(Wastewater Tank)

DIVISION 13
SECTION 13000 –WIRE-WOUND, PRESTRESSED CONCRETE WASTEWATER TREATMENT TANKS WITH STEEL DIAPHRAGM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included

1. This section specifies the design and construction of the precast, wire-wound, prestressed, concrete circular tank with steel diaphragm complete; including all site work, excavation, reinforcing, concrete work, appurtenances, testing, and backfill directly related to the tank unless otherwise specified.

2. The Contractor shall furnish all labor, materials, tools, and equipment necessary to construct, and test the wire-wound, prestressed concrete tank and appurtenances as indicated on the drawings, and as specified.

B. Related Work Described Elsewhere

1. Rock Excavation

2. Piping

{NOTE: Add items as necessary, i.e. earthwork, concrete formwork, cast-in-place concrete, reinforcing, etc.}

C. Description of System

FOR COVERED TANKS

The tank shall consist of a cast-in-place reinforced concrete floor, a precast, wire-wound prestressed concrete wall with a continuous mechanically bonded steel diaphragm, and a precast or cast-in-place prestressed clear span concrete dome with no interior columns.

FOR OPEN TOP TANKS

The tank shall consist of a cast-in-place reinforced concrete floor, and a precast, wire-wound prestressed concrete wall with a continuous mechanically bonded steel diaphragm.

1.02 QUALITY ASSURANCE

A. Qualifications and Experience

1. All tank work shall be performed by a company which specializes in the design and construction of precast, wire-wound prestressed concrete tanks using the method of circumferential prestress wire reinforcing and with proven capability of meeting all the requirements of these specifications. No company is considered qualified unless it has designed and built in its own name at least 20 precast, wire-wound prestressed concrete tanks conforming to AWWA D110, Type III in the last ten years. At least 10 of the above tanks shall have been in successful service for a minimum of five years.

2. The tank contractor shall have in its' employ a design engineer with a minimum of ten years experience in the design of AWWA D110 Type III tanks. The design engineer shall have been the engineer of record for a minimum of 10 AWWA D110 Type III tanks.

3. Experience in the design and construction of AWWA D110 Type I, Type II, or Type IV tanks is not acceptable.

B. Prequalification

1. All tank contractors are required to be prequalified. The bidder is required to state on the face of his sealed proposal the name of the prequalified tank contractor. Sealed proposals which do not state the name of the prequalified tank contractor will be returned to the bidder unopened.

2. Natgun Corporation, Wakefield, Massachusetts, and, *(NOTE: Add other prequalified tank contractors, if any)* are prequalified for precast, wire-wound prestressed, concrete tank construction. Additional tank contractors seeking prequalification shall make a complete submittal to the Engineer for review and approval no later than ten (10) days prior to the date set for receipt of bid, in accordance with Section 1.03A. The submittal shall include detailed design

drawings and calculations meeting the requirements of these specifications, and the company's record of previous experience in the design and construction of circular precast, wire-wound prestressed concrete tanks constructed in their own name, conforming to AWWA D110 Type III. Within five (5) days prior to the date of receiving bids, the engineer will publish a list of additional prequalified tank contractors.

3. Experience in the design and construction of AWWA D110 Type I, Type II, or Type IV tanks is not acceptable.

4. All tank manufacturers not prequalified in accordance with Paragraph 1.02 will be rejected.

C. Codes & Standards

1. ACI 301 Specifications for Structural Concrete for Buildings

2. ACI 305 Hot Weather Concreting

3. ACI 306 Cold Weather Concreting

4. ACI 309R Guide for Consolidation of Concrete

5. ACI 318 Building Code Requirements for Reinforced Concrete and Commentary

6. ACI 350 Building Code Requirements for Environmental Engineering Concrete Structures and Commentary

7. ACI 506R Guide to Shotcrete

8. ASTM A185 Specification for Steel Welded Wire, Fabric, Plain for Concrete Reinforcement

9. ASTM A615/A615M Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

10. ASTM A821 Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks by Redrawing

11. ASTM A1008/A1008M Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality

12. ASTM C31 Test Methods for Making and Curing Concrete Test Specimens in the Field

13. ASTM C33 Specification For Concrete Aggregates

14. ASTM C39 Test Method for Compressive Strength of Cylindrical Concrete Specimens

15. ASTM C920 Specification for Elastomeric Joint Sealants

16. ASTM D1056 Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

17. ASTM D1556 Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

18. ASTM D1557 Test Method for Laboratory Compaction, Characteristics of Soil Using Modified Effort (56,000 Ft. - lbf/ft3) 2700 KN.M/M3)

19. ASTM D2000 Classification System for Rubber Products in Automotive Applications

20. ASCE Standard 7-02 Minimum Design Loads for Buildings and Other Structures

21. AWWA D110 Standard for Wire-Wound Circular Prestressed Concrete Water Tanks, Type III.

22. US Army Corps of Engineers Specification CRD-C-572, Specification for PVC Waterstop

D. Design Criteria

1. The prestressed concrete tank shall be designed and constructed in accordance with the provisions of AWWA D110 Standard for Wire Wound Circular Prestressed-Concrete Water Tanks, Type III: Precast Concrete with a Steel Diaphragm.

2. Horizontal prestressing shall be continuous. Discontinuous prestressing tendons or strands will not be allowed.

3. The Contractor shall use the following loadings and requirements in the design calculation:

a. Capacity: _____ million gallons.

b. Dimensions: _____ inside diameter x _____ water depth.

c. Dead Load: shall be the estimated weight of all permanent imposed loads. Unit weight of concrete 150 pounds per cubic foot; steel 490 pounds per cubic foot.

d. Live Load: shall be the weight of all the liquid when the reservoir is filled to overflowing. Unit weight of liquid 62.4 pounds per cubic foot.

ADD FOR COVERED TANKS

e. Total Roof Live Load: _____ psf

{NOTE: If live load and snow loads are unknown, they shall be as required by ASCE 7-02}

f. Backfill Pressure: earth loads shall be determined by rational methods of soil mechanics. Backfill pressure shall not be used to reduce the amount of required prestressing.

g. Foundation Loads: the tank foundation shall be proportioned so that soil pressure shall be less than the soil bearing capacity. The allowable soil bearing capacity is _____ psf

h. Seismic Criteria: Zone _____

i. Wind Loads: shall be as required by ASCE 7-02

ADD FOR COVERED TANKS

j. Vent Capacity Requirements:

Maximum fill rate = _____ cfm

Maximum draw down rate = _____ cfm

ADD FOR CSO TANKS

k. Overflow Design Capacity: _____ mgd

4. The precast, wire-wound prestressed tank wall shall be designed as a composite concrete wall with an embedded mechanically bonded steel diaphragm in combination with vertical mild steel reinforcement.

a. The prestressed tank wall shall be considered as a cylindrical shell with partial edge restraint.

b. The prestressed tank wall shall be reinforced vertically by deformed steel reinforcing rods. The continuous mechanically bonded steel diaphragm can be taken as effective vertical reinforcing.

c. The prestressed tank wall shall be of precast construction. Shotcrete or cast-in-place concrete core walls are not permitted.

d. A stress plate shall be required at all above grade locations where prestress wires are displaced 24" or greater. The stress plate shall be designed to transfer stress across the opening.

e. Minimum precast wall thickness shall be four inches.

f. No reduction in ring compression or tension in the wall will be taken due to restraint at the bottom.

FOR MEMBRANE FLOORS

5. The floor slab shall be designed as a membrane floor not less than four inches thick and shall be placed monolithically. No construction joints will be allowed unless otherwise approved by the engineer. Wall footings may be above or below floor grade, but shall be placed monolithically with the floor.

FOR NON-MEMBRANE FLOORS

6. Tank Floor With Hydrostatic Uplift

a. The tank floor shall be reinforced cast-in-place concrete and shall have a minimum floor slab thickness of 8 inches. The floor shall be designed as a structural type bearing directly on the soil, or be supported on a deep foundation system. The tank contractor shall provide protection against uplift under the most severe condition such as when the tank is empty and the groundwater

table is the highest by using a thickened base slab, soil anchors, or a deep foundation system. If a deep foundation system is used, a minimum of two axial compressive load tests and a minimum of two axial tensile load tests shall be performed on deep foundation elements prior to installation of the foundation system. The results of these four separate load tests shall be used by the Contractor to adjust the length of the deep foundation elements. Load tests shall be performed and results shall be reported in accordance with ASTM D1443 and ASTM D3689. The location of the load tests shall be acceptable to the Engineer. If soil anchors are used to resist uplift forces, anchors shall be proof-tested. The first 3 anchors and 2 percent of the remaining anchors shall be performance tested. The floor shall be designed in accordance with ACI 350, except as modified herein. The factored load combinations for total factored design load, U, required by ACI 350 shall be increased by the sanitary durability coefficients.

b. The floor shall have an area of reinforcing steel of not less than 0.5 percent in any direction of the gross cross-sectional concrete.

c. If a thickened base slab is used, the minimum factor of safety against uplift shall be 1.15.

d. The allowable soil adhesion value shall be ___ pounds per square foot for design of soil anchors and deep foundation elements to resist uplift forces. The use of a less conservative adhesion value shall be verified by load tests on deep foundation elements or proof and performance tests on the soil anchors.

e. The evaluation of group effect shall be considered in design. A minimum factor of safety of 2 should be used when evaluating group effect. If the tank structural floor is designed to bear directly on the soil, the allowable bearing capacity is ____ psf.

ADDED FOR COVERED TANKS

5. The dome roof shall have a rise to span ratio within the range of 1:8 to 1:14. Minimum dome thickness shall be four inches. The dome shall be fixed to the tank wall. Columns or interior

supports will not be allowed. Dome design shall be based on elastic spherical shell analysis.

1.03 SUBMITTALS

A. Prequalification Submittals Ten Days Prior to Bid Date

1. Tank contractors not previously prequalified shall submit preliminary design drawings and calculations showing the dimensions of the tank, details of the type of construction, wire-wound prestressing methods, and sizes of principal members. The drawings and calculations shall be of sufficient detail to show compliance with the specification and all required standards and shall be signed and sealed by an Engineer registered in the state the tank is to be constructed. The registered Engineer shall certify the design is in conformance with AWWA D110, Type III.

2. Tank contractors not previously prequalified shall submit a complete record of their experience in the design and construction of precast, wire-wound, prestressed concrete tanks conforming to AWWA D110, Type III. The record shall indicate the size of the tank, the name and address of the Owner, the year of construction, and the name of the Engineer for each project.

3. Tank contractors not previously prequalified shall submit the name of the tank designer, currently in its' employ, and his/her experience as the designer of record for AWWA D110 Type III tanks.

4. Experience in the design and construction of AWWA D110 Type I, Type II, or Type IV tanks is not acceptable.

B. Design Submittal Within 30 Days after Execution of Contract

1. Design calculations and shop drawings in quadruplicate, showing details and procedures of construction, shall be submitted to the Engineer for approval within 30 days after execution of the Contract. After approval by the Engineer, one set of the drawings and calculations will be returned to the Contractor, and any changes found necessary by the Engineer shall be made by the Contractor.

2. Approval by the Engineer of the drawings and calculations submitted by the Contractor will not in any way relieve the

Contractor of full responsibility for the accuracy and completeness of the drawings and calculations.

3. Design calculations and shop drawings shall be stamped by a Professional Engineer experienced in the design of AWWA D110, Type III wire-wound, prestressed concrete tanks and registered in the state of _____.

C. Construction Submittals for Review Prior to Use

1. Design proportions for all concrete and shotcrete. Concrete strengths of trial mixes.

2. Admixtures to be used in the concrete or shotcrete and their purpose.

3. Reinforcing steel shop drawings showing fabrication and placement.

4. Catalog cuts or shop drawings of all appurtenances, i.e. hatch, vent, ladders, waterstops.

1.04 GUARANTEE

The Contractor shall guarantee the structure against defective materials or workmanship for a period of one year from the date of completion. If any materials or workmanship prove to be defective within one year, they shall be replaced or repaired by the Contractor at the Contractor's expense.

PART 2 - MATERIAL

2.01 CONCRETE

A. Concrete shall conform to ACI 301.

B. Cement shall be Portland cement Type I or Type II.

C. Admixtures, other than air-entraining and water reducing admixtures, will not be permitted unless approved by the Engineer.

D. Concrete for tank wall and dome construction shall have a minimum compressive strength of 4,000 psi at 28 days. All precast wall and dome concrete shall be air-entrained.

E. Concrete for the tank floor, footings, pipe encasement, and all other work shall have a minimum compressive strength of 3,500 psi at 28 days and shall not be air-entrained. The course and fine aggregate shall meet the requirements of ASTM C33. Course aggregate shall be No. 467 with 100% passing the 1-1/2" sieve. Superplasticizer and water-reducing admixtures shall be incorporated into the floor concrete. Polypropylene fibers shall be included in the floor concrete. Fibers shall be Microfiber by Grace, Stealth Fibers by Synthetic Industries, or equal. Fiber lengths shall be a maximum of 3/4 inches. The amount of polypropylene fibers added to the concrete mix shall conform to the manufacturer's recommendations.

F. Proportioning for concrete shall be in accordance with ACI 301.

G. Concrete or shotcrete in contact with prestressing steel shall have a maximum water soluble chloride ion concentration of 0.06 percent by weight of cement.

2.02 REINFORCING STEEL

A. Reinforcing steel shall be new billet steel Grade 60, as shown on the Drawings, meeting the requirements of ASTM A615. Welded wire fabric shall conform to ASTM A185.

B. Reinforcing steel shall be accurately fabricated and shall be free from loose rust, scale, and contaminants which reduce bond.

C. Reinforcing steel shall be accurately positioned on supports, spacers, hangers, or other reinforcements and shall be secured in place with wire ties or suitable clips. Rebar chair supports may be either steel or plastic.

2.03 MORTAR FILL AND NON-SHRINK GROUT

Mortar fill and non-shrink grout shall have a minimum compressive strength of 4,000 psi at 28 days.

2.04 SHOTCRETE

A. Shotcrete shall conform to ACI Standard 506, except as modified herein.

B. The wet mix process shall be employed for shotcreting.

C. Shotcrete used for covering prestressed wire shall consist of not more than three parts sand to one part Portland cement by weight. Additional coats of shotcrete shall consist of not more than four parts sand to one part Portland cement by weight. Polypropylene fibers shall be included in the shotcrete used for the finish covercoat. Fibers shall be Harbourite by Synthetics Industries, or equal. Fiber length shall be 1/4". The amount of the fibers added to the shotcrete used for the finish covercoat shall conform to the manufacturer's recommendations. Shotcrete shall have a minimum strength of 4,500 psi at 28 days.

2.05 STEEL DIAPHRAGM

A. The steel diaphragm shall conform to ASTM A1008 and shall be a minimum of 26 gauge thickness. It shall be vertically ribbed with reentrant angles. The back of the channels shall be wider than the front, providing a mechanical keyway anchorage with the concrete and shotcrete encasement.

B. The steel diaphragm shall extend to within one inch of the full height of the wall panel with no horizontal joints. Vertical joints within a wall panel shall be roll seamed or otherwise fastened in a fashion which results in a firm mechanical lock. Joints between wall panels that are not roll seamed shall be edge sealed with polysulfide or polyurethane sealant.

C. No punctures will be permitted in the diaphragm except those required for pipe sleeves, temporary construction openings, or special appurtenances. Details of the openings shall be approved by the Engineer. All openings shall be completely edge sealed with polysulfide or polyurethane sealant.

D. Diaphragm steel may be considered as contributing to the vertical reinforcement of the wall.

2.06 PRESTRESSING STEEL

A. Steel for prestressing shall be cold drawn, high carbon wire meeting the requirements of ASTM A821, having a minimum ultimate tensile strength of 210,000 psi.

B. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the reinforcement and shall develop the full strength of the wire. Wire splice and anchorage accessories shall not nick or otherwise damage the prestressing.

2.07 ELASTOMERIC MATERIALS

A. 9” minimum waterstop with centerbulb shall be polyvinyl chloride meeting the requirements of the Corps of Engineers Specification CRD-C 572. Splices shall be made in accordance with the manufacturer’s recommendations subject to the approval of the Engineer. Waterstop shall be manufactured by Greenstreak Plastic Products Company, Inc., or equal.

B. Bearing pads shall be natural rubber or neoprene.

1. Natural rubber bearing pads shall contain only virgin natural polyisoprene as the raw polymer and the physical properties shall comply with ASTM D2000 Line Call-Out M 4 AA 414 A1 3.

2. Neoprene bearing pads shall have a hardness of 40 to 50 durometer, a minimum tensile strength of 1500 psi, a minimum elongation of 500%, and a maximum compressive set of 50 percent. Pads shall meet the requirements of ASTM D2000 Line Call-Out M 2 BC 410 5 A1 4 B14 for 40 durometer material.

C. Sponge filler shall be closed-cell neoprene or rubber conforming to ASTM D1056, Type 2, Class A, and Grade 1. Compression deflection limited to 25 percent at 2 to 5 psi.

D. Polysulfide or polyurethane sealant will be a two or three component elastomeric compound meeting the requirements of ASTM C920. Sealants must have permanent characteristics of bond to metal surfaces, flexibility, and resistance to extrusion due to hydrostatic pressure. Air cured sealants shall not be used.

E. Decorative coating shall be applied to the exterior dome surface using one coat of a cementitious based damp-proofing product such as “Tamoseal” or equal, and one coat of a non-cementitious, high build, 100% acrylic resin polymer such as “Tammscoat” smooth textured protective coating or equal. A decorative coating shall be applied to the exterior wall surfaces using two coats of a non-cementitious, high build, 100% acrylic resin polymer such as “Tammscoat Smooth” textured protective coating or equal.

2.08 APPURTENANCES

The Contractor shall provide and install all appurtenances as shown on the drawings. Appurtenances shall include the following:

FOR CLARIFIERS

1. Influent-Effluent Piping

2. Sludge and Scum Return Piping

3. Effluent Trough with support system as required

4. Center Pedestal Support

FOR DIGESTERS WITH CONCRETE DOME

1. Sludge Influent-Effluent Piping

2. Roof Hatch Aluminum: Lockable, not less than 4'-0" x 4'-0", Halliday Series F1R4848 with options MADASZ or equal. All hardware shall be stainless steel.

3. Hatch Covers and Sampling Tube hatches shall be of aluminum construction.

{NOTE: If the distance from final grade to the top of the roof ring is greater than 30'-0", an exterior ladder may be added.}

4. Exterior Ladder: An aluminum ladder shall extend from 8'-0" above the final grade to the tank roof. The ladder shall have an OSHA-approved fall prevention device (if required) consisting of a sliding, locking mechanism and safety belt. Location as shown on the drawings.

FOR COVERED CSO TANKS

1. Influent - Effluent Piping

2. Overflow Weir and Piping

3. Roof Hatch Aluminum: Lockable, not less than 3'-6" x 3'-6", Halliday Series F1R4242 with options MADASZ or equal. All hardware shall be stainless steel.

4. Roof Vent: Fiberglass or Aluminum, with Type 304 stainless steel insect 20 x 20 screen, minimum diameter 2'-0".

{NOTE: If the distance from final grade to the top of the roof ring is greater than 30'-0", an exterior ladder may be added.}

5. Exterior Access Ladder - An aluminum ladder shall extend from the tank roof to 8' above the final grade. The ladder shall have an OSHA-approved fall prevention device (if required) consisting of a sliding, locking mechanism and safety belt. Location as shown on the drawings.

{NOTE: If the distance from final grade to the top of the roof ring is greater than 40'-0", an Access Manway may be added.}

6. Access Manway: A circular 25 inch diameter or elliptical 18" x 24" Type 304 stainless steel wall manway with a hinged cover. A Type 304 stainless steel grab bar and an aluminum ladder shall be installed at the manway location. Locate access manway as shown on drawings.

FOR OPEN TOP CSO TANKS

1. Influent - Effluent Piping

2. Overflow Weir and Piping

{NOTE: If the distance from final grade to the top of the wall is greater than 30'-0", an exterior ladder may be added.}

3. Exterior Access Ladder - An aluminum ladder shall extend from the tank roof to 8' above the final grade. The ladder shall have an OSHA-approved fall prevention device (if required) consisting of a sliding, locking mechanism and safety belt. Location as shown on the drawings.

{NOTE: If the distance from final grade to the top of the wall is greater than 40'-0", an Access Manway may be added.}

4. Access Manway: A circular 25" diameter or elliptical 18" x 24" Type 304 stainless steel wall manway with a hinged cover. A Type 304 stainless steel grab bar and an aluminum ladder shall be installed at the manway location. Locate access manway as shown on drawings.

{NOTE: Additional appurtenances, if required, such as anti-vortex plates, pressure-sensing devices, etc., may be included here.}

PART 3 - CONSTRUCTION

3.01 CLEARING, GRUBBING, AND STRIPPING

A. All trees, shrubs, brush, stumps, roots, and other objectionable material shall be removed to a minimum distance of 12'-0" outside the edge of the tank floor, plus additional areas necessary for the tank construction. In addition, all vegetation shall be removed from areas designated for precast panel casting beds, material storage, and construction trailers.

B. Select trees may be designated by the Owner/Engineer to remain. The Contractor shall take precautions against injuring designated trees.

C. No burning will be allowed unless approved by the Engineer and local authorities. All trees and vegetation shall be disposed of off site.

D. The area to be "worked" in the construction of the tank, or any area interfered with, shall be stripped of all topsoil, loam, etc., and any other unsuitable materials, to the depth encountered below the original ground surface as specified herein or as directed by the Engineer.

E. All approved topsoil or loam shall be stripped to the depths encountered. All loam or topsoil so removed and deemed suitable by the Engineer for use in finish grading, whether incorporated in the work or not, shall be separately stockpiled on the site where directed by the Engineer. The suitability of the stripped material for

use as loam shall be determined by the Engineer. All loam shall remain the property of the Owner and none shall be removed from the site. Sticks, stones, roots, etc., over three inches in size, shall be removed from the loam when it is replaced in the finish grading.

3.02 EXCAVATION AND BACKFILL

A. The Contractor shall excavate to such depths and widths as will provide adequate room for tank construction with a minimum working area of 12'-0" beyond the circumference of the tank footing at the elevation of the top of the floor.

B. The Contractor shall excavate rock, if encountered, to the lines and grades indicated on the drawings, or as directed; shall dispose of the excavated material; and, shall furnish acceptable material for backfill in place of the excavated rock. Rock excavation shall be measured separately and paid by the unit price indicated in the bid. The pay limit for rock in the area of the tank shall be 10'-0" from the exterior of the tank footing.

C. If the tank is to be built on undisturbed earth, under no circumstances shall the earth be plowed, scraped, or dug by machinery in a way that will result in the disturbance of material below final grade. In the event the subgrade material is disturbed, it shall be removed and replaced as detailed below, at the Contractor's expense.

D. If, in the opinion of the Engineer, the earth or rock at or below grade is unsuitable for the foundation, the Engineer shall direct that it be removed by the Contractor and replaced with compacted gravel at the expense of the Owner.

E. After excavating rock and boulders, the bottom of the excavation shall be proof rolled and leveled as directed by the Engineer before the compacted gravel is placed. Before any gravel is to be placed against rock surfaces, the rock shall be relatively free of all vegetation, dirt, clay, boulders, scale, excessively cracked rock, loose fragments, ice, snow, and other objectionable substances. All free water left on the surface of the rock shall be removed.

F. Compacted gravel, if required, shall be well graded sandy gravel or gravelly sand having not more than 8% by weight passing the 200 mesh sieve. The maximum size stone shall be three inches. Gravel shall be placed in layers not exceeding 12 inches and compacted to a minimum density equal to 95% of the maximum laboratory density under the footing and floor in accordance with ASTM

D1557. Field testing for the density achieved shall be in accordance ASTM D1556. Testing shall be performed at the expense of the Contractor.

G. The excavation shall be dewatered during all construction operations. The dewatering method used shall prevent disturbance of the earth below grade.

H. The tank shall be backfilled and rough graded to the contours shown on the drawings. In general, and unless other material is specified by the Engineer, material used for backfilling or building embankments shall be the excavated material.

I. Frozen material shall not be used for backfill or embankments, nor shall fill material be placed on snow, ice, or frozen material. Rock shall not be used in backfilling or embankment construction within 2-ft 0-in of the structure.

J. Backfill material shall be placed in uniform layers and compacted to a minimum density of 90% of the maximum density determined by ASTM D1557. Avoid unbalanced backfill placement except as may be fully provided for in the design.

K. Surplus excavated material remaining after backfill or embankments are completed shall be removed from the site and/or disposed of as directed by the Engineer.

L. Minimum backfill depth shall be determined by local code requirements.

3.03 FLOOR

A. The floor and wall footings shall be constructed to the dimensions shown on the Approved Shop Drawings.

B. Prior to placement of the floor reinforcing, a six mil polyethylene moisture barrier shall be placed over the subbase. Joints in the polyethylene shall be overlapped a minimum of six inches.

C. Prior to placement of the floor concrete, all piping that penetrates the floor, shall be set and encased in concrete.

D. The vertical waterstop shall be placed and supported so that the bottom of the center bulb is at the elevation of the top of the footing. The waterstop shall be supported without puncturing any portion of the waterstop unless it is manufactured with holes for tying. The

waterstop shall be spliced using a thermostatically controlled sealing iron and each splice shall be successfully spark tested prior to encasement in concrete.

E. The floor shall have a minimum thickness of four inches and be poured monolithically. There shall be no construction joints in the floor or between the floor and footing. Floors over 30,000 sq. ft. in surface area may, at the option of the Contractor, have one or more construction joints. Such construction joints shall be approved by the Engineer prior to placement.

F. The floor shall be cured by applying one coat of curing compound and/or flooding with water, and shall remain saturated for a minimum of seven days.

3.04 PRECAST PANEL CONSTRUCTION AND ERECTION

A. The precast wall shall be constructed with a continuous waterproof steel diaphragm embedded in the exterior of the precast panel. Horizontal joints in the diaphragm will not be allowed.

B. No holes for form ties, nails, or other punctures will be permitted in the wall.

C. Temporary wall openings may be provided for access and removal of construction materials from the tank interior subject to the approval of the Engineer.

D. Precast panel beds shall be located around the periphery of the tank as required. The beds shall be constructed to provide finished panels with the proper curvature of the tank.

E. Polyethylene sheeting shall be placed between successive pours to provide a high moisture environment and a long slow cure for the concrete.

F. The erecting crane and lifting equipment shall be capable of lifting and placing the precast panels to their proper location without causing damage to the panel.

G. The precast panels shall be erected to the correct vertical and circumferential alignment. The edges of adjoining panels shall not vary inwardly or outwardly by more than 3/8 inch and shall be placed to the tank radius within $\pm$ 3/8 inch.

H. Joints between precast wall panels shall be bridged with a 10 gauge steel plate edge sealed with polysulfide or polyurethane and filled with mortar as shown on the drawings. No through-wall ties will be permitted.

I. Minimum precast panel thickness shall be four inches.

3.05 CONCRETE

A. All concrete shall be conveyed, placed, finished, and cured as required by pertinent ACI standards.

B. Weather Limitations

1. Unless specifically authorized in writing by the Engineer, concrete shall not be placed without special protection during cold weather when the ambient temperature is below 35 degrees Fahrenheit and when the concrete is likely to be subjected to freezing temperatures before initial set has occurred and the concrete strength has reached 500 psi. Concrete shall be protected in accordance with ACI 306. The temperature of the concrete shall be maintained in accordance with the requirements of ACI 301 and ACI 306. All methods and equipment for heating and for protecting concrete in place shall be subject to the approval of the Engineer.

2. During hot weather, concreting shall be in accordance with the requirements of ACI 305.

3. Placement of concrete during periods of low humidity (below 50 percent) shall be avoided when feasible and economically possible, particularly when large surface areas are to be finished. In any event, surfaces exposed to drying wind shall be covered with polyethylene sheets immediately after finishing, or flooded with water, or shall be water cured continuously from the time the concrete has taken initial set. Curing compounds may be used in conjunction with water curing, provided they are compatible with coatings that may later be applied, or they are degradable.

C. Finishes

The tank shall be given the following finishes:

FOR FLAT FLOORS

1. The floor slab shall receive a bull float finish or fresno finish.

FOR SLOPED FLOORS

1. The floor slab shall receive a bull float finish or fresno finish.
2. The interior of precast wall panels shall receive a light broom finish.
3. Exterior shotcrete shall receive a nozzle finish.

ADD FOR COVERED TANKS

4. The exterior of precast dome panels, dome slots, and cast-in-place domes shall receive a light broom finish.

D. Curing

Concrete shall be cured using water methods, sealing materials, or curing compounds. Curing compounds shall not be used on surfaces to which decorative coatings, mortar, or shotcrete is to be applied. Curing compounds used within the tank shall be suitable for use with potable water.

E. Testing

1. For concrete placed in precast panels or wall slots, a set of three cylinders shall be made for each truck load of concrete placed. For concrete placed in the floor, dome ring, or dome slots, two sets of three cylinders for the first 50 cubic yards, and 1 set of three cylinders for every 150 cubic yards thereafter placed in the same day. One cylinder shall be tested at seven days, one at 28 days, and one held as a spare.

2. Slump tests on each delivery shall be made prior to placement. Slump shall not exceed four inches unless a high range water reducer is being used.

3. All concrete testing shall be in accordance with ASTM C-31 and C-39, at the expense of the contractor, and shall be conducted by an independent testing agency approved by the Engineer.

3.06 PRESTRESSING

A. Prestressing wire will be placed on the wall with a wire winding machine capable of consistently producing a stress in the wire within a range of -7 percent to +7 percent of the stress required by the design. No circumferential movement of the wire along the tank wall will be permitted during or after stressing the wire. Stressing may be accomplished by drawing the wire through a die or by another process that results in uninterrupted elongation, thus assuring uniform stress throughout its length and over the periphery of the tank.

B. Each coil of prestressing wire shall be temporarily anchored at sufficient intervals to minimize the loss of prestress in case a wire breaks during wrapping.

C. Minimum clear space between prestressing wires is 5/16 inch or 1.5 wire diameters, whichever is greater. Any wires not meeting the spacing requirements shall be respaced. Prestressing shall be placed no closer than two inches from the top of the wall, edges of openings, or inserts, nor closer than three inches from the base of walls or floors where radial movement may occur.

D. The band of prestressing normally required over the height of an opening shall be displaced into circumferential bands immediately above and below the opening to maintain the required prestressing force. Bundling of wires shall be prohibited.

E. A stress plate shall be used at all permanent wall penetrations that results in displacement of wire equal to or greater than 24” in height above grade. The stress plate shall accommodate a portion of the prestressing wires normally required for the height of the opening. The remaining prestress wires normally required shall be displaced into circumferential bands immediately above and below the penetration. The effect of banded prestressing shall be taken into account in the design.

F. Ends of individual coils shall be joined by suitable steel splicing devices capable of developing the full strength of the wire.

G. The Contractor shall furnish a calibrated stress recording device, which can be recalibrated, to be used in determining wire stress levels on the wall during and after the prestressing process. At least one stress reading per vertical foot or one stress reading for every roll of wire, whichever is greater, shall be taken immediately after the wire has been applied on the wall. Readings shall be recorded and shall refer to the applicable height and layer of wire for which the stress is being taken. A written record of stress

readings shall be kept by the Contractor. All stress readings shall be made on straight lengths of wire. If applied stresses fall below the design stress in the steel, additional wire will be provided to bring the force on the corewall up to the required design force. If the stress in the steel is more than 7% over the required design stress, the wrapping operation should be discontinued, and satisfactory adjustment made to the stressing equipment before proceeding.

3.07 SHOTCRETING

A. Weather Limitations

1. Shotcrete shall not be placed in freezing weather without provisions for protection against freezing. Shotcrete placement can start without special protection when the temperature is 35 degrees Fahrenheit and rising, and must be suspended when the temperature is 40 degrees Fahrenheit and falling. The surface to which the shotcrete is applied must be free from frost. Cold weather shotcreting shall be in accordance with ACI 301 and ACI 306.

2. Hot weather shotcreting shall be in accordance with the requirements of ACI 301 and ACI 305.

B. Coating of Steel Diaphragm

1. The steel diaphragm shall be covered with a layer of shotcrete at least ½ inch thick prior to prestressing.

2. Total minimum coating over the steel diaphragm shall be 1-1/2 inches including diaphragm cover, wire cover, and finish covercoat.

C. Coating Over Prestressing Wire

1. Each prestress wire shall be individually encased in shotcrete. Wire coat thickness shall be sufficient to provide a clear cover over the wire of at least 1/4 inch.

2. Finish covercoat shotcrete shall be applied as soon as practical after the last application of wire coat. The total thickness of shotcrete shall not be less than one inch over the wire.

D. Placement of Shotcrete

1. Shotcrete shall be applied with the nozzle held at a small upward angle not exceeding five degrees and constantly moving during application in a smooth motion with the nozzle pointing in a radial direction toward the center of the tank. The nozzle distance from the prestressing shall be such that shotcrete does not build up or cover the front face of the wire until the spaces behind and between the prestressing elements are filled.

2. Total covercoat thickness shall be controlled by shooting guide wires. Vertical wires shall be installed under tension and spaced no more than 2'-0" apart to establish uniform and correct coating thickness. Monofilament line (100 lb. test) or 18 or 20 gauge high tensile strength steel wire shall be used. Guide wires shall be removed after placement of the covercoat.

E. Curing

Shotcrete shall be cured using water curing methods or sealing materials at the option of the Contractor.

F. Testing

1. Testing of shotcrete shall be in accordance with ACI 506, except as specified herein. One test panel shall be made for each of the following operations: corewall, cove, wire cover, and covercoat. Test panels shall be made from the shotcrete as it is being placed, and shall, as nearly as possible, represent the material being applied. The method of making a test sample shall be as follows: A frame of wire fabric (one foot square, three inches in depth) shall be secured to a plywood panel and hung or placed in the location where shotcrete is being placed. This form shall be filled in layers simultaneously with the nearby application. After 24 hours, the fabric and plywood backup shall be removed and the sample slab placed in a safe location at the site.

2. The sample slab shall be moist cured in a manner identical with the regular surface application. The sample slab shall be sent to the testing laboratory. Nine 3" inch cubes shall be cut from the sample slab and subjected to compression tests in accordance with current ASTM Standards. Three cubes shall be tested at the age of 7 days, three shall be tested at the age of 28 days, and three shall be retained as spares. Testing shall be by an independent testing laboratory, approved by the Engineer, at the contractor's expense.

3.08 DECORATIVE COATINGS

A. All exposed exterior dome surfaces shall be given a two-coat finish consisting of one coat of damp-proofing product such as “Tamoseal with AKKRO-7T” or equal, and one coat of “Tammscoat Smooth” or equal. All exterior exposed wall surfaces shall be given a two-coat finish of a non-cementitious 100% acrylic such as “Tammscoat Smooth” or equal. Work shall be performed by workmen skilled in the application of these types of products. The manufacturer’s application instructions shall be submitted to the Engineer for approval. The Contractor shall confer with the manufacturer’s representatives regarding application techniques and shall follow the manufacturer’s instructions implicitly.

B. The concrete surface to be coated must be clean, free of all laitance, dirt, grease, or other foreign materials. All defective surfaces shall be filled and/or repaired. Application shall be in full accordance with the manufacturer’s instructions or as amended by the Engineer.

C. The Owner shall select the color.

{NOTE: Many tanks include additional architectural treatments which should be specified here.}

3.09 WATERTIGHTNESS TEST

A. Upon completion, the tank shall be tested to determine watertightness. The tank shall be filled with water to the maximum level. Water will be furnished to the tank by the owner. 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.

B. 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.

C. Damp spots will not be permitted at any location on the tank 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.

D. 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.

3.10 CLEAN-UP

The premises shall be kept clean and orderly at all times during the work. Upon completion of construction, the contractor shall remove or otherwise dispose of all rubbish and other materials caused by the construction operation. The Contractor shall leave the premises in as good a condition as it was found.