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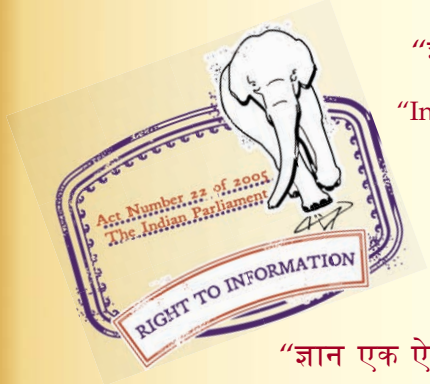
IS 5903 (1970): Recommendations for safety devices for gas cylinders [MED 16: Gas Cylinders]



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RECOMMENDATION FOR SAFETY DEVICES FOR GAS CYLINDERS

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

Gr 5 *April* 1971

Indian Standard

RECOMMENDATION FOR SAFETY DEVICES FOR GAS CYLINDERS

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Indian Standard

RECOMMENDATION FOR SAFETY DEVICES FOR GAS CYLINDERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 5 October 1970, after the draft finalized by the Gas Cylinders Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 This standard has been prepared to provide guidance on the requirements of safety devices used for gas cylinders.

0.3 Manufacture, possession and use of any gas when contained in cylinders in a compressed or liquefied state are regulated under the Gas Cylinder Rules, 1940 of the Government of India. This specification has been prepared in consultation and agreement with the statutory authorities under those rules.

0.4 Whilst all essential requirements have been set out in considerable details, other requirements are purposely left out to permit a reasonable degree of latitude to designers and users.

0.5 In the preparation of this standard, considerable assistance has been derived from the following:

A.S. B 281-1969 Safety devices for gas cylinders. Standards Association of Australia.

CGA Pamphlet S-1.1 Safety relief device standards. Part I Cylinders for compressed gases. Compressed Gas Association, U.S.A.

0.6 Where provision is made in this standard for certain details to be settled by agreement between the purchaser and the manufacturer, it shall be understood that, where applicable, such details are subject also to agreement by the Chief Inspector of Explosives, Nagpur.

0.7 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, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers requirements for the design, construction, testing and certification of safety devices for gas cylinders.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 **Approach Channel** — The passage or passages through which gas must pass from the cylinder to reach the operating parts of the safety device.

2.2 **Bursting Disc** — An operating part of a safety device in the form of a disc, usually of metal and which is so held as to close the safety device channel under normal conditions. The disc is intended to burst at a predetermined pressure to permit the escape of gas.

NOTE — Such discs are generally flat, preformed, reinforced, or grooved types.

2.3 **Combination Bursting Disc — Fusible Plug** — A bursting disc in combination with a low melting point fusible metal, intended to prevent the disc bursting at its predetermined bursting pressure unless the temperature also is high enough to cause yielding or melting of the fusible metal.

2.4 **Combination Pressure-Relief Valve — Fusible Plug** — A safety device utilizing a pressure-relief valve in combination with a fusible plug. This combination device may be an integral unit or separate units and is intended to open and to close at predetermined pressures or to open at a predetermined temperature.

2.5 **Discharge Channel** — The passage or passages beyond the operating parts through which gas must pass to reach the atmosphere exclusive of any piping attached to the outlet of the device.

2.6 **Flow Capacity** — The capacity in cubic metre per hour of free air discharged at the required flow rating pressure.

2.7 **Flow Rating Pressure** — The pressure at which a safety device is rated for capacity.

2.8 **Free Air or Free Gas** — Air or gas measured at normal atmospheric pressure and a temperature of 15°C.

2.9 **Fusible Plug** — An operating part in the form of a plug of suitable low melting point material, usually a metal alloy, which closes the safety device channel under normal conditions and is intended to yield or melt at a predetermined temperature to permit the escape of gas.

2.10 Liquefied Gas — For the purposes of flow capacity assessment a gas which, under the charging pressure, is partially liquid at a temperature of 21°C. A flammable compressed gas which is normally non-liquefied at 21°C, but which is partially liquid under the charging pressure and temperature, is also deemed to be a liquefied gas.

2.11 Operating Part — The part that normally closes the safety discharge channel but when moved from this position as a result of the action of heat or pressure or a combination of the two, permits escape of gas from the cylinder.

2.12 Non-liquefied Gas — For the purposes of flow capacity assessment, a gas, other than a gas in solution, which, under the charging pressure, is entirely gaseous at a temperature of 21°C.

2.13 Pressure Opening — The orifice against which the bursting disc functions.

2.14 Pressure-Relief Valve — A safety device containing an operating part that is held normally in a position closing the safety device channel by spring force and is intended to open and to close at predetermined pressures.

2.15 Rated Bursting Pressure (of a Bursting Disc) — The maximum pressure at which the disc is designed to burst at the rated temperature when in contact with the pressure opening for which it was designed, when tested as required in **7.2.2.**

2.16 Rated Temperature (of a Bursting Disc) — The temperature at which a bursting disc is designed to burst when the rated bursting pressure is applied to the disc and when it is in contact with the pressure opening for which it was designed. Unless otherwise specified and stated, it is to be taken as 65°C.

2.17 Reinforced Fusible Plug — A fusible plug consisting of a core of suitable material having a comparatively high yield temperature surrounded by a low melting point fusible metal of the required yield temperature.

2.18 Safety Device — A device intended to prevent rupture of a cylinder under abnormal conditions of exposure.

NOTE — The term as used herein includes the approach channel, the operating parts, and the discharge channel (*see* **2.1, 2.5** and **2.11**).

2.19 Safety Device Channel — The channel through which gas released by operation of the device must pass from the cylinder to the atmosphere exclusive of any piping attached to the inlet or outlet of the device.

2.20 Set Pressure (of a Pressure-Relief Valve) — The minimum pressure at which a pressure-relief valve is set to start-to-release (*see* **6.1.4**).

2.21 Start-to-Release Pressure (of a Pressure-Relief Valve) — The pressure at which the first bubble appears through a water seal of not over 100 mm on the outlet of the pressure-relief valve (*see* **7.5**).

2.22 Test Pressure of the Cylinder — The internal pressure required for hydraulic stretch or pressure test of the cylinder.

2.23 Type Test — A test applied to a representative sample of each design or modification, of a safety device to establish the adequacy of the design or modification (*see* **7**).

2.24 Yield Temperature (of a Fusible Plug) — The temperature at which the fusible metal or alloy will yield when tested as required in **7.3.2.4**.

3. TYPES OF SAFETY DEVICES

3.1 Types of Safety Devices — Types of safety devices covered by this specification are designated as follow.

3.1.1 *Type BD* — Bursting disc.

3.1.2 *Type* FP_1 — Fusible plug or reinforced fusible plug utilizing a fusible alloy with yield temperature not over 77°C, nor less than 69°C (74°C nominal).

3.1.3 *Type* FP_2 — Fusible plug or reinforced fusible plug, utilizing a fusible alloy with yield temperature not over 104°C, nor less than 98°C (100°C nominal).

3.1.4 *Type* BD/FP_1 — Combination bursting disc/fusible plug, utilizing fusible alloy with yield temperature not over 77°C, nor less than 69°C (74°C nominal).

3.1.5 *Type* BD/FP_2 — Combination bursting disc/fusible plug, utilizing a fusible alloy with yield temperature not over 104°C, nor less than 98°C (100°C nominal).

3.1.6 *Type PRV* — Pressure-relief valve.

3.1.7 *Type PRV/FP* — Combination pressure-relief valve/fusible plug.

4. INFORMATION TO BE SPECIFIED BY THE PURCHASER

4.1 The purchaser in his enquiry and order shall supply sufficient information to fully identify the fitting required including, where appropriate, the following:

a) Name of gas for use with safety device;

b) Type of safety device (*see* **3**);

c) Set pressure in kgf/cm² (gauge) (for pressure-relief valves);

d) **Nominal yield temperature**, °C (for fusible plugs) (*see* 3);

e) **Flow capacity**;

f) Any special material, dimensional, finish, or identification requirements; and

g) Pressure opening of the orifice against which the bursting disc has to operate and the rated bursting pressure of the disc.

5. FIELD OF APPLICATION

5.1 Cylinders containing obnoxious or poisonous gases shall not be provided with any safety device. Some of these gases are listed below:

Carbon monoxide	Methyl bromide
Anhydrous hydrogen chloride	Nitrogen peroxide
Anhydrous hydrogen bromide	Nitrosyl chloride
Anhydrous hydrogen fluoride	Boron trifluoride
Sulphur dioxide	Town gas
Chlorine	Hydrogen sulphide
Methylamine	Carbonyl Chloride

6. DESIGN AND CONSTRUCTION

6.1 Specific Requirements

6.1.1 *All Safety Devices* — In addition to the requirements for the specific type of safety device given in **6.1.2** to **6.1.5**, the following general requirements shall apply:

a) The material, design and construction of a safety device shall be such that there will be no significant change in the functioning of the device and no serious corrosion or deterioration of the materials within the period between renewals, due to service conditions. The chemical and physical properties of the materials shall be uniform and suitable for the requirements of the part manufactured therefrom.

b) Methods of manufacture, inspection and tests shall conform to best current practices in order to attain satisfactory performance of the safety devices.

c) The design, material and location of safety devices shall have been proved to be suitable for the intended service.

6.1.2 *Bursting Discs* — When a bursting disc is used with a compressed gas cylinder, the rated bursting pressure of the disc, when tested at a temperature of 65°C in accordance with **7.2.2**, shall not exceed the minimum required test pressure of the cylinder for which the device is intended.

6.1.3 *Combination Bursting Disc/Fusible Plug* — In combination bursting disc/fusible plug devices, the fusible metal shall be on the discharge side of the bursting disc. The fusible metal shall not be used in place of a gasket to seal the disc against leakage around the edges. Gaskets, if used shall be of material which will not deteriorate when in contact with the gas to be contained at the maximum temperature specified for the fusible metal.

6.1.4 *Pressure-Relief Valves*

6.1.4.1 When a pressure-relief valve is used on a compressed gas (liquefied or non-liquefied) cylinder, the flow rating pressure shall not exceed the minimum test pressure of the cylinder on which the pressure-relief valve is installed and the resealing pressure shall not be less than 70 percent of the minimum test pressure of the cylinder.

6.1.4.2 The set pressure shall be not less than 80 percent of the minimum required test pressure of the cylinder on which the pressure-relief valve is installed.

6.1.4.3 The design of the pressure-relief valve shall be such that the valve will have direct communication with the vapour space of the cylinder when in normal use and the possibility of unauthorized adjustment will be minimized.

6.1.5 *Combination Pressure-Relief Valve/Fusible Plug* — A combination pressure-relief valve/fusible plug safety device shall meet the following requirements:

a) If 100 percent of the required flow capacity is provided by a pressure-relief valve, the supplementary fusible plug may be either Type FP_1 or FP_2.

b) Where the pressure-relief valve provides less than 100 percent of the required flow capacity, the balance shall be supplied by a Type FP_1 fusible plug.

c) Where the flow capacities of a pressure-relief valve and a Type FP_1 fusible plug are to be combined to provide the required flow capacity, the minimum flow capacity to be provided by the fusible plug shall be that calculated as follows:

Using the total water capacity of the container, the flow capacity for a pressure-relief valve shall be calculated by using the formula in **6.2.4** or **6.2.5**; the flow capacity of the pressure-relief valve shall then be divided by the calculated flow capacity required to obtain the percentage provided by the pressure-relief valve; the remaining percentage for the fusible plug shall then be multiplied by total

water capacity to obtain the water capacity figure for use in calculating the minimum flow capacity to be provided by the fusible plug, using the formula in **6.2.2** or **6.2.3**.

Example:

Liquefied gas; a 450-litre water capacity cylinder; a pressure-relief valve with flow capacity 2 060 m³/h at 35 kgf/cm² (absolute).

Using formula in **6.2.5**

$$Q_a = 0{\cdot}164\ PW_c$$
$$= 0{\cdot}164 \times 35 \times 450$$
$$Q_a = 2\,580\ \text{m}^3/\text{h}$$
$$\frac{2\,060}{2\,580} = 80 \text{ percent by pressure-relief valve}$$

Using formula in **6.2.3**

20 percent of 450 = 90 litre water capacity

$$Q_a = 1{\cdot}148\ W_c$$
$$= 1{\cdot}148 \times 90 = 103{\cdot}3\ \text{m}^3/\text{h}$$ flow capacity at 7 kgf/cm² (absolute) provided by fusible plug

Where Q_a is the flow capacity at 7 kgf/cm² (absolute) test pressure in m³/h of free air.

6.2 Flow Capacity of Safety Devices

6.2.1 *General* — The flow capacity of each design and modification thereof of all types of safety devices shall be determined from the relevant formula in **6.2.2** to **6.2.5** by an actual flow test in accordance with **7.1.1**.

6.2.2 *Safety Devices for Use with Non-liquefied Gas (Except Pressure-Relief Valves)* — The minimum required flow capacity of safety devices, except pressure-relief valves, for installation in non-insulated cylinders for non-liquefied gas shall be calculated by the following formula:

$$Q_a = 0{\cdot}574\ W_c$$

where

Q_a = flow capacity at 7 kgf/cm² (absolute) in m³/h of free air, and

W_c = water capacity of the cylinder in litres, which in any case shall not be taken as less than 10 litres.

NOTE — The above formula expresses flow capacity requirements equal to 70 percent of that which will discharge through a perfect orifice (having 0·15 mm² area for each litre of water capacity of the cylinder).

6.2.3 *Safety Devices for Use with Liquefied Gas (Except Pressure-Relief Valves)* — The minimum required flow capacity of safety devices, except pressure-relief valves, for installation in non-insulated cylinders for liquefied gas shall be calculated by the following formula:

$$Q_a = 1{\cdot}148\ W_c$$

where

Q_a = flow capacity at 7 kgf/cm² (absolute) in m³/h of free air, and

W_c = water capacity of the cylinder in litres, which in any case shall not be taken as less than 10 litres.

NOTE — The above formula expresses flow capacity requirements equal to 35 percent of that which will discharge through a perfect orifice (having 0·15 mm² area for each litre of water capacity of the cylinder).

6.2.4 *Safety Devices for Use With Non-liquefied Gas Pressure-Relief Valves Only)* — The minimum required flow capacity of pressure-relief valves for installation in non-insulated cylinders for non-liquefied gas shall be calculated by the following formula:

$$Q_a = 0{\cdot}082\ PW_c$$

where

Q_a = flow capacity in m³/h of free air,

P = flow rating pressure in kgf/cm² (absolute), and

W = Water capacity of the cylinder in litres, which in any case shall not be taken as less than 5 litres.

6.2.5 *Safety Devices for Use with Liquefied Gas (Pressure-Relief Valves Only)* — The minimum required flow capacity of pressure-relief valves for installation in non-insulated cylinders for liquefied gas shall be calculated by the following formula:

$$Q_a = 0{\cdot}164\ PW_c$$

where

Q_a = flow capacity in m³/h of free air,

P = flow rating pressure in kgf/cm² (absolute), and

W_c = water capacity of the cylinder in litres, which in any case shall not be taken as less than 5 litres.

6.3 Piping for Safety Devices — Where fittings and piping are used on either the upstream or downstream side or both of a safety device or devices the passages shall be so designed that the flow capacity of the

safety device will not be reduced below the capacity required for the cylinder on which the safety device assembly is installed, nor to the extent that the operation of the device could be impaired. Fittings, piping and method of attachment shall be designed to withstand normal handling and the pressures developed when the device or devices function.

6.4 Shut-Off Device Prohibited — No shut-off device, other than that which may be built into the safety device itself, shall be installed in either the approach channel or the discharge channel.

6.5 Identification and Marking

NOTE — If the performance of safety devices is not to be jeopardized by improper service practices, certain safeguards or guides in regard to identification and marking are essential. The aim, in general, is to make it possible to identify the manufacturer of the devices and to have the main replaceable parts so identified or coded that it may be readily determined, usually by reference to manufacturer's published data, if parts are intended to function together, what operating pressure range or temperature range they will provide for, and whether they have adequate flow capacity for the cylinder with which they are to be employed. In particular, it is pointed out that bursting discs can be applied only against pressure openings for which they are specifically designed. For example, some manufacturers may be employing sharp pressure opening contours while others may be employing rounded or other shaped contours. Because of these contour variations, an intercharge of discs will give widely different bursting pressures, even though the same diameter may be employed for the bursting pressure opening. In addition, variation in diameter for the pressure opening will give still wider variation in bursting pressure if discs are interchanged improperly.

6.5.1 *All Safety Devices*

6.5.1.1 In addition to the specific requirements for the type of safety devices given in **6.5.2** to **6.5.5**, all uninstalled safety devices shall be identified by impressing on metal where practicable, or alternatively, by firmly affixing an identification tag (which may be removed at the time of installation) showing:

a) the manufacturer's name or trade-mark;

b) type number;

c) batch identification; and

d) pressure, flow capacity, and/or temperature rating, as applicable.

6.5.1.2 Where a knowledge of the date of manufacture is necessary for proper maintenance of a safety device, the month and year of manufacture shall be marked on the device.

6.5.1.3 Where there is insufficient room for marking the full information, identification required may be coded in which case the code designation shall be determined from the data provided by the manufacturer.

6.5.2 *Individual Components of Bursting Disc Assemblies* — When bursting discs and pressure opening parts are designed to be replaced as components, they shall be marked to indicate the rated bursting pressure (with the proper mating part), the flow capacity and the manufacturer.

NOTE — The following are suggested methods of marking:

a) Stamp to identify the rated bursting pressure or identifying part number, on the part containing the pressure opening,

b) Ink, or otherwise mark, the number on the bursting disc, or apply other code mark, to facilitate determination of bursting pressure range and proper mating parts.

6.5.3 *Fusible Plugs* — Fusible plugs shall be externally marked (by coding if necessary) to indicate yield temperature rating and flow capacity.

6.5.4 *Pressure-Relief Valves* — Pressure-relief valves shall be marked by coding, if necessary, to indicate:

a) the set pressure for which the valve is 'set to start to release';

b) the flow rating pressure in kgf/cm^2 gauge at which the flow capacity of the valve is determined; and

c) the flow capacity in cubic metre per hour of free air.

6.5.5 *Combination Safety Devices* — When bursting discs and pressure opening parts are combined in factory assembled safety devices designed to be replaced as a unit, the assembly shall be externally marked to indicate pressure rating, flow capacity and yield temperature rating (where applicable).

NOTE — Examples of these are:

a) Bursting disc assemblies (BD),

b) Combination bursting disc/fusible plug (BD/FP$_1$ or BD/FP$_2$), and

c) Combination pressure-relief valve/fusible plug (PRV/FP$_1$ or PRV/FP$_2$).

7. ACCEPTANCE AND APPROVAL REQUIREMENTS

7.1 General Requirements

7.1.1 *Type Test* — Only those safety devices which have complied with the requirements of **7.1.2** and the requirements for the specific type of safety device shall be accepted as meeting the requirements. Such devices may then be identified by the relevant type designation specified in **3.1.**

7.1.2 *Flow Capacity Test* (*For All Safety Devices*)

7.1.2.1 *General* — The flow capacity of each design and modification thereof of all types of safety devices shall be determined by a competent authority by actual flow test by an approved method and a copy of results obtained. The form to be used for such submission shall be as given in Appendix A.

7.1.2.2 *Number of samples for test* — Three samples of each size of each device representative of standard production shall be tested in accordance with **7.1.2.3** by a competent authority by an approved method.

7.1.2.3 *Test procedure* — Each sample device shall be tested as follows:

a) The device shall be completely assembled from the inlet of the approach channel to the exit of the discharge channel in the manner normally assembled for use.

b) Air or gas shall be supplied to the safety device through a supply pipe provided with a pressure gauge and a thermometer for indicating and recording the pressure and temperature of the supply. Observations shall be made and recorded after steady flow conditions have been established. Test conditions need not be the same as the conditions under which the device is expected to function in service, but the following limits shall be met. The inlet pressure of the air or gas supplied to the safety device shall be not less than 7 kgf/cm² (absolute), except that the flow capacity of a pressure-relief valve shall be made at the flow rating pressure.

c) Each device shall be caused to operate by either pressure or by temperature or by a combination of such effects which shall not exceed the maximum temperature and pressure for which it was designed.

d) After pressure testing and without cleaning, removal of parts, or reconditioning, each safety device shall be subjected to an actual flow test wherein the amount of air or gas released by the device is measured.

e) Where fusible plugs are being flow capacity tested, the fusible alloy shall be removed from the orifice by heating the plug above the melting point of the fusible alloy.

7.1.2.4 *Requirements* — The average capacity of the three devices tested shall be recorded as the flow capacity. The design of the device shall be considered acceptable provided the capacities of the three sample devices fall within 10 percent of the highest capacity recorded.

7.2 Specific Requirements for Bursting Discs

7.2.1 *Number of Samples for Test* — From every production batch of completed discs of the same size and made from the same roll of foil, or from every batch of disc holders as appropriate, the number of discs shown in Table 1 shall be selected at random for testing (*see also* **7.2.4**).

7.2.2 *Bursting Test for Discs*

7.2.2.1 *Procedure* — Each sample disc shall be mounted in a proper holder with a pressure opening having dimensions identical with that in the device in which it is to be used, and submitted to a bursting test

using any suitable fluid at a temperature of 65°C. The test pressure may be raised rapidly to 85 percent of the rated bursting pressure, held there for at least 30 seconds, and thereafter shall be raised at a rate of not in excess of 7 kgf/cm² (gauge) per minute untill the disc bursts. The actual bursting pressure shall not be in excess of the rated bursting pressure and not less than 90 percent of the rated bursting pressure. If the actual bursting pressure of each sample is not within the limits prescribed above, the entire production batch of bursting discs shall be rejected unless a retest is carried out in accordance with **7.2.2.2.**

The determination of rated bursting pressure may be carried out at room temperature, provided that the relationship between bursting pressure and temperature is established by test for type of material used.

Alternatively, the following relationship may be assumed:

$$\text{Calculated bursting pressure of the disc at 65°C} = \frac{AB}{C} \text{ kgf/cm}^2 \text{ (gauge)}$$

where

A = actual bursting pressure of the disc in kgf/cm² (gauge) at 15°C,

B = actual bursting pressure of a 25-mm disc made from the same batch of material as the disc in A in kgf/cm² (gauge) at 65°C, and

C = actual bursting pressure of a 25-mm disc made from the same batch of material as the disc in A in kgf/cm² (gauge) at 15°C.

TABLE 1 NUMBER OF DISCS OR HOLDERS TO BE TESTED

(*Clause* 7.2.1)

NUMBER IN BATCH	NUMBER TO BE TESTED *Min*
(1)	(2)
3 up to and including 8	2
9 „ „ „ „ 15	3
16 „ „ „ „ 30	4
31 „ „ „ „ 100	6
101 „ „ „ „ 250	8
251 „ „ „ „ 1 000	10
1 001 „ „ „ „ 10 000	25

NOTE — Where the number of discs and/or holders in the batch exceeds 101, the number to be tested should include 5 from the first 100 manufactured in the batch.

7.2.2.2 *Retests* — If the manufacturer so desires, he may subject double the original number of discs selected at random from the same batch to identical test. If all of these additional discs meet the requirements, the remaining discs in the batch shall be acceptable. If any of the additional discs fails, the entire batch shall be rejected.

7.2.3 *Bursting Test for Holders*

7.2.3.1 *Procedure* — The sample holders selected in accordance with Table 2 shall be assembled with bursting discs taken from the batch accepted by the tests in **7.2.2** and the assembly subjected to the bursting test specified in **7.2.2**. The actual bursting pressure shall not be in excess of the rated bursting pressure and not less than 85 percent of the rated bursting pressure of the disc. If the actual bursting pressure is not within the above limits the entire production batch of bursting disc holders shall be rejected unless a retest is carried out in accordance with **7.2.3.2**.

The determination may be carried out at room temperature provided that the relationship between bursting pressure and temperature is established by test for the type of material used. Alternatively, the relationship given in **7.2.2.1** may be assumed.

7.2.3.2 *Retests* — If the manufacturer so desires he may subject double the original number of holders selected at random from the same batch to identical tests. If all of these additional holders meet the requirements, the remaining holders in the batch shall be acceptable; if any of the additional holders fails, the entire batch shall be rejected.

7.2.4 *Bursting Test for Combined Disc and Holder*

7.2.4.1 *Procedure* — As an alternative to the testing of individual components (*see* **7.2.2** and **7.2.3**), bursting discs and holders may be tested as an assembly. Assemblies so tested shall meet the following requirements:

a) The actual bursting pressure shall not be in excess of the rated bursting pressure and not less than 85 percent of the rated bursting pressure of the disc; and

b) If the actual bursting pressure is not within limits prescribed in (a) the entire production batch of assemblies shall be rejected unless a retest is carried out in accordance with **7.2.4.2**. Alternatively the individual components may be retested in accordance with **7.2.2.2** and **7.2.3.2**.

7.2.4.2 *Retests* — If the manufacturer so desires, he may subject double the original number of assemblies selected at random from the same batch to identical tests. If all of these additional assemblies meet the requirements, the remaining assemblies in the batch shall be accepted; if any of the additional assemblies fails, the entire batch shall be rejected.

7.3 Specific Requirements for Fusible Plugs

7.3.1 *Test of Fusible Alloy* — For each production batch, a laboratory control test of fusible alloy shall be made. The following procedure is recommended:

a) Two sticks of the fusible alloy shall be selected at random from each batch.

b) A test sample shall consist of a piece 50 mm long and of approximately 5 mm diameter cut from each stick. Each sample shall be suspended horizontally on suitable supports spaced 25 mm apart and presenting knife edges to the sample so that the ends of the sample will overhang the knife edges 12·5 mm. The supported samples shall be immersed in a glycerine bath not closer than 5 mm to the bottom of the container. This batch shall be suspended in and controlled by an outer glycerine bath.

c) Two samples from the same stick shall be tested at one time. A thermometer (bulb immersion) shall be inserted into the batch between and closely adjacent to the samples so that the bulb will be completely immersed at the same level as the samples. The bath temperature shall be raised at a rate not in excess of 3°C/min.

d) The yield temperature shall be taken as that temperature at which the second of the four ends of the samples loses its rigidity and drops.

NOTE — The test outlined above has been found to be a satisfactory laboratory control test for determining the yield temperature of fusible alloys. While this test is recommended, equivalent tests using samples of different dimensions and different rates of heat rise are permissible provided that they yield reproducible results.

7.3.2 *Extrusion and Yield Temperature Test of Fusible Plugs or Reinforced Fusible Plugs.*

7.3.2.1 *General* — Plugs selected in accordance with **7.3.2.2** shall be installed in a test rig which will simulate actual conditions of installation in a cylinder, and tested in accordance with **7.3.2.3** and **7.3.2.4**.

7.3.2.2 *Number of samples for test* — From every production batch of completed fusible plugs of the same size, made from the same batch of fusible alloy (*see* **7.3.1**), the number of plugs shown in Table 2 shall be selected at random.

TABLE 2 NUMBER OF PLUGS TO BE TESTED

NUMBER IN BATCH	NUMBER TO BE TESTED *Min*
(1)	(2)
3 up to and including 8	2
9 „ „ „ „ 15	3
16 „ „ „ „ 30	4
31 „ „ „ „ 100	6
101 „ „ „ „ 250	8
251 „ „ „ „ 1 000	10
1 001 „ „ „ „ 10 000	25

7.3.2.3 *Test to determine resistance to extrusion* — Each sample shall be subjected to a controlled temperature of not less than 55°C for 24 hours with a gas pressure of 35 kgf/cm² (gauge) on the end normally exposed to the contents of the cylinder. No leakage or visible extrusion of material shall be evident upon examination of the end exposed to atmospheric pressure.

7.3.2.4 *Test for determination of the yield temperature of a fusible plug* (*see* **3**) — Each sample shall be tested for determination of the yield temperature, as follows:

a) The samples shall be subjected to an air pressure of not less than 0·2 kgf/cm² (gauge) applied to the end normally exposed to the contents of the cylinder. While subjected to this pressure the samples shall be immersed in a glycerine-water bath, at a temperature in the range of 3°C immediately below the minimum yield temperature, and held in that temperature range for 10 minutes. The temperature of the bath shall then be raised at a rate not exceeding 3°C/min during which the pressure may be increased to not more than 3·5 kgf/cm² (gauge). When the temperature of the bath reaches the point where material is extruded sufficiently to produce leakage of air from all sample plugs the temperature of the bath should be recorded as the yield temperature of the plugs. It shall be within the temperature limits specified in **3** for that particular type of fusible plug.

b) As an alternative method, these plugs, after passing the test at a temperature in the range of 3°C immediately below the minimum yield temperature, may at once be immersed in another bath held at a temperature not exceeding the maximum yield temperature specified in **3** for that particular type of fusible plug. If air leakage occurs from all sample plugs for 5 minutes at that temperature the requirements shall be considered to have been met.

NOTE 1 — Variation in temperature within the liquid bath in which the plug is immersed for either test(a) or (b) shall be kept to a minimum by stirring while making the tests.

NOTE 2 — It is recommended that, for safety reasons, a restricting orifice be installed in the air supply line to restrict flow when conducting this test.

7.3.2.5 *Rejection* — If any of the samples fails to meet the requirements of **7.3.2.3** and **7.3.2.4**, the entire batch of plugs shall be rejected unless a retest is carried out in accordance with **7.3.2.6**.

7.3.2.6 *Retests* — If the manufacturer so desires, he may subject double the original number of samples, selected at random from the same batch, to identical tests. If all of these additional plugs meet the requirements, the remaining plugs of the batch shall be acceptable; if any of the additional plugs fail the entire batch shall be rejected.

7.4 Specific Requirements for Combination Bursting Disc/Fusible Plug Safety Devices

7.4.1 *Number of Samples for Test* — The production of combination bursting disc/fusible plug devices of any one rated bursting pressure and any one yield temperature on any one day shall be considered a production batch. Two representative assembled devices shall be selected at random from every production batch and tested to the requirements of **7.4.2** and **7.4.3** or **7.4.4**.

7.4.2 *Yield Temperature Test* (*see* **3**) — Each assembled device shall be subjected to a pressure of 70 to 75 percent of the rated bursting pressure of the bursting disc used, using a suitable fluid and while under this pressure shall be immersed in a liquid bath held at a temperature not less than 3°C below the minimum yield temperature of the fusible alloy for at least 10 minutes. The fusible alloy shall not show evidence of melting. The temperature of the bath shall then be raised at a rate not exceeding 3°C/min without appreciable change in pressure. When the maximum yield temperature of the fusible alloy is reached the fusible alloy shall have melted.

7.4.3 *Bursting Test* — The bursting disc shall then be tested in accordance with the requirements of **7.2.2**. The device may be removed from the bath for this test.

7.4.4 *Alternative Tests* — As an alternative to tests in **7.4.2** and **7.4.3**, the bursting disc and fusible alloy may be tested separately to requirements of **7.2.2** and **7.3.2** respectively, provided that the design of the device is such as to allow for the separation of the parts and the separate tests.

7.4.5 *Rejection* — If any of the samples fails to meet the requirements specified in **7.4.2** and **7.4.3** or **7.4.4** the entire batch shall be rejected unless a retest is carried out in accordance with **7.4.6**.

7.4.6 *Retests* — If the manufacturer so desires, he may subject double the original number of samples selected at random from the same batch to identical tests. If all of these additional devices meet the requirements, the remaining safety devices in the batch represented by the samples are acceptable; otherwise the entire batch shall be rejected.

7.5 Specific Requirements for Pressure-Relief Valves — Every pressure-relief valve shall be subjected to an air or gas pressure test to determine the following, in the sequence indicated:

a) That the start-to-discharge pressure at which the first bubble appears through a water seal of not over 100 mm on the outlet of the pressure-relief valve is not less than 80 percent of the flow rating pressure for which the pressure-relief valve is marked.

b) That the pressure to hold the pressure-relief valve fully opened is not greater than the flow rating pressure.

c) That the resealing pressure or the pressure at which leakage ceases through the water seal on the outlet of the pressure-relief valve is not less than 75 percent of the flow rating pressure.

7.6 Reworked Devices — Rejected safety devices or components may be reworked provided they are subjected to such additional tests as are required to ensure compliance with all the requirements of this specification.

8. PERIODIC INSPECTION AND MAINTENANCE

8.1 General Requirements — Safety devices in service shall be maintained in reliable operating condition by observing the following minimum requirements:

a) Exercising care in handling and storage to avoid damage to the cylinder and connected components.

b) Handling and storage to prevent plugging of openings by the accumulation of extraneous matter, such as paint and dirt.

c) The replacement of damaged or malfunctioning assemblies by serviceable safety devices.

d) Ensuring that all repairs are executed by approved technical personnel.

NOTE — Only replacement parts or assemblies provided by the manufacturer shall be used unless the adviseability of interchange is proved by adequate tests.

8.2 Routine Checks of Safety Devices — Each time a compressed gas cylinder is received at a point for refilling, all safety devices shall be examined externally for corrosion, damage, plugging of the discharge channel and any piping connected thereto, and mechanical defects, such as leakage or extrusion of fusible alloy. If there is any doubt regarding the suitability of the safety device for service, the cylinder shall not be filled until it is equipped with a suitable device.

APPENDIX A

(*Clause* 7.1.2.1)

APPLICATION FORM FOR APPROVAL OF SAFETY DEVICE

Date .....

Manufacturer .....

Address.....

Catalogue or Model No. .....

Drawing No. ..... Date of drawing and latest revision.....

Safety device type..... (*see* **3.1** of this standard)

Set pressure ..... kgf/cm² (gauge)

Flow rating pressure ..... kgf/cm² (absolute)

Yield temperature ..... °C

Rated bursting pressure ..... kgf/cm² (absolute)

Gas for which valve has been designed .....

Rated flow capacity .....

Actual flow.....m³/h of air at 15°C and base pressure of one normal atmosphere (absolute) (*see* **7.1.2.1**)

Test conducted by .....

(Signature)

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