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**Fire fighting — Portable fire  
extinguishers — Performance and  
construction**

*Lutte contre l'incendie — Extincteurs portatifs — Performances et  
construction*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 7165 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 2, *Manually transportable fire extinguishers*.

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# Fire fighting — Portable fire extinguishers — Performance and construction

## 1 Scope

This International Standard specifies the principal requirements intended to ensure the safety, reliability and performance of portable fire extinguishers.

It is applicable to a fully charged extinguisher having a maximum mass of 20 kg.

NOTE In some cases, extinguishers having a total mass of up to 25 kg when fully charged may be approved, subject to local acceptance.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3130:1975, *Wood — Determination of moisture content for physical and mechanical tests.*

ISO 3941:1977, *Classification of fires.*

ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources.*

ISO 5923:1989, *Fire protection — Fire extinguishing media — Carbon dioxide.*

ISO 7202:1987, *Fire protection — Fire extinguishing media — Powder.*

ISO 7203 (all parts), *Fire extinguishing media — Foam concentrates.*

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests.*

ISO 14520 (all parts), *Gaseous fire-extinguishing systems — Physical properties and system design.*

## 3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

### 3.1

#### Classification of fires

[ISO 3941:1977]

**3.1.1**

**Class A**

fires involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers

**3.1.2**

**Class B**

fires involving liquids or liquefiable solids

**3.1.3**

**Class C**

fires involving gases

**3.1.4**

**Class D**

fires involving metals

**3.2**

**portable extinguisher**

portable appliance containing an extinguishing medium which may be discharged and directed onto a fire by the action of internal pressure; discharge may be achieved by:

- stored pressure (constant pressurization of the extinguishing media container);
- cartridge operated [pressurization at the time of use by the release of a pressurizing gas stored in a separate high pressure container (cartridge)]

**3.3**

**extinguishing medium**

substance contained in the extinguisher that causes extinguishment

**3.4**

**charge of extinguisher**

mass or volume of the extinguishing medium contained in the extinguisher expressed in volume (litres) for water-based extinguishers and in mass (kilograms) for other extinguishers

**3.5**

**service pressure**

$p_s$

equilibrium pressure developed in a normally charged and pressurized extinguisher conditioned at 20 °C for at least 18 h

**3.6**

**maximum service pressure**

$p_{ms}$

equilibrium pressure developed in a normally charged and pressurized extinguisher which is conditioned at 60 °C for at least 18 h

**3.7**

**complete discharge**

point in the discharge of an extinguisher when the internal pressure has equalized with the external pressure, with the valve control being kept fully open

**3.8**

**effective discharge time**

time from the commencement of discharge of the extinguishing medium at the nozzle to the gas point of the discharge stream with the control valve fully open

**3.9****rechargeable extinguisher**

extinguisher designed to be recharged after use

**3.10****disposable extinguisher****non-rechargeable extinguisher**

extinguisher designed not to be recharged in the field or at the factory, but intended to be discarded after use

**3.11****fill density**

mass in kilograms of extinguishing medium per litre of container volume as fitted for use, complete with valve and internal fittings

**3.12****bulk range**

range of the extinguisher when 50 % of its media has been expelled

**3.13****batch**

group of the same products made on the same production line using the same lot of materials during one production shift

**3.14****gas point**

point where the medium discharge changes from predominately liquid medium to predominately expellant gas

**3.15****propellant**

non-flammable compressed gas used to expel the extinguishing medium

**3.16****clean agent**

electronically non-conductive gaseous or vaporizing liquid fire extinguishant that does not leave a residue upon evaporation

**3.17****lowest observable adverse effect level****LOAEL**

lowest concentration at which an adverse physiological or toxicological effect has been observed

## **4 Classification of extinguishers**

Extinguishers shall be classified by the type of extinguishing medium which they contain.

At present, the main classes of extinguishers are:

- a) water-based;
- b) powder;
- c) carbon dioxide;
- d) clean agents.

These classes of extinguishers may be further sub-divided, for example water-based extinguishers may contain pure water or water with additives such as wetting agents, viscosity-increasing agents, flame-retardant, or foaming agents, etc.

Powders may be of the "BC" or "ABC" types, or may be specially prepared for Class D (metals) fires.

NOTE In some countries, the manufacture and use of clean agents are regulated by the Montreal Protocol or by national regulations.

## 5 Extinguishing media, propellants and filling requirements

### 5.1 Extinguishing media

#### 5.1.1 Carbon dioxide

Carbon dioxide used in extinguishers shall comply with ISO 5923.

#### 5.1.2 Clean agents

Clean agents used in extinguishers shall comply with the appropriate part of ISO 14520.

NOTE In some countries, the manufacture and use of clean agents is regulated by the Montreal Protocol or by national regulations.

#### 5.1.3 Powders

Powders used in extinguishers shall comply with ISO 7202.

EXCEPTION: Powders for use on Class D fires.

#### 5.1.4 Foam concentrates

Foam concentrates used in extinguishers shall comply with the appropriate part of ISO 7203.

NOTE There is no ISO Standard covering non-foaming additives sometimes added to water to produce antifreeze, wetting or other special characteristics. However, such extinguishers are included in the category of water-base extinguishers.

### 5.2 Propellants

The propellants for stored pressure and cartridge-operated extinguishers shall be air, argon, carbon dioxide, helium, or nitrogen or mixtures of these gases having a maximum dew-point of  $-55\text{ }^{\circ}\text{C}$ .

EXCEPTION: Propellant for stored-pressure water-based extinguishers need not meet the above dew-point.

### 5.3 Filling requirements

#### 5.3.1 Fill density

The maximum fill density for carbon-dioxide extinguishers shall not exceed 0,75 kg/l. The fill density for clean agent fire extinguishers shall not exceed the values given in the appropriate part of ISO 14520.

NOTE 1 The above fill densities may be subject to national pressure vessel regulations.

#### 5.3.2 Filling tolerance

The actual charge of an extinguisher shall be the nominal charge within the following limits:

- a) water-based extinguisher:  $\pm 5\%$  by volume;

- b) powder extinguishers:
- $\leq 1$  kg nominal charge  $\pm 5$  % by mass;
  - $> 1$  kg but  $< 3$  kg nominal charge  $\pm 3$  % by mass;
  - $\geq 3$  kg nominal charge  $\pm 2$  % by mass;
- c) clean-agent extinguishers:  $_{-5}^0$  % by mass;
- d) carbon-dioxide extinguishers:  $_{-5}^0$  % by mass.

### 5.3.3 Charges

The following are the recommended charges for fire extinguishers:

- water-based (l): 2, 3, 6, 9;
- powder (kg): 1, 2, 3, 4, 6, 9, 12;
- CO<sub>2</sub> (kg): 2,5;
- clean agent (kg): 1, 2, 4, 6.

## 6 Pressure requirements for low-pressure extinguishers

### 6.1 Test pressure ( $p_t$ )

The test pressure ( $p_t$ ) for low-pressure extinguishers shall be  $1,43 \times p_{ms}$  but in no case less than 2 MPa<sup>1)</sup> (20 bar).

### 6.2 Minimum burst pressure ( $p_b$ )

The minimum burst pressure ( $p_b$ ) for low-pressure extinguishers is  $2,7 \times p_{ms}$  but in no case less than 5,5 MPa (55 bar).

## 7 General operating performance requirements

### 7.1 Operating temperatures

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

- + 5 °C to + 55 °C;
- 0 °C to + 55 °C;
- 10 °C to + 55 °C;
- 20 °C to + 55 °C;
- 30 °C to + 55 °C;
- 40 °C to + 55 °C;
- 55 °C to + 55 °C;

NOTE The temperature range selected from the above ranges shall be marked on the fire extinguisher (see 10.2.1.5).

1) 1 bar = 100 kPa = 0,1 MPa; 1 Pa = 1 N/m<sup>2</sup>.

## 7.2 Minimum effective discharge time and bulk range of discharge

### 7.2.1 Class A rated extinguishers

The minimum effective discharge time of extinguishers with a 1A rating shall be no less than 8 s. Extinguishers with ratings of 2A or higher shall have a minimum discharge time of 13 s.

### 7.2.2 Class B rated extinguishers

The minimum effective discharge time of extinguishers with a Class B rating shall be no less than the appropriate value given in Table 1.

**Table 1 — Minimum effective discharge time of Class B rated extinguishers**

| Classification                                                       | Minimum discharge time<br>s |
|----------------------------------------------------------------------|-----------------------------|
| 8B <sup>a</sup>                                                      | —                           |
| 13B <sup>a</sup>                                                     | —                           |
| 21B                                                                  | 8                           |
| 34B                                                                  | 8                           |
| 55B                                                                  | 9                           |
| (70B)                                                                | 9                           |
| 89B                                                                  | 9                           |
| (113B)                                                               | 12                          |
| 144B                                                                 | 15                          |
| (183B)                                                               | 15                          |
| 233B                                                                 | 15                          |
| <sup>a</sup> This fire size is for a low-temperature fire test only. |                             |

### 7.2.3 Bulk range

#### 7.2.3.1 Requirements

The minimum bulk range of extinguishers with a Class A rating shall be no less than 3 m when determined in accordance with 7.2.3.2.

#### 7.2.3.2 Test method

Carry out the test indoors using lighting which gives the best possible illumination of the extinguisher media during discharge. Use a black background marked to indicate the horizontal distance. Condition the extinguisher for no less than 18 h at a temperature of  $(20 \pm 5) ^\circ\text{C}$  and place it in normal operating position with the discharge nozzle held horizontally 1 m above the floor. Fully discharge the extinguisher with the control valve fully open within 5 min of conditioning. Record the bulk range of the extinguisher as the range at the time corresponding to 50 % of the effective discharge time.

**NOTE** Where the range of effective discharge is difficult to determine visually, supplementary means, such as collection boxes for powders and condensing plates for liquefied gases may also be used.

### 7.3 Resistance to temperature changes

#### 7.3.1 Requirements

Portable extinguishers shall be able to operate at temperatures within one of the temperature ranges given in 7.1 as indicated by the manufacturer and comply with the following requirements after being subjected to the conditions given in 7.3.2:

- a) shall operate as intended;
- b) commence discharge within 5 s of the opening the control valve;
- c) not retain more than 10 % of initial charge within the extinguisher following complete discharge.

#### 7.3.2 Test method

Subject four extinguishers to the temperature cycles given in Table 2, two extinguishers to each cycle.

**Table 2 — Temperature cycles**

| Duration<br>h                                                                                                               | Cycle 1                                                                   | Cycle 2                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
| $24 \pm 1$                                                                                                                  | Store at minimum <sup>a</sup> stated temperature ( $-2^{\circ}\text{C}$ ) | Store at $(55 \pm 2)^{\circ}\text{C}$                                     |
| $24 \pm 1$                                                                                                                  | Store at $(20 \pm 5)^{\circ}\text{C}$                                     | Store at $(20 \pm 5)^{\circ}\text{C}$                                     |
| $24 \pm 1$                                                                                                                  | Store at $(55 \pm 2)^{\circ}\text{C}$                                     | Store at minimum <sup>a</sup> stated temperature ( $-2^{\circ}\text{C}$ ) |
| The storage temperatures refer to the ambient temperature within the conditioning chamber. A liquid bath shall not be used. |                                                                           |                                                                           |
| <sup>a</sup> See 7.1.                                                                                                       |                                                                           |                                                                           |

Operate the extinguisher within 1 min of its removal from the conditioning chamber.

The extinguisher is to be held in its normal working position and shall remain immobile for the duration of the test.

NOTE For cartridge extinguishers the cartridge shall be pierced and the pressure allowed to build for 6 s before opening the control valve.

### 7.4 Retention of charge

#### 7.4.1 Routine checks

**7.4.1.1** Extinguishers and gas cartridges shall be designed so as to permit their charge to be checked at regular intervals when they are installed.

**7.4.1.2** The charge of the following shall be measured by weighing:

- a) all types of gas cartridges for extinguishers;
- b) carbon-dioxide extinguishers;
- c) stored-pressure extinguishers of various types including some clean agents in which a mass loss of 1 % of total mass is accompanied by a pressure loss of not more than 10 % of the service pressure at  $(20 \pm 2)^{\circ}\text{C}$ .

**7.4.1.3** The charge of stored-pressure extinguishers of types not covered in 7.4.1.2 b) and c) shall be checked by direct measurement of internal pressure at  $(20 \pm 2) ^\circ\text{C}$ . For this purpose, the extinguisher shall be fitted with a built-in pressure-indicating device which can be checked for satisfactory operation.

A connection to which an independent pressure-measuring appliance can be attached may be used as the means for checking the built-in pressure-indicating device; in this case, a connection of this type shall be equipped with a pressure-retaining cap.

## **7.4.2 Retention of charge following partial discharge**

### **7.4.2.1 Requirements**

Fire extinguishers shall be fitted with a control valve allowing the discharge of the extinguishing medium to be interrupted at any time.

The extinguisher shall be adequately resistant to leakage and the second pressure (or weight of contents as appropriate) shall be no less than 75 % of the first, after interruption of the discharge as determined in 7.4.2.2.

### **7.4.2.2 Test method**

Discharge a fully charged extinguisher for a period equal to half the time for total discharge and the control valve shall then be closed. Measure the internal pressure (or weight of contents as appropriate) and after a further 5 min with the valve having remained closed, measure the pressure (or weight of contents as appropriate) again.

## **7.4.3 Long-term leakage test**

### **7.4.3.1 Requirements for stored-pressure extinguishers**

Stored-pressure extinguishers covered by 7.4.1.3 shall not leak at a rate exceeding 5 % per annum of service pressure.

### **7.4.3.2 Requirements for gas cartridges and extinguishers checked by mass**

Long term leakage requirements are as follows:

- stored-pressure extinguishers without a pressure gauge shall not leak at a rate exceeding 5 % of its contents per annum or 50 g per annum, whichever is less [see 7.4.1.2 c)];
- gas cartridges shall not leak at a rate exceeding 5 % of its contents per annum or 7 g per annum, whichever is less;
- carbon-dioxide extinguishers shall not leak at a rate exceeding 5 % of its contents per annum.

### **7.4.3.3 Test method**

Check six samples for leakage after 30 d, 90 d, and 120 d. Any loss in pressure or contents at constant ambient temperature is an indication of a leak.

## **7.5 Mechanical resistance**

### **7.5.1 Resistance to impact**

**NOTE** This test is intended to prove the resistance of the extinguisher, and particularly that of the head and fittings, to damage from falling objects or from impact with fixed surfaces.

### 7.5.1.1 Requirements

The extinguisher shall not release pressure in a potentially dangerous manner when tested in accordance with 7.5.1.2.

### 7.5.1.2 Test method

Condition an extinguisher, correctly charged and equipped with all the fittings which are subject to internal pressure in normal operation, for 18 h to the minimum working temperature (see 7.1) with a tolerance of  $\pm 5^\circ\text{C}$ , and maintain it at this temperature during the impact test described below.

For the purpose of this test, an anti-freeze agent may be added to prevent freezing of the contents of water-based extinguishers, and water or antifreeze may be utilized in carbon-dioxide extinguishers for safety reasons.

If the extinguisher is of the gas cartridge type, fit the charged cartridge and activate the extinguisher with the control valve shut, so as to keep the extinguisher under pressure.

Conduct the impact test as follows.

Mount a steel cylindrical hammer, of 75 mm diameter and total mass of 4,0 kg with flat faces, vertically in loose guides so that it can drop freely through a height  $h$  (minimum height 300 mm) given by:

$$h = \frac{m}{20} \text{ and } h \geq 0,3$$

where

$h$  is the height, expressed in metres;

$m$  is the total mass of extinguisher, expressed in kilograms.

The extinguisher shall be placed on a rigid flat surface in each of the following two positions in turn:

- a) in the normal upright position, with the longitudinal axis of the hammer coincident with the longitudinal axis of the valve;
- b) lying on its side so that the valve rests on a rigidly fixed steel block.

In each of the above positions, submit the valve of the extinguisher to an impact by allowing the steel hammer to fall vertically onto it from the height  $h$ . The point of impact is to be determined by the authority carrying out the test.

## 7.5.2 Resistance to vibrations

### 7.5.2.1 Test principle

An extinguisher shall be capable of withstanding exposure to the conditions of a vibration test without development of physical weakness which would impair its normal operation.

### 7.5.2.2 Extinguisher mounting requirements

Extinguishers supplied with a wall hook or bracket not intended for use in vehicles shall be subjected to the test specified in 7.5.2.5.2.

Extinguishers supplied with a bracket for use in vehicles shall be subjected to the test specified in 7.5.2.5.3.

Extinguishers supplied with a bracket suitable for both general and vehicle use shall be subjected to the test specified in 7.5.2.5.3.

### 7.5.2.3 Test criteria

— The test criteria are as follows:

- a) following exposure to the vibration test the extinguisher shall comply with the discharge requirements specified in 7.2;
- b) physical failure of components which would require repair or replacement of the extinguisher and/or components before it can be returned to normal service shall be cause for rejection.

### 7.5.2.4 Mounting of the test specimen

Mount a fully charged extinguisher in an upright position. Mount extinguishers intended for use in vehicles in their intended bracket. Extinguishers not intended for use in vehicles may be tested without a bracket.

### 7.5.2.5 Test orientation

#### 7.5.2.5.1 Axes of orientation

Subject the extinguisher to the vibration test specified in 7.5.2.5.2 or 7.5.2.5.3 in each of the three rectilinear axes in the following order: horizontal, lateral, and vertical.

#### 7.5.2.5.2 General extinguishers

The vibration applied shall have the following parameters.

Frequency: 40 Hz

Amplitude: 0,25 mm  $\pm$  0,03 mm

Duration: 2 h (in each orientation specified in 7.5.2.5.1)

#### 7.5.2.5.3 Vehicle extinguishers

Subject the vehicle extinguishers to the following tests.

- a) Subject the extinguisher to the variable frequency and amplitude specified below in each orientation specified in 7.5.2.5.1.

| Frequency (Hz) | Amplitude (mm)  |
|----------------|-----------------|
| 10 to 19       | 0,75 $\pm$ 0,08 |
| 20 to 39       | 0,50 $\pm$ 0,05 |
| 40 to 60       | 0,25 $\pm$ 0,03 |

Vibrate the extinguisher for 5 min at each frequency and increase the frequency at discrete intervals of 2 Hz.

- b) Vibrate the extinguisher for 2 h at the frequency which produced the maximum resonance as determined in a) above or if no resonance is observed subjected to the test specified in 7.5.2.5.2.

Complete the tests specified in a) and b) above in one plane before making tests in the next plane.

## 7.6 Resistance to corrosion

### 7.6.1 External corrosion test

Subject complete and fully charged extinguishers, including their mounting bracket and wall hook, to a salt spray test as defined in ISO 9227 for a period of 480 h. Following a drying period of at least 24 h at room temperature, carefully wash the extinguisher to remove any salt deposits. Test two samples i.e. either two of the same size or one sample each of two different sizes from the same family.

At the conclusion of the test the following requirements shall be satisfied:

- the mechanical operation of all working parts shall be unimpaired;
- the minimum effective discharge time and method of operation shall comply with requirements specified in 7.2 and 9.10;
- the pressure gauge, if one is fitted, shall remain functional and watertight;
- there shall be no corrosion of the metal of the extinguisher body; discoloration or superficial corrosion of non-ferrous metals is acceptable, but galvanic corrosion between dissimilar metals shall not be permitted.

### 7.6.2 Internal corrosion test for extinguishers using water-based media

Subject two extinguishers, charged in accordance with the manufacturer's filling instructions, eight times to the temperature cycle defined in Table 3.

**Table 3 — Temperature cycle**

| Stage                                                                                                                                                                          | Duration<br>h | Temperature<br>°C |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------|
| 1                                                                                                                                                                              | $24 \pm 1$    | a                 |
| 2                                                                                                                                                                              | $\geq 24$     | $20 \pm 5$        |
| 3                                                                                                                                                                              | $24 \pm 1$    | $60 \pm 2$        |
| 4                                                                                                                                                                              | $\geq 24$     | $20 \pm 5$        |
| The temperature refers to the ambient temperature of the conditioning chamber. A liquid bath shall not be used. The duration of any one complete cycle shall not exceed 120 h. |               |                   |
| a The lowest temperature marked on the extinguisher $\pm 2$ °C. See 7.1.                                                                                                       |               |                   |

On completion of the eight temperature cycles, cut each body into two sections in a manner sufficient to permit internal examination. Disregard detachment of any protective coating local to the plane of section. There shall be no visible signs of corrosion of the metal nor detachment, cracking or bubbling of any protective coating. There shall be no visible change in the colour of the extinguishing media other than that resulting from the thermal cycling.

**NOTE** Allowance should be made for a change of colour that occurs naturally due to the temperature changes. It is recommended that two samples of the agent be stored in closed glass containers and subjected to the same cycles as the extinguishers in order to establish a reference sample.

## 7.7 Tapping test

### 7.7.1 Requirements

Portable extinguishers shall comply with the following requirements after being subjected to the conditioning specified in 7.7.3:

- a) shall operate satisfactorily;
- b) commence discharge within 5 s of the opening of the control valve;
- c) not retain more than the following percentage of initial charge within the extinguisher following complete discharge:
  - powder: 15 %;
  - all other media: 10 %.

### 7.7.2 Test apparatus

**7.7.2.1 Compaction machine**, designed to accept only one extinguisher at a time which shall be raised by a rod and guided by castors.

The plate supporting the extinguisher shall be steel  $(300 \pm 5)$  mm square and  $(60 \pm 1)$  mm thick. Figure 1 is an example of an acceptable test apparatus.

Observe the following points:

- ensure that the rod is adjustable as to adjust to the extinguisher base;
- ensure that the rod can move freely in the guide castors;
- the extinguisher shall also be guided without constraint.

### 7.7.3 Test method

An extinguisher in a normally charged condition shall be held in the vertical position and dropped vertically 500 times from a height of 15 mm at a frequency of 1 Hz onto a rigid horizontal steel plate.

The extinguisher is to be removed from the test apparatus with a minimum amount of agitation, held in its normal working position, and operated.

**NOTE** For cartridge extinguishers, the cartridge shall be pierced and the pressure allowed to build for 6 s before the opening of the control valve.

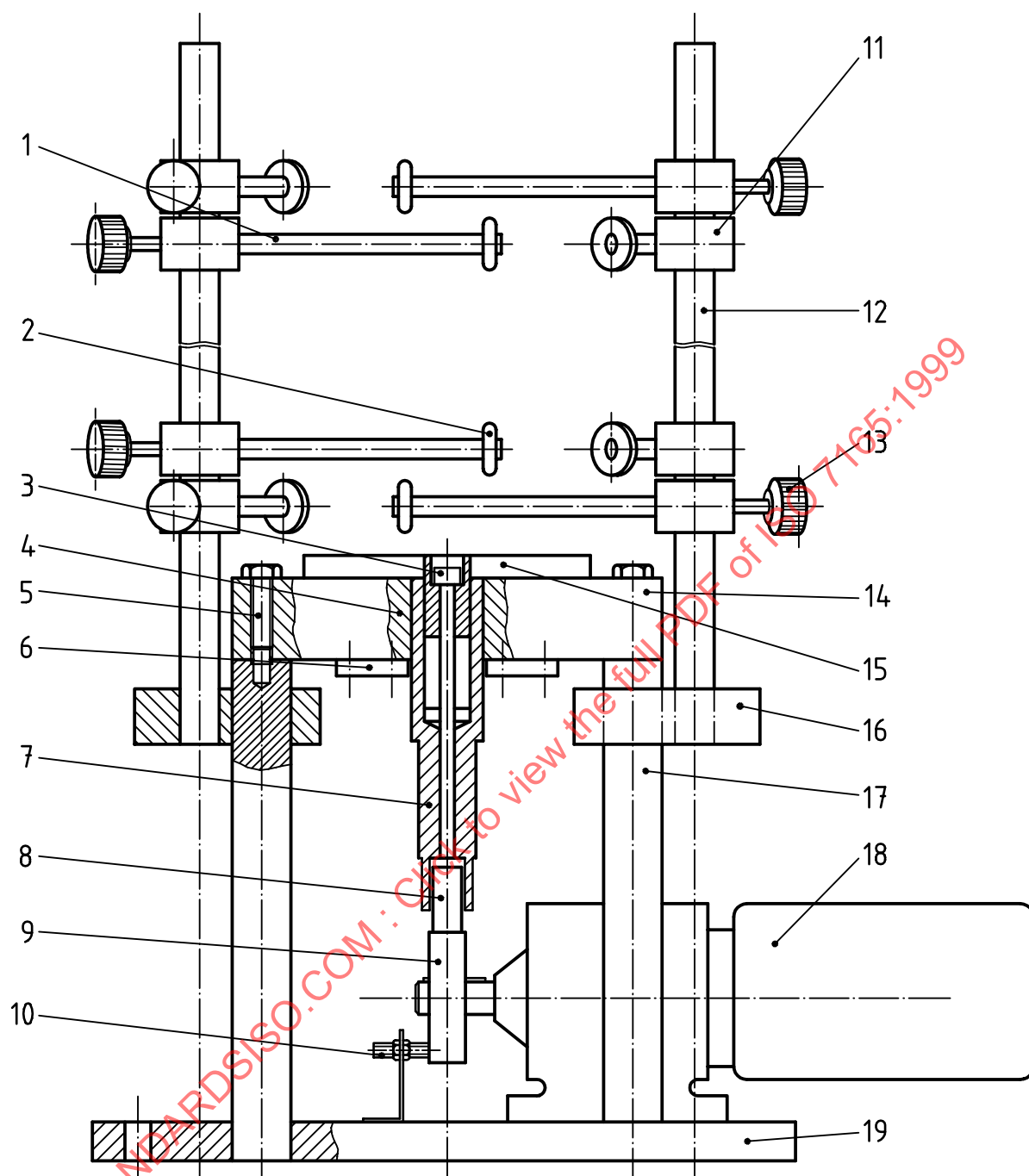
## 7.8 Intermittent discharge test

**7.8.1** An extinguisher conditioned at its minimum operating temperature  $(\pm 2^\circ\text{C})$  and at  $55^\circ\text{C} (\pm 5^\circ\text{C})$  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 the following percentages of its original charge:

- powder: 15 %;
- all others: 10 %.

**7.8.2** Condition a correctly charged extinguisher at each of the specified temperatures 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.

**7.8.3** For cartridge-operated extinguishers, pierce the cartridge and allow the pressure to build for 6 s before opening the control valve.

**Key**

- |                         |                      |                                |
|-------------------------|----------------------|--------------------------------|
| 1 Castor support axis   | 8 Castor             | 15 Adjusting block             |
| 2 Castors               | 9 Cam                | 16 Support axes                |
| 3 CH+C, M12-190 screw   | 10 Inductive pick-up | 17 Plate support axis          |
| 4 Push-nut extinguisher | 11 Rotation guidance | 18 Flender-Himmel geared motor |
| 5 H, M16-90 screw       | 12 Axes              | 19 System support plate        |
| 6 Plates                | 13 Castor nut        |                                |
| 7 Piston                | 14 Support plate     |                                |

**Figure 1 a) — Tapping machine — General diagram**

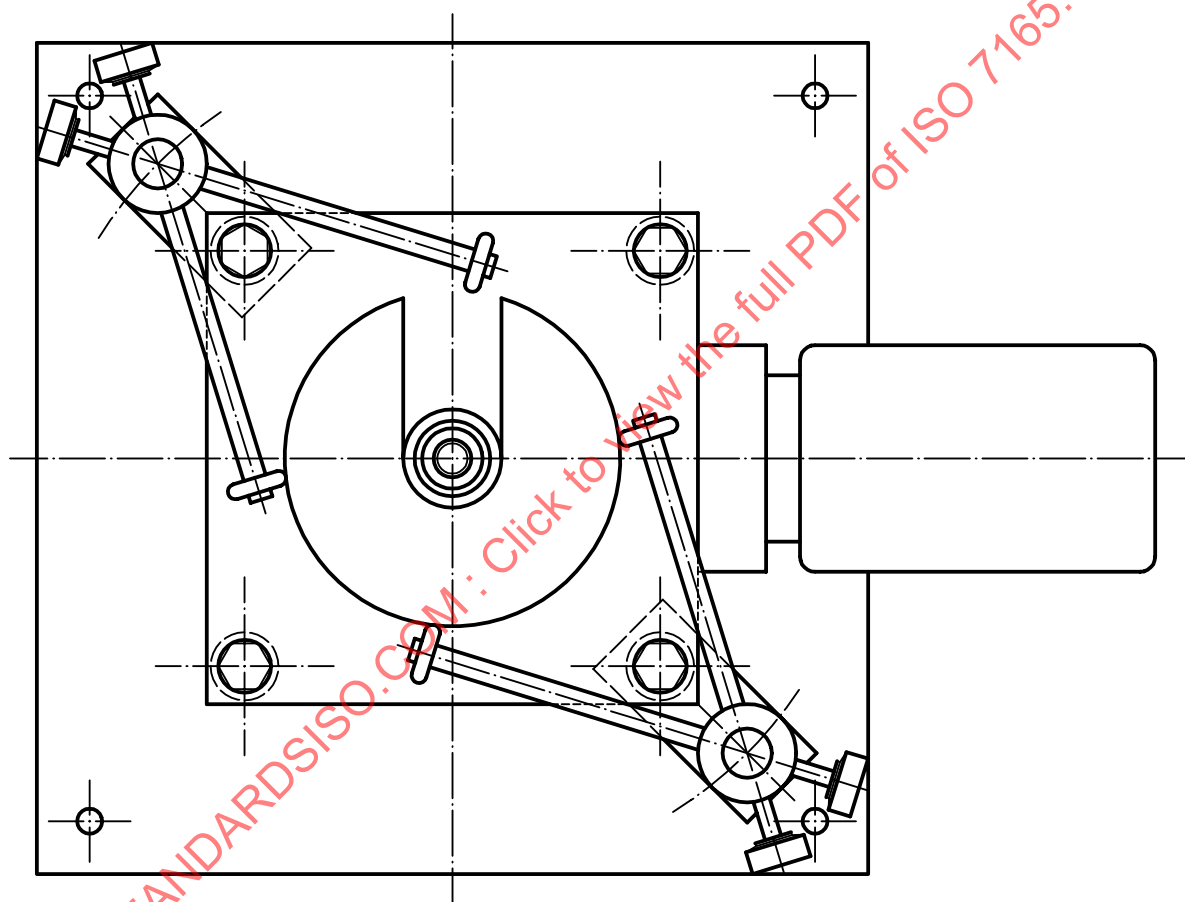
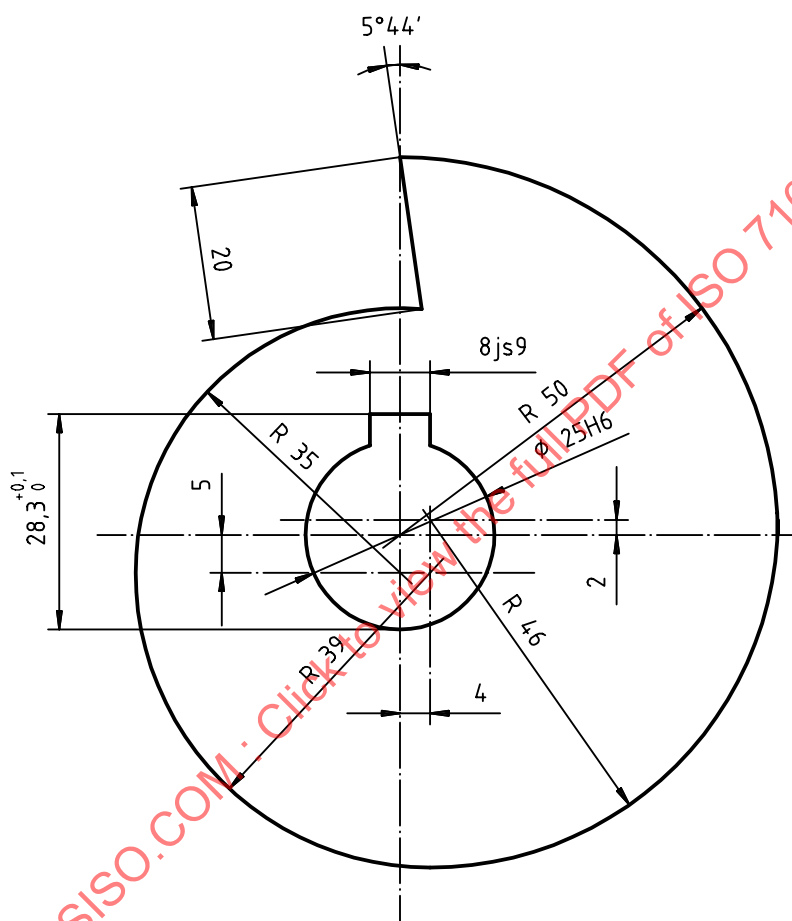


Figure 1 b) — Tapping machine — View from above

Dimensions in millimetres



Cam thickness: 20 mm

Figure 1 c) — Tapping machine — Details of item No. 9 in Figure 1 a)

## 8 Performances requirements for test fires

### 8.1 Rating suitability for the various classes of fire

#### 8.1.1 Class A

The rating of extinguishers recommended as suitable for Class A fires shall be determined using the method described in 8.3. 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 4.

Table 4 — Amount of extinguishing medium used to obtain a minimum Class A rating of extinguishers

| Extinguishing medium content (charge)<br><i>l</i> |                                                |                   | Minimum<br>Class A rating |
|---------------------------------------------------|------------------------------------------------|-------------------|---------------------------|
| Powder<br>kg                                      | Water/foam<br>Water with additives<br><i>l</i> | Clean agent<br>kg |                           |
| $l \leq 2$                                        | $l \leq 6$                                     | $l \leq 6$        | 1A                        |
| $2 < l \leq 4$                                    | $6 < l \leq 10$                                | $6 < l \leq 8$    | 2A                        |
| $4 < l \leq 6$                                    | $l > 10$                                       | $l > 8$           | 3A                        |
| $6 < l \leq 9$                                    |                                                |                   | 4A                        |
| $l > 9$                                           |                                                |                   | 6A                        |

#### 8.1.2 Class B

The rating of extinguishers recommended as suitable for Class B fires shall be determined using the method given in 8.4. 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 5.

Table 5 — Amount of extinguishing medium used to obtain minimum Class B rating of extinguishers

| Extinguishing medium content (charge)<br><i>l</i> |                      |                   |                                             | Minimum<br>Class B rating |
|---------------------------------------------------|----------------------|-------------------|---------------------------------------------|---------------------------|
| Powder<br>kg                                      | Carbon dioxide<br>kg | Clean agent<br>kg | Foam or water<br>with additives<br><i>l</i> |                           |
| $l \leq 2$                                        | $l \leq 2$           | $l \leq 2$        |                                             | 21B                       |
| $2 < l \leq 3$                                    | $2 < l \leq 5$       | $2 < l \leq 4$    |                                             | 34B                       |
| $3 < l \leq 4$                                    | $l > 5$              | $4 < l \leq 6$    | $l \leq 6$                                  | 55B                       |
| $4 < l \leq 6$                                    |                      | $l > 6$           | $6 < l \leq 9$                              | 89B                       |
| $l > 6$                                           |                      |                   | $l > 9$                                     | 144B                      |

### 8.1.3 Class C

There are no test requirements for the performance of extinguishers against Class C fires included in this International Standard. Suitability for use against Class C may be claimed for Class B or Class AB powder extinguishers only.

### 8.1.4 Class D

Extinguishers recommended as suitable for Class D fires shall extinguish the appropriate test fire or fires when tested as described in 8.5.

NOTE Extinguishers suitable for Class D fires are usually not suitable for use on fires of other classes. Specialized media and applicators are typically used.

## 8.2 Test fires — General

### 8.2.1 Operator's clothing

To carry out these tests the operator shall wear suitable working clothing.

NOTE 1 Attention is drawn to the necessity for taking precautions to safeguard the health and safety of personnel conducting the tests against the risk of fire and inhalation of smoke and any toxic products of combustion, and compliance with any national legislation which may apply concerning the health and safety of the extinguisher operator and other personnel.

NOTE 2 Respiratory protection may be worn to protect the operator from effects of the repeated testing over a period of time. Such protection is not intended to permit an otherwise intolerable exposure to any fumes and/or smoke from a single fire.

NOTE 3 Suitable working clothing should not be liable to ignite or melt during the firefighting process and may include a safety helmet with heat resistant face guard (visor), a long coat or overalls, and gloves of aluminized, insulated cloth.

### 8.2.2 Requirements for extinguishment

Test fires shall be regarded as extinguished if:

- Class A: all flames are extinguished. There shall be no flames visible 10 min after complete discharge of the extinguisher. The appearance of non-persistent flames during the 10 min period shall be ignored. Non-persistent flames are defined as less than 50 mm in height and less than 1 min duration;
- Class B: all flames are extinguished and there remains a minimum depth of 40 mm (water plus fuel) in the tray.

If the Class A crib collapses during the test, it shall be considered void and a fresh test carried out.

### 8.2.3 Test extinguishers and method of use

Use extinguishers filled and charged according to the manufacturer's instructions. Store the extinguishers for no less than 24 h at a temperature of  $(20 \pm 5) ^\circ\text{C}$  and maintain this temperature until tested.

Use the extinguishers according to the manufacturer's operating instructions.

It is permitted, at the operator's discretion, to operate a gas cartridge extinguisher so as to allow the operating pressure to increase in the body prior to discharge.

### 8.2.4 Test schedule

The basic schedule of testing is a set of three fires. A Class A or Class B rating is achieved by extinguishing two out of three fires of the same size. Class D suitability for a particular metal or form of metal is established by extinguishing either the first fire of the set, or if this is not extinguished, extinguishing the second and third test fires.

A set comprises fires consecutively carried out and the result of any particular test fire is not to be disregarded. Each set is to be completed before another is started. For Class A and Class B fires, a set is completed either when all three test fires are carried out or when the first two test fires are both successful or both unsuccessful. For Class D fires, a set is complete when the first test is successful, or when the first and second fires are both unsuccessful, or when all three are carried out.

### 8.3 Class A test fire

#### 8.3.1 Location

Conduct the tests in an essentially draught-free room having adequate volume and ventilation to ensure the necessary supply of oxygen and reasonable visibility for the period of the test.

Air inlet openings at or near ground level as given in Table 6, with a flue area of 4,5 m<sup>2</sup> have been found to provide adequate ventilation.

NOTE For example, it has been established that a room having a ceiling height of approximately 7,5 m and a volume of at least 1 700 m<sup>3</sup> with adjustable inlet openings near the four corners is suitable for these purposes. The room should have a smoothly finished concrete floor.

**Table 6 — Example of typical air inlet sizes for ventilation of Class A test fires**

| Classification and rating | Air-inlet opening surface area<br>m <sup>2</sup> |
|---------------------------|--------------------------------------------------|
| 1A                        | 0,10                                             |
| 2A                        | 0,10                                             |
| 3A                        | 0,15                                             |
| 4A                        | 0,20                                             |
| 6A                        | 0,30                                             |
| 10A                       | 0,50                                             |
| 15A                       | 0,75                                             |
| 20A                       | 1,00                                             |

#### 8.3.2 Construction

The test fire consists of a crib made of pieces of wood. The pieces of wood forming the outside edges of the crib may be stapled or nailed together to provide strength. Construct the crib on two 63 mm × 38 mm angle irons or other similar and appropriate supports, placed on concrete blocks or support frame so as the height of the supports above the floor is (400 ± 10) mm.

Stack the pieces of wood in the appropriate arrangement specified in Table 7. Stack each layer of the pieces of wood at right angles to the layer below. Stack individual pieces of wood on each layer with even spacing and in the form of a square with sides equal to the length of the piece of wood (see Figure 2).

Use pieces of wood of *Pinus Sylvestris*, or of other wood which can be shown to be equivalent, of appropriate length as specified in Table 7 and of square cross-section with sides of (39 ± 1) mm, a moisture content of 10 % to 14 % by mass (dry basis).

NOTE 1 Wood is considered to be equivalent if the rating achieved using wood that is not more than that achieved when *Pinus Sylvestris* is used. In North America mixed spruce-pine-fir lumber, which may include *Picea Glauca*, *Picea Engelmannii*, *Pinus Contorta* and *Abies Lasioscapa*, or *Pinus Banksiana*, *Picea Rubens*, *Picea Maraina* and *Abies Balsamea* depending on geographical location, may be used. *Cryptomeria Japonica* may be preferred in parts of Asia.

NOTE 2 Determine the moisture content of the pieces of wood using commercially available instruments which measure electrical conductivity between needle probes pushed into the sticks or other suitable method. Some variation in reading may be obtained due to structural variation of the timber and the direction of the grain. Calibrate the instrument by determination of moisture content in accordance with ISO 3130.

Table 7 — Wood crib construction

| Class A rating | Number of pieces of wood | Length of pieces of wood<br>mm | Arrangement of pieces of wood  |
|----------------|--------------------------|--------------------------------|--------------------------------|
| 1A             | 72                       | 500                            | 12 layers of 6 pieces of wood  |
| 2A             | 112                      | 635                            | 16 layers of 7 pieces of wood  |
| 3A             | 144                      | 735                            | 18 layers of 8 pieces of wood  |
| 4A             | 180                      | 800                            | 20 layers of 9 pieces of wood  |
| 6A             | 230                      | 925                            | 23 layers of 10 pieces of wood |
| 10A            | 324                      | 1 100                          | 27 layers of 12 pieces of wood |
| 15A            | 450                      | 1 190                          | 30 layers of 15 pieces of wood |
| 20A            | 561                      | 1 270                          | 33 layers of 17 pieces of wood |

NOTE If necessary in the future, it is intended that this table be extended to include larger test fires. These will be constructed on the same principles as those now listed. Each Class A rating is designated by a number in a series which is proportional to the mass of wood contained in a crib, i.e. a 20A crib contains twice the mass of wood as in a 10A crib. All cribs are cubic with the volume of the open space approximately equal to the volume of the wood.

### 8.3.3 Procedure

Place an ignition pan of appropriate size as specified in Table 8 on the floor under the crib. Level the pan as far as is possible and add sufficient water to cover the base. Pour the appropriate volume of fuel (as specified in Table 8) into the pan. Ignite the fuel. Remove the pan once the liquid has been consumed.

Allow the crib to burn until its mass is reduced to  $(55 \pm 2)$  % of its original mass. The mass loss may be determined directly or by other methods which can be demonstrated to provide equivalent correlation.

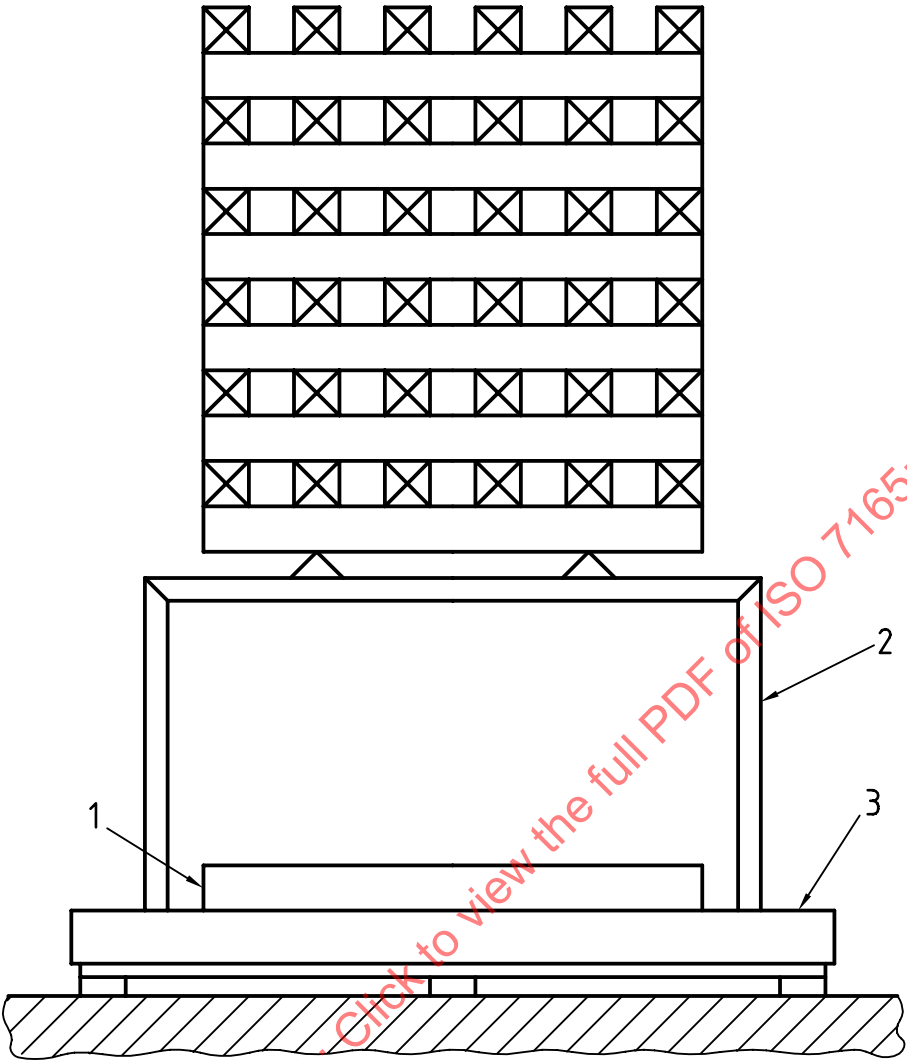
NOTE This will take 6 min to 10 min. Either monitor the mass continuously or determine the time by a preliminary test or tests, extinguishing the fire(s) and measuring the mass and core diameters making adjustments as necessary.

Apply the discharge of the extinguisher to the test fire, initially to the front and from a distance of not less than 1,8 m. Reduce the distance of attack and apply the discharge to the top, bottom, front or either side but not the back of the crib, at will. Maintain all devices for controlling the flow of the extinguishing media in the position for maximum discharge to ensure a continuous jet.

## 8.4 Class B test fire

### 8.4.1 Location

Carry out test fires up to and including 144B indoors. Carry out test fires larger than 144B indoors or outdoors but with the wind speed not exceeding 3 m/s. Do not carry out tests outdoors when rain, snow or hail is falling.



- Key**
- 1 Ignition pan
  - 3 Weighing platform
  - 2 Support frame

Figure 2 — Crib fire

Table 8 — Wood-crib ignition arrangement

| Class A rating          | Ignition pan size<br>mm | Heptane charge <sup>a</sup><br>l |
|-------------------------|-------------------------|----------------------------------|
| 1A                      | 400 × 400 × 100         | 1,1                              |
| 2A                      | 535 × 535 × 100         | 2,0                              |
| 3A                      | 635 × 635 × 100         | 2,8                              |
| 4A                      | 700 × 700 × 100         | 3,4                              |
| 6A                      | 825 × 825 × 100         | 4,8                              |
| 10A                     | 1 000 × 1 000 × 100     | 7,0                              |
| 15A                     | 1 090 × 1 090 × 100     | 7,6                              |
| 20A                     | 1 170 × 1 170 × 100     | 8,2                              |
| <sup>a</sup> See 8.4.3. |                         |                                  |

### 8.4.2 Construction

Class B test fires utilize a range of welded-sheet-steel cylindrical trays (dimensions given in Table 9). The sides are vertical. The base 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 9. Each test fire is designated by a number followed by the letter B.

### 8.4.3 Fuel

Use an aliphatic hydrocarbon having an initial boiling point of no less than 88 °C and a final boiling point of no more than 105 °C.

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

Table 9 — Dimensions of Class B test fires

| Classification   | Minimum discharge of extinguisher | Volume of liquid <sup>a</sup> | Dimensions of test fire tray |                             |                            |                                  |
|------------------|-----------------------------------|-------------------------------|------------------------------|-----------------------------|----------------------------|----------------------------------|
|                  |                                   |                               | Diameter <sup>b</sup>        | Internal depth <sup>b</sup> | Minimal thickness of walls | Approximate surface area of fire |
|                  | s                                 | l                             | mm                           | mm                          | mm                         | m <sup>2</sup>                   |
| 8B <sup>c</sup>  | —                                 | 8                             | 570 ± 10                     | 150 ± 5                     | 2,0                        | 0,25                             |
| 13B <sup>c</sup> | —                                 | 13                            | 720 ± 10                     | 150 ± 5                     | 2,0                        | 0,41                             |
| 21B              | 8                                 | 21                            | 920 ± 10                     | 150 ± 5                     | 2,0                        | 0,66                             |
| 34B              | 8                                 | 34                            | 1 170 ± 10                   | 150 ± 5                     | 2,5                        | 1,07                             |
| 55B              | 9                                 | 55                            | 1 480 ± 15                   | 150 ± 5                     | 2,5                        | 1,73                             |
| (70B)            | 9                                 | 70                            | (1 670) ± 15                 | (150) ± 5                   | (2,5)                      | (2,20)                           |
| 89B              | 9                                 | 89                            | 1 890 ± 20                   | 200 ± 5                     | 2,5                        | 2,80                             |
| (113B)           | 12                                | 113                           | 2 130 ± 20                   | (200) ± 5                   | (2,5)                      | (3,55)                           |
| 144B             | 15                                | 144                           | 2 400 ± 25                   | 200 ± 5                     | 2,5                        | 4,52                             |
| (183B)           | 15                                | 183                           | 2 710 ± 25                   | (200) ± 5                   | (2,5)                      | (5,75)                           |
| 233B             | 15                                | 233                           | 3 000 ± 30                   | 200 ± 5                     | 2,5                        | 7,32                             |

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>a</sup> 1/3 water and 2/3 heptane

<sup>b</sup> Measured at rim.

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

#### 8.4.4 Procedure

**8.4.4.1** Add the appropriate volume of water and heptane specified in Table 9. 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.

**8.4.4.2** For the testing of foam and clean agent extinguishers use fresh fuel for each test.

**8.4.4.3** When testing powder extinguishers it shall be demonstrable that the rating can be achieved using fresh fuel.

**8.4.4.4** Ignite the fuel.

**8.4.4.5** Permit the fuel to burn freely for a minimum of 60 s before operating the extinguisher.

**8.4.4.6** Operate the extinguisher and apply the extinguishing medium to the test fire.

NOTE 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.

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

#### 8.4.5 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 9.

### 8.5 Class D test fire

#### 8.5.1 General

The extinguishment of these test fires is based on the use of a portable extinguisher having a nominal charge of 13,6 kg of media. Extinguishers having a lesser charge shall be tested using a proportionally reduced quantity and surface area of fuels. Extinguishers with a charge of less than 8 kg shall not be allowed.

**WARNING** — Some extinguishing media used for Class D fires are toxic (for example, barium chloride  $\text{BaCl}_2$ ) and/or may react with the burning metal to produce materials which are toxic or otherwise hazardous (for example, phosphates which react to form metal phosphides, which are decomposed by water to produce phosphine,  $\text{PH}_3$ , a spontaneously flammable gas).

Before carrying out these tests, establish procedures to protect personnel and to safely dispose of residues from test fires.

Conduct the tests in an essentially draught-free room having adequate volume and ventilation to ensure the necessary visibility for the period of the test.

There are no numerical components for Class D ratings. The type of combustible metal for which the extinguisher is applicable and the area, depth, and other characteristics of the fires which may be controlled and extinguished are to be summarized on the extinguisher nameplate and described in the manufacturer's installation instructions.

## 8.5.2 Metal chip or turning fires

### 8.5.2.1 Construction

The fires consist of a bed of the metal fuel 600 mm × 600 mm square positioned centrally on a steel baseplate 1 m × 1 m square and 5 mm thick. Use a removable metal or wood frame to build the bed.

For ignition, use a device such as a gas/oxygen torch which will ignite the metal within 30 s.

### 8.5.2.2 Fuel

Carry out four series of tests using:

- a) magnesium alloy;
- b) magnesium alloy with cutting oil;
- c) reagent-grade magnesium;
- d) reagent-grade magnesium with cutting oil.

The magnesium alloy shall contain  $(8,5 \pm 1)$  % of aluminium and at maximum 2,5 % zinc, and the nominal particle size shall be 10 mm to 25 mm long, 6 mm to 13 mm wide, and 0,05 mm thick.

The reagent-grade magnesium shall contain no less than 99,5 % magnesium, and the nominal particle size shall be 6 mm to 9 mm long, 3 mm wide and 0,25 mm thick.

For the tests without cutting oil, use  $(18,0 \pm 0,1)$  kg of metal for each fire. For the tests with cutting oil, use  $(16,2 \pm 0,1)$  kg metal evenly coated with  $(1,8 \pm 0,1)$  kg of a petroleum base cutting oil of relative density  $(0,86 \pm 0,01)$  having a Cleveland open-cup flashpoint value of  $(146 \pm 5)$  °C for each fire.

### 8.5.2.3 Procedure

For each test, prepare the fuel bed in the removable metal or wood frame. Level the surface of the fuel using a rake or straight-edged board. Remove the frame.

Apply the igniting torch to the centre of the fuel bed, removing the torch after 25 s to 30 s.

Allow the fire to spread until it is estimated that either 25 % of the fuel is burning or the fire covers 50 % of the fuel bed surface, whichever occurs sooner. The extinguisher may then be discharged onto the fire at the operator's discretion, continuously or intermittently, according to the manufacturer's instructions.

Check that fuel is not scattered off the base plate during the attack.

After discharge is completed, allow the fire bed to remain undisturbed for the period of time recommended by the extinguisher manufacturer, or if no time is recommended, for 60 min. Examine the fuel bed and check that the fire is completely extinguished and that more than 10 % of the original metal fuel remains.

## 8.5.3 Metal powder or dust fires

### 8.5.3.1 Construction

Construct the fires in the same manner as the metal chip fires (see 8.5.2.1).

### 8.5.3.2 Fuel

Use magnesium powder containing not less than 99,5 % magnesium. All the particles shall pass a 387  $\mu\text{m}$  sieve and no less than 80 % of the powder shall be retained on a 150  $\mu\text{m}$  sieve. Carry out two series of tests one series using  $(11,0 \pm 0,1)$  kg of dry metal and one series using  $(9,9 \pm 0,1)$  kg of the metal plus  $(1,1 \pm 0,1)$  kg of the oil specified in 8.5.2.2 for each fire.

### 8.5.3.3 Procedure

Carry out the tests using the same procedure as the metal chip fires in 8.5.2.3.

## 8.5.4 Shallow liquid metal fires

### 8.5.4.1 Construction

Two series of tests are carried out. One series will be carried out in a circular steel pan approximately 540 mm in diameter and  $(150 \pm 10)$  mm deep, fitted with a tight fitting cover, and with suitable means of handling, moving and tipping, and with a horizontal thermocouple to be positioned in the approximate centre of the pan. This pan is also used to melt the metal fuel, using a heat source which does not allow any flames to extend beyond the base of the pan. In the second series, melted burning fuel is poured on a tray approximately 600 mm  $\times$  600 mm square and having a depth of  $(155 \pm 5)$  mm.

### 8.5.4.2 Fuel

Use commercial sodium. Use  $(1,36 \pm 0,04)$  kg of sodium for the spill fire, and for the pan fire sufficient sodium to give a melted fuel depth of  $(25 \pm 1)$  mm.

### 8.5.4.3 Procedure

#### 8.5.4.3.1 Spill fire

Position the square tray on a flat level surface. Heat the metal in the covered melting pan until the temperature is  $(520 \pm 10)$  °C. Carefully remove the cover, allowing the liquid metal to ignite as air enters. Stop heating when the temperature reaches  $(550 \pm 10)$  °C and pour the burning liquid fuel into the square tray. As soon as the burning fuel has spread across the tray the fire can be attacked at the operator's discretion using the manufacturer's recommended extinguishing techniques.

After the discharge is completed, allow the fire tray to remain undisturbed for the period of time recommended by the manufacturer, or if no time is recommended for  $(4 \pm 0,5)$  h. Then using a suitable temperature measuring device check that the fuel/extinguishing medium mixture in the tray is at a temperature no more than 20 °C above the ambient air temperature and that more than 10 % of the original fuel remains.

#### 8.5.4.3.2 Pan fire

This test is carried out entirely in the melting pan.

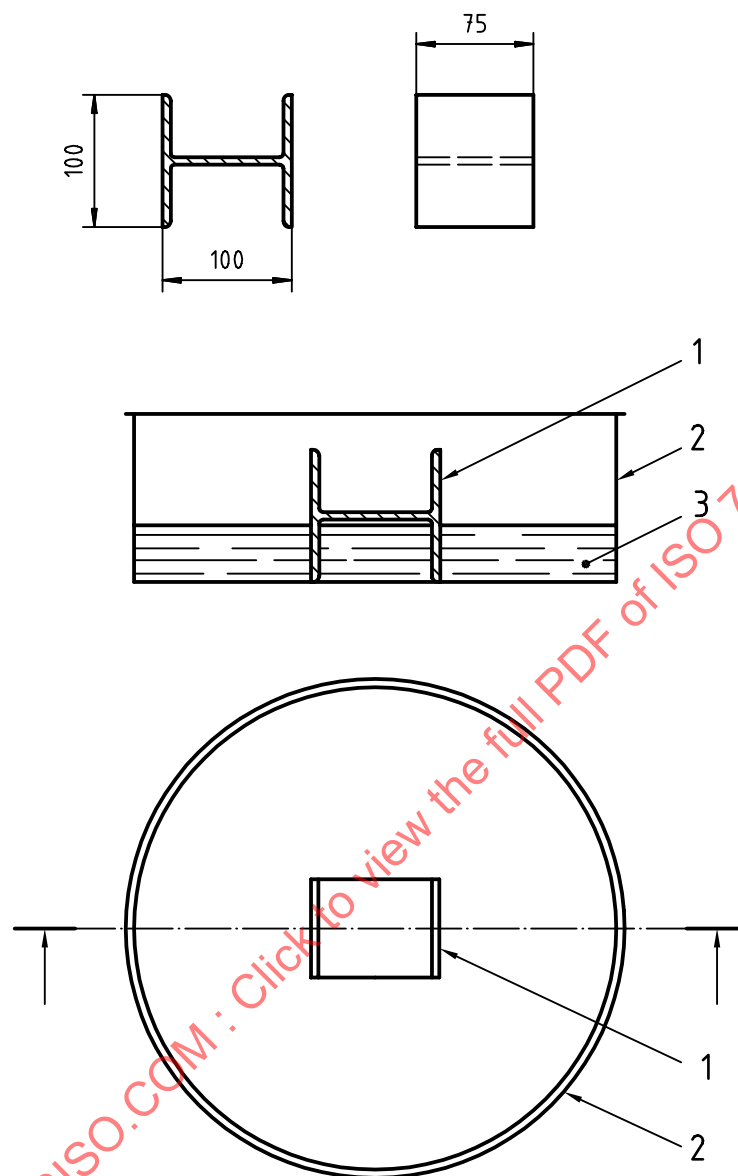
Melt the fuel and allow it to ignite generally as described in 8.5.4.3.1. When the temperature reaches  $(550 \pm 10)$  °C move the pan from the heat source and place it on a level floor, where it may be attacked at the operator's discretion, using the manufacturer's recommended extinguishing techniques. After discharge is completed, follow the procedure described in 8.5.4.3.1.

## 8.5.5 Simulated casting fire

### 8.5.5.1 General

The fire consists of melted metal poured into the steel tray described in 8.5.4.1 positioned on a level surface with an obstruction, formed from a  $(50 \pm 5)$  mm length of steel I-beam, 100 mm deep and 100 mm wide, positioned centrally in the tray, on its side in the attitude of an arch, as shown in Figure 3.

Dimensions in millimetres

**Key**

- 1 Obstruction
- 2 Test pan
- 3 Molten fuel

**Figure 3 — Obstructed magnesium spill fire configuration****8.5.5.2 Fuel**

Use  $(11,3 \pm 0,1)$  kg of the magnesium alloy described in 8.5.2.2.

**8.5.5.3 Procedure**

Heat the magnesium alloy in the covered melting pan described in 8.5.4.1 until completely melted. Carefully remove the cover and continue to heat until the temperature reaches  $(650 \pm 10)$  °C above the melting point if the fuel does not ignite spontaneously use the gas torch (see 8.5.2.1) to ignite it. Pour the fuel into the tray, but not directly over the obstruction. As soon as the burning fuel has spread across the tray, the fire can be attacked at the operator's discretion using the manufacturer's recommended extinguishing techniques.

After discharge is completed follow the procedure described in 8.5.2.3.

## 8.6 Electrical conductivity of extinguisher discharge

### 8.6.1 Water-based extinguishers

Water-based extinguishers that are marked as suitable for use on energized electrical equipment fires shall not pass a current of more than 0,5 mA when tested as described in 8.6.3.

### 8.6.2 Requirements

Test the extinguisher in accordance with 8.6.3. When the extinguisher is in operation and the metallic plate is live, the current between the handle or the nozzle and earth and between earth and the extinguisher shall be no more than 0,5 mA at any time during the complete discharge duration of the extinguisher.

### 8.6.3 Test for electrical conductivity

Hang a metal plate, of dimensions  $(1\text{ m} \pm 25\text{ mm}) \times (1\text{ m} \pm 25\text{ mm})$ , vertically from insulating supports. Connect the plate to a transformer so that an alternating voltage of  $(36 \pm 3,6)\text{ kV}$  is established between the plate and earth. The impedance of the circuit should be such that when a voltage equal to 10 % of the normal primary voltage is applied to the primary, and the secondary is short-circuited, the current in the secondary is not less than 0,1 mA.

Mount the extinguisher on an insulating support with the nozzle fixed 1 m from the centre of the plate, at right angles to it and directed towards it. Connect the extinguisher to the earth. In the case of an extinguisher with a hose connect it to the earth by connection at the nozzle or in the case of an extinguisher not fitted with a hose, by connection at the handle.

Measure any current flowing between the extinguisher and the earth when the plate is live and the extinguisher discharging.

## 9 Construction requirements

### 9.1 High-pressure extinguishers

Extinguishers with a service pressure greater than 2,5 MPa (25 bar) shall be fitted with a cylinder which is designed, tested and marked according to national regulations.

### 9.2 Low-pressure extinguishers

#### 9.2.1 General requirements

**9.2.1.1** These requirements are applicable to extinguishers having a service pressure ( $p_s$ ) not exceeding 2,5 MPa (25 bar).

**9.2.1.2** A portable extinguisher with a charge exceeding 3 kg shall be constructed so that it can be stood vertically without support.

**9.2.1.3** The manufacturer shall ensure that the welds show continuous penetration with no deviation in the weld. Welds and brazed joints shall be free from defects which are prejudicial to the safe use of the cylinder. All welders, weld operators and weld procedures shall be qualified and certified by an independent third party recognized by national authorities.

All welders, weld operators and weld procedures shall be qualified and certified by an independent third party recognized by national authorities.

**9.2.1.4** Parts attached to the body of the extinguisher shall be manufactured and fitted in a way that minimize concentrations of stress and corrosion risks. In the case of welded and brazed parts, the metal shall be compatible with the cylinder material.

**9.2.1.5** The cylinder manufacturer shall obtain the works certificate for the cast analysis of material supplied and shall keep this available for inspection.

**9.2.1.6** Where plastic components are threaded into metallic parts they shall be designed to minimize the possibility of cross-threading. This shall be accomplished by the use of coarse threads of less than five threads per centimetre or by the use of square-cut threads.

**9.2.1.7** Extinguishers which are free standing shall either be fitted with a means to raise the pressure-retaining part of the body at least 5 mm above the floor, or the thickness of metal in the lowest pressure retaining part or parts of the body shall not be less than 1,5 times the minimum thickness of the cylindrical part of the body.

**9.2.1.8** Determination of maximum service pressure ( $p_{ms}$ ).

**9.2.1.8.1** Conduct the test on a minimum of three extinguishers conditioned at 55 °C for 18 h.

**9.2.1.8.2** For stored-pressure type extinguishers, determine the pressure immediately after taking each extinguisher out of the oven. For cartridge-operated type extinguishers, remove each extinguisher from the oven and activate the cartridge immediately.

**9.2.1.8.3** For each type of extinguisher the highest pressure observed during 9.2.1.8.2 is recorded as the maximum service pressure ( $p_{ms}$ ).

## **9.2.2 Burst test**

**9.2.2.1** Fill the extinguisher with a suitable liquid and increase the pressure at a rate not exceeding  $(2,0 \pm 0,2)$  MPa/min [ $(20 \pm 2)$  bar/min] until the minimum burst pressure ( $p_b$ ) is achieved. Maintain this pressure for 1 min without the cylinder rupturing. Increase the pressure until rupture occurs. The minimum burst pressure ( $p_b$ ) shall be  $2,7 \times p_{ms}$  but in no case less than 5,5 MPa (55 bar).

**9.2.2.2** The bursting test shall not cause the cylinder to fragment.

**9.2.2.3** The break shall not show any sign of brittleness, that is the edges of the break shall not be radial but shall be slanting in respect of a diametrical plane and shall exhibit a reduction in area over their entire thickness.

**9.2.2.4** The break shall not show any characterized defect in the metal.

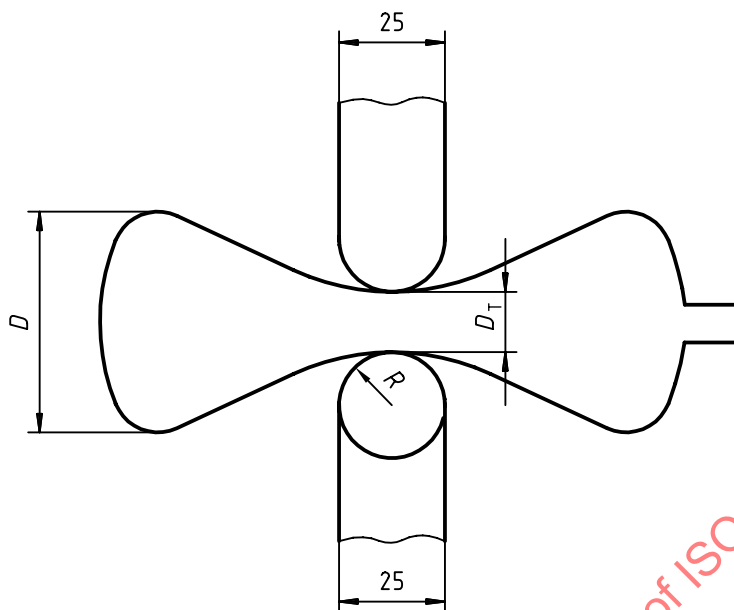
**9.2.2.5** The break shall not occur in the weld at a pressure less than  $5,4 \times p_{ms}$  or 8,0 MPa (80 bar), whichever is greater.

**9.2.2.6** During the burst test, no parts shall be ejected from the extinguisher.

## **9.2.3 Crushing test**

**9.2.3.1** Crush a minimum of three extinguishers perpendicularly to their longitudinal axis, and at their midpoint using two 25-mm thick mandrels with a radius at their apex of 12,5 mm and a width sufficient to extend beyond the sides of the extinguisher (see Figure 4). Crush the cylinder over a period between 30 s and 60 s. In the case of extinguishers with a longitudinal weld place, the weld seam at 90° to the support lines. For extinguishers with central transverse welds, apply the mandrel at 45° to the weld seam.

**9.2.3.2** After the crushing test, fill the extinguishers with water and increase the pressure to test pressure ( $p_t$ ). The extinguishers shall not exhibit any cracks or leaks.



$$R = 12,5 \text{ mm}$$

$$D_T = \frac{D}{3}$$

where

$D_T$  is the distance after test;

$D$  is the outside diameter of cylinder.

**Figure 4 — Crushing test**

#### 9.2.4 Permanent volumetric expansion test

There shall be no permanent expansion in excess of 10 % of the total expansion of the cylinder when subjected to the test pressure ( $p_t$ ) for 30 s. For cylinders that have been proof-pressure tested prior to the deformation test, the test pressure shall be increased by 10 %.

**NOTE** An acceptable test apparatus is the water jacket test as defined in CGA (Compressed Gas Association) pamphlet C-1, section 1.0. Other methods are also acceptable.

#### 9.2.5 Pressure cycling test

A minimum of two cylinders shall be tested.

An extinguisher cylinder shall sustain, without rupture, 5 000 cycles from 0 to the test pressure ( $p_t$ ) and back to 0 at the rate of 6 cycles/min. At the conclusion of testing, the cylinder shall be subjected to and comply with the burst test.

#### 9.2.6 Welded low carbon steel cylinder

**9.2.6.1** The cylinder material shall be capable of being welded and shall contain a maximum of 0,25 % carbon, 0,05 % of sulfur and 0,05 % of phosphorous.

**9.2.6.2** Filler material shall be compatible with the steel to give welds with properties equivalent to those specified for the base sheet.

**9.2.6.3** The cylinder shall have a measured thickness greater than the minimum thickness given by the following formula but in no case less than 0,70 mm:

$$S = \frac{D}{300} + k$$

where

- $S$  is the minimum thickness, expressed in millimetres;
- $D$  is the outside diameter of the cylinder or, for non cylindrical bodies, the greatest external diagonal of the extinguisher body, expressed in millimetres;
- $k$  is the coefficient equal to:
- 0,45 for  $D \leq 80$ ;
- 0,50 for  $80 < D \leq 100$ ;
- 0,70 for  $D > 100$ .

## 9.2.7 Stainless steel cylinders

**9.2.7.1** Stainless steel domes and bottoms shall be drawn from fully annealed stock.

**9.2.7.2** Only austenitic stainless steel having a maximum carbon content of 0,03 % shall be used.

NOTE An example of such steel is AISI type 304L.

**9.2.7.3** The cylinder shall have a minimum measured wall thickness greater than the minimum wall thickness given by the following formula but in no case less than 0,64 mm:

$$S = \frac{D}{600} + k$$

where

- $S$  is the minimum wall thickness, expressed in millimetres;
- $D$  is the outside diameter of the cylinder or, for non cylindrical bodies, the greatest external diagonal of the extinguisher body, expressed in millimetres;
- $k$  is equal to 0,3.

## 9.2.8 Aluminium cylinders

**9.2.8.1** Aluminium cylinders shall be of a seamless construction.

**9.2.8.2** Aluminium cylinders shall have a measured wall thickness greater than or equal to the minimum thickness given by the following formula but in no case less than 0,71 mm:

$$S = \frac{D}{80} + k$$

where

- $S$  is the minimum thickness, expressed in millimetres;
- $D$  is the outside diameter of the cylinder, or for non cylindrical bodies the greatest external diagonal of the extinguisher body, expressed in millimetres;
- $k$  is the coefficient equal to
- 0,2 for  $D \leq 100$  mm;
- 0,3 for  $D > 100$  mm.

### 9.3 Carrying handle

**9.3.1** An extinguisher having a total mass of 1,5 kg or more and having a cylinder diameter of 75 mm or more, shall have a carrying handle.

NOTE The valve assembly head itself may be considered a handle, provided it meets the requirements of 9.3.2 and 9.3.3.

**9.3.2** A handle shall be no less than 90 mm long for an extinguisher of 7,0 kg or more total mass and no less than 75 mm long for an extinguisher of less than 7,0 kg total mass.

**9.3.3** There shall be no less than 25 mm clearance between extinguisher body and the carrying handle when the handle is in the carrying position.

### 9.4 Mounting

**9.4.1** Each extinguisher intended for wall mounting shall be provided with a means of mounting.

**9.4.2** A wall mounting hook shall require both a horizontal and a minimum 6 mm vertical motion to remove the extinguisher from the wall.

EXCEPTION: A minimum vertical motion of 3 mm is acceptable for an extinguisher having a gross mass of 5,4 kg or less.

**9.4.3** A mounting bracket shall be capable of withstanding a static load of five times the fully charged mass of the extinguisher, but no less than 45 kg when tested in accordance with 9.4.4.

**9.4.4** Place an extinguisher charged to its rated capacity in the mounting bracket provided with the extinguisher after the mounting bracket has been secured to a wood board. Secure the board in a vertical position and apply a static load of four times the full extinguisher mass (or a total load of 45 kg minus the full extinguisher mass, minimum) to the top of the extinguisher. Hold the load for 5 min.

**9.4.5** A mounting bracket equipped with a strap shall not permit the extinguisher to drop to the floor when the strap clamp is opened. The clamp releasing device shall be of a colour contrasting with that of the immediate extinguisher background and shall be visible. The method of release shall be obvious when viewing the front of the extinguisher.

**9.4.6** A hanger loop shall be located so that the operating instructions face outward when the extinguisher is supported by the mounting means.

### 9.5 Caps, valves and closures

**9.5.1** Cylinder caps, valves and closures shall be designed to provide release of pressure before complete disengagement.

**9.5.2** Threaded connections on cylinder shall have at least four full threads of engagement and be required to relieve pressure with at least two full threads of engagement. Other types of valves, caps and closures are permissible if they can satisfy the same requirements, particularly with regard to recurrent tests and filling.

**9.5.3** The inside diameter of a filling opening for a rechargeable type extinguisher shall be no less than 19 mm.

**9.5.4** An extinguisher collar with external threads shall have sufficient height so that the cap or valve does not contact the dome or bottom with the gasket removed.

**9.5.5** A cap, valves or closure shall withstand the burst test pressure specified for the cylinder for 1 min without rupture. For this test, remove or plug pressure relief devices.

**9.5.6** The edges and surfaces of a fire extinguisher and its mounting bracket shall not be sufficiently sharp to constitute a risk of injury to persons during intended use or while performing maintenance.

NOTE One method of evaluating sharpness of edges is described in ANSI/UL 1439, *Safety Standard for the Determination of Edges on Equipment*. Other methods are acceptable.

## 9.6 Safety devices

**9.6.1** High pressure cylinders and cartridges shall be provided with a safety device in accordance with national regulations.

**9.6.2** There are no compulsory safety systems required for low-pressure extinguishers. However, if such a system is used, it must be appropriately sized and positioned. The operating pressure of the device shall not exceed the test pressure ( $p_t$ ) nor be less than the maximum service pressure ( $p_{ms}$ ).

## 9.7 Manufacturing tests

### 9.7.1 Low-pressure cylinders

**9.7.1.1** At least one cylinder from each batch of 500 or less shall be subjected to the crush and burst tests. If the test results are not acceptable, randomly select five additional cylinders from the same batch and repeat the tests. If one of the cylinders does not pass the test, the batch is rejected and made unserviceable. At the option of the manufacturer, the burst and crushing test may be conducted on the same cylinder.

**9.7.1.2** Each cylinder shall be subjected to the test pressure ( $p_t$ ) for 30 s, without leakage, failure or visible deformation.

### 9.7.2 Leakage tests

Each stored-pressure and carbon-dioxide extinguisher and gas cartridge shall be subjected to a leakage test and comply with the following requirements:

- a) for stored-pressure extinguishers fitted with a gauge as specified in 7.4.1.3, the leakage rate shall not exceed a rate of loss of pressurizing content equivalent to 5 % per annum of service pressure;
- b) for gas cartridges and stored-pressure extinguishers without gauges as specified in 7.4.1.2, the maximum loss of contents per annum shall not exceed the following:
  - for extinguishers: 5 % or 50 g, whichever is less,
  - for gas cartridges: 5 % or 7 g, whichever is less;
- c) for carbon-dioxide extinguishers the maximum loss of contents shall not exceed 5 % per annum.

## 9.8 Requirements for plastics components

### 9.8.1 General requirements

**9.8.1.1** Plastics components of portable fire extinguishers shall comply with the following requirements.

The test and conformity checks shall be carried out on components which correspond to the mass-produced components in respect of the material used, the form and the method of manufacture.

**9.8.1.2** It is recommended that the plastic used, be identifiable at all times.

Any change in the material, the form, or the method of manufacture requires a new test.

**9.8.1.3** It is necessary to have access to data supplied by the manufacturer relating both to the material itself and the manufacturing procedures.

**9.8.1.4** To verify the attachment of plastic parts following the air-oven ageing, ultraviolet light exposure and impact-resistance tests, attach the plastic part(s) to an extinguisher and then subject the assembly to the appropriate pressure test.

### 9.8.2 Requirements for normally pressurized components

#### 9.8.2.1 Burst strength

**9.8.2.1.1** Conduct burst tests at three temperatures as described below:

Subject at least three components to the burst test in accordance with 9.2.2 using an appropriate liquid at temperatures of  $(20 \pm 3)^\circ\text{C}$ , the minimum recommended operation temperature marked on the extinguisher (see 7.1), and  $(55 \pm 3)^\circ\text{C}$ . Increase the pressure at a rate of  $(2,0 \pm 0,2) \text{ MPa/min}$  [ $(20 \pm 2) \text{ bar/min}$ ].

**9.8.2.1.2** The bursting pressure before and after the ageing and ultraviolet light exposure test shall be at least equal to the minimum burst pressure ( $p_b$ ).

#### 9.8.2.2 Air-oven ageing

**9.8.2.2.1** Subject at least three components to accelerated ageing in an oven at  $100^\circ\text{C}$  for 180 days. Fit the components with adapters to apply normal assembly stresses.

**9.8.2.2.2** Following the exposure, condition the components for 5 h at  $(20 \pm 3)^\circ\text{C}$  and subsequently inspect them for cracking. No cracking shall be permitted.

**9.8.2.2.3** Subject the components to the burst test in accordance with 9.2.2 at  $(20 \pm 3)^\circ\text{C}$  using a suitable liquid at a rate of pressure increase of  $(2,0 \pm 0,2) \text{ MPa/min}$  [ $(20 \pm 2) \text{ bar/min}$ ]. The bursting pressure ( $p_b$ ) shall be at least equal to that specified for the cylinder.

### 9.8.3 Ultraviolet light exposure

**9.8.3.1** Subject at least six components to an artificial weathering test in accordance with 9.8.3.4 for 500 h and then condition them for 5 h at  $(20 \pm 5)^\circ\text{C}$ .

**9.8.3.2** Following the exposure, inspect the samples for cracking. No cracking shall be permitted.

**9.8.3.3** Subject the components to the burst test in accordance with 9.2.2. at  $(20 \pm 5)^\circ\text{C}$  using a suitable liquid at a rate of pressure increase of  $(2,0 \pm 0,2) \text{ MPa/min}$  [ $(20 \pm 2) \text{ bar/min}$ ]. The bursting pressure ( $p_b$ ) shall be at least equal to that specified for the cylinder.

**9.8.3.4** Use two stationary enclosed carbon-arc lamps to obtain the ultraviolet light. The arc of each lamp is to be formed between two vertical carbon electrodes, 12,7 mm in diameter, located at the centre of a removable vertical metal cylinder, 787 mm in diameter and 450 mm in height. Enclose each arc in a clear borosilicate-glass globe. Mount the samples vertically on the inside of the revolvable cylinder, facing the lamps, and revolve the cylinder continuously around the stationary lamps at 1 rev/min. Provide a system of nozzles so as to spray each sample, in turn, with water as the cylinder revolves. During each operating cycle (total of 20 min), expose each sample to the light and water spray for 3 min and to the light only for 17 min. Maintain the air temperature within the revolving cylinder of the apparatus during operation at  $(63 \pm 5) ^\circ\text{C}$ .

An acceptable alternate test is described in method A of ISO 4892-2:1994 using a Xenon arc source, for a period of 500 h. Use the following conditions:

- a)  $(65 \pm 3) ^\circ\text{C}$  black panel temperature;
- b)  $(50 \pm 5) \%$  relative humidity;
- c) spray cycle: 102 min dry interval, 18 min water spray;
- d) total dose of exposure  $1 \text{ GJ/m}^2$  (500 h at  $550 \text{ W/m}^2$ ).

#### **9.8.4 Impact resistance**

**9.8.4.1** Mount at least four samples subjected to the ageing test (see 9.8.2.2) (two with and two without the safety-locking device engaged), and pressurize the extinguisher cylinder to the maximum service pressure ( $p_{\text{ms}}$ ) with nitrogen after being filled 95 % with a water and anti-freeze solution. Test the samples at  $(-20 \pm 3) ^\circ\text{C}$  or at the minimum recommended operation temperature, whichever is lower. The test is carried out as described in 7.5.1.

**9.8.4.2** No hazardous changes shall occur to the valve assembly such as splinters, fractures or cracks.

The valve shall then be capable of withstanding the test pressure ( $p_t$ ) without bursting.

#### **9.8.5 Normally non-pressurized components**

**9.8.5.1** Subject plastic extinguisher components which withstand pressure upon extinguisher operation to the burst, air-oven ageing and impact-resistance tests. The air-oven exposure is either  $100 ^\circ\text{C}$  for 70 days or  $87 ^\circ\text{C}$  for 180 days at the manufacturer's choice.

**9.8.5.2** External plastic components shall comply with the ultraviolet light test.

#### **9.8.6 Test for exposure to extinguishing medium**

**9.8.6.1** There shall be no damage to polymeric siphon tubes which have been conditioned in accordance with 9.8.6.3, when installed in test extinguishers and subjected to the mechanical resistance test described in 7.5.

**9.8.6.2** Following conditioning in accordance with 9.8.6.3, ring samples cut from polymeric siphon tubes shall not exhibit degradation in excess of 40 % of the original tensile or ring crushing strength value.

**9.8.6.3** Place complete siphon tubes in contact with the media with which they are to be used. Totally cover or immerse ring samples, 12,7 mm wide, cut from unaged siphon tubes in the media. Ensure the samples do not touch each other or the container holding the media and samples. Place the container of media, with the samples in place, in a preheated oven at  $(90 \pm 3) ^\circ\text{C}$  for 210 days. After the test exposure, cool the samples in air at  $(23 \pm 2) ^\circ\text{C}$  for at least 24 h before any tests or dimensional measurements are conducted. Subject the ring samples to a crush test between two parallel flat plates using a testing machine capable of applying a compressive load at a uniform rate of 5 mm/min and recording the load versus the deflection. If the nature of the material is such that meaningful test results cannot be obtained, other tests, such as tensile tests, may be conducted.

## 9.9 Hose assemblies

**9.9.1** Extinguishers with a charge greater than 3 kg shall be equipped with a hose assembly having a minimum length of 400 mm.

**9.9.2** The hose and coupling system shall function throughout the operating temperature range, and coupling systems shall be designed and fitted in such a way that they cannot damage the hose.

**9.9.3** The burst pressure of a hose assembly fitted with a shut-off nozzle shall be equal to or greater than the appropriate value below. The test pressure shall be established by increasing the pressure to the minimum allowable burst pressure in a time no less than 30 s, maintaining that pressure for 30 s during which failure shall not occur and then increasing the pressure until failure.

For all types except CO<sub>2</sub> and clean agent extinguishers:

- 2,0 times the maximum service pressure ( $p_{ms}$ ), the test being carried out at  $(20 \pm 5) ^\circ\text{C}$ ;
- 1,5 times the maximum service pressure ( $p_{ms}$ ), the test being carried out at  $(55 \pm 2) ^\circ\text{C}$ .

For CO<sub>2</sub> and clean agent extinguishers:

- 1,5 times the maximum service pressure ( $p_{ms}$ ), the test being carried out at  $(20 \pm 5) ^\circ\text{C}$ ;
- 1,25 times the maximum service pressure ( $p_{ms}$ ), the test being carried out at  $(55 \pm 2) ^\circ\text{C}$ .

**9.9.4** A hose assembly without a shutoff nozzle shall be capable of withstanding, without leakage, a hydrostatic pressure equal to the extinguisher test pressure, ( $p_t$ ) held for at least 30 s.

## 9.10 Method of operation

The extinguisher shall be operated by piercing, opening and/or breaking a sealing device, thus releasing its contents. Extinguishers shall operate without inversion. It shall not be necessary for any movement of the actuating mechanism to be repeated in order to initiate discharge of the extinguisher. The forces or the energy necessary to operate the extinguisher shall not exceed the values in Table 10 for temperatures up to 55 °C.

The energy of 2 J is obtained by allowing the 4 kg mass used in the mechanical resistance (impact) test described in 7.5 to fall from a height of 50 mm. The impact shall be applied in the direction of the operating mode.

**Table 10 — Force or energy required to operate the extinguisher**

| Type of operation         | Maximum force required<br>N | Energy<br>J |
|---------------------------|-----------------------------|-------------|
| With one finger           | 100                         | 2           |
| With full hand            | 200 <sup>a</sup>            |             |
| With impact (strike knob) |                             |             |

<sup>a</sup> For carbon-dioxide extinguishers, this maximum force may be increased to 300 N.

## 9.11 Safety-locking devices

**9.11.1** The operating mechanism shall be provided with a safety device to prevent inadvertent operation. The release of the safety device with tamper indicator shall involve an operation distinct from that of the operation mechanism and shall require a force of no less than 20 N but not exceeding 100 N. It shall be possible to determine whether the apparatus may have been operated.