**SPECIFICATION SECTION xxxx**
**BOLTED STORAGE TANKS**

## PART 1 – GENERAL

### 1.1 DESCRIPTION

**A. Scope of Work:** The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to design, fabricate, deliver, erect, and test a tank constructed of factory-prefabricated, epoxy-coated, bolt-together steel panels. The scope of work will also include the construction of a foundation and other accessory components as detailed in the Contract Drawings and Specifications.

**B. Material Supply:** Phoenix Fabricators & Erectors LLC shall supply all required tank materials and principal appurtenances.

**C. Installation:** Installation shall be performed by a qualified and experienced erection crew, trained and certified by the tank manufacturer.

**D. New Materials:** Tank structures and appurtenances shall be new and unused

### 1.2 QUALITY ASSURANCE

**A. Tank Construction:** The Supplier shall provide a factory-applied, epoxy-coated, bolt-together, shop-prefabricated sectional steel tank.

**B. Manufacturer Expertise:** The Supplier is a specialized manufacturer with expertise in the design, fabrication, and erection of factory-applied, epoxy-coated, bolted tank systems. The structural design of these tanks will strictly adhere to the AWWA D103-19 Standard - Factory-Coated Bolted Carbon Steel Tanks for Water Storage.

**C. Design and Fabrication Criteria:**

1. Except as otherwise shown or specified, all materials, joints, workmanship and all other aspects of the tank and fabrication shall conform to ANSI/AWWA D103-19 hereinafter AWWA D103.
2. Design Loading Criteria
    - i. Ground Snow Load - (specify per D103 5.2.4)
    - ii. Roof Live Load - (specify per D103 5.2.5)
    - iii. Wind Design Criteria
        1. Design Wind Speed - (specify per D103 15.1.1.1)
        2. Exposure Category - (specify per D103 15.1.1.2)
        3. Gust Effect Factor - (specify per D103 15.1.1.4)
    - iv. Seismic Design Criteria
        1. Risk Category - (specify per D103 5.2.1)
        2. Importance Factor - (specify per D103 14.2.1)
        3. Site Class - (specify per D103 14.2.3)

### 1.3 SUBMITTALS

**A. Action Submittals:** Construction will be governed by the Owner's drawings and specifications, which outline general dimensions and construction details. The tank bidder must obtain written approval from the Engineer for detailed erection drawings before proceeding. No deviations from the Owner's drawings and specifications are permitted without written authorization from the Engineer.

1. Submit for approval the following:
    a. Copies of detailed tank Design Drawings & Structural Calculations Submittals shall be sealed/stamped by a Professional Engineer licensed in the applicable State.
    b. Drawings shall include all dimensions, sizes, plate thicknesses, anchorage, nozzle details, and details of all required accessories.
    c. Fabrication cannot begin until submitted drawings are approved. Once approved, an electronic copy of the submittal information marked "APPROVED FOR CONSTRUCTION" will be returned to the tank manufacturer. These approved drawings will govern the work detailed therein. The Engineer's approval of the tank supplier's drawings confirms general conformity with the bidding drawings and specifications. However, it does not guarantee specific dimensions and quantities, which remain the tank supplier's responsibility.

**B. Warranty:**

1. If within one (1) year from the date of final acceptance, the tank structure or any part thereof, including the tank coating system, proves to be defective in material or workmanship as determined by the manufacturer, the manufacturer shall, at its own expense, repair or replace the defective component.
2. The tank manufacturer shall provide a standard Maintenance Manual upon final acceptance of the tank installation.

## PART 2 – PRODUCTS

### 2.1 GENERAL

**A. Tank** shall be manufactured by the following manufacturer:

1. Phoenix Fabricators & Erectors LLC
2. Pre-approved equal

### 2.2 TANK

**A. Tank Size:**

1. Nominal Diameter: xx.xx feet.
2. Maximum Nominal Tank Sidewall Height: xx.xx feet.
3. Design Freeboard: xx inches.
4. Minimum Nominal Tank Capacity: xxx.xxx US Gallons.
5. Minimum Usable Tank Capacity: xxxx.xxx US Gallons.
6. Number of Tanks: x

**B. Plates and Sheets:**

1. Plates and sheets used in the construction of the tank shell, tank floor and tank roof shall meet or exceed structural requirements of AWWA D103, Section 4.4.
2. Design requirements for mild strength steel shall be ASTM A36 or ASTM A1011 Grade 30,36,40,or 50 with a maximum allowable tensile stress 18,000 psi. Design requirements for high strength steel shall be ASTM A1011 Grade 42, 50, 55, or 60 with a maximum allowable tensile stress of 30,000 psi, unless otherwise noted in the engineering specifications and/or submittals
3. Steel plates shall be mechanically rolled in factory to the required tank radius utilizing rolling machines.
4. When Structural Shapes are used, the design and engineering shall conform to minimum standards of AWWA D-103, Section 4.5.

**C. Horizontal Wind Girders/Stiffeners:** A36, Q235, or equal.

1. The design of such elements shall be limited in use. When the design requires them, a full and detail calculation to their strength and stresses must follow AWWA D103.

**D. Bolt Fasteners:**

1. Bolts used in tank lap joints shall be ½" - 13 UNC- 2A rolled thread, with 4-splines, and shall meet the minimum requirements of AWWA D103, Section 4.2.
2. Bolt Material SAE J429 Grade 8/ASTM A490/ASTM A354
3. SAE J429 Grade 8
    a. Tensile Strength - 150,000 psi Min.
    b. Proof Load - 120,000 psi Min.
    c. Allowable shear stress with threads excluded from the shear plane: 36,818psi minimum.
    d. Tank sidewall bolts shall be installed such that the head portion is located on the interior of the tank and the washer and nut are located on the exterior.

**E. Bolt Finish**

1. JS1000 Coating/Plating System by Leland Industries or equal.
2. NFZ3000 Coating/Plating System by Leland Industries or equal.
3. Zinc, mechanically deposited. 2.0 mils minimum - under bolt head, on shank and threads.

**F. Bolt Shank**

1. Fully threaded Carriage Type Bolts shall not be permitted.
2. Bolts shall have a shank.
3. Threaded portion of the bolt shall not exceed 1” in length and the rest shall be unthreaded bolt shank that is positioned between the tank plates.
4. All lap joint bolts shall be properly selected such that threaded portions will not be exposed in the "shear plane" between the sheets.
5. Bolt lengths shall be sized as to achieve a neat and uniform appearance.
6. Excessive threads extending beyond the nut will not be permitted.

**G. Bolt Head Encapsulation:**

1. High impact polypropylene copolymer encapsulation of entire bolt head up to the shank.
2. Resin shall be stabilized with an ultraviolet light resistant material such that the color shall appear black.
3. The bolt head encapsulation shall be certified to meet the ANSI/NSF Standard 61 for indirect additives.

**H. Sealants:**

1. The lap joint sealant must be a one-component, moisture-cured, polyurethane-based elastic sealant. For potable water storage tanks, the sealant must be NSF61-certified for indirect additive use and approved by the tank manufacturer. Suitable sealants include Manus Bond 75AM, Sikaflex 1a and Sikaflex 201. For non-potable water applications, Sikaflex TS Plus or Sikaflex 403 may be used.
2. A sealant will be used to seal lap joints, bolt connections, and edge fillets for sheet notches and starter sheets. The sealant should cure to a rubber-like consistency, adhere well to the coating material, have low shrinkage, and be suitable for both interior and exterior use. Neoprene gaskets and tape-type sealers will not be used.
3. Sealant curing rate at 73°F and 50% RH.
    a. Tack-free time: 6 to 8 hours.
    b. Final cure time: 5 to 12 days.

**I. Surface Preparation and Cleaning:**

1. After plate fabrication and prior to application of the coating system, all sheets/plates shall be steel grit-blasted to SSPC SP-10/NACE2 (Near White Metal) on both sides.
2. The surface angular anchor profile shall be a minimum of 2.0 mils.
3. All sheets shall be air blasted to remove any latent grit.

**J. COATINGS, APPLICATION, COLOR, & INSPECTIONS**

1. Interior Wet Surfaces: Phoenix UltraTec Epoxy Lining System
    a. Surface Preparation: Abrasive blast referencing SSPC-SP 10 to provide a uniform 2.0 mil angular surface profile. Prepared substrate must be clean, dry, and free of contaminants.
    b. Pit Filler, Seam Sealer, and Fairing Compound: Tnemec Series 215 Surfacing Epoxy
    c. Finish: Tnemec Series 21 Epoxoline applied at 8.0 to 12.0 mils DFT
2. Exterior Surfaces: Phoenix UltraTec Epoxy Lining System
    a. Surface Preparation: Abrasive blast referencing SSPC-SP 6 to provide a uniform 1.5 mil angular surface profile. Prepared substrate must be clean, dry, and free of contaminants.
    b. Pit Filler, Seam Sealer, and Fairing Compound: Tnemec Series 215 Surfacing Epoxy
    c. Primer: Tnemec Series 21 Epoxoline applied at 3.0 to 5.0 mils DFT
    d. Finish: Tnemec Series 2E84 DTM Finish Coat applied at 2.0 to 4.0 mils DFT

    **NOTE:** The same epoxy coating as applied to the sheet surface shall be applied to the exposed edges and bolt holes.

3. Tank Colors:
    - Interior:
        - Pure White
    - Exterior:
        - Pure White
        - Forest Green
        - Desert Tan
        - Cobalt Blue
        - Storm Grey
4. Inspections:
    a. Holiday testing
        1. Low voltage “wet sponge” holiday detector, (5 to 90 volts DC) equipped with an audible signal device with an exploratory electrode consisting of an open cell cellulose sponge saturated with potable water to push the liquid film over the coated surface. When a discontinuity is encountered, DC current will flow through the liquid to the conductive substrate thus completing the circuit and causing an audible signal to be emitted.
        2. Holiday tests be performed on each panel on both sides of every panel.
        3. Any sheet registering a discontinuity shall be rejected.
        4. All inside sheet surfaces shall be holiday free.
        5. Frequency of the test shall be every sheet.
    b. Visible inspection as well as Holiday Detection Test shall be performed on both sides of the coated plates. If any unacceptable pinholes are found, they shall be repaired (i.e. - coated a second time) and Holiday Detection Test shall be performed again on the entire panel.
    c. If upon completion of Holiday repairs any unacceptable pinholes are found at least on one side of the panel, the entire plate shall be rejected and substituted with the one that has successfully passed Holiday Testing inspection.
5. Measurement of Coating Thickness:
    a. All coated sheets shall be inspected for mil thickness (Mikrotest or equal).
    b. The thickness gage shall have a valid calibration record.
        1. Interior and Exterior surfaces.
        2. Coating thickness shall be measured using an electronic dry film thickness gauge
        3. Frequency of the test shall be every tank sheet per SSPC-PA2 Level 2

**K. Tank Foundations and Tank Floors:**

1. The top of the foundation shall be a minimum of 6-inches above the finished grade.
2. Tank foundation design shall be based on the maximum allowable soil design bearing capacity as determined by the geotechnical report/soils analysis performed by a licensed geotechnical engineer.
3. Tank Foundation Type:
    a. Type 1 & 2: Steel-bottom tanks supported on ringwall. The floor is to be an epoxy-coated bolted steel floor. Bolted steel panels shall be placed over a compacted gravel base contained by a steel or concrete ringwall, or a concrete slab, with a non-extruding and resilient bituminous type filler meeting the requirements of ASTM D1751 placed between the tank floor and gravel base to act as a cushion.
    b. Type 6: Concrete-bottom tanks with embedded steel base setting ring.
    c. As per AWWA D103 Type 6 foundations Concrete-bottom tanks with embedded steel base setting ring and as follows:

1. The base-setting ring shall be properly assembled in strict accordance with the construction drawings and rigidly supported and attached to the concrete ringwall footing before placement of concrete for the curb and tank bottom.
2. Tolerances shall be as per section 13.6.4 and as follows:
    a. Anchor bolt locations, projection, and embedment tolerance shall be +/- ¼" (6mm).
3. A greater depth may be required for design, but the base-setting ring shall be embedded in concrete at least 6" (150mm).
4. A minimum distance of 3" (76mm) between the top of footing and the bottom of the base-setting ring shall be provided. Unless a greater width is required for design, the exterior curb shall have a width of 8" (200mm), and its finished top shall coincide +/- 1" (25mm) with the finished top of the concrete bottom.
5. A minimum of one elastomeric water stop shall be installed on the interior surface of the base-setting ring, completely around the entire circumference, before placement of concrete for the curb and tank bottom.
6. The top of the sealing material shall be a minimum distance of 2" (50mm) below the finished top of the concrete bottom. Concrete shall be reinforced and designed in accordance with ACI318 and ACI350.
7. Additional reinforcing steel shall be installed around the base-setting ring, as required, to control shrinkage and resist horizontal loads.

4. Tolerances on Concrete Foundations.
    a. As per AWWA D103-19std section 13.6 and as follows:
        1. Ringwalls and slabs, after grouting, or before placing the cane-fiber joint filler (if tank is a self-anchored tank), shall be level within +/- 1/8 in. (3 mm) in any 30-ft (9-m) circumference under the shell.
        2. The levelness on the circumference shall not vary by more than +/- ¼ in. (6 mm) from an established plane.
        3. The tolerance on poured concrete before grouting shall be +/-1 in. (25 mm).
5. Anchor Bolt Tolerances.
    a. Tolerances on anchor bolt locations, projection, and embedment tolerance shall be +/- ¼" (6mm). Anchor bolt plumbness tolerance shall be +/- 3deg. from vertical.
6. Finish on Concrete Foundations.
    a. The top portions of foundations, to a level 6 in. (150 mm) below the proposed ground level, shall be finished to a smooth form finish in compliance with ACI 301. The top corners of the foundation shall be either neatly rounded or finished with a suitable bevel. Any small holes may be troweled over with mortar as soon as possible after the forms are removed.
7. Size of foundation top.
    a. The tops of foundations shall project at least 3 in (76 mm) beyond the tank sidewall, or greater if required by design. In base-setting ring applications, the top of the foundation should project a minimum of 8 in (200 mm) beyond the tank sidewall, or greater if required by design.
    b. When anchor bolts are used, the foundations shall project min. 9 in. (230 mm) beyond the tank.

8. Foundation allowable settlement:
    a. AWWA D103-19std Type 1 foundations: Steel-bottom tanks supported on ringwall.
        1 The total settlement shall not exceed 2”, and the differential settlement shall not exceed 13mm per 10m (1/2” per 32’) of circumference.
    b. AWWA D103-19std Type 2 foundations: Steel-bottom tanks supported on concrete slabs.
        1. The total settlement shall not exceed 2”, and the differential settlement shall not exceed 13mm per 10m (1/2” per 32’) of circumference.
    c. AWWA D103-19std Type 6 foundations: Concrete-bottom tanks with embedded steel base setting ring.
        1. The total settlement shall not exceed 1”, and the differential settlement between the center and edge of the tank shall not exceed 0.5”.

**L. General: Tank Roof System:** Tank roofs shall be furnished by the tank manufacturer.

1. Steel Cone Type Roof
    a. The tank will feature a radially sectioned roof constructed from epoxy-coated, bolted steel panels, produced by the tank manufacturer. The roof will be assembled similarly to the sidewall panels. The roof will be either clear-span or center-supported, with both live and dead loads carried by the tank walls and any center supports.
    b. The manufacturer will provide a roof opening near the outside tank ladder, equipped with a hinged cover and hasp for locking. The opening will measure at least 24 inches by 15 inches. It will have a 4-inch curb, and the cover will overlap by at least 2 inches. Alternatively, a gasketed weather-tight cover may be used in lieu of the 4-inch curb and 2-inch overlap.
    c. Roof Vent:
        1. Vent - A properly sized atmospheric vent assembly in accordance with AWWA D103-19 shall be furnished and installed on the roof.
        2. The overflow pipe shall not be considered as a tank vent.
        3. The vent to prevent the entrance of birds and/or animals by including an expanded aluminum or stainless steel screen.
        4. When insect screening is specified, a pressure-vacuum screened vent or a separate pressure-vacuum relief mechanism must be installed. This mechanism should automatically activate if the screens frost over or become clogged with debris, preventing damage to the screens or relief mechanism. Once the obstruction is cleared, the system should return to its normal operating position.

2. Aluminum Geodesic Dome Roof- Design Standards: ADM2015, AWWA D108-19std, ASCE7-16, IBC 2018/2021.
    a. Tank shall be equipped with a Clear-span self-supporting aluminum geodesic dome. Roof live loads and dead loads shall be carried by tank sidewalls, without any additional support
    b. Aluminum dome roofs shall be constructed of non-corrugated, triangular aluminum panels, which are sealed and firmly clamped in an interlocking manner within a fully triangulated aluminum space truss system.

c. Dome roof and tank will be designed to act as an integral unit. The tank will be designed to support an aluminum dome roof including all specified live loads.
d. Roof Vent: A properly sized atmospheric vent assembly in accordance with AWWA D103-19 shall be furnished and installed on the roof. The overflow pipe shall not be considered as a tank vent. The vent to prevent the entrance of birds and/or animals by including an expanded aluminum screen.
e. Material: All aluminum alloys shall be as defined by the Aluminum Association, ADM 2015 and published in the ALUMINUM STANDARDS AND DATA.
f. Triangulated space truss: 6061-T6 or 6005A-T6 aluminum struts and gussets.
g. Triangulated closure panels: .050"t 3003-H16 aluminum sheet.
h. Tension ring: 6061-T6 or 6005A-T6 aluminum.
i. Fasteners: 7075-T73 anodized aluminum or series 300 stainless steel.
j. List of standard accessories for aluminum dome roof:
    1. 30" x 30" Roof Access Hatch composed of AL
    2. Eyebolt/Safety Pin/Painters Pin composed of SS304
    3. OSHA approved handrails composed of AL
    4. SS304 Safety Line

**2.3 TANK ACCESSORIES**

**A. Level Indicator:**

1. Manufacturer shall supply and install visual liquid level indicator type on the side of the tank (Float Type, Sight Gauge or a Pressure Gauge type).

**B. Pipe Connections:**

1. Where pipe connections are shown to pass through tank panels, they shall be factory located and cut at factory prior to the application of the coating system.
2. The manufacturer shall utilize an interior and/or exterior flange assembly and the tank shell reinforcing as required by the project engineer and owner's requirements.
3. Nozzles & Accessories: material as per plans
    a. Standard: Phoenix UltraTec Epoxy
    b. Optional:
        1. SS304L
        2. SS316L

**C. Access Door/Manway:**

1. Tank shall be provided with min. One (1) 24-inch diameter manway in first (bottom) ring as shown on Contract Drawings or as per AWWA D103.
2. To be shop located and cut in factory, and shall receive Phoenix UltraCoat Epoxy coating system on all surfaces approx. 8-12mils DFT.

**D. Identification Plate:**

1. A manufacturer's nameplate shall list the tank serial number, tank diameter and height, maximum design capacity, intended storage use, and date of installation. The nameplate shall be affixed to the tank exterior sidewall at a location approximately 5' from grade elevation in a position of unobstructed view.

**E. External Overflow Weir and Pipe:**

1. Overflow pipe shall be determined by the manufacturer or specified by the Engineer and shall be composed of galvanized CS sch 40 pipe, Schedule 80PVC, SS304 or DI Pipe.

**F. Roof Access Hatch:**

1. Provide min. One (1) 30-inch x 30-inch access hatch.

**G. Ladders:**

1. An exterior vertical caged tank ladder shall be furnished and installed as shown on the contract drawings and as per OSHA
2. Ladders shall be fabricated of carbon steel. Finish shall be hot dipped galvanized, epoxy coated or SS304 as specified on the pans.
3. Safety cage and step-off platform shall be constructed of galvanized steel. A locking cage gate shall be attached to the bottom of the safety cage, HDG CS or SS as specified on the plans

**2.4 TANK PACKAGING**

**A.** All sheets that pass Factory Inspection and Quality Control will be protected from damage before shipment.

**B.** Non-abrasive packaging materials will be placed between each panel to prevent damage during shipping.

**C.** Individual stacks of panels will be wrapped in heavy plastic, secured with steel bands, and placed on custom wooden pallets designed to fit the panel curvature. This method minimizes panel movement and damage during shipping.

**PART 3 – EXECUTION**

**3.1 - ERECTION**

**A.** Except as otherwise shown or specified, Tank shall be erected in accordance with the requirements of AWWA Standard D103 latest edition and manufacturer's recommendations and instructions.

**B.** Supervisory personnel of the erection crew shall identify themselves to responsible personnel of the Engineer or Inspector upon initially entering the job site.

**C. Tank Foundation:**

1. The tank foundation shall be designed by a certified PE to safely sustain the structure and its live loads.
2. Tank footing design shall be based on the soil bearing capacity given by the geotechnical engineer or as specified in these specifications.

**D. Tank Structure:**

1. Field erection of the epoxy-coated, bolted-steel structures and components must strictly adhere to the procedures established by the tank manufacturer and be executed by the manufacturer or an authorized dealer experienced in erecting these tanks.

2. Specialized erection jacks, and other building equipment provided by the tank manufacturer, along with scaffolding, wooden ladders, cranes, scissor lifts, or other equipment, may be used to erect the tanks, depending on the application, location, and specific dimensions to optimize value for the tank owner or purchaser.
3. Particular care must be taken during the handling and bolting of epoxy-coated steel tank panels, appurtenances, and members to prevent coating abrasion. Before the liquid test, all surface areas must be visually inspected. Any coating chips or scrapes must be repaired according to the tank manufacturer's recommended procedure.
4. Sealant placement on each panel may be inspected before adjacent panel placement. However, this inspection does not absolve responsibility for liquid tightness.
5. No backfill should be placed against the tank sidewall without prior written approval from the tank manufacturer. Any permitted backfill must be placed strictly according to the manufacturer's instructions.

**3.2 - FIELD TESTING**

**A.** After tank erection and cleaning, the structure will undergo a liquid tightness test by filling it to the overflow elevation.

**B.** The erector will correct any leaks identified during the test, following the manufacturer's recommendations.

**C.** The owner will provide water for testing at no cost to the manufacturer or erector. Water disposal is the owner's responsibility.

**D.** Hydrostatic tank testing, including labor, water, and equipment, can be optionally included in the tank's contract price upon request.

**3.3 – TANK DISINFECTION**

**A.** The tank structure shall be disinfected at the time of testing in accordance with AWWA Standard C652-02 “Disinfection of Water Storage Facilities” using chlorination method number two. Disinfection shall be performed by a competent water treatment contractor.

**B.** Disinfection shall not take place until tank sealant is fully cured.

**3.4 - TANK MANUFACTURER’S WARRANTY**

**A.** The tank manufacturer shall provide a warranty covering both tank materials and coating. This warranty must, at a minimum, guarantee against defects in materials or workmanship for the specified minimum duration.

**B.** Structure – The tank manufacturer warrants that the liquid storage tank will be free from material or workmanship defects under normal, proper use, maintenance, and operation for a period of one (1) year, commencing ten (10) days after final tank erection.

**END OF SECTION**