TECHNICAL SPECIFICATIONS
FOR
SELF SUPPORTED
FIXED CONE ROOF TANK
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1.0 SCOPE

1.1 This specification covers the minimum requirements for design, selection of materials, fabrication, erection, inspection, testing, fitting of other attachments and appurtenances, cleaning, calibration and painting of A/G SELF SUPPORTING FIXED CONE ROOF TANKS storage and is intended to supplement the minimum requirements of the applicable codes.

1.2 Engineering drawings shall take precedence over specifications/standards.

1.3 The Review/ approval of design by HPCL shall not absolve Contractor from the responsibility of successful performance of Self Supporting Cone Roof. It shall be the sole responsibility of the Contractor to ensure successful performance of Roof design.

1.4 The tanks shall be designed as per API 650 strictly. The design calculation in the scope of contract includes Bottom Plate(Annular/Sketch), Shell, Wind girders if any, Top Kerb Angle, Roof Plates, Self Supporting Trusses(Main Beam) and Rafters, Check for overturning of tank under wind load, seismic design etc for HPCL’s approval prior to drawing preparation.

2.0 REFERENCE
2.1 Design Codes

The following codes in their latest edition shall form the basis for design, fabrication, inspection, testing and acceptance of storage tanks:

API Standard 650 : Welded steel tanks for oil storage (Latest edition)

IS : 875 (Part 3) : Code of practice for design loads Wind loads (other than earthquake) for building and structures.

IS : 1893 : Criteria for earthquake resistant design of Structures.


API : RP 2003 : Protection against ignitions arising out of static, lightning and stray currents.

OISD-129 : Inspection of storage tanks.

OISD-11 : Fire Protection facilities for Petroleum Depots and Terminals

OISD-118 : Layouts for Oil & Gas installations.
OISD-105 : Work permit system.

2.2 Materials Codes

Material to be used shall conform to:
- Steel plates confirming to IS 2062.
- Indian Standard Specifications or ASTM standards as Applicable

2.3 Regulations

Central laws and regulations together with local bye-laws for the location wherever the tanks are to be erected must be compiled with.

3.0 SELECTION OF MATERIALS

3.1 All materials shall be as per applicable Codes.

3.2 Manhole necks, nozzle necks 250 mm NB and above may be fabricated from same plate material as used for shell.

3.3 Plate material used for ring flanges shall have a minimum UTS of 4200 Kg./cm². For Flange thickness over 38 mm, plate material shall be boiler quality, fine-grained, killed, normalised and impact tested as per the requirements of API Standard 650.

3.4 All clips and attachments shall be fabricated from carbon steel plates of weldable quality.

3.5 Gaskets for manholes fitted with blind flanges shall conform to IS: 2712. Thickness of gasket shall be 3.0 mm. Champion OIL Service gaskets may be used.

3.6 Bolts and nuts for all nozzles fitted with blind flanges shall conform to IS: 1367, ASTM A-307 Gr. B, A-193 Gr. B-7, or
A-194 Gr. 2H. Bolts and nuts for all structural steel shall conform to IS: 1363.

3.7 Following classifications of electrodes are recommended for welding. However, minimum requirements of applicable codes and appendices should be adhered to:

a] Low hydrogen electrodes namely, E-7018 shall be used for all manual metal-arc welds of shall courses having a thickness of 12mm or more and for attachment of shell courses to bottom or annular plates.

b] High cellulose/rutile type electrodes namely, E-6013 as per the AWS classification SFA 5.1 is acceptable for all other welding.

ESAB and ADVANI OERLIKON make electrodes will only be permitted to be used in the works. Based on above, fabricator shall furnish samples of welding electrodes to Engineer-in-Charge for approval.

4.0 DRAWINGS AND DOCUMENTS

4.1 All individual tank data sheets shall have dimensional/design as well as material specification. Final drawing with revisions, if any, shall be issued after award of contract/purchase order.

Contractor shall submit the detailed design calculation for self supporting Cone roof (C.R.) to HPCL for vetting and review of design and approval by HPCL.
4.2 Contractor shall prepare all design calculations and fabrication drawings based on the drawings issued on award of contract/purchase order and shall include the following:

1. Drawing index and Schedule of Submission.

2. Design calculation for Self supporting Cone roof for HPCL review & approval.

3. GA drawing covering all details shown in HPCL data sheets like list of appurtenances, lists of standards and specifications, materials of construction, Tank design data, General Notes including details of test to be conducted on tank, specification and brand-name of welding electrodes to be used etc.

4. Plate layout, details of welding and bill of material for bottom sketch & annular plates.

5. Development details of welding and Bill of Materials for shell including shell extensions showing location of all the Shell appurtenances including Manholes, nozzles, inlet trough and stairway on developed shell through a Nozzle orientation drawing.

6. 2 No. Water draw off Nozzle & 1 No. Fast Flush Nozzle are provided with pipes that extend up to the Sump and dip in to the sump. This arrangement is to be shown on drawing.

7. Plate layout, details of welding and Bill of Material for Cone Roof Layout.

8. Details of spiral stairway and extension stairway to Top platform, landings and handrails with bill of materials.

10. Details of Earthing connections for Shell with Bill of Material.

11. Details of Roof Supporting Structure with Bill of Material.

12. Details of shell nozzles and Inlet Troughs with Bill of Material.

13. Details of Roof appurtenances including Roof manholes, vents, Temperature transmitter Nozzles, Temperature hatch, Gauge well & Dip Pipe, Gauge Hatch along with respective Bill of Materials.

14. Nozzle Orientation of roof appurtenances, plate joints, Stairway, etc.

15. Details of mounting of Roof vents.

16. Details of Foam Cooling System, supports for the Foam intake pipes, Foam intake pipes along with Foam makers and orifice plates.

17. Details of Pressure relief lines & pressure transmitter nozzles.

18. Plate cutting diagrams for all free issue material.

19. Plate reconciliation statement for free issue material.

20. Details of all datum plates.

In case the contractor intends to make some modification for accommodating his fabrication
facilities or available materials, the same shall be submitted to HPCL for approval with supplementary design calculations. The approved modifications shall be incorporated in fabrication drawing and submitted to HPCL for approval.

4.3 Requisite number (as per the Time schedule of this Work/Tender document) of prints of detailed fabrication drawings prepared by contractor shall be sent to HPCL for approval and one copy shall be returned to the contractor after comments/approval. No fabrication / erection shall be carried out without approved drawings.

5.0 FABRICATION AND ERECTION

5.1 Plates

a] Plates edges shall preferably be sheared or machine cut as per code. All machined parts shall be suitably protected before assembly.

b] Gas cut plates shall be grounded to the satisfaction of the Engineer-in-Charge.

c] All formed plates shall be match marked with paint on the concave side with numbers as shown on erection drawings.

5.2 Structural steel and Roof

a] Structural steel fabrication shall be carried out to the required shapes for making the structure.

b] A pre-assembly of a sufficient part of roof structure may be called for by the Engineer-in-Charge to assess the correct workmanship.
5.3 Bottom
   a] Bottom slope shall be as indicated in the respective tank drawings.

   b] Overlaps shall be properly cleaned with steel wire brush before welding.

   c] Single pass welds are not permitted.

   d] Arrange the laps as per requirements of the code.

   e] Annular plates shall be assembled by butt welding with backing strips and the sketch plates shall be lap welded to the Annular & Sketch plates.

   f] Three plates lap joints shall be suitably jogged to a length of 150 mm minimum to facilitate welding. Joggling shall be to the satisfaction of Engineer-in-Charge.

   g] Contractor shall provide a Welding sequence which shall be adopted so as to give minimum shrinkage and distortion and it shall be indicated on fabrication drawings. This shall be approved by Engineer-in-Charge.

   h] Bearing plates & Datum plates shall be fabricated as per standard drawings and positioned as per AFC Drawings.

5.4 Shell
a) Shell erection shall be carried out by Jack – up method only. Calculations for deployment of number of jacks and their placement/ location shall be submitted by the Contractor for HPCL’s approval.

b) All vertical and horizontal shell joints shall be full penetration and full fusion welds using any one of the edge preparations permitted by the Code. Single side butt welds are not permitted.

c] Top curb angle shall be lap or butt welded to the top course with flange turned outside.

d] Drain holes of 20 mm diameter suitably staggered shall be provided on the horizontal plates of the stiffening ring (wind girder).

e] Hand railing shall be provided all around when stiffening ring is used as walkway for floating roof rank.

f] Curb angle and stiffening ring joints shall not coincide with the vertical shell plate welds.

g] Vertical joints should preferably be offset by at least 1000mm.

h] First shell course plates shall be so arranged that the vertical joints clear the annular ring welds or sketch plates welds by at least 300 mm. Vertical joints of the shell courses shall also clear the nozzle attachment welds or reinforcement pad welds as per code and applicable appendices.

i] Holes shall not be made in shell plates for erection purpose.
j] Shell plate alignment shall be within the limits specified in code and as approved by HPCL.

k] For floating roof tanks, internal diameter shall be maintained in all shell courses.

l] During erection, strapping must be carried out at three different levels for each strake as a crosscheck for plumb.

5.5 Fixed Roof

a) The Roof plates shall be supported by structures as indicated in the drawings.

b) The slope of the Cone Roof shall be in accordance with API 650.

c) All supporting structures shall be designed to carry the minimum loads as specified in codes. While designing, contractor shall also consider lateral loads caused by one bay loaded and the other bay not loaded.

d) Roof shall be joined to the shell by means of continuous fillet (5mm max) weld on the curb angle. Roof to shell joint shall be frangible type.

e) Roof plates shall not be welded to the supporting structure. The roof plates shall rest on the structure.

5.6 Vents

Roof shall be provided with 300mm diameter goose neck type vent.

5.7 Gauge Wells
Gauge hatch size shall be as indicated in the drawing and it shall have a quick opening cover. Gauge hatch shall be spark proof type. Gauge well pipe and Telescopic Pipes for Radar Gauge/Temperature transmitter shall be located accessible to Top landing platform. Gauge well pipes shall be provided with slot holes.

6.0 APPURTENANCES

6.1 Nozzles & Accessories

a) All appurtenances and accessories as shown in the respective tank drawings shall be supplied by the Contractor.

b) Manhole and nozzles with blind flanges shall be provided with gaskets and boltings.

c) Nozzle and manholes may be shop assembled.

d) Flange faces shall be varnished and protected by wooden discs using at least three bolts.

e) All nozzles and accessories shall be prefabricated and attached to the shell plate. The prefabricated assembly shall be stress relieved prior to installation, wherever required as per code and applicable appendices.

6.2 Stairways, Roof Access and Handrailing.
Each tank shall be provided with stairway and roof access. Hand railing shall be provided all around.

6.3 **Settling Marker** :

Marker shall be provided on the shell, 500mm from the bottom to check tank settlement. Size shall be 50x50x5mm angle and 100mm long. The distance between settling marker is approximately 5 meter.(minimum 4 numbers).

Shell settlement measurement shall be made after tank erection, prior to hydro testing and during water filling.

Bottom internal measurements shall be made after hydro testing; such measurement shall be made at all pipe support locations. Additional measurements shall be made in annular plate region at 5 meter intervals around the tank shell.

7.0 **INSPECTION AND TESTING**

Inspection shall be carried out by HPCL Engineer-in-Charge at all stages.

7.1 **Inspection**

a) All tanks shall be offered for inspection at all stages as desired by Engineer-in-Charge.

b) HPCL’S representatives shall have free access to the entire contractor’s shops as well as to worksite.
c) The contractor shall provide all facilities, such as access ladder, lighting, tools and tackles, instruments etc. and personnel to inspectors, for proper execution of their inspection.

d) All the inspection shall be carried out in accordance with the relevant codes and requirements of drawings and specifications.

e) Approval of the HPCL’S Engineer-in-Charge shall in no way relieve the contractor of his responsibilities for proper execution of work.

7.1.2 Welding Procedure

a) Welding procedure qualification shall be carried out as per Exhibits enclosed in tender and as per details in Scope of Work.

b) No welding shall be undertaken without approval of the welding procedure and welder qualification test by the Engineer-in-charge.

7.1.3 Radiography and Inspection of Welds

a) All welds shall be inspected and tested as per Section 6.1 of API 650 and this specification.

b) All long seams of fabricated nozzles shall be fully radiographed.

c) Weld areas to be radiographed shall be designated by the Engineer-in-charge.
d) Radiographs shall be taken as soon as welding of the Joint is completed. If repairs are required, these shall be carried out before starting other welds. New radiography examination of such repairs shall also be carried out by the Contractor at his own cost.

e) Radiograph film length shall be 250 mm min. except if the weld is less than 250 mm long. In such cases, film length shall be full length of weld.

f) Radiographic film shall be of approved quality.

g) The radiography films and reports shall be reviewed and approved by a HPCL approved Third Party Agency. The quoted rates are deemed to include same.

7.1.4 Liquid penetrant examination:
Wherever specified in drawing/code, liquid penetrant examination shall be carried out as per specifications and codes.

7.2 Testing
All equipment required for testing shall be supplied by the contractor.

Openings other than those used for hydrostatic test or any other test shall be closed by plugs and blind flanges supplied by the contractors.

7.2.1 Bottom test
a) A detailed description of the proposed test method shall be first submitted for approval to the Engineer-in-Charge.

b) Vacuum box testing shall be carried out for detection of leaks in the bottom.

c) The weld joints under the shell periphery shall be tested before erection and welding of first shell course.

d) Contractor shall test the tank bottom for the entire weld length in the presence of the Engineer-in-Charge and test reports shall be issued accordingly.

7.2.2 Shell Test

a) Bottom to shell joints shall be tested as follows:

i) Inner filter weld shall be inspected and tested prior to welding the outside fillet weld. Leak test shall be performed with penetrating oil after removal of slag. Oil shall be removed before, welding the outer fillet.

ii) Examination for inner fillet to detect cracks shall be performed using either the liquid penetrant method or Magnetic particle method.

b) All welded lugs and brackets used for erection purpose shall be carefully removed from inside and outside surface of the tank to the satisfaction of the Engineer-in-Charge.
c) The shell joints up to kerb angle shall be subjected to hydrotest.

d) Contractor shall perform the hydrostatic test in the presence of Engineer-in-Charge on each tank after complete erection. Any defects observed during the test shall be repaired by the contractor. No Hot work shall be permitted after Hydrotest.

e) Filling of the tank may be restricted by HPCL Engineer-in-Charge for preloading of foundation and hydrostatic test may be extended over a period of 4 weeks or more to ensure proper settlement of the tanks.

f) The filling height shall be restricted to a maximum height while carrying out the hydrostatic testing/filling up water. The steps shall be as follows:

g) On completion of tank and after cleaning, the tank shall be filled with water as follows, unless otherwise specified in the tender documents.

   Filling shall be in 4 stages- 25%, 50%, 75% and 100%. After each stage a load stabilization period shall be observed:

   - 24 hrs between each stage for tanks with a capacity equal or more than 10,000 cu.m.
   - 12 hrs between each stage for tanks with a capacity under 10,000 cu.m.
Filling rate shall not exceed 5 metres per day.

d) When the tank is full all the weld joints shall be hammered by the Contractor in the presence of Engineer-in-Charge. In case of any defect it shall be repaired and retested by the Contractor as per instructions of Engineer-in-Charge.

e) Tank shall be emptied at a maximum water level variation rate of 5 metres per day or as per instructions of Engineer-in-Charge.

f) All weld repairs shall be done with water level minimum 300 mm below the joint being repaired.

7.2.3 Fixed roof testing

a) After filling the tank upto curb angle or max. liquid level, all openings in the roof shall be closed and internal air pressure shall be applied equivalent to the weight of roof plates.

b) Pressure testing of roof for leak detection shall be carried out as per code.

c) For vacuum test the tank shall be emptied up to 1m level from the bottom. The openings shall be closed and draining continued with care until the vacuum of 25mm water gauge or the design vacuum whichever is higher is obtained and checked by vacuum gauge. However for tanks having diameter 20m and above, design check for vacuum shall be made before proceeding with the test.

7.2.4 Nozzle Reinforcing Plates

a) Nozzle reinforcing plates shall be pneumatically tested at 1.05 kg/cm²g with soap solution. This test shall be carried out before filling the tank for hydrostatic testing. All
the weld joints in roof shall be checked with soap suds for detection of leaks.
b) Observations will be made for leakages during Hydrostatic testing.

7.2.5 **Pipes for water draw off & fast flush**

Pipes for above shall be pressure tested with water at 6 kg/cm².

**8.0 CALIBRATION**

Strapping and Calibration of all tanks shall be done in accordance with IS:2007 & 2008 (Latest editions).

**9.0 PAINTING**

For details of primer and painting, Painting specification shall be referred to.

**10.0 TOLERANCE**

10.1 **Shell**

For tanks to have acceptable appearance and to permit proper functioning, they shall have tolerances strictly as specified in applicable codes.

**11.0 IDENTIFICATION, PACKING AND TRANSPORTATION**

11.1 **Identification**

Each plate and structural member shall be clearly marked with the specification number, drawing number and assembly number.
11.2 Packing and Transportation

a. All plates shall be transported in tractor or trailer and shall not be dragged.

b. All rolled shell plates shall be packed properly to retain the shape and shall be handled carefully to avoid damage during transit.

c. Contractor shall be responsible for transportation of material fabricated in his workshop or worksite.

12.0 GUARANTEE

Guarantee, if not covered by the General Conditions of contract, shall be as following:

12.1 The entire Work shall be guaranteed in accordance with conditions given in the “General terms and Conditions of Contract” and “Special Conditions of Contract”.

12.2 Any part of tank found detective within 12 months from the date of Completion of work as per Completion Certificate and not having been subjected to faulty operations or incorrect service conditions shall be promptly replaced/repai red and reassembled by the contractor at his own cost, failing which owner has the right to get the same replaced/repai red by others and charge the cost incurred to the contractor.

13. STRUCTURAL STEEL

Structural Steel sections manufactured by SAIL, RINL, VIZAG, TISCO or JINDAL only shall be permitted to satisfactory sample testing.