इंटरनेट मानक

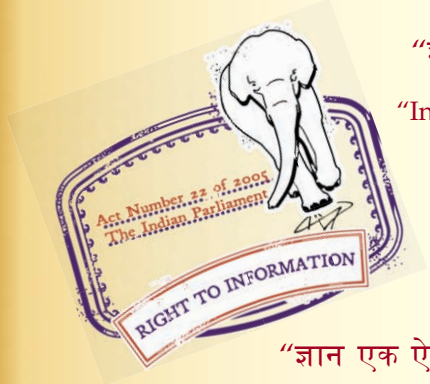
Disclosure to Promote the Right To Information

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 3196-4 (2001): Welded Low Carbon Steel Cylinders Exceeding 5 Litre Water Capacity for Low Pressure Liquefiable Gases, Part 4: Cylinders for Toxic and Corrosive Gases (Amalgamation of IS 7680,7681 and 7682) [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 4) : 2001
(Superseding IS 7680, IS 7681 and IS 7682)
(Reaffirmed 2012)

भारतीय मानक

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

भाग 4 आविषालु और संक्षारक गैसों के लिये सिलिंडर

Indian Standard

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

PART 4 CYLINDERS FOR TOXIC AND CORROSIVE GASES

ICS 23.020.30; 71.100.20

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

November 2001

Price Group 7

FOREWORD

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

Cylinders for Ammonia (anhydrous), Chlorine and Methyl Bromide gases were earlier covered in IS 7680, IS 7681 and IS 7682 respectively, which were published in 1975 and later on revised in 1985. Since various tests given in these standards were identical in nature, therefore in order to make them more user friendly; these standards have been amalgamated into a single standard. Accordingly this standard shall supersede IS 7680, IS 7681 and IS 7682.

Ammonia (anhydrous), Chlorine and Methyl bromide gases contained in cylinders constitute a grave danger if not handled properly due to the toxicity and/or corrosiveness of the contents involved. This standard has been prepared for the guidance to the manufacturers and users of these gas cylinders. Technical data for ammonia, chlorine, methyl bromide gases and the cylinders are given in Annex C, D and E respectively to this standard for reference.

Manufacture, possession and use of any gas, when contained in cylinders of more than 500 ml water capacity in a compressed or liquefied state, are regulated under the Gas Cylinder Rules, 1981, of the Government of India. This specification has been prepared in consultation and agreement with the statutory authority under those rules.

The composition of the Committee responsible for formulation of this standard is given in Annex F.

For the purpose of deciding whether a particular requirement of this standard is compiled 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.

The relevant SI units and the corresponding conversion factors are given below for guidance.

Pressure 1 Pa (Pascal) = $1 N/m^2$

1 kgf/mm^2 = 9.806 65 N/mm^2

AMENDMENT NO. 2 NOVEMBER 2009
TO
IS 3196 (PART 4) : 2001 WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES — SPECIFICATION

PART 4 CYLINDERS FOR TOXIC AND CORROSIVE GASES

(*Page* 13, *Annex* C, *clause* **C-10**) — Substitute the following for the existing matter:

'Minimum test pressure shall be as specified in IS 8867.'

(*Page* 13, *Annex* D, *clause* **D-9**) — Substitute the following for the existing matter:

'Minimum test pressure shall be as specified in IS 8867.'

(*Page* 14, *Annex* E, *clause* **E-9**) — Substitute the following for the existing:

'Minimum test pressure shall be as specified in IS 8867.'

(MF 16)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 1 MARCH 2003
TO
IS 3196 (PART 4) : 2001 WELDED LOW CARBON STEEL CYLINDERS EXCEEDING 5 LITRE WATER CAPACITY FOR LOW PRESSURE LIQUEFIABLE GASES

PART 4 CYLINDERS FOR TOXIC AND CORROSIVE GASES

(*Page* 7, *clause* **18.1.1**) — Insert **'18.1.7'** after **'18.1.6'** in third line.

(*Page* 9, *clause* **18.1.6**) — Insert the following **new clause 18.1.7** after **18.1.6:**

18.1.7 *Macro Examination* — The macro-etching of a complete cross section of the weld shall show a good penetration and absence of lack of fusion, significant inclusions and other defects. In case of doubt, a micro-etching of the doubtful zone shall be investigated.'

(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 — SPECIFICATION

PART 4 CYLINDERS FOR TOXIC AND CORROSIVE GASES

1 SCOPE

1.1 This standard deals with welded low carbon steel cylinders intended for storage and transportation of toxic and/or corrosive low pressure liquefiable gases of nominal capacity up to and including 250 litres water capacity. This standard lays down the requirements for the design, materials to be used, manufacture, construction, tests and marking of these cylinders.

1.1.1 Cylinders intended for storage and transportation of methyl bromide gas shall have a maximum nominal capacity up to and including 130 liters water capacity.

2 REFERENCES

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

3 TERMINOLOGY

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

4 MATERIAL

4.1 The steel used in the manufacture of cylinders shall conform to IS 6240, the manufacturer of cylinder shall guarantee the value of yield strength as 240 MPa minimum.

4.1.1 Suitable low carbon steel other than those given in **4.1** may to be used with 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. Such a 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 manufacture shall obtain and provide certificate of cast (heat) analysis of the steels supplied for the construction of gas cylinders and establish means to identify the cylinders with the casts of steel from which they are made. The inspecting authority shall be given the opportunity of making an independent analysis, if necessary.

4.1.3 Material with seams, cracks, laminations or other injurious defects shall not be used.

4.2 The bung shall be hot forged from rolled steel bars either conforming to Class 1A or 2 of IS 1875 or IS 7283 or IS 9550. The bung machined from such forging shall be free from surface defects such as fissures, surface cracks, porosity, laminations, pinholes, etc.

4.3 The material used for backing strip shall conform to IS 2062. Steel of equivalent or superior qualities may be used with the prior permission of statutory authority.

5 GENERAL

A fully dimensioned sectional drawing of the cylinder, together with design calculations and scheme of manufacture, shall be submitted by the manufacture 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 cylindrical portion with hemispherical, ellipsoidal or torispherical ends welded to it or two halves of cold or hot drawn and circumferentialy welded together or any other construction approved 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 manufacture 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. $$t = \frac{P_h \times D_o}{2 \times 0.8\, JR_e + P_h} = \frac{P_h \times D_i}{2 \times 0.8 JR_e - P_h}$$

OR

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

b) **For torispherical part or end (*see* Fig. 1A)**

$$t_e = \frac{P_h \times D_o}{2 \times 0.8\ JR_e + P_h} \times \frac{KZ}{5}$$

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

$$t_e = \frac{P_h \times D_o}{2 \times 0.8\, JR_e + P_h} \times \frac{K(0.65 + 0.1K)}{4}$$

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 force due to normal handling *(see* **8.4**).

t_e = calculated minimum wall thickness torispherical or semi ellipsoidal ends in mm;

P_h = test pressure in MPa as specified in IS 8867. For the gases not covered in the above standard, one and a half times the gas manufacturers declaration of vapour pressure at 65°C and approval from statutory authority shall be taken. The minimum test pressure shall not be less than 1.8 MPa (18 kgf/cm^2);

D_i = inner diameter in mm;

D_o = outer diameter in mm;

J = weld joint factor = 0.9 *(see also* **13.2**);

R_e = yield strength (minimum value specified in **4.1** and **4.1.1** in MPa); However, the value of 'R_e' shall not be more than the minimum value specified in the material specification;

H = depth of dishing in mm;

K = the ratio D_o/H;

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

r = knuckle radius in mm ($r \geq 0.1\ D_o$); and

$$Z = \frac{\frac{20r}{R} + 3}{\frac{20r}{R} + 1}$$

6.2.1.1 For hemispherical ends 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 2.4 mm and the actual thickness of the ends or dished part shall be not less than the thickness of the cylindrical portion.

6.3 Before the design in finally approved, the statutory authority may require or more prototype cylinders to be subjected to various tests as specified in this specification or such other tests, as authority deems fit.

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 radiographed, and to the requirements of IS 817 when the cylinder welding is not to be radiographed, for example, foot ring or any other non-pressure parts to be welded on the cylinder body.

7.2 Prior to welding, components shall be examined in accordance with the requirement 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 such that the external surface of the container is smooth. 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.

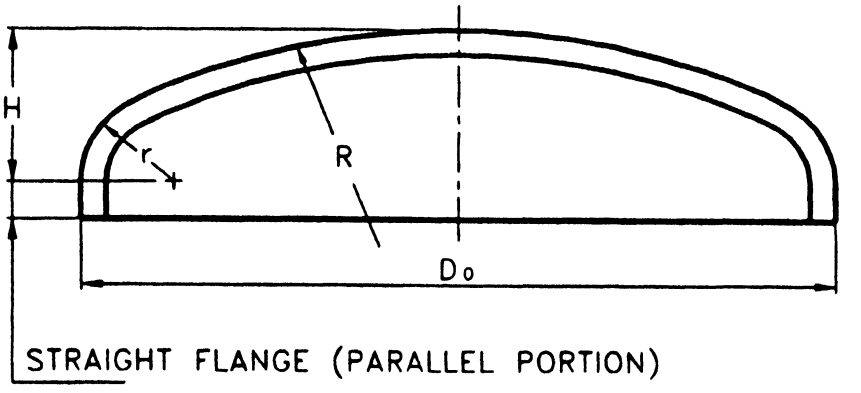
7.4 Surface of the plates at the seams shall not be out of alignment with each other at any point more than 10 percent of the plate thickness.

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).

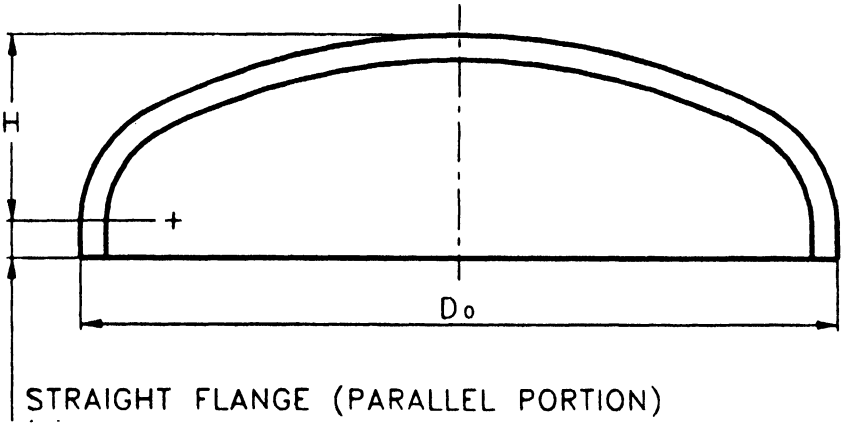
7.6 All welding of the shell and attachments shall be completed before the final heat treatment.

7.7 Before welding, the plates to be joined shall be free from scales, 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



1A TORISPHERICAL END



1B. SEMI-ELLIPSOIDAL END

FIG. 1 TORISPHERICAL AND SEMI-ELLIPSOIDAL ENDS

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 the parent metal.

7.8.2 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.

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. Bung weld shall be not considered as circumferential seam.

8.1.1 There shall be no longitudinal seam for methyl bromide gas cylinders.

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 hemispherical, semit-ellipsoidal or torispherical shape. These shall be forging suitably thickened at the neck to take the valve or pressed ends, with provision for the valve made by a welded on cap piece or nipple. 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

8.4.1 The agreed finished thickness shall be not 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 manufacturing tolerances and stress due to horizontal acceleration and retardation during transportation. The amount of this allowance shall be as agreed to between the manufacturer and the purchaser.

8.4.2 Corrosive gas cylinders shall be provided with corrosion allowance of 1.5 mm in addition to the allowances given in **8.4.1.**

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, off set 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 more than 1 percent of the normal 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 surface 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 the dished end shall not deviate from the approved dimensions by more than 1.25 percent of the nominal diameter in respect of radial dimensions and by more than one percent in respect of axial dimensions. Such deviations shall not be abrupt changes and shall be outside the specified shape.

8.5.4 *Offset at the Joint*

The misalignment measure at the surface of the plates shall not exceed 10 percent of the nominal plate thickness. Where the thickness of the ends exceeds the shell thickness by more than 25 percent, the abutting edge shall be reduced by a smooth taper extending for a distance of four times the offset between the abutting edges.

8.5.5 *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.

9 VALVES PAD AND VALVES

9.1 Valve Pad

The valve connection shall consist of a welded or brazed boss or nipple 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.

9.2 Valves

The valves fitted shall conform to IS 3224 or any other design as approved by statutory authority.

9.3 Valve Protection

9.3.1 Every cylinder shall be provided with means of protection of valve against mechanical damage as under. 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 :

a) 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 or a protective metal ring or grill of a design approved by the statutory authority shall be provided, the design being such that the cap or cover or ring or grill is no where in close proximity to any part of the valve or valve body.

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

c) The protective metal ring or grill shall be welded to the upper end of the cylinder concentric with the neck.

d) The thickness of metal cap or metal cover or a protective ring or grill shall not be less than the calculated wall thickness of the cylinder.

9.3.2 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 weight of gas to be filled in the cylinder 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.

9.4 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 cradel or by a stout guard. If the cylinders 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 transportation.

10 FITTINGS OTHER THAN VALVES

10.1 Handle

Handle or other suitable arrangement wherever provided for lifting the cylinder 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 compatible with that of the cylinder prescribed in IS 1079, or of any other steel having equivalent properties. The bottom of the footring shall not be less than 8 mm below the outside bottom of the cylinder shell for cylinder up to 34 litres nominal water capacity. For cylinders of more than 34 litres nominal water capacity and up to 50 litres nominal water capacity, this value shall be minimum 15 mm and cylinder exceeding 50 litres nominal water capacity, value shall be minimum 25 mm.

10.3 Bung

The requirements of bungs shall be in accordance with Annex B.

10.4 Dip Tube

A dip tube/pipe for liquid off take may be provided and in that case the dip tube inside the cylinder to go up to a point where minimum clearance of two millimeter shall be given from inside lowest point of cylinder under normal position of use. A typical drawing of bottom of the dip tube in the cylinder for liquid offtake is illustrated in Fig. 2.

11 HEAT TREATMENT

All cylinders shall be efficiently normalized, or stress relieved in accordance with the steel maker's recommendation, 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.

12 INSPECTION

12.1 General

12.1.1 The inspecting authority shall have free access, at all reasonable time to that part of the manufacture's works engaged in 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 man power and equipment for such inspection and test as are required and for any additional checks which may be agreed between the inspecting authority and the manufacturer.

12.1.3 The visual inspection of cylinders shall 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, two percent or more of the pressings, halves and the cylindrical shells shall be selected at random to represent all batches of material used for the manufacturer of the cylinders, and these batches shall be examined for minimum thickness before any seam is welded. If any pressing, half or shell found to have thickness 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 that the specified minimum thickness shall be rejected. For the purpose of this clause "batch of material" is defined to mean pressings or cylindrical shells manufactured in a continuous production run.

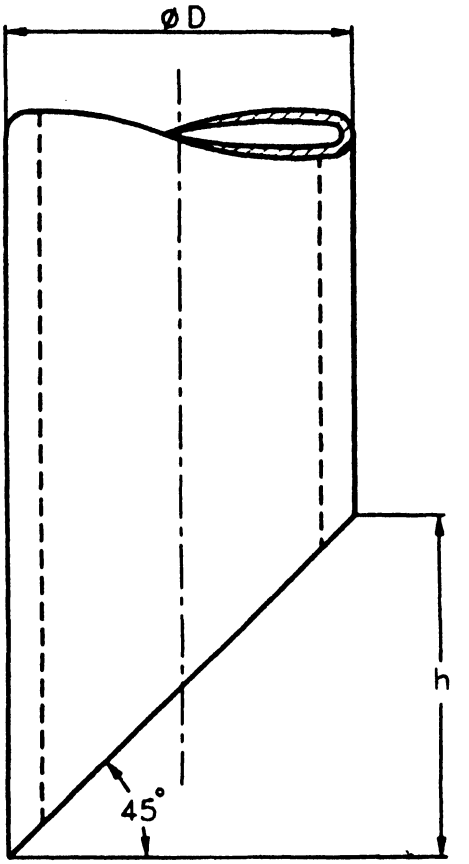


FIG. 2 DRAWING OF BOTTOM OF DIP TUBE IN CYLINDERS FOR LIQUID OFFTAKE

13 RADIOGRAPHIC EXAMINATION

13.1 Each cylinder shall be subjected to 100 percent radiographic examination at the longitudinal and circumferential seams. Radiographic examination 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 two percent of the combined thickness of the weld and the backing strip.

13.2 Subject to the prior permission of the statutory authority, the requirements of radiographic examination at **13.1** may be relaxed to the extent permitted by the statutory authority. In such a case the value of weld joint factor J *(see* **6.2.1)** shall be fixed by the statutory authority.

13.3 Non destructive testing methods such as dye penetrant or magnetic particles *(see* IS 3658 and IS 3703) may also be employed to ascertain the quality of weld where X-ray radiography cannot be easily employed as in the case of fillet and butt welds for bung or valve pad.

13.4 Interpretation of Radiographs

For correct interpretation of radiographs the film density shall preferably be between 2 and 3 but in no case less than 1.7 *(see* IS 1182 and IS 4853). Any one of the following imperfections shall be unacceptable:

a) Any type of crack or zone of incomplete fusion or penetration;

b) Any elongated slag inclusion which has a length greater than half the thickness;

c) Any group of inclusion of slag in alignment the total length of which exceeds the thickness over a length of 12 times the thickness except when the distance between successive defects exceeds 6 times the length of the longest defect in the group; and

d) Any porosity greater than given in Fig. 8.12A, 8.12B, 8.12C, 8.12D and 8.12E of IS 2825.

13.5 Failure in Radiography

If minor but unacceptable defects found by radiography, the weld may, at the discretion of inspecting authority, be repaired by rewelding. After rewelding the cylinder shall be re-radiographed and if found acceptable shall then be processed further. The weld repairs shall then be radiographed and if it passes, the cylinder shall be subjected to hydrostatic test and pneumatic leakage tests which tests it shall also pass, to be acceptable.

14 CHECKING OF WATER CAPACITY

One cylinder taken at random from each batch of 403 cylinders shall be checked for water capacity. This shall be done by weighing or by volumetric method. The tolerance for water capacity shall be + 3 percent.

15 HYDROSTATICS 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 30s. 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. For the gases not covered in the above standard, 1.5 times the gas manufacturer's declaration of working pressure shall be taken.

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 shall be tested for leakage by subjecting to air pressure of not less than 686 kPa ($7 kgf/cm^2$) for a period of one minute while immersed in water and shall show no leakage.

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

17 HYDROSTATIC STRETCH AND BURSTING TEST

17.1 Hydrostatic Stretch Test

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

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 the cylinder due to application of 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 Bursting Test

17.2.1 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.

17.2.2 Bursting test shall be carried out according to 9 of IS 3196 (Part 3).

17.2.3 The nominal Hoop stress value (f_b) shall be not less than 0.95 of the minimum specified tensile strength of the material of the cylinder.

The cylinder shall burst without fragmentation.

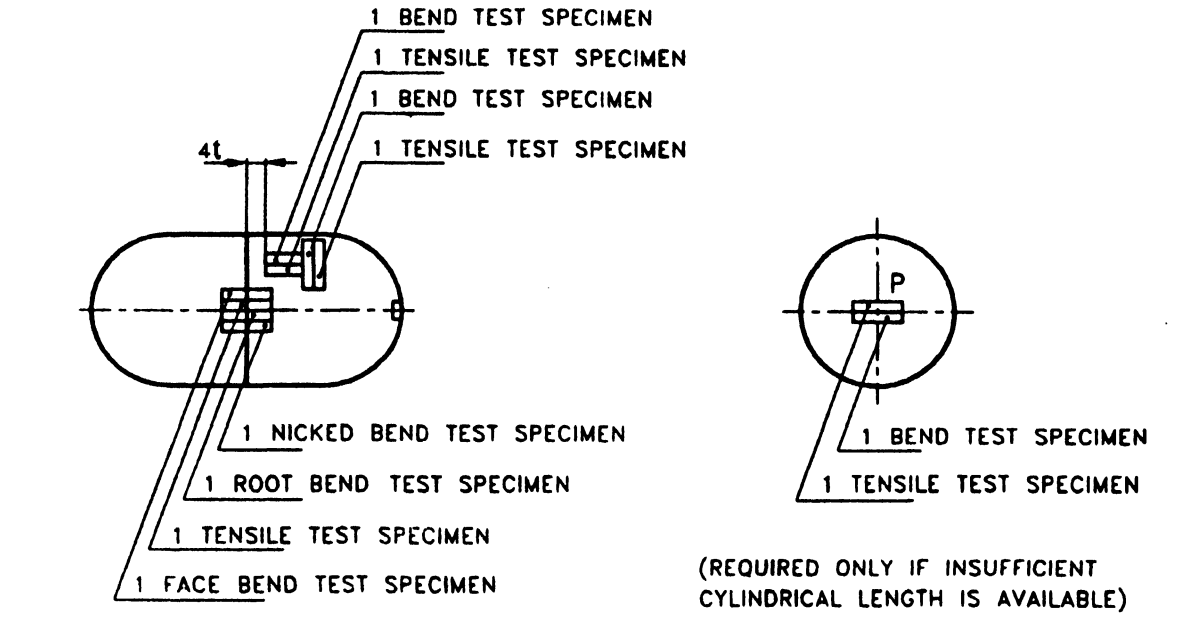
During burst test in case leakage starts from any welding before fracture or before achieving required hoop stress the specimen shall be discarded and fresh test specimen shall be taken.

Fracture in the weld shall not occur parallel to the direction of the circumferential or longitudinal seam. The fracture shall not occur in the direction parallel to circumferential weld within 10 mm from its edge.

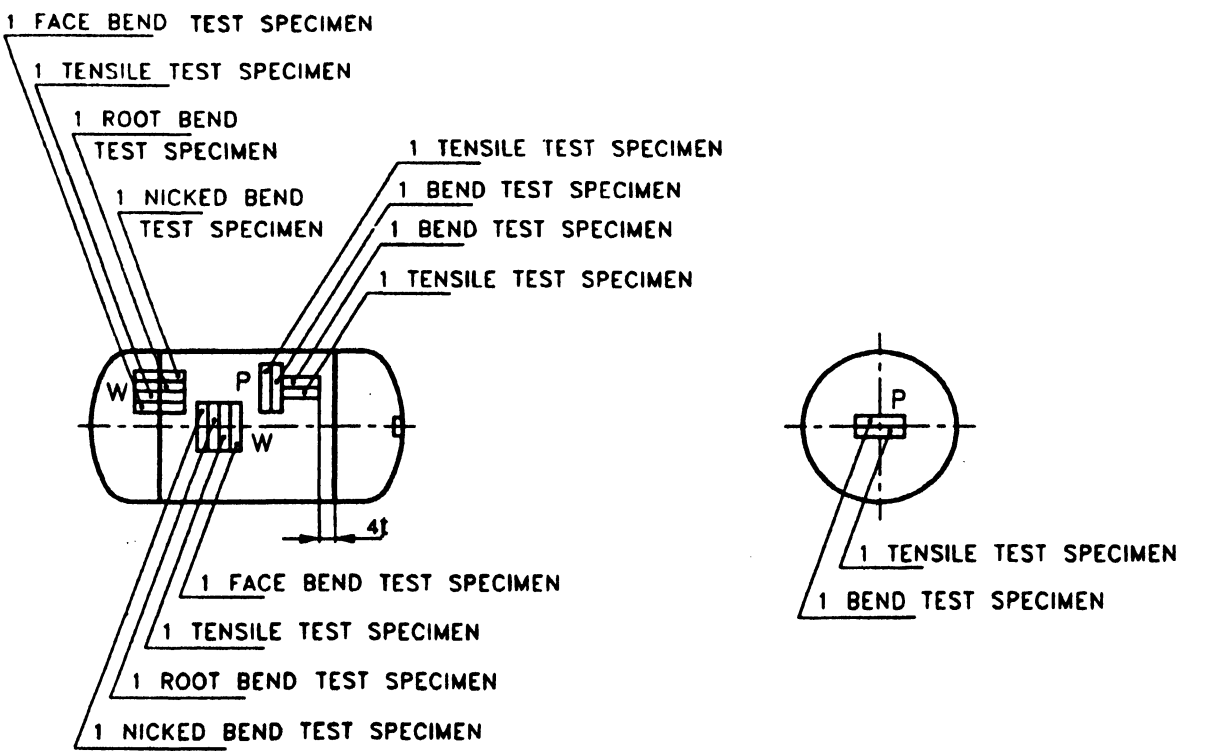
18 ACCEPTANCE TEST

18.1 For every batch of 202 or less heat treated and finished cylinders produced during one quarter of a year or 202 cylinders produced whichever is earlier, one test cylinder shall be selected at random, and the various acceptance test 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). In addition, nicked bend test according to **18.1.6** shall be carried out. The location of test specimen to be taken from the cylinder are given in Fig. 3.



3A TWO-PIECE CYLINDERS



3B THREE-PIECE CYLINDERS

P DENOTES SPECIMENS FROM PARENT METAL
W DENOTES SPECIMENS FROM WELDED JOINTS

FIG. 3 TEST SPECIMENS FOR ACCEPTANCE TESTS

18.1.2 The percentage elongation and yield strength, wherever applicable and tensile strength thus determined shall not 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.

18.1.6 *Nicked Bend Test*

The nicked bend test specimen shall be of rectangular section as shown in Fig. 4. The specimen is similar to the bend test except that a slot is cut along the weld on each side of the center line. The test piece shall be suitably supported so that the notch is at the center of fusion surface of the test specimen. The specimen shall be broken by means of a former or by a blow. To be acceptable, the fracture, on inspection, shall show complete penetration throughout the entire thickness of the weld and absence of oxide. It shall not show any porosity or slag inclusions in excess of what is permitted in **10** of IS 3196 (Part 3).

19 MARKING

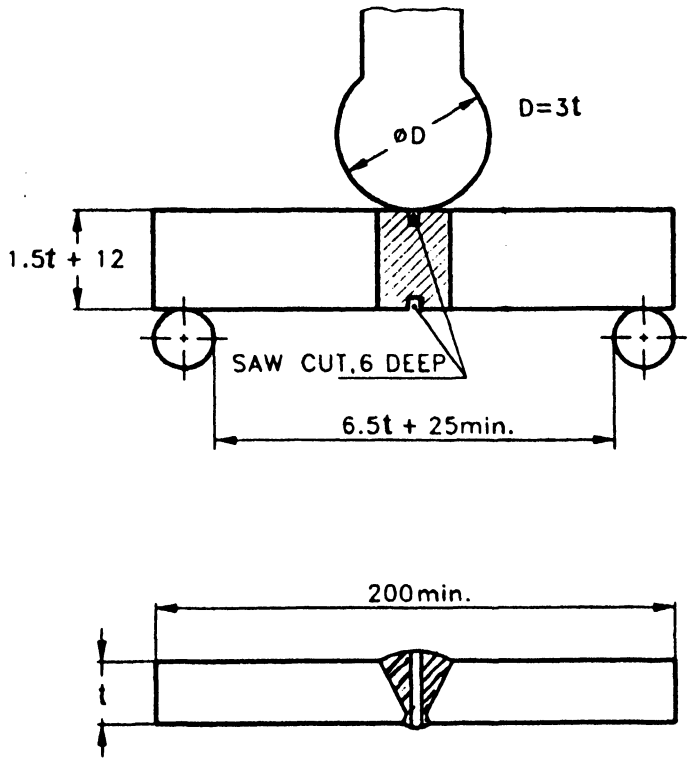
19.1 General Instructions

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

b) The 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 a shape and size that the marking is clear and easily legible.



All dimensions in millimetres

FIG. 4 NICKED BEND TEST PIECE

e) The 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) Month and year of manufacture or date of hydrostatic test or hydrostatic stretch test as the case may be (such as 9/01 for September 2001),
b) Serial number of the cylinder,
c) Identification of the manufacturer,
d) Tare weight in kg,
e) Gross weight in kg,
f) Identification of the owner,
g) The number of this Indian Standard,
h) Maximum working pressure in MPa,
j) Test pressure in MPa,
k) Water capacity in litres,
m) Maximum gas capacity in litres,
n) Inspection agency's official mark,
p) Name of chemical symbol of gas,
q) Material identification, and
r) Letters 'ST' for stress relieved or letter 'N' for normalised cylinders next to IS number marking.

19.2.1 *BIS Certification Marking*

The cylinders may also be marked with the Standard Mark.

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

19.3 The markings at (a), (b), (c), (d) of **19.2** shall be stamped on the cylinder bung. The other markings may be made at any of the following places:

a) Footring;
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 cylinders 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 manufacture'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 inspecting authority shall be forwarded to the statutory authority and the purchaser.

22 PREPARATION FOR DESPATCH

Before being fitted with valves, all cylinders shall be thoroughly cleaned and dried internally. The outside shall be given a suitable protective metal coating before painting and dispatch, as agreed to between the buyer and the manufacturer.

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 sheet and strip *(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)*
2062 : 1992	Steel of general structural steel purposes *(fourth revision)*
2595 : 1978	Code of practice for radiographic testing *(third revision)*
2825 : 1969	Code for unfired pressure vessels
3196 (Part 3): 1991	Welded low carbon steel cylinders exceeding 5 liter water capacity for low pressure liquefiable gases - Part 3 Methods of test *(fourth revision)*
3224 : 1979	Valve fittings for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders *(second revision)*
3657 : 1978	Radiographic image quality indicators *(first revision)*
3658 : 1999	Code of practice for liquid penetrant flaw detection *(second revision)*
3703 : 1980	Code of practice for magnetic particle flaw detection *(first revision)*
3710: 1978	Filling ratios for low pressure liquefiable gas *(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)*
5903 : 1970	Recommendation for safety devices for gas cylinders
6240 : 1999	Hot rolled steel plate (up to 6 mm) sheet and strip for the manufacture of low pressure liquefiable gas cylinder *(third revision)*
7202 : 1974	Inspection gauges for checking threads of gas cylinder valves for use with breathing apparatus
7241 : 1981	Glossary of terms used in gas cylinder technology *(first revision)*
7283 : 1992	Hot rolled bars for production of bright bars and material parts for engineering application *(first revision)*
8867 : 1978	Saturated vapour pressure and test pressure for low pressure liquefiable gases contained in gas cylinders
9121 : 1979	Inspection gauges for checking taper threads of gas cylinder valves, type 1 taper 1 in 16
9122 : 1979	Inspection gauges for checking taper threads of gas cylinder valves, type 2 taper 3 in 25
9550: 1980	Bright bars
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 cylinder valves taper 1 in 16

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 manufacture 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 the 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 threads :

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 threads plug 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-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 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)

TECHNICAL DATA FOR AMMONIA (ANHYDROUS) GAS AND THE CYLINDERS

C-1 PHYSICAL CLASSIFICATION

Ammonia (anhydrous) is a low pressure liquefied, nonflammable, slightly toxic, non-corrosive gas.

C-2 CRITICAL TEMPERATURE

Critical temperature of ammonia (anhydrous) is + 132.4°C.

C-3 CRITICAL PRESSURE

Critical pressure of ammonia (anhydrous) is 11.65 MPa (116.5kgf/cm^2) (abs).

C-4 BOILING POINT AT 760 TORR

Boiling point of ammonia (anhydrous) at 760 torr is 33.4°C.

C-5 IGNITION RANGE IN AIR

15 to 30 percent by volume. (This means that within the above range of concentration, the gas is capable of forming mixture with air in which at an initial temperature of 20°C and an initial pressure of one atmosphere, there is propagation of ignition, started by an ignition source).

C-6 MAXIMUM PERMISSIBLE TOXICITY

Maximum permissible toxicity is 100 ppm by volume. (This is the maximum concentration in air to which nearly all workers may be exposed day after day without adverse effects). Inhalation of air containing more than 5 000 ppm of ammonia may cause death. Permanent eye injury may result from exposure to 700 ppm concentrations for longer than 30 min.

C-7 USE OF SAFETY DEVICE ON GAS CYLINDERS

Safety devices on cylinders may be used *(see* IS 5903).

C-8 FILLING RATIO

Filling ratio of ammonia shall be 0.51 *(see* IS 3710).

C-9 VAPOUR PRESSURE AT 65°C

Vapour pressure of ammonia (anhydrous) at 65°C is 2.904 MPa (29.04 kgf/cm^2) (gauge). (Also called maximum working pressure or service pressure).

C-10 MINIMUM TEST PRESSURE

Minimum test pressure shall be at least 1.5 times maximum working pressure, which shall be at least 4.36 MPa (43.6 kgf/cm^2) (gauge).

C-11 TYPE OF VALVE OUTLET TO BE USED

Outlet No.9 of IS 3224 shall be used. The thread specification is EXT-FP ½ A-RH.

C-12 CHEMICAL REACTION WITH METALS

Dry ammonia does not react with most of the metals. When mixed with even very little water it vigorously attacks copper, zinc, silver and many alloys especially those containing copper. Hence absolutely no brass or bronze valve fittings are to be used for ammonia cylinders. Fittings should be made of iron or steel since ammonia will not attack these materials.

ANNEX D

(Foreword)

TECHNICAL DATA FOR CHLORINE GAS AND THE CYLINDERS

D-1 PHYSICAL CLASSIFICATION

Chlorine is a low pressure liquefiable, non-flammable but supports combustion, toxic, corrosive gas.

D-2 CRITICAL TEMPERATURE

Critical temperature of chlorine is +144°C.

D-3 CRITICAL PRESSURE

Critical pressure of chlorine is 7.86 MPa (78.6 kgf/cm^2) (abs).

D-4 BOILING POINT AT 760 TORR

Boiling point of chlorine at 760 torr is -34°C.

D-5 MAXIMUM PERMISSIBLE TOXICITY

Maximum permissible toxicity is one ppm by volume. This is the maximum concentration in air to which nearly all workers may be exposed day after day without adverse effects. Concentration above 2 to 3 ppm in the air are readily detectable by a normal person. Inhalation of air containing 40 to 60 ppm of chlorine for a period ranging from 30 to 60 min is quite dangerous.

D-6 USE OF SAFETY DEVICE ON GAS CYLINDERS

Use of safety device on cylinders shall be prohibited *(see* IS 5903).

D-7 FILLING RATIO

Filling ratio of chlorine shall be 1.19 *(see* IS 3710).

D-8 VAPOUR PRESSURE

Vapour pressure of chlorine at 65°C is 1.99 MPa (19.90 kgf/cm^2) (gauge). (This is also called maximum working pressure or service pressure).

D-9 MININUM TEST PRESSURE

1.5 times maximum working pressure = 2.98 MPa (29.85 kgf/cm^2) (gauge).

D-10 TYPE OF VALVE OUTLET TO BE USED

Outlet No. 5 to IS 3224 shall be used. The thread specification is EXT – FP $\frac{5}{8}$ A – RH (similar to **C-11**).

D-11 CHEMICAL REACTION WITH METALS

Dry chlorine reacts with aluminium, tin, arsenic, gold, mercury, selenium, tellurium and titanium. Metals resistant to dry chlorine are steel, iron, copper nickel and lead. Even small amounts of moisture when mixed with chlorine form hypochlorous and hydrochloric acids that are very corrosive to most of the metals. Only silver, platinum and tantalum can resist attack by moistchlorine.

D-12 PRECAUTIONS IN HANDLING CHLORINE CYLINDERS

Chlorine cylinders should not be stored next to cylinders containing other compressed gases. They should also not be stored in the vicinity of turpentine, ether, anhydrous ammonia, finely divided metals, hydrocarbons, such as oil grease and gasoline.

ANNEX E

(Foreword)

TECHNICAL DATA FOR METHYL BROMIDE GAS AND THE CYLINDERS

E-1 PHYSICAL CLASSIFICATION

Low pressure liquefiable non-flammable, toxic, non-corrosive gas.

E-2 CRITICAL TEMPERATURE

Critical temperature of methyl bromide is +194°C.

E-3 BOILING POINT AT 760 TORR

Boiling point of methyl bromide at 760 torr is +4.5°C (similar to **C-4** and **D-4).**

E-4 IGNITION RANGE IN AIR

13.5 to 14.5 percent by volume. (This means that within the above range of concentration, the gas is capable of forming mixture with air in which at an initial temperature of 20°C and an initial pressure of one atmosphere, there is propagation of ignition, started by an ignition source).

E-5 MAXIMUM PERMISSIBLE TOXICITY

20 ppm by volume. (This is the maximum concentration in air to which nearly all workers may be exposed day after day without adverse effects).

E-6 USE OF SAFETY DEVICE ON GAS CYLINDER

Use of safety device on cylinder shall be prohibited *(see* IS 5903) (similar to **D-6).**

E-7 FILLING RATIO

Filling ratio of methyl bromide is 1.39 *(see* IS 3710) (similar to **C-8** and **D-7).**

E-8 VAPOUR PRESSURE AT 65°C

[*See* IS 3710) 0.57 MPa (5.70 kgf/cm^2) (gauge)]. (Also called maximum working pressure or service pressure).

E-9 MINIMUM TEST PRESSURE

1.5 times maximum working pressure is equal to 0.855 MPa (8.55 kgf/cm^2) (gauge).

E-10 TYPE OF VALVE OUTLET TO BE USED

Outlet No. 15 of IS 3224 shall be used. The thread specification is EXT - FP 1/4 A - RH (similar to **C-11** and **D-10**).

E-11 SUITABLE MATERIAL OF CONSTRUCTION — Steel, copper brass.

E-12 UNSUITABLE MATERIALS — Aluminium.

ANNEX F

(Foreword)

COMMITTEE COMPOSITION

Cylinders Sectional Committee, ME 16

Organisation	*Representative(s)*
Department of Explosives, Nagpur	SHRI R. H. BHALEKAR *(Chairman)*
	SHRI SHAMBHU PRASAD *(Alternate)*
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National Safety Council, Mumbai	SHRI H.N.GUPTA

(Continued on page 16)

(Continued from page 15)

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Director (MED), BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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