इंटरनेट मानक

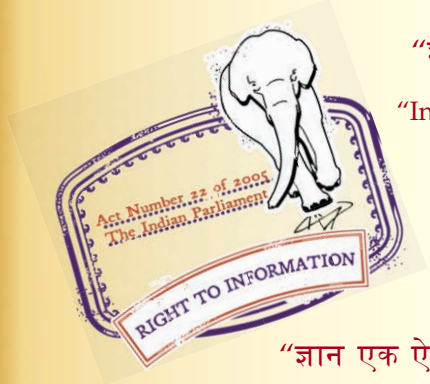
Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 3196-1 (2006): Welded Low Carbon Steel Cylinders Exceeding 5 Litre Water Capacity for Low Pressure Liquefiable Gases, Part 1: Cylinders for liquefied Petroleum Gases (LPG) [MED 16: Mechanical Engineering]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

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

IS 3196 (Part 1) : 2006
(Reaffirmed 2010)

भारतीय मानक

अल्प दाब द्रवणीय गैसों के लिए 5 लिटर से अधिक जल क्षमता वाले वेल्डित अल्प कार्बन इस्पात के सिलिंडर

भाग 1 द्रवित पैट्रोलियम गैस (एल. पी. जी.) के लिए सिलिंडर की विशिष्टि

(पाँचवां पुनरीक्षण)

Indian Standard

WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 1 CYLINDERS FOR LIQUEFIED PETROLEUM GASES (LPG) — SPECIFICATION

(Fifth Revision)

ICS 23.020.30; 75.160.30

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

March 2006

Price Group 7

FOREWORD

This Indian Standard (Part 1) (Fifth Revision) was adopted by 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 was originally issued in 1965 and subsequently revised in 1968, 1974, 1982 and 1992. In this revision all the amendments have been included. This revision incorporates the following changes:

a) Definitions of some terms has been added,

b) Fatigue test/cycle test has been added, and

c) Volumetric expansion during the burst test has been incorporated.

Assistance has been taken from ISO/CD 4706-1 'Gas cylinders – Refillable — Part 1: Welded steel cylinders 90 bar test pressure and below'.

Manufacture, possession and use of any gas, when contained in cylinders of more than 500 ml water capacity in compressed or liquefied state, are regulated under the *Gas Cylinder Rules,* 2004 of the Government of India, This standard has been prepared in consultation and in agreement with the statutory authorities under those rules.

Welded low carbon steel cylinders exceeding 5 litres water capacity for low pressure liquefiable gases are covered in IS 3196. This standard has four parts, the other parts in the series are:

Part 2 Cylinders for liquefiable gases other than LPG

Part 3 Method of tests

Part 4 Cylinders for toxic and corrosive gases

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

The composition of the Committee responsible for the preparation of this standard is given in Annex C.

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.

AMENDMENT NO. 4 JULY 2010
TO
IS 3196 (PART 1) : 2006 WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 1 CYLINDERS FOR LIQUEFIED PETROLEUM GASES (LPG) — SPECIFICATION

(Fifth Revision)

(*Page* 4, *clause* **7.3**) — Insert the following at the end:

For a typical joggled butt joint, *see* Fig. 3.

FIG. 3 ILLUSTRATION OF TYPICAL CIRCUMFERENTIAL JOGGLE BUTT JOINT

(*Page* 6, *clause* **10.1**) — Insert the following Note at the end:

'NOTE — The frequency of the test shall be once in six months.'

(*Page* 7, *clause* **14**, *second sentence*) — Substitute the following for the existing:

'This shall be done by weighing method.'

Amend No. 4 to IS 3196 (Part 1) : 2006

[*Page* 8, *clause* **17.3.3**(b)] — Substitute the following for the existing:

'b) Fracture shall not occur in the weld. The fracture shall also not occur in the direction parallel to circumferential weld within 10 mm from the edge of the circumferential weld.'

(ME 16)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 AUGUST 2009

TO

IS 3196 (PART 1) : 2006 WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 1 CYLINDERS FOR LIQUEFIED PETROLEUM GASES (LPG) – SPECIFICATION

(Fifth Revision)

(*Page* 4, *clause* **7.8.1**) — Delete the clause.

(*Page* 4, *clause* **7.8.2**) — Substitute the following for the existing:

'As far as possible, all welded joints shall be double welded butt joints, in case where second side welding is not possible, single, welded butt joints (with or without backing strip) may be used, provided sufficient care is taken to ensure complete fusion and penetration.'

(*Page* 5, *Fig.* 2) — Substitute the following for the existing figure:

1 = Max 0.01 *l*
2 = Max 0.003 *l*

FIG. 2 ILLUSTRATION OF DEVIATION OF CYLINDRICAL PART OF SHELL FROM A STRAIGHT LINE AND FROM VERTICAL

(*Page* 9, *clause* **22.2**, *first sentence*) — Substitute the following for the existing sentence

'The outside surface shall be grit (*see* IS 4683) blasted with minimum Sa 2½ grade of blast (*see* IS 9954) and shall be given following protective coatings.'

[*Page* 9, *clause* **22.2**(a)] — Substitute the following for the existing:

'a) Spraying zinc to give a coating of minimum thickness of 37 microns unless otherwise agreed to between the purchaser and the manufacturer. The zinc wire used for spraying shall be as per IS 12447 and the zinc spraying shall be as per IS 6586.'

[*Page* 9, *clause* **22.2**(a)] — Add the following at the end:

'Adhesion of zinc on metal surface shall be as per IS 5905.'

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

IS 4683 : 1968	Chilled iron shot and grit for use in foundries
IS 5905 : 1989	Sprayed aluminium and zinc coatings on iron and steel (*first revision*)
IS 6586 : 1989	Recommended practice for metal spraying for protection of iron steel (*first revision*)

[ME 16)

AMENDMENT NO. 2 MAY 2008
TO
IS 3196 (PART 1) : 2006 WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 1 CYLINDERS FOR LIQUEFIED PETROLEUM GASES (LPG) — SPECIFICATION

(Fifth Revision)

(*Page* 5, *Fig.* 2) — Substitute '0.01 *l, Max' for* '0.001 *l Max'.*

[*Page* 8, *clause* **17.3.3**(e)] — Substitute the following for the existing matter:

'e) The ratio of the volumetric expansion of the cylinder to its initial volume shall be greater than or equal to the following values:

1) 20 percent, if the length of the cylinder is greater than its diameter; and
2) 17 percent, if the length of the cylinder is equal to or less than its diameter.'

[*Page* 9, *clause* **22.2**(c), *first line*] — Delete the word 'super'.

(ME 16)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 1 AUGUST 2006
TO
IS 3196 (PART 1) : 2006 WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 1 CYLINDERS FOR LIQUEFIED PETROLEUM GASES (LPG) — SPECIFICATION

(Fifth Revision)

[*Page* 9, *clause* **22.2**(c), *first sentence*] — Substitute the following for the existing;

'One coat of super synthetic enamel paint conforming to IS 2932 of signal red colour (Shade No. 537 of IS 5) or any other colour with the approval of statutory authority.'

(ME 16)

Reprography Unit, BIS, New Delhi, India

Indian Standard

WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 1 CYLINDERS FOR LIQUEFIED PETROLEUM GASES (LPG) — SPECIFICATION

(Fifth Revision)

1 SCOPE

1.1 This standard (Part 1) deals with welded low carbon steel cylinders intended for storage and transportation of liquefied petroleum gases (*see* IS 4576) of nominal capacity exceeding 5 litre up to and including 250 litre water capacity. This standard lays down the minimum requirements for the materials, design, manufacture, construction, tests and marking of these cylinders.

1.1.1 Cylinders of water capacity up to 5 litre are covered in IS 7142.

2 REFERENCES

The standards listed in Annex A are necessary adjuncts to this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

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

3.1 Normalizing — Heat treatment in which, a cylinder 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.

3.2 Stress Relieving — Heat treatment given to a cylinder, 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 cooing in a controlled or still air atmosphere.

3.3 Stabilizing — Heat treatment given to a cylinder, the object of which is to stabilize the structure of the steel by heating to a uniform temperature below the upper critical point (AC_3) of the steel and subsequently cooled to obtain the desired mechanical properties.

3.4 Critical Temperature — The temperature at which a phase or a magnetic changes takes place [*see* IS 1956 (Part 1)].

3.5 Test Pressure ***(P_h)*** — Test pressure means the internal pressure required for the hydrostatic test and the hydrostatic stretch test of the cylinders.

NOTE — It is used for cylinder wall thickness calculation.

3.6 Burst Pressure ***(P_b)*** — Highest pressure reached in a cylinder during a burst test.

4 MATERIAL

4.1 The steel used in the manufacture of cylinders shall conform to IS 6240.

4.1.1 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 cylinder manufacturer for the finished cylinder shall be used for the purpose of calculating the wall thickness of the cylinder. 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 frilly killed.

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

4.2 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. The bung machined from such forging shall be free from surface defects such as fissures, surface cracks, porosity, laminations, pinholes, etc *(see* **10.3).**

4.3 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 cylinder.

4.4 The materials used for foot ring, stout metal cap, shroud and/stay plate shall conform to Grade '0' of IS 1079 or IS 2062 or IS 6240 or as agreed to between the purchaser and the manufacturer.

5 GENERAL

A fully dimensioned sectional drawing of the cylinder, 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.

6 DESIGN

6.1 The cylinder shall be of welded construction having a cold or hot drawn or pressure formed cylindrical portion with hemi-spherical, ellipsoidal or tori-spherical ends welded to it, or two halves of cold or hot drawn and circumferentially welded together, or any other construction approved by the statutory authority.

6.2 The calculation of the thickness of pressure parts of the gas cylinder is related to the minimum value of yield strength guaranteed by the cylinder manufacturer for the finished cylinder and the test pressure.

6.2.1 The agreed finished thickness shall not be lower than that calculated from the following formulae:

a) For cylindrical portion, greater of the following two:

1) $$t = \frac{P_h D_o}{200 \times 0.8 J R_e + P_h} = \frac{P_h D_i}{200 \times 0.8 J R_e - P_h}$$

2) $t = 0.136 \times \sqrt{D_o}$

b) For tori-spherical part or end [*see* Fig. 1 A]:

$$t_e = \frac{P_h D_o}{200 \times 0.8 J R_e + P_h} \times \frac{KZ}{5}$$

c) For semi-ellipsoidal part or end [*see* Fig. 1B]:

$$t_e = \frac{P_h D_o}{200 \times 0.8 J R_e + P_h} \times \frac{K(0.65 + 0.1 K)}{4}$$

where

t = calculated minimum wall thickness of cylindrical shell, in mm, excluding any additional thickness to resist influences other than those of internal pressure and of external forces due to normal handling *(see* **8.4**);

t_c = calculated minimum wall thickness of tori-spherical or semi-ellipsoidal ends, in mm;

P_h = test pressure, in kgf/cm^2, which shall be taken as = 25 kgf/cm^2;

D_1 = inner diameter, in mm;

D_o = outer diameter, in mm;

J = weld joint factor;

= 1.0, if each weld is to be fully radio-graphed;

= 0.9 for cylinders with circumferential seam only (not radio-graphed);

= 0.9 for cylinders with seams other than circumferential which are spot radio-graphed in accordance with **13.2;**

= 0.7 for all other cases;

R_e = yield strength (minimum value specified in **4.1** and **4.1.1**), in kgf/mm^2. However, the value of 'R_e' shall not be more than the minimum value specified in the material specification;

h_o = external height of domed ends, in mm;

h_1 = internal height of domed ends, in mm;

K = ratio $D_o/h_o[(h_o/D_o) \geq 0.192]$;

R = dishing radius $(R_1 \leq D_o)$, in mm;

r_1 = knuckle radius ($r_1 \geq 0.1\ D_o$ or $r_1 \geq 3$ times the actual wall thickness of dished end as manufactured), in mm;

S_f = length of straight flange, in mm; and

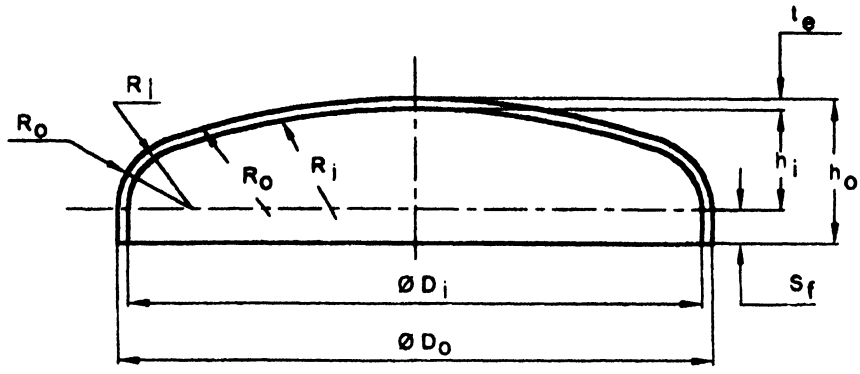
$$Z = \frac{\frac{20 r_1}{R_1} + 3}{\frac{20 r_1}{R_1} + 1}$$

NOTE — $S_1 \geq 0.3 \sqrt{D_o t_e}$

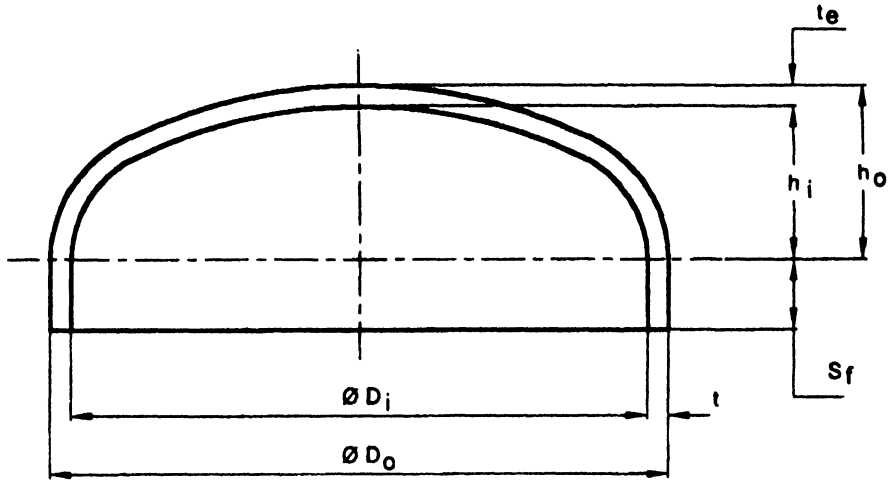
6.2.1.1 For hemi-spherical ends [*see* Fig. 1C] or parts, the minimum finished thickness need not exceed that of the cylindrical portion of the cylinder.

6.2.2 The thickness of the shell shall not be less than 2.0 mm for cylinders up to and including 13 litre water capacity and not less than 2.4 mm for cylinders above 13 litre water capacity.

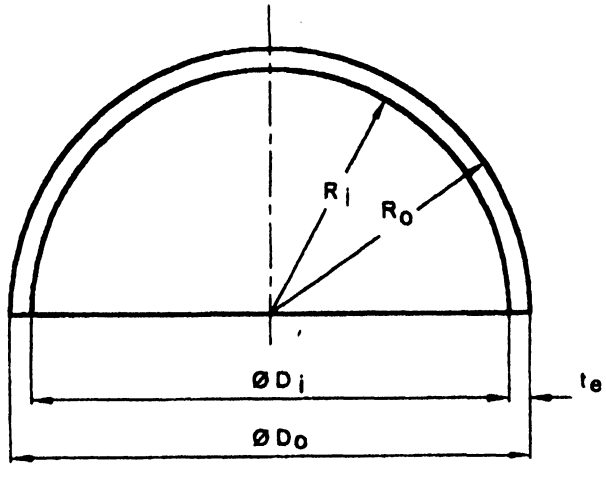
6.3 Before the design is finally approved, the statutory



1A Tori-Spherical



1B Semi-Ellipsoidal



1C Hemi-Spherical

FIG. 1 DOMED ENDS

authority may require one or more prototype cylinders to be subjected to various tests as specified in this standard or such other tests, as the authority deems fit.

6.4 Design of Openings

6.4.1 Opening in the cylinder shall be reinforced, either by a valve boss or pad, of weldable and compatible steel, securely attached by welding and so designed as to be adequate strength and to result in no harmful stress concentrations. This shall be confirmed by design calculations or a fatigue test in accordance with **17.2.**

6.4.2 *Closure of Openings*

Apertures in the finished cylinders shall be fitted with the appropriate valve in the closed position or fitting to protect the thread from damage and to prevent entry of moisture into the cylinder.

7 WELDING

7.1 The cylinder shall be welded by any suitable fusion welding method and shall conform, as for welding procedure and welder's performance qualifications, to the requirements of IS 2825, when cylinder welding is required to be radio-graphed, and to the requirements of IS 817 when the cylinder welding is not to be fully radio-graphed.

7.2 Prior to welding, components shall be examined in accordance with the requirements of **12.2.**

7.3 Manual arc welding shall not be employed for circumferential seam which shall consist of a butt joint in conjunction with permanent or temporary backing material, or alternatively, a joggle joint may be used so that the external surface of the container is smooth. The backing strip when used shall have a minimum overlap of 4 times the agreed finished thickness on each side. Permanent backing strips shall not be used with longitudinal welds. Joggle joint shall have overlap of minimum of three times the agreed finished thickness. A longitudinal seam shall consist of a butt joint with or without backing material. Manual arc welding shall not be employed for external longitudinal seam.

7.4 Surfaces of the plates at the seams shall not be out of alignment with each other at any point by more than 10 percent of the plate thickness.

7.5 Welds, except the ends of longitudinal welds, shall not be dressed without the approval of the inspecting authority. The weld surface shall have a smooth contour. The weld joint shall be free from undercuts but slight intermittent occurrences may be disregarded provided that such undercut is not in the form of a sharp notch (*see* IS 817).

7.6 All welding of the shell and attachments shall be completed before the final heat treatment.

7.7 Before welding, the plates to be joined shall be free from scale, grease, oil and dirt. Before the cylinders are closed, longitudinal welds, wherever used, shall be visually examined from both sides to ensure that the welds are satisfactory.

7.8 Welding consumables used shall be such that the desired properties of the weld are obtained and the physical values of the welded metal are not lower than the specified values of the parent metal.

7.8.1 The chemical composition of the weld metal shall be compatible with that of the parent metal.

7.8.2 All welded joints shall be double welded butt joints and sufficient care is taken to ensure complete fusion and penetration.

7.8.2.1 Butt weld shall have full penetration. The excess thickness shall be such that the weld integrity is not compromised.

7.8.2.2 Joggled butt welds shall have adequate penetration verified by macro etch bend testing and or tensile testing.

7.8.3 The fusion of the welded metal with the parent metal shall be smooth and free from overlapping, undercutting or abrupt irregularity. There shall be no cracks, notching or porous patches in the welded surfaces and the surface adjacent to the weld. The welded bead shall not be concave.

8 MANUFACTURE

8.1 The number of longitudinal seams in the welded cylinder shall not exceed one and the number of circumferential seams shall not exceed two.

8.2 When the welded cylinder contains a longitudinal seam, the edges of the plate forming the longitudinal joint of the shell shall be rolled or formed by pressure, not by blows, to the required curvature.

8.3 The end or dished part shall be of hemi-spherical, semi-ellipsoidal or tori-spherical shape. The end shall have a cylindrical skirt or parallel portion of minimum length 20 mm or three times the shell thickness, whichever is greater.

8.4 Agreed Finished Thickness

The agreed finished thickness shall not be less than the minimum calculated wall thickness obtained by the application of formulae given in **6.2.1** at any point and at any transverse section of the cylindrical portion. Additional thickness may also have to be provided to cover corrosion

allowance and stresses due to horizontal acceleration and retardation during transportation. The amount of the allowance shall be as agreed to between the manufacturer and the purchaser.

8.5 Examination of Cylinders Before Closing-in Operation

Cylinders shall be examined for wall thickness, before the closing-in operation, circularity of the cylindrical shell and the skirt portion of ends, external and internal surface defects, the profile regularity of the ends, offset at the joints, and straightness. The manufacturer shall assure himself that the wall thickness is not less than the agreed finished thickness at any point. The eccentricity of bung hole centre line with respect to centre line of half/body of cylinder shall not be more than one percent of the nominal diameter of cylinder subject to a maximum of 2 mm.

8.5.1 *Circularity*

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

8.5.2 *Surface Defects*

The internal and external surfaces of the cylinder shall be free from defects which will adversely affect the safe working of the cylinder.

8.5.3 *Profile Regularity*

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 1 percent in respect of axial dimensions. Such deviations shall not be abrupt changes and shall be outside the specified shape.

8.5.4 *Straightness*

Unless otherwise shown on the drawing, the maximum deviation of the shell from a straight line shall not exceed 0.3 percent of the cylindrical length (*see* Fig. 2).

8.5.5 *Verticality*

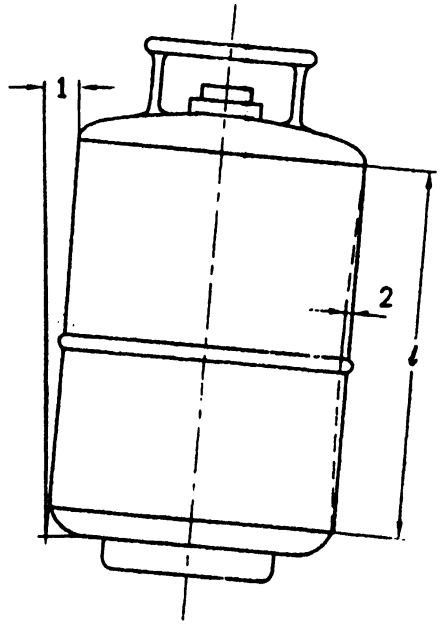
Deviation from vertical shall not exceed 10 mm/m length (*see* Fig. 2).

9 VALVE CONNECTION, VALVE PAD AND VALVE PROTECTION

9.1 Valve Connection

The valve connection shall consist of a welded pad/bung and shall be threaded to suit the type of valve specified in IS 8737.

9.1.1 Prior to fitting the valve, the bung threads shall be cleaned using a machine tap of the same thread profile as the bung threads. The cleaning shall ensure freedom from grit, zinc and other foreign matter, if any. Also it shall ensure, breaking of scale formed on the thread and re-correction of any distortion, experienced during heat treatment. The valve shall be fitted using approved jointing compound at the specific torque, after ensuring that internal cleaning of the cylinder has been done for removal of any water, grit, welding slag, flux, metal or any other foreign particles.



1 = 0.001*l*, *Max*.
2 = 0.003*l*, *Max*.

FIG. 2 ILLUSTRATION OF DEVIATION OF CYLINDRICAL PART OF SHELL FROM A STRAIGHT LINE AND FROM VERTICAL

9.1.2 Any other valve connection may be provided as agreed to between the manufacturer and the purchaser and approved by the statutory authority.

9.2 Valve Pad

Two runs of welding shall be employed for bungs which have a backing pad (either on the outside or one on the outside and one on the inside). In the case of bungs without backing pad, one run of welding shall be given on the inside and one on the outside. If the positive projection of a bung inside the cylinder is 4 mm or more, the same may be welded only on the outside with two runs of weld.

9.3 Valve Protection

9.3.1 Cylinder shall have their valve protected against damage by the provision of a stout metal cap or shroud or metal cover or protective metal ring or grill of an approved design. Where the design of the cylinder provides for the valve lying wholly below the level of the body of the cylinder such a protection is not necessary. The metal cap or metal cover when used, shall be vented and screwed on to the neck of the cylinder.

9.3.2 The protective metal ring or grill shall be welded to the upper end of the cylinder concentric with the neck. The eccentricity of the welded metal ring or grill with respect to the valve pad/bung shall not be more than 1 percent of the nominal diameter of cylinder subject to a maximum of 3 mm.

9.3.3 The metal cap or metal cover shall be screwed on to the neck of the cylinder.

9.3.4 In case the protective ring is made out of tube/pipe the dimensions of tube/pipe may be as agreed between the purchaser and the manufacturer.

9.3.5 The protective device shall be of adequate construction to prevent such damage to the valve as would cause the escape of the product. When a water filled container with quantity being half the nominal water capacity is dropped from a height of 1.2 m, so that the protective device struck a hard flat surface, there shall be no damage to the valve.

NOTE — The drop test should only be carried out on de-pressurized cylinders, as it may cause release of dangerously high levels of energy resulting in injury or death to personnel.

10 FITTINGS OTHER THAN VALVES

10.1 Handle

Handle or other suitable arrangement for lifting the cylinder shall be provided. It shall be capable of withstanding static loading in any direction equal to twice the weight of the cylinder when filled with water.

10.2 Foot Ring

The foot ring, where fitted as a separate fixture to the bottom end of the cylinder, shall be at least 20 mm away from the circumferential weld. The thickness of the sheet from which the foot ring is made shall not be less than the calculated wall thickness of the cylinder body. The foot ring may be intermittently welded. In case, the bottom edge is curled, the curling shall be inwards to facilitate safe handling. It shall be provided with holes for ventilation, and if curled, drainage holes to be provided to avoid corrosion. The maximum permissible deviation from the vertical shall not exceed 1°. Foot rings shall be sufficiently strong and made of steel *(see* **4.4**). The bottom of the foot ring shall not be less than 8 mm below the outside bottom of the cylinder shell for cylinders up to 34 litre nominal water capacity. For cylinders of more than 34 litre nominal water capacity and up to 50 litre nominal water capacity, this value shall be minimum 15 mm and for cylinders exceeding 50 litre nominal water capacity, this value shall be minimum 25 mm.

NOTE — Attachment such as VP shroud or foot ring, when directly welded to pressure retaining parts shall be designed to prevent crevice corrosion. They may have intermittent contact, such as scalloping or attachment by ears. However they ought to be continuously welded at all points of contact with the pressure retaining body of the cylinder.

10.3 Bung

The requirements of bungs shall be in accordance with Annex B and its material shall be as specified in **4.2**.

11 HEAT TREATMENT

All cylinders shall be efficiently and uniformly normalized or stress relieved in accordance with the recommendations of steel manufacturers and approved by the inspecting authority after manufacture and completion of all welding (including that of attachments) and before hydrostatic test is applied. A complete record of the heat treatment cycle shall be maintained *(see* **3.1** and **3.2**).

11.1 Localized heat treatment not permitted.

12 INSPECTION

12.1 General

12.1.1 The purchaser and the inspecting authority shall have free access, at all reasonable time to that part of the manufacturer's works engaged in the execution of the order. They shall also be at liberty to inspect the fabrication at any stage and to reject any cylinder, or part of a cylinder that does not comply with the requirements of this standard.

12.1.2 The manufacturer shall supply the man power and equipment for such inspection and tests as are required and for any additional checks which may be agreed to between the inspecting authority and the manufacturer.

12.1.3 The visual inspection of cylinders should be carried out and the limits of defects shall be as given in IS 9639.

12.2 Inspection of Components

12.2.1 All pressings, halves and cylindrical shells shall be examined for surface defects before any seam is welded. If there are defects which in the opinion of the inspecting authority would be detrimental to the sound construction of the container, the pressing or shell shall be rejected.

12.2.2 At the discretion of the inspecting authority, 2 percent or more of the pressings halves and the cylindrical shells shall be selected at random to represent all defects of material used for the manufacture of the cylinders and these defects shall be examined for minimum thickness before any seam is welded.

12.2.3 Should any pressing, half or shell be less than the minimum specified thickness, the whole output from the relevant batch of material shall be examined for minimum thickness, and any pressing or shell which is less than the specified minimum thickness shall be de-shaped in such a way that it can not be used at later stage.

12.2.4 For the purpose of this clause batch of material is defined to mean pressings or cylindrical shells manufactured in a continuous production run.

13 RADIOGRAPHIC EXAMINATION

13.1 Radiographic examination, when required shall conform to the techniques and acceptability criteria set forth in the relevant Indian Standards. For general guidance, reference may be made to IS 1182, IS 2595, IS 3657 and 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.

13.2 Spot Radiography *(see* definition of *J* under 6.2.1).

13.2.1 One out of every 50 consecutive cylinders from continuous production shall be taken at random for spot radiography.

13.2.2 In addition, after a change in the type or size of cylinder or the welding procedure (including machine settings) or after a break in the production exceeding 4 h, the first cylinder welded shall be taken for spot radiography.

13.3 Refer **10** of IS 3196 (Part 3) for testing details of radiography.

14 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 $\frac{1}{2}$ percent for cylinders up to and including 13 litre water capacity and $\frac{1}{2}$ percent or 0.65 litre whichever is more for cylinders above 13 litre water capacity.

15 HYDROSTATIC TEST

15.1 Each heat treated cylinder shall be subjected to hydrostatic test. During the hydrostatic test, the pressure shall be increased gradually till the required test pressure is reached. After the test pressure is reached and the external surfaces of the cylinder are dried, it shall be retained for a period of not less than 30 s. 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.

15.1.1 The values of hydrostatic test pressure for LPG shall be taken as 25 kgf/cm^2.

15.1.2 Hydrostatic test shall be carried out according to **7** of IS 3196 (Part 3).

16 PNEUMATIC LEAKAGE TEST

16.1 Each cylinder, after it has been dried, and fitted with valve 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 1 180 kPa (12 kgf/cm^2) for a period of 1 min while immersed in water and shall show no leakage from the body of the cylinder and valve pad joint. This test shall be carried out by using dry air after fixing the safety cap on the valve.

NOTE — Suitable air drying methods may be adopted as long as they ensure no condensate is present in the cylinders.

16.1.1 Alternatively any other method approved by the statutory authority may be used.

16.1.2 Pneumatic leakage test shall be carried out according to **8** of IS 3196 (Part 3).

17 HYDROSTATIC STRETCH TEST AND BURSTING TEST

17.1 Hydrostatic Stretch Test

One cylinder taken at random for each lot of 403 or less shall be subjected to a hydrostatic stretch test. Pressure greater than 80 percent of the test pressure shall not be applied to any cylinder before the test and shall be applied gradually.

17.1.1 Hydrostatic stretch test shall be carried out according to **6** of IS 3196 (Part 3).

17.1.2 Permanent stretch suffered by cylinder due to application of the test pressure shall not exceed the following limits:

a) In the case of cylinders below 20 litre water capacity 10 percent of the total stretch suffered during test; and

b) In other cases, 10 percent of the total stretch suffered during the test or 1/5 000 of the original volume of the cylinder, whichever is less.

17.2 Fatigue Testing/Cycle Testing

17.2.1 For the purpose of this test, three cylinders which are guaranteed by the manufacturer to be representatives of the minimum end(s) thickness set by design and which shall include all markings shall be filled with non-corrosive liquid and subjected to successive reversals of hydraulic pressure. This test shall be considered as type test.

17.2.2 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 cylinder shall be subjected to 80 000 cycles without failure; or

b) Equal to the test pressure, in which case the cylinder shall be subjected to 10 000 cycles without failure.

The values of lower cyclical pressure shall not exceed 10 percent of the upper cyclic pressure. The frequency of reversals of pressure shall not exceed 0.25 Hz (15 cycles/min). The temperature measured on the outside surface of the cylinder shall not exceed 50°C during the test.

17.2.3 After the test the cylinders shall be burst tested and meet the requirements of **17.3.**

17.3 Burst Test under Hydraulic Pressure

The cylinder which has passed the hydrostatic stretch test under **17.1** or alternatively one cylinder selected at random from those which have passed the hydrostatic test shall then be subjected to a hydrostatic pressure till it bursts.

17.3.1 Bursting test shall be carried out according to **9** of IS 3196 (Part 3). The rate of pumping shall not exceed five times the water capacity of the cylinder per hour.

17.3.2 The criteria adopted for the interpretation of the burst test are as follows:

a) Volume of the water used between the time when the pressure starts to rise and at the time of bursting, or

b) Difference between the volume of the cylinder at the beginning and the end of the test (*see* **17.3.3).**

17.3.3 Minimum Test Requirement

The nominal hoop stress value of (f_b) shall be not less than 0.95 of the minimum specified tensile strength of the material of the cylinder and shall conform to the following requirements:

a) Cylinder shall burst without fragmentation. During burst test in case leakage starts from any welding before fracture or before achieving required hoop stress, the specimen shall be discarded and fresh test specimen shall be taken;

b) Fracture shall not occur in the weld in the direction of the circumferential or longitudinal seam. The fracture shall also not occur in the directional parallel to circumferential weld within 10 mm from the edge of the circumferential weld;

c) Main fracture shall not show any brittleness, that is the edges of the facture shall not be radial but shall be at an angle to a diametrical plane and display a reduction of area through out their thickness;

d) Fracture shall not reveal a visible defect in the metal; and

e) For tensile strength less than or equal to 410 N/mm^2 (41 kg/mm^2), the ratio of the volumetric expansion of the cylinder to its initial volume shall be greater than or equal to the following values:

1) 20 percent, if the length of the cylinder is greater than its diameter; and

2) 14 percent, if the length of the cylinder is equal to or less than its diameter.

18 ACCEPTANCE TESTS

18.1 For every batch of 202 or less heat-treated and finished cylinders, one test cylinder shall be selected at random and the various acceptance tests shall be carried out on test specimens taken from this cylinder.

18.1.1 Number of test specimen and method of testing shall be in accordance with **5** of IS 3196 (Part 3).

18.1.2 The percentage elongation and yield strength, wherever applicable and tensile strength thus determined shall not be less than the respective requirements for the material specified in **4.**

18.1.3 The bend test specimen having cracks or any other open defects, which exceed 3 mm, measured in any direction on the convex surface of the specimen, shall be treated as a failure.

18.1.4 The weld shall show a good penetration and absence of lack of fusion.

18.1.5 The thickness shall not be less than the calculated thickness.

19 MARKING

19.1 General Instructions

a) Each cylinder shall be clearly and permanently marked by stamping or similar processes on such a part, which is inseparably bound with the cylinder which is not or only negligibly affected by stresses due to the gas pressure within it.

b) Name plate shall not be affixed to the cylinder's shoulder, if there is a risk of corrosion or embrittlement.

c) In conjunction with the original markings, space shall be provided for stamping the date of the test.

d) Marking shall be so carried out and the letters and numerals used shall be of such shape and size that the marking is legible.

e) Stamps used for marking shall have small radii at changes of section to avoid formation of sharp edges in the stamped marking.

19.2 Each cylinder shall be permanently stamped with the following:

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 (kgf/cm^2);

d) Test pressure, in MPa (kgf/cm^2) and date of hydrostatic test or hydrostatic stretch test as the case may be (such as 3/05 for March 2005);

e) Tare weight in kg, gross weight in kg and water capacity in litres;

f) Inspecting agency's official mark; and

g) Letter 'N' or 'SR' next to IS number, if the cylinder is normalized or stress relieved.

NOTE — The tare weight shall include the weight of the valve fitted to the cylinders.

19.2.1 *BIS Certification Marking*

Details available with the Bureau of Indian Standards.

19.2.1.1 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 licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

19.3 The marking may be made at any of the following places:

a) Foot ring;

b) Any non-pressure part;

c) Dished end, provided it can be demonstrated in the bursting test that fracture does not initiate in the markings; and

d) A plate of material compatible to the body of the cylinder may be welded soundly at an appropriate place on the cylinder.

20 COLOUR IDENTIFICATION

The cylinder shall be painted externally in accordance with the colour scheme specified in IS 4379.

21 RECORD

A record shall be kept of all test made at the cylinder manufacturer's works and copies shall be made available to the inspecting authority and the purchaser of the cylinder (if desired). A test certificate duly approved and signed by the inspecting authority shall be forwarded to the statutory authority and the purchaser.

22 PREPARATION FOR DESPATCH

22.1 All cylinders shall be thoroughly cleaned and dried internally before being fitted with valves.

22.2 The outside surface shall be grit blasted with minimum SA 2.5 grade of blast *(see* IS 9954) and shall be given following protective coatings:

a) Spraying zinc as per IS 12447 to give a coating of minimum thickness of 37 microns unless otherwise agreed to between the purchaser and the manufacturer;

b) One coat of zinc chromate primer as agreed to between the purchaser and the manufacturer;

c) One coat of super synthetic enamel paint conforming to IS 2932 of signal red colour (Shade No. 537 of IS 5). Both the layers of the primer and paint shall have a total thickness of minimum 30 microns unless otherwise agreed to between the purchaser and the manufacturer.

d) As an alternate to (b) and (c) cylinders shall be powder coated (as per IS 13871) or stoving primer coated (as per IS 2074) and enamel coated (as per IS 2932) as per the agreement between the manufacturer and the buyer.

e) The total minimum combined thickness shall be 67 microns.

NOTE — Procedure for measurement of coating of thickness:

1 Five gauge readings for each spot shall be taken moving the probe a short distance for each new gauge reading within an approximate area of 2 cm × 2 cm. Discard any unusually high or low gauge reading that cannot be repeated consistently. Take the average of the five gauge readings as a spot measurement.

2 Make five such spot measurements approximately evenly spaced over the surface of the cylinder.

3 Each spot measurement shall not be below 80 percent of the specified minimum thickness and average of the five spot measurements shall not be below the specified thickness.

ANNEX A
(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
5 : 1994	Colours for ready mixed paints and enamels *(fourth revision)*
817 : 1966	Code of practice for training and testing of metal arc welders *(revised)*
1079 : 1994	Hot rolled carbon steel sheets and strips *(fifth revision)*
1182 : 1983	Recommended practice for radiographic examination of fusion welded butt joints in steel plates *(second revision)*
1875 : 1992	Carbon steel billets, blooms, slabs and bars for forgings *(fifth revision)*
1956 (Part 1) : 1976	Glossary of terms relating to iron and steel: Part 1 General metallurgy, heat treatment and testing *(first revision)*
2062 : 1999	Steel for general structural purposes *(fifth revision)*
2074 : 1992	Ready mixed paint, air drying, red oxide zinc crome, priming — Specification *(second revision)*
2595 : 1978	Code of practice for radiographic testing *(first revision)*
2825 : 1969	Code for unfired pressure vessels
2932 : 2003	Enamel, synthetic, exterior (a) undercoating, (b) finishing — Specification *(third revision)*
3196 (Part 3) : 1991	Welded low carbon steel cylinders exceeding 5 litre water capacity for low pressure liquefiable gases: Part 3 Methods of test *(fourth revision)*.
3657 : 1978	Radiographic image quality indicators *(first revision)*
4379 : 1981	Identification of contents of industrial gas cylinders *(first revision)*
4853 : 1982	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes *(first revision)*
6240 : 1999	Hot rolled steel plate (up to 6 mm) sheet and strip for the manufacture of low pressure liquefiable gas cylinder *(third revision)*
7142 : 1995	Welded low carbon steel gas cylinders for low pressure liquefiable gases not exceeding 5 litre capacity—Specification *(first revision)*
7202 : 1974	Inspection gauges for checking threads of gas cylinders valves for use with breathing apparatus
7241 : 1981	Glossary of terms used in gas cylinder technology *(first revision)*
8737 : 1995	Valve fittings for use with liquefied petroleum gas (LPG) cylinders of more than 5 litre water capacity *(first revision)*
9121 : 2005	Inspection gauges for checking type 1 (size 2) taper threads of gas cylinder valves, taper 1 in 16 — Specification *(first revision)*
9122 : 1979	Specification for inspection gauges for checking type 2 taper threads of gas cylinder valves, taper 3 in 25
9639 : 1980	Code of practice for visual inspection of newly manufactured low pressure welded steel gas cylinders during manufacturer
9687 : 1980	Specification for inspection gauges for checking type 1 (size 1) taper threads of gas cylinders valves, taper 1 in 16
9954 : 1981	Pictorial surface preparation standards for painting of steel surfaces
12447 : 1988	Zinc wire for sprayed zinc coatings
13871 : 1993	Powder coatings — Specification

ANNEX B
(Clause 10.3)

REQUIREMENTS OF BUNGS

B-1 FINISH

The bung 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 finish and shall not be broken at any point.

B-2 The cylinder manufacturer shall check on each finished machined bung the dimensions that match with the corresponding dimensions on the cylinder, such as neck diameter that fits into bung hole, chamfer angle at the skirt, etc. Bung threads shall be inspected for conformity with the required sizes using all the gauges as laid down in anyone of the following standards depending upon the nominal size and specification of the thread:

a) IS 7202

b) IS 9121

c) IS 9122

d) IS 9687

B-3 After welding and before fitting the valve, the bung thread shall be cleaned with appropriate tap and checked for conformity to threads using only taper thread plug gauges as laid down in anyone of the following standards depending upon the nominal size and specification of the thread:

a) IS 7202

b) IS 9121

c) IS 9122

d) IS 9687

B-4 However, the inspecting authority for the purpose of carrying out the inspection shall test 3 percent of the lot of machined bungs. 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 rejected.

B-5 One bung out of the sample size shall be sectioned and checked for conformity to thread form and finish.

ANNEX C
(Foreword)

COMMITTEE COMPOSITION

Composition of Gas Cylinders Sectional Committee, ME 16

Organization	*Representative(s)*
Petroleum and Explosives Safety Organization (PESO), Nagpur	SHRI M. ANBUNATHAN *(Chairman)* SHRI C. R. SURENDRANATHAN *(Alternate)*
All India Industrial Gases Manufacturers Association, New Delhi	CONSULTANT SHRI R. P. KHATOR (*Alternate* I) SHRI S. DEB *(Alternate* II)
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Indian Gas Cylinders, Faridabad	SHRI D. C. JAIN
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LPG Equipment Research Centre, Bangalore	SHRI G. P. GUPTA SHRI S. M. VENUGOPAL *(Alternate)*
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Met Lab Services Pvt Ltd, Mumbai	SHRI S. C. PARIKH SHRI SUDHIR KAUL *(Alternate)*

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National Safety Council, Mumbai	SHRI H. N. GUPTA
Research & Development Estt (Engineers), Pune	SHRI P. K. CHATTOPADHYAY SHRI A. BASU *(Alternate)*
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Tekno Valves, Kolkata	SHRI Y. K. BEHANI SHRI R. BEHANI *(Alternate)*
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Composition of Low Pressure Gas Cylinders Subcommittee, ME 16:2

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Verny Containers Ltd, Hyderabad	SHRI R. V. K. RANGA RAO SHRI P. K. MATHUR *(Alternate)*

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This Indian Standard has been developed from Doc: No. ME 16 (0780).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Simco Printing Press, Delhi