

Technical Specifications for Metal Reservoirs Construction

PART 1 GENERAL

1.01 SUMMRY

This section covers all work related to the construction and erection of galvanized steel water tanks with all accessories, materials and work required to deliver complete water systems at the locations, sizes and components specified in the bill of quantities, drawings and other contract documents. The galvanized steel tanks sides shall be built utilizing hot-dipped galvanized steel panels at least 1.5 mm in thickness bolted with 10 mm diameter galvanized bolts with washer under the nut. The floor shall contain 25 cm of compacted base coarse materials and 15 cm of sand. The tank shall be lined with a heavy duty PVC liner of thickness 0.51 mm or more with suitable protection layer and the cover shall be a geosynthetic fabric with 90% shading. In addition to that a reinforced concrete ring beam shall be placed around the circumference of the tank. Work shall include all materials and labor required to complete the job as described in these specifications, contract drawings and bill of quantities. The work shall need constructing one 1000 m³ tank in Al-Buqaiyaa, Atuf (with possibility of moving the location to Nassariyah), four 500 m³ and two 250 m³ in Ein El-Beida and Kardala (northern Jordan valley). The work includes installing booster pumps at some of these sites as detailed in the bill of quantities, and installing a booster pump in Bardala village. Work related with booster pump will include installing electric control units and pump protection. The work will include installing water meters, strainers, gate valves, pressure relieve valves, check valve and air relieve valves as shown in bill of quantities and detailed in drawings.

1.02 QUALITY ASSURANCE

- A. The contractor shall offer a new tank structure as supplied from a manufacturer specializing in the design, fabrication and erection of factory applied galvanized steel, bolt together tank systems. The manufacturer should have successfully implemented similar work for at least 3 years.
- B. The contractor shall have the experience and knowledge necessary to furnish and erect the highest quality of tank possible. Under no circumstances shall an inexperienced Contractor be awarded the project. The contractor shall be fully responsible for the entire installation including excavation, appurtenances, and the final product. Contractors shall prove that they have successfully implemented similar work specified in this section in at least 3 other projects.

1.03 SUBMITTALS

Water Tanks:

- A. Provide shop drawings with structural designs approved and certified by the factory supply steel panels. Details of fabrications and erection of the tank and its inlets and outlets, sources and testing results of borrow material, base coarse, concrete and sand.
- B. Construction shall be governed by the drawings and specifications showing general dimensions and construction details, after written approval by the Engineer of detailed erection drawings prepared by the contractor. There shall be no deviation from the drawings and specifications, except upon written order from the Engineer. The contractor is required to furnish a complete set of structural calculations, for the approval of the Engineer and at no increase in contract price

- C. PVC liner: Samples of PVC fabrics and a certificate from the manufacturer that the PVC fabrics supplied satisfies these specifications including thickness and other characteristics. The contractor shall be responsible for testing the fabrics at a certified laboratory if required by the engineer.
- D. The geosynthetic cover: 3 samples of covers shall be submitted to the engineer to select one from.
- E. Steel panels: sources and certificates of origin and testing for steel panels and their galvanization shall be submitted for approval before installation.
- F. Booster pumps: provide shop drawings, pump test results, performance curves, warranty and certificate approving installation for the pump by the contractor.

Operation and Maintenance

- A. Operation and Maintenance Manuals: Provide 4 copies of the Operation and Maintenance manual; containing complete parts list, recommended maintenance schedules and procedures, and guide for the operation of the water tank.

1.04 WARRANTY

- A. The contractor shall warrant the water tank and its durability against defects in workmanship and materials including shell, liner and cover for at least 3 years.
- B. The tank manufacturer shall warrant the water storage tank shall be free from any defect in material or workmanship, under normal and proper use, maintenance and operation for at least three years after water is first introduced into the tank.
- C. The manufacturer of the PVC liner and cover shall warrant their durability for such application for at least 3 years after water is first introduced to the tank and under normal and proper use, maintenance and operation.
- D. The pump manufacturer shall warrant the pump unit being supplied against defects in workmanship and materials for 3 years or 9,000 hours of operation, whichever comes first.

1.05 REFERENCE STANDARDS

American Water Works Association ANSI/AWWA D103-97. AWWA Standard for Factory Coated Bolted Steel Tanks for Water Storage

American Water Works Association ANSI/AWWA D130-96. AWWA Standard for Flexible-membrane-lining and floating cover materials for potable water storage.

ACIS 301-Standard Specification for Structural Concrete

ACI 318-Building Code Requirements for Structural Concrete.

ANSI/ASTM A36-Standard Specification for Carbon Structural Steel

ANSI/ASTM A53-Standard Specification for Pipe, Steel, Black and Hot -Dipped, Zinc-Coated, Welded and Seamless

ASTM D7176 - 06 Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications

ASTM D 751 Hydrostatic Burst Test, Section 33, Procedure A

ASTM D 792 Specific Gravity

ASTM D 882 Tensile Properties

ASTM D 1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting

ASTM D 4354-99 Standard Practice for Sampling of Geosynthetics for Testing

ASTM D 4551 PVC Plastic Concealed Water Containment Membrane

ISO 6002-1992: Bolted bonnet steel gate valves

PSI 186-97: Steel pipes for general use.

PWA, 2000: Planning and design guidelines “ pumping stations for water”

PWA, 2003. Construction and installation of pipes in water supply and sewerage trenches.

PWA, 2003: Design Guidelines for construction of welded and bolted steel tanks.

PART 2 MATERIALS

Galvanized steel water tank

Plates and sheets used in the construction of the tank shell shall be galvanized steel waved sheets with a thickness of 1.5 mm or more.

Bolt Fasteners

Bolts, nuts and washers used in tank lap joints shall be 10 mm Hot Dip galvanized steel with metric coarse threads, and shall meet the minimum requirements of AWWA D103.

All bolts on the vertical tank wall shall be installed such that the head portion is located inside the tank, and the washer and nut are on the exterior.

Bolt lengths shall be sized to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after torquing will not be permitted.

PVC liner

The geomembrane sheet shall consist of polyvinyl chloride (PVC) resin in amounts greater than 50% of the total polymer content suitably compounded with plasticizers, stabilizers, additives, and pigments, to satisfy the physical property requirements. An insulation layer between the PVC liner and the tank sheets shall be installed in accordance with manufacturer recommendation. The PVC liner shall be manufactured for the purposes of lining water tanks and **the manufacturer of the PVC** shall guarantee its suitability for that purpose. The PVC liner shall have the following properties:

Property	PVC 20	PVC30	PVC 40	PVC50
thickness (mm)	0.51	0.76	1.02	1.27
Tensile break strength (KN/m)	8.4	12.8	17	20.3

Property	PVC 20	PVC30	PVC 40	PVC50
Elongation (%)	360	380	430	430
Modulus(KN/m)	3.7	5.6	7	8.8
Tear strength (N)	27	35	44	58
Dimensional stability (%)	4	3	3	3
Specific gravity(g/cc)	1.2	1.2	1.2	1.2
Water extraction percent loss	0.15	0.15	0.2	0.2
Water extraction volatile loss	0.9	0.7	0.5	0.5
Hydrostatic resistance (Kpa)	470	690	830	1030
Shear strength (KN/m)	6.7	10	14	17
Peel Strength (KN/m)	2.2	2.6	2.6	2.6
mass per unit area (g/m ²)	612	912	1224	1524

Cover net

High density polyethylene, UV stabilized, 90% coverage. UV resistance: 8 years or more. Should be water and weather resistant

Booster pumps:

Each of the booster motor pump set consists of a single stage centrifugal pump coupled directly with an induction motor and fitted with mechanical shaft seals and appropriate for outdoor installation.

Pump: Single stage centrifugal pump which should deliver the discharge and head specified in the bill of quantities at best efficiency. Efficiency should be more than 70%.

Pump Materials: Pump Housing: Cast iron ASTM A48. Impeller: Stainless steel (ASTM 304) or ASTM B584 Silicon Bronze (Zinc free bronze).

Pump Motor: High quality three phase squirrel cage induction motor with two poles, totally enclosed fan cooled including thermistors (Max ambient temperature: 45°C), Input Voltage: 3x400V, 50Hz, Speed: about 2900 rpm, Motor Efficiency: >85%, Power Factor : >87%, Output Power sufficient to operate the pump, Motor-Shaft: Stainless steel ASTM A582 Type 416, Motor Housing : Cast iron ASTM25, Enclosure Class: IP 65, Insulation Class : F

Booster pump electric control panel for pumps with power equal or larger than 10 horses (control panel includes soft starter):

The electric control panel shall include motor protection as follows. Motor connection terminals, all wiring and all electric components necessary for protection of the induction motor have to be built in a dust tight, water proof IP65 steel sheet cabinet (2mm thick) rust free, factory made with front door and lock (gray thermally painted). Cabinet dimensions have to be not less than 50 X 40X 30 cm. The cabinet should include a high quality soft starter appropriate for driving the pump motor with all protection relays timers, fuses, circuit breakers, bypass contactors and any other components necessary for protecting the motor. On/Off push button, emergency button, warning lamps, alarm to be built on the front door of the cabinet. Digital

screen for indicating the three input voltages and three input currents have to be installed inside the cabinet. Cabinet's body must be connected to the motor housing and to earth (the rods of the Water Metal tank could be used if the steel reinforcement is connected to the earth during construction of ring beam). All circuit breakers must be secured through thermal and magnetic combination action while over load relays should be of thermal type with calibration adjustable between 0.8 and 1.5 of the motor full current. Over load protection adjustable 0.8 – 1.5x Nominal motor current, short circuit capacity 4PX20 kA surge arrestors of replicable type. Relays, circuit breakers, contactors, fuses, timers and any other protection components should be of best quality as Schneider, Moeller, ABB or approved equivalent.

Booster pump electric control panel for pumps with power less than 10 horses (control panel without soft starter):

The panel to include motor protection as follows. Motor Protection: Motor connection terminals, all wiring and all electric components necessary for protection of the induction motor have to be built in a dust tight, water proof IP65 steel sheet cabinet (2mm thick) rust free, factory made with front door and lock (gray thermally painted). Cabinet dimensions have to be appropriate for installation of all wiring and protection components. The cabinet should include all protection relays timers, fuses, circuit breakers, and any other components necessary for protecting the motor. On/Off push button, emergency button, warning lamps, alarm to be built on the front door of the cabinet. Cabinet's body must be connected to the motor housing and to earth (Water Metal tank could be used if reinforcement of ring beam was connected to earth during construction). All circuit breakers must be secured through thermal and magnetic combination action while over load relays should be of thermal type with calibration adjustable between 0.8 and 1.5 of the motor full current. Over load protection adjustable 0.8 – 1.5x Nominal motor current, short circuit capacity 4PX20 kA surge arrestors of replicable type. Relays, circuit breakers, contactors, fuses, timers and any other protection components should be of best quality as Schneider, Moeller, ABB or approved equivalent.

Accessories

1. Water Flow Meter: Turbine water flow meter (6" or 4" as specified in BoQ, cast iron body, at least 16 bars) complete with flanges, gaskets, bolts and nuts all according to AWWA C207, AWWA C701, or appropriate ISO standards. The meter shall have an accuracy of $\pm 1.5\%$ or better, maximum pressure drop at maximum discharge 0.3 bar. Materials: meter housing (cast iron epoxy coated or cast bronze), rotor (thermoplastic or stainless steel), rotor bearing pivots (stainless steel type 316). The standard register is a straight-reading in SI units.

2. One Way (check) Valves, cast iron, swing type: Check valves shall be swing type and shall meet the material requirements of ISO 5781 or EN 1074-3. The valves shall be iron body, bronze mounted, single disc, 16 bars (350 psi) working water pressure, nonshock, and hydrostatically tested at a minimum of 36 bars (525 psi). The check valve shall:

A. When there is no flow through the line the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.

B. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.

C. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line. Valves shall be fitted with an extended hinge arm with outside lever and spring. Springs with various tensions shall be provided and springs approved by the Engineer shall be installed.

3. Gate Valves: (Resilient seated Rising Stem Gate Valves, metal seal, at least 16 bars) complete with flanges, gaskets, bolts and nuts according to AWWA C509, AWWA C207 standards and drawings. The Gate valve shall be of iron body, have flanged ends, and shall be bronze, solid wedge, rising-stem-type gate valve. The valve shall be rated for 16-bar pressure. The valve should have the following characteristics:

A. Valves shall be outside screw and yoke type with rising stem.

B. Face to face metal valves dimension shall conform to ISO 5752 or EN 558-1,2.

C. Bronze gate rings shall be fitted into grooves of dovetail or similar shape in the gates. For grooves or other shapes, the rings shall be firmly attached to the gates with bronze rivets.

D. Hand wheels shall turn counterclockwise to open the valves. Hand wheels shall be of ample size and shall have an arrow and the word OPEN cast thereon to indicate the direction of opening.

E. Stuffing box follower bolts shall be of steel and the nuts shall be of bronze.

F. The design of the valves shall permit packing the valves without undue leakage while they are wide open and in service.

G. O-ring stuffing boxes may be used.

4. Analog Pressure Gages (range: 0- 20 bar): Pressure gauges (with Analog Scale) shall be manufactured in accordance with ISO 5171 or EN 837-1,2,3 and shall be furnished and installed in each pump suction and discharge nozzle and in accordance with the drawings and bill of quantities. Where gauge taps are not available in the pump's suction or discharge nozzle, the necessary taps in the adjacent piping shall be made for installation of gauge connections. Each pressure gauge should be equipped with a stop valve of the same pressure rating.

5. Air Release/ Relief Valves: Air relief valves shall be of the double orifice pattern with cast iron bodies, the inlet flange shall be fitted and drilled in accordance with EN 1074-4. The valves shall be adequately sized for the release of air from the pipeline without restriction of rate of filling or flow due to backpressure. Air shall be allowed to enter at a rate sufficient to prevent excessive reduction of pressure in the pipe during pipeline emptying. The "aerokenetic" type shall be provided, air valves with internal operating linkages shall be avoided. Valves shall be designed to prevent the operating elements being in contact with the pipeline liquid by approved means such as the provision of an auxiliary float and chamber sufficiently large to isolate the orifice valves and seats throughout the rated operational range.

Air valves shall be fitted with a separate isolating sluice, ball or gate 2" valve to facilitate operation. EN 1074-4. All air relief valves and associated isolating valves shall be works tested and capable of withstanding the same test pressure as the pipeline or vessel on which they operate. All materials used in the manufacture of the valve shall conform to EN 1074-4.

6. Pressure Relief Valves with adjustable setting to allow pressure relief when pressure exceeds an adjustable setting in accordance with ISO 4126. The pressure/surge relief valve shall be heavily constructed cast iron valve body. Isolation valves shall be installed upstream pressure relieve valves in the form of 2" ball or gate valves. The disc shall be cast iron having a replaceable resilient seat for tight shut-off. The Pivot shaft shall be stainless steel and be a single unit (not stubs), extending through the valve body with a weight and lever mounted on one or both ends.

The pressure/surge relief valve shall be adjusted at the factory to hold closed against the normal operating system pressure. When the system pressure exceeds this setting, the surge relief Valve shall open immediately to relieve the pressure rise, but closes slowly at an adjustable rate as the system pressure returns to normal.

A heavy-duty oil dashpot system and stainless steel oil reservoir shall be externally mounted on the valve to control the rate of closure, in such a manner, to positively prevent any slam. The closing rate shall be externally and infinitely adjustable thru a color-coded flow control valve having a locking device to prevent tampering, once the close rate is set.

Prior to shipment of the valves the manufacturer shall factory test the valves under the pressure and flow conditions specified above. The manufacturer shall submit to the Engineer with certified copies of the factory test results. Surge relief valves shall be in accordance with ISO 4126 and shall be installed on the plant water lines as shown on the Drawings.

The surge relief valve shall be heavily constructed cast iron valve body, with integral end flanges and full unobstructed flow through area. The disc shall be cast iron having a replaceable resilient seat for tight shut-off. The Pivot shaft shall be stainless steel and be a single unit (not stubs), extending through the valve body with a weight and lever mounted on one or both ends.

The surge relief valve shall be adjusted at the factory to hold closed against the normal operating system pressure. When the system pressure exceeds this setting, the surge relief Valve shall open immediately to relieve the pressure rise, but closes slowly at an adjustable rate as the system pressure returns to normal.

A heavy-duty oil dashpot system and stainless steel oil reservoir shall be externally mounted on the valve to control the rate of closure, in such a manner, to positively prevent any slam. The closing rate shall be externally and infinitely adjustable thru a color-coded flow control valve having a locking device to prevent tampering, once the close rate is set.

Prior to shipment of the valves the manufacturer shall factory test the valves under the pressure and flow conditions specified above. The manufacturer shall submit to the Engineer with certified copies of the factory test results.

Surge relief valves shall be installed where indicated on the Drawings. Valves shall be rated 40 bars (600 psi) working pressure.

7. Black Steel Pipes at least 3.96mm Thick externally coated with backed epoxy manufactured in accordance with PSI 186-97 and AWWA C-200 for connecting the tanks or existing piping with the valves, meters, strainer, gages and dressers in accordance with BoQ and drawings and engineer's directions. Price includes all jacks, accessories, material, welding, cutting and supports needed to connect and support the pipe in place and its connections. Black steel pipe should have been tested at a pressure of 50 bars or above.

8. Flanged Dresser: 6" and 4" complete for (16 bars) with two tie rods 60 cm long diameter of 5" / 8 and 4 ears for each dresser in accordance with drawings and engineers. Material of dresser shall be high strength steel.

9. Strainers (cast iron, at least 16bars). Strainers body will be made of cast iron. Strainer body will be coated with an epoxy powder minimum thickness 120 microns. Screen shall be made of stainless steel. For maintenance purposes, covers shall be provided to allow ample access to inspection,

cleaning and servicing. A drain bend at the bottom of the body, fitted with a stopcock shall be incorporated. Head loss shall not be more than 0.1 bars, when clean, at the nominal flow rate of the control valve or water meter protected by the strainer box.

PART 3 EXECUTION

- 1) Foundation preparation: The contractor shall excavate and to remove at least the top 50 cm agricultural soil layer, excavate to reach a level surface and then place engineering backfill or rock fill, compact and smooth the backfill to produce a sub grade suitable for erection the tank. The sub grade shall be rolled and compacted 95% of the dry bulk density. Final grade shall be zero slope in all directions and at the elevation of the highest point of the ground surface under the tank. The foundation shall extend at least 1 meter around the tank.
- 2) A 25 cm layer of base coarse material shall be placed, rolled and compacted 98% of the dry bulk density. The final surface of the compacted layer shall be level and extends for the dimensions and depths shown on the drawings. The contractor shall be responsible for testing base coarse material and base coarse density at an accredited laboratory. After approval from engineer and laboratory results prove that the base coarse material and compaction are accepted, the contractor can proceed with the erection of the tank sides.
- 3) A layer of construction sand shall be placed for a depth of 15 cm over the base coarse and to the extents shown on the drawings.
- 4) The first row of galvanized steel panels shall be erected and shall be placed in perfect level cylindrical shell. The installation of one row of panels is to make sure that the top of the tank will be level without any inclination of the sides. The contractor is to perform level measurements and adjust the panels so that their top side form a level perimeter.
- 5) Discharge pipe connections which pass through tank panels, shall be field located, saw cut, and utilize an interior and exterior flange assembly and the tank shell reinforcing shall comply with AWWA D103. The contractor to install the water level measurement hose as shown in drawings which shall include at least a 0.75" ball valve, 20 mm transparent hose, tied to the tank. The transparent hose to be tied to the tank screws and stabilized in place with suitable steel hooks. The measurement hose shall have a steel measuring tape or rod to show the readings of water height in the tank. The measurement hose will be connected to the outlet pipe through cutting and welding a galvanized steel pipe (0.75").
- 6) The contractor to construct a reinforced concrete beam with the reinforcement and concrete shown in the drawings. The contractor to excavate at least 10 cm in the base coarse for the ring beam so the concrete beam will start 10 cm lower than the bottom of the steel panels by at least 10 cm. The contractor to install at least 8 steel rods in the form of 2" galvanized pipes in the ring beam to be used to tie the steel cables (10 mm in diameter of galvanized steel) which will carry the net cover of the tank. The height of these pipe columns shall be equal to the height of the tank. At the sites where booster pumps will be installed, the contractor might consider connecting the steel reinforcement to earth through a steel plate and use the steel tank to connect pump to earth.
- 7) The sides of the galvanized steel tanks shall be erected in accordance with the procedures outlined by the manufacturer and performed by an authorized erector of the tank manufacturer, regularly engaged in erection of these tanks, using factory trained and certified personnel. Particular care shall be taken in handling and bolting of the tank panels and members to avoid

abrasion of the coating system. Prior to a liquid test and the placement of PVC liner, the Engineer shall visually inspect all surface areas and approves the continuation of construction.

- 8) The PVC liner shall be placed and fasten to tank sides in accordance to manufacturer recommendations and an insulation layer shall be placed between liner and steel tank as recommended by manufacturer. The liner should extend over the sides of the tank for about 25 cm on the outside.
- 9) The contractor to install galvanized steel cables (at least 10 mm in diameter) and tie them to the column pipes installed in the ring beam and the middle pipe in the center of the tank as shown in the drawings. The contractor to install the net cover over these steel cables and fasten the net through durable plastic robes to the bolts of the tank.
- 10) Inlet pipe to be installed in accordance with the contract drawings, manufacturer recommendations and as approved by engineer.
- 11) The booster pump, its electric panel (if required in BoQ) and the piping connections shown in the bill of quantities to be installed in the sites as indicated in the bill of quantities and shown in the drawings and in accordance with manufacturer recommendations and engineer's directions.
- 12) Field hydrostatic testing:

Following completion of erection and cleaning of the tank, the structure shall be tested for liquid tightness and the levels of the tank walls by filling tank to its maximum elevation. The top of the walls for the tank shall be level (the variation shall not exceed 5 cm which is the difference between the water level in the tank when it is full and the maximum level of the top of the tank walls). The contractor in accordance with the manufacturer's recommendations shall correct any leaks disclosed by this test. The owner shall furnish water required for testing at the time of tank erection completion, and at no charge to the contractor. Disposal of test water shall be the responsibility of the owner. Labor and equipment necessary for tank testing is to be included in the price of the tank.

- 13) In sites with booster pumps, the booster pump with its fittings to be installed on the discharge pipe as shown on the drawings and bill of quantities.
- 14) The electric control panels to be installed and mounted to the steel rods in the ring beam of the tank as indicated in the bill of quantities and the specifications above.

PART FOUR

MEASUREMENT AND PAYMENT

The payment for this section will be in accordance of the unit prices shown in the bill of quantities. Only items mentioned clearly in the bill of quantities and implemented under this specification and approved by the supervising engineer will be measured and paid for. Any extra items used to complete the connections of the system or used in the electrical connections to get the water and electrical system operational will be considered incidental to the project and will not be covered or paid for as separate items.

END OF SECTION