

PRESTRESSED CIRCULAR CONCRETE TANK SPECIFICATION (13414)

These Prestressed Concrete Tank Specifications are for construction in accord with industry standards. In reviewing the specifications please note the following areas as they may need to be adjusted to make the tank specification site specific.

ACCESSORIES - Go over the list of accessories to see that all of them are required for the project in Paragraph 2.06. In many instances the liquid level indicator in sub Paragraph I is not desired or required.

FLOOR - The floor shown is for a standard membrane slab in Paragraph 3.01. If a structural slab, such as piles or a ballast slab, is required, this paragraph needs to be adjusted.

DOME ROOF - In paragraph 3.05B the dome roof is specified as a 1:10 rise, which is a standard rise. In some instances a lower rise dome will be required for appearance and this can be altered down to a 1:14 rise on smaller size tanks.

DECORATIVE COATINGS - Generally the interior of the tank is not painted. If it is desired to be painted for installations such as aggressive water or liquids such as in a reverse osmosis water plant or a waste water treatment plant then an interior coating can be specified. Generally two coats of Tnemec Potapox or Sherwin Williams Macro Poxy are used for this purpose. In the case of tanks with aerators the underside of the dome and top 2' of the wall should be coated with Macro Poxy to prevent hydrogen sulfide attack.

The exterior exposed surfaces of the tank are often painted for appearance. The painting does not add to the structural integrity or life of the tank and is virtually the only maintenance item that is required on the tank. If painting of the exterior surface is not required, delete paragraph 3.08 in its entirety.

STERILIZATION - Sterilization may not be required, and if this is the case, it can be eliminated in Paragraph 3.09 A&B.

MATERIALS TESTING - In Paragraph 3.10 the typical materials testing for prestressed tanks is outlined. It may be that this is to match the testing required in the concrete specifications.

DESIGN DATA – Fill in the appropriate information in Paragraph 1.05

SECTION 13414
PRESTRESSED CIRCULAR CONCRETE TANK

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the work necessary for the design, submittals, construction, and testing of the prestressed concrete tank.
- B. Furnish all labor, materials, equipment, tools, scaffolding and incidentals required to construct a prestressed concrete water storage tank as shown on the drawings and as specified herein.
- C. The prestressed concrete tank shall have a wire-wound prestressed shotcrete core wall in which a steel shell diaphragm of a height equal to the full wall height has been encased. All prestressing shall be done with high tensile wire permanently bonded to the tank wall. The tank floor shall be a concrete membrane slab. The tank roof shall be a free span concrete dome.
- D. The entire tank, including all portions of the floor, wall, and roof shall be built by a specialty tank contractor, using its own trained personnel and equipment.

1.02 REFERENCES

- A. ACI 301 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
- B. ACI 318 - Building Code Requirements for Reinforced Concrete
- C. ACI 506 - Recommended Practice for Shotcreting
- D. ASTM A 185 - Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
- E. ASTM A 227 - Steel Wire, Hard-Drawn for Mechanical Springs
- F. ASTM A 366 - Specification for Sheet Steel
- G. ASTM A 416 - Uncoated Seven-Wire, Stress-Relieved Strand for Prestressed Concrete
- H. ASTM A 586 - Zinc-Coated Steel Wire Structural Strand

- I. ASTM A 615 - Specification for Deformed Billet Steel Bars for Concrete Reinforcement
- J. ASTM A 821 - Steel Wire, Hard-Drawn for Prestressing Concrete Tanks
- K. AWWA C 652 - Disinfection of Water Storage Facilities
- L. AWWA D110 - Wire Wound Prestressed Concrete Water Tanks
- M. CRD - C572 - Specification for PVC Waterstop - Corps of Engineers

1.03 SUBMITTALS

- A. Submit detailed design drawings sealed by a professional engineer registered in the state where the tank is located.
- B. Submit design calculations sealed by a professional engineer registered in the state where the tank is located.
- C. Submit mix designs for floor and dome roof concrete mixes.
- D. Submit mix designs for shotcrete mixes.

1.04 QUALITY ASSURANCE

- A. The tank contractor shall be a specialist in the design and construction of wire-wound circular prestressed concrete tanks. The tank contractor shall have had at least five (5) years of experience in this specialty and have built, completely in its own name, in the past five (5) years, no less than five (5) prestressed concrete tanks of comparable size demonstrating satisfactory service.
- B. The tank contractor's staff shall include a full-time professional engineer having no less than (5) years of experience in the design and field construction of circular prestressed concrete tanks, who will be the responsible engineer in charge of the work to be done. All working drawings and design calculations shall carry the seal of such registered professional engineer.
- C. The intent of the Specification is to create a singular responsibility for the design and construction of the prestressed concrete tank. The design and construction of all aspects of the floor, wall, prestressing, shotcrete and dome roof of the prestressed concrete tank must be performed by the tank contractor.

- D. The tank contractor shall be Precon Corporation of Newberry, Florida or approved equal.
- E. Any tank contractor desiring to be considered as an approved equal shall submit experience record, detailed design drawings, design calculations, and any deviations from the specifications at least ten days prior to the bid date.

1.05 DESIGN DATA

- A. The tank shall be designed for at a minimum the following:
 1. Weight of Structure
 2. Weight of Water
 3. Winds to _____ mph
 4. Earthquake Zone _____
 5. Live Load on the Dome of _____ psf
 6. Groundwater Table at EL. _____ ft
 7. Backfill Loads
 8. Sliding
 9. Subgrade with _____ psf allowable bearing capacity

1.06 GUARANTEE

- A. The tank construction company shall guarantee workmanship and materials on the entire tank structure for a period of five (5) years from date of acceptance of the work. In case leakage or other defects appear within the five (5) year period, the tank construction company shall proceed to make repairs promptly upon written notice by the owner that such defects have been found. Leakage is defined as the stream flow of liquid appearing on the exterior surface of the tank, or leakage through the base slab, the source of which is from the inside of the tank.
- B. To satisfy the 5-year guarantee, any tank contractor listed under Paragraph 1.04D shall furnish a written company warranty .

PART 2 - PRODUCTS

2.01 CONCRETE

- A. Concrete materials shall meet the requirements of ACI 301. Cement shall be Portland Type I or II. Up to 25% of cement may be replaced by fly ash.
- B. Mix proportions shall be in accordance with ACI 301. Concrete or shotcrete in direct contact with prestressed reinforcement shall not contain

chloride ions in excess of 0.06 percent of the weight of the cement in the mix.

- C. Concrete for floor and footing construction shall have a minimum 28-day strength of 3,500 psi. Concrete for wall and dome roof construction shall have a minimum 28-day strength of 3,500 psi.

2.02 SHOTCRETE

- A. Shotcrete materials shall meet the requirements of ACI 506. Cement shall be Portland Type I or II. Up to 25% of cement may be replaced by fly ash.
- B. Shotcrete shall have a minimum 28-day strength of not less than 4000 psi.
- C. Wet mix process referred to in ACI 506 for shotcreting shall be used.
- D. Shotcrete wire coat used for covering intermediate layers of prestressing wire shall consist of not more than three parts fine aggregate to one part cement.

2.03 REINFORCING STEEL

- A. Reinforcing steel bars shall be new billet steel grade 40 or 60 meeting the requirements of ASTM A615.
- B. Welded wire fabric shall conform to ASTM A185.

2.04 PRESTRESSING STEEL

- A. Steel for prestressing shall be cold drawn, high carbon wire, meeting the requirements of ASTM A821 or ASTM A227, having a minimum ultimate tensile strength of 230,000 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 splices shall not nick or otherwise damage the prestressing.

2.05 STEEL DIAPHRAGM

- A. The steel diaphragm shall conform to ASTM A366 for black and shall be a minimum of 26 gauge thickness. It shall be vertically ribbed with reentrant angles which provide a mechanical keyway within the wall.

- B. The steel diaphragm shall extend the full height of the wall.

2.06 ACCESSORIES

- A. The tank contractor shall furnish and install those accessories shown on the drawings.
- B. Wall Manhole - shall be fabricated of 304 stainless steel frame, cover, stainless steel bolts and neoprene gasket.
- C. Exterior Ladder - shall be fabricated of 6061-T6 aluminum with safety climbing device where required by OSHA or shown on drawings.
- D. Interior Ladder - shall be fabricated of 6061-T6 aluminum with safety climbing device where required by OSHA or shown on drawings.
- E. Ventilator - shall be all fiberglass construction with minimum 3/16" thickness located in the center of the dome. The ventilator shall be fastened with stainless steel bolts. Openings shall be covered with fiberglass screen.
- F. Overflow outlets - shall be precast concrete and located on the dome near the edge and positioned so that they start to function when the liquid level is three inches above the design high water level. The combined opening size of all overflows shall be three times the area of the largest pipe. The openings shall be covered with removable fiberglass screen and shall function as additional ventilators.
- G. Thru wall pipe sleeves shall be 304 stainless steel and shall seal the thru pipe with neoprene link-seal units using stainless steel bolts.
- H. Hatch cover shall be constructed of fiberglass or aluminum and capable of supporting a 240 pound live load. It shall be located on the dome near the edge and shall have a thirty inch square minimum opening.
- I. Liquid level indicator shall have a half travel board with an interior float. The board shall be fabricated of fiberglass. The remaining components shall be fabricated from aluminum, stainless steel or PVC pipe. Level indicator shall be included when called for on drawings.

PART 3 - EXECUTION

3.01 FLOOR

- A. The floor shall be reinforced concrete construction and shall be designed as a membrane slab in accord with AWWA D-110.

- B. Floor shall be 4 inches thick with 0.5 percent reinforcing steel in each direction.
- C. Floor thickness shall be 8 inches over all pipe encasements. Additional reinforcing shall be used over the encasement to maintain the 0.5% reinforcement. This additional mat shall extend a minimum of 2 feet into the adjacent floor.
- D. A 6 mil visqueen layer shall be placed under the flat portion of the floor slab prior to placing reinforcing.
- E. Floors shall be vibratory screeded to consolidate concrete and obtain encasement of floor reinforcing steel.
- F. Floors shall be water-cured until tank construction is completed.
- G. Floors shall be given a light broom or trowel finish.

3.02 COREWALL

- A. Core wall shall be constructed of shotcrete, encasing a continuous steel shell diaphragm. The thickness of the core wall shall be designed to accept the initial compressive forces applied by prestressing, backfill, and other applicable loads. The wall may taper uniformly on the outside face from top to bottom as required by design computations. In no case shall the core wall be less than 3 ½ inches thick as established by wall pins, line wires, or other positive means of controlling wall thickness. Horizontal sections of the wall shall form true circles without flats, excessive bumps, or hollows.
- B. The wall shall be designed for bending, shrinkage, and temperature stresses and shall be reinforced horizontally with reinforcing bars and vertically with reinforcing bars and the steel diaphragm.
- C. The steel diaphragm shall have a minimum 1 inch shotcrete cover.
- D. The top 2 feet of core wall shall have not less than one percent circumferential reinforcing and the bottom 3 feet of core wall shall have not less than one percent circumferential reinforcing.
- E. The wall exterior finish shall be a light broom finish or float finish.
- F. The interior wall finish shall be a light broom finish with the ripple pattern of the steel diaphragm being acceptable.

- G. Interior and exterior surfaces of the core wall shall be water cured.

3.03 DIAPHRAGM

- A. A steel diaphragm shall be embedded in the prestressed wall to form a waterstop. The diaphragm shall extend the full height and circumference of the tank wall and shall be composed of vertical panels.
- B. The diaphragm shall be fabricated with vertical re-entrant ribs that key the wall on each side of the diaphragm together. Steel diaphragm with vertical ribs may be used for vertical reinforcement.
- C. The steel diaphragm shall be encased and protected with shotcrete no less than 1 inch thick at all places.
- D. The steel shell diaphragm shall be epoxy bonded to a waterstop to the floor/wall connection.
- E. All vertical laps and joints between the diaphragm sheets shall be sealed with an epoxy sealant with a proven method that is visually inspected.
- F. No horizontal splices of the diaphragm will be allowed.
- G. No nail or other holes shall be made in the steel shell except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. All penetrations shall be sealed with epoxy.

3.04 SHOTCRETE

- A. All shotcrete shall be wet mix and in accordance with ACI-506, and shall be applied by or under direct supervision of experienced nozzlemen.
- B. The nozzle shall be held at such a distance and position that the stream of flowing material shall be as near as practical to the surface being covered. Shotcrete shall be applied in such a way that it flows into position. No air pockets shall form and good bond shall develop between reinforcement and shotcrete. Any deposit of loose sand shall be removed prior to placing of any original or succeeding layers.
- C. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.
- D. Shotcrete shall not be placed in freezing weather without provisions for protection of the shotcrete 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.

3.05 DOME ROOF

- A. The dome roof shall be constructed of cast in place reinforced concrete and shall be of thin shell design.
- B. The dome roof shall be a spherical shape and have a rise of one tenth of the tank diameter. The dome roof shall be supported by the tank wall and be free span with no interior columns or supports.
- C. Dome reinforcement shall consist of wire mesh or reinforcing bars as required by the design. Domes shall have a one-tenth rise and be free span. The dome shall be mesh reinforced shotcrete or concrete with a minimum 0.25% reinforcing.
- D. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have a cross section suitable to accept the applied prestressing forces. All surfaces in the wall-dome ring girder joint shall be coated with bonding epoxy.
- E. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.
- F. Bolsters for wire fabric and reinforcing bars shall be plastic tipped. Wire ties shall be galvanized.
- G. The exterior dome surface shall be given a light broom finish.

3.06 HORIZONTAL PRESTRESSING

- A. Prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire placed under high tension. An allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.
- B. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent upon the cold working or redrawing of the wire.

- C. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive stress equivalent to that shown on the drawings. The clear space between adjacent wires is to be no less than one wire diameter.
- D. Splicing of the wire shall be permitted only when completing the application of a full coat of wire, or when removing a defective section of wire.
- E. Anchor each reel of prestressing wire to the wall to minimize the loss of wire in case of a wire break. Join prestressed wires by splices that will develop the guaranteed ultimate strength of the wire. Do not use dissimilar alloys in the splicing material.
- F. The average theoretical vertical spacing between any two wires wrapped circumferentially shall have a minimum clearance of 1 wire diameter. Wires not meeting the spacing requirements shall be spread or otherwise removed.
- G. Do not bundle or drape wires around pipe or manhole openings. Spread wire falling in such areas over a predetermined area above and below such wall openings in conformance with the above wire spacing requirements.
- H. Only the aggregate force of all stressed wires per foot shall be considered rather than the force per individual wire, and such aggregate force shall not be less than required design values. No circumferential movement of the wire along the tank will be permitted during or after stressing of the wire.
- I. The tank contractor shall provide stress-measuring equipment capable of measuring stress in the wire after it is in place. The equipment shall be field calibrated for the wire being placed.
- J. The initial design force in the wire shall be 146,500 psi with a working force equal to 115,000 psi.
- K. The minimum initial compression in the core wall shall be 500 psi for tanks without domes and 300 psi for domed tanks.

3.07 EXTERIOR COVERCOAT

- A. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This shotcrete encasement shall completely encapsulate each wire and shall permanently bond the wire to the tank wall. The shotcrete shall have a thickness of no less than one inch over all wires. When multiple layers of wire are required, shotcrete cover between layers shall be no less than 1/8-inch thick.
- B. Total covercoat thickness shall be controlled by shooting guide wires or screed boards. Vertical wires shall be installed under established uniform and correct coating thickness. Wires of 18 or 20 gauge steel shall be used. Wires shall be removed after placement of the covercoat and prior to finishing.

3.08 DECORATIVE COATINGS

- A. All exposed concrete shall be given a three-coat finish consisting of one coat of a cementitious waterproofing product, Thoroseal or equal, and two coats of acrylic masonry paint, Porter 520 or equal.
- B. The concrete surface to be coated must be clean, free of all laitance, dirt, grease, and foreign material. All defective surfaces shall be filled or repaired.
- C. Painting shall be performed by skilled workmen familiar with this type of work. The manufacturer's application instructions shall be followed.
- D. Color shall be selected by the Owner.

3.09 STERILIZATION AND TESTING

- A. Sterilization of the completed tank follow the criteria found in AWWA C652.
- B. Bacteriological sampling of the tank shall be performed by the owner.
- C. Prior to placing in service the tank shall be filled with water furnished by the Owner. The tank shall remain filled for a period of at least 24 hours to allow for absorption and initial settlement.
- D. The liquid volume loss for a period of 24 hours shall not exceed one-twentieth of one percent of the tank capacity. If the liquid volume loss exceeds this amount, leakage shall be considered excessive, and the tank shall be repaired and retested.

- E. Damp spots on the footing are permissible within the allowable leakage requirements. Running water on the footing regardless of the leakage allowance, will not be permitted.

3.10 MATERIAL TESTING

- A. Prepare sets of three 6-inch by 12-inch cylinders or 4-inch by 8-inch cylinders for each 75 cubic yards of concrete used on the footing, floor, and dome. Prepare and test a minimum of two sets for the outside portion of the core well and one set for the inside portion of the core wall.
- B. Test cylinders as follows: One at 7 days, one at 28 days and one hold.
- C. Submit mill test reports certifying that the prestressing steel meets ASTM standards.