior)

Sur. Prep.: Abrasive Blast (SSPC-SP13 ) Fill bugholes and voids with coating manufacturer's epoxy filler.

| | | |
|---|---|---|
| 1st Coat: | N69 Epoxoline II | 4.0 - 6.0 |
| 2nd Coat: | N69 Epoxoline II | 4.0 - 6.0 |

2. Concrete Walls, Tanks and Basins (Exterior, Exposed)

| | | |
|---|---|---|
| Sur. Prep.: | Abrasive Blast (SSPC-SP13, Severe Service) Fill bugholes and voids with coating manufacturer's epoxy filler | |
| 1st Coat: | Series 156 Enviro-Crete | 125 sf/gal. |
| 2nd Coat: | Series 156 Enviro-Crete | 200 sf/gal. |

3. Concrete Floors (Interior, Heavy Traffic and Chemical Exposure)

| | | |
|---|---|---|
| Sur. Prep.: | SSPC-SP 13/NACE 6 | |
| Primer: | 237 Power-Tread, double broadcast | 1/8 inch |
| 1st Coat: | 280 Tneme-Glaze | 6.0 – 8.0 |
| 2nd Coat: | 290 CRU | 2.0 – 3.0 |

4. Concrete Tanks & Basins (Immersion and Exposed, Interior)

| | | |
|---|---|---|
| Sur. Prep.: | Abrasive Blast (SSPC-SP13, Severe Service) Fill bugholes and voids with recommended coating manufacturer's epoxy filler. | |
| 1st Coat: | N69 Epoxoline II | 3.0 - 5.0 |
| 2nd Coat: | N69 Epoxoline II | 4.0 - 6.0 |
| 3rd Coat: | N69 Epoxoline II | 4.0 - 6.0 |

| | | Dry Mils |
|---|---|---|
| 5. Chemical Containment Areas | | |
| Sur. Prep.: | Abrasive Blast (SSPC-SP13, Severe Service) Fill bugholes and voids with recommended coating manufacturer's epoxy filler. | |
| 1st Coat: | 201 Epoxoprime | 6.0 - 8.0 |
| 2nd Coat: | 275 Stranlock | 25.0 – 40.0 |
| Finish Coat: | 282 Tneme-Glaze | 8.0 – 12.0 |
| 6. Concrete Tanks and Basins (Below Grade) | | |
| Sur. Prep.: | Abrasive Blast (SSPC-SP13,) Clean and Dry | |
| 1st Coat: | 46 H – 413 Hi-Build Tneme-Tar | 14.0 - 20.0 |
| 7. Concrete Tanks & Basins (Hydrogen Sulfide Exposed) | | |
| Sur. Prep.: | Abrasive Blast (SSPC-SP13, Severe Service) | |
| 1st Coat: | 218 MortarClad or 219 MortarCast | 1/8" to 1/4" |
| 2nd Coat: | 434 Perma-Shield H2S | 125 mils |
| 3rd Coat: | 435 Perma-Glaze | 15.0 - 20.0 |

E. Wood

Interior or Exterior

| | | |
|---|---|---|
| Sur. Prep.: | Surface shall be clean and dry | |
| 1st Coat: | 151-1051 Elasto-Grip FC | 1.0 - 1.5 |
| 2nd Coat: | 29 Tufcryl | 2.0 - 3.0 - 3.5 |
| 3rd Coat: | 29 Tufcryl | 2.0 - 3.0 |

F. Insulated Pipe

| | | |
|---|---|---|
| Sur. Prep.: | Surface shall be clean and dry | |
| 1st Coat: | 6-Color Tneme-Cryl | 2.0 - 3.0 |
| 2nd Coat: | 6-Color Tneme-Cryl | 2.0 - 3.0 |

G. Gypsum Board

1. Interior Drywall - Architectural

| | | |
|---|---|---|
| Sur. Prep.: | Surface shall be clean and dry | |
| 1st Coat: | 151-1051 Elasto-Grip FC | 1.0 - 1.5 |
| 2nd Coat: | 6-Color Tneme-Cryl | 2.0 - 3.0 |

2. Interior Drywall - Severe Exposure

| | | |
|---|---|---|
| Sur. Prep.: | Surface shall be clean and dry | |
| Prime Coat: | 151-1051 Elasto-Grip FC | 1.0 - 1.5 |
| 1st Coat: | 113 H.B. Tneme-Tufcoat | 2.0 - 3.0 |
| 2nd Coat: | 113 H.B. Tneme-Tufcoat | 2.0 - 3.0 |

H. PVC Piping – **Do Not Paint**

I. Aluminum Windows, Doors, Handrails & Grating – **Do Not Paint**

J. Fiberglass Reinforced Plastic Doors & Windows – **Do Not Paint**

## 3.08 PIPING COLOR CODE

To facilitate identification of piping in plants and pumping stations it is recommended that the following color scheme be utilized:

| | |
|---|---|
| \WATER LINES | |
| Raw Water | Olive Green |
| Settled Water | Light Blue |
| Filtered or Finished Water | Dark Blue |
| CHEMICAL LINES | |
| Acid | Red |
| Ammonia | White |
| Caustic | Yellow w/ green band |
| Chlorine | Yellow |
| Coagulant | Orange |
| Fluoride | Light Blue w/ red band |
| Polymer | Orange w/ green band |
| WASTE LINES | |
| Overflow (Backwash waste) | Light Brown |
| Sewer (Sanitary or Other) | Dark Gray |
| OTHER | |
| Compressed Air | Dark Green |
| Other Lines | Light Gray |

## 3.09 STENCILING

A. The Contractor shall supply all materials and labor necessary for stenciling of legends on pipes. The legend shall show the name of the contents. Review by the Architect-Engineer of legends will be required. Names shall be "plainly visible". Arrows showing direction of flow shall also be stenciled on pipes. The legends shall be located not more than 10 feet apart and, in general, at each valve and piece of equipment. The size and location of the legend shall be in general accordance with ANSI A13.1-1981 "Scheme for the Identification of Piping Systems". All visible piping 6" in diameter and larger shall be color-coded and stenciled. "Stick-on" labels are not acceptable.

## 3.10 PLASTIC IDENTIFICATION MARKERS

A. All visible piping 3/4" and greater and less than 6" which is accessible for maintenance operations shall be color-coded and identified with semi-rigid plastic identification markers equal to SETMARK Pipe Markers as manufactured by Seton Name Plate Corporation, New Haven, Conn.; T & B/Westline, Los Angeles, California; or equal. Direction of flow arrows are to be included on each marker, unless otherwise specified.

B. Each marker background is to be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ANSI A 13.1 - 1981).

C. For pipes under 3/4" O.D. (too small for color bands and legends), brass identification tags 1-1/2" in diameter with depressed 1/4" high black-filled letters above 1/3" blackfilled numbers shall be fastened securely at specified locations.

D. All electrical conduits, which are accessible for maintenance operations, shall be identified with semi-rigid identification markers similar to those specified above.

E. Each marker background is to be color-coded with a clearly printed legend to identify the conductor. Size of markers and sizes of lettering to generally conform with the "Scheme for Identification of Piping Systems" (ANSI A 13.1 - 1981)

F. Locations for pipe and electrical markers to be as follows:

1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
2. At each branch and riser take-off.
3. At each pipe passage through wall, floor and ceiling construction.
4. At each pipe passage to underground.
5. On all horizontal pipe runs-marked every 25 feet.

## 3.11 PAINT SCHEDULE

All items at the Project site shall be painted in accordance with these Specifications and Drawings. The following paint schedule is provided only to assist the Owner and Contractor in selection of the appropriate paint system and is not intended to be a complete list of items to be painted.

Repainting of existing structures, tanks, piping, and all other existing items shall be part of this Contract.

A. Paint Application Schedule

| Location and/or Description | System |
|---|---|
| 1. All Structures | |
| a. Aluminum/FRP Doors and Frames, Exterior | Do not Paint |
| b. Aluminum/FRP Doors and Frames, Interior | Do not Paint |
| c. Cast-in-Place Concrete Walls/Floors | Do not Paint |
| d. Cast-in-Place Concrete – Wetwell Area | Do not Paint |
| e. Exterior, Non-Immersion | A.1, A.5 |
| f. Ferrous Metals – Interior, Non-Immersion | A.2, A.4 |
| g. Ferrous Metals – Immersion | A.3 |
| h. Wood | E.1 |
| i. Aluminum Hatches | Do not Paint |
| j. Pumps | Do not paint |
| k. Pipes/Valves Interior, Non-Immersion | A.2, A.4 |
| l. Pipes/Valves - Immersion | A.3 |
| m. Pipes/Valves - Exterior, Non-Immersion | A.1, A.5 |

| | |
|---|---|
| n. Electrical conduit, Cabinets, and equipment | Do not paint |

END OF SECTION

# DIVISION 10

# SPECIALTIES

## SECTION 10441 - FIRE EXTINGUISHERS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

### 1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.03 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Six years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

### 2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen's Model MP20 Steel Cylinder fire extinguisher or comparable product by one of the following:

a. Ansul Incorporated.

b. Buckeye Fire Equipment Company.

c. Guardian Fire Equipment, Inc.

d. JL Industries, Inc.; a division of the Activar Construction Products Group.

2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 10A-120B:C nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

## 2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen's Model 864 mounting bracket or comparable product by one of the following:

a. Ansul Incorporated.

b. Buckeye Fire Equipment Company.

c. Guardian Fire Equipment, Inc.

d. JL Industries, Inc.; a division of the Activar Construction Products Group.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Horizontal.

## PART 3 - EXECUTION

## 3.01 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction. One (1) required – Electrical Building.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated, with appropriate fasteners.

END OF SECTION

# DIVISION 11

# EQUIPMENT

## SECTION 11133 - SUBMERSIBLE SUMP PUMPS – VALVE VAULT

## PART 1 - GENERAL

### 1.01 REQUIREMENTS

A. The Contractor shall furnish and install submersible non-clog sump pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the general requirements of these contract documents.

### 1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Sump Pump Schedule:

| Item | Fill Vault Sump Pump | Valve Vault 36" Force Main Control |
|---|---|---|
| Arrangement | Simplex | Simplex |
| Design Capacity (gpm)* | 57 | 57 |
| Total Dynamic Head (ft.) | 20 | 20 |
| Motor Horsepower | ½ | ½ |
| Max. Pump Speed (rpm) | 3,450 | 3,450 |
| Min. Size of Solids (in.) | ¾" | ¾" |
| Discharge Diameter (in.) | 1.5" | 1.5" |
| Area Classification | Class 1, Division 2, Group D | Class 1, Division 2, Group D |

### 1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals:

1. Equipment and motor nameplate data
2. Complete electrical schematic wiring diagram drawings.
3. Copies of certified shop test reports.
4. Spare Parts List
5. Field test results.
6. Certificates of installation.
7. Operation and Maintenance Manuals

## 1.03 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 01782 with the exception that the warranty period shall be for two (2) years.

## PART 2 - PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

A. The pumps shall be submersible sewage pumps as manufactured by Hydromatic, Myers,Zoeller, or equal.

## 2.02 MATERIALS

A. Pump Construction - The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48-Class 25 through 35. All exposed nuts, bolts, washers, and other fastening devices shall be Type 304 stainless steel.

B. Casing shall be completely open from suction to discharge with no wearing rings or impeller faceplates required. All internal case clearances shall be equal to the inlet diameter so that all materials which will pass through the inlet can pass through the pump.

C. Impeller shall be of either the flow through or recessed design. The impeller shall be secured to the motor shaft per manufacturers recommendations.

D. Shafting shall be constructed of high grade carbon steel, Grade 1045 (minimum), for the pump and motor, and sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat-treated, turned, ground, and polished over its entire length. The shaft shall be protected from wear through the seal box by a removable hardened 416 stainless steel shaft sleeve with seal to prevent leakage under the sleeve.

E. Shaft Seal for the pump and motor shaft shall utilize a mechanical seal. The mechanical seal shall consist of carbon and ceramic seal faces running in an oil-filled chamber to provide constant lubrication, BUNA N or ethylene propylene flexible members, brass or stainless steel metal parts and 18-8 stainless steel spring.

F. Bearings shall be of the anti-friction ball or roller type. Bearings shall be heavy-duty, permanently oil lubricated which will carry all radial and axial thrust loads. Bearings shall have a minimum AFBMA L-10 life of 30,000 hours under worst possible operating conditions.

## 2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. All electrical appurtenances shall be rated for installation in classified areas as indicated in the Sump Pump Schedule.

B. Motors shall conform to all applicable parts of Section 16220. The pump motor shall be designed for 115 volt, 60 Hertz, single-phase operation. See sump pump schedule for motor horsepower. Motors shall be mounted on each pump and shall conform to the latest applicable NEMA, IEEE, and ANSI standards for submersible service. The motors shall be rated for continuous duty with a minimum service factor of 1.15.

1. The pump motor shall be squirrel-cage induction type, housed in a watertight chamber.

2. The stator winding and stator leads shall be moisture resistant.

3. Insulation shall be manufacturer's premium grade Class F insulation rated 155 degrees Celsius, 40 degrees Celsius ambient plus 115 degrees Celsius rise. The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing.

4. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.

5. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of ten (10) starts per hour without overheating.

6. The motor shall be provided with pre-lubricated radial and thrust bearings which are designed to carry the entire load which may be imposed upon it under all operating conditions.

7. All motors shall be of nationally known manufacture and shall be housed in enclosures specifically designed for submersible pump application.

C. The cable entry water seal design shall insure a watertight and submersible seal.

1. The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression O-ring seal.

2. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board and thus perfectly leak proof.

D. Power cable between the pumps and the local manual starter shall be provided by the pump manufacturer who shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same application shall be provided with the same length of cable. No splices shall be allowed unless specifically called for in the electrical drawings. Cable shall be hypalon jacketed SPC cable suitable for submersible pump applications and shall be sized according to NEC and ICEA standards. Stainless steel strain relief connectors shall be furnished for all cables.

E. Float switches shall be integral with the pump.

## 2.05 SPARE PARTS

A. Spare parts shall be provided in accordance with these contract documents and shall include the following for each size pump:

Two (2) - sets of seals, "O" rings
One (1) – spare pump

# PART 3 - EXECUTION

## 3.01 SHOP TESTING

A. Shop testing shall be in accordance with applicable standards and with the following additional requirements:

1. Prior to shipment, Manufacturer shall submit certified pump curve for each pump for approval.

## 3.02 FIELD TESTING

A. Field testing shall be in accordance with Section 01400 and these contract documents.

END OF SECTION

## SECTION 11252 - VERTICAL MOUNTED MECHANICAL SCREEN

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

Scope: The contractor shall furnish, install and place into satisfactory operating condition, one (1) vertical mount deflection screens. Each screen shall consist of a screen frame, bar rack assembly, cleaning carriage assembly, overflow weir, hydraulic power pack, external supports and controls, and all other appurtenances required or shown on the drawings.

### 1.02 DESIGN CRITERIA

| | | |
|---|---|---|
| Number of screens | 1 | |
| Designed for a peak flow $Q_{max}$ of: | 57 | MGD |
| Total unobstructed open screening area: | 24 | sf |
| Bar Screen opening: | 4 | mm |
| Max Screen length: | 29 | ft |
| Screen height: | 2.33 | ft |
| Max velocity through open area at peak flow: | 5 | ft/s |

### 1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with these specifications shall be submitted for review. Submittals shall include at least the following:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with each paragraph check-marked to indicate specifications compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. I deviation from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. **Failure to include a copy of the marked-up specifications sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.**
2. Certified general arrangement drawings showing all important details including materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
3. Descriptive literature, bulletins and/or catalogs of the equipment.
4. Complete data on motors and gear reducers.
5. Wiring diagrams and electrical schematics for all control equipment to be furnished.

### 1.04 EXPERIENCE AND QUALIFICATON

A. To show evidence of being able to provide the quality of equipment and services described in this specification, the equipment supplier shall submit their quality system ISO 9001 certification. The quality procedures shall provide for a means of qualifying all sub-vendors and shall specify that the fabrication facility is a critical vendor and shall require inspection. The quality system shall be audited by a third party independent inspector. Certification shall remain in effect throughout the project startup.

B. Due to the special importance of proper functioning of the equipment specified in this section to the satisfactory operation of the entire treatment system, the Contractor shall demonstrate in writing, to the satisfaction of the Owner at the time of the shop drawing submittal that the manufacturer has produced the specified type and size of equipment for CSO service that has been in successful operation for a minimum period of five years prior to the bid date.

C. In the event the Contractor elects to install equipment whose manufacturer cannot comply with the above experience requirement, then the Contractor shall submit with shop drawings, appropriate bonds or deposits guaranteeing replacement of the equipment in the event of a failure for a period of three years after warranty: Such three-year period shall start upon termination of the Contractor's basic warranty and guarantee obligations under the Contract.

D. During such three-year period the Contractor shall repair, modify or replace the equipment in a manner acceptable to the Owner, if in the opinion of the Owner, the operation of the equipment is unsatisfactory.

1. Normal wear or malfunctions due to neglect or abuse will not be considered justifiable reasons for unsatisfactory operation.

2. In the event the Owner determines the operation of the equipment to be unsatisfactory during this three year period and the Contractor fails to correct the deficiencies within six months from the time the Contractor is first notified in writing that such deficiencies exist, the Owner will make the necessary repair or replacement and deduct such costs from the aforementioned bonds or deposits of the Contractor.

## PART 2 PRODUCTS

### 2.01 MANUFACTUER

A. The mechanical screening equipment manufacturer and model shall be the following:

1. WesTech CleanFlo™ ROMAG Screens Model RSW 6 x 8/4.

### 2.02 GENERAL DESIGN

A. Functional Description: The influent stream to be screened will be introduced to the screen during wet weather event. Solids will be retained in the normal wastewater channel and will be carried away with the wastewater to a downstream treatment facility. Screened overflow will be discharged as outfall to a receiving body of water.

B. Materials of Construction: All wetted parts shall be constructed from high strength plastic or stainless steel. Electrical devices, motor and power packs shall be of the manufacturer's standard materials.

C. Shop Surface Preparation/Coating: All welds shall be cleaned and passivated to remove weld spatter, slag and discoloration. Electrical devices, motor and power packs shall be provided with the manufacturer's standard coating system.

### 2.03 FINE SCREEN ASSEMBLY

A. Frame: The screen frame shall be a rectangular support structure that provides stability for the screen, the required mounting surface for the bar rack assembly, and the guiding surfaces for the traveling cleaning carriages.

1. The unit frame shall be designed to be anchored at the base and sides of the screen. The frame will be a welded construction, fabricated of formed stainless sheet and plate from type 304L stainless steel.

2. One side member will be drilled and tapped for mounting of the stationary end of the bar rack assembly.

3. A machined mounting block will be welded to the opposite side member for mounting of the tensioning end of the bar rack assembly.

B. Control Weir:

1. The control weir shall be fastened to the discharge side of the screen to provide the desired water elevation and flow velocity through the screen.
2. The weir shall be constructed of type 304L stainless steel.

C. Bar Rack Assembly:

1. The bar rack assembly will consist of parallel stainless steel bars secured to the screen frame with specially designed end blocks. Spacing between each bar will be 4 mm (0.16 inch).

2. Each bar will be made of minimum 4 mm (0.16 inch) type 304L stainless steel and will be continuous from one end of the screen to the other. Designs without continuous bars will not be allowed.

3. The end sections of each bar will be designed to facilitate the removal of solids from the bar rack. A hole will be drilled at both ends of each bar to allow the bars to be secured to the end blocks.

4. Modular end blocks will be made from type 304L stainless steel. Each end block will be machined to secure a set of bars to the screen frame. Bars will be fastened to each end block with a stainless steel pin connection. Modular end blocks will be stacked to provide the necessary screen height.

5. Stationary end blocks will be provided at the fixed end of the bar rack assembly. These end blocks will be fastened directly to the screen frame.

6. Tensioning end blocks will be provided at the opposite end of the bar rack assembly. Tensioning end blocks will be a floating-type connection to be tensioned after securing the frame to the concrete structure. As torque is increased on the bolts, the tension end blocks will be pulled, creating the required pre-tension on the bars.

7. Designs which do not incorporate a bar tensioning feature are specifically excluded.

D. Cleaning Carriage Assembly:

1. The cleaning carriage will consist of sets of cleaning tines mounted on a traveling carriage assembly. Travel of the carriage assembly will be provided by a hydraulic cylinder. Each set of cleaning tines will travel forward and backward across a section of the screen length. The travel distance of each set of cleaning tines will overlap the travel distance of the adjoining set. The shape of the tines will be designed to move accumulated solids forward during forward travel of the carriage, and to allow accumulated solids to pass over during backward travel of the carriage assembly. The travel distance overlap and tine shape will allow solids to be transported to the end of the screen.

2. The carriage assembly will consist of tine support members fastened together by cross-member angles. Slide blocks mounted on the carriage assembly will guide the travel of the carriage.

3. Each tine support member will be fabricated of type 304L stainless steel angles welded to each side of a type 304L stainless steel structural tube. The flanking angles will provide a mounting surface for the cleaning tines. Mounting tabs will be welded to the tube for attachment of the cross-member angles.

4. The cross-member angles will be structural angles made of type 304L stainless steel. Both cross-member angles will be fastened to the top and bottom of all tine support members to provide an integral carriage assembly. A mounting bracket will be welded to the top cross-member to provide a clevis-type mount for the rod end of the hydraulic cylinder.

5. Slide blocks made of UHMW polyethylene will be fastened to the top and bottom cross-member angles.

E. Cleaning Tines:

1. Cleaning tines will be provided in replaceable sections. The standard cleaning tine section will be machined from a block of UHMW polyethylene.

2. The end cleaning tine sections will consist of individual tines fastened to a UHMW PE mounting block. Each individual tine will be made of alloy bronze. The extended shape of the end tine will push accumulated solids past the end of the bars.

F. Overflow Weir:

1. A stainless steel overflow weir will be fastened to the top of the screen frame. It will provide protection of the hydraulic cylinder and ensure that emergency overflow water flows smoothly over the top of the screen into the outfall channel.

2. The overflow weir, fabricated of type 304L stainless steel, will extend the length of the screen. In the width direction, the shroud will extend beyond the cleaning carriage assembly.

G. Hydraulic Cylinder:

1. A stainless steel hydraulic cylinder will be mounted above the carriage assembly. The housing of the cylinder will be secured to the screen frame, while the rod end will be pinned to the clevis bracket on the top cross-member of the carriage assembly.

2. The piston rod will be made of hard chrome plated carbon steel. The rod end will be supplied with an eye bolt fitted with a bronze bushing. The rod end will be connected to the clevis bracket with a stainless steel pin, secured by two (2) cotter pins.

H. Hydraulic Hoses:

1. Four (4) 48 inch long hydraulic hose pigtails will provided by the screen manufacturer.

2. The hose will be rated for 4250 psi, made from synthetic rubber tube with double braid wire reinforcement and synthetic rubber cover.

3. The nominal inside diameter will be 0.45 inch and the end fittings will be #8 (FJIC) female swivel, stainless steel.

I. Hydraulic Tubing:

1. The contractor shall provide 5/8-inch diameter stainless steel tubing with operating pressure no less than 3000 psi for connection to the screen and to the hydraulic power pack, including all connectors and anchors required to support the hydraulic lines. The tubing as well as its support system will be made of stainless steel. Tube connections shall be JIC fittings.

J. Hydraulic Power Pack:

1. The hydraulic cylinder will be driven by a remote- mounted hydraulic power pack. The hydraulic power pack will be mounted indoors and protected from freezing and the weather. The hydraulic power pack will include the following:

    a. Hydraulic gear pump
    b. Replaceable suction filter
    c. 5 HP, 1800 RPM, 230/460 volt, 3 Phase, 60 Hz, TEFC, severe duty electric motor.
    d. 10 gallon capacity oil reservoir
    e. 0-3000 psi pressure gauge
    f. Pressure transducer, 4-20 mA, NEMA 4 enclosure.
    g. Pressure limiting/relief valve
    h. Directional control valves, 4 way, 3 position, double solenoid, spring return to all ports, Burna seals, 120 VAC coils, ½" NPT conduit box rated for NEMA 4.
    i. Replaceable oil filter
    j. Filler/breather cap with strainer
    k. Temperature switch, SPDT, snap action switching element, NEMA 4 enclosure.
    l. Oil Level switch.
    m. The hydraulic pressure of the cleaning carriage cylinder will be monitored by a pressure transducer which will produce an analog signal that will be sent to the PLC in the control panel.
    n. The oil reservoir will be constructed of welded carbon steel and provided with a gasket bolt-on lid.
    o. Hydraulic fluid shall be supplied and as recommended by the screening manufacturer.
    p. Viscosity @ 40°C shall be no less than 26.9 centistokes.
    q. Viscosity @ -40°C shall be no less than 85.0 centistokes.

K. External Supports:

1. External supports will be furnished by the equipment supplier to provide structural stability for the screen.

2. The supports will be made from type 304L stainless steel structural tubing. Support locations, lengths and means of attachment shall be as per the manufacturer's recommendations.

L. Spare Parts: The following spare parts will be furnished:

1. Two (2) Cleaning Tine Sections (Standard)
2. Two (2) Cleaning Tine Section (End)
3. Two (2) oil filters

## 2.04 ANCHORAGE AND FASTENERS

A. Anchor Bolts: All anchor bolts shall be a minimum of 1/2 inch diameter and made of type 304L stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.

B. Fasteners: All fasteners shall be type 18-8 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

## 2.05 CONTROLS

A. Control Devices: All controls necessary for the fully automatic operation of the screen shall be provided. The equipment supplier shall furnish all electrical items specifically called for in this specification section. The contractor shall supply all other electrical items, and interconnecting wiring of proper size, including all conduit and supports required to place the equipment into service. The interior of the diversion structure is a Class 1, Division 1, Group C and D hazardous atmosphere. All equipment shall be rated appropriately.

B. Ultrasonic Level Controller: A 120V controller shall be provided in a windowed NEMA 4X polycarbonate enclosure suitable for wall mounting, to receive and interpret a 4-20mA scaled signal from an upstream and downstream transducer. The controller shall have 6 internal relays and provide an LCD display and handheld programmer for use interface.

C. Ultrasonic Level Transducer: One (1) ultrasonic level transducer shall be provided with type 304 stainless steel mounting brackets and expansion anchors. Each sensor shall have an ETFE housing with an integral sensor to provide compensation for acoustic variations due to temperature. Each sensor shall have a range of 1-33 ft and be supplied with a 30 ft integral cable. Interconnecting cable between the sensors and the ultrasonic level controller must be 3-wire shielded cable, run through a separate raceway.

D. Control Panel: A 460 volt primary control panel will be provided in a NEMA 4X, type 304L stainless steel enclosure. A 460 volt main disconnect switch, a non-reversing motor starter, and a 460 to 120 volt step down transformer will be provided in the panel. The panel will contain the following logic devices for proper operation of the equipment:

1. Indicating Lights, push-to-test LED type:

    a. Oil Temperature FAULT
    b. Low Oil Level FAULT
    c. Screen RUNNING
    d. Carriage Stroke Reduced FAULT
    e. Carriage Blocked FAULT
    f. Loss of Pressure Signal FAULT
    g. Motor Overload FAULT
    h. High Screen Level FAULT

2. Pushbuttons:

    a. EMERGENCY STOP
    b. FAULT RESET

3. Programmable Logic Controller, Allen Bradley CompactLogix type with Operator Interface Unit, Allen Bradley Panelview C400. Micrologix is prohibited.

4. Elapsed Time Meter.

5. Outputs for connection to SCADA via Ethernet Communications drop:

    a. Motor running.
    b. Motor overload.
    c. High oil temperature.
    d. Low oil level.
    e. E-stop.
    f. Carriage stroke reduced.

g. Carriage blocked.
h. Loss of pressure signal.

6. Mount controls so that they avoid the Class 1, Division 2, Group C & D hazardous atmosphere.

E. SEQUENCE OF OPERATION

6. Screen Hand Operation: When the screen selector switch is in the Hand position, the screen will run continuously forward and backward. Turning the screen selector switch to Off will return to home position and stop the unit.
7. Screen Automatic Operation: When the screen selector switch is in the Auto position, the screen will cycle on demand by the level sensor or repeat cycle timer. After the level sensor condition has cleared, the screen shall continue to run for an off delay time to prevent excessive starting and stopping of the unit. The repeat cycle timer shall reset after the screen is called to run by the level sensor. During each stop, the carrier will return to its home position.
   a. Upper level sensor initiates travel of assembly
   b. Assembly travels continuously until lower level sensor detects a low water level. Assembly continues to run 0 to 15 minutes (as set by the off-delay timer).
   c. In order to ensure that the screen is operational a the time of a rain event, it is automatically put into operation every week for 5 minutes. If a failure occurs, an alarm will be reported.
8. Fault Conditions:
   a. Excessive motor current will trip the starter overload relays, immediately stop the power pack motor, and illuminate the alarm indicating light. This fault must be reset by depressing the motor starter overload reset internal to the control panel.
   b. Momentary motor over current will trip the current monitor, immediately stop the drive motor, and illuminate the alarm indicating light. Pushing the reset pushbutton will reset this fault.
   c. High Oil Temperature. If the oil temperature exceeds 140° F, the high temperature will close, the screen will shut down and the illuminate the High Oil Temperature fault light. When the oil temperature cools below 140° F, the screen starts again. The high temperature fault light remains illuminated until acknowledged.
   d. Low Oil Level. If the oil level in the reservoir drops below the low level switch, the switch will close, the screen will shut down and illuminate the Low Oil Level fault light.
   e. Carriage Stroke Reduced Fault. The pressure transducer mounted on the hydraulic power pack will continuously monitor the operating pressure of the unit. The pressure transducer will output a 4-20 mA signal. If the pressure spikes five (5) times in 10 second (adjustable) period, the screen will shut down and illuminate the Carriage Stroke Reduced Fault light.
   f. Carriage Blocked Fault. If the preset maximum pressure measured by the pressure transducer is maintained for longer than 30 seconds, the screen will shut down and illuminate the Carriage Blocked Fault light.
   g. Loss of Pressure Signal Fault. If the control panel does not receive a 4-20 mA signal from the pressure transducer for 2 minutes the screen will shut down and illuminate the Loss of Pressure Signal Fault.
   h. High Screen Level Fault. If the water level during a bypass condition exceeds a pre-set level, the screen will shut down and illuminate the High Screen Level Fault.
   i. All faults may be reset by pressing the FAULT RESET push button after the cause of the fault is corrected.

## PART 3 EXECUTION

### 3.01 GENERAL

The equipment shall be installed properly to provide a complete working system. Installation shall follow the supplier's recommendations. Take great care to keep the hydraulic tubing for the hydraulic power pack free from debris during installation.

A. Contractor shall coordinate with the screen manufacturer to provide the exact dimensions of the screen openings required for proper installation.

B. The concrete dimensions and tolerances, and concrete finish as shown on the Contract Drawings are required for the proper installation and operation of the screening system. No deviations will be permitted from the dimensions and tolerances on the approved drawings.

C. The supplier shall be responsible for programming the PLC, and shall coordinate with the System Integrator to establish communications and data exchange with the plant SCADA system.

### 3.02 HYDRAULIC TUBING INSTALLATION

A. All turns shall be made with long radius bends and not 90 degrees. Tube connections shall be JIC fittings.

B. Do not use Teflon Tape on any connection for hydraulic piping. Use only pipe dope suitable for use with hydraulic oil.

C. Provide a continuous fall in tubing from the power pack to the screen. No high spots in the tubing are allowed, which can trap air. If high spots are unavoidable, provide air bleed devices at each high point in the line.

D. Secure tubing and hoses to prevent movement.

E. Flush hydraulic lines to prevent dirt and metal shavings from fouling the hydraulic system. Cap all ends to prevent dirt from contaminating tubing lines. Upon completion of all field tubing, but before connection to control components, clean the tubing system by circulating oil continuously at a rate of not less than 12 fps. Filter the hydraulic oil through a 2 micron filter for a period of not less than 24 until the filter fails to retain any particulate material during a filter run o not less than 1 hour duration, whichever is the greater period of time.

F. Proper precautions should be taken to avoid contamination of hydraulic lines and equipment during storage and installation.

### 3.03 MANUALS

The equipment supplier shall furnish digital and hardcopy copies of operation and maintenance manuals which will be retained at the installation site to assist plant operators. The manual shall include the supplier's erection and assembly recommendations, operation and maintenance procedures, a complete parts list, and a list of recommended spare parts. All manuals shall be prepared in accordance with Section 01780, Operation and Maintenance Manuals.

### 3.04 SHOP ASSEMBLY

The equipment specified herein shall be completely factory assembled and inspected prior to shipment.

## 3.05 FIELD SERVICES

A. The equipment supplier shall provide the service of a qualified representative for three (3) trips and four (4) days to inspect the equipment installation, assist in start-up, and instruct plant personnel in the proper operation and maintenance of the equipment.

B. The qualified representative shall spend a minimum of eight (8) hours in training of plant personnel.

C. Perform operating tests to demonstrate the units turn on and off based on the required level sensor settings and that the equipment operates without excessive vibration. Make adjustments required to place equipment in proper operating condition. Submit report of test results.

END OF SECTION

## SECTION 11285 - SLIDE GATES

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Gates shall be furnished with all necessary accessories for a complete installation and shall be the latest standard products of a manufacturer regularly engaged in the production of equipment of this type. All slide gates shall be furnished by the same manufacturer.

### 1.02 SUBMITTALS

A. Descriptive literature, catalog cuts, and dimensions all prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein.

B. Comply with the requirements of Section 01300.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURER

A. Gates shall be base bid Series 25 (Channel Gates) and Series 20 (Sluice Gates) as manufactured by H. Fontaine Ltd., Waterman, or equal. See Bid Form for base bid details.

### 2.02 STAINLESS STEEL SLUICE GATES

A. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the Drawings, specified herein, or otherwise required for a complete properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of stainless steel water control gates.

B. Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA C501 (latest edition).

C. Gates shall be substantially watertight under the design head conditions (maximum design head shall be taken as the height of the slide unless otherwise specified). Leakage shall not exceed 0.05 gallon per minute per foot of seal periphery under the design seating head and 0.10 gallon per minute per foot of seal periphery for the design unseating head of under 20 feet. For an unseating head of 20 feet or more, the maximum allowable leakage shall not exceed the rate per foot of perimeter specified by the following equation:

*Gallon per minute per foot of perimeter = 0.10 + [0.0025 x (unseating head in feet – 20)]*

The gate's sealing system shall have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration. Certification of this testing shall be provided to the Engineer or Owner upon request.

D. Gates shall be self-contained of the rising stem configuration. Self contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

E. Gate frames shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be suitable for mounting on a concrete wall at the

end of a pipe opening. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the tope and side seals without removing the gate frame from the wall.

F. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.

G. The guides shall be made of UHMWPE and shall be of such length as to retain and support at least two-thirds (2/3) of the vertical height of the slide in the fully open position.

H. The side seals for gates shall be made of UHMWPE of the self-adjusting type. A compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only below the slide plate. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

I. The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lb. effort on the crank or handwheel. The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type. Where an electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the electric motor in the stalled condition. For stems in more than one piece and with a diameter of 1¾ inches and larger, the different sections shall be joined together by solid couplings. Stems with a diameter smaller than 1¾ inches shall be pinned to an extension tube. The couplings shall be grooved and keyed and shall be of greater strength than the stem.

J. Gates having width equal to or greater than two (2) times their height shall be provided with two (2) lifting mechanisms connected by a tandem shaft.

K. Stem guides shall be fabricated from type 304L stainless steel and shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/R ratio shall not be greater than 200.

L. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

M. Manual operators shall be provided by the gate manufacturer and shall be crank or handwheel operated as indicated in the Schedule. Each operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lb. on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lb.

N. All bearing and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.

O. Materials for the gate shall be as follows:

| Part | Material |
|---|---|
| Frame, Yoke, Stem Guides, Slide, Stem Extension | Stainless Steel ASTM A-276, Type 304L |
| Side Seals, Stem Guide Liner | UHMWPE ASTM D-4020 |
| Bottom seal | Neoprene ASTM D-2000, Grade 2 BC-510 |
| Compression cord | Nitrile ASTM D-2000 M6BG 708, A14, B14, EO14, EO34 |
| Threaded stem | Stainless Steel ASTM A-276, Type 303 MX |
| Fasteners | ASTM F593 and F594, GR1 for Type 304 and GR2 for Type 316 |
| Pedestal, Handwheel, Crank | Tenzaloy aluminum |
| Gasket (between frame and wall) | EPDM ASTM 1056 |
| Stem Cover | Polycarbonate ASTM A-707 |
| Lift Nut | Manganese bronze ASTM B584 Alloy 432 |

## 2.03 ELECTRIC ACTUATOR

A. The actuator shall consist of an electric motor, worm gear reduction, absolute position encoder, electronic torque sensor, mechanically and electrically interlocked reversing motor contactor, electronic control, protection, and monitoring package, manual override hand wheel, valve interface bushing, 32-character graphical LCD (Liquid Crystal Display), and local control switches all contained in an enclosure that is sealed to NEMA 4, 4X, 6, IP68 to 15M for 96 hours, and (XP as required). Actuator design life shall be at least one million drive sleeve turns.

B. The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and bronze alloy worm gear; oil-bath lubricated using synthetic oil designed specifically for extreme pressure worm and worm gear transmission service.

C. The motor shall be three-phase/60-cycle with Class F insulation and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling.

D. Valve position shall be sensed by an 18-bit, optical, absolute position encoder with redundant position sensing circuits designed for Built-In-Self-Test [BIST]. Each of the position sensing circuits shall be redundant permitting up to 50% fault tolerance before the position is incorrectly reported. The BIST feature shall discern which failures signal a warning only and which require a warning plus safe shutdown of the actuator. Open and closed positions shall be stored in permanent, nonvolatile memory. The encoder shall measure valve position at all times, including both motor and hand wheel operation, with or without power present, and without the use of a battery. The absolute encoder will be capable of resolving ±7° of output shaft position over10,000 output drive rotations.

E. An electronic torque sensor shall be included. The torque limit may be adjusted from 40-

100% of rating in 1% increments. The motor shall be deenergized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating and during extreme arctic temperature operation (-50°C), and a "Jammed Valve" protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs.

F. The control module shall include power and logic circuit boards, control transformer, and at least two primary power protection fuses, all mounted to a steel plate and attached in the control compartment with captive screws. The use of O rings or other such devices to secure the control boards shall not be permitted. The module shall be easily removed through the use of plug-in connectors. The module shall also include a reversing contactor, local control switches, 32-character graphical LCD, and LED indicators. It shall also be Bluetooth ready. All internal wiring shall be flame-resistant, rated 105°C, and UL/CSA listed. Voltage shall be selectable via a jumper included on the power board.

G. The reversing contactor shall be mechanically and electrically interlocked to prevent simultaneous energizing of the open and close coils. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals. The control transformer shall include vacuum-impregnated coils and dual primary fuses.

H. A Phase Correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit shall also detect the loss of a phase and disable operation to prevent motor damage. The monitor relay shall trip and an error message shall be displayed on the LCD screen when loss of phase occurs and indicate the fault for Remote operation.

I. Discrete remote control may be configured as 2, 3, or 4 wires for open-stop-close control. Remote control functions may be powered by external 24 VDC, 125 VAC, or the actuator's internal supply 24 VDC supply. The voltage values for signal threshold shall be 19.2V AC/DC and 5.0V AC/DC respectively. The maximum load for 24Vdc is 2mA. The internal supplies shall be protected against over current and short circuits faults and utilize optical isolation to minimize electro-magnetic interference. Discrete control shall have an isolated common.

J. ESD (Emergency Shut Down) provision shall be included in each actuator. The actuator shall permit up to three inputs for ESD and they shall be configurable. The ESD signal shall override any existing signal (except LOCAL, STOP, and INHIBIT) and send the valve to its configured emergency position. The ESD may also be configured to override LOCAL, STOP, and/or INHIBIT. Provision for an isolated common shall be provided.

K. Inhibit movement provision shall be included in each actuator. The actuator shall permit up to three inputs for Inhibits and they shall be configurable. Provision for an isolated common shall also be provided.

L. Terminals shall be included to connect the electronic controls package, including display, to a back-up 24 VDC power source. As a standard alternative the actuator shall have the ability to maintain the status and alarm contacts in order to update status to the control room and also provides status visibility on the LCD screen without main power applied. It should be configurable for at least one hour and, once main power is restored, be available for the next unforeseen power outage. The use of an integral battery is prohibited.

M. A dedicated circuit to prevent undesired valve operation in the event of an internal circuit fault or erratic command signal shall be included. A single point failure will not result in erratic actuator movement. An open or short-circuit in the internal circuit board logic shall not energize the motor contactor, nor shall a single fused control relay contact fail to deenergize the motor contactor. The command inputs shall be optically coupled and require a pulse width of at least 250 ms to 350 ms to turn on or off. In the event of an internal circuit fault, an alarm shall be signaled by tripping the Monitor Relay and through LCD indication.

N. Four latched status contacts rated 125VAC, 0.5A and 30VDC, 2 amps shall be provided for

remote indication of valve position, configured as 1-N/O and 1-N/C for both the open and closed positions. Two contacts may be configured to represent any other actuator status; mid-travel position, switched to local, overtorque, motor over temperature, manual operation, switched to remote, switched to stop, valve moving, close torque switch, open torque switch, hardware failure, ESD active, inhibits active, valve jammed, analog IP (input) lost, lost phase, and network controlled.

O. A monitor relay shall be included and shall trip when the actuator is not available for remote operation. Both N/O and N/C contacts shall be included, rated 125VAC, 0.5A and 30VDC, 2 amps. The monitor relay shall be configurable for three additional fault indications; lost phase, valve jammed, and motor overtemp. The yellow LED shall blink when the monitor relay is active.

P. The ACP (Actuator Control Panel) cover & module shall use solid-state Hall-effect devices for local communication and configuration. The use of reed switches on the module is prohibited. A 32-character, graphical LCD shall be included to display valve position as a percent of open, 0-100%, and current actuator status. "STATUS OK" shall be displayed for an operable actuator. If the actuator is not operable, the appropriate alarm shall be displayed. The alarm shall be continuously displayed until the actuator is operable. Red, green, and yellow LEDs shall be included for open, close, stopped, and moving indication. The Red and Green LEDs shall be reversible. A padlockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator's internal components from the external environment. The OPEN-CLOSE switch may be configured for maintained or push-to-run (inching) control.

Q. The device shall be non-intrusive - All calibration shall be possible without removing any covers and without the use of any special tools. All calibration shall be performed in clear text languages, no icons shall be used. The languages shall be English, Spanish, French, German, Portuguese, Italian, Mandarin, Russian, Malay, and Katakana. All calibration shall be performed by answering the "YES" and "NO" questions displayed on the LCD. "YES" is signaled by using the OPEN switch and "NO" by using the CLOSE switch, as indicated adjacent to the switches. A configurable password option shall be available to prevent unauthorized changes.

R. Double sealed terminal compartment & Terminal block - All customer connections shall be located in a terminal chamber that is separately sealed from all other actuator components. Site wiring shall not expose actuator components to the environment. The internal sealing within the terminal chamber is suitable for NEMA 4, 6, and IP68 to 15M for 96 hours. The chamber shall include screw-type terminals, three for power and 54 for control, for site connections. Three conduit entries, available as: (2) - 1.25" NPT (M32) and (1)-1.5" NPT (M40) shall be located in the terminal chamber.

S. Coatings - The actuator shall be coated with a polymer powder coat. The coating system shall be suitable for an ASTM B117 salt spray test of 1500 hours. External fasteners shall be stainless steel or high-strength carbon steel that has been chromate-hexavalent coated, and then top coated with a high-strength, high-endurance polymer. The fasteners shall be suitable for an ASTM B117 salt spray test of 500 hours.

T. A handwheel and declutch lever shall be provided for manual operation. The handwheel shall not rotate during electric operation nor can a seized motor prevent manual operation. Changing from motor to manual operation is accomplished by engaging the declutch lever. Energizing the motor shall return the actuator to motor operation. The lever to enable the declutch shall be padlockable to permit motor operation only.

U. The actuator shall include a removable torque or thrust bushing to mate with the valve shaft.

V. Diagnostic facilities shall be included to accumulate and report the performance of the motor, encoder, contactor, cycle time, handwheel operations, actuator ID, firmware revision, and

output turns. In addition, a torque profile of the reference baseline valve stroke and the last valve stroke shall be included. A feature for reset shall be provided. All diagnostic information shall be displayed on the LCD. Diagnostics shall also include an FDA (Frequency Domain Analysis) feature. The Frequency Domain Analysis methodology shall capture torque, position or speed values at regular time intervals while the actuator is motoring, and calculate the resulting data set with a Fast Fourier Transform [FFT]. The resulting information shall be used to isolate any components in the mechanical drive train that may exhibit excessive wear or may effect normal actuator operation. FDA and resultant fault indications shall be displayed via the graphical LCD. The actuator shall contain the ability for diagnostics information to be downloaded to a PC or PDA via both IRDA and Bluetooth ports.

W. Factory testing - Every actuator shall be factory tested to verify: rated output torque, output speed, handwheel operation, local control, control power supply, valve jammed function, all customer inputs and outputs, motor current, motor thermistor, LCD and LED operation, direction of rotation, microprocessor checks, and position-sensor checks. A report confirming successful completion of testing shall be included with the actuator.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Sluice gates shall be installed in accordance with the manufacturer's recommendations.

B. A qualified factory representative shall be onsite to provide a minimum of eight (8) hours training of plant personnel in the operation and maintenance of all equipment, gates and actuators.

END OF SECTION

## SECTION 11290 - INTERIOR PROCESS PIPING

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all plant process piping as shown on the Drawings and specified herein.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Interior Process Valves: Section 11295

B. Yard Piping: Section 02505

C. Valves: Section 02515

D. Piping furnished with equipment is included in the specific equipment item.

### 1.03 SUBMITTALS

A. The Contractor shall comply with the requirements of Section 01300 of these specifications.

B. A notarized certification shall be furnished for all pipe and fittings which verifies compliance with all applicable specifications.

## PART 2 - PRODUCTS

### 2.01 DUCTILE IRON PIPE/DUCTILE IRON FITTINGS

A. Unless otherwise noted or required, all inside ductile iron piping shall be flanged pipe with threaded flanges in accordance with AWWA C 115. All piping flanges shall have ring gaskets, 1/8-inch thick.

B. All exposed iron pipe to be field painted shall be furnished with an external coating of rust inhibitive primer, such as Tnemec Series 1 OmniThane, Sherwin-Williams Corothane I GalvaPac, or equal. Pipe manufacturer shall be responsible for compatibility of shop applied coatings with the field paint systems and products specified in Division 9, Section 09961. Do not apply asphalt or bituminous coatings on pipe to be painted.

C. Protecto 401 Ceramic Epoxy Interior Lining

1. Condition of ductile iron prior to surface preparation

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

2. Lining Material

The standard of quality is Protecto 401™ Ceramic Epoxy. The material shall be an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

a. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

b. The following test must be run on coupons from factory lined ductile iron pipe:

* ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.
* ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5 mm undercutting after 30 days.
* Immersion testing rated using ASTM D-714-87.
  —20% Sulfuric acid—No effect after two years.
  —140°F 25% Sodium Hydroxide—No effect after two years.
  —160°F Distilled Water—No effect after two years.
  —120°F Tap Water (scribed panel)—0.0 undercutting after two years with no effect.
* ASTM G-22 90 Standard practice for determining resistance of Synthetic Polymeric materials to bacteria. The test should determine the resistance to growth of Acidithiobacillus Bacteria and should be conducted at 30 degrees centigrade for a period of 7 days on a minimum of 4 panels. The growth must be limited only to trace amounts of bacteria.

c. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

3. Application

a. Applicator

The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

b. Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective any substance that can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be re-blasted.

c. Lining

After surface preparation and within 12 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40°F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

d. Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401™ Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

e. Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

f. Touch-Up and Repair

Protecto 401™ Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

4. Inspection and Certification

a. Inspection

All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.

The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

b. Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

5. Handling

Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.

Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

D. Ductile iron fittings shall conform to AWWA C 110 with flanges faced and drilled 125-pound. Fittings shall have interior lining and exterior coating same as the pipe.

## 2.02 POLYVINYL CHLORIDE (PVC) PLASTIC PRESSURE PIPE

A. PVC Pressure Pipe, 3" and Smaller: Polyvinyl chloride plastic pipe shall be ASTM D 1785 Schedule 80 or F441 CPVC, Schedule 80 with solvent weld joints. Fittings shall be ASTM D 2467 Schedule 80 socket type. All socket type connections shall be made with PVC solvent cement complying with ASTM D 2564 PVC solvent cement shall be furnished from the same supplier as the PVC pipe. Provide socket-threaded adapters for connection to threaded appurtenances where required.

## 2.03 WALL PIPE AND SLEEVES

A. All wall pipe shall be furnished with cast or welded collar water stops in the positions shown on the Drawings. Welding of water stop collars on pipe shall be accomplished by the wall pipe manufacturer in their shop. All centrifugally cast wall pipe shall be ductile iron meeting the requirements of AWWA C151 for the pipe barrel, conforming to the pressure rating of the pipeline in which installed, and in no case be lighter than Class 53.

B. All statically cast wall pipe shall be ductile iron meeting the requirements of AWWA C110 for fittings. Mechanical joint end and cast-on flange end wall pipe shall conform to AWWA C110 and threaded flange wall pipe shall conform to AWWA C115. Where flanged or mechanical joint bell ends are flush with the wall, they shall be drilled and tapped for stud bolts which are to be of 300 Series stainless steel.

C. The length of all wall pipe shall be not less than the thickness of the wall in which installed. Wall pipe shall have the same pressure rating as connecting pipe. All wall pipe shall be lined with Induron Protecto 401, as specified in paragraph 2.01. The outside of wall pipes shall be left uncoated and shall be field primed for painting on the portion exposed, uncoated where embedded and field coated with standard bituminous coated where buried.

D. Contractor may have the option to install wall pipe flush face-to-face of wall in lieu of the dimensioned length wall pipe shown on the Drawings, in order to eliminate form penetrations. This option will be subject to Engineer`s review at each wall pipe location and covers both flanged and mechanical-joint bell-end wall pipe. Embedded flanged and M.J. bell-end bolt holes shall be tapped for stud bolts; tapped bolt holes in embedded flanges shall be plugged for protection during concrete pouring.

E. All pipe wall sleeves shall be plain end galvanized steel pipe of diameter noted on Drawings and length to fit flush face-to-face of wall.

## 2.04 INTERLOCKING LINK PIPE SEALS

A. In all locations indicated on the Drawings, interlocking link pipe seals shall be used in lieu of lead packing a pipe wall sleeve. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall sleeve. Seals shall be "Link-Seal" as manufactured by Thunderline Corporation, Wayne, Michigan, or approved equal.

B. The Contractor shall determine the required diameter of each individual wall opening according to the manufacturer's recommendations before ordering and installing the seal.

Pipe shall be accurately centered in the sleeve and the link seals shall be sized, installed and tightened in accordance with the manufacturer's instructions.

## 2.05 COUPLINGS AND ADAPTERS

A. Flexible couplings shall be of the sleeve type with a middle ring, two round-wedge shaped rubber gaskets at each end, two following rings together and compress the gasket against the pipe. Flexible couplings shall be steel with minimum wall thickness of the middle ring or sleeve installed on pipe being 5/16-inch for pipe smaller than 10 inches, 3/8-inch for pipe 10 inches or larger. The minimum length of the middle ring shall be 5-inches for pipe sizes up to 10 inches and 7 inches for pipe 10 inches to 30 inches. The pipe stop shall be removed. Gaskets shall be suitable for 250 psi pressure rating or at rated working pressure of the connecting pipe. Couplings shall be harnessed and be designed for 250 psi.

B. Flanged adapters shall have one end suitable for bolting to a pipe flange and the other end of flexible coupling similar to that described hereinbefore. All pressure piping with couplings or adapters shall be harnessed with full threaded rods spanning across the couplings or adapters. The adapters shall be furnished with bolts of an approved corrosion resistant steel alloy, extending to the adjacent pipe flanges. Flanges on flanged adapter (unless otherwise indicated or required) shall be faced and drilled ANSI B16.1 Class 125.

C. Flexible couplings and flanged adapters shall be as manufactured by Dresser, Rockwell, or equal, per the following, unless otherwise specified and/or noted on the Drawings:

1. Steel couplings for joining same size, plain-end, steel, cast iron, and PVC plastic pipe -

| Dresser | Smith-Blair |
|---|---|
| Style 253 (2"-15")<br>Style 38/138 (18" & above) | 4II |

2. Transition couplings for joining pipe of different outside diameters-

| Dresser | Smith-Blair |
|---|---|
| Style 162 (4"-12")<br>Style 62 (2"-24") | 413 steel (2"-24")<br>415 steel (6"-48")<br>433 cast (2"-16")<br>435 cast (2"-12") |

3. Flanged adapters for joining plain-end pipe to flanged pipe, fittings, valves and equipment.

| Dresser | Smith-Blair |
|---|---|
| Style 227 cast (3"-12")<br>Style 128 steel (3"-48" D.I. Pipe)<br>Style 128 steel (2"-96" steel pipe) | 912 cast (3"-12")<br>913 steel (3"-24" D.I. Pipe) |

## 2.06 FLANGED JOINTS

A. Flange bolts and nuts shall be ASTM A 307, Grade B and shall have hexagonal heads. All bolts, nuts and studs for flanged pipe in submerged locations shall be of 300 Series stainless steel. The flanges shall be drawn together until the joint is perfectly tight, with bolts of a length such that they will not project greater than 1/4-inch from the nut nor fall short of the end of the nut when drawn up. No washers shall be used. Gaskets shall be carefully fabricated prior to installation and must be suitable for pressure rating for the pipe for which it is used.

B. All flanges (unless otherwise indicated or required) shall be faced and drilled ANSI B16.1 125-pound for ductile iron and ANSI B16.5 150-pound for steel.

C. At the Contractor's option, and at no additional expense to the Owner, the following patented SBR flange gaskets or approved equal may be substituted for standard sheet packing ring gaskets in ductile iron flanged pipe:

1. TORUSEAL by American Cast Iron Pipe Company

2. FLANGE-TYTE by United States Pipe & Foundry Company

When using such gaskets, flange bolts shall be torqued to manufacturer's recommended torque values.

## 2.07 METAL PIPE SUPPORTS AND HANGERS

A. The Contractor shall furnish and install all pipe hangers, inserts, brackets, plates, anchors, and other supports not specifically included under other items. Generally pipe supports are not shown on the Drawings, but shall be supplied as specified herein. However, any bracing or support details shown on the Drawings shall be followed.

B. Prior to installation, the Contractor shall submit to the Engineer for review, manufacturer's data sheets on all catalogued items to be used and sketches covering all specially designed hanger and support assemblies and fabrications.

C. Supports and hangers shall be as manufactured by Grinnell, Elcen, or Fee & Mason, or equal or fabricated by the Contractor. Field fabricated supports may be used only for special conditions where manufactured items may not be suitable. In such cases, details of proposed supports shall be submitted to the Engineer for review. All such supports shall be galvanized.

D. Except as shown on the Drawings or as directed by the Engineer, supports and hangers shall be as follows:

1. Pipes with centerlines less than 24 inches from a wall shall be supported by a typical wall support bracket. Pipes with centerlines less than 6 feet above a floor shall be supported from below. All other pipes shall be hung from above. Piping shall be supported at no greater than 10 feet 0 inches on centers.

2. Pipe supported from underneath shall have adjustable pipe saddle supports on properly sized pipe stanchions. The saddle assembly shall be of cast iron. Standard pipe stanchions with hold-down "U" bolts shall be Grinnell Fig. 259, Elcen Fig. 49, Fee & Mason Fig. 2595, or equal.

3. Hangers are to be suspended from concrete work. Hangers shall be supported from approved metal inserts placed in concrete before the concrete is placed. Standard concrete inserts shall be Grinnell Fig. 28l or 282, Elcen Fig. 86 or 65, Fee & Mason Fig. 186 or 2570, or equal. If special support from overhead concrete is necessary due to unusually heavy loads, support shall be as detailed on the Drawings. In no case shall standard concrete inserts be used where pipe load exceeds the manufacturer's recommended load for the insert, or where the hanger rod exceeds 7/8" diameter.

4. All pipe hangers, inserts, clamps, supports and other like items shall be submitted for review by the Engineer prior to installation.

5. All inside horizontal flanged piping shall be supported with approved split ring type adjustable hangers of malleable iron with suitable hanger rods unless shown otherwise on the Drawings. Special supports shall be constructed in accordance with details shown on the Drawings. Wall supports and/or hangers shall be placed not over 10 feet apart. All piping shall be rigidly supported to prevent loosening under vibration.

6. Pipe, valve operating stems, fixtures and conduits shall be bracketed or suspended from walls, ceilings, and beams at or near valves and fittings and where needed for firm

support, by standard brackets, rods, turnbuckles, and rings made especially for pipe of sizes supported. Perforated strap iron and/or copper will not be acceptable.

7. Clevis hangers for "iron pipe size" O.D. pipe shall be Grinnell Figure 65, Elcen Figure I2, Fee & Mason Figure 239, or equal. Clevis hangers for Cast Iron O.D. pipe shall be Grinnell Figure 260, Elcen Figure 12C, Fee & Mason Figure 104, or equal. All clevis hangers shall be galvanized.

8. Turnbuckles shall be forged steel. Rods shall be of black steel, machine threaded of following sizes:

| Pipe Size | Rod Diameter |
|---|---|
| 1/2" - 2" | 3/8" |
| 2 1/2" - 3" | 1/2" |
| 4" - 5" | 5/8" |
| 6" | 3/4" |
| 8" - 12" | 7/8" |
| 14" - 16" | 1" |
| 18" | 1 - 1/8" |
| 20" - 24" | 1 - 1/4" |

9. Brackets shall be of standard castings of fabricated steel and shall be reviewed by the Engineer. Standard catalogued bracket shall be medium duty Grinnell Fig. 195, Elcen Fig. 57, Fee & Mason Fig. 151, or equal, galvanized, size as noted on Drawings. Provide light or heavy duty brackets if specifically noted on Drawings. "U" bolts shall be Grinnell Fig. 137, Elcen Fig. 68 or 68A, Fee & Mason Fig. 176, or equal.

10. Column type pipe supports shall consist of pipe columns of size required to carry the full pipe and standard cast iron bases and saddles as required. Saddles shall be of proper size to fit the pipe being supported.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF PIPING

A. Materials shall be new and of the best grade and quality; workmanship shall be first class in every respect.

B. Each piece of iron pipe and each fitting shall be plainly marked at the foundry with class number and weight.

C. Where indicated on the Drawings, plain-end pipe shall be joined by means of flanged adapters or flexible couplings which shall be Rockwell, Dresser, or equal.

D. All pipe couplings shall be designed to safely withstand the operating pressure of the lines in which they are installed. All couplings shall be shop primed with an approved rust inhibitive primer.

E. Taps and connections to piping shall be made as required to connect equipment, sample lines, etc., and where otherwise shown on the Drawings.

F. Piping shall be installed straight and true, parallel or perpendicular to walls, with approved offsets around obstructions. Standard pipe fittings shall be used for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted unless accepted by the Engineer.

G. All piping, fittings, valves and other accessories shall be thoroughly cleaned of dirt, chips and foreign matter before joint connections are made.

H. All plastic pipe shall be adequately supported and braced. Support spacing shall not exceed the recommendations of the Plastics Pipe Institute.

I. Teflon tape shall be used on all plastic pipe threaded connections.

J. Field cut male threads on plastic pipe shall be made with plastic pipe threading dies.

K. The annular space of plain wall sleeves shall be packed tight with lead wool to within 3/4" of wall face and then patch grouted flush to wall face with non-staining nonshrink grout, Masterflow 713 by Master Builders, Sonogrout by Sonneborn-Contech, or equal.

L. All pipe sleeves passing through walls or floors of chlorine feed and storage areas shall be provided with gas tight seals.

M. All pipe threads shall conform to ANSI B2.1.

N. Piping shall be erected to provide for expansion and contraction.

O. Screwed or soldered unions shall be provided in all small piping as required to permit convenient removal of equipment, valves and piping accessories from the piping system.

P. Dielectric insulating couplings or brass adapters shall be used whenever the adjoining materials being connected are of dissimilar material such as connections between copper tubing and steel pipe.

Q. All inside piping shall be color coded, stenciled and label tagged for identification as specified in Section 9961.

END OF SECTION

## SECTION 11295 - INTERIOR PROCESS VALVES

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all new valves as shown on the Drawings and/or specified herein.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Yard Piping: Section 02505

B. Valves: Section 02515

C. Interior Process Piping: Section 11290

D. Valves furnished with equipment are included with equipment specifications.

### 1.03 SUBMITTALS

A. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein to the Engineer for review before ordering. Comply with provisions of Section 01300.

B. At the time of submission, the Contractor shall, in writing, call Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

## PART 2 - PRODUCTS

### 2.01 PLUG VALVES

A. All plug valves shall be eccentric plug valves unless otherwise specified.

B. Valves shall be of the non-lubricated eccentric type with flanged ends faced and drilled per ANSI B16.1 125 lb.

C. Valve bodies shall be flushing body type and made of ASTM A126 Class B cast iron. Valves shall be furnished with a 1/8" welded overlay seat of not less than 95% pure nickel. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.

D. Plugs shall be made of ductile iron and have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be resilient faced with neoprene or hycar, suitable for use with sewage.

E. Valves shall have replaceable sleeve type bearings and grit seals at the upper and lower journals.

F. Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the bonnet or actuator from the valve under pressure. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable.

G. Valve pressure ratings shall be 175 psi through 12" and 150 psi for 14" through 72". Each valve shall be given a hydrostatic and seat test with test results being certified when required by the specifications.

H. Manually operated valves 4-inch and larger shall have a worm gear actuator, stainless steel input shaft and handwheel operator. Manually operated valves 3-inch and smaller shall have a lever operator. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft shall be stainless steel and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for change in pressure differential or flow direction change. All exposed nuts, bolts and washers shall be stainless steel.

I. Any cylinder actuators shall be equipped with 2-inch square operating nuts to allow manual valve operation in case of supply failure.

J. Valves shall provide drip tight shutoff up to the full pressure rating. Valves shall be provided with adjustable limit stops and rotate 90 degrees from fully opened to fully closed.

K. Valves located 6 feet or more above the floor shall be furnished with chain wheel operators.

L Valves shall have rectangular port openings for throttling service, and shall open to 100% of the corresponding pipe diameter.

M. Plug valves shall be as manufactured by DeZurik, or approved equal,

## 2.02 CHECK VALVES

A. The valve is a counterweighted, rubber seated check valve with attached cushion chamber whose function is to permit flow in only one direction, close tightly when its discharge side pressure exceeds its inlet pressure, and to close without a slam or bang.

B. The swing check valve shall be constructed with heavy cast iron or cast steel body with a bronze or stainless steel seat ring, a non-corrosive shaft for attachment of weight and lever, and complete non-corrosive shockless chamber.

C. It shall absolutely prevent the return of water, oil or gas back through the valve when the inlet pressure decreases below the delivery pressure. The valve must be tight seating, and must be shockless in operation. The seat ring must be renewable.

D. The cushion chamber shall be attached to the side of the valve body externally and so constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The shock absorption shall be by air, and the cushion chamber shall be so arranged that the closing speed will be adjustable to meet the service requirements.

E. The valve disc shall be of cast iron or cast steel and shall be suspended from a non-corrosive shaft which will pass through a stuffing box and be connected to the cushion chamber on the outside of the valve.

F. All material and workmanship shall be first class throughout and the purchaser reserves the right to inspect this valve before shipment.

G. The valves will be Golden-Anderson Industries, Inc. Fig. No. 250-D, 125# or equal.

## 2.03 VALVE OPERATORS

A. Valve operators shall be as shown on the plans and specified herein and in Section 2.05.

B. Valves located six (6) feet or more from floor level shall be furnished with chain wheel operators or chain level operators. Chains shall extend to within four (4) feet off the floor. All NRS floor stands and geared operators shall be indicating type.

## 2.04 ELECTRIC ACTUATOR

A. The actuator shall consist of an electric motor, worm gear reduction, absolute position encoder, electronic torque sensor, mechanically and electrically interlocked reversing motor contactor, electronic control, protection, and monitoring package, manual override hand wheel, valve interface bushing, 32-character graphical LCD (Liquid Crystal Display), and local control switches all contained in an enclosure that is sealed to NEMA 4, 4X, 6, IP68 to 15M for 96 hours, and (XP as required). Actuator design life shall be at least one million drive sleeve turns.

B. The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and bronze alloy worm gear; oil-bath lubricated using synthetic oil designed specifically for extreme pressure worm and worm gear transmission service.

C. The motor shall be three-phase/60-cycle with Class F insulation and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling.

D. Valve position shall be sensed by an 18-bit, optical, absolute position encoder with redundant position sensing circuits designed for Built-In-Self-Test [BIST]. Each of the position sensing circuits shall be redundant permitting up to 50% fault tolerance before the position is incorrectly reported. The BIST feature shall discern which failures signal a warning only and which require a warning plus safe shutdown of the actuator. Open and closed positions shall be stored in permanent, nonvolatile memory. The encoder shall measure valve position at all times, including both motor and hand wheel operation, with or without power present, and without the use of a battery. The absolute encoder will be capable of resolving ±7° of output shaft position over10,000 output drive rotations.

E. An electronic torque sensor shall be included. The torque limit may be adjusted from 40-100% of rating in 1% increments. The motor shall be deenergized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating and during extreme arctic temperature operation (-50°C), and a "Jammed Valve" protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs.

F. The control module shall include power and logic circuit boards, control transformer, and at least two primary power protection fuses, all mounted to a steel plate and attached in the control compartment with captive screws. The use of O rings or other such devices to secure the control boards shall not be permitted. The module shall be easily removed through the use of plug-in connectors. The module shall also include a reversing contactor, local control switches, 32-character graphical LCD, and LED indicators. It shall also be Bluetooth ready. All internal wiring shall be flame-resistant, rated 105°C, and UL/CSA listed. Voltage shall be selectable via a jumper included on the power board.

G. The reversing contactor shall be mechanically and electrically interlocked to prevent simultaneous energizing of the open and close coils. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals. The control transformer shall include vacuum-impregnated coils and dual primary fuses.

H. A Phase Correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit shall also detect the loss of a phase and