CONSTRUCTION STANDARD

FOR

PRESSURE STORAGE (FOR LPG) SPHERES

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0. INTRODUCTION

"Storage Tanks" are broad and contain variable types and usages of paramount importance therefore, a group of construction standards are prepared to cover the subject. This group includes the following standards:

STANDARD CODE	STANDARD TITLE
IPS-C-ME-100	"Atmospheric above Ground Welded Steel Storage Tanks "
IPS-C-ME-110	"Large Welded Low Pressure Storage Tanks "
IPS-C-ME-120	"Aviation Turbine Fuel Storage Tanks "
IPS-C-ME-130	"Pressure Storage Spheres (for LPG)"

However when purchasing of equipment or materials to be incorporated into storage spheres, Engineering and design or periodic inspection is concerned, reference is made to the relevant IPS material, engineering and inspection standards.

1. SCOPE

1.1 This construction standard, covers the minimum requirements for site erection of pressure storage spheres designed and fabricated in accordance with ASME Section VIII.

1.2 This standard also covers safety requirements governing the layout and spacing of pressure storage spheres. This also includes the design of dikes.

1.3 This standard gives general requirements to be met by a tank erector (or erection contractor) when submitting quotations for above ground pressure storage spheres.

1.4 It should be noted that when only purchasing of materials and equipment to be incorporated into the storage spheres are involved, the requirements of Iranian Petroleum Material and Equipment Standard for pressure storage spheres (for LPG) (IPS-M-ME-130 shall be met.

1.5 Design and engineering of pressure storage spheres (for LPG) shall be in accordance with Iranian Petroleum Engineering and Design Standard for pressure Storage spheres (for LPG) (IPS-E-ME-130).

2. SOURCES AND REFERENCES

2.1 Sources

In preparation of this Standard, in addition to the Referenced Codes and Standards mentioned in 2.2, the following standards and publications have also been considered:

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME section VIII division 1 & 2 "Pressure Vessels" 1989.

BSI (BRITISH STANDARDS INSTITUTION)

BS 5500 "Unfired Fusion Welded Pressure Vessels "1991.

BS 2654 "Manufacture of Vertical Steel Welded Non-refrigerated Storage tanks with Butt Welded Shell for the Petroleum Industry" 1989.

2.2 References

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the contractor:

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Section VIII div. 1-89 "Pressure Vessels"
Section IX-89 "Welding and Brazing Qualification"
Section V-89 "Non-destructive Testing"

AWS (AMERICAN WELDING SOCIETY)

IPS (IRANIAN PETROLEUM STANDARDS)

M-ME-130	"Material and Equipment Standard for Pressure Storage Spheres (for LPG)"
E-TP-100	"General Requirements for Paints"

3. UNITS

International system of units (SI) in accordance with IPS-E-GN-100 shall be used.

4. MATERIAL

4.1 The erection contractor shall inspect and keep stock of all materials delivered and be fully responsible for their safekeeping. All fittings, valves, plates, etc. shall be properly laid out on wooden supports clear of soil. Special care shall be taken that damage does not occur to joint faces of valves and flanges or to beveled ends of fittings.

4.2 Any part which does not comply with the requirements shall be held in abeyance and material which shows defects may be repaired provided acceptance by the owner's inspector is first obtained for the method and extent of repairs. Defective material that cannot be satisfactorily repaired shall be rejected. The owner shall be advised in writing immediately.

4.3 Welding electrodes shall be stored in their original packets or cartons in a dry place adequately protected from weather effects. Hydrogen controlled electrodes shall be stored and baked in accordance with the electrode manufacturer's recommendations.

5. SUPPORTS

5.1 Supports for pressure storage spheres, either reinforced concrete, pipe or structural shapes shall be constructed according to their relative drawings.

5.2 Pressure storage sphere supports shall be fire proofed. The fireproofing encasement shall not, however, cover any portion of the supports at points where they are welded to the shell of the sphere.

6. SITE ERECTION

6.1 Site erection of pressure storage spheres shall be per ASME Section VIII and the following supplementary requirements.

6.2 No modifications shall be made to the approved design except with prior agreement between the owner and the erection contractor.

6.3 Before commencing erection, the erection contractor shall obtain approval for the followings:

a) Welding procedures to be adopted for all parts of storage sphere.
b) Welder's qualification.
c) Use of welding consumables other than those used in the welding procedure test.
d) Preheat and post-weld heat treatment procedures.
e) Welding carried out after final post-weld heat treatment.
f) Choice of non-destructive testing technique.
g) Comprehensive schedule covering non-destructive testing requirements.

6.4 Temporary attachments shall be severed from the parent body by cutting through the attachment adjacent to the weld followed by grinding the remainder smooth and flush with the surface of the parent body.

6.5 The workmanship and finish shall be such that all requirements specified are met and shall be subjected to close inspection by the erector whether or not the owner waives any part of his own inspection.

6.6 Unless otherwise specified, the responsibility for supplying welding electrodes and/or key plating equipment lies with the fabricator. The responsibility for the supply of site erection equipment, labor, false work, etc. lies with the erection contractor.

7. WELDING

7.1 Welding on pressure storage spheres shall be in accordance with Subsection "B" part UW of the ASME pressure vessel code Section VIII.

7.2 Qualification for welding procedures, welders and welding operators shall be in accordance with the requirements of ASME code Section IX.

7.3 The erection contractor shall show on a drawing the applicable welding procedure and non-destructive tests required.

7.4 Tack welds shall be removed when making the final weld.

7.5 Attachments and shell openings, wherever practicable, shall be located so that the welds do not overlap shell seams or interfere with welds of other attachments.

7.6 Joints between plates in different thicknesses for shell plates shall be aligned at the inside surface.

7.7 Welding electrode shall be of AWS approved quality or equivalent. Welding electrodes for use with carbon steels shall be "low-hydrogen" type.

7.8 All surfaces to be welded shall be thoroughly cleaned of oxide scale, oil or other foreign substances to a clean metal surface and for a distance of at least 12 mm from each welding edge.

7.9 Each run of weld metal shall be thoroughly cleaned and all slag removed before the next run is deposited.

7.10 Distortion due to welding shall be minimized by suitable attention to the welding sequence.

7.11 Where preheat is specified welding shall continue without interruption. If however, continuity is affected, preheat shall be maintained or the joint shall be slowly cooled under an insulation blanket. Before commencing welding preheat shall be applied.

7.12 Thermal stress relieving, if required, shall be done in accordance with Table UCS-56 of ASME code Section VIII division I or as specified in the sphere specification sheet. Stress relief procedure specification and certificates shall be submitted for owner’s approval.

8. TOLERANCES

8.1 There shall be no discernible flats or excessive peaking at welded seams. Any local deviation from circularity shall be gradual.

8.2 Diameter of both upper and lower edges of sphere center plates shall not deviate more than 3% of theoretical diameter.

8.3 Curvature of each joint of sphere shell plates shall not deviate more than 3 mm for the specified curvature over a span of 1.0 meter.

8.4 Inside diameter of the sphere shell shall not deviate more than 1% of theoretical inside diameter.

8.5 Tolerance for groove angle shall be ±5° and tolerance for the root opening shall be within ±3 mm.

8.6 Perpendicular tolerance of support columns of the sphere shall be within 1/500 of the height from bottom of base plate to the center of sphere.

8.7 Tolerances for nozzles and manholes

8.7.1 Position of nozzles in shells and domed ends measured from tangent line, ±6 mm.

8.7.2 Projection for nozzles on shell measured from shell curvature, and for nozzles on domes measured from tangent line, 6 mm.

8.7.3 Radial orientation measured from reference center line to center line of nozzle ±1 degree with a maximum circumferential tolerance of 15 mm.

8.7.4 Maximum rotation for bolt hole orientation measured at bolt circle is 1.5 mm.

8.7.5 Position of manhole measured from bottom tangent line ±12 mm.

8.7.6 Height of manhole measured from shell curvature ±12 mm.

8.7.7 Alignment of flange face for manholes maximum 1 degree in any direction.

8.8 Tolerances for nozzles for level instruments:

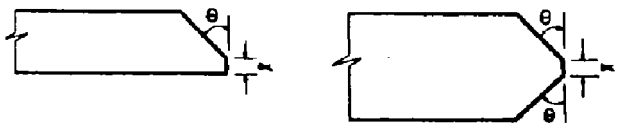
8.8.1 Distance measured from center to center ±1.5 mm.

8.8.2 Projection difference for each pair of flanges, measured from shell curvature 1.0 mm.

8.9 Tolerances of weld bevels shall be per Fig. 1.

Note:

Bolt holes to straddle center lines, if not indicated otherwise.



θ = Bevel angle : ±2.5

α= Root face : ±1.5 mm

TOLERANCES OF WELD BEVELS

Fig. 1

9. INSPECTION

9.1 The inspection of pressure storage spheres shall be performed in accordance with the requirements of ASME code Section VIII and the following requirements.

9.2 Pressure storage spheres shall be spot radiographed per ASME code Section VIII para. UW-52, except that acceptance standards shall be per para. UW-51.A minimum of one spot radiograph shall be taken at each weld intersection and one in each vertical (meridonal) weld seam.

9.3 Visual examination shall accompany all non-destructive testing and this examination shall be recorded.

9.4 Examination by sectioning is prohibited.

9.5 Nozzle to shell welds shall be inspected prior to installation of any reinforcing pads.

9.6 Shell seams covered by a nozzle reinforcing pad or any other structural overlay shall be spot radiographed in the portion to be covered.

9.7 Nozzle and attachment welds shall be tested by means of magnetic particle test; dye penetrants shall not be used except for nonmagnetic materials.

9.8 Where radiography is not possible, ultrasonic or magnetic particle test shall be applied.

9.9 Method and acceptance standard for magnetic particle test shall be per Appendix 6 of ASME code Section VIII, division 1.

9.10 Method and acceptance standard for liquid penetrant test shall be in accordance with Appendix 8 of ASME code Section VIII, division 1.

9.11 Method and acceptance standard for ultrasonic test shall be per Appendix 12 of ASME code Section VIII, div. 1.

9.12 Inspection stages during erection of pressure storage spheres which participation of owner's inspecting authority is mandatory are as follows:

9.12.1 Correlation of material certificates with materials and check for conformity with material specification zones.

9.12.2 Approval of weld procedures.

9.12.3 Approval of welders and operators.

9.12.4 Examination of set up of seams for welding, including dimensional check, examination of weld preparations, tack welds, etc.

9.12.5 Inspection of second side of weld preparations after first side is completed and root cleaned.

9.12.6 Examine non-destructive test reports and check compliance with agreed procedure and acceptability of any defects.

9.12.7 Examine heat treatment records and check compliance with agreed procedure.

9.12.8 Witness pressure tests.

9.12.9 Examine completed sphere.

9.13 Weld joints of reinforcing pad for opening shall be leak tested by pneumatic pressure. The test shall be preferably performed at 98 kPa minimum using compressed air. The test shall be carried out before post-weld heat treatment where this is to be conducted. If post-weld heat treatment is not necessary, the leak test shall be performed before hydrostatic test.

9.14 Unacceptable defects shall be repaired. Repair welds shall be carried out to an approval procedure and subjected to the same acceptance criteria as original work.

10. HYDROSTATIC PRESSURE TESTING

10.1 Hydrostatic test shall be performed after confirming the acceptance of final visual inspection and all records of non-destructive examination excepting that requested to be conducted after hydrostatic test.

10.2 Hydrostatic pressure testing shall be carried out in accordance with the pressure storage data/requisition sheet and the code requirements.

10.3 Test fluid used for hydrostatic testing shall be clean water. The quality of water to be used depends on the material(s) from which the pressure storage vessel or sphere is manufactured. In all cases the PH of the water shall be kept between 6 and 8.

10.4 Foundation level check shall be conducted before filling water, at the time when the half volume is filled with water and after filling with water.

10.5 Test pressure shall be kept minimum 60 minutes before starting visual inspection.

10.6 Hydrostatic test shall commence and finish during daylight hours.

10.7 Hydrostatic test include filling and emptying. The temperature of the test water shall be not lower than 20°C except approved otherwise.

10.8 No repairs shall be carried out by welding prior to or after hydrostatic testing without written permission by the inspector representing the owner. When repairs have been made following hydrostatic testing, a second hydrostatic test may be required.

11. PAINTING

11.1 If required, painting of pressure storage spheres shall be in accordance with Iranian Petroleum Standard IPS-E-TP-100 "General Requirements for Paints".

12. SPACING AND DIKES

12.1 Definitions

12.1.1 Vessel spacing is the unobstructed distance between vessel shells, or between vessel shells and the nearest edge of adjacent equipment, property lines or buildings.

12.1.2 Dike is an earth or concrete wall providing a specified liquid retention capacity.

12.1.3 Toe wall is a low earth, concrete or masonary unit curb without capacity requirements for the retention of small leaks or spills.

12.1.4 Diversion wall is an earth or concrete wall which diverts spills to a safe disposal area.

12.1.5 where vessel spacing is expressed in terms of vessel diameter, the diameter of the largest vessel is used. For spheres, the diameter at the maximum equator is used.

12.2 Diversion walls and sloping of the ground away from vessels to a remotely located retention basin is permitted for vessels storing liquids with a vapor pressure equal to or less than pentane, when approved by the owner’s engineer.

12.3 Earth dikes shall be used, except where space limitations require the use of concrete.

12.4 All dikes, diversion walls and toe walls shall be suitable for the static hydraulic and temperature conditions which may be encountered, and shall be liquid tight.

12.5 Piping and equipment dikes or toe walls, above ground piping for any storage sphere or group of spheres shall not run through other diked areas or other areas enclosed by toe walls. Equipment shall not be located inside diked areas or areas enclosed by toe walls.

12.6 Dike Arrangement and Capacities

12.6.1 Pressure storage spheres

12.6.1.1 Spheres shall be enclosed in individually diked areas.

12.6.1.2 Capacities of dikes for spheres shall be as follows:

a) For spheres storing flammable materials with a Reid Vapor Pressure (RVP) of 690 kPa or less, retention capacity of the diked area surrounding each sphere shall be a minimum of 50% of the capacity of the enclosed sphere.

b) For spheres storing flammable materials with RVP greater than 690 kPa retention capacity of the diked area surrounding each sphere shall be a minimum of 25% of the capacity of the enclosed sphere.

c) Height of common dikes between adjacent spheres shall be 150 mm less than the height of the peripheral dike. Both measurements include freeboard when earth is used.

12.6.1.3 Minimum height of dikes, as measured from within the dike shall be 300 mm if constructed of concrete and 450 mm plus freeboard if constructed of earth. The freeboard allowance for earth construction shall be a minimum of 200 mm. Additional freeboard allowance may be required for soil consolidation.

12.6.1.4 Maximum height of dikes shall not exceed 1m as measured from inside and 2 m as measured from outside the dike excluding freeboard.

12.6.1.5 When spheres are located on sloping terrain portions of the dike may exceed these specified limits except for the side adjacent to the road or accessway.

12.6.1.6 Access and egress

At least one stairway shall be provided over earth and concrete dikes, however at least two stairways shall be provided for concrete dikes 1m or more high. When two stairways are provided they shall be on opposite sides of the dike enclosure. At least one stairway shall be located as close as possible to a fire hydrant.

12.6.2 Earth dike or toe wall construction shall be as follows:

a) When granular material that is pervious to the liquid being stored is used the slopes subject to the liquid exposure shall be covered with a blanket of impervious material such as clay. This blanket layer shall be at least 150 mm thick (measured perpendicular to the slope) after compaction.

b) The surface of the dike or toe wall shall be protected against erosion.

12.6.3 Grading of diked or toe wall enclosures shall direct the liquid from a leak in the spheres or piping to an area within the enclosure that is remote from the spheres and piping.

12.6.4 Draining diked or toe wall enclosures

Where rain water will not percolate through the bottom of the enclosure within 24 hours, a drain system shall be installed to provide for rain run off. The drain system shall be provided with a gate valve or shear gate located in an accessible position outside of the enclosure. The valve normally shall be kept closed. The drain systems shall be either:

a) A sealed catch basin within the enclosure discharging to the sewer system, or,
b) A pipe through the dike or toe wall discharging to an open ditch draining system outside the enclosure.

12.7 Location, Layout and Spacing of Pressure Storage Spheres

12.7.1 Spheres shall be arranged in rows not more than two deep. At least one side of every sphere shall be adjacent to a road or accessway.

12.7.2 The minimum spacing between pressure storage spheres and boundaries, or between spheres and other facilities shall be per Table 1.

TABLE 1 - PROXIMITY TO BOUNDARIES AND OTHER FACILITIES

BOUNDARY LINES OR OTHER FACILITIES	MINIMUM SPACING TO PRESSURE STORAGE SPHERES
PROPERTY LINES ADJACENT TO LAND WHICH IS DEVELOPED OR COULD BE BUILT UPON, PUBLIC HIGHWAYS, MAIN LINE RAILROADS AND MANIFOLDS LOCATED ON MARINE PIERS	60m (1)
BUILDINGS OF HIGH OCCUPANCY (OFFICES, SHOPS, LABS, WAREHOUSES, ETC.)	60m (1)
NEAREST PROCESS EQUIPMENT OR UTILITY PLANT (OR NEAREST UNIT LIMITS IF FIRM LAYOUT IS NOT AVAILABLE)	60m (1)
REFRIGERATED STORAGE FACILITIES	¾ TANK DIAMETER BUT NOT LESS THAN 30m. NEED NOT EXCEED 60m
ATMOSPHERIC STORAGE TANKS (STOCK ENCLOSED CUP FLASH POINT OF 55°C AND BELOW)	ONE TANK DIAMETER BUT NOT LESS THAN 30m. NEED NOT EXCEED 60m
ATMOSPHERIC STORAGE TANKS (STOCK) ENCLOSED CUP FLASH POINT ABOVE 55°C)	½ TANK DIAMETER BUT NOT LESS THAN 30m NEED NOT EXCEED 60m

Note:

1) Distance from boundary line or facility to centerline of peripheral dike wall surrounding the pressure storage vessel/sphere shall not be less than 30m at any point.

12.7.3 Spacing between pressure storage spheres shall be as follow:

Between any two spheres spacing shall not be less than ¾ sphere diameter.

APPENDICES

APPENDIX A
PIPE COMPONENTS - NOMINAL SIZE

The purpose of this appendix is to present an equivalent identity for the piping components nominal size in imperial system and SI system.

TABLE A

NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE	
DN (1)	NPS (2)	DN (1)	NPS (2)	DN (1)	NPS (2)	DN (1)	NPS (2)
15	½	100	4	500	20	1000	40
20	¾	125	5	600	24	1050	42
25	1	150	6	650	26	1100	44
32	1¼	200	8	700	28	1150	46
40	1½	250	10	750	30	1200	48
50	2	300	12	800	32	1300	52
65	2½	350	14	850	34	1400	56
80	3	400	16	900	36	1500	60
90	3½	450	18	950	38	1800	72

Note:

1) Diameter nominal (DN), mm.

2) Nominal pipe size (NPS), inch.

APPENDIX B
PIPE FLANGES, PRESSURE - TEMPERATURE RATINGS

The purpose of this appendix is to present an equivalent identity for the pipe flange nominal pressure temperature ratings in imperial system and SI system.

TABLE B

PN (1)	ANSI EQUIVALENT (2)
20	150
50	300
68	400
100	600
150	900
250	1500
420	2500

Note:

1) Pressure nominal (PN), bar gage.

2) Pounds per square inch gage, (psig).