इंटरनेट मानक

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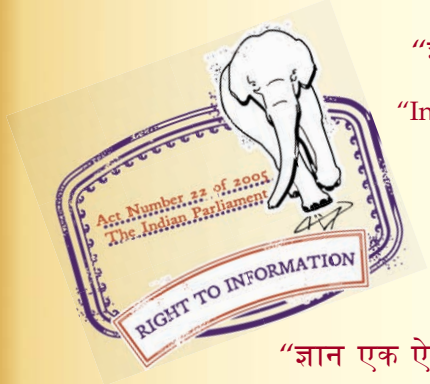
IS 14899 (2000): Liquefied Petroleum Gas (LPG) Containers for Automotive Use [MED 16: Gas Cylinders]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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भारतीय मानक

स्वचल उपयोग के लिये द्रवित पेट्रोलियम गैस (एल॰ पी॰ जी॰) के धारक — विशिष्टि

Indian Standard

LIQUEFIED PETROLEUM GAS (LPG) CONTAINERS FOR AUTOMOTIVE USE — SPECIFICATION

ICS 20.020.30; 43.040.01

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 2000

Price Group 8

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Gas Cylinders Sectional Committee had been approved by the Mechanical Engineering Division Council.

This Standard is for Liquefied Petroleum Gas (LPG) container for automotive use (auto LPG tank) essentially for automotive vehicle service and it is desirable that the level of safety currently existing for other pressure vessels must also be maintained.

Owners and fillers of cylinders should note that cylinder designed to this standard are to operate safely if used in accordance with specified service conditions for a specified finite service life only. It is the responsibility of the owners and users to ensure that cylinders are periodically tested as per norms laid down in *Gas Cylinder Rules,* 1981, as amended from time to time and as enforced by statutory authorities under these rules.

In preparing this standard, assistance has been derived from United Nations Regulation No. 67, Uniform Provision Concerning: Part I — Approval of specific equipment of motor vehicles using liquefied petroleum gases in their propulsion system and Part II — Approval of a vehicle fitted with specific equipment for the use of liquefied petroleum gases in its propulsion system with regard to the installation of such equipment.

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 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

LIQUEFIED PETROLEUM GAS (LPG) CONTAINERS FOR AUTOMOTIVE USE — SPECIFICATION

1 SCOPE

This standard specifies the requirements of design, construction and testing of all welded steel containers for automotive liquefied petroleum gas (LPG) for vehicle propulsion, to be fixed permanently on the vehicle and filled in that position.

2 REFERENCES

The Indian 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 the standards listed in Annex A.

3 SYMBOLS AND ABBREVIATIONS

Symbols and abbreviations used in this standard shall have the following meaning:

P_h = hydrostatic test pressure in MPa

P_r = container bursting pressure measured in the bursting test, in MPa

R_e = minimum yield stress in MPa guaranteed by the manufacturer of container and it shall not be more than minimum specified by the material standard

R_m = minimum tensile strength in MPa guaranteed by the material standard

R_{mt} = actual tensile strength, in MPa

a = calculated minimum thickness of the cylindrical shell wall, in mm

b = calculated minimum thickness of dished ends, in mm

D = nominal outside diameter of the container, in mm

R = inside radius of the dished end of the standard cylindrical container, in mm

r = inside knuckle radius of the dished end of the standard cylindrical container, in mm

H = outside height of dished part of container end, in mm

h = height of cylindrical part of dished end, in mm

L = length of container's stress-resistant shell, in mm

A = percentage elongation value of parent material

V_0 = initial volume of the container at the moment when the pressure is increased in the burst test, in dm^3

v = final volume of the container on bursting, in dm^3

g = acceleration due to gravity, in m/s^2

C = shape factor (refer Annex B, Fig. 2 and 3)

z = weld joint factor

4 MATERIAL

4.1 The material used for the manufacture of the stress-resistant container shells shall conform to IS 6240. Stainless steel, if used for manufacturing shall conform to chemical composition and mechanical properties as given in Tables 1 and 2 respectively.

Table 1 Chemical Composition

Type	C % *Max*	Si % *Max*	Mn % *Max*	Ni %	Cr %	S % *Max*	P % *Max*	N % *Max*
304 L 1/16 hard	0.03	0.75	2.00	8.00-12.00	18.00-20.00	0.030	0.045	0.10

Table 2 Mechanical Properties

Type	Tensile Strength MPa, *Min*	Yield Stress MPa, *Min*	Percentage Elongation at 50 mm Gaug Length, *Min*
304 L 1/16 hard	550	310	40

4.1.1 Suitable low carbon steel or stainless 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 container manufacturer for the finished cylinder shall be used for the purpose of calculating the wall thickness of the container. However, minimum percentage elongation value shall not be less than 25. Such steel should be certified by the steel maker to be other than of rimming quality, suitable for pressing or drawing, with acceptable non-ageing properties and shall be fully killed.

4.1.2 The container manufacturer shall obtain and provide chemical cast analysis certificates and

mechanical properties of the material as given by the steel manufacturer in respect of steel used and establish means to identify the containers with the casts of steel from which they are made.

4.2 All components of the container body and all the parts welded thereto shall be of mutually compatible materials.

4.3 The filler materials shall be compatible with the parent material so as to form welds with properties equivalent to those specified for the parent material.

5 GENERAL

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

6 DESIGN

6.1 Design Temperature

The design operating temperature of the container shall be from –20 to 65°C.

6.1.1 For extreme operating temperatures outside the above mentioned temperature ranges, special test conditions are applicable which shall be approved by statutory authority.

6.2 Design Pressure

The design pressure of the container shall be 3 MPa intended for Liquefied Petroleum Gas as per IS 14861 having vapour pressure at 65°C not exceeding 2 MPa.

6.3 Calculation of Minimum Wall Thickness

6.3.1 The wall thickness of the cylindrical shell of the container shall not be less than that calculated by the following formula.

6.3.1.1 *Containers without longitudinal welds*

$$a = \frac{P_h \cdot D}{2\frac{R_e}{4/3} + P_h} = \frac{P_h \cdot D}{1.5R_e + P_h}$$

6.3.1.2 *Containers with longitudinal welds*

$$a = \frac{P_h \cdot D}{2\frac{R_e}{4/3} \cdot z + P_h} = \frac{P_h \cdot D}{1.5R_e \cdot z + P_h}$$

a) $z = 0.85$ where the manufacturer radiographs each weld intersection and 100 mm of the adjacent longitudinal weld and 50 mm (25 mm each side of the intersection) of the adjacent circumferential weld.

For each welding machine, one out of every 50 consecutive containers from continuous production shall be taken at random for radiographic examination. This shall be read in conjunction with requirement laid down in **7.2.3.2.**

b) $z = 1$, where each weld intersection and 100 mm of the adjacent longitudinal weld and 50 mm (25 each side of the intersection) of the circumferential weld is spot radiographed.

Radiographic examination shall be performed at 10 percent of the container production. The containers to be tested shall be chosen randomly. This shall be read in conjunction with requirement laid down in **7.2.3.2.**

Should these radiographic tests reveal unacceptable defects, as defined in **10.5.1** all the necessary steps shall be taken to examine the production run in question and eliminate the defects.

6.3.2 *Dimensions and Calculations of Ends*

The container ends shall be in one piece, shall concave to the pressure and shall be either a torispherical or an ellipsoidal (*see* Annex B).

6.3.2.1 The container ends shall fulfil the following conditions:

a) *For torispherical ends*

Simultaneous limits: $0.003\ D \leq 0.08\ b \leq 0.08\ D$

$r \geq 0.1\ D$

$R \leq D$

$H \geq 0.18\ D$

$r \geq 2\ b$

$h \geq 4\ b$

$h \leq 0.15\ D$ (not applicable for containers as shown in Fig. 5A of Annex C).

b) *For ellipsoidal ends*

Simultaneous limits: $0.003\ D \leq 0.08\ b \leq 0.08D$

$H \geq 0.18\ D$

$h \geq 4\ b$

$h \geq 0.15\ D$ (not applicable for containers as shown in Fig. 5A of Annex C)

The thickness of these barreled ends shall not in toto be less than the value calculated by means of the following formula:

$$b = \frac{P_h \cdot D}{1.5R_e} C$$

The shape factor C to be used for full ends shall be obtained from Annex B.

The wall thickness of the cylindrical edge of the ends shall not be less or differ more than 15 percent from the smallest wall thickness of the shell.

For carbon steel containers, the nominal wall thickness of the cylindrical part and of the barreled end shall not be less than:

$$\frac{D}{250} + 1 \text{ mm}$$

with a minimum of 1.5 mm.

For stainless steel containers, the wall thickness of the container shall not be less than 1.5 mm.

6.3.2.2 *Special containers*

For special containers having shapes other than the standard cylindrical container (*see* Annex D), the adequacy of their design shall be proved by a calculation formula or demonstrated by a strength assessment on the basis of type tests in accordance with **10.6** or by appropriate stress analysis acceptable to the inspecting authority and statutory authority.

All welding requirements for cylindrical containers shall apply.

7 CONSTRUCTION AND WORKMANSHIP

7.1 General Requirements

7.1.1 The manufacturer shall demonstrate by having a suitable quality control system that he has and maintains the manufacturing facilities and processes to ensure that containers produced satisfy the requirements of this standard.

7.1.2 The manufacturer shall ensure through adequate supervision that the parent plates and pressed parts used to manufacture the containers are free from defects likely to jeopardize the safe use of the containers.

7.1.3 The contour of dished end shall not deviate from the approved dimensions by more than 1.25 percent of the nominal diameter in respect of radial dimensions and by more than one percent in respect of axial dimensions. Such deviations shall not be abrupt changes and shall be outside the specified shape.

7.2 Parts Subjected to Pressure

7.2.1 *Welding Requirements*

The manufacturer shall describe the welding methods and processes used and indicate the inspections carried out during production. The low carbon steel containers shall be welded by any suitable fusion welding method and shall conform, as for welding procedure and welder's performance qualifications, to the requirement of IS 2825.

7.2.1.1 The manufacturer shall make available to the inspection authority the welding procedures of welds and shall also provide with a description of welding methods and processes, which can be regarded as representative of welds made during production.

7.2.1.2 The butt welds shall be executed by an automatic welding process.

7.2.1.3 The butt welds on the stress-resistant shell shall not be located in any area where there are changes of profile, except for special containers as shown in Annex D.

7.2.1.4 Fillet welds shall not be superimposed on butt welds and shall be at least 10 mm away.

7.2.1.5 For stainless steel container, MIG or TIG welding with argon as inert gas shall be employed in fabrication.

7.2.2 Welds joining parts making up the shell of the container shall satisfy the following conditions (*see* Fig. 7 to 10 given as examples in Annex E).

7.2.2.1 *Longitudinal weld*

The weld shall be executed in the form of a butt weld on the full section of the material of the wall. The shell of the container may be made up of one, two or three parts. When the shell is made up from two or three parts, the longitudinal welds shall be shifted/ rotated with a minimum of 10 times the thickness of the container wall (10 × a). The ends shall be in one piece. There shall not be more than one longitudinal weld on any shell section.

7.2.2.2 *Circumferential weld*

7.2.2.3 This weld is executed in the form of a butt weld on the full section of the material of the wall. A joggle weld is considered to be a special type of butt weld.

7.2.2.4 Welds of the studded valve plate or ring shall be carried out according to Annex E. For valve plate or ring indicated in Fig. 10A of Annex E one run of weld from outside and one run from inside shall be given. For valve plate or ring indicated in Fig. 10B of Annex E either one run of weld from outside and one run from inside or two runs of welds from outside shall be given.

7.2.2.5 A weld fixing the collar or supports to the container shall be either a butt or fillet weld.

7.2.2.6 Welded mounting supports, if provided, shall be welded in the circumferential way. The welds shall be strong enough to withstand vibration, braking actions and outside forces of at least 30 times the gravitational force (30 × g) in all directions.

7.2.2.7 In case of butt welds, the misalignment of the joint faces shall not exceed one-fifth of the thickness of the walls (1/5 × a).

7.2.3 *Inspection of Welds*

7.2.3.1 The manufacturer shall ensure that the welds show continuous penetration without any deviation of the weld seam and that they are free from defects likely to jeopardize the safe use of the container.

7.2.3.2 The frequency and extent of radiographic examination shall be as follows:

a) For the main longitudinal weld, 100 mm of each end of the longitudinal weld shall be radiographed on one container taken from the first five consecutively welded containers and one container taken from the last five consecutively welded container of a production run. Remaining samples, as applicable, shall be selected at random as given in **6.3.1.2**.

b) For circumferential welds, 100 mm of each circumferential weld shall be radiographed on container taken from the first five consecutively welded containers and one container taken from the last five consecutively welded container of a production run.

c) On re-commencement of welding operation following shutdown exceeding four hours, the extent of radiographic examination specified in (a) and (b) above shall apply.

7.2.3.3 Treatment of imperfection disclosed by radiographic examination:

a) Imperfection as specified in **10.5.1** and disclosed by radiographic examination shall require the subject container to be deemed unacceptable. Containers, which are deemed unacceptable, shall be condemned, or be repaired in accordance with approved procedures.

b) Where a container deemed unacceptable represents a batch, the entire batch shall be deemed unacceptable or radiographic examination shall be carried out on the weld(s) under consideration of two additional containers. These containers shall be from the group of containers consecutively welded from not more than 20 containers earlier and not more than 20 containers later than the failed container. The batch shall then be assessed as follows:

   i) Where the additional radiographic examination of both containers discloses no imperfections, the batch shall be deemed to comply with the requirements of the radiographic examination.

   ii) Where the additional radiographic examination discloses any imperfections these containers shall be deemed unacceptable and radiographic examination shall be carried out on all the welds under consideration of all remaining containers of that batch or all remaining containers shall be deemed unacceptable.

   iii) Joints or section of joints rewelded or repaired to remove defects shall be radiographed. Each radiograph shall include the identification symbol R1 or R2 to denote that a first or second weld repair has been carried out in the length of weld represented by those radiographs. Not more than two attempts shall be made to repair any one section of weld.

7.3 Out-of-Roundness

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

8 FITTINGS

8.1 General Fittings

8.1.1 The supports shall be manufactured and welded to the container body in such a way as not to cause dangerous stress concentration or be conducive to the collection of water.

8.1.2 The mounting of the container shall be sufficiently strong and made of metal compatible with the type of steel used for the container. The form of the base shall give the container sufficient stability.

8.1.3 The top edge of the base shall be welded to the container in such a way as not to be conducive to the collection of water nor to allow water to penetrate between the base and the container.

8.1.4 A reference mark shall be affixed on the containers to ensure their correct installation.

8.1.5 An identification plate shall be fixed on to the stress resistant shell and shall not be removable. All the necessary corrosion prevention measures shall be taken.

8.1.6 The container shall have provisions to mount a gas-tight housing or kind of protection device over the container accessories.

8.1.7 Material used for the housing shall have adequate strength and that all risk of container end corrosion is eliminated.

8.2 Openings for Fittings

8.2.1 Size of the opening in the shell of the container

shall be maximum which can be included within a square of 110 mm × 110 mm but shall not exceed 50 percent of the inside diameter of the container in any direction. Any other size of opening for fittings may be provided with prior approval of statutory authority. This shall have adequately strong pad to withstand the tests prescribed in this standard.

8.2.2 In case any housing for the cover of fitting is required to be welded around the valve pad, it shall be done as per relevant clauses for welded attachments to the container.

9 HEAT TREATMENT

9.1 All containers shall be normalized or stress relieved suitably after manufacture and completion of all welding (including that of attachments) and before hydrostatic test is applied. A complete record of the heat treatment shall be maintained.

9.2 No post fabrication heat-treatment is required for stainless steel containers, however the yield strength (0.2 percent proof stress) and tensile strength of the finished container as determined from the mechanical tests shall not be less than values used in design calculation and elongation shall be minimum 25 percent.

NOTE — Container made from steel produced by using fully killed fine grain steel making practice with grain refining elements need not be stress relieved, provided type testing showed that the desired properties are achieved without stress relieving. This provision may be invoked provided it is approved by the statutory authority.

10 TEST

10.1 Mechanical Tests

From every batch (consisting of 202 or less heat-treated and finished containers), one test container shall be selected at random and various acceptance tests shall be carried out on the test specimens taken from this container.

10.1.1 All the mechanical tests for checking the properties of the parent metal and welds of the stress resistant shells of the container shall be carried out on test pieces taken from finished containers after heat-treatment, if employed procedurally.

10.1.2 *Acceptance Tests and Evaluation of Test Results*

Each sample container shall be subjected to the following tests.

10.1.2.1 *Container with longitudinal and circumferential welds (three sections)*

10.1.2.1.1 On test-pieces taken from the places shown in Fig. 4 of Annex C:

a) One tensile test on parent material; the test piece to be taken in the longitudinal direction (if this is not possible, it may be taken in the circumferential direction);
b) One tensile test on parent material of the bottom;
c) One tensile test perpendicular to the longitudinal weld;
d) One tensile test perpendicular to the circumferential weld;
e) One bend test on the longitudinal weld, the inner surface in tension;
f) One bend test on the longitudinal weld, the outer surface in tension;
g) One bend test on the circumferential weld, the inner surface in tension;
h) One bend test on the circumferential weld, the outer surface in tension;
k) One macroscopic test of circumferential weld; and
n) One macroscopic test of longitudinal weld.

10.1.2.1.2 A minimum of two macroscopic tests of valve boss/plate sections shall be conducted as shown m1, m2 in Fig. 4 of Annex C. In case of the sidewall mounted valves refer Fig. 5B of Annex C.

10.1.2.1.3 *Containers with circumferential welds only (two sections)*

On test-pieces taken from the places shown in Fig. 5A and 5B of Annex C.

10.1.2.1.4 The test as specified **10.1.2.1.1** with the exception of samples c, e, f and n which are not applicable. The test-piece for the tensile test on parent material shall be taken from *a* and *b* as indicated in Fig. 5A of Annex C.

10.1.2.1.5 Test pieces, which are not sufficiently flat, shall be flattened by cold pressing.

10.1.2.1.6 In all test pieces containing a weld, the weld shall be machined to trim the surplus.

10.1.3 *Tensile Tests*

10.1.3.1 *Tensile test on the parent metal*

10.1.3.1.1 The procedure for carrying out the tensile test is as per IS 1608.

10.1.3.1.2 The two faces of the test-piece representing the inside and outside walls of the container respectively shall not be machined.

10.1.3.1.3 The minimum value for yield stress shall comply with values of steel specified in **4** or as guaranteed by the container manufacturer, which is used at the time of approval of the design.

10.1.3.1.4 The minimum tensile strength and elongation after the parent metal breaks shall comply with values for steels specified in **4**.

10.1.3.2 *Tensile test on the welds*

10.1.3.2.1 The tensile test perpendicular to the weld shall be carried out on a test-piece having a reduced cross-section 25 mm in width for a length extending up to 15 mm beyond the edges of the weld, as shown in Fig. 11 of Annex F.

10.1.3.2.2 The tensile strength value obtained shall be at least equal to that guaranteed for the parent metal irrespective of whether the fracture occurs in the cross-section of the central part of the test piece.

10.1.4 *Bend Test*

10.1.4.1 The test shall be carried out by placing the test piece on two supports consisting of parallel rollers. The test piece shall be slowly and continuously bent by applying in the middle of the span on the axis of the weld, a concentrated pad perpendicular to the test piece surface. The load shall be applied by means of a mandrel. The width of the test piece shall be minimum 25 mm.

10.1.4.2 Cracks shall not appear in the test-piece when it is bent round a mandrel as long as the inside edges are separated by a distance not greater than the diameter of the mandrel + 3*a* (*see* Fig. 12 of Annex F). Any crack initiated from the edges shall not be treated as failure.

10.1.4.3 The value (*n*), which is ratio between the diameter of the mandrel and the thickness of the test piece, shall not be more than as given in Table 3.

Table 3 Values of (*n*)

Actual Tensile Strength R_{mt} in (MPa)	Value (*n*)
Up to 440	2
Above 440 up to 520	3
Above 520	4

10.1.5 *Macroscopic Examination*

The macroscopic examination of a full transverse section of the weld shall show a good penetration and absence of lack of fusion.

10.1.6 *Retesting*

10.1.6.1 Retesting is permitted for the tensile and bend test. A second test shall consist of two test pieces taken from the same container. If the results of these tests are satisfactory, the first test shall be ignored.

10.1.6.2 In the event where one or both the retests fail to meet the requirements of weld tests, the entire batch shall be rejected. However reheat-treatment may be given in case of failure in mechanical testing of parent material, if post weld heat-treatment is employed procedurally. Two containers shall be drawn randomly and all tests specified in **10.1** shall be carried out and both the containers shall pass otherwise the batch shall be rendered unserviceable for holding gas under pressure. No further heat-treatment is permitted.

10.1.7 *Checking of Water Capacity*

The water capacity of the cylinders shall be checked. This shall be done by weighing or by volumetric method. The tolerance for water capacity shall be $^{+5}_{0}$ percent for cylinders up to and including 13 litres water capacity and $^{+3}_{0}$ percent or 0.65 litres whichever is more for cylinders above 13 litres water capacity.

10.2 Permanent Stretch Test and Burst Test under Hydraulic Pressure

10.2.1 *Hydrostatic Stretch Test*

One container taken at random from each lot of 403 or less shall be subjected to a hydrostatic stretch test. No pressure greater than 80 percent of the test pressure shall have been applied before this test.

Permanent stretch suffered by the cylinder due to application of test pressure shall not exceed 10 percent of the total stretch suffered during the test or 1/5 000 of the original volume of the cylinder whichever is less.

NOTE — This test method is based on IS 5844 which may be referred in case further references are required.

10.2.2 *Burst Test*

Containers subjected to this test shall bear the inscriptions, which it is proposed to affix on the section of the container subjected to pressure.

10.2.2.1 The burst test under hydraulic pressure shall be carried out with equipment which enables the pressure to be increased at an even rate, until the container bursts and the change in pressure over time to be recorded. The maximum flow rate during the test shall not exceed 3 percent of the capacity of the container per minute.

10.2.2.2 *Interpretation of test* — The criteria for the interpretation of the burst test are as follows:

Volumetric expansion of the container; is equal to Volume of water used between the time when the pressure starts to rise and the time of bursting.

10.2.3 *Test Acceptance Conditions*

10.2.3.1 The measured bursting pressure (P_f) shall not be less than 2.25 × 3 = 6.75 MPa.

10.2.3.2 The specific change in the volume of the container at the time of bursting shall not be less than:

20 percent if the length of the container is greater than the diameter;

17 percent if the length of the container is equal

to or less than the diameter; and

8 percent in the case of a special container as shown in Annex D.

10.2.3.3 The burst test shall not cause any fragmentation of the container.

10.2.3.4 The main fracture shall not show any brittleness, that is, the edges of the fracture shall not be radial but shall be at an angle to a diametrical plane and display a reduction of area throughout their thickness.

10.2.3.5 The fracture shall not reveal an inherent defect in the metal. The weld shall be at least as strong as the original metal but preferably stronger.

10.2.3.6 Retest is permitted for the burst test. A second burst test shall be performed on two containers which have been produced successively to the first container within the same batch. If the results of these tests are satisfactory, the first test shall be ignored. In the event where one or both of the retests fail to meet the requirements, the batch shall be rejected.

10.3 Hydrostatic Test

Each container, heat-treated or otherwise (*see also* **9**), shall be subjected to hydrostatic test. During the hydrostatic test, the pressure shall be increased gradually till the required test pressure of 3 MPa is reached. After the test pressure is reached and the external surfaces of the container are dried, it shall be retained for a period of not less than 60 seconds. Any reduction in pressure noticed during this retention period or any leakage, or visible bulge or deformation shall be treated as a case of failure in the test.

10.4 Pneumatic Leakage Test

10.4.1 Each container, after it has been dried and fitted with all accessories, as applicable, using a suitable jointing material as agreed to between the purchaser and the manufacturer, shall be tested for leakage by subjecting to air pressure of not less than 2 MPa for a period of one minute while immersed in water and shall show no leakage from the body of the container and valve pad joint. This test shall be carried out after fixing the safety cap on the valve(s) fittings as applicable.

10.4.2 The container in horizontal position shall be immersed in water tank, which shall be adequately illuminated with light both from outside and inside the tank.

10.5 Non-Destructive Examination

10.5.1 *Radiographic Examination*

10.5.1.1 Radiographic examination shall conform to techniques set forth in the relevant Indian Standards. For general guidance, reference may be made to IS 1182, IS 2595, IS 3657, IS 4853 and **8.7** of IS 2825. The radiographic technique used shall be sufficiently sensitive to reveal a defect having a thickness equal to 2 percent of the combined thickness of the weld and the strip.

10.5.1.2 When a wire-type indicator is used, the smallest diameter of the wire visible may not exceed the value of 0.10 mm.

10.5.1.3 When a stepped and holed type indicator is used, the diameter of the smallest hole visible may not exceed 0.25 mm.

10.5.1.4 The film density shall preferably be between 2 and 3 but in no case less than 1.7.

10.5.2 The following defects are not acceptable.

Cracks, inadequate welds, incomplete fusion or inadequate penetration.

10.5.3 For the container wall thickness ≥ 4 mm, the inclusions listed below are regarded as acceptable.

10.5.3.1 Any gas inclusion measuring not more than a/4 mm.

10.5.3.2 Any gas inclusion measuring more than a/4 mm but not more than a/3 mm, which is more than 25 mm away from other gas inclusion measuring more than a/4 mm and measuring not more than a/3 mm.

10.5.3.3 Any elongated inclusion or any group of rounded inclusions in a row where the length represented (over a weld length of 12 × a) is not greater than 6 mm.

10.5.3.4 Gas inclusions over any 100 mm weld length, where the total area of all the inclusions is not greater than (2 × a) mm^2.

10.5.4 For the container wall thickness < 4 mm, the inclusions listed below are regarded as acceptable.

10.5.4.1 Any gas inclusion measuring not more than a/2 mm.

10.5.4.2 Any gas inclusion measuring more than a/2 mm but not more than a/1.5 mm, which is more than 25 mm away from other gas inclusion measuring more than a/2 mm and measuring not more than a/1.5 mm.

10.5.4.3 Any elongated inclusion of any group of rounded inclusions in a row where the length represented (over a weld length of 12 × a) is not greater than 6 mm.

10.5.4.4 Gas inclusions over any 100 mm weld length, where the total area of all the inclusions is not greater than (2 × a) mm^2.

10.5.5 *Examination of the Outside Surface of the Weld*

10.5.5.1 This examination is carried out when the weld has been completed. The welded surface examined shall be well illuminated, and shall be free from grease, dust, scale residue or protective coating of any kind.

10.5.5.2 The fusion of the welded metal with the parent metal shall be smooth and free from etching. There shall be no cracks, notching or porous patches in the welded surface and the surface adjacent to the weld. The welded surface shall be regular and even. Where a butt weld has been used, the excess thickness shall not exceed one-fourth of the width of the weld.

10.5.5.3 Unacceptable welding imperfections shall be removed and be rewelded in accordance with a qualified procedure or the container shall be condemned. Any repair of weld after heat-treatment, if employed procedurally, shall follow heat-treatment except that heat-treatment is not consider necessary following minor repair welding of pinholes, under cuts, etc, where the depth of weld matter removed is not greater than half the shell thickness and the length does not exceed 12 mm.

10.6 Type Test

10.6.1 *Bonfire Test*

10.6.1.1 *General*

The bonfire test is designed to demonstrate that a container complete with all accessories as specified in the design, will prevent the burst of the container when tested under the specified fire conditions. A container representative of each type fitted with all accessories on it shall be subjected to this test.

10.6.1.2 *Container set-up*

10.6.1.2.1 Container shall be placed horizontally with the container bottom approximately 100 mm above the fire source.

10.6.1.2.2 Metallic shielding shall be used to prevent direct flame impingement on container valves, fittings and/or pressure relief device. The metallic shielding shall not be in direct contact with the specified fire protection system (pressure relief device or container valve). Any failure during the test of a valve, fitting or tubing that is not part of the intended protection system for the design shall invalidate the result.

10.6.1.3 *Fire source*

10.6.1.3.1 A uniform fire source of 1.65 m in length shall provide direct flame impingement on the container surface across its entire diameter.

10.6.1.3.2 Any fuel may be used as the fire source provided it supplies uniform heat sufficient to maintain the specified test temperatures until the container is vented. The arrangement of the fire shall be recorded in sufficient detail to ensure that the rate of heat input to the container is reproducible. Any failure or inconsistency of the fire source during the test shall invalidate the result.

10.6.1.4 *Temperature and pressure measurements*

10.6.1.4.1 During the bonfire test, the following temperatures shall be measured:

a) The fire temperature just below the container, along the bottom of the container, at minimum two locations, not more than 750 mm apart;

b) The wall temperature at the bottom of the container;

c) The wall temperature within 25 mm from the pressure relief device; and

d) In case of containers longer than 2.65 m, the wall temperature on the top of the container, in the centre of the fire.

10.6.1.4.2 Metallic shielding shall be used to prevent direct flame impingement on the thermocouples. Alternatively, thermocouples may be inserted into the blocks of metal, measuring less than 25 mm^2. During the test the thermocouple temperatures and the container pressure shall be recorded at intervals of 30 seconds or less.

10.6.1.5 *General test requirements*

10.6.1.5.1 Container shall be filled with 80 percent in volume of LPG (as per IS 14861) and tested in the horizontal position at working pressure.

10.6.1.5.2 Immediately following the ignition, the fire shall produce flame impingement on the surface of the container, along 1.65 m length of the fire source across the container.

10.6.1.5.3 Within five minutes of ignition at least one thermocouple shall indicate the temperature of fire just below the container of at least 590°C. This temperature shall be maintained for the remaining duration of the test, that is, until when no overpressure is present in the container.

10.6.1.5.4 The centre of the container shall be positioned over the centre of the fire source.

10.6.1.6 *Acceptable results*

The container shall vent through the pressure relief device and no burst shall occur.

10.6.2 *Fatigue Test*

10.6.2.1 For the purpose of this test, three containers

which are guaranteed by the manufacturer to be reasonably representative of the minimum thickness set by the design and which include all markings as specified in **12** shall be filled with water and subjected to successive reversals by hydraulic pressure.

10.6.2.2 The test shall be carried out at an upper cyclic pressure either:

a) Equal to two-thirds of the test pressure, in which case the tank shall be subjected to 80 000 cycles without failure; or

b) Equal to test pressure, in which case the tank shall be subjected to 12 000 cycles without failure.

10.6.2.3 The value of the lower cyclic pressure shall not exceed 10 percent of the upper cyclic pressure.

10.6.2.4 The frequency of reversals of pressure shall not exceed 0.25 Hz.

10.6.2.5 The temperature measured on the outer surface of the tank shall not exceed 50°C during the test.

10.6.2.6 After the fatigue test, a burst test shall be carried out on the same container.

10.6.2.7 The results shall comply with the requirements in the burst test.

10.6.3 *Crash Test*

10.6.3.1 *Test conditions*

10.6.3.1.1 The container shall be 80 percent filled with water, closed with its original approved valves and pressurized up to 1 MPa.

10.6.3.1.2 The impact has to be carried out on a horizontal and undeformable wedge.

10.6.3.1.3 The wedge defined by two faces of a dihedron, whose apex is 90 degrees, has a curve-radius between 2.2 to 2.5 mm.

10.6.3.1.4 The minimum length of the wedge is equal to the total length of the container.

10.6.3.1.5 The location of the wedge is perpendicular to the drive direction of the vehicle and on a height of the theoretical gravity centre of the considered container.

10.6.3.1.6 The position of the container shall be in accordance with the position in the vehicle.

10.6.3.1.7 In case of different possible positions of the container in the vehicle, the test shall be carried out for every position.

10.6.3.1.8 During the test, the container shall make a collision with the wedge at a minimum speed of 50 km/h before the impact. Examples are given in Annex G.

10.6.3.2 *Test requirements*

After the crash test, the container shall be subjected to a hydraulic test for a minimum 1.1 MPa for at least 60 seconds. The container shall not show any leak.

10.6.4 *Strength Assessment*

This test is meant for special containers as per Annex D of this standard

10.6.4.1 A strength assessment on the basis of pressure test shall be carried out on containers and shall be determined by one of the following.

10.6.4.1.1 Brittle lacquer test.

10.6.4.1.2 Measurement with micrometers.

10.6.4.1.3 Measurement of the volumetric expansion.

10.6.4.1.4 Strain gauge measurement.

10.6.4.2 By determining, subjected to the hydraulic test pressure of 3.3 MPa, the total elongation at each point of the container in each direction does not exceed 0.2 percent.

10.6.4.3 The pressure shall rise with 0.5 MPa each time from the beginning at zero till the pressure of 3.3 MPa is reached.

10.6.4.4 Any permanent deformation after the test is not allowed.

11 SURFACE COATING AND COLOUR

The surface coating shall provide corrosion protection by zinc base, lead base or iron oxide base coat primer and top coat synthetic enamel paint with minimum combined thickness of 75 microns or as agreed to between the manufacturer and the buyer. Surface coating is optional for stainless steel. The colour scheme shall be as specified by the statutory authority.

12 MARKINGS

12.1 Each container shall bear a marking plate permanently attached with the following data, clearly legible:

a) A unique serial number,

b) The minimum/nominal water capacity in litres,

c) Tare weight (excluding fittings) in kg,

d) The marking: LPG (Liquefied Petroleum Gas),

e) Test pressure in MPa,

f) The wording: maximum degree of filling 80 percent,

g) Year and month of testing,

h) An approval mark of inspecting authority,
j) Name and trade-mark of the manufacturer,
k) Specification number,
m) Enough space for requalification mark, and
n) Maximum working pressure in MPa.

12.2 The containers shall carry an orientation mark to install the container in correct position.

12.3 BIS Certification Marking

The container may also be marked with the Standard Mark.

12.3.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

13 TECHNICAL REQUIREMENTS FOR TYPE APPROVAL

The manufacturer shall make available to the inspection authority a batch of at least 50 containers for each design from which the inspection authority shall select containers for the following tests:

a) Radiographic test in accordance with **10.5.1** : 2 Containers
b) Mechanical tests in accordance with **10.1** : 2 Containers
c) Burst test in accordance with **10.2.2** : 2 Containers
d) Bonfire test in accordance with **10.6.1** : 1 Container
e) Fatigue test in accordance with **10.6.2** : 3 Containers
f) A crash test in accordance with **10.6.3** : 3 Containers
g) Strength assessment for special containers (*see* Annex F) in accordance with **10.6.4** : 2 Containers

14 ACCESSORIES

The following accessories shall be fitted to the container:

a) 80 percent stop valve;
b) level indicator;
c) pressure relief valve;
d) remotely controlled service valve with excess flow valve;
e) gas-tight housing;
f) power supply bushing (applicable only where fuel pump is provided for multi fuel injection system);
g) non-return valve; and
h) pressure relief device (fuse, to be designed to open at temperature of 120 ± 10°C).

ANNEX A

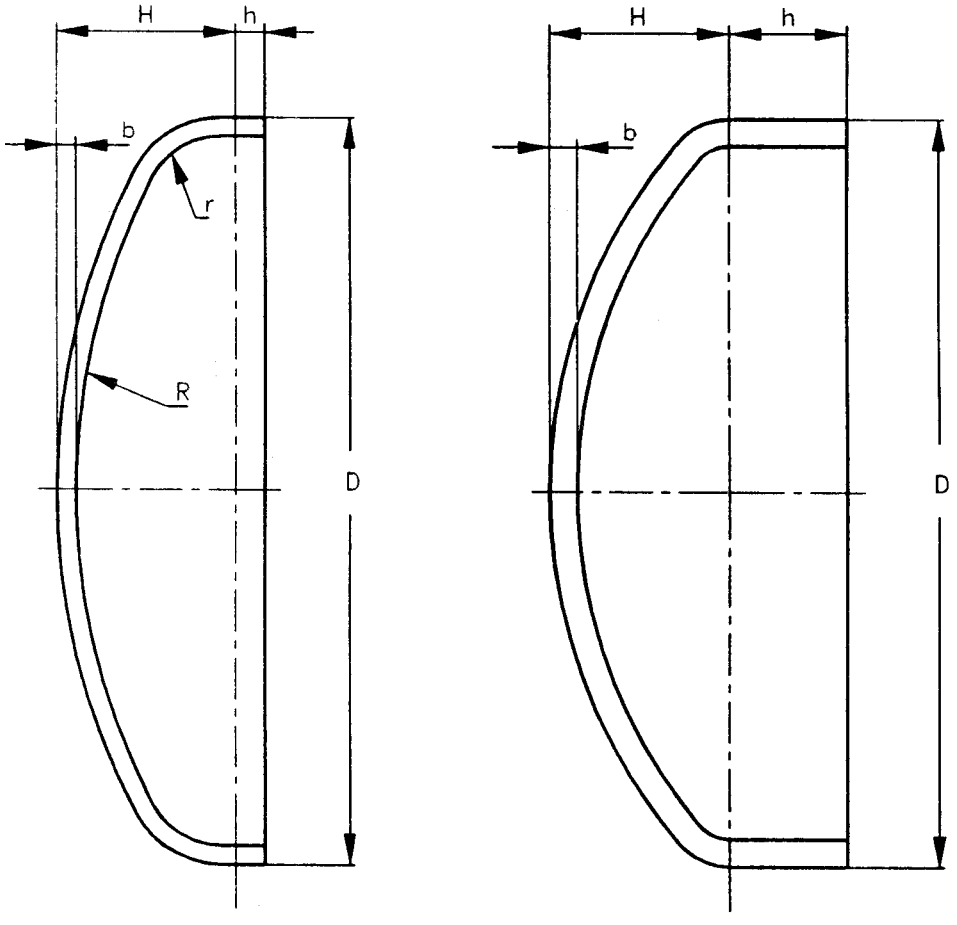
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1182 : 1983	Recommended practice for radiographic examination of fusion welded butt joints in steel plates (*second revision*)
1608 : 1995	Mechanical testing of metals tensile testing (*second revision*)
2595 : 1978	Code of practice for radiographic testing (*third revision*)
2825 : 1969	Code of unfired pressure vessels
3196 (Part 3) : 1991	Welded low carbon steel cylinders exceeding 5 litres water capacity for low pressure liquefiable gases : Part 3 Methods of test (*fourth revision*)
3657 : 1978	Radiographic image quality indicators (*first revision*)
4853 : 1982	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes (*first revision*)
5844 : 1970	Recommendation for hydrostatic stretch testing of compressed gas cylinders
6240 : 1999	Hot rolled steel plate (up to 6 mm) sheet and strip for the manufacture of low pressure liquefiable gas cylinders — Specification. (*third revision*)
14861 : 2000	Liquefied petroleum gases (LPG) for automotive purposes

ANNEX B

(*Clauses* 6.3.2 *and* 6.3.2.1)



TORISPHERICAL ENDS

ELLIPSOIDAL ENDS

NOTE — For Torispherical Ends:

$$H = (R+b) - \sqrt{\left[(R+b) - \frac{D}{2}\right]\left[(R+b) + \frac{D}{2} - 2(r+b)\right]}$$

FIG. 1 SHAPE OF ENDS

RELATIONSHIP BETWEEN H/D AND SHAPE FACTOR C

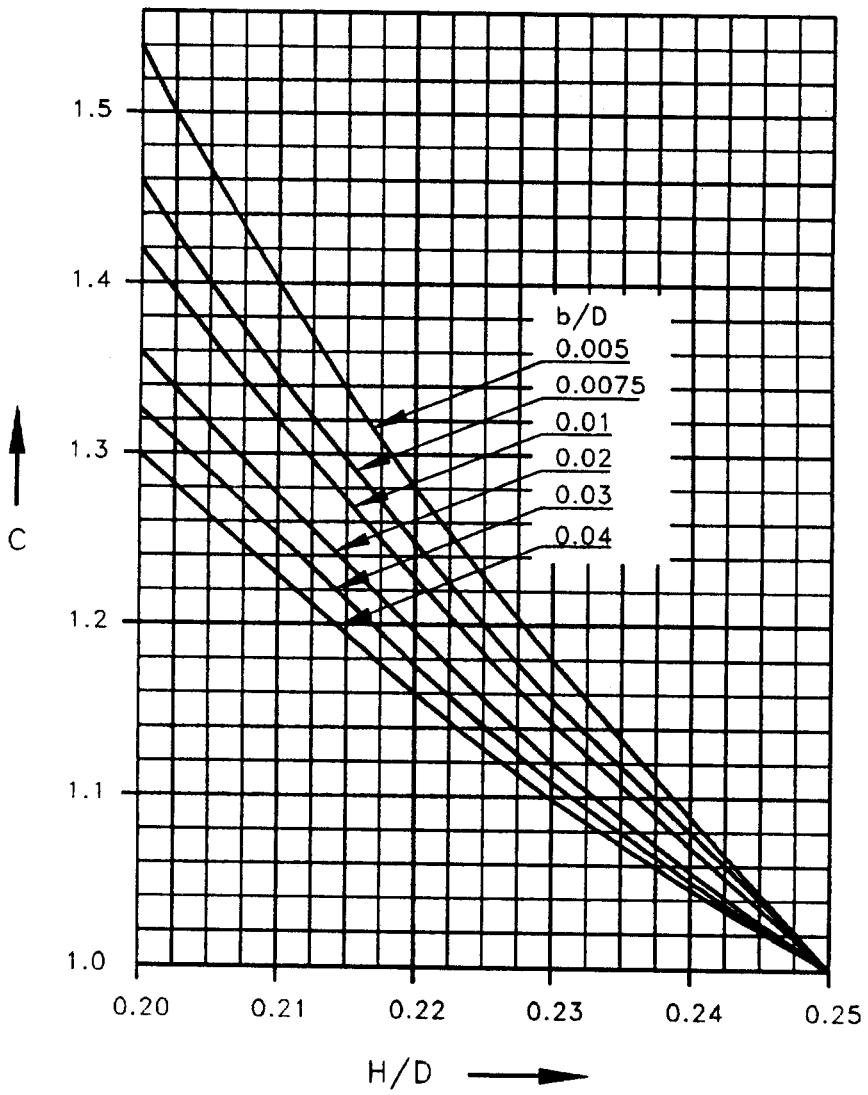
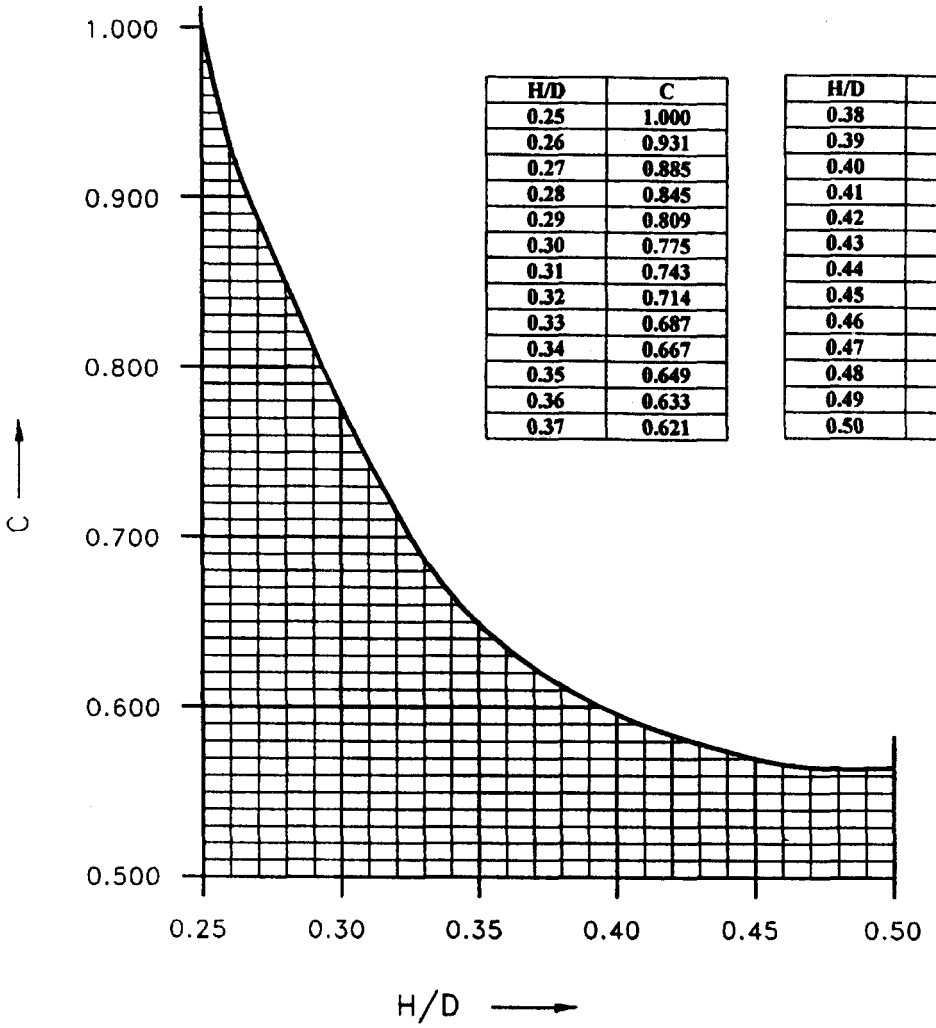


FIG. 2 VALUES OF SHAPE FACTOR C FOR H/D FROM 0.20 TO 0.25

RELATIONSHIP BETWEEN H/D AND SHAPE FACTOR C



H/D	C
0.25	1.000
0.26	0.931
0.27	0.885
0.28	0.845
0.29	0.809
0.30	0.775
0.31	0.743
0.32	0.714
0.33	0.687
0.34	0.667
0.35	0.649
0.36	0.633
0.37	0.621

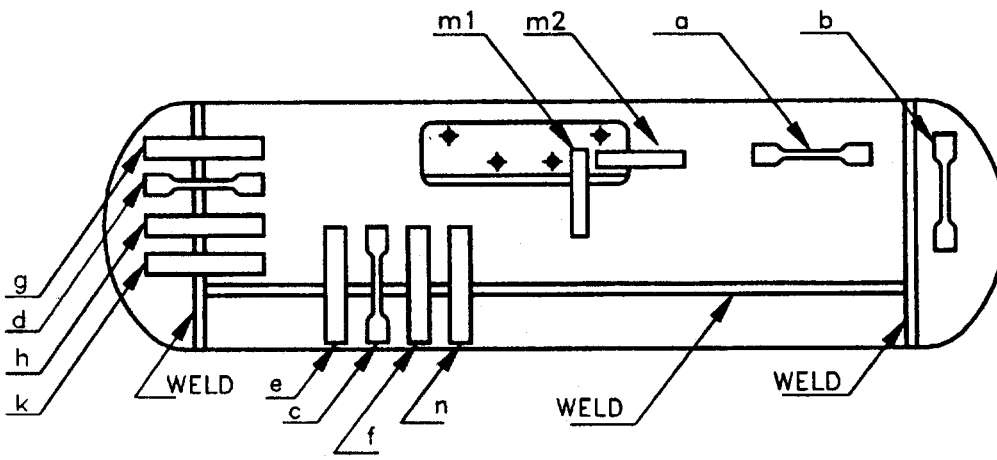
H/D	C
0.38	0.612
0.39	0.604
0.40	0.596
0.41	0.588
0.42	0.581
0.43	0.576
0.44	0.572
0.45	0.570
0.46	0.568
0.47	0.566
0.48	0.565
0.49	0.564
0.50	0.564

NOTE — Intermediate values may be obtained by Linear interpolation.

FIG. 3 VALUES OF SHAPE FACTOR C FOR H/D ABOVE 0.25 TO 0.50

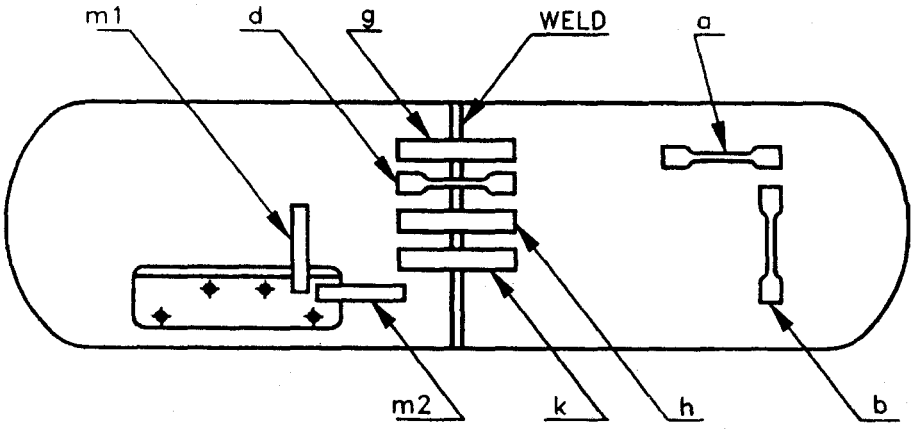
ANNEX C

(*Clauses* 6.3.2.1, 10.1.2.1.1, 10.1.2.1.2, 10.1.2.1.3 *and* 10.1.2.1.4)



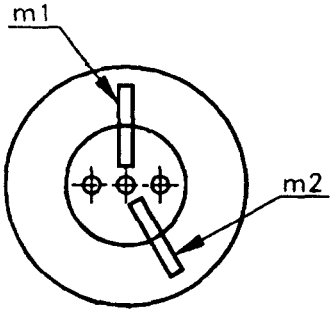
a	=	tensile test on parent material
b	=	tensile test on parent material of the botom
c	=	tensile test on longitudinal weld
d	=	tensile test on a circumferential weld
e	=	bend test on a longitudinal weld, the inner surface in tension
f	=	bend test on a longitudinal weld, the outer surface in tension
g	=	bend test on a circumferential weld, the inner surface in tension
h	=	bend test on a circumferential weld, the outer surface in tension
k	=	macroscopic test on a circumferential weld
n	=	macroscopic test on a longitudinal weld
m1, m2	=	macrosections through valve boss/plate welds (side-mounted block)

FIG. 4 CONTAINERS WITH LONGITUDINAL AND CIRCUMFERENTIAL WELDS, LOCATION OF TEST PIECES



a and b = tensile test on parent material
d = tensile test on a circumferential weld
g = bend test on a circumferential weld, the inner surface in tension
h = bend test on a circumferential weld, the outer surface in tension
k = macroscopic test on a circumferential weld
m1, m2 = macrosections through valve boss/plate welds (side-mounted valve block)

FIG. 5A CONTAINERS WITH CIRCUMFERENTIAL WELDS, ONLY AND SIDE-MOUNTED VALVE BLOCKS, LOCATION OF TEST PIECES

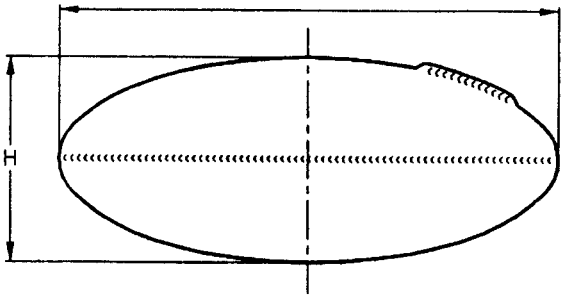


m1, m2 = macrosections through valve boss/plate welds
(Refer to Fig. 5A for other location of test pieces)

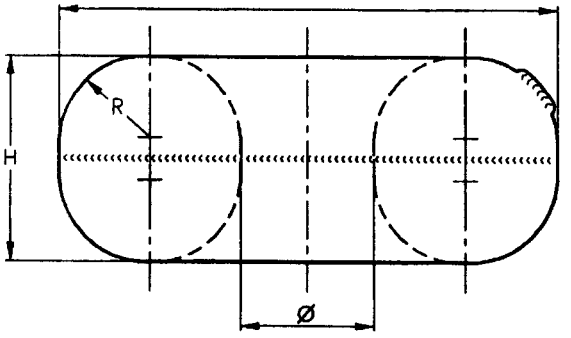
FIG. 5B CONTAINERS WITH CIRCUMFERENTIAL WELDS ONLY AND VALVE BOSS/PLATE FITTED TO THE END

ANNEX D

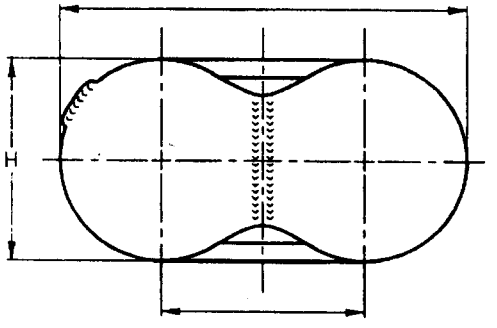
(*Clauses* 6.3.2.2, 7.2.1.3 *and* 10.6.4)



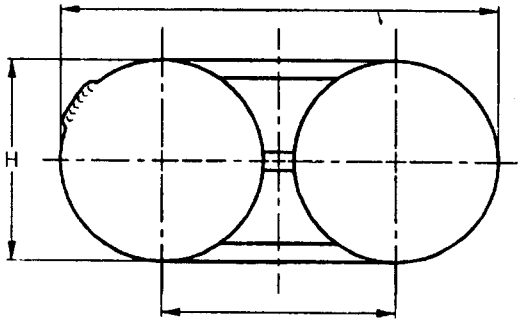
6A ELLIPTICAL CONTAINER



6B TOROIDAL CONTAINER



6C DUO CONTAINER



6D TWIN CONTAINER

FIG. 6 EXAMPLES OF SPECIAL CONTAINERS

ANNEX E

(*Clauses* 7.2.2 *and* 7.2.2.4)

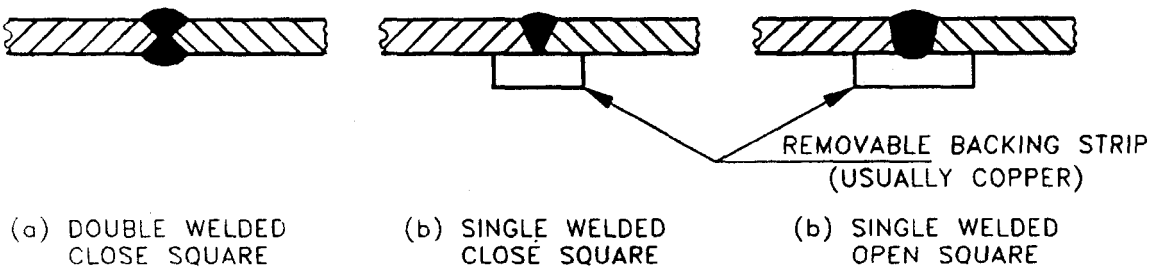
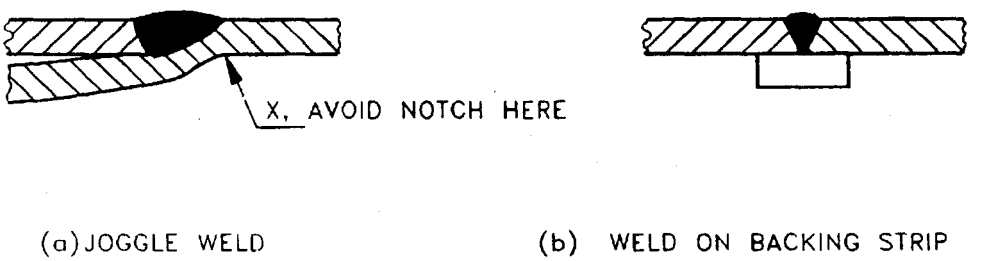
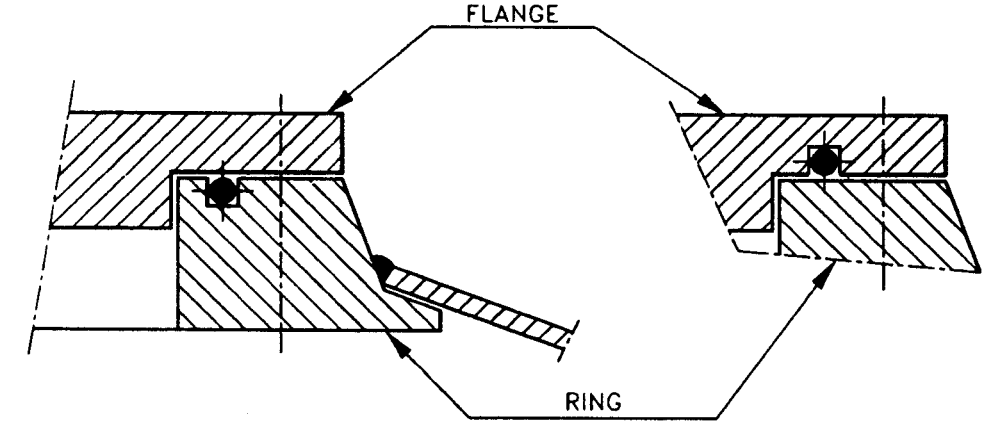


FIG. 7 TYPES OF MAIN LONGITUDINAL BUTT WELDS

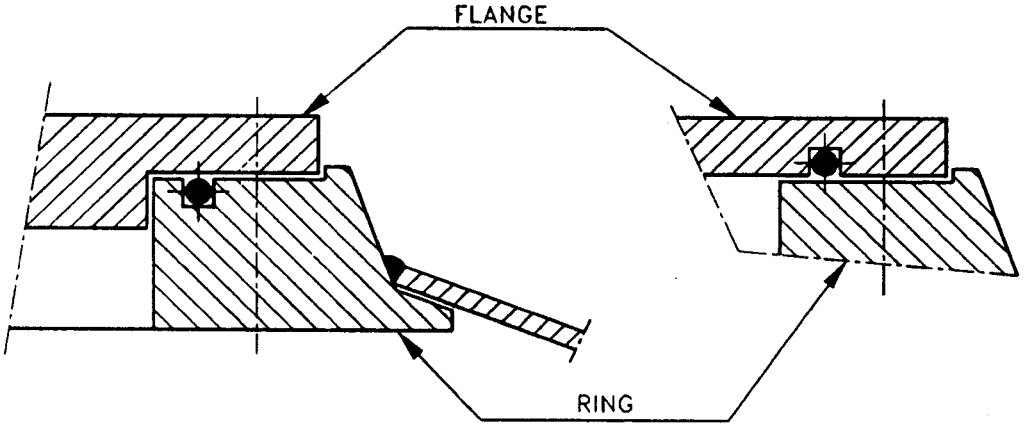


NOTE — The Fillet weld can be performed as a "Chain Weld".

FIG. 8 CIRCUMFERENTIAL BUTT WELDS

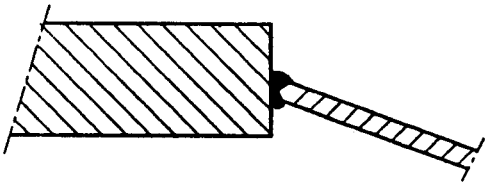


9A

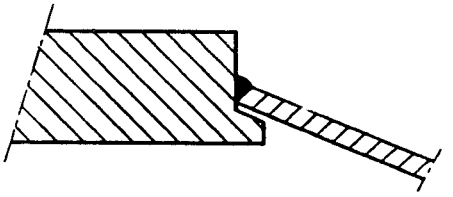


9B

FIG. 9 EXAMPLES OF WELDED RINGS WITH FLANGES



10A

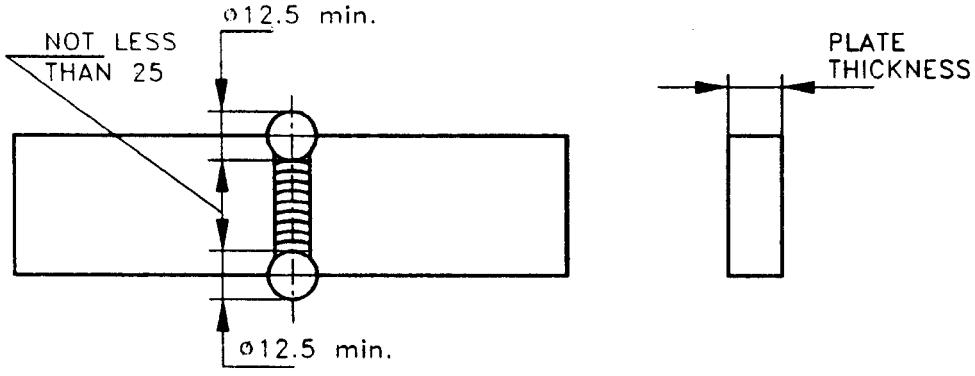


10B

FIG. 10 EXAMPLES OF WELDED STUDDED PLATES

ANNEX F

(*Clauses* 10.1.3.2.1, 10.1.4.2 *and* 13)



All dimensions in millimetres.

FIG. 11 RADIUS REDUCED TRANSVERSE TENSILE TEST SPECIMEN

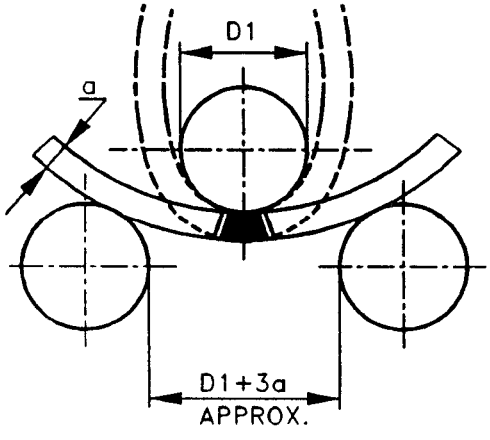


FIG. 12 ILLUSTRATION OF BEND TEST

ANNEX G

(*Clause* 10.6.3.1.8)

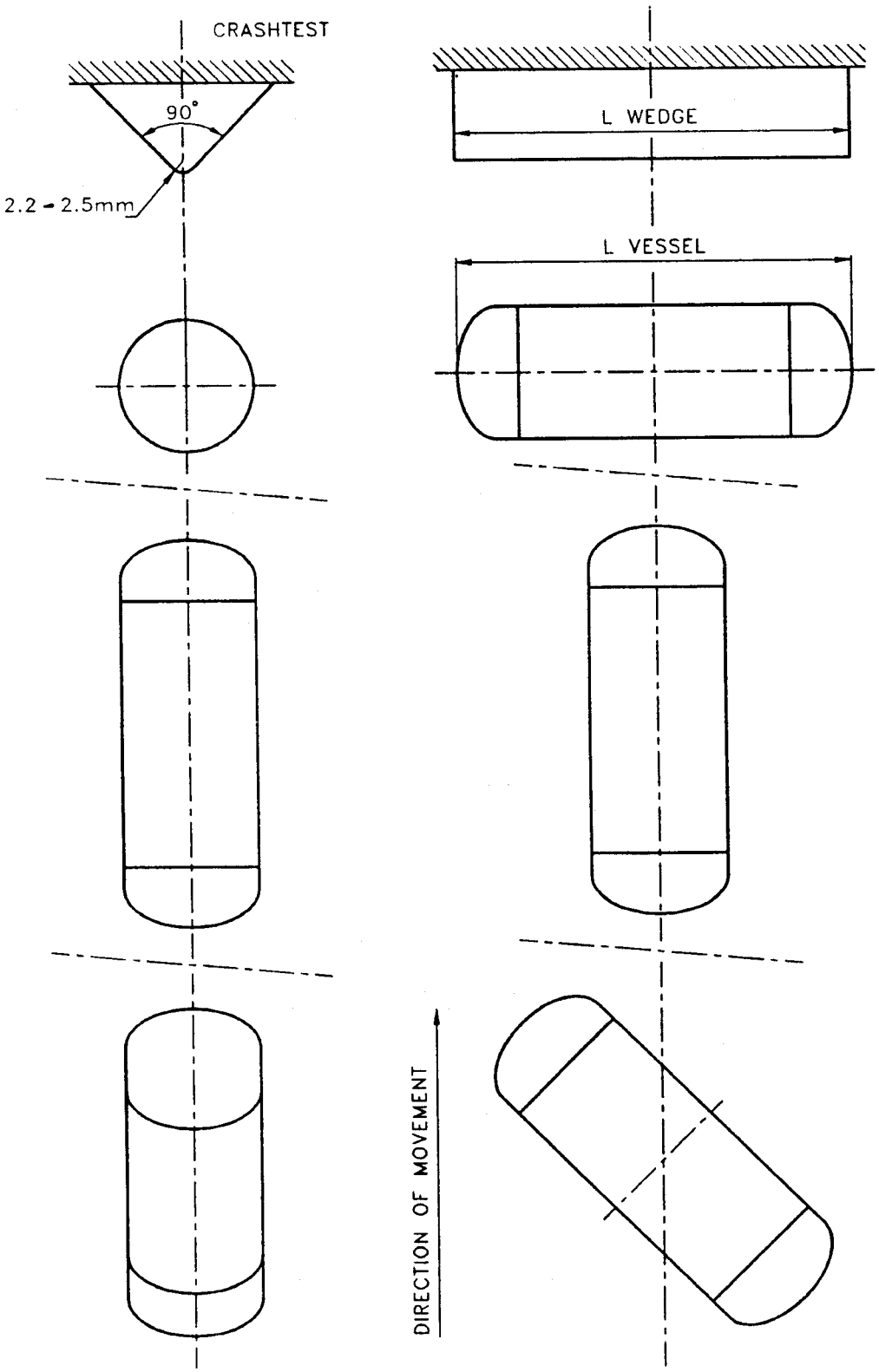


FIG. 13 CRASH TEST

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Review of Indian Standards

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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AMENDMENT NO. 1 SEPTEMBER 2001
TO
IS 14899 : 2000 LIQUEFIED PETROLEUM GAS (LPG) CONTAINERS FOR AUTOMOTIVE USE — SPECIFICATION

[*Page 2, clause* **6.3.2.1** (a) *and* (b)] – Substitutes '0.003 $D \leq b \leq 0.08\ D$' *for* '0.003$D \leq$ 0.08 $b \leq 0.08\ D$'.

(MED 16)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 2 APRIL 2003
TO
IS 14899 : 2000 LIQUEFIED PETROLEUM GAS (LPG) CONTAINERS FOR AUTOMOTIVE USE — SPECIFICATION

(*Page* 1, *clause* **4.1.1**) — Insert the following matter after third sentence:

'The tensile test shall be carried out in accordance with IS 1608 using a proportional gauge length of $l_o = 5.65\sqrt{S_o}$. , where S_o is the cross sectional area of the test piece. Test piece with a non-proportional gauge length may be used. In that case the elongation values shall be converted in accordance with IS 3803 (Part 1).'

(*Page* 2, *clause* **6.2**) — Substitute the following for the existing clause:

'6.2 Design Pressure

The container shall be designed for a test pressure of 3 MPa and intended for use with liquefied petroleum gas as per IS 14861 having vapour pressure at 65°C not exceeding 2 MPa.'

(*Page* 10, *clause* **14**) — Substitute the following for the existing clause:

'14 ACCESSORIES

The container shall be fitted with multi function valve assembly conforming to IS 15100 or any other multi function valve assembly approved by the statutory authority and shall contain the following accessories:

a) 80 percent stop valve;
b) Level indicator;
c) Pressure relief valve;
d) Remotely controlled service valve with excess flow valve;
e) Gas-tight housing;
f) Power supply bushing (applicable only where fuel pump is provided for multi fuel injection system);
g) Non-return valve; and
h) pressure relief device (fuse to be designed to open at temperature of 120 ± 10°C).

NOTE— The containers may be supplied by the manufacturer without fitting multi function valve as agreed between the manufacturer and supplier. In such case the approved type of multi function valve assembly shall be fitted either by the OEM or retrofitter before use.

(*Page* 10, *Annex* A) — Insert the following matter after IS 3657 : 1978:

IS 3803 (Part 1) : 1989	Steel-conversion of elongation values : Part 1 Carbon and low alloy steels (*second revision*)

(ME 16)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 4 MAY 2007
TO
IS 14899 : 2000 LIQUEFIED PETROLEUM GAS (LPG) CONTAINERS FOR AUTOMOTIVE USE — SPECIFICATION

(*Page* 9, *clause* **11**, *first sentence*) — Substitute the following for the existing:

'The surface coating shall provide corrosion protection by zinc base or lead base primer coating and top coat synthetic enamel paint with minimum thickness of 75 microns or powder coated as per IS 13871 or as agreed to between the manufacturer and the buyer.'

(*Page* 10, *Annex* A) — Insert the following at the appropriate place:

'IS 13871 : 1993 Powder coatings — Specification'

(ME 16)

Reprography Unit, BIS, New Delhi, India

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TO
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(*Page* 5, *clause* **9.2**, *Note*) — Delete.

(ME 16)

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