BUREAU OF INDIAN STANDARDS
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भारतीय मानक **मसौदा**

ऑटोमोटिव उपयोग के लिए संपीड़ित गैसीय हाइड्रोजन (सीजीएच2) और हाइड्रोजन/प्राकृतिक गैस मिश्रण वाल्व सोलनॉइड ऑपरेशन (दूरस्थ रूप से नियंत्रित) के साथ एकीकृत — विशिष्टि

DRAFT *Indian Standard*

COMPRESSED GASEOUS HYDROGEN (CGH2) AND HYDROGEN/NATURAL GAS BLENDS VALVE INTEGRATED WITH SOLENOID OPERATION (REMOTELY CONTROLLED) FOR AUTOMOTIVE USE — SPECIFICATION

ICS 23.020.35; 23.060.40; 43.060.40; 75.060

Gas Cylinders Sectional Committee, MED 16	Last date for receipt of comments is **07 September 2024**

FOREWORD
(*Formal clause will be added later*)

Compressed gases supplied in cylinders are diverse in their chemical composition and properties. Some are oxidizers, some are flammables, some are inert, etc. Gases vary in degree of corrosiveness, toxicity and exist not only in pure state but also in variety of mixtures. Thus, it becomes a primary safety requirement of the cylinder valve that it must be appropriate for the intended use. The intended use must be identified and the cylinder valve must incorporate proper pressure capacity as well as functional reliability for safe operation.

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

Other standards for valve fitting are:

a) IS 3224 : 2021 Valve for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders — Specification (*fourth revision*)
b) IS 7302 : 2018 Valve fittings for self contained breathing apparatus (SCBA) and self contained underwater breathing apparatus (SCUBA) — Specification (*first revision*)
c) IS 8737 : 2017 Valve fitting for use with liquefied petroleum gas (LPG) cylinders of more than 5 litre water capacity — Specification (*second revision*)

d) IS 8776 : 1988 Specification for valve fittings for use with liquefied petroleum gas (LPG) cylinder up to and including 5-litre water capacity (*first revision*)
e) IS 12300 : 1988 Valve fittings for refrigerant cylinders — Specification
f) IS 16988 : 2018 Compressed natural gas cylinder valve integrated with solenoid operation (remotely controlled) for automotive use — Specification

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

1 kgf/cm^2 = 98.066 5 kPa (kilopascal) = 10 m of Water column (WC)
= 0.098 066 5 MPa (megapascal)
= 0.980 665 bar

1 Pa = 1 N/m^2

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

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COMPRESSED GASEOUS HYDROGEN (CGH2) AND HYDROGEN/NATURAL GAS BLENDS VALVE INTEGRATED WITH SOLENOID OPERATION (REMOTELY CONTROLLED) FOR AUTOMOTIVE USE — SPECIFICATION

1 SCOPE

This standard covers the requirements for design, materials, manufacture and testing of hydrogen (CGH2) and hydrogen/natural gas blends cylinder valve having working pressure 200 bar upto and including 800 bar integrated with solenoid operation (remotely controlled) for automotive use.

2 REFERENCES

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

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 3224, IS 7241 and the following shall apply.

3.1 Solenoid Valve

A remotely controlled and normally closed, shut off valve, which can open or close the hydrogen supply to the pressure regulator on downstream side.

3.2 Bleed Valve

A bleed valve is a valve that typically utilizes a threaded bleed screw to open or close. Generally, these valves vent pressure or release media from within a system.

4 VALVE DESIGN

Hydrogen gas cylinder valve integrated with solenoid operation (remotely controlled) for automotive use is also having provision for manual operated valve, which overrides the solenoid valve closing operation as and when required may be for servicing purpose or in case of emergency.

The manual operated valves with following designs are used.

a) Wheel/knob operated o-ring gland seal valves with soft seat (*see* Fig. 1); and

b) Operating torque of the valve for opening and closing shall be as per Table 9.

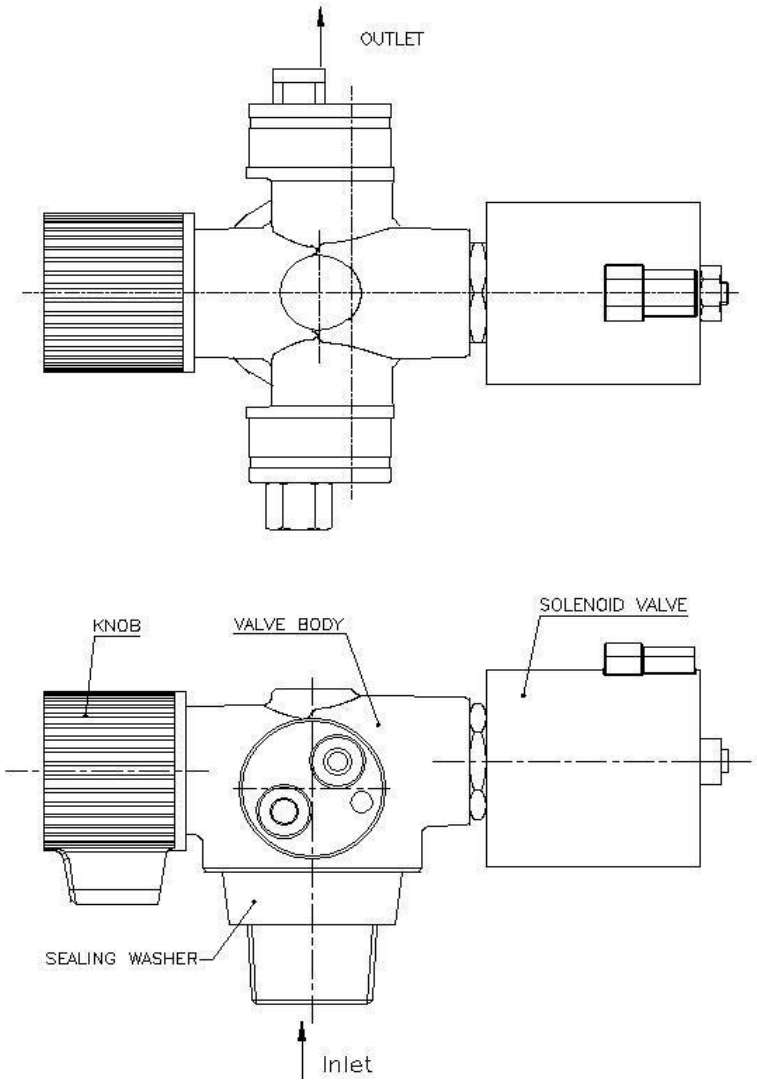


FIG. 1 ILLUSTRATION OF TYPICAL KNOB OPERATED O-RING GLAND SEAL VALVE WITH SOFT SEAT

5 SUITABILITY OF MATERIALS

5.1 Material

All materials used in the manufacture of valves, including gaskets, seats and protective coatings shall compatible with hydrogen and also shall be compatible with cylinder material. The material of the valve bodies shall comply with the material properties in **5.2**, **5.3** and **5.4**.

5.2 Chemical Composition

5.2.1 *Valve Body*

Valve body shall be forged or machined from extruded section of brass/aluminium. Chemical composition of the valve body material will be as agreed between user and manufacturer.

5.2.2 All other metallic and non-metallic material shall meet the requirements of IS/ISO 11114-1 and IS/ISO 11114-2.

5.3 Mechanical Properties

The material of the valve body shall comply with the requirements of mechanical properties given in **5.3.1** and **5.3.2**.

5.3.1 *Tensile Strength and Elongation*

The tensile strength and elongation of the material of the valve body determined according to IS 1608 (Part 1 to Part 3) shall be respectively at least 392 MPa (40 kgf/mm^2) and 18 percent measured on a gauge length $5.65\sqrt{S_o}$ (S_o being the original area of cross-section).

5.3.2 *Impact Strength*

The Izod impact strength of valve body determined according to IS 1598, shall not be less than 21.5 J (2.2 kg.m) for brass.

5.4 Test Samples

Test samples for tensile and Izod impact tests shall, wherever practicable, be drawn from a valve body blank; where this is not practicable, the test samples shall be made from same raw material (wrought or extruded section), giving the same outside shape as the valve body blanks it represents. The scale of sampling and criteria for conformity shall be in accordance with the requirements of Annex B.

6 VALVE DESIGN REQUIREMENT

6.1 General Criteria

6.1.1 Valve shall be designed to operate satisfactorily and be leak tight over a range of service temperatures, from −40 ºC to +85 °C in indoor and outdoor environments.

6.1.2 The solenoid valve shall be suitable for 12 V or 24 V system**.**

6.1.2.1 The minimum opening voltage at room temperature shall be less than or equal to 8 V for a 12 V system and less than or equal to 16 V for 24 V system. The valve shall be pressurised at 0.75 times working pressure during the test.

6.1.3 The valve shall be controlled such that it is automatically closed when de-energised (normally closed).

6.1.4 Working pressure (P_w) of the valve shall be at least the filling pressure or settled pressure at 15 °C, of the cylinder (*see* IS 15975). Minimum working pressure should not be less than 200 bar, maximum working pressure of valve shall not be more than 800 bar.

6.1.5 The valve should have a provision for manual (wheel/knob) operated valve which overrides the solenoid valve closing operation as and when required for servicing purpose or in case of emergency.

6.1.6 The minimum finished wall thickness shall be suitable for the application and at any point of the valve shall not be less than 2.5 mm. However, this requirement shall be relaxed in case of sections not susceptible to tamper, damage or rupture during use or where any damage to the section will not affect the sealing off of the valve.

6.1.7 The component and parts of valves of same design of a manufacturer shall be interchangeable.

6.1.8 The excess flow valve shall be provided and shall not restrict the flow through PRD and shall conform to **12**.

6.1.9 A bleed valve shall be installed between the outlet side and pressure-relief device to enable the system to be safely depressurized prior to performing maintenance.

6.1.10 Excess flow valve, shall be secured in a manner that will protect it from becoming loose or detached or break during transit and use.

6.1.11 Target mass flow rate shall be designed for 60 gr/sec to 100 gram/second.

6.1.12 Filter for filtration of 50 micron shall be provided at outlet of valve towards engine supply.

6.2 Valve Dimensions

6.2.1 The valve dimensions and connecting bore diameters shall be determined by the application of the rate of flow required, service pressure, the required mechanical strength of the connections and any other safety aspects subject to agreement between the purchaser and the manufacturer.

6.2.2 Valve inlet connection details/dimensions shall be as per **8**.

6.2.3 Valves outlet connection details/dimension shall be as per **9**.

6.3 Valve Operating Device for Manual Operated Valve

The valve operating mechanism shall fulfil the following requirements:

6.3.1 It shall withstand over torque as specified in Table 9 without damage or failure of any component of the valve operating mechanism and/or valve operating device. Failure torque shall not be less than torque as specified in Table 9.

6.3.2 It shall function satisfactorily 250 opening and closing cycles with torque as specified in Table 9 at valve test pressure (P_w) without replacement of the sealing system.

6.3.3 Valve operating mechanism shall close the valve by rotation in clockwise direction when viewed from the spindle end.

6.3.4 Hand wheel or knob shall be clearly marked with ‘Open’ or ‘Close’ positions in words or in figure.

6.3.5 The valve operating device shall be designed to permit the closure of the valve after exposure to a flame impingement test given in **10.3**.

6.4 Solenoid Operation

6.4.1 The continued operation for test of solenoid operating mechanism is given in **13.3**.

6.4.2 Solenoid operated valve shall be closed when de-energized. Additional test requirements for solenoid operating mechanism are given in **13**.

6.5 Safety

The valve stem shall be of sufficient strength to withstand valving torque. Valving torque test shall be carried out as specified in **10.2.1**.

6.6 Leakage

6.6.1 The internal leakage shall not exceed 6 cm^3/h corrected to NTP over the range of pressures at room temperature specified in the Table 7 and Table 10, with the manually operating mechanism in the ‘Fully Closed’ position (*see* **10.5.2**). During this test the solenoid valve shall be energized to make it in an open position.

6.6.2 The external leakage shall not exceed 6 cm^3/h corrected to NTP over the range of pressures at room temperature given in Table 10**.** During this test the solenoid valve shall be energized to make it an open position.

NOTE —The leakage of 6 cm^3/h is approximately 4 bubbles of 3.5 mm diameter per min.

7 PRESSURE RELIEF DEVICES

7.1 Design Criteria of Pressure Relief Devices

The materials, design and construction of a pressure relief device shall be such that it meets the following conditions.

7.1.1 There shall be two types of PRD — Thermal device and pressure device (bursting disc type).

7.1.1.1 Where the pressure relief device is a bursting disc fitted to the valves, the maximum bursting pressure shall not exceed the 110 percent of cylinder test pressure and shall be more than the developed pressure of hydrogen at 65 °C.

7.1.1.2 Valves shall be provided with thermal device safety glass bulb type which will operate at (125 $\pm$10) °C.

7.1.1.3 Safety pressure device and thermal device will be installed in parallel. Thermal safety relief device, and bursting disc are activated independently by high temperature and high pressure respectively will be independent of each other.

NOTE — The PRD's shall be subjected to periodic inspection by the user as required or during periodic inspection of the cylinder.

7.1.1.4 There shall be no significant change in the function of the device and no detrimental corrosion or deterioration of the materials due to hydrogen content of the cylinder.

7.1.1.5 The material of construction shall be compatible with hydrogen and other service conditions.

7.2 Flow Requirements of PRD

7.2.1 The minimum rated flow capacity of the pressure relief devices fitted to non-insulated cylinders having water capacity of 11 litres or more shall be as follows:

$$Q_1 = 0.009\ 67\ W_c$$

where

Q_1 = Rated flow capacity in m^3/min, of free air at 6 kgf/cm^2 gauge pressure; and

W_c = Water capacity of the cylinder, in litres.

For cylinders having water capacities of less than 11 litres, the rated flow capacities shall be as given above, except that the value of W_c shall be 11 litres that is, the rated flow capacity shall be 0.106 37 m^3/min.

7.2.2 The outlets from all pressure relief devices shall be so positioned that free discharge from the devices is not impaired. The discharge so coming out shall not come out as a single high velocity jet emerging radially to the axis of the cylinder to avoid injury to individuals working in that area.

7.2.3 The breakage or failure of any internal component of the valve shall not obstruct free and full flow of the gas through the pressure relief device.

8 INLET CONNECTIONS

The valve inlet connection shall be provided with taper (*see* **8.1**) threads.

8.1 Taper Screw Threads

Taper screw threads shall be any one of the types specified below:

a) Type 1 thread taper 1:16 on diameter (*see* **8.1.1**);
b) Type 2 thread taper 3:25 on diameter (*see* **8.1.2**); and
c) Type 4 thread taper 1:8 on diameter (*see* **8.1.3**).

NOTE — Threads may be without undercut provided minimum length of full threads in the drawing is maintained.

8.1.1 *Type 1 Threads (Size 2) with a taper of 1 in 16 on Diameter*

The basic thread form, the principal dimensions and limits of crest and root truncation of the threads shall be as shown in Fig. 2 and Table 1 and Table 2.

NOTE — This type of thread also conforms to CGA Standard V-1-2013 'Standard for compressed gas cylinder valve outlet and inlet connections'. The NGT threads are based on the American standard taper pipe threads but are longer to provide fresh threads if further tightening is necessary. They have their own tolerances, which require gauges specifically developed for these threads.

8.1.1.1 *Limits on size*

For final inspection, limits on size (pitch diameter) of both external and internal thread are ±1 turn from basic, although the preferred working limits are ±0.5 turn from basic.

8.1.1.2 *Limits on taper*

In cases where there is an unintentional there be an unintentional difference in taper at the pitch elements of the valve and of the cylinder threads, it is preferred to have greater tightness at the bottom of the valve. In view of this requirement, the limits in gauging shall be as under:

a) The taper on pitch elements of external threads shall be 1 in 16 on diameter with a minus tolerance of 1 turn but no plus tolerance in gauging; and
b) The taper on pitch elements of internal threads shall be 1 in 16 on diameter with a plus tolerance of 1 turn but no minus tolerance in gauging.

8.1.1.3 The tolerance on 60 degree angle of thread shall be ±2 degree.

8.1.1.4 The tolerance on lead angle in the length of effective threads shall be ± 0.076 2 mm valid for any size threaded to a thread length greater than 25.4 mm.

8.1.1.5 The maximum taper on pitch line per millimetre shall be 0.072 9 and minimum 0.057 3.

8.1.1.6 Type 1 threads shall be checked according to IS 15894.

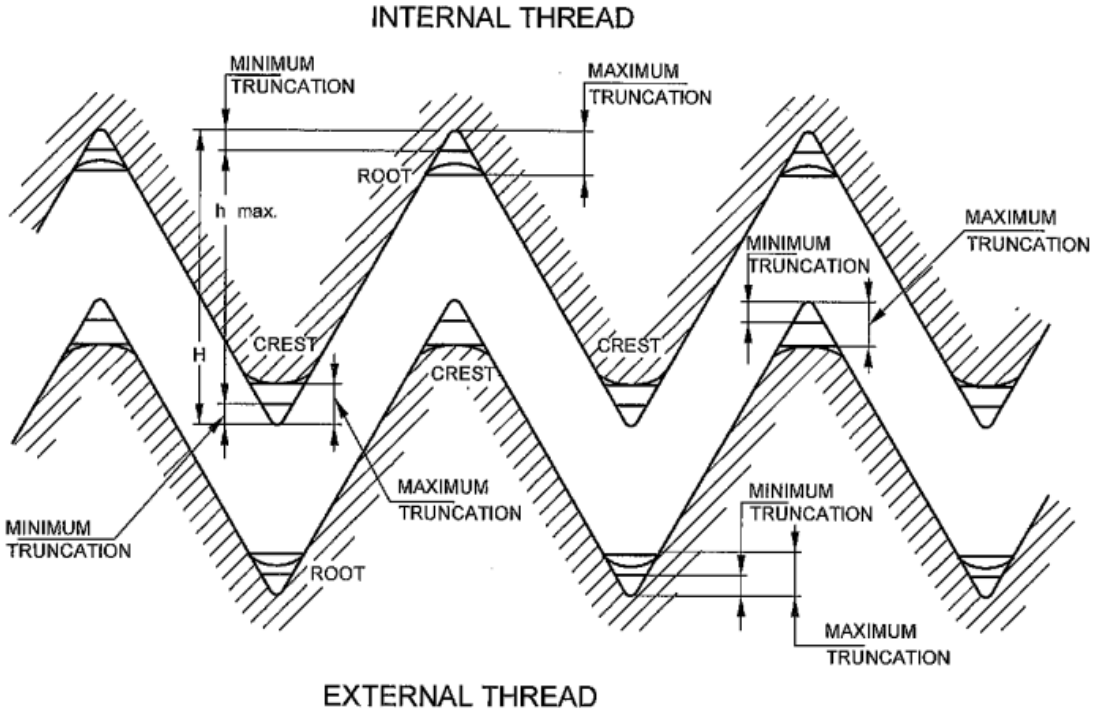
Table 1 Thread Details for Type 1 Threads

(*Clause* 8.1.1)

All dimensions in millimetre.

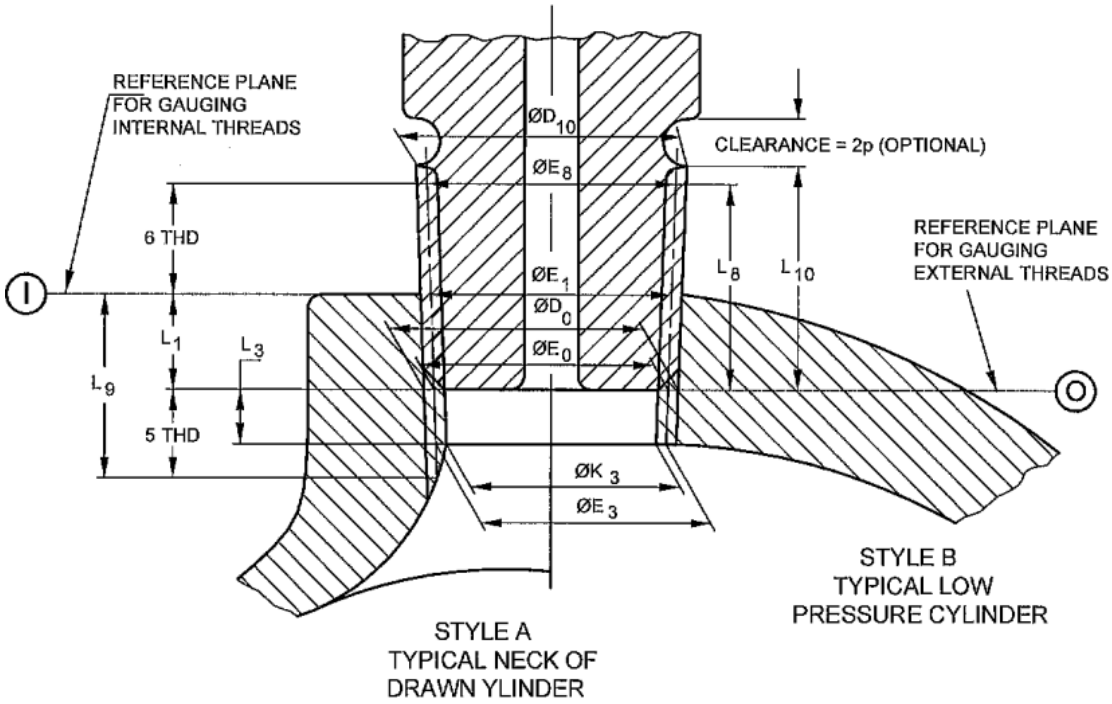
Sl No.		**Parameter**	**Thread Size 2 (¾ - 14 NGT)**	**Thread Size 3 (1 - 11½ NGT)**
(1)	(2)	(3)	(4)	(5)
i)	*p*	Pitch	1.814	2.208
ii)	*H*	Height of sharp V thread 0.866 025 *p*	1.571 22	1.913 2
iii)	*h*	Height of thread on product 0.800 025 *p*, *Max* 0.710 025 *p*, *Min*	1.451 1.288	1.767 1.568
iv)	*f*	Truncation on crest and root 0.033 *p*, *Min* 0.078 *p*, *Max* Tolerance	 0.059 87 0.141 51 0.081 64	 0.072 88 0.172 28 0.099 4

v)	*F*	Equivalent width of flat		
		0.038 *p, Min*	0.068 94	0.083 93
		0.090 *p, Max*	0.163 29	0.198 78
		Tolerance	0.094 35	0.114 85



2A THREAD PARAMETERS AND LIMITS ON CREST AND ROOT

TRUNCATION ON DIFFERENT TYPES OF TAPER SCREW THREAD



2B LIMITS ON CREST AND ROOT TRUNCATION ON DIFFERENT TYPES OF TAPER SCREW THREAD

FIG. 2 THREAD PARAMETERS AND LIMITS ON CREST AND ROOT TRUNCATION ON DIFFERENT TYPES OF TAPER SCREW THREAD

Table 2 Dimensions for Type 1 Taper Threads on Valve Stems and in Cylinder Necks

(*Clause* 8.1.1)

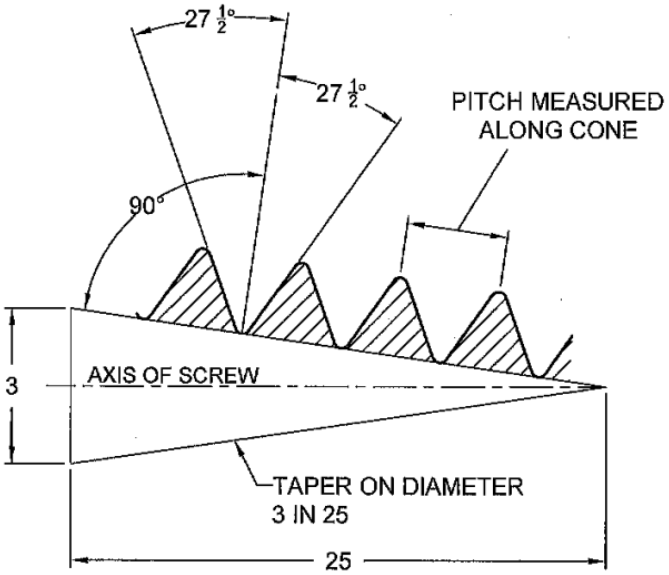
All dimensions in millimetres.

Sl. No.	**Thread Designation**		**Hand Tight Engagement L_1**	**External Threads (on Valve Stem)**							**Internal Threads (in Cylinder Neck)**					
				Small End			Full threads		Large End				Full threads			
				Major Dia D_o	Pitch Dia E_o	Chamfer-45° × Min Dia	Pitch Dia E_8	Length L_8	Major Dia D_{10} approx	Overall Length L_{10} approx	Pitch Dia at Face E_1	Counter 90° × *Max* Dia *KK*	Bore *Max* K_3	Pitch Dia E_3	Length L_1+L_3	Length of Full Root Min L_9
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	Size 2	¾-14 NGT	8.611	26.03	24.58	23	25.799	19.497	27.42	23	25.118	27	22.79	24.24	14.05	17.681

8.1.2 *Type 2 Threads (Size 2), with a Taper of 3 in 25 on Diameter*

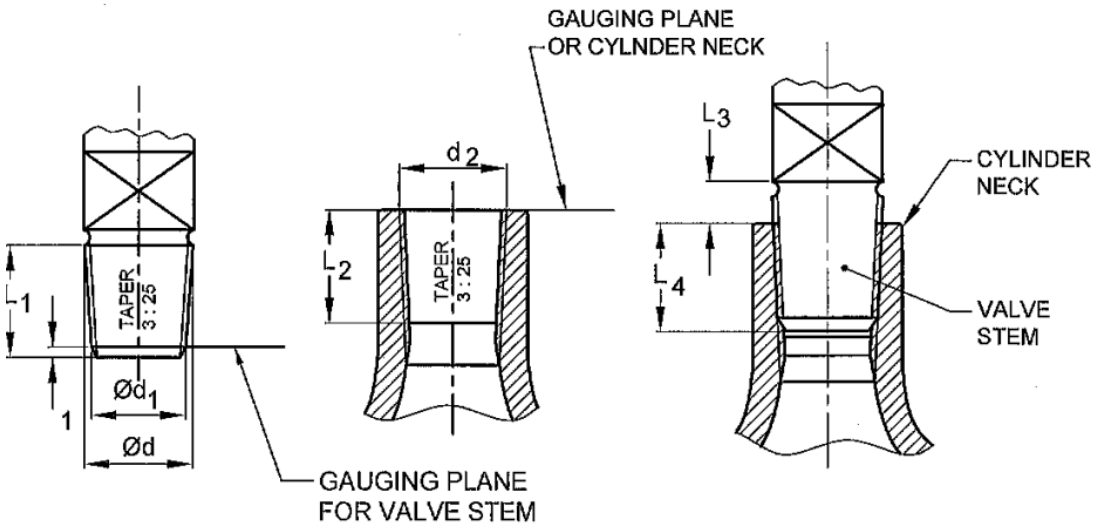
The basic form, principal dimensions and their limits are given in Fig. 3 and Table 3 and Table 4. Type 2 threads shall be inspected as per IS 9122.

NOTE — This type of thread also conforms to DIN 477-1 : 1990 'Gas cylinder valves — Types, sizes and outlets' and ISO 11363-1 : 2018 ' Gas cylinders — 17E and 25E taper threads for connection of valves to gas cylinders Part 1: Specifications'. The 28.8 threads have profile normal to the cone.



Pitch - 1.814 mm
Angle - 55°
Taper - 3 in 25 on Diameter

3A BASIC FORM OF TYPE 2 TAPER THREAD, RIGHT HAND NORMAL TO SURFACE CONE



3B PRINCIPAL DIMENSIONS FOR TYPE 2 TAPER THREADS ON VALVE STEM AND IN CYLINDER NECK

FIG. 3 BASIC FORM AND PRINCIPAL DIMENSIONS FOR TYPE 2 TAPER THREADS

Table 3 Dimensions for Type 2 Taper Threads on Valve Inlet and in Cylinder Necks

(*Clause* 8.1.2)

All dimensions in millimetres.

Sl No.	Nominal Diameter of Valve[1)]	Valve Inlet Thread			Thread in Cylinder Neck		Length of Valve Inlet Thread	
		d +0.12	d_1 +0.12	L_1	d_2 −0.12	L_2 Min	L_3 (*Remaining outside the cylinder*)	L_4 (*Engaged inside the cylinder*)
(1)	(2)	3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	28.8	28.8	25.8	26	27.8	22	8.33	17.67

[1)] Represents the minimum major diameter at the large end of the valve stem.

Table 4 Limits on Principal Dimensions for Type 2 Threads

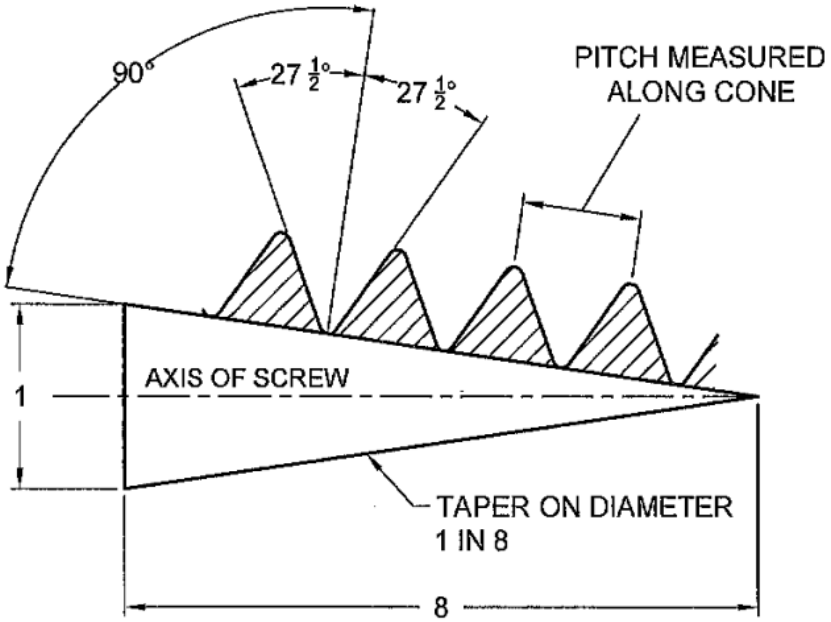
(*Clause* 8.1.2)

All dimensions in millimetres.

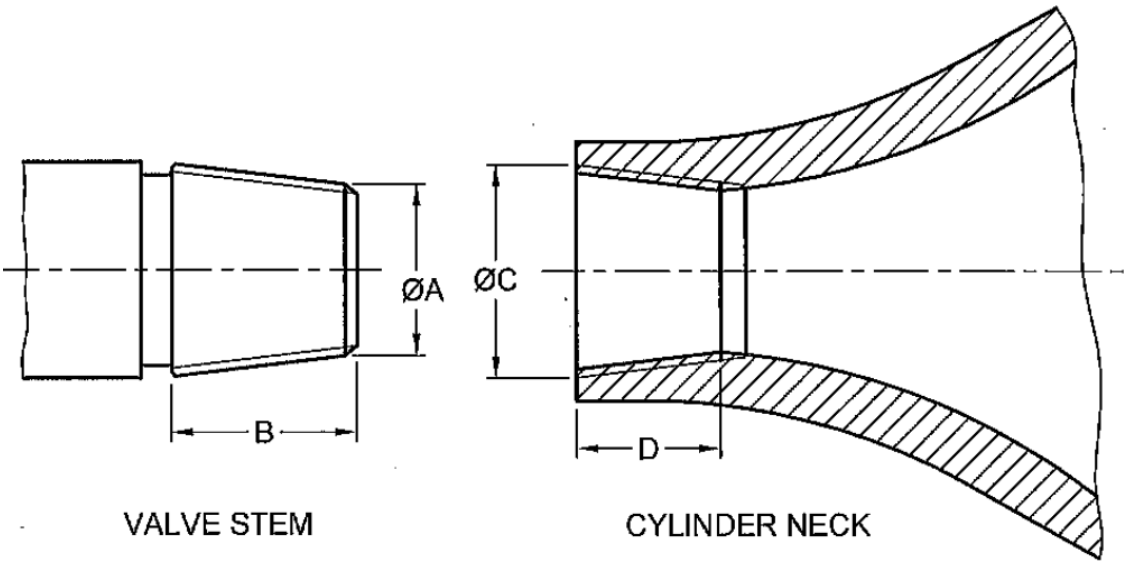
Sl No.	Nominal Diameter of Valve	Thread Element	Diameter of Thread on Valve Stem				Diameter of Thread at Mouth of Cylinder Neck	
			At small end d_1		At large end d			
			Max	*Min*	*Max*	*Min*	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	28.8	Major dia	25.920	25.800	28.920	28.800	27.800	27.680
ii)		Pitch dia	24.759	24.639	27.758	27.638	26.638	26.518
iii)		Minor dia	23.598	23.478	26.596	26.476	25.476	25.356

8.1.3 *Type 4 Threads (Size 2) with a Taper of 1 in 8 on Diameter*

8.1.3.1 The basic thread form, principal dimensions and their limits are given in Fig. 4 and in Table 5 and Table 6 respectively. Type 4 threads shall be checked according to IS 7202.



4A BASIC THREAD FORM OF TYPE 4 THREAD,
ON VALVE STEM AND IN CYLINDER NECK



4B PRINCIPAL DIMENSIONS OF TYPE 4 TAPER THREAD,
RIGHT HAND NORMAL TO SURFACE CONE

FIG. 4 BASIC FORM AND PRINCIPAL DIMENSIONS OF TYPE 4 TAPER THREAD

Table 5 Principal Dimensions of Type 4 Taper Screw Threads on Valve Stems and in Cylinder Neck

(*Clause* 8.1.3)

All dimensions in millimetres.

Sl. No.	Size Designation	Nominal Size of Valve	Taper on Diameter	Pitch Measured Along The Cone	Stem Major Diameter	Length of Thread	Cylinder Neck Major Diameter	Length of Engagement	Length of Thread In Cylinder Neck
		A			*A* *Max*	*B*	*C* *Min*	Min	*D* *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Size 2	25.40	1:8	1.814 3	25.400	$25.40\ ^{+3.17}_{0}$	27.788	19.05	25.40

Table 6 Limits for Type 4 Taper Screw Threads on Valve Stems and in Cylinder Necks

(*Clause* 8.1.3)

All dimensions in millimetres.

Sl. No.	Size Designation	Nominal Size of the Valve	Thread Element	Diameter of Thread on Valve Stem at Small End A		Diameter of Thread at Mouth of Cylinder C	
				Max	*Min*	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Size 2	25.40	Major Dia	25.400	25.197	28.059	27.788
			Pitch Dia	24.237	24.102	26.759	26.624
			Minor Dia	23.073	22.802	25.664	25.461

8.1.3.2 *Type 4 Threads*

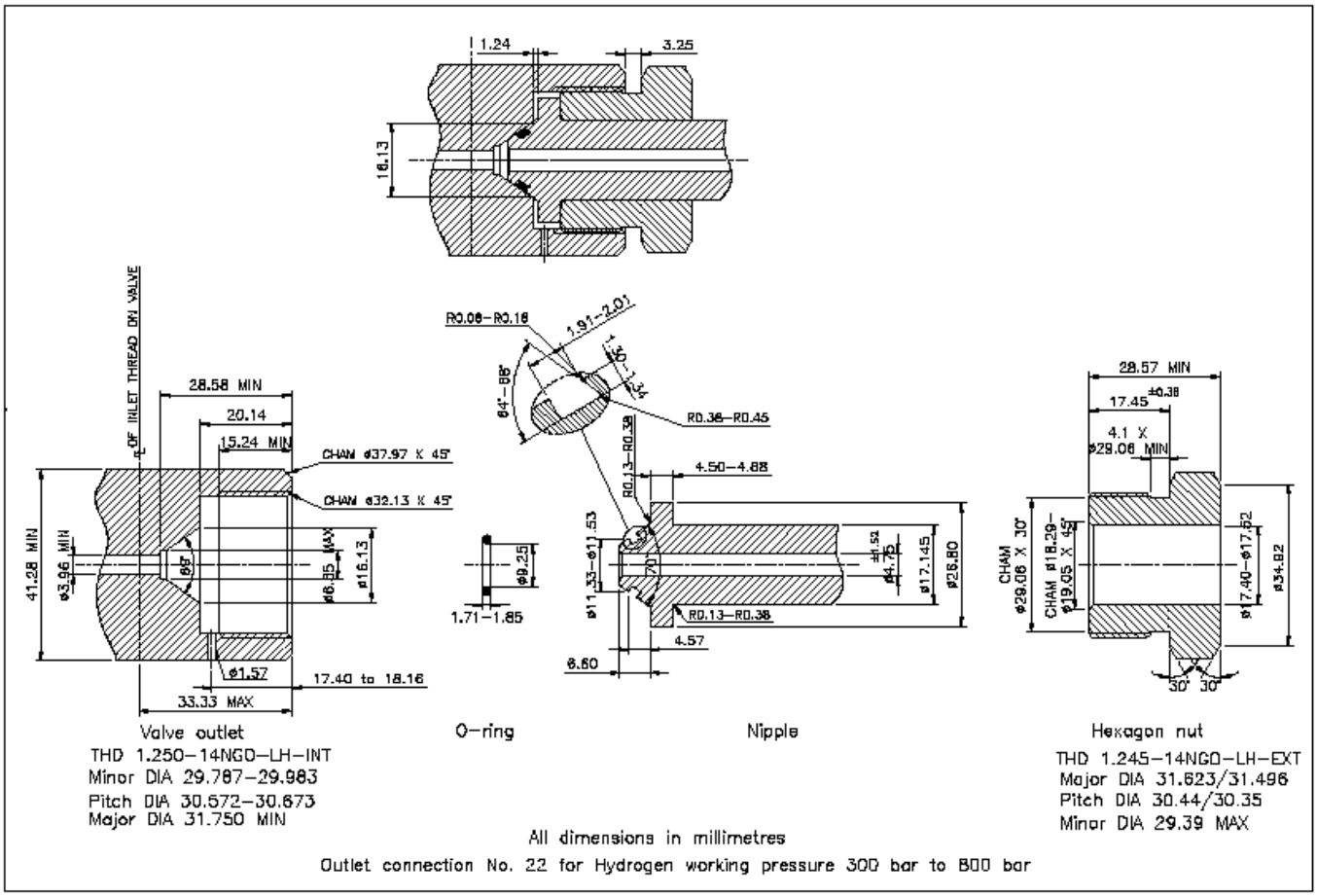
For valve fittings with Type 4 inlet threads on stem, the oversize dimensions are given in Table 8 and is to be read in conjunction with Fig. 4.

9 OUTLET CONNECTIONS

9.1 Valve outlet having internal threads.

9.1.1 The dimension of the valve outlet having internal threads shall be in conformity with the details given in the Fig. 5.

NOTE — Internal threads as shown in the drawing may be without undercut provided minimum length of full threads in the outlet drawing is as specified.



All dimensions in millimetres.

FIG. 5 OUTLET CONNECTION NO. 22 FOR HYDROGEN WORKING PRESSURE 300 BAR TO 800 BAR

9.1.1.2 Any hexagon with a left-hand thread on valve outlet connector shall have notches on the corners for easy identification of the direction of thread.

9.1.1.3 The dimension for connectors, washers and nuts shall be in accordance with the details given for appropriate outlet. These connectors, washers, nuts are not part of the valve.

10 DRAWING

Assembly drawing for a given valve design shall include the following details:

a) Part list and material specification;
b) Hydrogen and corresponding valve working pressure (P_w);
c) Lubricants, if used in the valve;
d) Inlet sizes;
e) Pressure relief device (PRD) details;
f) The maximum water capacity (W_c) of the cylinder for which the design is intended;
g) Electrical ratings; and
h) Variants within a valve design, if any.

Table 7 Test Schedule for Type Testing

(*Clause* 6.6.1)

Sl. No.	Test Schedule	Test and Relevant Sub-clause	Condition of Test Sample	Test Temperature °C	Test Pressure Bar	Test Sample Number	Number of Tests per Sample	Total Number of Tests
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	1	Hydraulic strength test for complete valve (*see* **13.1**)	As received	Room temperature	$2.5 \times P_w$	1	1	1
ii)	2	Excessive torque for complete valve (*see* **10.2.2**)	As received	Room temperature	-	7 to 10	1	4
iii)	3	Internal/external leak tightness, (*see* **10.5**)	As received	Room temperature	*see* Table 10	2 to 6	6	30
iv)	4	Flame Impingement (*see* **10.3**)	As received	Room temperature	—	11	1	1
	Pressure relief device test							
v)	10	Flow capacity of the PRD - Thermal type (*see* **10.4**)	As received	Room temperature		12 to 14	3	3
vi)	11	Flow Capacity of the PRD – Bursting disc type (*see* **10.4**)	As received	Room temperature		15 to 17		
	Mechanical test							
vii)	12	Valving torque test for complete valve (*see* **10.2.1**)	As received	Room Temperature	-	As marked	One from each category covered in the drawing	As applicable

10.2 Mechanical Strength

10.2.1 *Valving Torque Test*

One sample shall be tested from each size covered in the drawing to qualify for this test. Valve designs that have a smaller bore size than the tested sample also are qualified in accordance with this test.

The purpose of this test is to ensure that the valve stem has adequate mechanical strength to prevent shearing during valve installation. A rigidly anchored steel test rig/bung of the same inlet thread is to be used for this test.

Threads of the cylinder neck installed on the test rig and valve test sample shall be gauged to acceptance before carrying out the test.

The test sample shall be tightened using compatible thread sealant/o-ring as applicable. Table 8 gives the values of recommended valving torque for valves with taper stems.

Test sample shall be subjected to over torque value that is 50 percent in excess of the maximum torque value given in Table 8.

There shall be no sign of cracking or permanent deformation of the valve body or cracking of the valve stem. Deformation of the valve stem thread is acceptable.

Table 8 Recommended Valving Torques for Taper Threaded Valve Stems

(*Clauses* 8.2.2, 10.2.1 *and* 10.6.1)

Sl. No.	**Category**	**Inlet Thread Designation**	**Valving Torque (in N.m)**		**Valve Material**
			Seamless Steel Cylinders up to 30 MPa		
			Min	*Max*	
(1)	(2)	(3)	(4)	(5)	(6)
i)	I	¾ - 14 NGT	200	300	Copper and Al. base alloy
ii)		28.8			
iii)		25.4			

NOTE — The torque values given above are for use with PTFE thread sealant. If different sealant or pressure ranges are introduced, the torque figures given in the table may have to be changed to ensure a gas tight joint.

10.2.2 *Excessive Torque Test for Manual Operated Valve*

10.2.2.1 *General*

Four samples shall be used for this test. The purpose of this test is to check that the valve operating mechanism has adequate strength and fails safely, if subjected to excessive torque.

10.2.2.2 *Hand-wheel operated valves*

A closing torque on one test sample shall gradually be increased to T_o according to Table 9. At T_o the valve shall be able to work without noticeable difficulties. It shall not show any damage or failure of any component of the valve operating mechanism and/or valve operating device. This shall be checked by visual examination after dismantling the valve. The operating mechanism will not fail before T_f value.

This test shall then be repeated on two other test samples under the same conditions, but applying an opening torque instead of a closing torque.

Table 9 Torques to be used for the Cycle Test and Excessive Torque Tests
(*Clauses* 4, 6.3.1, 6.3.2, 10.2.2.2, 10.5.2 *and* 10.6.1)

Sl No.	Valve Design as Given in 4	Valve Seal/Seat	Valve Operating Device	Endurance Torque T_c (with a Relative Tolerance of +10/−0 percent) (Nm)	Over Torque T_o (Nm)	Failure Torque T_f (Nm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	O-ring gland seal valve, Pressure seal valve	Non-metallic	Hand wheel diameter D = 65 mm	7	20	25
ii)			Hand wheel/knob of another diameter	$D \times 7/65$	$D \times 20/65$	$1.25 \times T_o$

10.3 Flame Impingement Test

One test sample shall be tested. The valve operating device of the test sample in the open position shall be exposed for 60^{+5}_{0} s to an LPG blowpipe flame of 150 mm length, such that the flame reaches a typical temperature of between 800 °C and 1 000 °C. The valve operating device shall be completely enveloped by the flame.

Although the valve operating device may be damaged during the test, a manually operated valve shall still be possible to be closed by hand after cooling or using a simple tool. For solenoid operating mechanism, it shall be verified that either the operating mechanism is still functioning (open/close) or that the valve is in the closed position.

NOTE — The temperature of the operating device exposed to the flame may be less than the temperature of the flame and need not be measured.

10.4 Flow Capacity of the Pressure Relief Device (PRD)

Three samples shall be tested to determine flow capacity of both PRD with the PRD installed on the valve. The purpose of the test is to measure the rated flow capacity of the pressure relief device (PRD). In case parallel safety is provided both the PRD's shall meet the minimum flow capacity requirement.

The manufacturer will specify the maximum water capacity (W), subject to the minimum of 11 litre capacity for which the valve is designed. The measured flow capacity shall be equal to or greater than the minimum flow capacity calculated for the corresponding water capacity as per **7.2.1**.

10.4.1 *Procedure to Determine Flow Capacity*

a) The device shall be assembled from the inlet of the approach channel to the exit of the discharge channel in the manner normally assembled for use;
b) Each device shall be caused to operate either by pressure or temperature or by a combination of such effects and not exceeding either the maximum temperature or maximum pressure for which the device has been designed;
c) Without cleaning, removing parts, or reconditioning, each pressure relief device shall be subjected to an actual flow test wherein the amount of air released by the device is measured by flow measuring device;
d) Air or N_2 shall be supplied to the PRD through a supply pipe provided with a pressure gauge as close to the inlet of the valve as possible for recording the pressure;
e) The inlet pressure of the air or gas supplied to the safety device shall be 6 kgf/cm^2 gauge pressure;
f) Flow shall be recorded after steady flow conditions have been established; and
g) The rated flow capacity shall be the average flow capacity of devices tested, provided individual flow capacity falls within 10 percent of the highest flow capacity recorded.

NOTE — Ensure that there is no obstruction in flow line and the internal diameter for gas passage from the source/cylinder to the valve inlet is greater than the largest orifice inside the flow passage of the valve from the valve inlet to the opening of the PRD.

10.5 Leak Tightness Test

10.5.1 *General*

Minimum of five samples will be tested. The test shall be conducted with oil free dry air, nitrogen or any inert gas or hydrogen.

Table 10 Test Pressures for Leak Tightness Test

(*Clauses* 6.6.1, 6.6.2, 10.5.2, 10.5.3, 13.2.1, 13.2.2 *and* Table 7)

Sl No.	Test Pressures for Leak Tightness Test
(1)	(2)
i)	5 bar
ii)	10 bar
iii)	P_W

10.5.2 *Internal Leak Tightness Test*

The test shall be carried out in the following order:

a) Seal valve outlet connection(s);
b) Open the valve;
c) The pressure shall be applied to the valve inlet and be raised until the test pressure is reached;

d) Close the valve to the closing torque as specified in Table 9;
e) Open the valve outlet connection and energise solenoid valve to open it; and
f) Wait at least 1 min before measuring the seat leakage rate.

The internal leakage rate shall not exceed the rate specified in **6.6.1**. This test sequence shall be repeated for each test pressure given in Table 10. Before applying the next test pressure, it is allowed to vent the cylinder valve.

10.5.3 *External Leak Tightness Test*

The test shall be carried out in the following order:

a) Seal valve outlet connection(s);
b) Fully open the valve and energised solenoid valve to open it;
c) The pressure shall be applied to the valve inlet and be raised until the test pressure is reached; and
d) Wait at least one min before measuring the total leakage rate;

The external leakage rate shall not exceed the rate specified in **6.6.2.** This test sequence shall be repeated for each test pressure given in Table 10. Before applying the next test pressure, it is allowed to vent the cylinder valve.

10.6 Cycle Test for Manual Operated Valve

10.6.1 *General*

The valve shall perform satisfactorily for not less than 250 cycles of opening and closing operations with valve inlet connected to an air supply of not less than working pressure and the opening travel of the spindle shall not be less than minimum of designed travel during the test. After the cycle test, the valve shall be subjected to the pneumatic test given in **13.2** and shall meet the torque requirement of the Table 9**.**

11 TYPE TEST (DESIGN QUALIFICATION) FOR PRESSURE RELIEF DEVICE (PRD)

11.1 For the tests either the complete valve or the PRD removed from the valve may be tested unless specifically mentioned otherwise for example — vibration test (*see* **11.1.3**).

11.1.1 *Continued Operation (Cyclic) Test*

For thermal PRD and pressure PRD — Four PRD's of each type (each PRD has to be tested independently and not together) shall be tested for continued operation with water or air between maximum 10 percent and minimum 100 percent of the working pressure, at a maximum cyclic rate of 10 cycles per min at a temperature given below:

Sl No	*Temperature* ± 2°C	*Cycles*	*Number of Test Samples*
(1)	(2)	(3)	(4)
i)	85 °C	500	2

At the completion of the test, the PRD shall meet all the requirements of leakage test (*see* **11.1.4**) and activation test (*see* **11.1.5**).

11.1.2 *Thermal Cyclic Test*

For thermal PRD and pressure PRD — One PRD of each type (each PRD has to be tested independently and not together) shall be thermally cycled between −40 °C and 85 °C as given below:

a) Place the depressurized PRD in a fluid bath maintained at −40 °C or lower for a period of 2 h or more. Then transfer the device to a fluid bath maintained at 85 °C or higher within 5 min; and
b) Leave the depressurized PRD in a fluid bath maintained at 85 °C or higher for a period of 2 h or more. Then transfer the device to the fluid bath maintained at −40 °C or lower within 5 min.

Repeat step (a) and step (b) until a total of 15 thermal cycles have been achieved. Cycle the PRD between no more than 10 percent and no less than 100 percent of the working pressure for a total of 100 cycles.

At the completion of the test, PRD shall meet all the requirements of leakage test (*see* **11.1.5**) and activation test (*see* **11.1.4**).

11.1.3 *Vibration Test*

One valve sample shall be vibrated for 2 h in a test apparatus at 17 Hz with amplitude of 1.5 mm in each of the three directions (90 degree towards each other).

On completion of total 6 h of vibration, the valve shall comply with the requirements of leakage test (*see* **11.1.4**) and activation test (*see* **11.1.5**).

11.1.4 *Leakage Test at Low and High Temperature*

PRD's subjected to cyclic test (*see* **11.1.1**), thermal cyclic test (*see* **11.1.2**) and vibration test (*see* **11.1.3**) shall be tested for leakage at following temperatures and pressures given below:

Sl No	*Temperature* (°C)	*Pressure*
(1)	(2)	(3)
i)	−40 °C	$0.75 \times P_w$
ii)	85 °C	P_w

The PRD shall be either bubble free or have a leakage rate less than 10 bubbles per min from a tube of 2.5 mm inside diameter against a water seal of maximum 25 mm – leakage rate shall not be more than 6 cm^3/hr.

11.1.5 *Activation Test*

11.1.5.1 *General*

The purpose of this test is to demonstrate that a pressure PRD will activate consistently throughout its life.
Test one pressure PRD without subjecting it to other tests in order to establish a baseline for activation.

11.1.5.2 *Pressure activated relief device*

Test Setup — Test the bursting pressure of the bursting disc at room temperature.

11.1.5.2.1 *Test procedure*

Activate the PRD at room temperature by pressurizing until the rupture disc bursts and record the pressure of activation.

11.1.5.2.2 *Requirement*

The PRD subjected to cyclic test (*see* **11.1.1**), thermal cyclic test (*see* **11.1.2**) and vibration test (*see* **11.1.3**) shall activate at a pressure greater than 75 percent and less than 105 percent of the activation pressure of a PRD which has not been subjected to any previous tests.

12 TYPE TESTS FOR EXCESS FLOW

12.1 Excess flow valve shall be tested hydraulically at pressure at 2.5 times the working pressure.

12.2 The excess flow valve shall cut-off at pressure difference over the valve of 0.65 MPa maximum or as per customer requirement (not exceeding 0.65 MPa).

12.3 The residual leak of the excess flow valve when activated shall not exceed 0.05 Nm^3/min at differential pressure of 10 MPa.

12.4 Excess flow valve shall be cycled 20 times at working pressure at differential pressure. One cycle consists of one opening and one closing. Upon the completion of test, excess flow valve shall comply with **12.2** and **12.3**.

13 TYPE TESTS FOR SOLENOID OPERATING MECHANISM

13.1 Hydraulic Strength Test (For Complete Valve)

One valve sample shall be subjected to 2.5 times the working pressure (P_w) by water or any other suitable fluid at room temperature. During the test, the valve outlet shall be plugged and solenoid valve as well as manual valve shall be in open position. Valves shall not show visible evidence of rupture or permanent distortion after minimum 3 min of test period at room temperature.

The hydraulic pressure shall be increased at a rate of not more than 1.4 MPa/s.

NOTE — The samples used in this test shall not be used for any other testing.

13.2 *Internal and External Leak Tightness Test*

Five valve samples will be tested for leakage as per following procedure at a temperature and pressure given in Table 11.

Table 11 Test Temperatures and Pressures

(*Clause* 13.2)

Sl. No.	**Temperature** (°C)	**Pressure** (bar)	
		First	Second
(1)	(2)	(3)	(4)
i)	−40	$0.75 \times P_w$	5
ii)	Room temperature	$0.025 \times P_w$	P_w
iii)	85	$0.05 \times P_w$	
	NOTE — During the test both PRD will be removed and plugged.		

13.2.1 *Internal Leak Tightness Test*

The test shall be carried out in the following sequence:

a) Seal valve outlet connection(s);
b) Keep the manual valve in open position;
c) Energize the solenoid valve to make it in an open position;
d) The test pressure shall be applied to the valve inlet;
e) De-energise the solenoid valve to make it in close position;
f) Open the valve outlet connection; and
g) Wait at least 1 min before measuring the leakage rate.

The internal leakage rate shall not exceed 6 cm^3/h corrected to NTP, this test sequence shall be repeated for each test pressure given in Table 10. Before applying the next test pressure, it is allowed to vent the cylinder valve.

13.2.2 *External Leak Tightness Test*

The test shall be carried out in the following sequence:

a) Seal valve outlet connection(s);
b) Energize the solenoid valve to make in an open position;
c) The test pressure shall be applied to the valve inlet; and
d) Wait at least one min before measuring the total leakage rate.

The external leakage rate shall not exceed 6 cm^3/h corrected to NTP.

This test sequence shall be repeated for each test pressure given in Table 10. Before applying the next test pressure, it is allowed to vent the cylinder valve.

NOTE — During this test keep the manual valve in open position.

13.3 Continued Operation

Two samples shall be tested for 25 000 cycles of opening and closing of solenoid valve at working pressure. A cycle shall consist of one opening and one closing within a period of not less than 10 s ± 2 s. Following the continued operation, the leakage rate will confirm to **13.2**.

During the off-cycle, the downstream pressure of the test fixture shall be lowered to a maximum of 50 percent of working pressure.

13.4 Insulation Resistance

This test is designed to check for a potential failure of the insulation between the two-pin coil assembly and the automatic valve casing.

Apply 1 000 V d.c. between one of the connector pins and the housing of the test sample for at least 2 s. The minimum allowable resistance shall be 240 kΩ.

13.5 Minimum Opening Voltage

The minimum opening voltage at room temperature shall be less than or equal to 8V for a 12V system and greater than or equal to 16V for a 24V system. The component shall be pressurized at 0.75 times working pressure during the test.

13.6 Electrical over Voltage Test

Solenoid coil of the valve shall withstand application of 1.5 times the rated voltage ± 5 percent for 3 min without failure.

NOTE — If the Valve is enclosed in a gas-tight housing, it shall be intrinsically safe as defined in IEC 60079-10-1.

14 CORROSION RESISTANCE TEST

14.1 Valves shall perform safely following exposure to salt spray according to the following test method.

14.2 Valve supported in its normal installed position, expose it for 500 h to a salt spray (fog) test.

14.3 Maintain the temperature within the fog chamber between 33 ºC and 36 ºC.

14.4 The saline solution shall consist of 5 percent sodium chloride and 95 percent distilled water, by weight.

14.5 Immediately after the corrosion test, rinse the sample and gently clean it of salt deposits, then subject it to the test according to **10.5**. The valve should conform to the requirements of leakage tightness test as per **10.5**.

14.6 Immediately following the corrosion test and leakage testing, subject it to the hydrostatic strength test according to **13.1**. The valve should conform to the requirements of hydraulic strength test as per **13.1**.

15 OXYGEN AGING TEST

All synthetic or non-metallic parts components of the valve that shall not crack or show visible evidence of deterioration after oxygen ageing when tested according to the following procedure.

Subject representative samples to minimum 96 h of exposure to oxygen at a temperature of 70 ^{o}C $\pm$ 5 ^{o}C, at minimum 2 MPa (20 bar).

16 NON-METALLIC MATERIAL IMMERSION

16.1 A part made of non-metallic material in contact with gaseous hydrogen shall be in accordance with **14.2** of ISO 12619-2, and not show excessive change in volume or weight when tested according to the following procedure:

a) Prepare, measure and weigh a representative sample or samples of each non-metallic synthetic material used in a component, then immerse the sample or samples at room temperature in gaseous hydrogen at a pressure equal to its working pressure, but not less than 100 kPa for a minimum of 70 h; and
b) Following this period of immersion, rapidly reduce the test pressure to atmospheric pressure without causing shredding or disintegration.

No tested sample shall exhibit swelling greater than 25 percent or shrinkage greater than 1 percent. The weight change shall not exceed 10 percent.

17 METALLIC MATERIAL COMPATIBILITY TO HYDROGEN

All metallic components or subcomponents in contact with CGH2 shall be tested according to IS/ISO 11114-4.

18 OZONE AGEING

Sealing materials shall be tested for ozone ageing. They shall not crack or show visible evidence of deterioration subsequent to ozone ageing as specified herein.

The test piece, which has to be stressed to 20 percent elongation, shall be exposed to air at 40 C with an ozone concentration of 50 parts per hundred million for 120 h.

19 VIBRATION RESISTANCE

Complete valve pressurized to its working pressure with test gases and sealed at both ends for 30 min along each of the three orthogonal axed at the most severe resonant frequency determined with consideration of installing to the vehicle as follows:

a) By an acceleration of 1.5 g;
b) Within a sinusoidal frequency range of 10 Hz to 500 Hz;
c) With a sweep time of 10 min.

If the resonance frequency is not found in this range the test shall be conducted at 500 Hz.

At the completion of the test, the component shall not show any indication of fatigue or component damage, and shall comply with the leakage test specified in **10.5** and the hydraulic test in **13.1** specified.

20 PRODUCTION INSPECTION AND TESTING

20.1 Tensile Strength and Elongation Test

Samples from each batch of valve bodies as per Table 12 (Scale of Sampling) shall be subjected to the test for tensile and elongation of the material of the valve body for meeting the requirements as per **5.3.1** and the lot shall be declared satisfactory with respect to the requirement of tensile and elongation test if each sample passes the test satisfactorily.

20.2 Izod Impact Test

Samples from each batch of valve bodies as per Table 12 (Scale of Sampling) shall be subjected to the impact test (Izod impact strength) for meeting the requirements as per **5.3.2** and the lot/batch shall be declared satisfactory with respect to the requirement of Izod impact test, if each sample passes the test satisfactorily.

20.3 Internal and External Tightness Test

All valves shall be tested for external and internal leakage by air or nitrogen at room temperature at working pressure (P_w) tested with PRD fitted. For manual valve test to be carried out as per **6.6** and for solenoid valve as per **13.2**.

20.4 Tests for Pressure Relief Device (PRD)

20.4.1 Samples shall be randomly selected as per scale of sampling given in Table 14.

20.4.2 Bursting disc (pressure safety device) shall be checked for bursting pressure as per procedure described in IS 5903.

20.4.3 Thermal safety device shall be checked for yield temperature.

20.4.4 *Checking of Inlet Connection*

Samples from each batch of valves as per the scale of sampling given in Table 13 will be checked for inlet dimension. The threads shall be checked by calibrated ring gauges.

20.4.5 *Checking of Outlet Connection*

Samples from each batch of valves as per the scale of sampling given in Table 13 will be checked for outlet dimensions. The threads shall be checked by calibrated gauges and other dimensions by vernier caliper or suitable measuring device.

Table 12 Scale of Sampling

(*Clauses* 20.1 *and* 20.2)

Sl No.	**Lot/Batch Size**	**Sample Size**
(1)	(2)	(3)
i)	Up to 500	2
ii)	From 501 to 1 000	4
iii)	From 1 001 to 2 000	6
iv)	From 2 001 to 3 000	8

Table 13 Scale of Sampling

(*Clauses* 20.4.4 *and* 20.4.5)

Sl No.	**Lot/Batch Size**	**Sample Size**
(1)	(2)	(3)
i)	Up to 500	10
ii)	From 501 to 1 000	15
iii)	From 1 001 to 2 000	20
iv)	From 2 001 to 3 000	25

Table 14 Scale of Sampling

(*Clause* 20.4.1)

Sl No.	**Lot/Batch Size**	**Sample Size**
(1)	(2)	(3)
i)	From 3 to 8	2
ii)	From 9 to 15	3
iii)	From 16 to 30	4
iv)	From 31 to 100	6
v)	From 101 to 250	8
vi)	From 251 to 1 000	10
vii)	From 1 001 to 3 000	15

21 MARKING

21.1 Hydrogen/ Hydrogen natural gas valves complying with this standard shall be durably and legibly marked in service with:

a) Year and month of manufacture, that is, YYYY/MM;
b) Valve lot/batch identification;
c) H_2/hydrogen natural gas;
d) Manufacturer's identification;
e) Number of this standard;
f) Working pressure of the valve;
g) Inlet thread code;
h) Outlet thread code;
j) The specified bursting pressure of the bursting disc (pressure safety device);
k) Actuating temperature of the thermal safety device; and
m) Electrical ratings (operating voltage).

21.2 BIS CERTIFICATION MARKING

21.2.1 Each valve may also be marked with the Standard Mark.

21.2.2 The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 1598 : 1977	Method for Izod impact test of metals (*first revision*)
IS 1608 (Part 1) : 2022/ ISO 6892-1 : 2019	Metallic materials — Tensile testing: Part 1 Method of test at room temperature (*fifth revision*)
IS 1608 (Part 2) : 2020/ ISO 6892-2 : 2018	Metallic materials — Tensile testing: Part 2 Method of test at elevated temperature (*fourth revision*)
IS 1608 (Part 3) : 2018/ ISO 6892-3 : 2015	Metallic Materials — Tensile testing: Part 3 Method of test at low temperature
IS 3224 : 2021	Valve for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders —Specification (*fourth revision*)
IS 5903 : 2014	Recommendation of safety devices for gas cylinders (*first revision*)
IS 7202 : 2017	Inspection gauges for checking type iv (size 1, 2 and 3) taper threads of gas cylinder valves and cylinder necks — Specification (*first revision*)
IS 7241 : 1981	Glossary of terms used in gas cylinder technology (*first revision*)
IS 9122 : 2023	Inspection gauges for checking type 2 taper thread of gas cylinder valves, taper 3 in 25 — Specification (*second revision*)
IS/ISO 11114-1 : 2020	Gas cylinders — Compatibility of cylinder and valve materials with gas contents: Part 1 Metallic materials (*first revision*)
IS/ISO 11114-2 : 2013	Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents: Part 2 Non-metallic materials
IS/ISO 11114-4 : 2017	Transportable gas cylinders **—** Compatibility of cylinder and valve materials with gas contents: Part 4 Test methods for selecting steels resistant to hydrogen embrittlement (*first revision*)
IS 15894 : 2018	Inspection gauges for checking taper threads of gas cylinder valves and cylinder necks — Taper 1 in 16 on diameter — Specification (*first revision*)
IS 15975 : 2020	Gas cylinders — Conditions for filling gas cylinders (*first revision*)
ISO 12619-2 : 20174	Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — Part 2 Performance and general test methods
IEC 60079-10-1 : 2020	Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres

ANNEX B

(*Clause* 5.4)

SAMPLING SCHEME FOR EVALUATION OF MECHANICAL PROPERTIES OF MATERIAL OF VALVE BODY

B-1 SCALE OF SAMPLING

B-1.1 Lot

In any consignment, all valve body blanks of same material and size manufactured under similar processes of production shall constitute a lot.

B-1.2 Valve body blanks shall be selected and examined for each lot separately for ascertaining their conformity to the requirements of mechanical properties.

B-1.3 The number of valve bodies to be selected from a lot shall depend upon the size of the lot and shall be in accordance with col (2) and col (3) of Table 15. All these samples shall be taken at random from the lot.

Table 15 Scale of Sampling

(*Clauses* B-1.3 *and* B-1.4)

Sl. No.	Lot Size	Sample size
(1)	(2)	(3)
i)	Up to 500	4
ii)	From 501 to 1 000	8
iii)	From 1 001 to 2 000	12
iv)	From 2 001 to 3 000	16
	NOTE — An allowance of a maximum of 2 percent in the lot size is permissible.	

B-1.4 All the valve body blanks, selected in accordance with col (2) of Table 15, shall be divided into two equal sets. The tensile and elongation tests shall be carried out on all the samples of the first and the Izod impact test on the second set.

B-2 CRITERIA FOR CONFORMITY

B-2.1 For Tensile and Elongation Test (*see* 5.3.1)

All the samples of the first half (*see* **B-1.1**) shall be tested for tensile and elongation test. The lot shall be declared as satisfactory with respect to the requirements of tensile and elongation tests if each sample passes the test satisfactorily.

B-2.2 For Impact Test (*see* **5.3.2**)

All the samples of the second half (*see* **B-1.1**) shall be tested for Izod impact test. The lot shall be declared satisfactory with respect to the requirements of Izod impact test if each sample passes the test satisfactorily.

B-2.3 The lot shall be declared as conforming to the requirements of mechanical properties if it has been found satisfactory according to **B-2.1** and **B-2.2**. If any test sample fails to meet the requirements of **B-2.1** or **B-2.2**, additional specimens equalling twice the number of sample size for the failed test in the same lot shall be taken and tested for the failed test only. If any of these specimens fails to meet the requirements, the entire lot represented shall be rejected.