Item No. 524
Precast Wire Wound Prestressed Concrete Tank

Notes to Specifier:

Delete these notes and parts that are not applicable.

Where options are given, make appropriate selection and delete the other option, fill in all blanks.

Tank manufacturers should review this Section prior to Bid.

524.1 Description

A. This Section describes the design and construction of circular precast, wire-wound, prestressed concrete tank complete with steel diaphragm in accordance with AWWA D110, Type III. The acceptance of the prestressed concrete tank is predicated upon the design criteria and construction methods specified. In the case of conflict between this and other Sections of the Specifications, the requirements of this Section will govern.

B. The minimum acceptable site preparation must be as indicated on the Drawings and as specified in TXDOT Standard Specification Section 400 “Excavation and Backfill for Structures. “The tank manufacturer must increase site preparation as necessary to be compatible with the foundation design.

Note to Specifier: Delete if storing media other than potable water.

C. The tank, appurtenances, and all material exposed on the interior of the tank or in contact with stored water must be resistant to degradation from the use of chlorine and chloramines.

D. [Add any other special requirements, water chemistry, water temperature, raw water with dissolved solids, pH, etc.]

524.2 Quality Assurance

A. Qualifications: The tank manufacturer must be a specialist in the design and construction of circular, precast, wire wound prestressed, AWWA D110 Type III concrete tanks and must have constructed a minimum of thirty such structures of the same size tank as specified in this Project or larger, which have been in successful service for a minimum of 5 years.

B. Acceptable Tank Manufacturers:

1. DN Tanks.
2. Preload, Inc.

C. Singular Responsibility: It is the express intent of this Specification to create a singular point of responsibility for the design and construction of the precast wire wound prestressed concrete tank(s). The design indicated within the Drawings and Specifications for the floor slab and subgrade are the minimum requirements. The design and construction of all aspects, including but not limited to the floor slab, wall, subgrade, granular subbase, prestressing, concrete dome, and shotcrete of the prestressed concrete tank is the sole responsibility of the tank manufacturer. Tank

manufacturer must supervise and have a representative on-site at all times during excavation and backfill of the tank foundation to ensure Work is performed in compliance with the Drawings, Specifications and geotechnical report.

D. The tank manufacturer must have in its employ a design engineer with a minimum of 10 years of experience in the design of AWWA D110 Type III tanks. The design engineer must have been the engineer of record for a minimum of ten AWWA D110 Type III tanks.

E. The tank manufacturer must have in its employ for this Project a team consisting of a tank superintendent, project manager, shotcrete foreman, wire-winding foreman, and precast erection foreman, each of whom must have constructed a minimum of five AWWA D110 Type III tanks having a capacity of 1.0 MG or greater.

F. The tank manufacturer's construction superintendent must have a minimum of 4 years of experience with prestressed concrete tanks of similar design. The tank manufacturer must furnish a superintendent on the Site at all times during construction of the tank work. Tank manufacturer may designate a subcontractor's superintendent during the Work described herein. Tank manufacturer must submit proposed designated superintendent to the Engineer in writing with a resume indicating experience in excavation and foundation work.

G. The tank work is defined as the water containment portion of the tank, including the walls and floor slab, roof, floor slab penetrations, foundation, base, subgrade, waterstops, joints, bearing pads, cables, and all other items penetrating or attaching to the floor or walls of the tank. Only the following Work may be subcontracted to qualified subcontractors experienced in the type of work to be subcontracted, and under the supervision of the prestressed tank manufacturer:

   1. Earthwork including excavation, backfilling, foundation preparation and final grading.
   2. Reinforcing steel installation and the concrete slab placement labor.
   3. Coating of the exterior walls and exterior dome roof.
   4. Miscellaneous work exterior of the tank, including under floor piping and encasements.

H. The tank manufacturer is fully responsible for the water-tightness of the tank.

I. The tank manufacturer must obtain and review all the geotechnical information pertaining to this Work.

J. Tank manufacturer must conduct one pre-pour meeting with Owner and Engineer prior to pouring the foundation.

K. The tank manufacturer must retain and pay for the services of an Independent Testing Laboratory, subject to the approval by the Owner, to perform compaction and compressive tests of concrete and shotcrete for all Work associated with the tank and as indicated in this Section. All other testing responsibilities must be as indicated in the Specifications.

L. Field Measurements:

   1. Verify elevations by field measurements. Submit the following elevations as Product Data prior to proceeding with subsequent Work.
   2. Provide surveyed elevations on a 10-foot grid for the top of the granular subbase prior to placement of the floor slab.

3. Provide surveyed elevations on a 10-foot grid for the top of the finished concrete floor slab.
4. Provide survey required for the evaluation of settlement of the tank during water tightness testing.

524.3 Submittals

Submittal requirements of this specification item must include:

A. Contractor must provide a single Shop Drawing submittal for the tank design calculations and drawings. Partial submittals will not be accepted and will be returned without review.

B. Submittals for materials may be combined to reduce the total number of submittals required.

C. The Engineer's general review and approval must not relieve the tank manufacturer of their design responsibility.

D. Provide the following Shop Drawings:

1. After Contract award, and prior to the start of construction, the tank manufacturer must submit Shop Drawings to the Engineer for review and approval which include design calculations, proposed tank/dome roof connections, drawings, certification that the tank has been designed to support the concrete dome and construction procedures for the tank and all appurtenances. Include design calculations for tank design, and capacities for vent, overflow, and overflow weir. Design calculations and record drawings must be sealed by a professional engineer licensed in the state where the Project is located.
2. Concrete and shotcrete, include:
    i. Mix designs for all concrete and shotcrete used for the tank construction.
    ii. Admixtures to be used in the concrete and/or shotcrete, their purpose and Safety Data Sheets (SDS's).
3. Reinforcing Steel must include manufacturer's information and ASTM certifications.
4. Mortar fill and non-shrink grout submittal must include manufacturer's information, compressive strength and ASTM certifications.
5. Steel diaphragm submittal must include cut sheets indicating dimensions, gauge and form, certified copy of mill test, and ASTM certifications.
6. Prestressing steel submittal must include:
    i. Manufacturer's information, tensile strength and ASTM certifications.
    ii. Certified copy of mill test on each heat or reel of prestressing wire showing physical and chemical analysis must be submitted at the time of shipment of prestressing wire.
    iii. Methods and procedures for prestressing prior to operation.
7. Elastomeric materials submittal must include manufacturer's information, ASTM certifications, indication if product will be in contact with potable water and NSF certification if in contact with potable water.

8. Sealants and joint fillers submittal must include manufacturer's information, ASTM certifications, indication if product will be in contact with potable water and NSF certification if in contact with potable water.
9. Tank appurtenances submittal must include manufacturer's information, ASTM certifications, drawings, materials utilized, etc.
10. Coatings and architectural treatments submittal must include manufacturer's information, application data for coatings, SDS's for coatings, color, selection charts for coatings and brick and architectural renderings.

E. Provide the following Certified Test Reports:
1. Performance data for all approved concrete and shotcrete mix designs.
2. Estimate maximum chloride ion content in the hardened concrete and shotcrete in contact with reinforcing. Maximum chloride ion content shall not exceed that allowed by ACI 350. Perform all tests as required for estimating chloride content, but not less than:
    i. Mix water tested in accordance with ASTM C1602, Table 2, regardless of whether water is potable or not.
    ii. All aggregates tested in accordance with ASTM C1524.
3. Performance data for concrete, flowable fill and shotcrete placed during construction. Compressive strength test reports must be provided to Owner within 7 days of test.

F. Provide the following samples:
1. Color samples for coatings.
2. Brick and mortar samples. Refer to Appurtenances Section in Paragraph 524.8 for additional submittals and procedures for approval of architectural treatment.

G. Provide the following Product Data:
1. Documentation of experience as required herein. Submit prior to start of construction.
2. Disinfection and testing plan.
3. Field measurements as required herein.
4. After construction is complete, Contractor must submit a full set of sealed tank drawings in PDF format with all changes during construction identified and incorporated.

H. Results from watertightness testing and post construction foundation survey.

I. Provide the following Schedules:
1. Daily schedule during concrete placement operations with updates if changes are required.
2. Daily schedule during disinfection and watertightness testing.

524.4 Standards

The following standards dictate standards used in project:
A. ASTM International (ASTM):

ASTM A185	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A366	Specification for Steel, Sheet, Carbon, Cold Rolled, Commercial Quality
ASTM A416	Specification for Steel Strand, Uncoated Seven Wire for Prestressed Concrete
ASTM D471	Test Method for Rubber Property-Effect of Liquids
ASTM A475	Specification for Zinc Coated Steel Wire Strand
ASTM A615	Standard Specifications for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
ASTM A821	Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks
ASTM A996	Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1008	Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM C42	Test Method for Obtaining Drilled Cores and Sawed Beam of Concrete
ASTM C143	Test Method for Slump of Hydraulic Cement Concrete
ASTM C172	Practice for Sampling Freshly Mixed Concrete
ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C920	Elastomeric Joint Sealants
ASTM C1218	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM D1056	Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D6938-10	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Placing and Structural Construction

ASTM D2000	Classification System for Rubber Products in Automotive Applications
ASTM D395	Test Methods for Rubber Property Compression Set
ASTM D698	Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort 12,400 ft.-lb./ft^3
ASTM D1557	Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort 56,000 ft.-lb./ft^3
ASTM D2240	Test Methods for Rubber Property Durometer Hardness

B. American Water Works Association (AWWA):

AWWA D100	Welded Steel Tanks for Water Storage
AWWA C152	Standard for Ductile Iron Pipe, Centrifugally Cast
AWWA C210	Liquid-Epoxy Coating and Linings for Steel Water Pipelines
AWWA C222	Polyurethane Coatings and Linings for Steel Water Pipe and Fittings
AWWA C652	Standard for Disinfection of Water Storage Facilities

C. American Concrete Institute:

ACI 301	Specifications for Structural Concrete
ACI 304 R	Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 305 R	Hot Weather Concreting
ACI 306 R	Cold Weather Concreting
ACI 309 R	Guide for Consolidation of Concrete
ACI 347 R	Guide to Formwork for Concrete
ACI 350 R	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 372 R	Design and Construction of Circular Wire- and Strand- Wrapped Prestressed Concrete Structures
ACI 506 R	Guide to Shotcrete

D. American Welding Society (AWS):

AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel

E. Miscellaneous Standards:

ANSI ASC A14.3	Ladders – Fixed – Safety Requirements
ASCE/SEI 7	Minimum Design Loads for Buildings and Other Structures
International Concrete Repair Institute (ICRI)	Concrete Surface Profile Comparators

MIL R 219 31(A) OS	Military Specification Resin, Epoxy
NSF/ANSI Standard 61	Drinking Water System Components – Health Effects
TAC Title 30, Part 1, Chapter 290, Subchapter D	Rules and Regulations for Public Water Systems

In the event of a conflict between the published standards, codes, and this Section, the more stringent requirement shall govern.

524.5 Design Criteria

A. Design Requirements: The tank must be designed in accordance with the requirements of ANSI/AWWA D110 Standard for Wire Wound Circular Prestressed Concrete Tanks, Type III: Precast Concrete with Steel Diaphragm. No alternate designs will be considered.

Note to Specifier: Provide project requirements.

B. Tank Dimensions and Capacity Criteria: The tank manufacturer must use the following loadings and requirements in the design calculation:

Tank Name	XX MG Ground Storage Tank	XX MG Ground Storage Tank
Minimum Storage Capacity	**X.0 million gallons**	**X.0 million gallons**
Dimensions:		
Inside Diameter	**XX feet**	**XX feet**
Wall Height	T.B.D. by tank manufacturer and approved by the Engineer	T.B.D. by tank manufacturer and approved by the Engineer
Side Water Depth	**XX feet**	**XX feet**
Liquid Unit Weight	62.4 lb/ft^3	62.4 lb/ft^3
Capacities:		
Maximum Fill Rate	**XX MGD**	**XX MGD**
Maximum Drawdown Rate (normal operation)	**XX MGD**	**XX MGD**
Maximum Head on Overflow Weir	6 inches	6 inches
Design Subsurface Water Depth	Top of Proposed Final Grade at Tank	Top of Proposed Final Grade at Tank

C. Loads to be considered in the tank design must include internal liquid pressure, backfill, pressure, seismic effects, construction procedures, prestressing, end restraints, temperature and moisture gradients, dead loads, live loads, wind loads, and loads due to the concrete dome roof.

D. Seismic design must be in accordance with the requirements of the ASCE 7-10 and AWWA D110 with the most stringent requirements controlling with the following design

loads. Tank manufacturer must provide calculations for both criteria and indicate the most stringent requirements.

Note to Specifier: Refer to structural for review and input on minimum design loads.

1. Basic Wind Speed: **[Specify speed].**

Note to Specifier: Use III for raw water and IV for treated water.

2. Risk Category: **[III] [IV].**
3. Site Class: **[Specify class].**
4. Spectral Response Coefficients: SDS = **[specify coefficient],** SD1 = **[specify coefficient].**
5. Seismic Design Category: **[Specify category].**

E. Structural Design Requirements:

1. Allowable Stresses:
    i. Compressive stresses in concrete and shotcrete must not exceed 0.55 f'c initial (immediately after prestressing) and 0.45 f'c final (after all losses have taken place) where f'c is the 28-day compressive strength of concrete or shotcrete. Vertical tensile stresses must be taken fully by reinforcing steel and/or the diaphragm.
    ii. Maximum permissible initial stress f'si in any prestressing wire on the wall must not exceed 0.75 fpu, where fpu equals the ultimate tensile strength of the wire. Stress losses due to shrinkage, plastic and elastic shortening of concrete or shotcrete, and relaxation in steel must be assumed as 25,000 psi.
2. Strength Design: Reinforcing steel must be designed in accordance with the requirements of ACI 350. Load combinations must be per ACI 350 and must include the environmental durability factor (Sd).

F. Tank Wall Design:

1. The tank wall must be designed as a composite concrete wall with an embedded mechanically bonded steel diaphragm in combination with vertical mild steel reinforcement.
2. The prestressed tank wall must be considered as an elastic cylindrical shell, with no reduction in hoop tension or compression taken due to edge restraint at the wall base.
3. The wall must be precast, incorporating a continuous watertight and mechanically-bonded steel diaphragm. Shotcrete or cast-in-place walls are not permitted. Minimum core wall thickness must be 4.5 inches, which includes a minimum shotcrete cover of 0.5 inches, which must be applied to the exterior of the steel diaphragm prior to wire winding.
4. Circumferential prestressing steel must be furnished to resist all forces due to internal loads, after accounting for stress losses and residual compression. Minimum residual compression in the core wall under tank full condition must be 200 psi and must not be reduced for below grade portion of the tank wall.

5. Prestressing for buried tanks must be designed to increase compression as necessary to allow for localized excavations around under-slap piping for future maintenance. Localized excavation must provide 5 feet horizontal and 2 feet vertical clear distance at the base of the excavation and meet OSHA slope stability requirements. Shop Drawings must indicate, depth and dimensions of safe excavation near the tank foundation per the tank manufacturer's design.
6. Mild steel reinforcement must be used to resist vertical bending stresses. The horizontal cross-sectional area of the steel diaphragm may be included as part of the vertical reinforcing. A minimum vertical reinforcement ratio of 0.0025 on each face of the wall section must be provided. The minimum concrete or shotcrete cover over steel reinforcement or diaphragm must be 1 inch or 1.5 times the diameter of the reinforcement, whichever is greater. Shotcrete coats over circumferential prestressing must be considered as part of the minimum diaphragm cover.
7. A suitable stress plate must be required at all locations where prestress wires are displaced by wall openings of 12 inches or greater. The stress plate must be designed to transfer stress across the opening.

Note to Specifier: Delete if no architectural treatments are included.

8. Tank wall must be designed to accommodate architectural treatments indicated on the Drawings and within this Section. Hangers and accessories required for the architectural treatments must be discontinuous with the prestressing wires, reinforcing, and other metal components of the tank.

G. Concrete Dome Roof Design:

1. The dome roof must have a rise to span ratio within the range of 1:8 to 1:14. The dome must be fixed to the tank wall. Columns or interior supports will not be allowed. No less than 95 percent of the concrete dome will have a minimum roof slope of 0.75 in/ft. The entirety of the concrete dome must have positive drainage and no ponding will be permitted.
2. The underside of the dome ring must be provided with a continuous 3/4-inch perimeter drip groove or equivalent to prevent water from running off the dome and down the side of the tank.
3. The dome design must be based on elastic spherical shell analysis and must include a circumferentially prestressed dome ring.
4. Minimum shell thickness must be proportioned for buckling, but must not be less than 4 inches for precast and cast-in-place domes. All joints between precast dome panels must be the full thickness of the precast dome panel. There must be no discoloration or change in texture at the joints between the dome panels as compared to the adjacent dome panels.
5. Mild steel reinforcement in each of two perpendicular directions must be placed at the mid-depth of the shell, except in the edge region where two layers of reinforcement are required. The minimum concrete cover over steel reinforcement must be 1 inch.

H. Floor Design:

1. The foundation design must be per ACI 350.

2. The floor must be a membrane type concrete slab designed to transfer loads directly to the subbase. It must be able to deflect to the settlement shape of the underlying soil without excessive stresses.
3. If required by the geotechnical report, a structural foundation must be incorporated into this Project. The floor design must be in accordance with ACI 350R with special attention to crack control and designed to support the tank contents to resist the maximum hydrostatic uplift forces, to resist expansive soils, and/or to take into account any other unusual foundation conditions warranted.
4. Temporary foundation "block-outs" to relieve hydrostatic uplift forces during construction will not be allowed.
5. The floor must be placed monolithically. No construction joints will be allowed unless approved by the Engineer.
6. Minimum floor thickness must be 8 inches. The wall footing must be proportioned to resist imposed loads.
7. Reinforce the floor slab with a minimum of two mats of reinforcing steel in each direction and a minimum area of reinforcing steel per foot in accordance with ACI 350. The reinforcing minimum clear cover must be per ACI 350 and must not be less than 2 inches.
8. Wall footings may be above or below floor grade, but must be placed monolithically with the floor.
9. Piping placed under the floor slab:
    i. Piping placed under the floor slab must be concrete encased for added corrosion protection and to ensure against leakage during the useful life of the structure.
    ii. Base materials must be placed under any inlet/outlet pipe(s) and compacted to the same specifications as the tank foundation granular base. The remainder of the excavation for inlet/outlet pipe(s) must be backfilled with lean concrete or flowable fill to the bottom of the granular subbase. Concrete encasement of pipe below the floor and pipe penetrations through the floor slab must be designed by the manufacturer and floor slab thickened if required.
10. A 6-mil polyethylene vapor barrier must be placed under the bottom of the slab. Joints in the polyethylene must be overlapped a minimum of 6 inches.

Note to Specifier: Modify per project requirements.

11. Floor must be sloped to **[drain and/or outlet]** pipe as shown on the Drawings.

I. Concrete mix designs to be in direct contact with soil must be designed to resist severe sulfate attack risk category utilizing appropriate cement type, compressive strength, water-cement ratio, and pozzolans. Final mix designs to resist sulfate attack must be submitted by tank manufacturer and approved by the Engineer prior to construction.

Note to Specifier: Verify with electrical engineer that instrumentation exists on the tank requiring lightning protection, if not required, delete paragraph below. Insert relevant specification number and name.

J. Lightning Protection:

1. Lightning protection must be as specified in **[Insert Section # "Insert Section Name."]**
2. The tank manufacturer must coordinate with the lightning protection subcontractor for the locations of all connections and hangers. The tank manufacturer must provide shotcrete pads or other means approved by the Engineer for attaching grounding cables to the shell.
3. Stainless steel Unistrut with stainless steel hardware must be used to secure conductors. Adhesive type mounting devices are not allowed. The hangers and accessories for the lightning protection system must be discontinuous with the prestressing wires, reinforcing, or other metal components of the tank.

K. The tank manufacturer may make minor adjustments to the tank details indicated on the Drawings as required to facilitate the tank manufacturer's proprietary design and construction methods. All adjustments or deviations from the Drawings or Specifications must be submitted to the Engineer for review and approval prior to construction.

524.6 Guarantees and Warranties

Note to Specifier: Verify warranty period with the Supplementary Conditions.

A. Workmanship and Material Guarantee: The tank manufacturer must guarantee the tank structure against defects in workmanship and material for a period of **[5 years]**. If within **[5 years]** from Final Completion of the entire Project, workmanship or material is proven defective, the tank manufacturer must repair such defects at his own expense.

B. Design Warranty: The tank manufacturer must warrant its design of the proposed facility to be structurally and functionally applicable to serve the intended use of the Project. Such intended use is exemplified by the criteria of design, workmanship, and material expressed by the requirements of the Contract Documents prepared by the Engineer. The Owner's or Engineer's review of the tank manufacturer's design, or the Owner's acceptance and final payment for the Work will not relieve the tank manufacturer of design responsibility. The Owner must be the direct beneficiary of the warranty.

Note to Specifier: Coordinate the information below with the Supplementary Conditions.

524.7 Project Conditions

A. Subsurface and Physical Conditions:

1. The following reports of explorations and tests of subsurface conditions at or contiguous to the Site of the Work:
    i. Report dated **[specify date]** and addendum dated **[specify date**] prepared by **[specify company]** entitled: **[specify title of report**], consisting of [**specify number]** pages. The technical data contained in the report upon which the Contractor may rely is core depth. Contractor recognizes that the technical data listed reflect only the conditions for the day the data was collected and reflects only conditions existing at the exact location of samples.

ii. Copies of these reports and drawings that are not included with Bidding Documents may provided electronically by the Engineer. These reports and drawings are not part of the Contract Documents. Tank manufacturer is not entitled to rely upon other information and data utilized by Engineer and Engineer's Consultants in preparation of the Contract Documents.

iii. No additional geotechnical information will be provided by the Owner. It will be the complete responsibility of the tank manufacturer to satisfy itself of the geotechnical conditions at the proposed tank site. If the tank manufacturer deems it necessary for additional geotechnical investigations and analysis, such investigations and analysis must be provided by the tank manufacturer at no additional cost to the Owner and no additional time will be added to the contract for such investigations. All changes to the tank manufacturer's design based on any additional geotechnical information acquired after the Project is bid is to be included in the project cost and no additional payment or time is due to the Contractor.

B. Field Measurements:

1. Verify layout information for tank shown on the Drawings in relation to property survey and existing structures. Verify dimensions by field measurements. Prior to start of tank design submit the following elevations as Product Data, survey must be completed by licensed surveyor:

i. [Example: Bottom slab elevation of the existing ground storage tank.]

ii. [Example: Overflow elevation of the existing ground storage tank.]

524.8 Materials

Note to Specifier: Delete paragraph below for applications other than potable water.

Materials in Contact with Potable Water

A. All materials in contact with potable water with the exception of concrete and metals must comply with the requirements of the Safe Drinking Water Act, NSF 61 and other federal, state, local, and provincial requirements. Any constituents in the concrete must not be toxic or release toxicity into the water or impart any changes of color, taste or odor into the water.

Note to Specifier: The concrete materials below are for tanks above grade. If the tank is buried evaluate alternate concrete and shotcrete materials.

Concrete:

A. Concrete materials must meet the requirements of ACI 301. Cement must be ASTM C150 Portland Type I/II or II or ASTM C595 Type IL blended hydraulic cement. Tank manufacturer's engineer will be responsible for evaluating sulfate exposure class per ACI 318 and adjusting concrete materials accordingly with approval by Engineer.

B. Concrete or shotcrete in direct contact with prestressed reinforcement must 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, pipe encasements, and other Work must have a minimum 28-day strength of 3500 psi. Concrete for wall and roof construction must have a minimum 28-day strength of 4000 psi.

D. Concrete for tank wall construction must be placed at a slump of 3 inches plus or minus 1 inch, not to exceed 4 inches. Concrete for floor and dome must be placed at a slump not to exceed 4 inches plus or minus 1 inch. If a high range water reducer is used, concrete must be placed at a slump not to exceed 7 inches. Samples for concrete testing must be taken near the place of final deposit of the material.

E. Admixtures must comply with the requirements of ACI 301 and must not contain chlorides, (except as heretofore stipulated) fluorides, sulfides or nitrates. Concrete for tank wall, dome, and other concrete subjected to freeze-thaw cycling must be air entrained.

F. Curing compounds must be compliant with NSF Standard 61.

G. Concrete for floor and footing must contain polypropylene fibers per the tank manufacturer's mix design. The amount of polypropylene fibers added to the concrete mix must conform to the manufacturer's recommendations.

Flowable Fill

Flowable fill must be provided per Item No. 402 "Controlled Low Strength Material"

Shotcrete

A. Shotcrete materials must meet the requirements of ACI 506. Cement must be Portland Type I/II or II.

B. Shotcrete mix designs to be in direct contact with soil must be designed to resist severe sulfate attack risk category utilizing appropriate cement type, compressive strength, water-cement ratio, and pozzolans. Final mix designs to resist sulfate attack must be submitted by tank manufacturer and approved by the Engineer prior to construction.

C. Shotcrete for tank construction must not contain chloride ions in excess of 0.06 percent of the weight of the cement in the mix.

D. Shotcrete wire coat used for covering intermediate layers of prestressing wire must consist of not more than 3 parts sand to 1 part Portland cement by weight; additional coats of shotcrete must consist of not more than 4 parts sand to 1 part Portland cement by weight. The wet mix process referred to in ACI 506 for shotcreting must be employed.

E. Shotcrete must have a minimum 28-day strength equal to that for which the core wall is designed but not less than 4000 psi.

F. Wet mix shotcrete for dome roofs in areas subject to freeze-thaw must be air entrained with an air content of 5 to 8 percent at the pump. Dry mix shotcrete must not be used in domes subject to freezing cycles.

G. Admixtures must comply with the requirements of ACI 301 or ACI 506.2 and must not contain more than trace amounts of chlorides, fluorides, sulfides, or nitrates because of their possible corrosive effect on the prestressed reinforcement. Materials in contact with potable water must not impart taste, odor, or toxic chemicals to the water. All admixtures used in the concrete must be compatible.

H. Polypropylene fibers must be included in the shotcrete used for the finish covercoat. Fiber length and quantity must be per the fiber manufacturer's recommendations. Fly

ash may be incorporated into the finish overcoat. Fly ash must conform to ASTM C618, Type C or F.

I. Testing:

a. Testing of shotcrete must be in accordance with ACI 506, except as specified herein. One test panel must be made for each of the following operations: corewall, cove, wire cover, and covercoat. Test panels must be made from the shotcrete as it is being placed, and will, as nearly as possible, represent the material being applied. The method of making a test sample must be as follows: A frame of wire fabric (1 foot square, 3 inches in depth) must be secured to a plywood panel and hung or placed in the location where shotcrete is being placed. This form must be filled in layers simultaneously with the nearby application. After 24 hours, the fabric and plywood backup must be removed and the sample slab placed in a safe location at the Site.

b. The sample slab must be moist cured in a manner identical with the regular surface application. The sample slab must be sent to an approved testing laboratory and tested at the age of 7 days and 28 days. Nine 3-inch cubes must be cut from the sample slab and subjected to compression tests in accordance with current ASTM Standards. Three cubes must be tested at the age of 7 days, three must be tested at the age of 28 days, and three must be retained as spares.

Reinforcing Steel

A. Nonprestressed reinforcement must be new deformed billet-steel bars that conform to the requirements of ACI 350, Grade 60, meeting the requirements of ASTM A615. Strand for seismic cables must be galvanized and must conform to the requirements of ASTM A416 prior to galvanizing. Welded wire fabric conforming to ASTM A185 must not be used.

Mortar Fill and Non-Shrink Grout

A. Mortar fill and non-shrink grout must have a minimum compressive strength of 5000 psi at 28 days.

B. ACI 301 for mortar, ASTM C1107 grade A or C for nonshrink grout. Nonshrink grout is not to be used for bonding of prestressed tendons or to come into contact with the wire or strand prestressed reinforcement.

Steel Diaphragm

A. Steel sheet diaphragms must be vertically ribbed with adjacent and opposing channels that provide the mechanical bond to the concrete. The base of the channels must be wider than the throat. Uncoated steel sheet must comply with ASTM A366 and ASTM A1008. Diaphragm steel thickness must be a minimum of 26 gauge/0.016 inches.

B. The steel diaphragm must extend within 2 inches of the full height of the wall panel with no horizontal joints; moreover, the steel diaphragm must be continuous for the full height of the tank. Vertical joints within a wall panel must 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 must be edge sealed with polysulfide sealant. All

vertical diaphragm joints must be sealed to be fully and completely watertight under full tank load.

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

D. Diaphragm joints between precast wall panels must be sealed with polysulfide sealant.

Prestressing Steel

A. Steel for prestressing must 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 must be ferrous material compatible with the prestressing wire, and must develop the full strength of the prestressing wire. Wire splice and anchorage accessories must not nick or otherwise damage the prestressing.

C. Circumferential prestressing wire must conform to the requirements of ASTM A648 or ASTM A821. Splices and anchor clamps for prestressing wire must be ferrous material compatible with the wire and must develop the full strength of the wire.

Electrometric Materials

A. Water stops:

Note to Specifier: Delete NSF 61 requirements below for non-potable systems.

1. Thermoplastic Elastomeric Rubber (TPE) waterstops: Waterstops must have a center bulb and be NSF 61 approved. Splices must be made in accordance with the manufacturer's recommendations.
   a. Approved Manufacturer(s):
      i. JP Specialties, Inc., Earth Shield Waterstop.
      ii. Sika Greensteak, WESTEC Envirostop TPE-R.
      iii. Approved Equal.
2. Polyvinylchloride (PVC) waterstops: Waterstops must have a center bulb and be NSF 61 approved. Splices must be made in accordance with the manufacturer's recommendations.
   a. Approved Manufacturer(s):
      i. JP Specialties, Inc.
      ii. Sika Greensteak.
      iii. Approved Equal.

B. Bearing pads must consist of neoprene or natural rubber.

1. Neoprene bearing pads must have a minimum elongation of 500 percent and a maximum compressive set of 50 percent, and must comply with ASTM D2000, Line Call Out M 2 BC 410 A14 B14 for 40 durometer material.

2. Natural rubber bearing pads must contain only virgin natural polyisoprene as the raw polymer, and the physical properties must comply with ASTM D2000, Line Call Out M 4 AA 414 A13. The tank manufacturer must verify that bearing pads must be resistant to damage caused by chlorine or chloramines.

Sealants and Joint Fillers

A. Sponge filler must be closed cell neoprene or rubber conforming to the requirements of ASTM D1056, Type 2A1 through 2A4, and must be resistant to damage by chlorine or chloramines. Contractor may provide Type 2C1, with a letter from the product manufacturer certifying that the sponge filler meets or exceeds all of the requirements of ASTM D1056, Type 2A1. Compression deflection limited to 25 percent at 2 to 5 psi. The sponge filler pad may be removed after construction in lieu of being NSF 61 approved.

B. Polysulfide sealant will be a multi-component elastomeric compound meeting the requirements of ASTM C920, Type M. Sealants and joint material must have permanent characteristics of bond metal surfaces, flexibility, and resistance to extrusion due to hydrostatic pressure and resistant to damage from chlorine or chloramines. Air-cured sealants must not be used. Sealant must provide watertightness under the full tank head.

C. Epoxy coatings for inserts and temporary openings must be of a high-build flexible coating for concrete. It should be 100 percent solids epoxy system coat or equal. Epoxy coatings must only be used upon the recommendation and approval of the tank manufacturer and the approval of the Owner. All epoxy fillers in contact with potable water must be compliant with NSF Standard 61.

Note to Specifier: Delete perimeter drain system if not required for project.

Perimeter Drain System

A. Geotextile Fabric:
   1. Fabric must be needle-punched nonwoven geotextile composed of polypropylene fibers.
   2. Fabric must be inert to biological degradation and resist naturally encountered chemicals, alkalis and acids present in soils.
   3. Approved Manufacturers:
      i. Tencate – Mirafi 1100 N.
      ii. Approved Equal.

B. Drain Piping:
   1. Drain pipe and fittings must be ASTM D3034, SDR35 PVC.
   2. Two 1/2-inch drain holes must be drilled 5 inches on-center at the 6 o'clock and 12 o'clock positions alternating to the 3 o'clock and 9 o'clock positions or as indicated on the Drawings. Tank manufacturer's must verify adequacy and may alter size of hole and position as required.

C. Crushed Stone Embedment:

1. Crushed stone embedment must be free of fines.
2. Crushed stone embedment must be coarse gravel open graded stone, ASTM C33 No. 67 crushed stone aggregate or as indicated on the Drawings.

Appurtenances

A. The Contractor must provide and install all appurtenances shown on the Drawings and as indicated below. All hardware furnished with interior tank appurtenances must be 316 stainless steel.

B. Inlet/Outlet Piping: All exposed piping on the interior of the tank must be concrete encased. 316 stainless steel piping may be provided in lieu of concrete encasement. Piping material must be similar from floor connection to its terminus. Mixing of pipe materials will not be allowed. All hardware must be 316 stainless steel.

Note to Specifier: Review materials, pipe thickness and pressure class per application. Specifier must indicate flange isolation gasket kit or isolation coupling at inlet/outlet and yard piping connection on the Drawings for dissimilar metals to limit corrosion potential.

Note to Specifier: Lining indicated is for water applications, revise lining to be for WW applications as required.

1. Inlet piping must be:
   a. AWWA C110 – Class 250 ductile iron pipe, mortar lined.
   b. AWWA C200 – Schedule 10 steel pipe (D/t=230 or 0.250-inch min. wall thickness). All steel piping must be lined with a NSF 61 certified polyurethane coating in accordance with AWWA C222.
   c. AWWA C220 – Schedule 10S 316L - stainless steel pipe.

Note to Specifier: Lining indicated is for water applications, revise lining to be for WW applications as required.

2. Outlet piping must be:
   a. AWWA C110 – Class 250 ductile iron pipe, mortar lined.
   b. AWWA C200 – Schedule 10 steel pipe (D/t=230 or 0.250-inch min. wall thickness). All steel piping must be lined with a NSF 61 certified polyurethane coating in accordance with AWWA C222.
   c. AWWA C220 – Schedule 10S 316L - stainless steel pipe.
   d. Silt stop must be made of Class 250 ductile iron. Coat and line as specified in Item No. 530 “High Performance Coatings.”
3. Piping encased in concrete is not required to be coated. All encased piping must be clean and free of rust and other foreign matter.
4. Buried piping must be as specified in Item No. 510 “Pipe”
5. All above grade or exposed piping must be coated per Item No. 530 “High Performance Coatings”

Note to Specifier: Verify requirements when air gaps are required by the TCEQ, Delete paragraph below if not required or use alternate bolded text depending if exception was approved by the TCEQ.

6. Inlet piping must have an air gap of two times the inlet pipe diameter**. [Inlet piping must have an air gap of X.XX feet above the maximum water rise as shown on the Drawings.]**
7. Outlet piping must have an aluminum baffle plate designed by the tank manufacturer to prevent vortexing.
8. All pipe to concrete anchors and connections must be designed by tank manufacturer. Interior supports and hardware must be 316 stainless steel. Exterior supports and hardware must be 316 stainless steel.

Notes to Specifier: Include section below and complete specification ID if a Hydrodynamic Water Storage Mixing System is required.

C. Hydrodynamic Water Storage Tank Mixing System (HMS):
   1. Install an HMS on the interior of the tank as specified in **Section [Insert Section #] "Insert Section Name."**
   2. Tank manufacturer is responsible for coordination and compatibility of the design of the HMS system and the construction of the tank.

Commented [KS1]: No NBU spec

Note to Specifier: Include section below and complete specification ID if an active mixing system is required. Remove this section if mixing system is not required.

D. Active Water Storage Tank Mixing System:
   1. Install an active mixing system on the interior of the tank as specified in **Section [Insert Section #] "Insert Section Name."**
   2. Tank manufacturer is responsible for coordination and compatibility of the design of the mixing system and the construction of the tank.

Commented [KS2]: No NBU spec

Note to Specifier: Delete/modify paragraph below if in-tank baffle system is not required; verify size and location of additional tank penetrations per the tank manufacturer.

E. Baffle System:
   1. Fabric Baffle Walls:
      a. Baffle walls must be as indicated on the Drawings. Tank manufacturer is responsible for design, fabrication and erection of tension-fabric baffle system as specified and as indicated on the Drawings.
         i. Approved Manufacturer(s):
            1. Seaman Corporation, 8130 XR-3 PW Fabric.
            2. Carlisle Geo-Membranes, 45 mil Polypropylene (PPE) Fabric.
            3. Approved Equal: The baffle fabricator must have furnished and had in satisfactory service for a period of not less than 5 years, at least one baffle system with dimensions and quantities similar to the one specified for this Project. The fabricator must submit evidence of such with design submittal.

ii. Baffles must be designed for installation in potable water with chlorine and ammonia present in the tank.

iii. Baffles must be designed for expected fluctuations in water level with adequate strength to resist 0.5 inches of water depth difference across the baffle.

iv. Baffles must be secured to the floor and walls with 316 stainless steel plates with 316 stainless steel anchors. Baffle penetrations must be punched. Provide 1/4-inch 316 stainless steel cable in double hem on the ends of the baffles, behind the stainless steel plate at floor and wall locations. NSF 61 approved fiberglass reinforced plastic (FRP) may be used for continuous support members on straight wall systems. Continuous FRP double angle support must be used for straight wall sections. 316 stainless steel support members must be used for curved baffle walls.

v. Provide 316 stainless steel angles on top of the baffle wall with 3/8-inch 316 stainless steel bolts for attaching the top of the baffle to the dome.

vi. All metal materials must be 316 stainless steel.

vii. Fabric:

viii. Fabric must consist of knitted polymer coated polyester fabric with a 6.5 oz./sq. yd. minimum weight. Coated fabric must not be less than 30 mils thick with a plus 10 percent allowable variation. There must be not less than 7 mils thickness of polymer coating over base fabric.

1. Fabric must be non-wicking.
2. Fabric and all components within the tank must be NSF 61 approved.
3. The coated fabric must be UV stable.
4. The fabric will be connected by thermal welding methods. Glues and solvents are not allowed.
5. The fabric must meet or exceed the following minimum physical properties:
    a. Tongue tear (ASTM D751) not less than 125 lb.
    b. Trapezoid tear (ASTM D2263) not less than 35 lb.
    c. Grab tensile strength (ASTM D751) not less than 475 lb. (parallel) and 425 lb. (perpendicular).
    d. Strip tensile strength (ASTM D751) not less than 400 lb./in. (parallel) and 350 lb./in. (perpendicular).
    e. Dielectric seam adhesion (ASTM D751) not less than 10 lb./in.
    f. Hydrostatic resistance (ASTM D751) not less than 500 psi.
    g. Puncture resistance (ASTM D751) not less than 600 lb.
    h. Crack resistance at cold temperatures (ASTM D2136) pass at minus 30 F.

2. Concrete Baffle Walls:
    a. Baffle walls must be precast or cast-in-place reinforced concrete, or reinforced concrete masonry, and must be constructed to the configuration and dimensions shown on the Drawings. They must be designed in accordance with the applicable requirements of ACI 318 and ACI 350R, including requirements for minimum wall thickness, reinforcement and maximum unbraced height. They must be adequately braced for lateral stability. Circular baffle walls that are self-supporting due to arc action need not be braced except at their open ends.
    b. Bracing members must be 316 stainless steel or concrete. Bracing hardware must be 316 stainless steel.

Note to Specifier: Verify with proposed O&M for Project.

    c. If the Specifications call for a differential hydrostatic pressure on one side of the baffle wall, the wall must be designed accordingly. In this case, additional bracing may be necessary.
    d. Baffle walls must be fixed to the floor either directly by anchoring into the floor slab or indirectly by connecting to a thickened base curb, which is in turn anchored to the floor. Attachment to the floor must be by means of brackets and inserts in the case of precast walls or deformed dowels in the case of cast-in-place concrete or reinforced masonry walls. When the baffle wall is anchored directly into the floor slab, the slab along and immediately below the wall must be thickened to safely accommodate the base forces and moments transmitted through the anchorage. Minimum slab thickness in this area must be equal to the thickness of the wall itself. When a base curb is used to provide base fixity, the slab thickness under the curb will not be less than 8 inches.
    e. Minimum reinforcing for cast-in-place walls must be 0.0025 times the cross-sectional area of the wall in each direction, vertical and horizontal.
    f. Finishes:
        i. Cast-In-Place: Wall Surfaces must have a form finish on the sides and a float finish on the top.
        ii. Precast: Wall Surfaces must have a form finish where formed and a light broom finish on non-formed surfaces.
    g. Joints in baffle walls are permitted and do not require waterstops. The joint between precast panels must be plus or minus 1/2 inch in width.

Note to Specifier: Delete pressure relief valves if they are not required by the geotechnical report and indicated in Paragraph 524.5 H.

F. Pressure Relief Valves:
    1. Pressure relief valves may be utilized in the foundation design as required by the tank manufacturer.
    2. Valve size and quantity must be per the tank manufacturer's design.
    3. Valves must be constructed of 304 stainless steel with a removable stainless steel grating, integrally cast water stop and a resilient seat.

4. Manufacturers: Troy Valve or approved equal.

G. Overflow weir, piping, flap valve, and splash pad must be as indicated on the Drawings. Flap valve must have a gravity-hinge and the cover must fit tight with no gap over 1/16-inch per TCEQ requirements. Refer to **[Insert Section # "Insert Section Name"]** for flap valve requirements. The tank manufacturer must be responsible for sizing the overflow weir and associated piping for the maximum fill rate indicated in Paragraph **[524.5 B]** at the maximum static water surface permitted in the wall and roof design. Maximum static water surface permitted must be at least 1 inch below the joint between the wall and dome. Pipe supports must be 316 stainless steel. Contractor must include detailed calculations for sizing overflow pipe and weir with design calculations and Shop Drawings.

Commented [KS3]: Not sure where flap valves are mentioned. Not mentioned in Item No. 511

H. Vent must be as indicated on the Drawings. The tank manufacturer to size roof ventilator to pass air so that the maximum fill/draw rate must not develop pressure within the tank as stated in Paragraph **[524.5 B]** and a broken pipe analysis assuming a broken pipe immediately outside of the tank's foundation. Broken pipe analysis must be based on largest diameter inlet/outlet pipe.

Note to Specifier: Min. diameter is 24 inches. Verify minimum based on flow.

1. Vent must be constructed of **[Aluminum or 316 Stainless Steel]** with a minimum diameter **[24]** inches, meeting current AWWA and TCEQ standards. If the tank manufacturer determines that a larger vent is required, based on their calculations then the larger diameter vent or vents must be installed at no additional cost to the Owner.
2. Vent must be screened with #16 316 stainless steel insect screen with openings not greater than 1/16 inch. Vent screen condition must be observable without removing the vent's hood.
3. Vent must be securely fastened using 304 stainless steel hardware.
4. Contractor must include detailed calculations of vent sizing and broken pipe analysis with design calculations and Shop Drawings.
5. Vent must be of sturdy construction with design and materials approved by the Engineer.
6. Vent is to be powder-coated to match the tank coating.
7. Provide a 1/8-inch 60-durometer, ANSI/NSF 61 certified neoprene gasket between the vent and the concrete curb.
8. Approved Manufacturers:
   a. ARC^3 Corporation – Omega High Security Vent.
   b. Approved Equal.

I. Sample Taps and Gauges:
   1. Sample taps must be provided as indicated on the Drawings.
   2. Gauges must be provided as indicated on the Drawings. Gauges must be in accordance with Item No. 511 "Water Valves & Fire Hydrants"

Note to Specifier: Coordinate heat trace with electrical.

3. Provide insulation and heat trace for sample taps and gauges.

Note to Specifier: Specify drain pipe if required or delete paragraph below.

J. **[Specify diameter]-**inch diameter drainpipe with **[specify dimension]-**inch gate valve. Refer to Item No. 511 "Water Valves & Fire Hydrants"

K. Tank Access:

Note to Specifier: Size dome hatch to fit largest diameter pipe flange used in tank; clear opening. Verify with NBU Engineering if fall prevention grates, etc. are desired on the project. Modify schedule below as required for project.

1. Dome Hatch:

a. Hatch dimensions indicate on the Drawings are to be considered internal clear opening length and width. Provide hatches as indicated on the Drawings and as below:

Hatch Location	Qty.	Clear Opening Size
Dome Access to Interior Shell Ladder	1	42" x 42"
Dome Access to Interior Overflow Weir [OPTIONAL]	**1**	**42" x 42"**

b. Hatch must be single leaf and constructed of aluminum with 316 stainless steel hardware. Hatch must be rated for a minimum live load of 150 psf.

c. The access door must be equipped with:

i. Exterior padlock staple.

ii. EPDM gasket/cushion to make a positive seal when the hatch is closed.

iii. 316 stainless steel/aluminum hold open arm.

iv. Stainless steel pressure locks on the exterior of hatch, 3-each minimum.

v. The door must have stainless steel gas shocks or springs to assist in opening the door and reducing the force during closing.

vi. Hatch lid must have a minimum 2-inch overhang as required by TCEQ Chapter 290.

d. Hatch must open to a 90-degree angle.

e. Hatch must be installed on a minimum 4-inch concrete curb. Provide a 1/8-inch 60-durometer, ANSI/NSF 61 certified neoprene gasket between concrete curb and hatch. Hatch must be completely isolated from concrete.

f. Aluminum must have a clear anodic finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

g. Installation must be in accordance with the manufacturer's written instructions.

h. Manufacturer must provide a lifetime guarantee against defects in materials and workmanship.

i. Where indicated, provide hinged aluminum safety grating for the hatch. Grating to be powder coated safety orange and incorporate all stainless steel hardware

j. Contractor must indicate location of hinges, latches, pad lock staple and lift handle on submittal for verification of orientation with the project plans.

k. Provide confined space label on roof hatches, Seton Item No. 5185C or approved equal.

l. Approved Manufacturers:

i. Halliday Products – F1R.

ii. U.S.F. Fabrication, Inc.

iii. Approved Equal.

2. Shell Manway:

a. Manways must be Type 304 stainless steel with hinged or davited cover.

b. Manways must open into the tank and seal an ASME flanged and dished head against a liquid-tight, replaceable EPDM gasket.

c. Manways is to be equipped with a handwheel release that operates only when the tank is empty and provides access in seconds without unbolting or use of tools.

d. Provide confined space label or placard at all manways, Seton Item No. 5185C or approved equal.

e. Provide manways as shown on the Drawings and as indicated below:

Note to Specifier: For 1 MG tanks, provide min. 1 – 36-inch hatch. For tanks larger than 1 MG, provide min. 2 – 36-inch hatches.

Quantity	Diameter
1 Each	36-inch I.D.

L. Ladders:

1. Install ladders with appurtenances as indicated:

Location	Material	Ladder Safety System Req.
Interior Shell (Tank Floor to Dome)	316 Stainless Steel	**X**
Wall Manway Access (Manway to Floor)	316 Stainless Steel	
Exterior Shell (Ground to Dome)	304 Stainless Steel	**X**

2. All ladders must be designed and installed per ANSI A14.3 and OSHA 1910 standards. D-rings and/or lanyard rings and tie-off points must be designed for a minimum tensile load of 5000 lbs. Tie-off locations must be provided at all ladder transition points and at hatches, including hatches that do not provide ladder access.

3. All stainless steel connections must be welded.

4. All ladder to tank connections must be by anchors designed by tank manufacturer. Shotcrete pads must be provided on the exterior of the tank at ladder connections. Interior ladders must be attached using epoxy type 316 stainless steel anchors. Epoxy must be ANSI/NSF 61/600 certified. Exterior ladders may be installed using wedge type 304 stainless steel anchors.

Note to Specifier: Complete specification ID and coordinate ladder safety system requirements with notes within the referenced specification.

5. Refer to Section **[Insert Specification Number "Insert Specification Name"]** for ladder safety system requirements.

Note to Specifier: Verify Subparagraph b below.

6. Manway Access:
   a. 316 stainless steel grab bars must be provided at all manways.
   b. Provide a ladder at each manway location where the centerline of the manway is greater than 4 feet from the finished floor elevation. If the centerline of the manway is 4 feet or less from the finished floor elevation, the tank manufacturer may provide a thickened concrete landing platform in lieu of a ladder. Landing platform dimensions must meet OSHA requirements. Manways where the invert is 2 feet or less from the finished floor elevation, do not require a ladder or platform.
7. Exterior Ladder Access:
   a. The exterior ladder must have a 7-foot high aluminum or 304 stainless steel security door to prevent ladder access to the top of the tank. The security door must fully block both sides of the ladder to prevent passage up the back side of the ladder.
   b. The security door must be equipped with a locking hasp and padlock keyed to match Owner's locks. Gate must not be connected to the ladder or encroach on OSHA required ladder clearances in the open position.
   c. Door must have a means to lock in the open position to keep door open while ladder is being accessed. All hardware and components must be 304 stainless steel.
   d. The door and all the connections to the tank must be designed by the tank manufacturer and approved by the Engineer.
8. Exterior Ladder Top Platform:
   a. Tank manufacturer to design top platform as indicated in the Drawings.
   b. Materials are to be 6061 T6 aluminum or 304 stainless steel.
   c. Elevated platforms must be designed for a minimum live load of 60 psf per the IBC.

Note to Specifier: Complete specification ID and coordinate self-closing gates with notes within the referenced specification.

   d. Provide self-closing safety gates per Section **[Insert Specification # "Insert Specification Name"]**

M. Guardrail:

1. Guardrail may be welded aluminum or 304 stainless steel and must be constructed on top of tank as shown on the Drawings. Welding must be per AWS D1.2.
2. All guardrail to tank connections must be by anchors designed by the tank manufacturer. Base plates must be square and secured to dome using 304 stainless steel epoxy anchors, four minimum per base plate. Isolate aluminum guardrail from tank with 1/8-inch neoprene pads. Base plates must be at least 1/2-inch thick. Posts must be welded directly to base plates.
3. Guardrail must be 2-inch diameter schedule 80 6061-T6 or 6005-T5 anodized aluminum or 305 stainless steel pipe. Top and middle rails are to be bent to radius and curvatures of the tank roof.
4. Beveled toe-board must be attached to railing along the circumference and sides of the guardrail.
5. All hardware must be 304 stainless steel.
6. Guardrail must be a structurally designed for loading per OSHA 1910 and any antennas, lights or other loading specified herein and as shown on the Drawings. Provide design calculations, design assumptions and design for guardrail with tank Shop Drawings.

N. Provide one 6-inch dome sleeve and one 4-inch dome sleeve for level sensor and level electrode as shown on the Drawings. Sleeves and flanges must be constructed on 316 stainless steel.

Note to Specifier: Delete paragraph below if not required by NBU Engineering ;

O. Exterior Visual Level Indicator:

1. Indicator must be provided with level demarcations at 6-inch intervals for the full depth of the tank's water levels. Indicator target on the exterior of the tank must match the height of the liquid inside of the tank or "direct-read" type indicator. Include level float, 316 stainless steel wire rope, attachments, pulley, and all other necessary items. Gauge boards must be aluminum with UV resistant lettering. All hardware and components must be 316 stainless steel. Locate access level indicator as shown on the Drawings. If a portion of the tank wall is below grade, the scale of the level indicator and pulleys must be adjusted to show the full depth of the tank.
2. Acceptable Manufacturer(s):
   a. Versa Steel Tank Indicators, model A030 (VS-A030).
   b. Approved Equal.

P. Name Plate: Provide minimum 8-inch by 10-inch laser engraved stainless steel name plate on the exterior of the shell adjacent to the ladder and mounted on a shotcrete pad. Name plate must include the following information:

1. Manufacturer.
2. Manufacturer's Job Number.
3. Date of Completion.
4. Capacity.

5. Tank Diameter.
6. Bottom Height AMSL.
7. Overflow Height AMSL.

Coatings **[and Architectural Treatments]**

A. Concrete Tank Interior Coating System:

Note to Specifier: Delete second paragraph for potable and raw water applications. Interior coating may be required for wastewater and other special applications.

1. Interior concrete surfaces do not require a coating.
2. Interior coating must be as specified in Item 531 “Coatings for Water Storage Tanks”

Note to Specifier: Verify if exterior surfaces are required to be coated per the Geotech report, delete paragraph below if not required.

B. Concrete Tank Exterior Coating System – Below Grade:
   1. Exterior surfaces of below-grade tanks must be protected with coatings suitable for sealing the exterior of the tank wall to 12 inches below the finished grade.
   2. Prior to applying coating system all joints, cracks and openings around protrusions must be sealed by caulking or prestriping. Joints and cracks less than 1/16 inch may be filled by prestriping. Striping must overlap the joint or crack to a width of 4 inches on each side. Caulking must be per the coating manufacturer’s recommendation and compatible with the coating system.
   3. All coatings must be applied per the manufacturer’s written instructions for submerged surfaces.
   4. Approved Manufacturers/Products:
      a. Tnemec – Series 46H-413 – High Build Tneme Tar or H.B. Tnemecol – Series 46-465 (20 mils DFT).
      b. Approved Equal.

C. Concrete Tank Exterior Coating System – Above Grade:
   1. Provide the following exterior coating system to 12 inches below finished grade.
   2. Decorative coating for precast dome surfaces:
      a. Coat 1: Cementitious based damp-proofing product. “Tamoseal” by Euclid or approved equal.
      b. Coat 2: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.
      c. Coat 3: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.
      d. Coat 4: Diamond Clear Vox by Euclid or approved equal.
   3. Decorative coating for cast-in-place dome surfaces:
      a. Coat 1: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.

b. Coat 2: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.

c. Coat 3: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.

d. Coat 4: Diamond Clear Vox by Euclid or approved equal.

4. Decorative coating for exterior wall surfaces:

a. Coat 1: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.

b. Coat 2: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.

c. Coat 3: Non-cementitious, high build, 100 percent acrylic resin polymer. “Tammscoat Smooth” textured protective coating by Euclid or approved equal.

d. Coat 4: Diamond Clear Vox by Euclid or approved equal.

5. Mix and apply the coating in strict accordance with the manufacturer’s directions. Do not apply coating when the temperature is below 45 F, or when the temperature is expected to fall below 45 F within 24 hours after completing application.

6. The curing time for coatings may be reduced, if the manufacturer provides written documentation approving the deviation from the manufacturer’s data sheets.

7. Provide additional coats as required to provide a consistent color on all surfaces. Obtain approval of consistent color by Owner’s representative before application of clear coat. Clear coat must be able to be overcoated with Tammscoat Smooth or equal product without removal of the clear coat.

8. See Section 530 “High-Performance Coatings” for general painting requirements.

Note to Specifier: Delete if architectural treatments are not included.

D. Architectural Treatments:

1. Brick Pilasters:

a. Contractor must provide **[10]** brick pilasters spaced at even intervals, and pilasters must have an approximate width of **[4]** feet.

b. Top Pilaster Elevation: Located at the elevation of the bottom of the Sto Arches.

c. Bottom Pilaster Elevation: Below finished grade as indicated on the Drawings. Tank manufacturer must provide design for below grade concrete corbel for brick pilasters.

d. 316 stainless steel ties must be used to connect pilasters to tank wall.

e. Top and sides of pilasters must be caulked as indicated on the Drawings, Sikaflex 1A or equal.

f. Provide concrete cornice at the top of the pilaster for tie to arches.

2. Arches:

a. Arches must be constructed using “Sto System Architectural Treatment” or equal. Sto must have “Armor Mat” ultra-high impact mesh.

b. Arches must be constructed to the dimensions as indicated on the Drawings or as recommended by manufacturer and approved by Engineer.

c. Arch installation must be in conformance with manufacturer's directions.

d. Provide backer rod and sealant at top of arch at tank dome ring.

E. Procedure for approval of exterior coating colors **[and architectural treatment colors]:**

1. Preliminary Color Selections:

a. Tank Coating Color Samples: Owner will select up to **[six]** colors from the manufacturer's color chart. Contractor must provide **[six]** 24-inch by 24-inch color samples on boards with texture matching that of the proposed tank.

b. [Brick Color Samples: Owner will select up to [six] brick colors from the manufacturer's color chart. Contractor must provide a minimum of [six] bricks for each color chosen for samples.]

2. Owner will choose up to five color combinations from the samples provided. Contractor must provide computer generated renderings detailing the view of the tank **[and pilasters]** from the adjacent road with selected color combinations. Renderings must accurately depict colors selected. Owner may request renderings to be resubmitted if renderings do not match selected **[brick and]** coating colors.

3. Owner will select **[two]** renderings for mock walls.

4. Contractor must construct mock walls consisting of:

a. Four-foot by 8-foot sheet of plywood with finish color and texture of proposed tank, including efface, dome ring and arch color and texture.

b. **[Three-brick wide by 12-brick tall mock brick column with selected mortar color constructed against plywood mock wall.]**

5. Owner selects colors from mock walls.

6. Contractor submits final rendering of the selected colors.

524.9 Construction Methods

A. Clearing, Grubbing and Stripping

1. All trees, shrubs, brush, stumps, roots, and other objectionable material must be removed to a minimum distance of 12 feet outside the edge of the tank floor, plus additional areas as necessary. In addition, all vegetation must be removed from areas designated for precast panel casting beds, material storage, and construction trailers. Refer to TxDOT Item 100 "Preparing Right of Way."

B. Excavation and Backfill

1. The Contractor must excavate to such depths and widths as will provide adequate room for tank construction with a minimum working area of 10 feet beyond the exterior of the tank footing plus additional area as required by the tank manufacturer.

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

3. Unsuitable material and compacted select fill must be measured separately and paid for by the unit price indicated in the Bid.

4. The area outside of the tank foundation must be backfilled and graded to the contours shown on the Drawings as indicated in TxDOT Item 400 “Excavation and Backfill for Structures”.
5. Frozen material must not be used for backfill or embankments, nor must fill material be placed on snow, ice, or frozen material. Rock or spoils (greater than 6 inches in diameter) must not be used in backfilling or embankment construction within 3 feet of the tank structure.
6. Surplus excavated material remaining after backfill or embankments are completed must be removed from the Site and/or properly disposed of as directed by the Owner.
7. Tank Contractor must provide geotechnical engineer to inspect and confirm/approve that the subgrade is consistent with the original geotechnical or report provided by the tank manufacturer and the subgrade is suitable for the contact loads anticipated. Confirmation must be documented prior to continuing with granular subbase and foundation construction.

C. Granular Subbase

1. A minimum 12-inch thick layer of granular material must be provided on top of the proposed subgrade foundation prior to tank floor construction, to a tolerance of within plus or minus 1/2 inch of the bottom of the floor and footing elevation.
2. The granular material must be Grade 5 aggregate fill or well graded crushed rock as required by tank manufacturer’s foundation design. Refer to TXDOT Standard Specification Item 421 “Hydraulic Cement Concrete”.
3. Refer to TxDOT Item 400 “Excavation and Backfill for Structures” for placement and compaction requirements.
4. Test granular sub-base for density and moisture using ASTM D6938-10.

D. Concrete

1. Concrete placement, finishing and curing must generally meet the requirements of ACI 301.
2. Weather Limitations: Hot and/or cold weather concreting conditions must be determined, as outlined in Chapter 7, Section 7.6 of ACI 301-99 and requirements of that Section must govern. Protection must be in accordance with Chapter 12, Section 12.3 of ACI 301-99. Concrete must not be placed when concrete temperature exceeds 90 F. The maximum temperature of concrete at placement with high range water reducing admixture(s) must not exceed 95 F. Concrete must not be placed when temperature is 40 F and falling.
3. Curing must be by membrane-forming curing compound, by covering exposed surfaces with polyethylene sheets, or by keeping surfaces continuously moist. Curing floor by flooding is an acceptable alternative to providing curing compound.
4. Testing:
    a. General:
        1. Tests must be required throughout the Work to monitor the quality of concrete per ACI 301. Samples must be taken in accordance with ASTM C172.

2. The Engineer may waive these requirements on concrete placements of 10 cubic yards or less. However, evidence must be furnished showing a design mix which meets the Specifications.
3. Testing of the materials, ready mix, transit mix or central plant concrete will be by a testing laboratory. A summary of all tests performed will be available within 7 days of 7-day and 28-day breaks. No concrete must be placed without a representative of the tank manufacturer present at either the plant or at the Site.

b. Slump Test:
Slump tests, in accordance with ASTM C143, must be used to indicate the workability and consistency of the concrete mix from batch to batch. Slump tests must be taken on each delivery prior to placement.

c. Air Content Test:
Tests for the concrete's air content must be made in accordance with ASTM C231 or ASTM C173 at the point of delivery of concrete prior to placing in forms. The test must be made frequently to monitor a proper air content uniform from batch to batch.

d. Temperature Test:
The temperature of the concrete to be placed must be taken with a thermometer immediately before placement, with the point of measurement being the chute or bucket. Temperature test must be performed for each truck. Record temperatures on batch ticket.

e. Compression Test:
1. Compression test specimens must be 6-inch by 12-inch concrete cylinders (4-inch cylinders may be used and tested per ACI 301) made and cured under laboratory conditions in accordance with ASTM C31. Additional concrete cylinders may be required for curing on the job under actual job curing conditions. These samples could be required when:
   a. There is a possibility of the air temperature surrounding the concrete falling below 40 F, or rising above 90 F.
   b. The curing procedure may need to be improved and/or lengthened.
   c. It is necessary to determine when the structure may be put into service.
2. Compression strength tests must be made on the laboratory-cured and job-cured concrete cylinders at 7 and 28 days, in accordance with ASTM C39. One cylinder must be tested at 7 days, two at 28 days, and one held as a spare. The tests made at 7 days must show strengths of not less than two-thirds of the design strength. For the 28-day cylinders, the strength level must be satisfactory if the averages of all sets of consecutive strength test results exceed the required design compressive strength, and no individual strength test result falls below the required compressive strength by more than 500 psi. Additional cylinders may be required by ACI 301 if 4-inch cylinders are used.

f. Testing Frequency:
1. No fewer than three specimens must be made for each test at each age (7 and 28 days).
2. Samples must be taken at a minimum of every 150 cubic yards of concrete of each class placed.
3. At least one set of test specimens per day must be made of each class of concrete used that day.
4. High Early Strength Concrete Test: When Type "III" High Early Strength Portland Cement is used instead of Type "I" Portland Cement, the minimum allowable 28-day strength for Type "I" Portland Cement concrete must be

at 7 days. The ages at time of test for Type “III” must be 3 days and 7 days, instead of 7 days and 28 days, respectively, for Type “I.”

5. For concrete placed in precast panels or wall slots, a set of three cylinders must be made for each truck load of concrete placed.
6. For concrete placed in the floor, dome ring, or dome slots, two sets of three cylinders for the first 50 cubic yards, and one set of three cylinders for every 100 cubic yards thereafter placed in the same day.

g. Failure to Meet Requirements:
   1. Should the 7-day strengths shown by the test specimens fall below the required values, additional curing must be performed on those portions of the structures represented by the test specimens at the Contractor’s expense. If the 28-day strength tests fall below the specified limits, test cores must be obtained from the extended cure structure and tested in accordance with ASTM Method of Obtaining and Testing Specimens from Hardened Cores and Beams of Concrete, Designation C42. If additional cure strength tests are below the specified limits, the Owner reserves the right to require strengthening, replacement of those substandard portions of the structure, or additional testing, at the Contractor’s expense.
   2. Upon receipt of the Contractor’s written request, substandard concrete Work may be reexamined in place by nondestructive testing methods or core samples, in accordance with ACI 301. The services of an independent testing laboratory must be retained and all expenses paid by the Contractor without compensation from the Owner. Laboratory results must be evaluated by the Engineer, who must make the final decision on acceptability of the concrete in question. Core sample holes must be repaired by the Contractor without additional compensation from the Owner.

5. Provide a grout-cleaned rubbed finish for exposed portions of the concrete foundation to provide a consistent surface free of air voids.
6. Owner may withhold payment for any section of concrete which does not meet the requirements of the Specifications. Withheld payment must be based upon the unit prices established for concrete and reinforcing steel. Payment must be withheld until the unacceptable concrete has been refinished, removed and replaced, or otherwise brought into conformance with the Specifications.

E. Nonprestressed Steel Reinforcement

1. Steel reinforcement must be placed to proper tolerances.
2. The minimum concrete or shotcrete cover over steel diaphragm and non-prestressed steel reinforcement must be 1 inch. Shotcrete cover over prestressing wires must be counted as part of cover.
3. If wall base cables are required, they must be installed between base of wall and footing. Sleeves of rubber or other suitable material must surround the strands at the joint to permit radial wall movements.
4. Reinforcing steel must be accurately fabricated and must be free from loose rust, scale, and contaminants, which reduce bond.
5. Reinforcing steel must be accurately positioned on supports, spacers, hangers, or other reinforcements, and must be secured in place with wire ties or suitable clips. Concrete block bar supports are not allowed. Rebar chair supports may be either steel or plastic.

F. Floor

1. The floor and wall footings must be constructed to the dimensions shown on the approved Shop Drawings.
2. Concrete floors or floor sections must be cast monolithically with no cold joints.
3. Waterstops:
   a. Vertical waterstops must be located to a tolerance of plus or minus 1/4 inch vertically and plus or minus 1/2 inch radially, and secured to ensure positive positioning.
   b. Horizontal waterstops must be secured in a manner allowing them to be bent up while concrete is placed and compacted underneath, thereby facilitating proper embedment.
   c. All waterstops must be spliced in a manner which provides complete continuity as a water barrier, and each splice must be electronically spark tested prior to concrete encasement. Punctures in the waterstop must not be permitted.
   d. Waterstops must be observed by the Owner's representative prior to concrete placement.
      1. Unacceptable splicing defects include:
      2. Misalignment of center bulb, ribs, and end bulbs greater than 1/16 inch.
      3. Bond failure at joint deeper than 1/16 inch.
      4. Misalignment which reduces waterstop cross-section more than 15 percent.
      5. Bubble or visible porosity in the weld.
      6. Visible signs of splice separation when a cooled splice is bent by hand at a sharp angle.
      7. Charred or burnt material.
4. Finish: The floor slab must be given a mechanical steel float or Fresno finish.
5. As soon as possible after final finishing operations, the floor concrete must receive a coat of non-toxic curing compound and must be kept moist for a minimum period of 7 days.
6. Exposed exterior of foundation must be uniform and free of bug holes, etc. Rub concrete as required to provide a uniform appearance.

G. Precast Core Wall

1. The core wall must be constructed of precast panels and vertical joints filled with shotcrete or cast in place concrete.
2. A continuous waterproof steel diaphragm must be provided throughout and within the tank wall, located between the stored tank contents and the prestressing wires. The steel diaphragm must be full length without horizontal joints. Vertical diaphragm joints must be mechanically seamed except where located between wall panels, where either mechanical seaming or sealing with polysulfide may be employed. All vertical diaphragm joints must be sealed to be fully watertight. Piercing of the diaphragm must not be permitted except by design. Form ties must not be permitted to pierce the diaphragm.
3. Precast panels must be fabricated to the curvature of the tank radius. The tolerance in panel wall thickness must be 0 to 1/4 inch. Concrete for each panel must be placed in one continuous operation.

4. After each precast panel has firmed sufficiently, it must be covered with polyethylene film for curing.
5. The maximum out-of-round tolerance for precast-concrete panel walls must be based on the ratio of plus 1/2 inch, minus 0 per 100 feet diameter circle, and the circumference must be a smooth curve. Tolerance in wall thickness must be plus 1/2 inch, minus 0. Wall thickness must not be less than specified. All transitions must be gradual and smooth. Walls must be plumb within a tolerance not exceeding 3/8 inch per 10 feet of vertical dimension.
6. Bearing pads must be located and held in their proper position prior to erection of wall panels. Nailing of pads must not be permitted.
7. Sponge filler pads must be properly secured. All voids around bearing pads and sponge must be caulked with an approved nontoxic sealant to prevent mortar seepage. The sponge filler located under the cove on the interior side of the waterstop must have a 1/2-inch wide by 1/2-inch deep grove at the center to key the sponge filler to the cove to prevent it from coming dislodged. Alternatively, if the groove is not utilized on the sponge filler on the interior side of the waterstop it must be removed by the tank manufacturer after the tank is prestressed but prior to the tank being watertightness tested. If the sponge filler is not NSF 61 approved it must be removed after the curb is poured, but prior to the tank being watertightness tested.
8. Finish:
    a. The interior of precast wall panels must have a smooth form finish and have a uniform appearance with a texture like CSP 1.
    b. The exterior of precast dome panels, dome slots, and cast-in-place dome must be given a light broom finish.

H. Dome Roof

1. The dome roof must be constructed to proper spherical curvature. Construction joints must be located and configured to maintain an adequate strength for cast-in-place concrete.
2. Dome forms must be designed to resist all forces acting with respect to its sloped surface. No portion of formwork for domes must be removed until the concrete has attained sufficient strength, and until the full circumferential prestressing force has been applied to the dome ring.
3. Finish:
    a. The exterior dome surface must be given a light broom finish.
    b. The interior dome surface must have a smooth form finish and have a uniform appearance with a texture like CSP 1.
    c. The dome soffit must be a form finish. The exterior dome surface must receive a coat of membrane-forming curing compound immediately after completion of the final finishing operation.
    d. Roof must have a uniform color and texture with no discernable pour lines or shading.

I. Prestressing

1. Circumferential prestressing must be accomplished by the application of high tensile steel wire. An essential feature of the wire wound stressing system is the

proper application of tension to the prestressing element before it is placed on the wall.

2. The stressing system must be capable of consistently producing a stress at any point around the wall, falling within plus or minus 7 percent tolerance of the specified initial stress fsi. A calibrated stress measuring device which can be easily recalibrated must be used to determine wire stress levels frequently throughout the wrapping process. At least one stress reading for every coil or foot of wall height must be taken immediately after application on the wall, and all such readings must be on straight lengths of wire. A written record of stress readings must be maintained and submitted as Product Data.
3. If measured wire stress falls below design fsi, additional prestress wire must be applied. If the applied stress of the wire exceeds 1.07 fsi, the wrapping operation must be discontinued immediately upon discovery and satisfactory adjustment made to the stressing equipment before proceeding. The total prestress force measured on the wall per vertical foot of height must not be less than the specified force, nor more than 5 percent greater.
4. Each coil of prestressing wire must be temporarily anchored. Ends of the individual coils must be joined by suitable steel splicing devices capable of developing the full strength of the wire.
5. The force diagram must be prepared for minimum spacing between the prestressing elements of 3/8 inch and the average minimum clear space between wires on the wall must be 1/4 inch or 1-1/2 wire diameters, whichever is greater. Wires in areas adjacent to openings or inserts must be uniformly spaced in accordance with the above. Any wires not meeting the spacing requirements must be respaced. Prestressing must be placed no closer than 2 inches from the top of the wall, edges of openings, or inserts, nor closer than 3 inches from the base of walls or floors where radial movement may occur.
6. A properly designed stress plate must be used at all permanent wall penetrations greater than 12 inches in height. The stress plate must accommodate a portion of the prestressing wires normally required over the height of the penetration. The remaining prestressing wires normally required must be displaced into circumferential bands immediately above and below the penetration. The effect of banded prestressing must be taken into account in the design. Bundling of wires is prohibited.
7. The Contractor must 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, must be taken immediately after the wire has been applied on the wall. Readings must be recorded and must refer to the applicable height and layer of wire for which the stress is being taken. A written record of stress readings must be kept by the Contractor and a copy thereof must be provided to the Engineer prior Owner's acceptance of the Project. All stress readings must 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 percent over the required design stress, the wrapping operation must be discontinued and satisfactory adjustment must be made to the stressing equipment before proceeding.

J. Shotcrete

1. Placement of Shotcrete:
    a. Shotcrete placement must meet the requirements of ACI 506.
    b. Shotcrete must be applied with the nozzle held at a small upward angle not exceeding 5 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 must 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.
    c. Total cover coat thickness must be controlled by shooting guide wires. Vertical shooting wires must be installed under tension and spaced no more than 2 feet apart to establish uniform and correct coating thickness. Wires of 18 or 20 gauge high tensile strength steel or a minimum 100-lb. monofilament line must be used. Wires must be removed after placement of the cover coat and prior to finishing.
2. Weather Limitations:
    a. Shotcrete must not be placed in freezing weather. Shotcrete placement can start without special protection when the ambient temperature is 40 F and rising, and must be suspended when the ambient temperature is 40 F and falling. The surface to which the shotcrete is applied must be free from frost. Cold weather shotcreting must be in accordance with ACI 301 and ACI 306, and only when approved by the Engineer.
    b. Hot weather shotcreting must be in accordance with the requirements of ACI 301 and ACI 305.
3. Coating of Steel Diaphragm:
    a. The steel diaphragm must be covered with a layer of shotcrete at least 1/2-inch thick prior to prestressing.
    b. Total minimum coating over the steel diaphragm must be 1-1/2 inches, including diaphragm cover, wire cover, and finish overcoat.
4. Each layer of circumferential prestressing must be protected by a shotcrete wire coat of not less than 1/4 inch. Each prestressing wire must be individually encased in mortar. The outer layer of wire must be protected by the wire coat plus two or more additional coats of shotcrete, totaling at least 1 inch in thickness over the outer layer of wire.
5. Dust, efflorescence, oil and other foreign material must be removed from surfaces to be shotcreted. The nozzle distance from the prestressing must be such that shotcrete does not build up or cover the front face of the wire until the spaces between the prestressing elements are filled.
6. Minimum shotcrete cover on the outside face of the steel diaphragm must be 1 inch.
7. All exposed shotcrete coatings must be kept moist for at least 3 days. Moist curing must be started as soon as possible without damaging the shotcrete. Curing must be by fog spraying or sprinkling. Curing may be interrupted for subsequent application of prestressing and shotcreting.
8. Finish: Exterior shotcrete must have a natural gun finish. The finish must be consistent on all surfaces as interpreted by the Engineer with no flat spots or areas with varying degrees of texture.

K. Tank Attachments

1. All attachments to the exterior of the tank are to be by mechanical means with 304 stainless steel hardware, unless specified otherwise.
2. No attachments to the tank may be made using adhesives or other bonding agents.
3. Provide shotcrete pads for attachments to the exterior shell, unless approved otherwise by the Engineer.
4. All electrical, grounding, etc. must be mounted on stainless steel Unistrut. Include shotcrete pads for Unistrut for attachment to the shell.

L. Disinfection and Testing

1. Contractor must submit disinfection, filling and testing plans to the Engineer as Product Data prior to completion of activities. Plans must detail the disinfection method, application, filling rates, etc.
2. Disinfection:
   a. Disinfect the tank in accordance with AWWA C652, latest edition, Disinfection of Water Storage Facilities. Unless directed by the Engineer, use Chlorination Method No. 2 or 3. After the specified drying time has passed, sweep the tank and wash down with water. The Owner will pay for the water to fill the tank once and the Contractor must pay for any subsequent water required.
   b. Equip personnel working inside the tank during the disinfection procedure with suitable air masks and safety lines leading through a manway to personnel outside the tank. Observe all safety precautions.
   c. Upon completion of the disinfection procedure, the Contractor must provide bacteriological testing of water samples from the tank. The tank must not be put in service until acceptable test results are obtained.
3. Completed Tank Survey: Survey the tank foundation and obtain the foundation elevation at 10-foot intervals around the perimeter of the tank before and after the tank is filled. Survey must be conducted by a licensed surveyor.
4. Watertightness Testing:
   a. Watertightness testing must be completed prior to backfilling at the footing.
   b. Potable water used for leak testing of the tank will be supplied to the Contractor by Owner at no charge if the tank passes the leak test and bacteriological tests and can be released into the distribution system as interpreted by the Owner. If the test water cannot be released into the distribution system and the tank must be drained, the cost of the water will be charged to the Contractor at the Owner's standard rates.
   c. Water tightness testing must be performed in accordance with ACI 350.1 with a hydrostatic test quantitative criterion of no measurable loss.
   d. Damp spots are defined as spots where moisture can be picked up on a dry hand. Damp spots on the wall footing or other areas of the tank will not be permitted and must be permanently sealed in a manner acceptable to the Engineer. Wet areas on top of the wall footing must not cause a failure of the hydrostatic tightness test, unless the water can be observed flowing.
   e. If the design includes a drainage system below the foundation, and leakage is found in the drainage system, the Contractor must investigate, identify the source of the water and repair any leakage through the foundation. This effort

must include, as a minimum, the use of divers to locate leaks in the slab and joints. All leaks must be repaired to the satisfaction of the Engineer.

f. The Contractor must provide all equipment, labor, and materials necessary to conduct the watertightness test. Contractor must provide the Engineer with documentation certifying the calibration accuracy of all equipment used in this test.
g. The leakage test, at the Owner's option, may be repeated at any time during the warranty period. If any leakage is found, the tank manufacturer must determine the cause of this change and make corrective repairs. If leakage exceeds the maximum allowable leakage as specified above, the Contractor must be responsible for all repair costs, including excavation and backfill.
h. All leaks must be repaired to the satisfaction of the Owner and repairs must be warranted for a period of 5 years from the date of acceptance of the repairs.

M. Clean Up

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

524.10 One-Year Warranty Inspection

A. The Contractor must observe all surfaces of the tank with the Owner within 11 months after the reservoir Work has been accepted for Substantial Completion and placed in service. If an observation date has not been established within 11 months after the reservoir has been placed in service, the anniversary observation must be considered waved, except in the event the Owner is unable to remove the reservoir from service due to extremely long dry climate conditions or otherwise adverse weather conditions or due to unexpected breakdowns in the distribution system. The date of anniversary observation may be extended for a period of time not to exceed 18 months beyond the date of Final Completion and acceptance of the Work.
B. The Owner will isolate the tank from the distribution system and drain the tank. The Contractor must open, clean out, high-pressure water wash and rinse the tank prior to the anniversary observation. After observation of the tank is complete and repair work accepted by Owner, the Contractor must follow disinfection procedures specified in Paragraph **[524.9 Tank Attachments A.].** Disinfection of the tank, after anniversary observation, must be by Owner as described above should Contractor meet cleanliness requirements.
C. The Contractor must provide suitable and adequate equipment including, lighting, ventilation, rigging, cable climbers, mirrors, inspection equipment, and sufficient man-power to clean, disinfect and move equipment and tools around the tank, etc., as may be necessary to facilitate complete observation of all interior surfaces. The Contractor must bear all costs of the anniversary observation and must incorporate such costs into its Bid. Contractor must provide digital copies of all photos taken by the Contractor during the warranty inspections within 14 days after the inspection date. The Owner will pay for the water to fill the tank once and the Contractor must pay for any subsequent water required.

End of Section