

इंटरनेट

मानक

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“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 2878 (2004): Fire Extinguisher, Carbon Dioxide Type  
(Portable and Trolley Mounted) -Specification [CED 22: Fire  
Fighting]



“ज्ञान से एक नये भारत का निर्माण”

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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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भारतीय मानक

अग्नि शामक, कार्बन डाई ऑक्साइड वाले ( सुवाह्य  
एवं ट्राली आरोपित ) – विशिष्टि

( तीसरा पुनरीक्षण )

*Indian Standard*

FIRE EXTINGUISHER, CARBON DIOXIDE TYPE  
( PORTABLE AND TROLLEY MOUNTED ) —  
SPECIFICATION

( *Third Revision* )

ICS 13.220.10

© BIS 2004

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

## FOREWORD

This Indian Standard ( Third Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

One of important types of fire extinguishers used for fire extinguishment is the carbon dioxide type which is suitable for fire fighting in oils, petroleum products and gaseous substances under pressure ( Classes B and C fires ) and also for fires involving electrical equipment. This standard was first published in 1964 and revised in 1976 and 1986. This revision is being prepared so as to include squeeze grip valve and aluminium body of fire extinguishers besides updating the requirements in respect of the materials, performance and to bring it in line with international practices specially as a replacement to Halon 1211 and high effectiveness weight ratio.

The cylinders used for manufacturing of CO<sub>2</sub> extinguishers shall be approved by Chief Controller of Explosives.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

**AMENDMENT NO. 8 JUNE 2012**  
**TO**  
**IS 2878 : 2004 FIRE EXTINGUISHER, CARBON DIOXIDE**  
**TYPE (PORTABLE AND TROLLEY MOUNTED) —**  
**SPECIFICATION**

*( Third Revision )*

[Page 1, clause **3.1** (see also Amendment No. 2)] — Delete **3.1(a)**.

*(Page 1, clause **3.3**)* — Substitute the following for the existing clause:

**3.3** Extinguishers shall be capable of operating reliably within one of the following temperature ranges of temperature:

- a) + 5°C to + 55°C;
- b) 0°C to + 55°C;
- c) -10°C to + 55°C;
- d) -20°C to + 55°C; and
- e) -30°C to + 55°C.

‘NOTE — The temperature range selected from the above shall be marked on the fire extinguisher.’

*(Page 8, clause **9.5.4**)* — Add the following at the end of clause:

‘For 2 kg and 3kg capacities, fire test shall be carried out for 8 B rating.’

(CED 22)

**AMENDMENT NO. 7 FEBRUARY 2010**  
**TO**  
**IS 2878 : 2004 FIRE EXTINGUISHER, CARBON**  
**DIOXIDE TYPE (PORTABLE AND TROLLEY**  
**MOUNTED) — SPECIFICATION**

*( Third Revision )*

*(Page 8, clause 8.1)* — Substitute the following for the existing:

“Each extinguisher body shall be painted either with epoxy powder coating or synthetic enamel paint. The shade shall be ‘Fire Red’ or ‘Post Office Red’ conforming to Shades No. 536 or 538 of IS 5.

NOTES

- 1 Whenever epoxy powder coating is applied on the external surface of mild steel body for anti-corrosive treatment, synthetic enamel paint coating is not required.
2. The body of extinguisher shall be of good finish, clear of all burrs and sharp edges.”

*(Page 8, clause 8.4)* — Delete.

(CED 22)

**AMENDMENT NO. 6 MAY 2009  
TO  
IS 2878 : 2004 FIRE EXTINGUISHER, CARBON DIOXIDE  
TYPE (PORTABLE AND TROLLEY MOUNTED) —  
SPECIFICATION**

*( Third Revision )*

*(Page 1, clause 3.4, line 1)* — Delete 'minimum' and add the following at the starting of clause:

'The effective discharge is the discharge delivered in continuous form.'

*(Page 1, clause 3.4)* — Add the following at the end of clause:

'However, if the discharge continues beyond the upper limit of discharge time, the extinguisher shall satisfy the requirements of 9.1 and 9.2.'

*(Page 1, clause 3.5)* — Substitute the following for the last sentence:

'The actual charge of an extinguisher shall be nominal charge (size) given in Table 1 with the filling tolerance of  $\pm 0.5$  percent by mass.'

*(Page 2, Table 1, col 5 (see also Amendment No. 4)* — In title, substitute 'Area of Tray' for 'Diameter of Tray/Fuel (n-Heptane)'.  
'

*(Page 2, Table 1)* — Add the following Note:

'NOTE — Volume of liquid shall be one-third water and two-third n-heptane.'

*(Page 2, Table 2, SI No. (iv), col 3)* — Substitute the following for the existing:

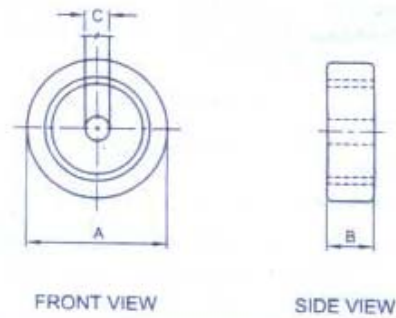
'The minimum bursting pressure shall be 140 kgf/cm<sup>2</sup>.'

*(Page 7, clause 6.5)* — Substitute the following for the second sentence:

Capacity	Trolley Dimensions in mm, Min		
	A	B	C
6.5 and 9 kg	132	28	20
22.5 kg	300	50	25

NOTE — See Fig. 7 also





Capacity of CO <sub>2</sub> Fire Extinguishers	Length		
	A	B	C
6.5 kg/9 kg	132	28	20
22.5 kg	300	50	25

NOTE — Tolerance shall be  $\pm 5$  mm.  
All dimensions in millimeters.

FIG. 7 DIMENSIONAL DETAILS OF RUBBER TROLLEY WHEEL FOR TROLLEY MOUNTED CO<sub>2</sub> FIRE EXTINGUISHERS

(Page 7, clause 9.1, line 6) — Delete 'within the following period from'.

(Page 7, clause 9.1, line 10) — Delete 'minimum'.

(Page 7, clause 9.2) — Substitute the following for the existing clause:

**9.2 Intermittent Discharge Test**

9.2.1 An extinguisher conditioned at its minimum operating temperature  $\pm 2^{\circ}\text{C}$  and  $55 \pm 5^{\circ}\text{C}$  shall operate in such a manner that no more than 1 s elapses from the time the control valve is opened until the extinguishing media starts to discharge. Additionally, at the end of discharge, the extinguisher shall not retain more than 10 percent of its original charge.

Amend No. 6 to IS 2878 : 2004

9.2.2 Condition a correctly charged extinguisher at each of the specified temperature for a minimum of 18 h. Operate the extinguisher intermittently by opening and closing the valve in cycles of 2 s 'open' and 2 s 'closed' until the end of discharge is reached."

(Page 8, clause 9.5.3.3) — Delete 'a minimum of'.

(Page 8, clause 9.5.4) — Delete.

[Page 9, clause 10.2.1 (see also Amendment No. 1)] — Delete.

[Page 9, clause 10.2.2 (see also Amendment No. 1)] — Delete.

[Page 9, clause 10.2.3 (see also Amendment No. 1)] — Delete.

[Page 9, clause 10.2.5 (see also Amendment No. 1)] — Delete.

(CED 22)

Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 5 FEBRUARY 2008  
TO  
IS 2878 : 2004 FIRE EXTINGUISHER, CARBON DIOXIDE  
TYPE (PORTABLE AND TROLLEY MOUNTED) —  
SPECIFICATION**

*( Third Revision )*

*(Page 1, clause 5.1, line 4)* — Substitute ' $0.667 + 0$ ' for ' $0.667 \pm 0.033$   
percent'.  $- 0.03$

(CED 22)

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Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 4 AUGUST 2007  
TO  
IS 2878 : 2004 FIRE EXTINGUISHER, CARBON DIOXIDE  
TYPE (PORTABLE AND TROLLEY MOUNTED) —  
SPECIFICATION**

*( Third Revision )*

*(Page 1, clause 3.5)* — Insert the following at the end of clause:

‘Fire test as per 9.5 for trolley mounted 6.5, 9 and 22.5 litre capacities is not required.’

*(Page 1, clause 6.1.1)* — Substitute the following for existing:

‘In case of aluminium body, seamless container shall conform to IS 15660.’

*[Page 2, Table 1 (see also Amendment No. 2)]* — Substitute the following for existing:

Sl No.	Nominal Size/ CO <sub>2</sub> Content, kg	Discharge Time, s	Class B Rating	Diameter of Tray/Fuel ( <i>n</i> -Heptane)
(1)	(2)	(3)	(4)	(5)
i)	2	8-16	13 B	0.41 m <sup>2</sup> (13 l)
ii)	3	8-18	21 B	0.66 m <sup>2</sup> (21 l)
iii)	4.5	10-18	34 B	1.00 m <sup>2</sup> (34 l)
iv)	6.5	10-20	55 B	1.73 m <sup>2</sup> (36 l)
v)	9	15-36	70 B	2.20 m <sup>2</sup> (47 l)
vi)	22.5	20-60	89 B	2.80 m <sup>2</sup> (60 l)

*(Page 2, Table 3)* — Delete.

*(Page 3, Table 4)* — Delete.

*(Page 6, clauses 6.2 to 6.2.2.3)* — Delete and renumber the subsequent clauses.

*(Page 7, clause 6.5)* — Insert the following at the end of clause:

‘The tolerance on trolley dimensions shall be ± 5 mm.’

**Amend No. 4 to IS 2878 : 2004**

*(Page 7, clauses 9.4 and 9.4.1)* — Delete and renumber the subsequent clauses.

*(Page 9, Annex A)* — Delete reference to Clause '9.4.1' and insert the following at the end:

<i>IS No.</i>	<i>Title</i>
15660 : 2006	Refillable transportable seamless aluminium alloy gas cylinder — Specification

*(Page 10, Annex B)* — Delete.

*(Page 13, Annex C)* — Delete.

*(Page 19, Annex D)* — Delete.

(CED 22)

**AMENDMENT NO. 3 SEPTEMBER 2006  
TO  
IS 2878 : 2004 EXTINGUISHER, CARBON  
DIOXIDE TYPE (PORTABLE AND  
TROLLEY MOUNTED) — SPECIFICATION**

*( Third Revision )*

[Page 9, clause 10 (see also Amendment No. 1)] — Substitute  
'ADDITIONAL' for 'OPTIONAL'.

(CED 22)

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Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 2 JUNE 2005  
TO  
IS 2878 : 2004 FIRE EXTINGUISHER,  
CARBON DIOXIDE TYPE (PORTABLE AND TROLLEY  
MOUNTED) — SPECIFICATION**

( *Third Revision* )

[ Page 1, clause 3.1(a) and (b) ] — Substitute the following for the existing:

a) *Portable:*

- 1) Mild steel body — 2, 3 and 4.5 kg
- 2) Aluminium body — 2, 3 and 4.5 kg

b) *Trolley Mounted:*

- 1) Mild steel body — 6.5, 9 and 22.5 kg

( Page 2, Table 1 ) — Substitute the following for the existing:

(1)	(2)	(3)	(4)	(5)
i)	2	8 - 16 s	13 B	0.41 m <sup>2</sup> (13 l)
ii)	3	8 - 18 s	21 B	0.66 m <sup>2</sup> (21 l)
iii)	4.5	10 - 18 s	34 B	1.00 m <sup>2</sup> (34 l)
iv)	6.5	10 - 20 s	55 B	1.70 m <sup>2</sup> (55 l)
v)	9	15 - 36 s	70 B	2.20 m <sup>2</sup> (70 l)
vi)	22.5	20 - 60 s	89 B	2.80 m <sup>2</sup> (89 l)

[ Page 2, Table 2, Sl No. (i) ] — Under column 4, insert 'wheel type or' before 'squeeze grip'.

( Page 7, clause 6.4.2 ) — Substitute 'suitable size' for 'not less than 10 mm'.

( Page 7, clause 7 ) — Delete.

( Page 7, clause 8.1, line 2 ) — Substitute '538' for '537.'

**Amend No.2 to IS 2878 : 2004**

( *Page 7, clause 9.1, Note* ) — Shift the existing note under clause 9.1 between clause headings 9 and 9.1.

( *Page 7, clause 9.5.1, lines 3 and 10* ) — Substitute 'Table 1' for 'Table 6' and 'Table 5'.

( *Page 8, clause 9.5.3.1, line 2* ) — Substitute 'Table 1' for 'Table 5'.

( *Page 8, clause 9.5.4, last line* ) — Substitute 'Table 1' for 'Table 5'.

( *Page 8, Table 5* ) — Delete.

( *Page 8, clause 9.5* ) — Substitute '9.6' for '9.5'.

( CED 22 )



**AMENDMENT NO. 1 APRIL 2005**  
**TO**  
**IS 2878 : 2004 FIRE EXTINGUISHER, CARBON**  
**DIOXIDE TYPE (PORTABLE AND TROLLEY**  
**MOUNTED) — SPECIFICATION**

*( Third Revision )*

*( Foreword )* — Insert the following new clause after third para:

'A scheme for labelling environment friendly products known as ECO Mark has been introduced at the instance of the Ministry of Environment and Forests (MEF), Government of India. The ECO Mark would be administered by the Bureau of Indian Standards (BIS) under the *BIS Act, 1986* as per the Resolution No. 71 dated 21 February 1991 and No. 425 dated 28 October 1992 published in the Gazette of the Government of India. For a product to be eligible for marking with ECO logo, it shall also carry the ISI Mark of BIS besides meeting additional optional environment friendly requirements. For the purpose, the Standard Mark of BIS would be a single mark being a combination of the ISI Mark and the ECO logo. Requirements to be satisfied for a product to qualify for the BIS Standard Mark for ECO friendliness being included in the relevant published standards through an amendment. These requirements are optional; manufacturing units are free to opt for the ISI Mark alone also.

The amendment is based on the Gazette Notification No. 160 dated 1 April 1999 for Fire Extinguishers as environment friendly products published in the Gazette of Government of India.'

*( Page 7, clause 8.1 )* — Substitute '538' for '537'.

*( Page 7, clause 9.4.1, line 3 )* — Delete 'Annex A'.

*( Page 7, clause 9.5 )* — Renumber clause '9.5' as '9.6'.

*( Page 7, clause 9.5 )* — Insert the following new clauses after 9.5 and renumber the subsequent clauses:

## **'10 OPTIONAL REQUIREMENTS FOR ECO MARK**

### **10.1 General Requirements**

**10.1.1** Any fire extinguisher having BIS Standard Mark qualifies for consideration of ECO Mark.

## **Amend No. 1 to IS 2878 : 2004**

**10.1.2** The products manufacturer must produce the consent clearance as per provision of the *Water (Prevention and Control of Pollution) Act, 1974*, *Water (Prevention and Control of Pollution) Cess Act, 1977* and *Air (Prevention and Control of Pollution) Act, 1981* respectively, along with authorization if required under *Environment (Protection) Act, 1986* and the Rules made thereunder to the Bureau of Indian Standards while applying for ECO Mark.

**10.1.3** The products may display in brief the criteria based on which the product has been awarded ECO Mark.

**10.1.4** The product may carry along with instructions for proper use so as to maximize product performance with statutory warning, if any, minimize waste and method of safe disposal.

**10.1.5** The material used for product packaging (excluding refills) shall be recyclable, reusable or biodegradable.

**10.1.6** The product must display a list of critical ingredients in descending order of quantity present in percent by weight. The list of such critical ingredients shall be identified by the Bureau of Indian Standards.

### **10.2 Specific Requirements**

**10.2.1** The fire extinguisher shall not contain any Ozone Depleting Substance (ODS) relevant to fire extinguishers industry as identified under the Montreal Protocol (*see Annex F*).

**10.2.2** Gas based extinguishing media once discharged in the atmosphere should not have atmospheric life time of more than a year (*see Annex G*).

**10.2.3** Chemical used should not have global warming potential (*see Annex H*).

**10.2.4** The metallic body and other metal parts of the fire extinguishers shall be free of lead or lead alloys.

**10.2.5** The coating used for the metallic part shall not be formulated with mercury and mercury compounds or be tinted with pigments of lead, cadmium, chromium VI and their oxides. Excluded are natural impurities entailed by the production process up to the amount 0.1 percent by weight which are contained in the raw material.

NOTE — CO<sub>2</sub> extinguishers may be permitted till suitable substitutes are available.

**ANNEX F**  
(*Clause 10.2.1*)

**LIST OF OZONE DEPLETING SUBSTANCES (ODS)  
CONTROLLED BY MONTREAL PROTOCOL**

<i>Trade Name</i>	<i>ODP</i>
Halon 1211	3.0
Halon 1301	10.0
Halon 2402	6.0
CFC-11	1.0
CFC-12	1.0
CFC-113	0.8
CFC-114	1.0
CFC-115	0.6
CCl <sub>4</sub>	1.1
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	0.1
CFC-13	1.0
CFC-111	1.0
CFC-112	1.0
CFC-211	1.0
CFC-212	1.0
CFC-213	1.0
CFC-214	1.0
CFC-215	1.0
CFC-216	1.0
CFC-217	1.0
Methyl Bromide	0.6
NOTE — ODP values are relative to CFC-II which has been assigned arbitrary value of 1.0.	

**ANNEX G**  
*(Clause 10.2.2)*

**LIST OF ATMOSPHERIC LIFE TIME OF GAS-BASED AGENTS**

<i>Trade Name</i>	<i>Designation</i>	<i>Atmospheric Life Time (Year)</i>
Halon 13001	(CF 31)	< 1 day
NAFS III	HCFC (Blend A)	12
FE 25	HCFC-125	36
FE 2414	HFC-12	6
FE 36	HFC-227 fa	250
FE13	HFC-23	250
FM 200	HFC-227 ea	41
CEA 410	FC-3-1-10	2 600
Halon 1301	Halon 1301	65
Inergen	IG 541	—
Argonite	UG 55	—
Argon	IG 01	—

## ANNEX H

(Clause 10.2.3)

LIST OF SUBSTANCES HAVING GLOBAL WARMING  
POTENTIAL (GWP)

<i>Trade Name</i>	<i>GWP (100 year) V<sub>5</sub>CO<sub>2</sub></i>
Halon 1301	5 600
Inergen	—
Argonite	—
Argon	—
CEA 410	5 500
FM 200	3 300
FE 13	12 100
FE 36	8 000
FE 241	480
FE 25	3 200
NAFS III	1 450
CF 31	< 5

(CED 22)

*Indian Standard*

**FIRE EXTINGUISHER, CARBON DIOXIDE TYPE  
( PORTABLE AND TROLLEY MOUNTED ) —  
SPECIFICATION**

*( Third Revision )*

**1 SCOPE**

This standard covers the requirements regarding material, shape, construction and performance test of carbon dioxide fire extinguishers ( portable and trolley mounted ).

**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 listed were valid. All standards are subject to revision and the parties to agreements based on this standard are encouraged to apply the most recent editions of the standards indicated in Annex A.

**3 CAPACITY**

**3.1** The extinguisher shall be of the following capacities:

- a) *Portable*:
  - 1) Mild steel body — 2 and 3 kg
  - 2) Aluminium body — 2, 3 and 4.5 kg
- b) *Trolley mounted*:
  - Mild steel body — 4.5, 6.5, 9 and 22.5 kg

**3.2** The capacity of the extinguisher shall be the mass of carbon dioxide when it is filled in the container to the filling ratio as in **5.1**.

**3.3 Operating Temperatures**

Extinguishers shall be capable of operating reliably between the following temperature ranges *t* :

$$-30^{\circ}\text{C to }+55^{\circ}\text{C}$$

NOTE — The temperature range shall be marked on the fire extinguisher.

**3.4** The minimum effective discharge time of extinguishers and fire rating shall be no less than the appropriate value given in Table 1.

**3.5 Rating Suitability ( Class B )**

The rating of extinguishers recommended as suitable for Class B fires shall be determined using the method given in **9.5**. The rating shall be based on the amount of extinguishing medium used to extinguish the fire of maximum size under the conditions of the test. This amount shall be no less than the appropriate minimum value given in Table 1.

**4 MATERIAL**

The material for construction of various components is given in Table 2.

**5 CONTENTS**

**5.1** The carbon dioxide gas shall conform to IS 15222. The extinguisher shall be cleaned internally and shall be filled with liquefied carbon dioxide to the filling ratio of not more than  $0.667 \pm 0.033$  percent. The quantity shall be determined by weighing. The filling ratio is the ratio of mass of liquefiable gas that is allowed to be filled into the container in view of safety considerations to the mass of water required to fill the container at  $15^{\circ}\text{C}$ .

**5.2** Weigh the extinguisher and compare mass marked on it for fully charged extinguisher as per C-7(b) of IS 2190. It shall not be less than 10 percent of mass.

**6 CONSTRUCTION****6.1 Body**

The typical shape showing the cylinder with other components is shown in Fig. 1. The extinguishers shall have concave base. In case of steel body, it shall conform to IS 7285.

**6.1.1** In case of aluminium, seamless containers shall be made only from materials whose compositions are given in Table 3 and the mechanical properties of the finished container shall be as given in Table 4.

**Table 1 Minimum Effective Discharge Time and Rating of Extinguishers**  
( Clauses 3.4 and 9.1 )

Sl No.	Nominal Size/ CO <sub>2</sub> Content kg	Discharge Time	Class B Rating	Fire Size/Fuel <i>n</i> -Heptane
(1)	(2)	(3)	(4)	(5)
i)	Under 3	8 – 18 s	5 B, C	5 m <sup>2</sup> ( 5 l )
ii)	4.5	8 – 18 s	8 B, C	8 m <sup>2</sup> ( 8 l )
iii)	9	8 – 30 s	10 B, C	10 m <sup>2</sup> ( 10 l )
iv)	22.5	12 – 30 s	20 B, C	20 m <sup>2</sup> ( 20 l )

**Table 2 Materials of Construction of Various Components**  
( Clauses 4 and 6.2.1 )

Sl No.	Component	Material	Conforming to Relevant Indian Standard
(1)	(2)	(3)	(4)
i)	Discharge valve	—	IS 3224 ( squeeze grip valve as shown in Fig. 2 and Fig. 3 )
ii)	Safety device	—	IS 5903
iii)	Syphon tube	a) Brass b) Copper c) Aluminium	Alloy No. 2 of IS 407 IS 1545 IS 738
iv)	Hose	The minimum bursting pressure shall be 275 kgf/cm <sup>2</sup> in control discharge and 140 kgf/cm <sup>2</sup> without control discharge	
v)	Discharge horn	Non-conductor of electricity like polyethylene, fibre-glass and similar materials	

## NOTES

- Safety device conforming to IS 5903 shall be in-built in discharge valve conforming to IS 3224.
- Carbon dioxide extinguisher with metal horn does not qualify for electrical fire rating.

**Table 3 Cast Analysis**  
( Clause 6.1.1 )

Sl No.	Type of Alloy AA Designation		Chemical Composition ( Weight, Percent )													
			Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Zr	Pb	Others		Alu- minium
														Each	Total	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
i)	5283 A	Min	—	—	—	0.50	4.5	—	—	—	—	—	—	—	—	Re- mainder
		Max	0.30	0.30	0.03	1.0	5.1	0.05	0.03	0.10	0.03	0.05	0.003	0.15	0.15	
ii)	6061 A	Min	0.40	—	0.15	—	0.8	0.04	—	—	—	—	—	—	—	Re- mainder
		Max	0.8	0.7	0.40	0.15	1.2	0.35	—	0.25	0.15	—	0.003	0.15	0.15	
iii)	6082 A	Min	0.7	—	—	0.40	0.60	—	—	—	—	—	—	—	—	Re- mainder
		Max	1.3	0.50	0.10	1.0	1.2	0.25	—	0.20	0.10	—	0.003	0.15	0.15	
iv)	6351 A	Min	0.7	—	—	0.40	0.40	—	—	—	—	—	—	—	—	Re- mainder
		Max	1.3	0.50	0.10	0.8	0.8	—	—	0.20	0.20	—	0.003	0.15	0.15	
v)	7060	Min	—	—	1.8	—	1.3	0.15	—	6.1	—	—	—	—	—	Re- mainder
		Max	0.15	0.20	2.6	0.20	2.1	0.25	—	7.5	0.05	0.05	0.003	0.15	0.15	

NOTE — Where a melt contains scrap or other re-used material the bismuth content shall not exceed 0.003 0 percent.

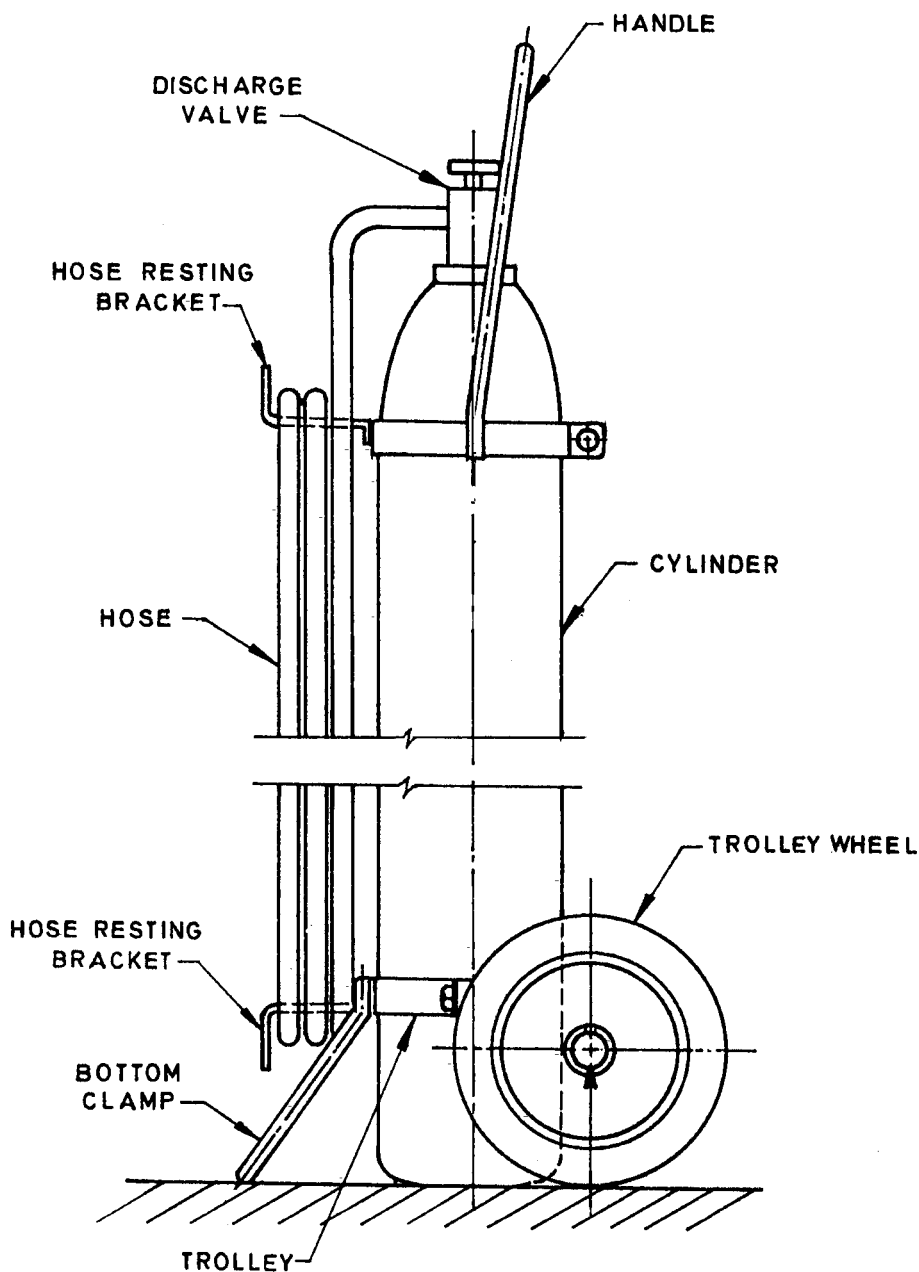


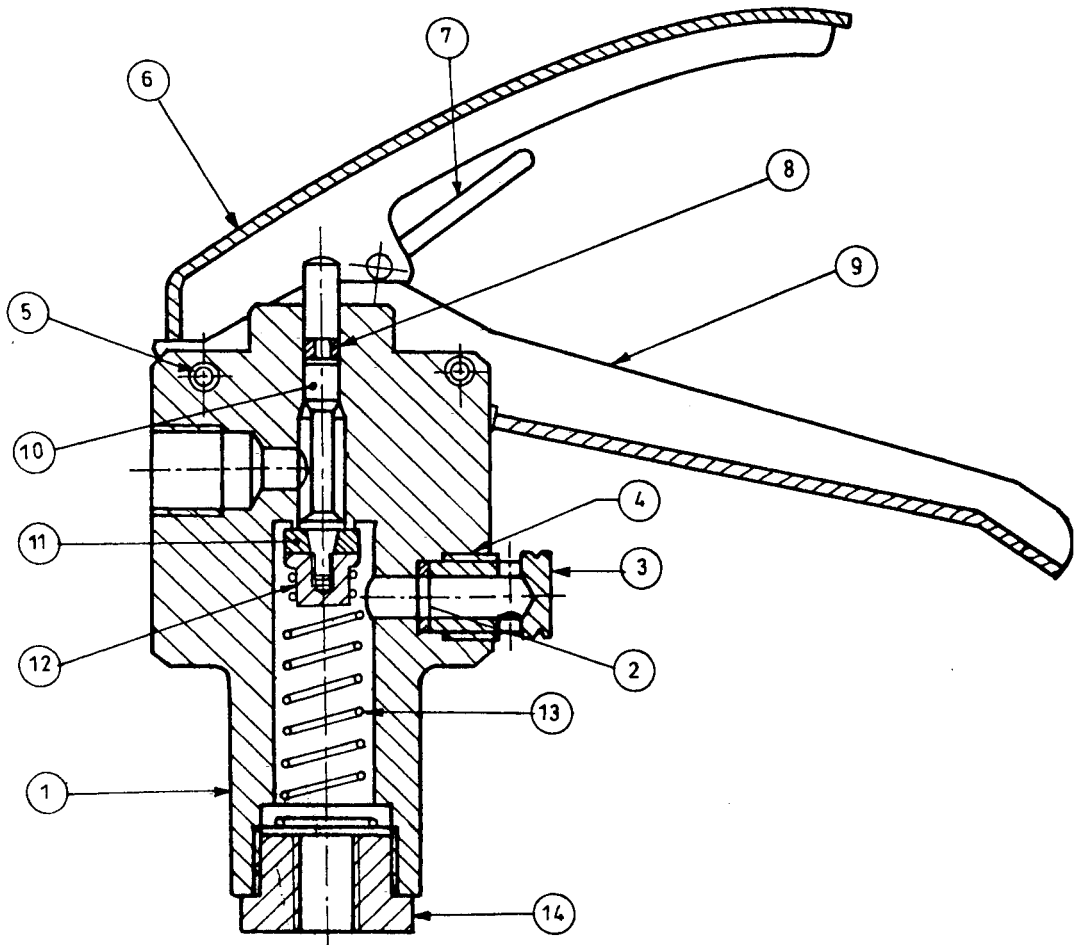
FIG. 1 GENERAL FEATURES OF CARBON DIOXIDE TYPE FIRE EXTINGUISHER, TROLLEY MOUNTED

**Table 4 Mechanical Properties**

(Clauses 6.1.1 and 6.2.2.3)

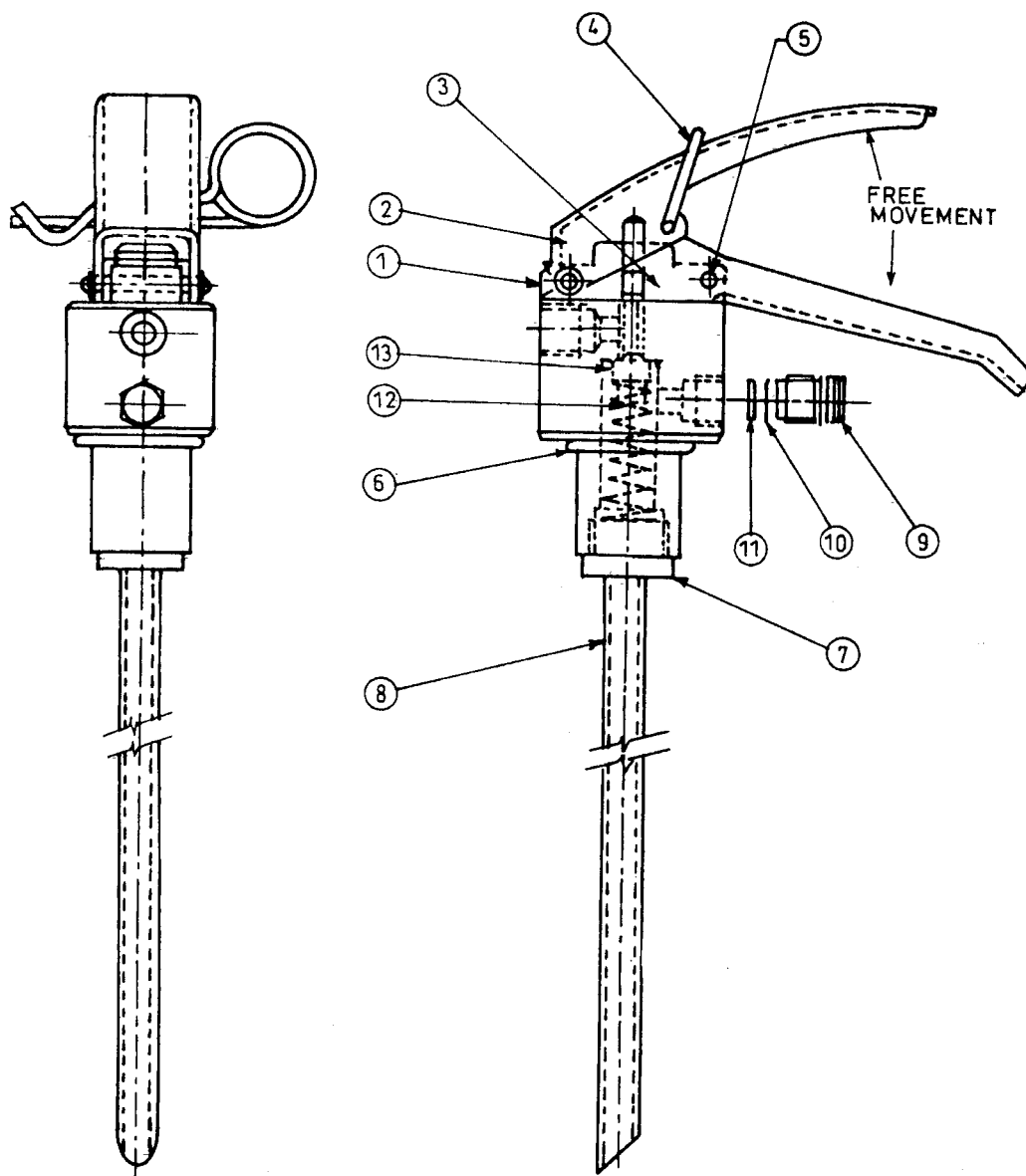
Sl No.	Mechanical Properties	Requirements
(1)	(2)	(3)
i)	Tensile strength ( $T$ )	325 N/mm <sup>2</sup> , <i>Min</i>
ii)	Specified minimum 0.2 percent proof stress ( $Y$ )	280 N/mm <sup>2</sup> , <i>Min</i>
iii)	Elongation percent, on $5.65\sqrt{S_0}$	12. <i>Min</i>
iv)	Bend test former radius	$3 t_a$ maximum ( $t_a$ is actual thickness of the specimen )
v)	Hardness equivalent to: Brinell or Rockwell B	90. <i>Min</i> 45. <i>Min</i>





- |                                      |                            |
|--------------------------------------|----------------------------|
| 1 — Head                             | 8 — O-ring-stem            |
| 2 — Burst disc                       | 9 — Handle                 |
| 3 — Safety plug                      | 10 — Valve stem            |
| 4 — Sealing washer                   | 11 — Valve stem seal       |
| 5 — Spring pin $\text{Ø}4 \times 30$ | 12 — Seat-valve stem       |
| 6 — Trigger                          | 13 — Spring                |
| 7 — Pull pin                         | 14 — Adopter — Syphon tube |

FIG. 2 SQUEEZE GRIP VALVE — GENERAL ARRANGEMENT



- |   |   |                                  |    |   |                      |
|---|---|----------------------------------|----|---|----------------------|
| 1 | — | Head                             | 8  | — | Syphon tube          |
| 2 | — | Trigger                          | 9  | — | Safety plug          |
| 3 | — | Handle                           | 10 | — | Burst disc           |
| 4 | — | Pull pin                         | 11 | — | Sealing washer       |
| 5 | — | Spring pin $\text{Ø}4 \times 30$ | 12 | — | Spring — compression |
| 6 | — | Seal O-ring                      | 13 | — | Valve stem assembly  |
| 7 | — | Syphon tube adopter              |    |   |                      |

FIG. 3 SQUEEZE GRIP VALVE — ASSEMBLY

## 6.2 Design for Aluminium Extinguishers

### 6.2.1 Thickness of Cylindrical Shell

The thickness of the cylindrical shell of a container for liquefiable gases, up to and including a charged pressure at 15°C at 210 bar, shall not be less than the value given by equation (1):

$$t = \frac{0.3 P_1 D_1}{7f_e - P_1} \text{ or } \frac{0.3 P_1 D_o}{7f_e - 0.4 P_1} \dots \dots \dots (1)$$

The thickness of the shell determined by equation (1) shall not be less than the value given by equation (2).

$$t = 2.48 \sqrt{(D_1/T)} \dots \dots \dots (2)$$

where

$t$  = minimum wall thickness, in mm, to resist internal pressure and external forces due to normal handling but excluding any additional thickness for other influences;

$P_1$  = test pressure ( in bar ) applicable to the design governed by equations (1) and (2);  
 $D_o$  is the external diameter of the container, in mm;

$D_1$  = internal diameter of the container, in mm;

$f_e$  = maximum permissible equivalent stress, in N/mm<sup>2</sup>, at test pressure [ = 0.75 × minimum specified 0.2 percent proof stress (  $Y$  ) of the material of construction];

$T$  = minimum tensile strength, in N/mm<sup>2</sup>;

$Y$  = minimum specified 0.2 percent proof stress, in N/mm<sup>2</sup>.

NOTE — Values of  $T$  and  $Y$  for the permissible materials are given in Table 2.

### 6.2.2 Manufacture

#### 6.2.2.1 Process of manufacture

The container shall be made:

- by cold or hot extrusion from cast or extruded billets; or
- by cold or hot extrusion followed by cold drawing from cast or extruded billets; or
- by cupping and cold drawing sheet or plate; or
- by necking at both ends extruded or cold drawn tube.

They shall be made only by a process that has been shown to produce containers free from cracks or other flaws that could adversely affect the safety of the containers.

The ends shall be of an approved shape and shall be

formed by forging, swaging, or spinning. Ends shall not be welded on and metal shall not be added in the process of closing.

#### 6.2.2.2 Examination of the cylinders before closing-in operation

Each cylinder shall be examined before final closing-in operation for external and internal surface defects, finished thickness and circularity of the cylindrical shell.

- Surface defects** — The internal and external surfaces of the cylinder shall be free from defects which might adversely affect the safe working of the cylinder. A cylinder which has a surface defect greater than 5 percent of the shell thickness may have the defect ground out to the satisfaction of the inspecting authority, provided the final thickness is checked before closing-in operation and is certified to be not less than the calculated minimum wall thickness plus additional allowance.
- Finished thickness** — The agreed finished thickness shall be not less than the minimum calculated wall thickness obtained by the formula at any point and at any transverse section of the cylindrical portion. If required by the purchaser, suitable allowance to cover corrosion, manufacturing tolerances and stresses due to horizontal acceleration and retardation during transportation may also be provided. The amount of this allowance shall be as agreed to between the manufacturer and the purchaser.
- Circularity** — The difference between the maximum and minimum external diameter measured at any cross-section of the cylindrical portion of the cylinder shall not exceed 1 percent of the nominal internal diameter.
- Mass** — The minimum and maximum mass of the cylinder shall be within the limits agreed upon between the manufacturer and the purchaser, depending on size, type and required thickness.
- Water capacity** — The water capacity of the cylinders shall be such that the nominal water capacity for the permanent gases and minimum water capacity for liquefiable gases shall be obtained as agreed to between the purchaser and the manufacturer.
- Permissible pressure** — The test pressure on which the design of the extinguisher container is based shall be not less than:

$1/0.85 \times$  the pressure developed by the gas at the reference temperature ( for liquefiable gases).

### 6.2.2.3 Heat treatment

Each container shall be heat treated at a temperature within the range 515°C to 545°C and water quenched and then artificially aged at a temperature selected within the range 150°C to 200°C.

Minimum values of mechanical properties required in the finished container after heat treatment and at room temperature shall be as given in Table 4.

The operations involving heat treatment shall be carried out carefully in furnaces equipped to control temperatures accurately, and the containers shall be maintained at the stipulated temperatures for the length of time necessary to ensure that all parts have reached the required temperature and all necessary metallurgical changes have been effected.

### 6.3 Discharge Valve or Operating Head

The valve shall be provided and it shall be squeeze grip type or wheel type.

### 6.4 Discharge Fittings

6.4.1 The discharge tube shall be provided to 2 and 3 kg capacity extinguishers fitted to discharge valve by swivel joints.

6.4.2 The hose of not less than 10 mm internal diameter shall be provided for 4.5, 6.5, 9 and 22.5 kg capacity fire extinguishers. The length of the hose shall be not less than 1 m for 4.5 and 6.5 kg capacity fire extinguisher, 2 m for 9 kg, and 5 m for 22.5 kg capacity fire extinguishers.

6.4.3 A discharge horn with a suitable handle shall be provided ( see Fig. 1 ).

### 6.5 Trolley

The details of trolley are given in Fig. 1. The dimensions of trolley shall be 132 mm  $\times$  28 mm  $\times$  20 mm for sizes up to 9 kg and for higher sizes 300 mm  $\times$  50 mm  $\times$  25 mm.

## 7 ANTI-CORROSIVE TREATMENT

The external surface of the body shall be completely coated with epoxy powder of minimum 0.050 mm thickness. The thickness of the coating shall be measured as per the procedure given in IS 3203.

## 8 PAINTING

8.1 Each extinguisher shall be painted fire red or post office red conforming to shade No. 536 or 537 of IS 5.

8.2 A picture showing operation of the extinguisher

in the correct manner shall be provided on the body of the extinguishers.

8.3 The extinguisher shall be marked with the letters B and C indicating their suitability for respective classes of fires as laid down in IS 2190. The letters B and C shall be of 2.5 cm size printed in white colour centrally contained in a square of 4 cm size and a circle of 2 cm radius respectively and shall be coloured black. For 2 kg capacity, size of square shall be 2 cm and a circle of 1 cm radius and size of letter 1.5 cm.

8.4 The paint shall conform to IS 2932.

## 9 PERFORMANCE REQUIREMENTS

### 9.1 Discharge Duration

The design and construction of the extinguisher shall be such that when operated at an angle of not more than 45°C from the vertical at a temperature of  $27 \pm 2^\circ\text{C}$ , it shall expel not less than 95 percent of the contents in the form of a continuous discharge within the following period from the time of operating the valve. The body shall be weighed 30 min after the discharge period and shall be wiped and dried before checking the contents. The minimum effective discharge time of extinguishers shall not be less than the appropriate value given in Table 1.

NOTE — Extinguisher should be conditioned for 1 h before testing.

### 9.2 Intermittent Operation

An extinguisher shall be capable of being operated intermittently without freeze up of the valve seat and causing any leak when conditioned at  $27 \pm 2^\circ\text{C}$ . The valve shall be opened for 3 s and closed for 10 s and the cycle shall be repeated and shall discharge at least 95 percent of the contents.

### 9.3 Leakage Test

The extinguisher without its attachment shall be filled with CO<sub>2</sub> gas to the specified filling ratio and dipped in water for 2 min and then check that no bubbles come out or soap solution test for leakage be carried out.

### 9.4 Inspection and Tests for Aluminium Cylinders

9.4.1 Inspection and test requirements for aluminium cylinders used in the extinguishers are given in Annex A, Annex B, Annex C and Annex D.

### 9.5 Class B Test Fire

#### 9.5.1 Construction

Class B test fires utilize a range of welded-sheet-

steel cylindrical trays ( dimensions given in Table 6 ). The sides are vertical. The bases of the trays are set horizontal and level with the surrounding ground.

NOTE — Reinforcement of the base of the larger test fire trays will be necessary to minimize distortion. In such cases it will be necessary to ensure that the underside of the trays are not exposed to the atmosphere.

Details of Class B test fires are given in Table 5. Each test fire is designated by a number followed by the letter B.

### 9.5.2 Fuel

Use an aliphatic hydrocarbon having an initial boiling point of no less than 88°C and a final boiling point of not more than 105°C. Most suitable and universally used fuel is *n*-heptane.

NOTE — Typical fuels meeting this requirement are *n*-heptane and certain solvent fractions sometimes referred to as commercial heptane.

### 9.5.3 Procedure

9.5.3.1 Add the appropriate volume of water and *n*-heptane specified in Table 5. Add additional water to compensate for distortion of the base so that all points are covered, subject to a maximum liquid depth of 50 mm and a minimum heptane depth of 15 mm at any point.

#### 9.5.3.2 Ignite the fuel

9.5.3.3 Permit the fuel to burn freely for a minimum of 10 s before operating the extinguisher.

9.5.3.4 Operate the extinguisher and apply the extinguishing medium to the test fire.

### NOTES

1 The extinguisher may be discharged continuously or in intermittent bursts at the discretion of the operator. The operator may move round the fire in order to obtain the best results. Operator should use proper fire protective suits, helmet and gloves.

2 For reasons of safety the operator shall not reach over the edge of the tray, and at no time shall the operator reach onto or into the tray.

### 9.5.4 Low-Temperature Extinguishment Test

An extinguisher, charged with its rated capacity of extinguishing agent and expellant gas, and conditioned at the minimum storage temperature for 18 h, shall extinguish a Class B test fire two classification sizes smaller than the rating of the extinguisher given in Table 5.

### 9.5 Special Requirements

The extinguisher horn shall be constructed to withstand crushing when 25 kg is applied to its extremity for 5 min immediately after having completely discharged the extinguisher through the horn.

Subject the horn to the following test:

- Condition the horn at 55°C for 18 h;
- Attach the horn to a fully charged extinguisher;
- Discharge the extinguisher with the valve fully open;
- Subject the horn to a static load of 25 kg using a circular contact surface of 50 mm diameter for 5 min applied at the end of the horn; and

**Table 5 Dimensions of Class B Test Fires**

( Clauses 9.5.1, 9.5.3.1, 9.5.4 and B-5 )

SI No.	Classification	Minimum Discharge of Extinguishers	Volume of Liquid <sup>1)</sup> i	Dimensions of Test Fire Tray			
				Diameter <sup>2)</sup> mm	Internal Depth <sup>2)</sup> , mm	Minimal Thickness	Approximate Surface of Fire
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	8B <sup>3)</sup>	—	8	570 ± 10	150 ± 5	2.0	0.25
ii)	13B <sup>3)</sup>	—	13	720 ± 10	150 ± 5	2.0	0.41
iii)	21B	8	21	920 ± 10	150 ± 5	2.0	0.66
iv)	34B	8	34	1 170 ± 10	150 ± 5	2.5	1.07

NOTE — Each test fire is designated by a number in a series in which each term is equal to the sum of the two preceding terms ( this series is equivalent to geometric progression having a common ratio of about 1.62 ). Test fires larger than those given may be constructed following the rules of this geometric progression. The additional fires 70B/113B/183B represent the product of the preceding term and  $\sqrt{1.62}$ .

<sup>1)</sup> 1/3 water and 2/3 heptane.

<sup>2)</sup> Measured at rim.

<sup>3)</sup> This fire size is for a low-temperature fire test only.

- e) Check that the horn does not show any evidence of cracking or breakage.

## 10 MARKING

10.1 Every extinguisher shall be clearly and permanently marked in accordance with the requirements laid down in 10.2 and 10.2.1.

10.2 The following information shall be marked on the extinguisher:

- Manufacturer's name or trade-mark;
- Method of operation in prominent letters;
- The words 'CARBON DIOXIDE TYPE' in prominent letters;
- Capacity;
- Year of manufacture of extinguisher and date of refilling; and
- Source, year of manufacture of the cylinder and its test pressure.

10.2.1 The following information to facilitate filling or recharging shall also be marked on the head of extinguisher or on the neck of the cylinder:

- Empty weight of extinguisher ( to include

operating head, internal discharge tube and carrying handle but not any hose or discharge horn assembly ), shown as EW; and

- Filled weight of extinguisher ( to include operating head, internal discharge tube, carrying hand and gas-filled contents but not any hose or discharge horn assembly ), shown as FW.

## 10.3 BIS Certification Marking

The extinguisher may also be marked with the Standard Mark.

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

## 11 SAMPLING AND CRITERIA FOR CONFORMITY

The details of sampling and criteria for conformity is given in Annex E.

## ANNEX A

( Clauses 2 and 9.4.1 )

### LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
5 : 1994	Colours for ready mixed paints and enamels ( <i>fourth revision</i> )	3203 : 1982	Methods of testing local thickness of electroplated coatings ( <i>first revision</i> )
407 : 1981	Specification for brass tubes for general purposes ( <i>third revision</i> )	3224 : 2002	Valve fittings for compressed gas cylinders excluding liquefied petroleum gas ( LPG ) cylinders — Specification ( <i>third revision</i> )
738 : 1994	Wrought aluminium alloys, drawn tube for general engineering purposes ( <i>third revision</i> )	5903 : 1970	Recommendations for safety devices for gas cylinders
1545 : 1994	Solid drawn copper and copper alloy tubes for condenser and heat exchangers — Specification ( <i>third revision</i> )	7285 : 1988	Specification for seamless steel cylinders for permanent and high pressure liquefiable gases ( <i>second revision</i> )
2190 : 1992	Selection, installation and maintenance of first-aid fire extinguishers — Code of practice ( <i>second revision</i> )	15222 : 2002	Carbon dioxide as fire extinguishing media for fire protection — Specification
2932 : 1993	Enamel, synthetic, exterior : (a) Undercoating (b) Finishing — Specification ( <i>second revision</i> )		

**ANNEX B**  
( Clause 9.4.1 )

**MECHANICAL TESTS**

**B-1 GENERAL**

Mechanical tests shall be carried out on the material of finished containers in accordance with 6.1.1.

For the purpose of testing, a batch is a group of containers of the same design not exceeding 201 in number, from the same cast heat treated at the same conditions of temperature and duration.

**B-2 FREQUENCY OF TESTING**

Tensile and bend tests in accordance with 6.1.1 shall be carried out on the material of one finished container in every batch. However, in case of change in production schedule, tests shall be carried out as follows:

- a) After a change of material cast: three containers shall be taken from the first 500 container produced, including the first container.
- b) After a significant break in production, for example, a weekend : a minimum of one container shall be taken from the first 500 containers produced.
- c) After the first 500 containers produced following start-up of a production run: testing shall be at regular intervals throughout the production run at the following minimum frequency:

<i>Daily Production Rate</i>	<i>Number ( Test at Even Intervals )</i>
Up to 1 000	1 container
Up to 5 000	2 containers
Up to 10 000	3 containers
Up to 20 000	4 containers
Up to 30 000	5 containers

All containers shall be identified so that if a container fails a test, containers produced since the last successful test can be isolated and submitted to further tests

NOTE — The frequency of tests may be increased to reduce the span of production between tests.

**B-3 HARDNESS TEST**

Each aluminium container after heat treatment shall be subjected to a hardness test as follows:

- a) Brinell hardness test, in which case:

$$\frac{\text{Load ( in kgf )}}{(\text{Ball diameter})^2 \text{ ( in mm}^2\text{)}} = 10; \text{ or}$$

- b) Rockwell hardness test , in which case the value obtained shall be as given below.

The test pressure on which the design of the container is based shall be not less than the greater of (1) or (2):

- 1) 1.5 × charged pressure at 15°C ( for permanent gases ); and
- 2) 1/0.85 × the pressure developed by the gas at the reference temperature ( for permanent and liquefiable gases ).
- c) Other equivalent method approved by the independent inspecting authority.

**B-4 TENSILE TEST**

The tensile test specimen shall be made from a strip cut longitudinally from a finished container or test ring. The cross-section shall either be formed by a portion of the wall of the container or ( when the wall thickness permits ) be circular with a diameter of not less than 7 mm for the central portion.

In preparing the test piece with the cross section formed by a portion of the wall of the container, the face and back of the test piece shall not be machined, but shall represent the surface of the container as manufactured.

NOTE — The ends only may be flattened for gripping in the testing machine.

**B-5 BEND TEST**

Cold bend tests shall be made on low strips cut from the same container or test ring as that used to provide the tensile test piece. A ring shall either be cut from container or test ring and divided into four strips of equal length or, alternatively, two rings shall be cut from a container and each ring shall be cut into two strips of equal length. The width of the ring shall be 25 mm unless 25 mm is less than four times the minimum manufacturing thickness of the container as specified on the drawing ( including corrosion allowance, if any ), in which case the width shall be not less than four times the minimum manufacturing thickness of the container or where machining of the test piece is permitted, not less than four times the thickness of the test piece. Except for large containers, the face and the back of the test piece shall not be machined but the edges may be rounded off. Where bending the full

thickness of the container is impracticable, the test piece, shall at the discretion of the independent inspecting Authority, be thinned uniformly by machining from one side; the un-machined surface shall be bent in tension.

The test piece shall remain un-cracked when bent inwards round a former radius not greater than three times the actual thickness of the specimen as specified in Table 5 until the gap between the ends is not greater than twice the radius of the former.

## **B-6 EXAMINATION OF THICKNESS AND SURFACE DEFECTS**

Before the closing-in operation each container shall be examined for minimum thickness and for external and internal surface defects by mechanical means or ultrasonic methods in accordance with Annex D. Any defects shall be removed by local dressing. The wall thickness of the dressed area shall not be reduced below the minimum wall thickness shown on the manufacturer's drawing.

## **B-7 EXAMINATION OF NECK FOLDS**

Each container shall be examined for neck folds by means of an introscope or other suitable method.

Folds that are visible as a line running into the threaded portion shall be removed by a machining operation, until the lines are no longer visible.

After this machining operation the thickness at the machined area shall not be less than twice the designed wall thickness of the container.

After machining, the whole area shall be re-inspected and measured for thickness. Where folding or lines have not been removed or cracks are visible the container shall be rejected.

Folds that extend beyond the machined area and are open depressions where no oxide skin has been forged into the metal shall be accepted provided that the peaks are smooth and the roots of the depressions are rounded.

## **B-8 HYDRAULIC TESTS**

Each container shall be subjected to a hydraulic test.

### **B-8.1 Type of Test**

When the examination is required, it shall be carried out by ultrasonic methods as specified in Annex D, each completed container, other than those required for the tests specified in 6.1.1, shall be subjected to proof pressure test.

When ultrasonic examination is not carried out on either container or bar stock, each container shall be subjected to a volumetric expansion test in

accordance with Annex C.

### **B-8.2 Test Pressure**

The test pressure shall be determined in accordance with design of container shell. No pressure greater than 80 percent of the test pressure shall be applied to any container before the test.

### **B-8.3 Volumetric Expansion Test**

The permanent volumetric expansion shown by the test expressed all proportion of the total expansion under the test pressure shall not exceed 5 percent.

If the test is made by the non jacket method ( see Annex C ) the container shall be examined for signs of leakage when subjected to the test pressure.

If the permanent volumetric expansion exceeds 5 percent of the total expansion under the test pressure, the container shall be deemed not to comply with this standard.

### **B-8.4 Proof Pressure Test**

Test equipment, all rigid pipe work, flexible tubing, valves, fittings and components forming the pressure system of the test equipment shall be capable of withstanding a pressure equal to the maximum test pressure of any container to be tested.

They shall be tested at regular intervals, and in any case not less frequently than once a month.

The design and installation of the equipment and the containers connected to it shall be such as to avoid trapping air in the system.

### **B-8.5 Test Method**

The test pressure shall be established from the making on the container. When applied to the container, it shall not be exceeded by more than 3 percent or 10 bar, whichever is the lower.

On attaining the test pressure the container(s) shall be isolated from the pump and the pressure held for a minimum period of 1 min, during which period the pressure as registered on the test gauge shall remain constant. Under these conditions of test the container(s) shall not show any sign of leakage, visible deformation or defect.

If there is a leakage in the pressure system it shall be collected and the container(s) retested.

NOTE — More than one container may be tested at a time provided that they all have the same test pressure and that each individual point is capable of being isolated.

### **B-8.6 Drying Out**

The interior of each container shall be thoroughly



dried by a suitable method immediately after hydraulic testing. Containers shall not be heated above 150°C.

**B-8.7 Re-heat Treatment**

Containers shall be solution treated not more than once.

NOTES

1 Where it can be established from the heat treatment furnace records that the artificial ageing treatment has not been adequate, additional time at the ageing treatment temperature is permissible.

2 Where it can be established that solution heat treatment was at fault resolution treatment and artificial ageing of the container are permissible.

**B-9 CHECKING OF WATER CAPACITY**

The water capacity of each container shall be checked and recorded. This shall be done by weighing, by filling the container with a calibrated volume of liquid or by other means approved by the Independent Inspection Authority.

If after the permitted number of retests and re-heat treatments the mechanical requirements have not been complied with, the containers in the batch shall be rendered unserviceable for holding gas under pressure, by one of the following methods:

- a) Container shall be crushed by mechanical means.
- b) An irregular hole shall be made in the top dome of the container, equivalent in area to approximately 10 percent of the area of the top dome; or, in the case of thin walled containers, the containers shall be pierced in at least three places. Drilling a hole or holes in a container shall not be considered as satisfying the requirement of this clause.

**B-10 TESTING OF PROTOTYPE CONTAINERS**

**B-10.1 New Design**

For the purpose of this clause a container shall be

considered a new design compared with an existing approved design, when:

- a) it is manufactured in a different factory; or
- b) it is manufactured by a different process; or
- c) the base profile and the base thickness have changed relative to the container diameter and calculated minimum wall thickness; or
- d) the length of the container has increased by more than 50 percent ( containers with an L/D ratio less than 3 shall not be used as referenced containers for any new design with an L/D ratio greater than 3 ); or
- e) the diameter has changed by more than 5 percent; or
- f) a change in hydraulic test pressure requires a change in design wall thickness.

Where a container is to be used for a lower pressure duty than that for which design approval has been given, it shall not be deemed a new design.

The nominal hoop stress corresponding to the pressure at which destruction occurs shall be calculated from the formula:

$$P_b = \frac{20 f_b t'}{(D_o - t')}$$

where

- $f_b$  = nominal hoop stress, in N/mm<sup>2</sup>, at which destruction occurs;
- $P_b$  = internal pressure, in bar, at which destruction occurs;
- $D_o$  = external diameter, in mm, of the container; and
- $t'$  = actual minimum wall thickness, in mm, for the container being tested.

The value of  $f_b$  shall be not less than 0.95 of the minimum specified tensile strength of the material of the container.

## ANNEX C

( *Clauses 9.4.1, B-8.1 and B-8.3* )

## VOLUMETRIC EXPANSION TESTING OF SEAMLESS CONTAINERS

**C-1 GENERAL**

This Annex gives details of two methods of determining the volumetric expansion of seamless aluminium alloy gas containers:

- a) Water jacket method ( preferred method ); and
- b) Non-water jacket method.

The water jacket volumetric expansion test may be carried out on equipment with a levelling burette with a fixed burette.

**C-2 TEST EQUIPMENT**

NOTE — The requirements specified in **B-2.1** to **B-2.7** are general to both methods of test.

**C-2.1** Hydraulic test pressure pipelines shall be capable of withstanding pressures equal to the maximum test pressure of container that may be tested.

**C-2.2** Glass burettes shall be of sufficient length to receive water equivalent to the full volumetric expansion of the container and capable of being read to an accuracy of 1 percent or 0.1.

**C-2.3** Pressure gauges shall be tested at regular intervals and in any case not less frequently than once a month.

**C-2.4** A suitable device shall be employed to ensure that the test pressure of the container is not exceeded by more than 3 percent or 10 bar whichever is the lower.

**C-2.5** Pipe work shall utilize long bends in preference to elbow fittings and pressure pipes shall be as short as possible. Flexible tubing shall be capable of withstanding equal to the maximum test pressure of any container that may be tested and have sufficient wall thickness to prevent kinking.

**C-2.6** All joints shall be leak-tight.

**C-2.7** Care shall be taken to avoid trapping air in the stem.

**C-3 WATER JACKET VOLUMETRIC EXPANSION TEST****C-3.1 Principle**

This method of test necessitates enclosing the water filled container in a jacket also filled with water. The total volumetric expansion of the container is

measured by the amount of water displaced from the jacket when the container has been pressurized. The permanent volumetric expansion of the container is measured by the amount of water that continues to be displaced from the jacket when the pressure has been released.

**C-3.2 Apparatus**

The water jacket shall be fitted with a safety device capable of releasing the energy from any container that may burst at the test pressure.

An air bleed valve shall be fitted to the highest point of the jacket.

**C-3.3 Procedure****C-3.3.1 General**

Two methods of performing this test are described in **C-3.3.2** and **C-3.3.3**. Other methods are acceptable provided that they are capable of measuring the total and, if any, the permanent volumetric expansion of the container.

**C-3.3.2 Water Jacket Volumetric Expansion Test ( Levelling Burette Method )**

A typical example of the equipment required is shown in Fig. 4. The following procedure shall be carried out:

- a) Fill the container with water and attach the water jacket cover to it.
- b) Seal the container in the jacket and attach the pressure line to the container.
- c) Fill the jacket with water, allowing air to bleed off through the air bleed valve. Close the air bleed valve when water issues freely from it.
- d) Adjust the zero level on the burette to the datum mark on the burette support stand. Adjust the height of the water to the burette zero level by manipulation of the jacket filling valve and the drain valve.
- e) Raise the pressure in the container to two-thirds of the test pressure. Close the hydraulic pressure supply valve and check that the burette reading remains constant.

NOTE — A rising water level indicates a leaking joint between container and jacket. A falling water level indicates a leaking joint between water jacket and atmosphere.

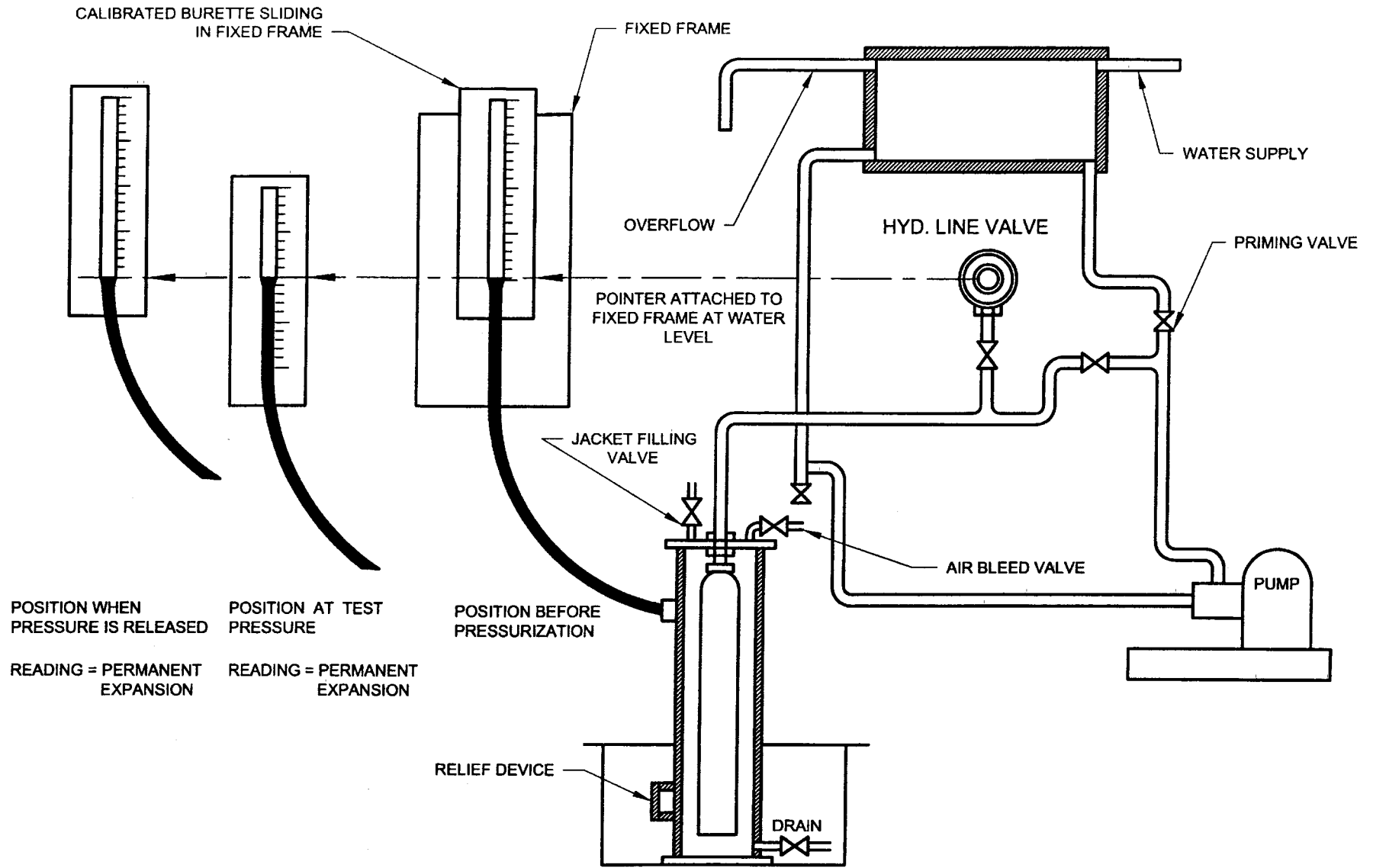


FIG. 4 WATER JACKET VOLUMETRIC EXPANSION TEST ( LEVELLING BURETTE )

- f) Open the hydraulic pressure line valve and continue the pressurization of the container until the test pressure is reached. Close the hydraulic pressure line valve.
- g) Lower the burette until the water level is at the datum mark on the burette support stand. Take the reading of the water level in the burette. This reading is the total expansion and shall be recorded on the test certificate.
- h) Open the hydraulic pressure line drain valve to release pressure from the container. Raise the burette until the water level is again at the datum line on the burette support stand. Check that the pressure is at zero and that the water level is constant.
- j) Read the water level in the burette. This reading is the permanent expansion, if any, and shall be recorded on the test certificate.
- k) Check that the permanent expansion does not exceed 5 percent of the total expansion as determined by the following:

$$\frac{\text{Permanent expansion} \times 100}{\text{Total expansion}} \text{ Percent}$$

$$\frac{\text{Permanent expansion} \times 100}{\text{Total expansion}} \text{ Percent}$$

### C-3.3.3 Water Jacket Volumetric Expansion Test (Fixed Burette Method)

A typical example of the equipment required is shown in Fig. 5. The following procedure shall be carried out :

- a) Fill the container with water and attach the water jacket cover to it.
- b) Seal the container in the jacket and attach the pressure line to the container.
- c) Fill the jacket with water, allowing air to bleed off through the air bleed valve. Close the air bleed valve when water issues freely from it.
- d) Adjust the water level to the zero mark on the burette.
- e) Raise the pressure in the container to two-thirds of the test pressure. Close the hydraulic pressure supply valve and check that the burette reading remains constant.

NOTE — A rising water level indicates a leaking joint between container and jacket. A falling water level indicates a leaking joint between water jacket and atmosphere.

- f) Open the hydraulic pressure line valve and continue the pressurization of the container until the test pressure is reached. Close the hydraulic pressure line valve.

## C-4 NON-WATER JACKET VOLUMETRIC EXPANSION TEST

### C-4.1 Principle

This method consists of measuring the amount of water passed into the container under proof pressure and on release of this pressure, measuring the water returned to the manometer. It is necessary to allow the compressibility of water and the volume of the container under test to obtain true volumetric expansion. No fall in pressure under this test is permitted.

### C-4.2 Apparatus

The equipment shall be arranged such that all air can be removed. The glass tube reservoir shall be calibrated in millimeters and be accurate to 1 percent of reading. It shall be so arranged that accurate readings can be determined of the volume of water required to pressurize the filled container and of the volume expelled from the container when depressurized. In the case of large containers, it may be necessary to augment the glass tube with metal tubes arranged in a manifold.

If a single-acting hydraulic pump is used, care shall be taken to ensure that the piston is in the 'back' position when water levels are noted.

The water used shall be free of air. Any leakage from the system or the presence of free air will result in false readings.

Every care shall be taken to maintain steady temperature conditions and sufficient time shall be allowed to permit the apparatus, the container and the water to attain a uniform constant temperature.

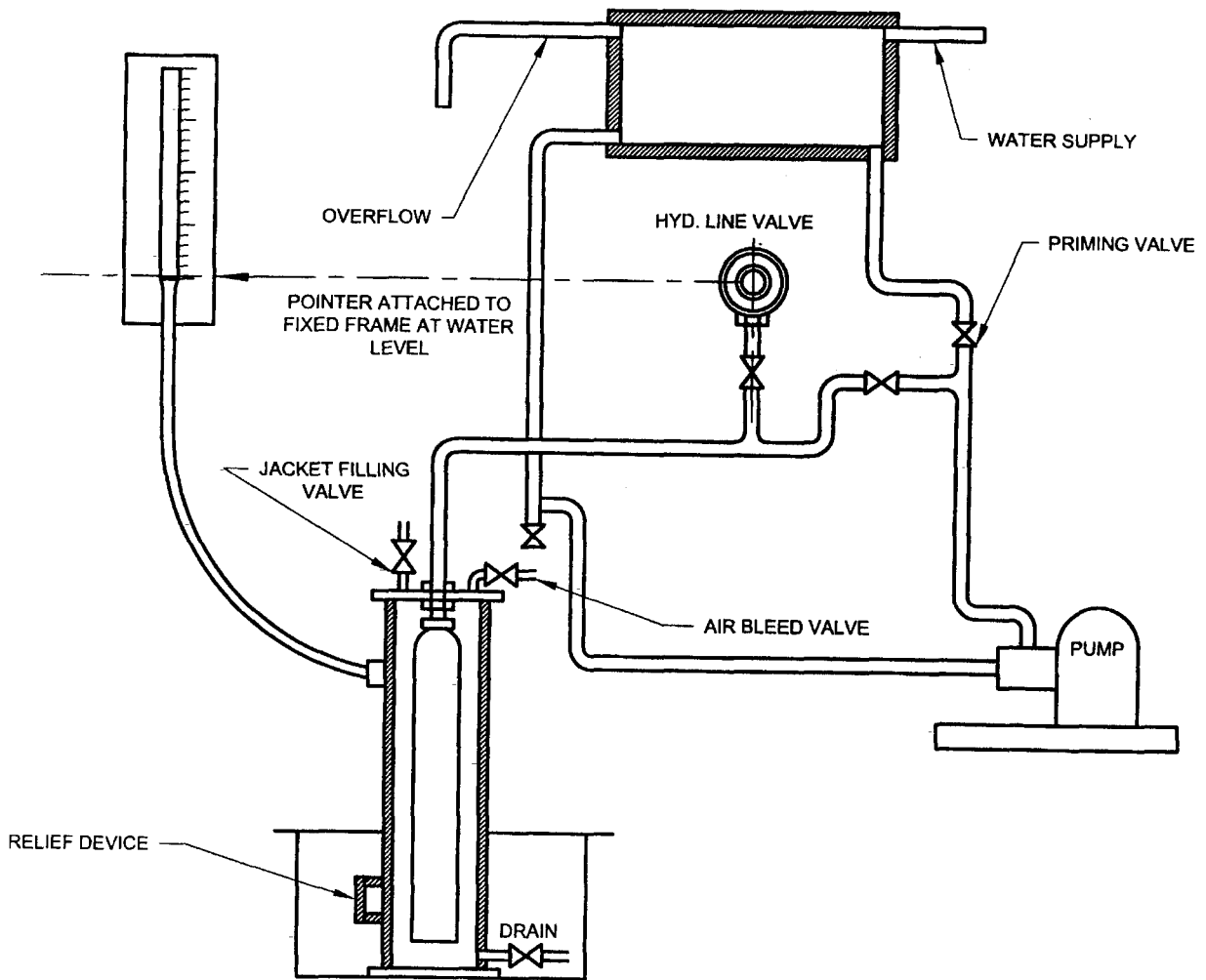


FIG. 5 WATER JACKET VOLUMETRIC EXPANSION TEST ( FIXED BURETTE )

A typical example of the equipment required is shown in Fig. 6. This figure illustrates diagrammatically the different parts of the apparatus. The water supply pipe shall be collected to an overhead tank or to some other supply giving a sufficient head of water.

#### C-4.2.1 Test Method

- a) Completely fill the container with water and determine the mass of water required.
- b) Connect the container to the hydraulic test pump through coil A and check that all valves are closed.
- c) Fill the pump and system with water from tank C by opening valves D, E and H.
- d) To ensure the expulsion of air from the system, close valve H and raise the system pressure to approximately one-third of the test pressure. Open bleed valve G to release trapped air by reducing the system pressure to zero and reclose valve G. Repeat if necessary.
- e) Continue to fill the system until the level in glass tube M is approximately 300 mm from the top of this tube. Close valve D and mark the water level by pointer P, leaving valves E and H open. Record the level.
- f) Close valve H. Raise the pressure in the system until pressure gauge K records the required test pressure. Stop the pump. After approximately 30 s there should be no change in either the water level or the pressure. A change in level indicates leakage. A fall in pressure, if there is no leakage, indicates that the cylinder is still expanding under pressure.
- g) Record the fall of the water level in the glass tube. Providing there has been no leakage, the water drained from the glass tube will have been pumped into the container to achieve test pressure. This difference in water level is the volumetric expansion.

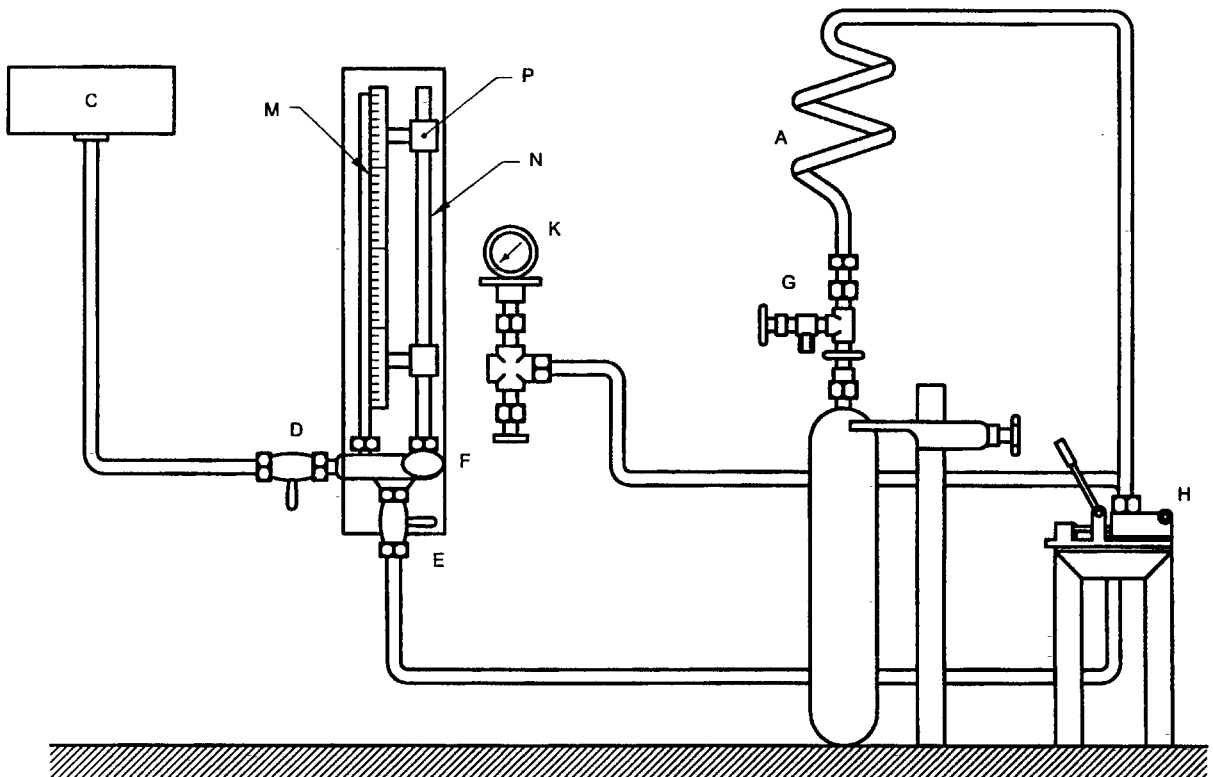


FIG. 6 NON WATER JACKET VOLUMETRIC EXPANSION TEST

- h) Open valve *H* slowly to release the pressure in the container and allow the water released to return to the glass tube. The water level should return to the original level should be marked by pointer *P*. If the water level returns to a point below pointer *P*, this difference in level will denote the amount of permanent volumetric expansion in the container, neglecting the effect of the compressibility of the water obtained from the calculation given in C-4.4.
- j) Before disconnecting the container from the test rig, close valve *E*. This will leave the pump and system full of water for the next test. Action as per C-4.2.1(d) shall, however, be repeated at each subsequent test.
- k) If permanent volumetric expansion has occurred, record the temperature of the water in container.

#### C-4.3 Test Results

**C-4.3.1** The tests determine the volume of water required to pressurize the filled container to test pressure.

**C-4.3.2** The total mass and temperature of the water in the container are known and compressibility to be calculated by the change in the volume of the water in the container. The volume of the water expelled from the container when depressurized is known. Thus total volumetric expansion (*TE*) and permanent volumetric expansion (*FE*) can be determined.

**C-4.3.3** The permanent volumetric expansion shall not exceed 5 percent of the total volumetric expansion.

**C-4.4** The compressibility of water is calculated from the following formula:

$$C = mP \left[ K - \frac{0.68P}{10^5} \right]$$

where

*C* = volume of water forced into the container due to compressibility of water, in ml;

*m* = mass of water in the container at test pressure, in kg;

*P* = test pressure, in bar; and

*K* = factor for individual temperatures as given in Table 6.

**Table 6 K Factors for the Compressibility of Water**  
( Clauses 9.5.1 and C-4.4 )

Sl No.	°C	K
(1)	(2)	(3)
i)	6	0.049 15
ii)	7	0.048 86
iii)	8	0.048 60
iv)	9	0.048 34
v)	10	0.048 12
vi)	11	0.047 92
vii)	12	0.047 75
viii)	13	0.047 59
ix)	14	0.047 42
x)	15	0.047 25
xi)	16	0.047 10
xii)	17	0.046 95
xiii)	18	0.046 80
xiv)	19	0.046 68
xv)	20	0.046 54
xvi)	21	0.046 43
xvii)	22	0.046 33
xviii)	23	0.046 23
xix)	24	0.046 13
xx)	25	0.046 04
xxi)	26	0.045 94

**ANNEX D***( Clauses 9.4.1, B-6 and B-8.1 )***ULTRASONIC THICKNESS MEASUREMENT****D-1 GENERAL**

This method covers the thickness measurement of seamless container employing either the pulse echo or the resonance system. Either contact or immersion techniques may be used. The container shall be examined to ensure that the thickness is not below the design minimum:

- a) on the base end;
- b) on the parallel body; and
- c) on any part of the container where surface blemishes have been removed by grinding, machining, etc.

NOTE — Both the testing and the reflecting surfaces of the containers shall be clean and free from any materials that will interfere with test.

**D-2 EQUIPMENT**

The test equipment shall be of either the pulse echo or the resonance type and shall be capable of

indicating a given thickness of material to any accuracy within  $\pm 2.5$  percent of the set value.

**D-2.1 Couplant**

A coupling method that ensures adequate transmission of ultrasonic energy between the testing probe and the container shall be used.

**D-2.2 Frequency**

The ultrasonic test frequency used shall be not less than 2 MHZ.

The container to be inspected and the search unit shall have a rotating motion and a translation relative to one another is such that a helical scans of the container are within  $\pm 10$  percent. The pitch of the helix shall be less than the probe and shall be related to the effective beam width so as to ensure 100 percent coverage at the speeds and feeds used during the calculation procedure.



**ANNEX E**  
( Clause 11 )

**SAMPLING AND CRITERIA FOR CONFORMITY**

**E-0 GENERAL**

The risk involved in failure of a fire extinguisher to work, when needed, is extremely large. Fire extinguisher, therefore, ought to have a high degree of reliability for performance during the entire specified period of its service. It can be achieved only through adequate design and control of quality of all raw materials, component parts and fittings followed by process control in all stages of manufacture and assembly.

**E-1 SAMPLING**

**E-1.1** All fire extinguishers of the same type, shape, design and capacity produced by the same manufacturer from similar materials under almost identical conditions of manufacture shall be grouped together to constitute a lot.

**E-1.2** Each lot shall be considered individually for the purpose of evaluation of quality in accordance with this specification.

**E-1.2.1** The number of samples for testing to be taken at random from a lot and the criteria for conformity shall be as given in **E-1.2.2**.

**E-1.2.2** From each lot, a number of samples as indicated below shall be selected at random.

<i>Number of Items in the Lot</i>	<i>Sample Size Percent</i>
(1)	(2)
Up to 25	3
26 to 50	5
51 to 100	8
101 and up to 200	8

**E-1.2.3** They shall be examined visually, as far as possible, in respect of requirement specified in **3 to 9**.

**E-1.2.4** All the samples tested shall pass all these tests for the lot to be declared to conform to these requirements.

**E-1.2.5** One sample shall then be examined for discharge duration and one for intermittent operation and one of these for leakage.

**E-1.2.6** In the absence of a test certificate from a manufacturer about conformity of various components ( *see 4* ) and the quality of charge ( *see 5* ) to the requirements of this specification, from a sample fire extinguisher, one item each of all the component parts and fittings shall be taken separately and examined individually in respect of the relevant requirements laid down in this specification. The sample shall also meet the requirements regarding the quality of charge ( *see 5* ).

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