# इंटरनेट मानक

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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.

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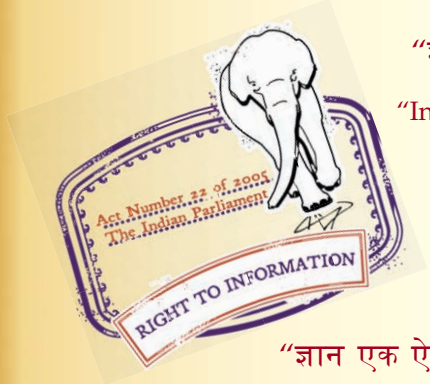
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

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

IS 3196-2 (2006): Welded Low Carbon Steel Cylinders Exceeding 5 Litre Water Capacity for Low Pressure Liquefiable Gases, Part 2: Cylinders for Liquefiable Non-Toxic Gases Other Than LPG [MED 16: Gas Cylinders]




"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"

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*भारतीय मानक*

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

## भाग 2 एल.पी.जी. के अलावा द्रवणीय अविषालु गैसों 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 2 CYLINDERS FOR LIQUEFIABLE NON-TOXIC GASES OTHER THAN LPG — SPECIFICATION

*( Fifth Revision )*

ICS 11.040.10



BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

*March* 2006

Price Group 7

FOREWORD

This Indian Standard (Part 2) (Fifth Revision) 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 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 litre 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 1 Cylinders for low pressure liquefiable petroleum gases (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.

*Indian Standard*

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

## PART 2 CYLINDERS FOR LIQUEFIABLE NON-TOXIC GASES OTHER THAN LPG — SPECIFICATION

*( Fifth Revision )*

### 1 SCOPE

**1.1** This standard (Part 2) deals with welded low carbon steel cylinders intended for storage and transportation of low pressure liquefiable gases other than LPG 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 a separate standard 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 those 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 cooled 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 change 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 ($P_b$)** — The 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 fully 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/vertical stay plate shall conform to Grade 'O' 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. 1A):

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

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

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

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**);

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

$P_h$ = test pressure, in kgf/cm², as specified in IS 8867;

$D_i$ = 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/mm². 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;

$h_i$ = internal height of domed ends, in mm;

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

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

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

$S_f$ = length of straight flange, in mm;

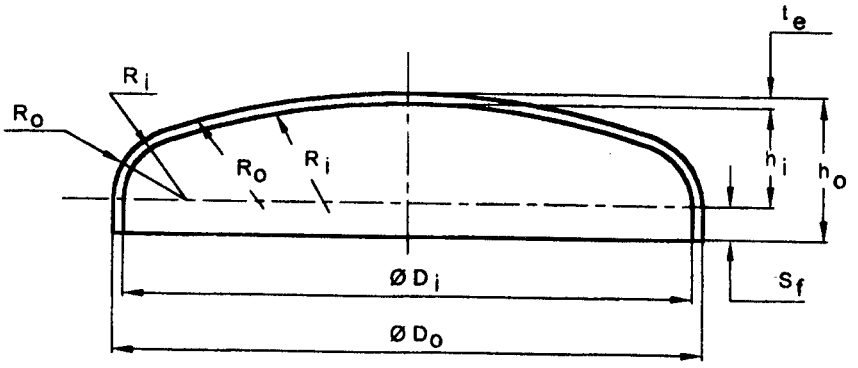
$$Z = \frac{\frac{20\, r_i}{R_i} + 3}{\frac{20\, r_i}{R_i} + 1}$$

NOTE — $S_f \geq 0.3\ \sqrt{D_o t_e}$

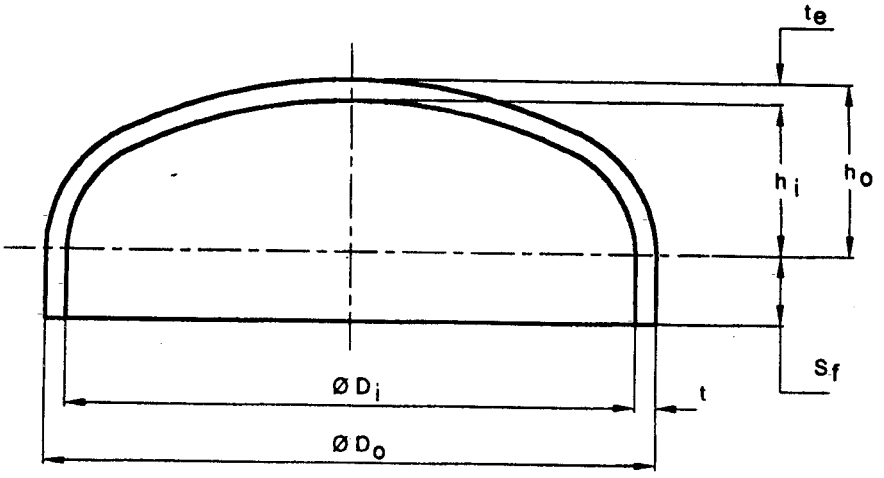
**6.2.1.1** For hemi-spherical ends or parts, the minimum finished thickness need not exceed that of the cylindrical portion of the cylinder (*see* Fig. 1C).

**6.2.1.2** 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.

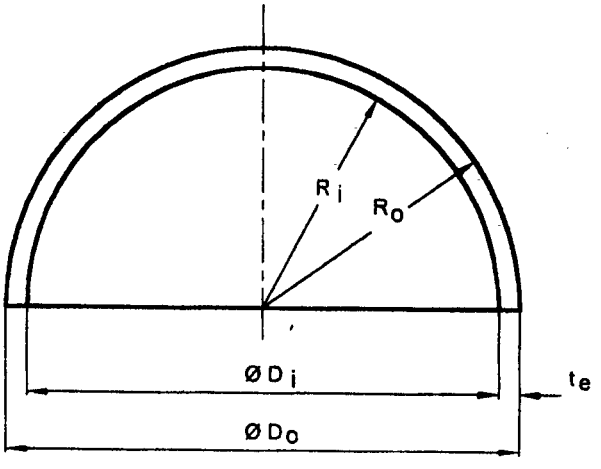
**6.3** Before the design is finally approved, the statutory




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** The location of openings shall be restricted to the ends of the cylinders.

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

**6.4.3** *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 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. Backing strip when used shall have a minimum overlap of 4 times the agreed finished thickness on each side. Permanent backing strip shall not be used with longitudinal welds. Joggle joint shall have overlap of minimum three times the agreed finished thickness. Manual arc welding shall not be employed for external longitudinal seam. Circumferential joggle butt joint shall have smooth and symmetrical off-set without notches. In both the above type of joints the weld shall have a tight fit at root region and shall exhibit full penetration till the root. 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 material.

**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 adjacent to the weld. The welded bead shall be regular and even. The weld 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 hemi-spherical, semi-ellipsoidal or tori-spherical in 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.

Also if the formed or deep-drawn end is tori-spherical, the minimum thickness shall essentially be ensured even in the formed end, since deep-draw of a tori-spherical shape causes thinning even in the formed ends.

**8.4.1** The uneven wall thickness rate of drawn halves, ends or shells in the same circumferential plane shall not be more than 10 percent all around.

$$e = \frac{t_{Max} - t_{Min}}{\frac{1}{2}(t_{Max} + t_{Min})} \times 100$$

where

$e$ = uneven wall thickness rate;

$t_{Max}$ = maximum wall thickness, in mm; and

$t_{Min}$ = minimum wall thickness, in mm.

### 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 1 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 1 percent of the mean of these diameters.

**8.5.2** *Surface Defects*

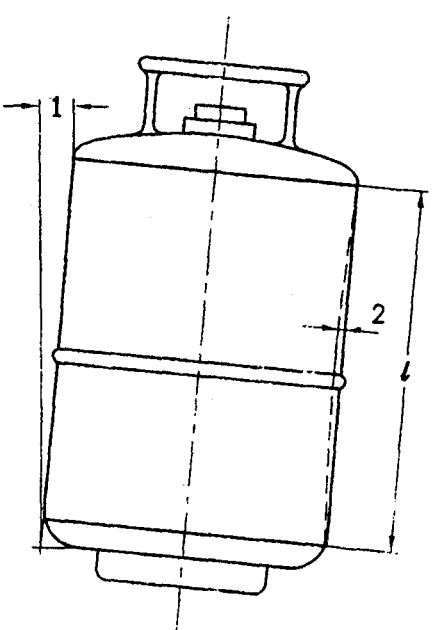
The internal and external surfaces of the cylinder shall be free from defects, which will adversely affect the safe working of the cylinder.

**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).




1 = 0.001 $t$ *Max.*

2 = 0.003 $t$ *Max.*

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

8.5.5 *Verticality*

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

## 9 VALVE CONNECTION, VALVE PAD AND VALVE PROTECTION

### 9.1 Valve Connection

Valves shall conform to requirements of IS 3224 or any alternative design as approved by statutory authority. They shall be suitable for the contents of the cylinder. 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 specified 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.

### 9.2 Valve Pad

The valve connection shall consist of a welded or brazed boss or nipple or pad or bung and shall be threaded to suit the type of valve specified in IS 3224 or any other design as approved by statutory authority. If welding is adopted, then 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** Every cylinder shall be provided with means of protection of valve against mechanical damage. The protective device shall be of adequate construction to prevent such damage to the valve as would cause the escape of the contents of the cylinder or even development of a leak.

**9.3.1.1** Where the design of the cylinder does not provide for the valve lying wholly below the level of the body of the cylinder, a stout metal cap, metal cover, shroud, protective metal ring or grill of a design approved by the statutory authority shall be provided, the design being such that the cap, cover, ring or grill is nowhere in close proximity to any part of the valve or valve body.

a) In case a metal cap or metal cover is provided to protect the valve fitted to the cylinder, it shall be provided with a vent of such size so as to prevent development of any gas pressure inside the cap or cover and shall be screwed on to the neck of the cylinder.

b) However, in case a protective metal ring or grill provided, it 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. Where the protective ring is made out of tube/pipe the dimensions of tube/pipe may be as agreed between the purchaser and the manufacturer.

**9.3.1.2** Where the design of the cylinder provides for the valve, wholly below the level of the body of the cylinder, such a protection is not necessary.

**9.3.2** The thickness of this protective device shall not be less than the calculated wall thickness of the cylinder.

**9.3.3** 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 equivalent to weight of gas to be filled in the cylinder is dropped from a height of 1.2 m, so that the protective device strikes a hard flat surface, there shall be no damage to the valve leading to valve leakage, cylinder valve combination leakage, or the valve becoming non-operable.

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.

**9.3.4** In the case of a group of cylinders securely attached to a cradle, the valves, shall be protected as required by **9.3.1** or alternatively; the valves shall be protected either by the design of the cradle or by a stout guard. If the containers are connected to a common manifold, the manifold as well as the valves, shall be protected by a stout guard. The guard may be hinged or removable and, if so, it shall be provided with a lock to enable it to be kept in the locked position during conveyance.

## 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 ring shall be sufficiently strong and made of steel as specified in **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 the bung shall be in accordance with Annex B and its materials 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 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 shall not be permitted.

NOTES

1 Cylinders made of steel with carbon content less than 0.15 percent are conventionally normalized, except those containing grain refining additives to inhibit critical strain grain growth. Also cylinders produced from steel containing micro-alloying elements when heated above 650° C, experience loss of strength and possibility of critical strain grain growth. Such cylinders are therefore stress relieved provided the steel maker recommends this process of heat treatment.

2 Stress relieving requires cooling in still atmosphere, which should be ensured. Consequently the manufacturer should be able to demonstrate a system to prevent airflow over the stress relieved cylinders, after they exit from the furnace.

## 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 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 requirement of this standard.

**12.1.2** The manufacturer shall supply the manpower and equipment for such inspection and tests as are required and for any additional checks which may be agreed to between the inspection 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 inspection authority would be detrimental to the sound construction of the container, the pressing or half 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 of 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 pressing 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 containers 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 the

cylinder or the welding procedure (including machine settings) or after a break in the production exceeding four hours, 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 $^{+5}_{0}$ percent for cylinders up to and including 13 litre water capacity and $^{+3}_{0}$ 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 different gases shall be in accordance with IS 8867.

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

## 16 PNEUMATIC LEAKAGE TEST

**16.1** Subsequent to the hydrostatic test, 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 dry 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. This test shall be carried out by using dry air before fixing the safety cap on the valve.

NOTES

1 The air used for testing shall be dry to prevent condensate development inside the cylinder. Suitable air drying methods may be adopted as long as they ensure no condensate is left in the cylinders.

2 Suitable precautions shall be taken since the high pneumatic pressure of 1 180 kPa can pose hazard and hence requires specific approval of equipment and procedure from the inspection authority.

**16.1.1** Alternatively any other leak test 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).

NOTE — During testing suitable arrangement shall be available for rotation of the cylinder, inside the water, so that fine leaks that tend to be missed due to head of the water column above the leak can be detected by bringing each point of the cylinder to the top while under water. The head of water shall not be more than 2 cm above the top of the cylinder.

## 17 HYDROSTATIC STRETCH TEST AND BURSTING TEST

### 17.1 Hydrostatic Stretch Test

One cylinder taken at random for each batch 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 within the weld in the direction of the circumferential or longitudinal seam. The fracture shall also not occur in the direction parallel to the circumferential weld within 10 mm from the edge of the circumferential weld;

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

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

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

1) Minimum value of tensile strength $\leq 410$ N/mm$^2$ (41 kgf/mm$^2$)

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

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

2) Minimum value of tensile strength $\geq 410$ N/mm$^2$ (41 kgf/mm$^2$)

i) 15 percent if the length of the cylinder is greater than its diameter; and

ii) 10 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 the 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/cm²);

d) Test pressure, in MPa (kgf/cm²) 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) 'SR' for stress relieved cylinders and 'N' for normalized cylinders, next to IS number.

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

**19.2.1** *BIS Certification Marking*

Cylinder may also be marked with the Standard Mark.

**19.2.1.1** The use of the Standard Mark is governed by the provision of *the Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of the conditions under which a licence for the use of Standard Mark may be granted to the 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 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 purchaser of the cylinder (if desired). A test certificate duly approved and signed by the inspection 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 to grade Sa 3 to Sa 2 ½ of IS 9954 using impeller wheel centrifugal force to remove mill scale, process (heat treatment) scale, rust, corrosion products and any other foreign particles.

**22.3** The metallic abrasive used for blasting shall be grit not shot and shall be so selected as to achieve the required surface roughness to facilitate adequate mechanical keying of the subsequent coating.

**22.4** After grit blasting the cylinders shall be given a suitable protective metal coating before painting and despatch as agreed to between the buyer and the manufacturer.

NOTE — The protective metallic coating shall be applied immediately, if possible but not exceeding one hour after blasting, with extra care being taken to ensure adequate coating on the inside of the foot ring and the portion of the lower halve closest to the edge of the foot ring.

### 22.5 Air Removal

On satisfactory completion of pneumatic test and before despatch, complete positive air pressure shall be released from the cylinder using approved means. Use of manual prodder or depressor on the valve pin that cannot control extent of depression is prohibited.

### 22.6 Transportation

Finished cylinders shall be adequately protected against in-transit damage both to the cylinder as well as the valve.

# ANNEX A
(*Clause* 2)

## LIST OF REFERRED INDIAN STANDARDS

| *IS No.* | *Title* |
|---|---|
| 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*) |
| 2595 : 1978 | Code of practice for radiographic testing (*first revision*) |
| 2825 : 1969 | Code for unfired pressure vessels |
| 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*) |
| 3224 : 2004 | Valve fittings for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders (*third 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 water 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*) |
| 8867 : 1978 | Saturated vapour pressure and test pressure for low pressure liquefiable gases contained in gas cylinders |
| 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 or 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 |
| 9687 : 1980 | 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 |

# ANNEX B
(*Clause* 10.3)

## REQUIREMENTS OF BUNGS

**B-1 FINISH**

The bung shall be 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 any one 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 any one of the standards specified in **B-2**, depending upon the nominal size and specification of the thread.

**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 size shall be drawn and inspected. In case of failure of any one 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***)<br>SHRI C. R. SURENDRANATHAN (*Alternate*) |
| All India Industrial Gases Manufacturers Association, New Delhi | CONSULTANT<br>SHRI R. P. KHATOR (*Alternate* I)<br>SHRI S. DEB (*Alternate* II) |
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| Indian Oil Corporation Ltd, Mumbai | SHRI S. S. SAMANT<br>SHRI RAJESH HAZARNIS (*Alternate*) |
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| J. R. Fabricators Ltd, Mumbai | SHRI S. SESHKUMAR |
| Jagadamba Engineering Pvt Ltd, Secunderabad | SHRI V. K. JANAKIRAM<br>SHRI M. VENUGOPAL (*Alternate*) |

| *Organization* | *Representative(s)* |
|---|---|
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| LPG Equipment Research Centre, Bangalore | SHRI G. P. GUPTA<br>SHRI S. M. VENUGOPAL (*Alternate*) |
| Maruti Koatsu Cylinders Ltd, Mumbai | SHRI NITIN J. THAKKAR<br>SHRI A. S. SARAN (*Alternate*) |
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| Ministry of Defence (DGQA), Pune | LT-COL MOHAN RAM<br>SHRI S. K. DAS (*Alternate*) |
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| National Safety Council, Mumbai | SHRI H. N. GUPTA |
| Research & Development Estt (Engineers), Pune | SHRI P. K. CHATTOPADHYAY<br>SHRI A. BASU (*Alternate*) |
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| Steel Authority of India Ltd, Salem/Delhi | SHRI T. KALYANASUNDARAM<br>SHRI N. K. VIJAYAVARGIA (*Alternate*) |
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| In personal capacity (*Menon & Patel, 14/3, Mathura Road, Faridabad*) | SHRI EBRAHIM M. PATEL |
| In personal capacity (*303, Shantikunj, Pandav Bunglows Lane Athwalines, Surat*) | SHRI L. D. THAKKAR |
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*Member Secretary*
SHRI S. B. ROY
Director (MED), BIS

## Composition of Low Pressure Gas Cylinders Subcommittee, ME 16 : 2

| | |
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| In personal capacity (*Menon & Patel, 14/3, Mathura Road, Faridabad*) | SHRI EBRAHIM M. PATEL (***Convener***) |
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