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BUREAU OF INDIAN STANDARDS

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भारतीय मानक **मसौदा**

एलपीजी के परिवहन के लिए 250 लीटर से अधिक और 1 000 लीटर से कम पानी की क्षमता वाले वेल्डित लो कार्बन स्टील धारक — विशिष्टि

DRAFT *Indian Standard*

WELDED LOW CARBON STEEL CONTAINERS ABOVE 250 LITRES AND NOT EXCEEDING 1 000 LITRES WATER CAPACITY FOR THE TRANSPORT OF LPG — SPECIFICATION

ICS 23.20.30

Gas Cylinders Sectional Committee, MED 16	Last date for receipt of comments is **16 November 2024**

FOREWORD
(*Formal clause will be added later*)

This standard has been formulated to keep pace with the latest technological developments and international practices. Also, the standard has been brought into the latest style and format of Indian Standards. BIS certification marking clause has been mentioned to align with the revised *Bureau of Indian Standards Act*, 2016.

Manufacture, possession and use of any gas contained in cylinders in compressed or liquefied state is regulated under the *Gas Cylinder Rules*, 2016 of the Government of India as amended from time to time. This standard has been prepared in consultation and agreement with the statutory authorities under those rules.

Cylinders of water capacity up to 5 litres are covered in IS 7142 : 1995 'Welded low carbon steel gas cylinders for low pressure liquefiable gases not exceeding 5 litre capacity — Specification (*first revision*)'.

Cylinders of water capacity exceeding 5 litres up to and including 250 litres water capacity are covered in IS 3196 (Part 1) : 2013 'Welded low carbon steel cylinders exceeding 5 litres water capacity for low pressure liquefiable gases: Part 1 cylinders for liquefied petroleum gases (LPG) — Specification (*sixth revision*)'.

Welded stainless steel cylinders for liquefied petroleum gases (LPG) from 0.5 litres to 250 litres water capacity are covered in IS 15637 : 2006 'Welded stainless steel cylinders for liquefied petroleum gases (LPG) from 0.5 litre to 250 litre water capacity — Specification'.

Periodic inspection and testing of LPG cylinders is covered under IS 16054 : 2013 'Periodic

inspection and testing — Welded low carbon steel cylinders exceeding 5 litre water capacity for liquefied petroleum gas (LPG) — Code of practice'.

The requirements for the inspection and re-conditioning of used LPG cylinders is covered under IS 13258 : 2014 'Welded low carbon steel cylinders exceeding 5 litre water capacity for low pressure liquefiable gas — Requirement for inspection and reconditioning of used LPG cylinders (*first revision*)'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

DRAFT *Indian Standard*

WELDED LOW CARBON STEEL CONTAINERS ABOVE 250 LITRES AND NOT EXCEEDING 1 000 LITRES WATER CAPACITY FOR THE TRANSPORT OF LPG — SPECIFICATION

1 SCOPE

This standard specifies the minimum requirements for the material, design, fabrication, workmanship, inspection, testing, manufacture and marking of refillable welded low carbon steel containers exceeding 250 litres and not exceeding 1 000 litres water capacity for liquefied petroleum gases (*see* IS 4576).

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to given in IS 7241 shall apply.

3.1 Yield Strength — Stress value corresponding to the lower yield strength, R_{eL} or, for steels that do not exhibit a defined yield point, the 0.2 percent proof strength, $R_{p0.2}$ for carbon steels and 1 percent proof strength for austenitic stainless steels, $R_{p1.0}$.

3.2 Normalizing — Heat treatment in which, a container is heated to a uniform temperature above the upper critical point (AC_3) of the steel to regenerate or homogenize the metallurgical structure of the steel and then cooled in a controlled or still air atmosphere.

3.3 Stress Relieving — Heat treatment given to a container, the object of which is to reduce the residual stresses without altering the metallurgical structure of the steel, by heating to a uniform temperature below the lower critical point (AC_1) of the steel and then cooling in a controlled or still air atmosphere.

3.4 Batch — A lot of 50 finished containers of a specific type made to the same design, size, and material specifications; using the same welding procedures and heat-treated under the same conditions of temperature and duration.

3.5 Test Pressure — The internal pressure required for the hydrostatic test of the container. The test pressure will be 1.5 times the saturated vapour pressure of the gas at 65 °C.

3.6 Finished Container — It is a container which is fully assembled and appropriately stamped, but without any external covering.

4 MATERIALS

4.1 The steel used in the manufacture of containers shall conform to IS 5986, IS 2041 or ISO 9328-2.

4.2 Suitable low carbon steel other than those given in **4.1** may be used with the prior permission of the statutory authority. In such a case, the minimum specified value of yield strength guaranteed by the manufacturer for the finished container shall be used for the purpose of calculating the wall thickness of the container.

4.3 The manufacturer shall obtain and provide certificate of cast (heat) analysis of the steels supplied for the construction of the containers and establish means to identify the containers with the casts of steel from which they are made.

4.4 The bung/valve pad shall be hot forged from rolled steel bars either conforming to Class 1A or Class 2 of IS 1875 or IS 2062 or IS 2004. The requirements of bungs/nozzles shall be in accordance with Annex B.

4.5 Compatibility of the Materials used for the Container

The materials used for the container, including welded zones, shall be compatible with the intended gas service and meet the applicable requirements of IS/ISO 11114-1, IS/ISO 11114-2, and IS/ISO 11114-4. Components (for examples, bolts and studs) in contact with the gas shall meet the applicable requirements of IS/ISO 11114-1, IS/ISO 11114-2, and IS/ISO 11114-4.

4.6 Welding Consumables

The welding consumables shall be such that they are capable of giving consistent welds with the material properties at least equal to that specified for the parent material in the finished container.

5 DESIGN

5.1 General Provisions

A fully dimensioned sectional drawing of the container, together with design calculations, guaranteed yield strength and scheme of manufacture, shall be submitted by the manufacturer to the inspecting authority for final approval by statutory authority.

5.2 Calculation of Thickness

P_h = test pressure (MPa);
D_i = internal diameter of the container (mm);
D_o = outer diameter of the container (mm);
Z = joint efficiency (0.85) with 100 percent radiography;
t_c = minimum finished thickness of the cylindrical shell (mm);
t_d = minimum finished thickness of the dish ends (mm);
f = maximum allowable stress in the container (N/mm²);
It shall not exceed minimum of the following:

YS/1.5 or TS/2.5

R = D_i × (0.44K + 0.02)

K = 2 for semi ellipsoidal dish end;

TS = minimum value of tensile strength guaranteed by the container manufacturer (N/mm²); and

YS = minimum value of yield strength guaranteed by the container manufacturer (N/mm²).

In both the above cases TS and YS shall not be more than the value stated by the steel manufacturer.

5.3 Cylindrical Wall

The minimum finished cylindrical section wall thickness (t_c), shall be not be less than the maximum value of thickness calculated using the following formula:

$$t_c = \frac{P_h \times D_i}{(3f - h)}$$

5.4 Dish Ends

The minimum thickness of the container with semi ellipsoidal dish end shall be calculated using the following formula:

$$\boldsymbol{t_d = \frac{10P_hR}{27.5fZ - 5P_h}}$$

6 FITTINGS

The mandatory fittings for containers defined in this standard shall include valves with Excess Flow Check Valve (EFCV) and pressure relief devices. The other optional fittings shall be level gauge, drain plug or any other fitting as approved by statutory authority.

While there is no restriction on the number of apertures, their number shall be kept to the minimum consistent with safe operation. Openings for the fittings shall be located only in the dished ends.

For opening greater than 15 mm, the fittings shall be attached to parts of the container that are locally reinforced by a pad, or to a flange or access plate of adequate thickness bolted to a flange. The reinforcement shall be provided as defined in this standard.

6.1 Screwed Fittings

Fittings up to 80 mm thread diameter can be screwed. If a tapered thread is used with sealing of the pressure on the threads, then a sealant (PTFE tape, PTFE dispersion, a lead ferrule or an aluminium ferrule) shall be inserted between the threaded components to effect a seal. Threads should be tapped to gauge, clean cut, even, and without cracks. Any thread standards acceptable

to the competent authority can be used.

6.2 Bolted Connections

Bolted connections shall be made with at least three bolts/studs. Studs shall be threaded to their ends. Joining surfaces shall be flat and true in accordance with the flatness, parallelism, and perpendicularity tolerances specified on the design drawings.

6.3 Valve

The containers shall be equipped with valve as per IS 16484 for combo valve or equivalent Indian standard as approved by statutory authority. Liquid withdrawal shall be equipped with Excess Flow Check Valve (EFCV).

6.4 Pressure Relief Valve

Pressure relief valve shall conform to ISO 4126-1 or equivalent Indian Standard as approved by statutory authority. The pressure relief valve shall be equipped with an isolation system for facilitating periodic maintenance and inspection. Periodic inspection shall be carried out once in a year. The periodic inspection shall be conducted to verify the set pressure, reset pressure, pop up action and discharge rate at full flow as defined by the manufacturer.

6.5 Drain Plug

Drain plug if provided shall have tapered thread as mentioned in clause **6.1**.

7 PROTECTION OF FITTINGS

Containers shall be such that all fittings are protected and are situated inside the contour of the end shrouds or support structure.

7.1 Fitting Protection at Shroud

The top of the shroud shall be higher than the top of the valve protective cap so as to prevent damage occurring to the valve/connector if the container is dropped or hit.

In addition to the general protection, fittings shall be provided with local protection for dust and moisture ingress. Pressure relief valves shall not be obstructed and do not require additional protection.

7.2 Fitting Protection for Container Bottom

Containers designed to be carried in their vertical position shall have a frame structure. Bottom outlets and their external pipe work shall be protected from impact.

8 LIFTING ATTACHMENTS

Containers shall have structural steel members of minimum thickness 5 mm to take the forks of a fork-lift inserted into the bottom structure. The configuration of the pockets/structures shall protect the container from being damaged during normal handling.

The fork apertures shall be positioned symmetrically about the container centre of gravity and their size shall be appropriate to accommodate the fork-lift/pallet truck forks which are to be used to move the container. The fork apertures shall be designed such that the container cannot accidentally disengage from the forks.

If lifting lugs are fitted to the container, they shall be designed to withstand a design load of 2 times the maximum gross weight of the container. Containers with more than one lifting eye shall be designed such that a minimum sling leg angle of 45 degree to the horizontal can be achieved during lifting using the lifting eyes.

Where four lifting eyes are used, their design shall be such that they are strong enough to allow the container to be lifted by only two. Where two or four lifting eyes are used, diametrically opposite lifting eyes shall be aligned with each other to allow for correct lifting using shackle pins.

9 FABRICATION

9.1 Shell Sections

The cylindrical shell shall be made from a single plate.

9.2 Dished Ends

The dished ends shall each be pressed from a single plate. All forming shall be done by stamping, rolling, or pressing machine. Local heating or hammering is not permissible.

Cold-formed dished ends shall be normalized after pressing by using a heat treatment process at a temperature recommended by the steel manufacturer.

Ends distorted during heat treatment beyond the allowable limits shall be re-aligned, and if it is done by cold deformation (for example, in a press), a further heat treatment for stress relieving shall be done.

Hot pressed dished ends heated to above 650 °C do not require normalizing after forming.

10 WELDING

The manufacturer, before proceeding with the production of a given design shall qualify the specific welding procedures and welders to be in accordance with the requirements of IS 15326 (Part 1 to Part 5). Records of such qualification shall be kept on file by the container manufacturer for a period of at least 10 years or as required by the statutory authority.

Procedural qualification tests shall be performed in such a manner that the welds shall be representative of those made in production.

10.1 Welded Joints

Plates and heads that are being welded shall be fitted, aligned, and retained in position during the welding operation. Bars, jacks, clamps, or other appropriate devices, including tack welds,

can be used to hold in alignment the edges to be welded.

The welding of the longitudinal and circumferential seams shall be by an automatic or a semi-automatic process. The longitudinal weld, of which there shall be no more than one in a cylindrical section, shall be a full penetration butt weld, and any backing bars shall be removed after welding. The weld bead reinforcement shall have a gradual transition from its maximum allowable crown to the plane of the base metal surface.

The circumferential welds shall be a butt weld or joggle joint weld. In case of butt weld, backing strip shall be used for the circumferential welds.

11 SURFACE FINISH OF MATERIAL

The internal surface finish shall be specified and take account of the intended service of the container. Any scale or corrosion shall be removed using an appropriate method (for example, shot blasting). Any surface defects(for examples, pits, scrapes, rolled-in scale or press marks), shall be ground out so that the reduced thickness is blended into the rest of the plate at an angle not less than 1:20.

The depth of any defects shall be limited to 1.5 mm. The thickness at all such locations shall be measured and proved to be greater than the minimum specified.

For carbon steel containers, before painting the finish of the external surface be grit blasted (*see* IS 4683) with minimum SA 2.5 grade of blast (*see* IS 9954).

Paint and/or primer may be used as per agreement between the manufacturer and the purchaser with approval of statutory authority. The container shall be painted externally as per IS 4379 or any other color as approved by statutory authority.

12 ASSEMBLY

12.1 Temporary Attachments

Any attachments (for examples, tacking strips and cleats) temporarily welded to the container to facilitate manufacture shall be of the same material as the container and shall be completely and carefully removed so as not to damage the container. Any surface imperfections remaining after removal shall be made good by repair welding.

The repaired areas shall be dressed to a smooth finish level with the surface of the adjacent parent material and be subjected to a check for surface cracks using an appropriate non-destructive testing (for example, dye penetrant test in accordance or a magnetic particle examination).

12.2 Alignment of Joints

The plate edges at all butt seams shall not be out of alignment by more than the limits specified in ISO 5817 level C.

Where joggle joints are used, the fit of the mating parts shall be such that there is no gap greater

than 0.5 mm before welding. When a joggling operation is performed on a cylindrical section, those lengths of weld that are deformed by the joggle shall be ground flush with the parent plate before the joggling operation and shall be crack detected before welding them into circumferential seams.

12.3 Attachments and Fittings

Any external attachments (for examples, shrouds or skirts) shall fit the contour of the part of the container. Any local gaps shall not exceed 2.5 mm and any change in the gap shall be gradual.

Attachments to the pressure envelope (for examples, shrouds and skirts) shall have all their welds visually inspected and 100 percent of their welds using non-destructive test (for example, dye penetrant test in accordance with IS 3658 or a magnetic particle examination in accordance with IS 7743) prior to fitting to the pressure container.

If any defects are detected by the non-destructive test used, then all the attachment welds shall be inspected using the same non-destructive test method chosen after rectification.

13 WELD DEFECT REPAIRS

13.1 Defects (*see* IS 9639) found during the manufacturing process shall be removed and re-examined to ensure complete removal.

13.2 Defects shall be repaired (for example by chipping, grinding, or machining out to sound metal) and re-welded. Whenever a defect is removed by grinding or machining and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners. Care shall be taken to ensure proper weld penetration and complete fusion of the fresh weld deposit with the plates and previously deposited weld metal.

13.3 Flame gouging could be used as an alternative method for cutting out defects provided the edges are subsequently machined or ground back to sound material.

13.4 Where welding is required after removal of a defect, the area shall be cleaned and welding performed using the same processes and qualified welders that are employed in the manufacture of the pressure container.

13.5 After a defect has been removed, and prior to making weld repairs, the area shall be examined by suitable methods as specified in this standard to ensure that the imperfection has been eliminated. After repair shave been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners, and re-examined using the same non-destructive examination method that failed the initial repair, and by all other methods of examination that were required for the affected area. After all repairs have been completed, it shall be ensured that the remaining thickness of the container meets the minimum design wall and head thicknesses.

13.6 After any rectification, 100 percent radiography shall be conducted for circumferential and longitudinal welds in addition to the non-destructive tests mentioned above.

14 CONSTRUCTION AND WORKMANSHIP

14.1 Thickness Measurement

To ensure maintenance of the minimum thickness as specified in the drawing, each finished container shall be checked ultrasonically on a grid basis at a minimum side size 500 mm (at dish end where thickness is affected by any procedure). The measurements will be made with a precision of 1/10 mm.

14.2 Out of Roundness

The out-of-roundness of the cylindrical shell shall be limited so that the difference between the maximum and the minimum outside diameter in the same cross-section is not more than 1 percent of the mean of these diameters.

14.3 Straightness

The maximum deviation of the cylindrical part of the shell from a straight line shall not exceed 0.3 percent of the cylindrical length.

15 TESTING AND EXAMINATION

15.1 Test Plates

Test plates for mechanical tests shall be provided on 1 container in every 50 containers manufactured, except that for the first 40 containers of a new design, test plates shall be tested for 1 in every 10 containers.

If different welding materials or different welding processes are used on the manufacturing of the batch, tests plates as specified above shall be provided for each of them.

15.2 Provision of Welded Test Plates

a) Test plates shall be provided at the end of a longitudinal seam;
b) The combined length of weld in each set of test plates shall be sufficient to provide material for the tests required together with any re-tests which might be necessary with suitable allowance for discards and cutting;
c) The material used for the test plates shall be from the same cast or to the same specification as the shell plates of the container and shall be of the same thickness as that of the shell plates represented. The test plates shall be attached at the end of the longitudinal seam in order to be welded at the same time as the longitudinal weld of the container and shall be suitably clamped or reinforced to prevent excessive distortion or warping. Alternatively, test plates can be made by making an over long cylindrical section and cutting off a complete ring using a process not involving excessive heat. When impact tests are required, the test plate shall be oriented the same as the cylindrical body plates with respect to mill rolling and weld directions. The test plate shall be heat treated at the same time and conditions as the container;
d) For the bend test, the test plates welds shall be dressed smooth and flush with, but not below, the surface of the adjacent plates;

e) Straightening of the test plates that have warped during fabrication shall be carried out cold; and

f) Test plates shall be subjected to non-destructive examination to the same standard as the main seams. If the non-destructive examination of a test plate reveals the presence of flaws, which in a main seam would normally require repair, these flaws shall be avoided in the selection of the test pieces. Repair of welded test plates shall not be permitted.

15.3 Number of Test Specimens

The number of specimens required from each set of test plates shall be in accordance with Table 2. When more than one specimen of a particular type is required, the specimens shall be taken as far apart as possible.

Table 2 Number of Test Specimens Required

Sl No.	Test Specimen	Plate Thickness	
		10 mm or less	*Over 10 mm*
(1)	(2)	(3)	(4)
i)	Macro examination	1	1
ii)	Transverse tensile	2	2
iii)	Root bent	2[b]	2[a]
iv)	Face bend	2	2
v)	Charpy	3	3

[a] For a butt joint made from only one side.
[b] Not necessary in case of joggle joint.

16 MECHANICAL TESTS

16.1 Tensile Tests

Tensile testing shall be carried out as specified in IS 1608 (Part 1)/ISO 6892-1. Tensile strength shall be not less than the specified minimum value for the parent metal.

Except for stress relieved containers or if the information is already available from the material certificate, tensile specimens T1 and T2 shall be made from strips cut in accordance with the requirements of **17**. The tensile specimen T3 shall be taken perpendicular to the longitudinal welded seam.

The form and dimensions of the test specimen shall be as specified in IS 3600 (Part 3)/ISO 4136. The face and back of the test specimen shall not be machined, but shall represent the surface of the container as manufactured.

16.2 Bend Tests

Bend test specimens and the conditions and the method for carrying out the tests shall be in accordance with IS 1599/ISO 7438.

Bend specimen with un-machined surfaces representing the outside or inside of the vessel shall

only be lightly dressed so that the rolled surface of the parent metal is not wholly removed. Where the rolled surfaces of abutting plates are not level with one another, one plate can be machined at each face to a depth not exceeding 1 mm.

Bend test specimens shall be cut transversely to the welded seam. They shall be the full thickness of plates and shall have a width not less than 1.5 times the plate thickness. The edges shall be rounded to a radius not exceeding 10 percent of the thickness tested.

Two transverse bend tests shall be made. One test piece shall be tested with the surface corresponding with the outer surface of the container in tension, and the other with the surface corresponding with the inner surface of the container in tension. The diameter of the former, around which the test specimens are bent, shall not be more than three times the thickness of the test specimen, and the test is to be continued until the two limbs are parallel.

On completion of the test there shall be no visible cracks or defects at the outer surface of the specimen.

Side bend tests shall be substituted for face and root bend test if wall thickness is 12.5 mm and more.

16.3 Impact Test

Except for the requirements set out in this clause, the impact test (Charpy V-notch) shall be carried out in accordance with the requirements of IS 1757 (Part 1)/ISO 148-1, IS 1757 (Part 2)/ISO 148-2 and IS 1757 (Part 3)/ISO 148-3 as applicable.

Three impact test samples (Charpy V-notch specimens) shall be taken from (*see* Fig. 1):

a) Weld metal; and
b) Fusion line;
c) Heat affected zone (fusion line + 2 mm).

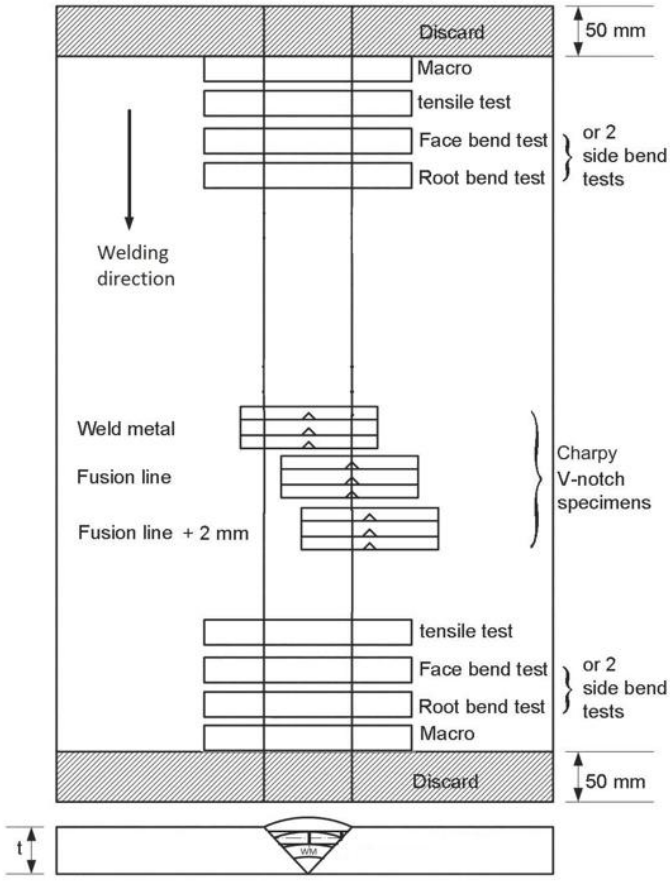

FIG. 1 TYPICAL LOCATION OF TEST PIECES

For the parent material samples, the transverse impact test pieces shall be taken from the wall of the container. The notch shall be perpendicular to the face of the wall. The test pieces shall be machined only on four faces with the inner and outer face of the container remaining unmachined.

For the welds, impact test pieces that are transverse to the weld shall be taken. The notch shall be in the centre of the weld and shall be perpendicular to the face of the pressure container. The test pieces shall be machined on all six faces. If the wall thickness does not permit a final test piece width of 10 mm, the width shall be as near as practicable to the nominal thickness of the container wall.

The average of three specimens shall meet a value of 27 J/cm^2 for the test impact energy. No specimen shall show a value less than 70 percent of the average test impact energy value.

16.4 Macro Examination

The macroscopic examination [*see* IS 3600 (Part 9)/ISO 17639] shall show complete fusion and shall be free of any assembly faults or an unacceptable defect.

16.5 Non-destructive Examination of Completed Welds

Following a full external visual examination, all welded seams shall be examined by radiography/radioscopy or other method as approved by statutory authority, if the method is

proved to be as sensitive as radiography.

Personnel performing non-destructive examination shall be qualified at least to level 1 and supervised by personnel certified at least to level 2 in accordance with IS 13805. Additionally, the manufacturer shall put in force a welding quality system [for example, as described in IS 15326 (Part 2)/ISO 3834-2] duly certified by inspection agency authorized by statutory authority.

16.6 Radiography/Radioscopy

All weld shall be radio graphed. Radiographs shall be taken of the entire length of each weld seam, together with the seams in the corresponding test plates. Sufficient overlap shall be ensured to cover the whole of the welded seam. The welds shall be radio graphed in accordance with the general principles for X-ray radiography as specified in ISO 17635 and Quality Level B of ISO 5817.

The image quality shall be in accordance with Quality Level B of ISO 5817. Images shall be retained digitally for approval if asked by the buyer.

16.7 Acceptance Criteria

Acceptance criteria shall allow for the detection of all significant indications and as specified to ISO 17635 and Quality Level B of ISO 5817.

16.8 Failure to meet Test Requirements

If samples fail to meet any of the above test requirements, re-testing to be carried out on two samples of the same type as that which failed from the same test plate and both of these shall conform to the above requirements. If one or both of these re- tests fail to conform, the containers represented by these tests shall be rejected.

16.9 Lifting Points

16.9.1 Where lifting points are fitted, the design shall be proven by a type test in which a sample attachment is tested to two times the maximum gross weight without failure or significant deformation.

16.9.2 In production, each lifting point shall be subjected to a lift test at the gross weight. These tests can be carried out by attaching external weights to the container. After completion of the lifting test, all lifting eyes and their associated attachment welds shall be tested for crack defects on 10 percent of the batch in accordance with IS 7743 and IS 10724. If a defect is detected, then the entire batch shall be tested.

16.9.3 All structural welded joints shall be tested for defects, on 10 percent of the batch. If a defect is detected, then the entire batch shall be tested.

It is not necessary to carry out lifting test on containers which are to be lifted via fork lift/pallet truck pockets.

17 TYPE APPROVAL PROCEDURE

17.1 General Requirements

17.1.1 A technical specification of each new design of containers, or containers family as defined here under, including design drawings, design calculations, steel details, manufacturing process, and heat treatment details, shall be submitted by the manufacturer to statutory authority for approval. The type approval tests detailed in the present clause shall be carried out on each new design under the supervision of the inspecting agency authorized by statutory authority.

17.1.2 A container shall be considered to be of a new design (family), compared with an existing approved design, when at least one of the following applies:

a) It is manufactured in a different factory;
b) It is manufactured by a different process;
c) It is manufactured according to a different material standard mentioned in the standard;
d) It is given a different heat treatment;
e) The protections of fittings are not in the limitation of this standard;
f) The number of the opening has increased;
g) The inside diameter of an opening has increased by 50 percent or more;
h) The minimum design wall thickness or end thickness is changed by 25 percent or more; and
j) The water capacity has change by more than 30 percent.

18 TYPE APPROVAL TESTS

18.1 Pressure Cycling Test

Container representative of the design shall be subjected to 12 000 cycles, the upper pressure being the test pressure P_h, the lower pressure not exceeding 10 percent of P_h.

The design shall pass if there is no leakage of pressure at the end of the test. A representative finished container shall be used for the prototype work. This container shall be scrapped after the completion of the pressure cycling test.

18.2 Hydraulic Burst Test

A container representative of the design and manufacture, including the nameplate (which might be the container designed for the fatigue test), shall be subjected (after the batch tests described in this standard) to a burst test. The pressure shall be raised at a rate not exceeding 5 bar/min.

The design shall pass if reversal of an end, or other plastic deformation does not occur at a pressure less than 20 percent above P_h . The final burst test shall be without fragmentation. The minimum burst pressure shall be 2.25 P_h for a test pressure of less than 60 bar.

18.3 Additional Test

In addition, tests required in **16** shall be performed.

19 MANUFACTURING TESTS ON EACH CONTAINER

19.1 Volume Check

The minimum volume (water capacity) of the container shall be checked against specification and recorded by the manufacturer. No negative tolerance and positive tolerance +1 percent from the specification is permitted.

19.2 Tare Weight Check

Each container shall be weighed to an accuracy of upto 1 percent of its tare weight. The value shall be stamp marked on the name plate. The tare weight shall include all non-removable fittings, internal coatings and external coatings, consistent with normal filling procedures.

19.3 Hydrostatic Test

19.3.1 Each container shall be subjected to a hydraulic proof pressure test at the test pressure, P_h , after all welding operations and heat treatment of the vessel have been completed, but before internal or external coating processes.

19.3.2 The water pressure in the vessel shall be increased at a controlled rate until the test pressure, P_h is reached. The process to be followed is given in Annex C.

19.3.3 The vessel shall remain under pressure, P_h, for at least 10 min to establish that the pressure does not fall and that there is no leakage.

19.3.4 The gaskets used on all pads, bosses, and other attachments for the test shall be of the same material and to the same dimensions as specified for the operating duty.

19.3.5 During the test the outside surface of the container shall be dry, and it shall be possible (with good access and illumination) to examine the welded seams. There shall be no leakage and no visible permanent deformation. There shall be no pressure drop at the end of the test.

19.3.6 If bolted connections leak, they shall be disassembled. The cause identified and corrected and the vessel re-tested. It is not permissible to retighten any fittings to cure a leak.

19.4 Pneumatic Test

The pneumatic test shall be conducted at 6 bar for minimum 10 min. While carrying out pneumatic test, measures shall be taken to ensure safe operation considering the larger amount of stored energy, relative to the hydraulic test. It should be noted that pneumatic pressure tests require more precautions than hydraulic pressure tests since, regardless of the size of the container, any error in carrying out this test is highly likely to lead to a rupture under gas pressure. Therefore, these tests shall be carried out only after ensuring that the safety measures satisfy the safety requirements.

All seams and joints shall be examined for leaks by an appropriate detection method (for example soap solution testing).

19.5 Final Inspection

Each container shall have a final internal and external examination. All container shall be thoroughly cleaned and dried internally before being fitted with valves. If a container fails to meet the specification, it shall be rectified or rejected. Information to be marked.

19.6 Tightness Test

Each container shall be subjected to a leak test at a minimum pressure of 6 bar (examples, using dry air or nitrogen as the pressure medium) when fitted as for use with studs, nuts, joints and valves. The joints shall be tested for leaks using a soap solution, or a method of equal sensitivity.

20 MARKING

20.1 Containers

Each container shall be permanently and legibly marked. Each container shall be permanently stamped with the following in addition to the requirements of *Gas Cylinder Rules* and any other statutory requirements.

a) Serial number, abbreviated name, monogram of the manufacturer and identification of the owner;
b) Number of this Indian Standard;
c) Maximum working pressure, in MPa;
d) Test pressure, in MPa and date of hydrostatic test as the case may be (such as 3/20 for March 2020);
e) Tare weight in kg, gross weight in kg and water capacity in litres;
f) Inspecting agency's official mark;
g) Name of gas;
h) PRV set pressure; and
j) Operating temperature;
k) Water capacity;
m) PESO Approval no.; and
n) PESO Approval for fittings;

20.2 Position and Size of Marking

All markings shall be made on a plate either welded to the head of the container, or on a plate securely fixed to a shroud, support or other part that is a permanent part of the container. The plate shall have space to mark re-test dates. It shall be positioned so that it is accessible for re-stamping, but is not damaged under normal handling. The container serial number shall be in characters at least 10 mm high. Other container markings shall be at least 5 mm high.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No./Other Standards	*Title*
IS 1079 : 2017	Hot rolled carbon steel sheet, plate and strip — Specification (*seventh revision*)
IS 1599 : 2023/ ISO 7438 : 2020	Metallic materials — Bend test (*fifth revision*)
IS 1608 (Part 1) : 2018/ ISO 6892-1 : 2019	Metallic materials — Tensile testing: Part 1 Method of test at room temperature (*fifth revision*)
IS 1875 : 1992	Carbon steel billets, blooms, slabs and bars for forgings — Specification (*fifth revision*)
IS 2004 : 1981	Carbon steel forgings for general engineering purposes — Specification (*third revision*)
IS 2041 : 2009	Steel plates for pressure vessels used at moderate and low temperature — Specification (*third revision*)
IS 2062 : 2011	Hot rolled medium and high tensile structural steel — Specification (*seventh revision*)
IS 1757	Metallic materials — Charpy pendulum impact test
(Part 1) : 2020/ ISO 148-1 : 2016	Test method (*fourth revision*)
(Part 2) : 2020/ ISO 148-2 : 2016	Verification of testing machines (*fourth revision*)
(Part 3) : 2020/ ISO 148-3 : 2016	Preparation and characterization of Charpy v-notch test pieces for indirect verification of pendulum impact machines (*fourth revision*)
IS 3600	Method of testing fusion welded joints and weld metal in steel
(Part 3) : 2018/ ISO 4136 : 2012	Destructive tests on welds in metallic materials —Transverse tensile test (*fourth revision*)
(Part 9) : 2022/ ISO 17639 : 2003	Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds (*third revision*)
IS 3658 : 1999	Code of practice for liquid penetrant flaw detection (*second revision*)
IS 4379 : 2021	Identification of the contents of industrial gas cylinders (*second revision*)
IS 4576 : 2021	Liquefied petroleum gases — Specification (*fourth revision*)
IS 4683 : 1968	Specification for chilled iron shot and grit for use in foundries
IS 5986 : 2017	Hot rolled steel sheet, plate and strip for forming and flanging purposes — Specification (*fourth revision*)
IS 7241 : 1981	Glossary of terms used in gas cylinder technology (*first revision*)
IS 7743 : 2006	Recommended practice for magnetic particle testing and inspection of steel forgings (*first revision*)
IS 9639 : 2017	Visual inspection of low pressure welded steel gas cylinders during manufacture — Code of practice (*first revision*)

IS 9954 : 1981	Pictorial surface preparation standards for painting of steel surfaces
IS 10724 : 2023	Acceptance standards for magnetic particle inspection of steel castings — Specification (*first revision*)
IS/ISO 11114	Gas cylinders — Compatibility of cylinders and valve material with gas contents
(Part 1) : 2012	Metallic materials (*first revision*)
(Part 2) : 2013	Non-metallic materials
(Part 4) : 2017	Test methods for selecting steels resistant to hydrogen embrittlement (*first revision*)
IS 13805 : 2004	General standard for qualification and certification of non-destructive testing personnel — Specification (*first revision*)
IS 15326	Quality requirements for fusion welding of metallic materials
(Part 1) : 2018/ ISO 3834-1 : 2005	Criteria for the selection of the appropriate level of quality requirements (*first revision*)
(Part 2) : 2022/ ISO 3834-2 : 2021	Comprehensive quality requirements (*second revision*)
(Part 3) : 2022/ ISO 3834-3 : 2021	Standards quality requirements (*second revision*)
(Part 4) : 2022/ ISO 3834-4 : 2021	Elementary quality requirements (*second revision*)
(Part 5) : 2019/ ISO 3834-5 : 2015	Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4 (*first revision*)
IS/ISO 15817 : 2012	Earth-moving machinery — Safety requirements for remote operator control systems
IS 16484 : 2017	Liquid off - Take valve fitting to gas cylinders or tanks (mobile or static) for liquid petroleum gas (LPG) — Specification
ISO 4126-1 : 2013	Safety devices for protection against excessive pressure: Part 1 Safety valves
ISO 5817 : 2023	Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections
ISO 17635 : 2016	Non-destructive testing of welds — General rules for metallic materials
ISO 9328-1 : 2018	Steel flat products for pressure purposes — Technical delivery conditions: Part 1 General requirements
ISO 9328-2 : 2018	Steel flat products for pressure purposes — Technical delivery conditions: Part 2 Non-alloy and alloy steels with specified elevated temperature properties
ISO 9328-3 : 2018	Steel flat products for pressure purposes — Technical delivery conditions: Part 3 Weldable fine grain steels, normalized

ANNEX B

(*Clause* 4.4)

REQUIREMENTS OF BUNGS/NOZZLES

B-1 FINISH

The bung/nozzles shall be clean, even, without chatter and free from any visual defects and shall have the required machining finish. The threads shall be of smooth finished and shall not be broken at any point. The container manufacturer shall check on each finished machined bung/nozzle the dimensions that match with the corresponding dimensions on the container, such as neck diameter that fits into bung/nozzle hole etc. Bung/nozzle threads shall be inspected for conformity with the required sizes using all the gauges as laid down in the standards depending upon the nominal size and specification of the thread.

B-2 After welding and before fitting the valve, plug, or any other fitting, the bung/nozzle thread shall be cleaned with appropriate tap and checked for conformity to threads using specific thread plug gauges laid down in a particular standards depending upon the nominal size and specification of the thread.

B-3 However, the inspecting authority for the purpose of carrying out the inspection may test 3 percent of the lot of machined bungs/nozzles. In the event of any failure a second sample size of double the above shall be drawn and inspected. In case of failure of anyone out of the second draw, the whole lot shall be inspected and those not passing the requirement shall be rejected.

B-4 One bung/nozzle out of the sample size shall be sectioned and checked for conformity to thread form and finish.

B-5 The materials used for backing strip when used, shall conform to IS 2062 or steel of equivalent or superior qualities with compatible chemical composition with the body of the container.

B-6 The materials used for other non-pressure parts like top shroud, bottom stand etc. shall conform to IS 1079 or IS 2062 or IS 5986 or IS 2041 or ISO 9328-1, ISO 9328-2 and ISO 9328-3, or as agreed to between the purchaser and the manufacturer and approved by statutory body.

ANNEX C

(*Clause* 19.3.2)

METHODS FOR INCREASING WATER PRESSURE IN THE VESSEL

C-1 Making sure the filling and pressurizing are done from the lowest point and venting from the highest point.

C-2 Water overflow through the venting in order to assure that no air bubbles remain in the vessel.

C-3 Controlling and witnessing which pressurizing is done in three stages as follow:

a) First stage — Raise the pressure to 40 percent of the final pressure, stop pressurizing, keep it for 5 min, and then make a fast visual inspection of the external surface;
b) Second stage — Restart pressurizing up to 70 percent of final pressure, stop the operation, keep for 5 min and make a fast visual inspection on external surface; and
c) Third stage — Restart pressurizing up to 100 percent of the final pressure, stop the operation, and keep for 45 min.

C-4 Inspection is carried out over the whole body of the vessel and in the welding joints and attachments.

C-5 The vessel hydro-static testing report needs to be prepared by the manufacturer quality control team and signed by the third party or authorized inspector.

C-6 If the test failed by leaking from weld joints or any other kind of defect, it is necessary that the vessel is drained and dried and repaired based on approved repair procedure. Pressure vessel hydro-static testing needs to be repeated.

ANNEX D

TEST CERTIFICATE

Certificate No			
Client Name :		**P.O. No.**	

Vessel Details	
Description	Vertical LPG Container
Drawing No	
PESO Approval No	
Batch No	
Serial Number	

Material		
Shell		
Dished Ends		

Manufacturing Activities		
Welding		
Heat Treatment		

Inspection and Testing		
Non Destructive Test	RT of Longitudinal and Circumferential seams	
Destructive Test on Production Coupon plate	Root Bend	
	Face Bend	
	Macro-examination	
Hydrotest	Test Pressure	
	Result	
Pneumatic Test	Test Pressure	
	Result	

	Fittings			
Item Name	**Make**	**Batch No.**	**Sr. No.**	**PESO Approval No.**
Combo valve				
Level Gauge				
Safety Relief Valve				
Actuator				
QCC				

This is to certify that the vessels as mentioned above are manufactured, inspected and tested in accordance with drawing number ---------- confirming to ---------- and stamped with ----

Manufacturer Name	**Inspection Agency Name**
Date :	**Date:**