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**Fire protection — Automatic sprinkler  
systems —**

**Part 10:  
Requirements and test methods for  
domestic sprinklers**

*Protection contre l'incendie — Systèmes d'extinction automatiques du  
type sprinkler —*

*Partie 10: Exigences et méthodes d'essai des sprinklers domestiques*

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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6182-10 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 5, *Fixed firefighting systems using water*.

ISO 6182 consists of the following parts, under the general title *Fire protection — Automatic sprinkler systems*:

- *Part 1: Requirements and test methods for sprinklers*
- *Part 2: Requirements and test methods for wet alarm valves, retard chambers and water motor alarms*
- *Part 3: Requirements and test methods for dry pipe valves*
- *Part 4: Requirements and test methods for quick-opening devices*
- *Part 5: Requirements and test methods for deluge valves*
- *Part 6: Requirements and test methods for check valves*
- *Part 7: Requirements and test methods for early suppression fast response (ESFR) sprinklers*
- *Part 8: Requirements and test methods for pre-action dry alarm valves*
- *Part 9: Requirements and test methods for water mist nozzles*
- *Part 10: Requirements and test methods for domestic sprinklers*
- *Part 11: Requirements and test methods for pipe hangers*
- *Part 12: Requirements and test methods for grooved end pipe couplings*
- *Part 13: Requirements and test methods for extended coverage sprinklers*

## Introduction

This part of ISO 6182 is one of a number of ISO Standards prepared by ISO/TC 21 covering components for automatic sprinkler systems.

They are included in a series of ISO Standards planned to cover the following:

- a) carbon dioxide systems;
- b) explosion suppression systems;
- c) foam systems.

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# Fire protection — Automatic sprinkler systems —

## Part 10:

# Requirements and test methods for domestic sprinklers

## 1 Scope

This part of ISO 6182 specifies performance requirements, test methods and marking requirements for domestic sprinklers.

These sprinklers are intended to provide control of fires in domestic occupancies, to prevent flashover (total involvement) in the room of fire origin and to improve the probability for successful escape or evacuation of the occupants.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 5660-1:2002, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)*

ANSI/UL 723:2003, *Test for surface burning characteristics of building materials*

## 3 Terms and definitions

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

### 3.1 General

#### 3.1.1

##### assembly load

force exerted on the sprinkler body at 0 MPa (0 bar) hydraulic pressure at the inlet

#### 3.1.2

##### average design strength

(axial) glass bulb suppliers' specified and assured lowest average design strength of any batch of 50 bulbs

#### 3.1.3

##### conductivity factor

*C*

measure of the conductance between the sprinkler's heat-responsive element and the fitting

NOTE The conductivity factor is expressed in units of (m·s)<sup>1/2</sup>.

**3.1.4**

**design length**

maximum length of the sprinkler coverage area

**3.1.5**

**design load**

force exerted on the release element at the service load of the sprinkler

**3.1.6**

**design width**

maximum width of the sprinkler coverage area

**3.1.7**

**response time index**

**RTI**

measure of sprinkler sensitivity, equal to  $tu^{1/2}$ , where  $t$  is the time constant of the heat-responsive element and  $u$  is the gas velocity

NOTE 1  $t$  is expressed in units of seconds,  $u$  is expressed in metres per second, and RTI is expressed in units of  $(m \cdot s)^{1/2}$ .

NOTE 2 RTI can be used in combination with the conductivity factor,  $C$ , to predict the response of a sprinkler in fire environments defined in terms of gas temperature and velocity versus time.

**3.1.8**

**service load**

combined force exerted on the sprinkler body by the assembly load of the sprinkler and the equivalent force of the maximum rated working pressure on the inlet

**3.1.9**

**sprinkler**

thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and quantity over a designated area

**3.1.10**

**standard orientation**

(symmetrical heat-responsive elements) orientation where the airflow is perpendicular to both the axis of the waterway and the plane of the frame arms

**3.1.11**

**standard orientation**

(non-symmetrical heat responsive elements) orientation where the airflow is perpendicular to both the waterway axis and the plane of the frame arms that produce the shortest response time

**3.1.12**

**standard orientation**

(worst-case (response) orientation) orientation that produces the longest response time with the axis of the sprinkler inlet perpendicular to the airflow

**3.2 Type of sprinklers according to type of heat-responsive element**

**3.2.1**

**fusible element sprinkler**

sprinkler that opens under the influence of heat by the melting of a component

**3.2.2**

**glass bulb sprinkler**

sprinkler that opens, under the influence of heat, by the bursting of the glass bulb, caused by pressure resulting from expansion of the fluid enclosed therein

### 3.3 Type of sprinklers according to type of water distribution

#### 3.3.1

##### **domestic sprinkler**

⟨residential⟩ sprinkler intended to be installed in domestic (residential) occupancies that opens automatically by operation of a heat-responsive releasing mechanism that maintains the discharge orifice closed

NOTE Upon operating at a specified temperature, water shall be discharged in a specific pattern and quantity over a definite protection area.

#### 3.3.2

##### **domestic sidewall sprinkler**

⟨residential⟩ domestic sprinkler intended to be installed on or near the wall and near the ceiling and intended to discharge water onto the wall and outward in a one-sided (half-paraboloid) water distribution over a definite protection area

### 3.4 Special types of sprinklers

#### 3.4.1

##### **concealed sprinkler**

recessed sprinkler that has a cover plate

#### 3.4.2

##### **flush sprinkler**

sprinkler all or part of whose body, including the shank thread, is mounted above the lower plane of the ceiling, but part of, or all of, the heat-responsive element is below the lower plane of the ceiling

#### 3.4.3

##### **recessed sprinkler**

sprinkler all or part of whose body, other than the shank thread, is mounted within a recessed housing

## 4 Product consistency

It shall be the responsibility of the manufacturer to implement a quality control program to ensure that production continuously meets the requirements of this part of ISO 6182 in the same manner as the originally tested samples.

Every domestic sprinkler shall pass a leak resistance test equivalent to a hydrostatic pressure of at least 3 MPa (30 bar) for at least 2 s.

## 5 Product assembly

### 5.1 General

All domestic sprinklers shall be designed and manufactured in such a way that they cannot be readily adjusted, dismantled or reassembled.

### 5.2 Domestic sprinklers

A domestic sprinkler shall be constructed to effect closure of its water seat for extend periods of time without leakage and to open as intended and release all parts from 0,034 MPa (0,34 bar) up to the rated working pressure. The closure of the water seat shall not be achieved by the use of a dynamic O-ring or similar seal (an O-ring or similar seal that moves during operation or is in contact with a component that moves during operation).

## 6 Requirements

### 6.1 Dimensions

#### 6.1.1 Orifices

6.1.1.1 Sprinklers shall comply with the dimensional requirements given in Table 1.

**Table 1 — Dimensional requirements**

Nominal diameter of orifice	Nominal thread size
mm	in
10	3/8
15	1/2
20	3/4

6.1.1.2 In some countries, sprinklers having orifices of nominal diameters 6 mm, 8 mm, 9 mm and 12 mm are acceptable.

6.1.1.3 All sprinklers shall be constructed so that a sphere of diameter 5 mm can pass through the sprinkler.

#### 6.1.2 Nominal thread sizes

6.1.2.1 Nominal thread sizes shall be suitable for fittings threaded in accordance with ISO 7-1.

6.1.2.2 If International Standards are not applicable, it shall be permitted to use national standards.

6.1.2.3 In some countries, the use of 1/2 in. threads for sprinklers having orifices of nominal diameters 6 mm, 8 mm, 9 mm, 10 mm and 20 mm is acceptable.

6.1.2.4 Special sprinklers, such as flush sprinklers, may have larger thread sizes.

### 6.2 Nominal operating temperatures

NOTE See 7.6.1.

The nominal operating temperature of domestic sprinklers shall be as indicated in Table 2.

The nominal operating temperature that is marked on the sprinkler shall be determined when the sprinkler is tested in accordance with 7.6.1, taking into account the specifications of 6.3.

**Table 2 — Nominal operating temperature**

Glass bulb sprinklers		Fusible element sprinklers	
Nominal operating temperature °C	Liquid colour code	Nominal operating temperature °C	Yoke arm colour code
57	Orange	57 to 77	Uncoloured
68	Red	79 to 107	White
79	Yellow	—	—
93, 100	Green	—	—

### 6.3 Operating temperatures

Domestic sprinklers shall operate within the temperature range given by Equation (1):

$$t = \pm (0,035 X + 0,62) \text{ } ^\circ\text{C} \quad (1)$$

where

$t$  is the temperature range, rounded to the nearest 0,1 °C;

$X$  is the marked nominal operating temperature.

### 6.4 Water flow and distribution

#### 6.4.1 Flow constant (see 7.10)

6.4.1.1 The flow constant,  $K$ , for domestic sprinklers is given by Equation (2):

$$K = \frac{q}{\sqrt{10p}} \quad (2)$$

where

$p$  is the pressure, expressed in MPa;

$q$  is the flow rate, expressed in litres per minute.

6.4.1.2 The value of the nominal flow constant,  $K$ , published in the manufacturer's design and installation instructions shall be verified using the test method of 7.10. Each flow constant,  $K$ , (calculated) shall be within  $\pm 5 \%$  or  $\pm 3$  units of the manufacturer's value, whichever is greater.

#### 6.4.2 Water distribution (see 7.11)

##### 6.4.2.1 General

To demonstrate the required coverage of the protected area allotted to it, a domestic sprinkler shall comply with the horizontal- and vertical-surface water-distribution requirements described in 6.4.2.2 and 6.4.2.3.

##### 6.4.2.2 Horizontal surfaces

When installed in accordance with the manufacturer's design and installation instructions and tested as described in 7.11.1.1 through 7.11.1.4, a domestic sprinkler shall distribute water over a horizontal surface such that the discharge density collected in any single 300 mm  $\times$  300 mm collection pan within the design area shall be at least 0,8 mm/min, except that

- a) no more than four collection pans in each quadrant shall be allowed to be at least 0,6 mm/min for upright and pendent sprinklers; and
- b) no more than eight collection pans shall be allowed to be at least 0,6 mm/min for each half (split along the sprinkler centreline) of the design area for sidewall sprinklers.

##### 6.4.2.3 Vertical surfaces

When installed in accordance with the design and installation instructions and tested as described in 7.11.2.1 through 7.11.2.5, a domestic sprinkler shall distribute water over vertical surfaces as follows

- a) Walls within the coverage area shall be wetted to at least 700 mm of the ceiling with one sprinkler operating at the specified design flow rate.
- b) For square coverage areas, each wall within the coverage area shall be wetted with at least 5 % of the sprinkler flow; for rectangular coverage areas, each wall within the coverage area shall be wetted with a proportional water amount based on 20 % of the total sprinkler discharge in accordance with Equation (3):

$$A_{\text{col}} = 0,2 \frac{l_W}{l_P} \quad (3)$$

where

$A_{\text{col}}$  is the required amount of water collected on a wall, expressed in percent;

$l_W$  is the wall length, expressed in metres;

$l_P$  is the total perimeter of coverage area e.g., the length of all walls combined, expressed in metres.

## 6.5 Function (see 7.5)

**6.5.1** When tested in accordance with 7.5.1 through 7.5.4, domestic sprinklers shall open and, within 5 s after the release of the heat-responsive element, shall operate satisfactorily. Any lodgement of released parts shall be cleared within 10 s of release of the heat-responsive element or the sprinkler shall then comply with the requirement of 6.4.1 and 6.4.2.

**6.5.2** The deflector and its supporting parts shall not sustain significant damage as a result of the functional test specified in 7.5.5 and shall meet the requirements of 6.4.2.

## 6.6 Strength of sprinkler body (see 7.3)

The sprinkler body shall not show permanent elongation of more than 0,2 % between the load-bearing points of the sprinkler body after being subjected to twice the service load as measured in accordance with 7.3.

## 6.7 Strength of heat-responsive element (see 7.9)

**6.7.1** When tested in accordance with 7.9, glass bulb elements shall

- a) have an average strength of at least six times the average service load, and
- b) have a design strength lower tolerance limit (LTL) on the strength distribution curve of at least two times the upper tolerance limit (UTL) of the service load distribution curve based on calculations with a degree of confidence,  $\gamma$ , of 0,99 for 99 % of the samples,  $P$ . Calculations will be based on normal or Gaussian distribution, except where another distribution can be shown to be more applicable due to manufacturing of design factors. (See Annex A).

**6.7.2** Fusible heat-responsive elements shall

- a) sustain a load of 15 times its design load, corresponding to the maximum service load measured in accordance with 7.3, for a period of 100 h when tested in accordance with 7.9.2.1, or
- b) demonstrate the ability to sustain the design load when tested in accordance with 7.9.2.2.

## 6.8 Leak resistance and hydrostatic strength (see 7.4)

**6.8.1** A domestic sprinkler shall not show any sign of leakage when tested by the method specified in 7.4.1.

**6.8.2** A domestic sprinkler shall not rupture, operate or release any parts when tested by the method specified in 7.4.2.

## **6.9 Heat exposure (see 7.7)**

**6.9.1** There shall be no damage to the glass bulb element when glass bulb domestic sprinklers are tested by the method specified in 7.7.1.

**6.9.2** Domestic sprinklers shall withstand exposure to increased ambient temperature without evidence of leakage, weakness or failure, when tested by the method specified in 7.7.2.

## **6.10 Thermal shock (see 7.8)**

Glass bulb domestic sprinklers shall not be damaged when tested by the method specified in 7.8. Proper operation shall not be considered damage.

## **6.11 Corrosion**

### **6.11.1 Stress corrosion**

NOTE See 7.12.1.

When tested in accordance with 7.12.1, each domestic sprinkler shall show no cracks, delaminations or failures that can affect its ability to function as intended.

### **6.11.2 Sulfur dioxide corrosion**

NOTE See 7.12.2.

Domestic sprinklers shall be resistant to sulfur dioxide saturated with water vapour when conditioned in accordance with 7.12.2. Following exposure, the sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with 6.5.1 and shall meet the requirements of 6.22 for concealed, flush or recessed sprinklers or the requirements of 6.14.2 for other types of sprinklers.

### **6.11.3 Salt spray corrosion**

NOTE See 7.12.3.

Domestic sprinklers shall be resistant to salt spray when conditioned in accordance with 7.12.3. Following exposure, the sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with 6.5.1, and shall meet the requirements of 6.22 for concealed, flush or recessed sprinklers or the requirements of 6.14.2 for other types of sprinklers.

### **6.11.4 Moist air exposure**

NOTE See 7.12.4.

Domestic sprinklers shall be resistant to moist air exposure when tested in accordance with 7.12.4. Following exposure, the sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with 6.5.1, and shall meet the requirements of 6.22 for concealed, flush or recessed sprinklers or the requirements of 6.14.2 for other types of sprinklers.

## **6.12 Rough usage test (see 7.13)**

A domestic sprinkler shall withstand the effects of rough usage without deterioration of its performance characteristics. Following 3 min of tumbling as described in 7.13, the sprinkler shall comply with the leak

requirement of 6.8.1 and the RTI requirement of 6.14.1 in standard orientation only, or in accordance with 6.22 b), the requirement for recessed, flush and concealed sprinklers.

### 6.13 Water hammer (see 7.15)

Sprinklers shall not leak during or after the pressure surges of 7.15. After being subjected to the test of 7.15, they shall show no signs of mechanical damage and shall meet the requirements of 6.8.1 and shall operate when functionally tested to the requirements of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only.

### 6.14 Dynamic heating (see 7.6.2)

**6.14.1** When tested in accordance with 7.6.2 in their standard orientation, domestic sprinklers shall have a RTI not exceeding  $50 \text{ (m}\cdot\text{s)}^{1/2}$  and a conductivity factor,  $C$ , less than  $1 \text{ (m}\cdot\text{s)}^{1/2}$ . When tested at an angular offset of  $25^\circ$  to the worst case orientation, the RTI shall not exceed 250 % of the value of RTI in the standard orientation.

**6.14.2** After exposure to the corrosion test described in 6.11.2, 6.11.3 and 6.11.4, domestic sprinklers shall be tested in the standard orientation as described in 7.6.2.1 to determine the post-exposure RTI. The post-exposure RTI values shall not exceed 130 % of the pre-exposure average value. All post-exposure RTI values shall be calculated as in 7.6.2.3 using the pre-exposure conductivity factor,  $C$ .

### 6.15 Resistance to heat (see 7.14)

Open domestic sprinklers shall be resistant to high temperatures when tested in accordance with 7.14. After exposure, the sprinkler shall not show visual deformation, fracture or breakage.

### 6.16 Resistance to vibration (see 7.16)

Domestic sprinklers shall be able to withstand the effects of vibration without deterioration when tested in accordance with 7.16. After the performance of the vibration test described in 7.16, sprinklers shall show no visible deterioration, shall meet the requirements of 6.8.1 and shall operate when functionally tested to the requirements of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only.

### 6.17 Resistance to impact (see 7.17)

Domestic sprinklers shall have adequate strength to withstand impacts associated with handling, transport and installation without deterioration of performance or reliability. After the performance of the impact test described in 7.17, these sprinklers shall show no fracture or deformation, shall meet the leak resistance requirement of 6.8.1, and the requirements of 6.8.1 and shall operate when functionally tested to the requirements of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only.

### 6.18 Fire performance (see 7.18)

#### 6.18.1 General

When fire tested as described in 7.18.1 through 7.18.22, domestic sprinklers shall limit temperatures as specified in items a) through d). Additionally, a maximum of two domestic sprinklers shall operate. The third sprinkler at the doorway shall not operate. The total discharge rate for two domestic sprinklers shall be twice the minimum discharge rate for a single sprinkler. The sprinklers shall limit temperatures as follows.

- a) Maximum temperature 76 mm below the ceiling shall not exceed  $315^\circ\text{C}$ .
- b) Maximum temperature 1,6 m above the floor shall not exceed  $93^\circ\text{C}$ .
- c) Temperature at the location described in item b) shall not exceed  $54^\circ\text{C}$  for more than any continuous 2-min period.
- d) Maximum ceiling material temperature 6,0 mm behind the finished ceiling surface shall not exceed  $260^\circ\text{C}$ .

See Figure 1 (pendent or upright sprinklers) or Figures 2 and 3 (sidewall sprinklers) for temperature measuring locations.

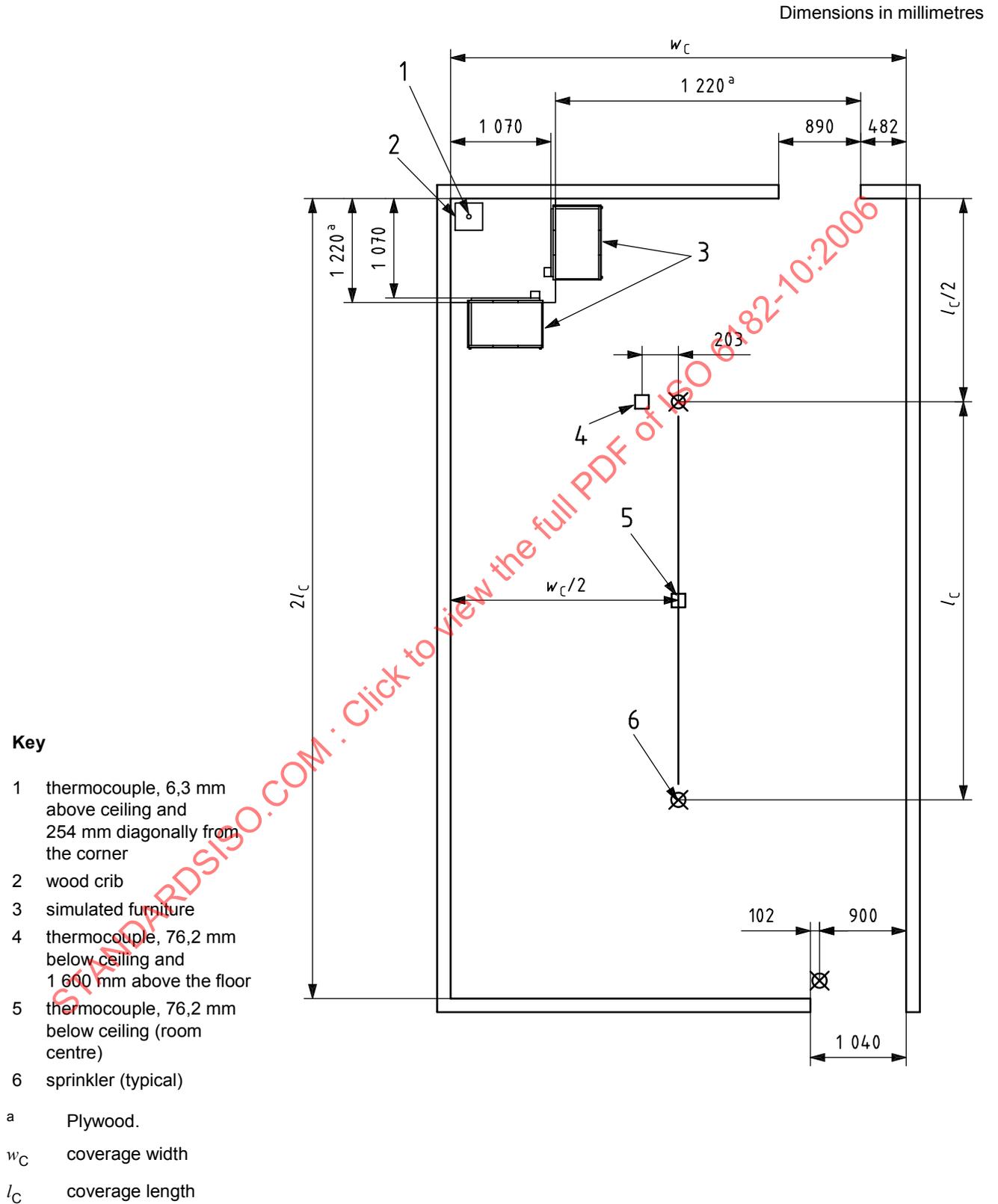
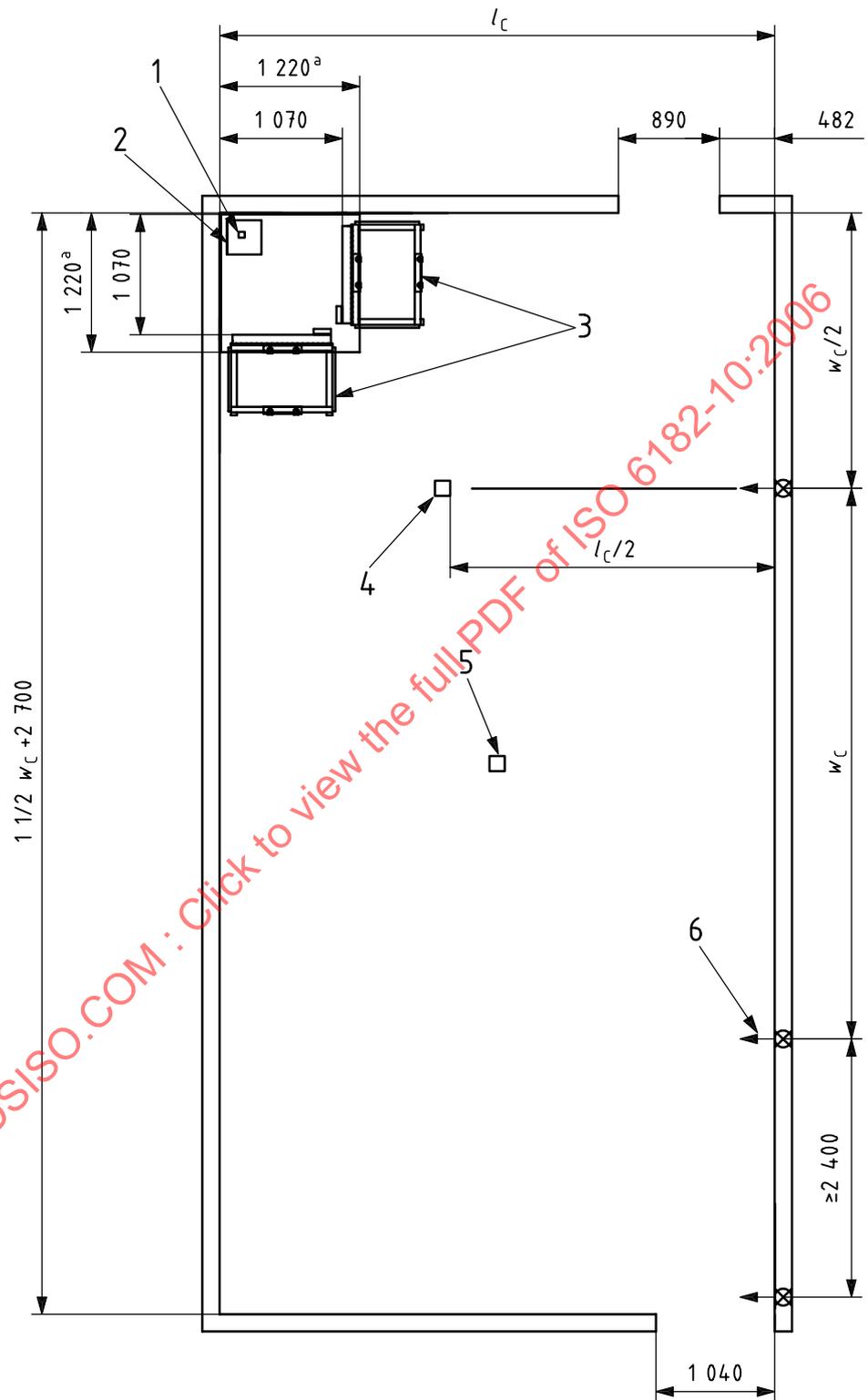


Figure 1 — Fire test arrangement — Pendent and upright

Dimensions in millimetres



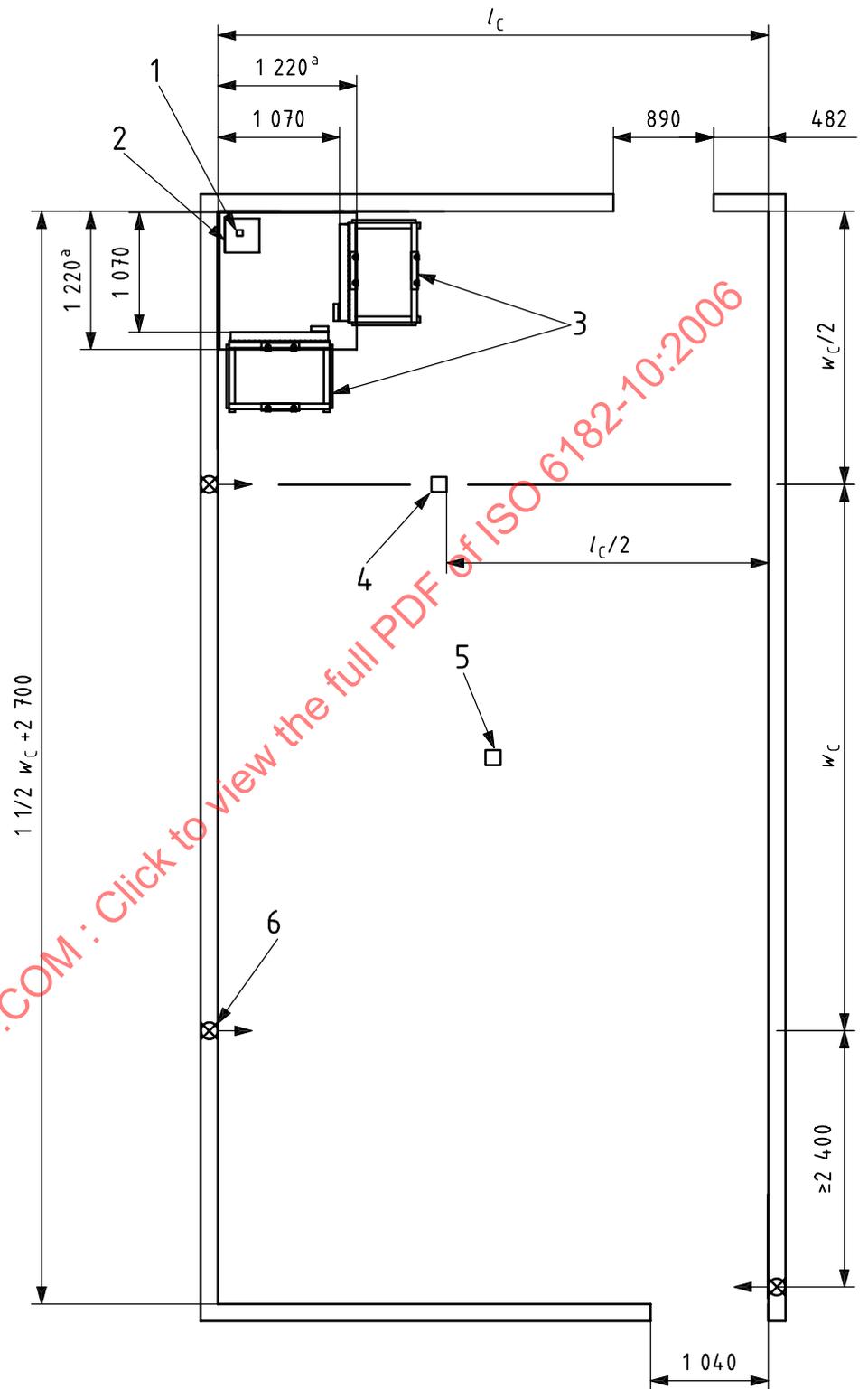
**Key**

- 1 thermocouple, 6,3 mm above ceiling and 254 mm diagonally from the corner
- 2 wood crib
- 3 simulated furniture
- 4 thermocouple, 76,2 mm below ceiling and 1 600 mm above the floor
- 5 thermocouple, 76,2 mm below ceiling (room centre)
- 6 sidewall sprinkler (typical)

- <sup>a</sup> Plywood.
- $w_C$  coverage width
- $l_C$  coverage length

**Figure 2 — Fire test arrangement 1 — Sidewall**

Dimensions in millimetres



**Key**

- 1 thermocouple, 6,3 mm above ceiling and 254 mm diagonally from the corner
- 2 wood crib
- 3 simulated furniture
- 4 thermocouple, 76,2 mm below ceiling and 1 600 mm above the floor
- 5 thermocouple, 76,2 mm below ceiling (room centre)
- 6 sidewall sprinkler (typical)

<sup>a</sup> Plywood.

$w_C$  coverage width

$l_C$  coverage length

**Figure 3 — Fire test arrangement 2 — Sidewall**

### 6.18.2 Alternative test methods

Alternative test methods and requirements are in preparation for applications in which building materials and contents differ significantly from those described in 7.18. These are special qualification tests for sprinklers that otherwise meet the requirements of this standard; (see 6.1 through 6.17 and 6.19 through 6.23).

### 6.18.3 Japanese style house (reserved)

### 6.19 Lateral discharge (see 7.19)

Domestic sprinklers shall not prevent the operation of adjacent sprinklers when tested in accordance with 7.19.

### 6.20 30-day leakage resistance (see 7.20)

Domestic sprinklers shall not leak or sustain distortion or other mechanical damage when subjected to 2 MPa (20 bar) water pressure for 30 d in accordance with 7.20. During this exposure and following exposure, the sprinklers shall satisfy these requirements.

### 6.21 Vacuum resistance (see 7.21)

Domestic sprinklers shall not exhibit distortion, mechanical damage or leakage after being subjected to the test in accordance with 7.21.

### 6.22 Room response (see 7.22)

A concealed, flush or recessed domestic sprinkler shall have the following operating time characteristics when tested as specified in 7.22.1 through 7.22.4:

- a) 75 s or less for each sprinkler when subjected to the test described in 7.22; and
- b) mean time equal to or less than a 1,30 multiple of the mean time of the sprinklers tested in accordance with item a) after being subjected to the exposure test specified in 6.9.2, 6.11.2, 6.11.3, 6.11.4, 6.12, 6.13, 6.16, 6.17 and 6.23.

### 6.23 Resistance to low temperatures (see 7.23)

Domestic sprinklers shall be resistant to low temperatures when tested in accordance with 7.23. After exposure, the sprinkler shall either be visibly damaged, leak subsequent to thawing, or not be damaged. Domestic sprinklers not visibly damaged or leaking shall meet the requirements of 6.8 and 6.14.

## 7 Test methods

### 7.1 Preliminary examination

The following tests shall be carried out for each type of domestic sprinkler. Before testing, precise drawings of parts and the assembly shall be submitted together with the appropriate specifications (using SI units). Tests shall be carried out at a room temperature of  $(20 \pm 5)$  °C, unless other temperatures are indicated. Sprinklers shall be tested with all the components required by their design and installation.

Unless otherwise stated, the tolerances given in Annex D shall apply.

The construction of domestic sprinklers shall be examined to ensure that it complies with the requirements of Clauses 4 and 5.

## 7.2 Visual examination

Before testing, sprinklers shall be examined visually with respect to the following points:

- a) marking;
- b) conformity of the sprinklers with the manufacturer's drawings and specification;
- c) obvious defects.

## 7.3 Strength of sprinkler body test (see 6.6)

**7.3.1** The service load shall be measured on ten domestic sprinklers by securely installing each sprinkler, at room temperature, in a tensile/compression test machine and applying an equivalent of a hydraulic pressure of 1,2 MPa (12 bar) at the inlet.

Alternatively, the service load shall be permitted to be determined by measurement of the assembly load and adding a calculated or measured value of the force equivalent to a hydrostatic pressure of 1,2 MPa (12 bar).

An indicator capable of reading deflection to an accuracy of 0,001 mm shall be used to measure any change in the length between the load-bearing points of the sprinkler. Movement of the sprinkler shank thread in the threaded bushing of the test machine shall be avoided or taken into account.

Release hydraulic pressure and remove the heat-responsive element of the sprinkler. When the sprinkler is at room temperature, make a second measurement using the indicator.

Apply an increasing mechanical load to the sprinkler, at a rate not exceeding 500 N/min, until the indicator reading at the deflector end of the sprinkler returns to the initial value achieved under hydrostatic load. The mechanical load necessary to achieve this shall be recorded as the service load.

**7.3.2** Increase the applied load progressively at a rate not exceeding 500 N/min on each of the ten specimens until twice the service load has been applied. Maintain this load for  $(15 \pm 5)$  s.

Remove the load and compare the permanent elongation with the requirement of 6.6.

## 7.4 Leak resistance and hydrostatic strength test (see 6.8)

**7.4.1** Twenty domestic sprinklers shall be subjected to a water pressure of 3,0 MPa (30 bar). Increase the pressure from 0 MPa (0 bar) to 3 MPa (30 bar) at a rate of  $(0,1 \pm 0,025)$  MPa/s [ $(1 \pm 0,25)$  bar/s]; maintain the pressure at 3,0 MPa (30 bar) for a period of 3 min, and then allow the pressure to fall to 0 MPa (0 bar). After the pressure has dropped to 0 MPa (0 bar), increase it to 0,05 MPa (0,5 bar) in not more than 5 s. Maintain this pressure for 15 s, and then increase it to 1,0 MPa (10 bar) at a rate of increase of  $(0,1 \pm 0,025)$  MPa/s [ $(1 \pm 0,25)$  bar/s], and maintain it for 15 s. Each sprinkler shall meet the requirement of 6.8.1.

**7.4.2** Following the test described in 7.4.1, the twenty sprinklers shall be subjected to a water pressure of 4,8 MPa (48 bar). The sprinkler inlet is to be filled with water at  $(20 \pm 5)$  °C and vented of air. The pressure shall be increased to 4,8 MPa (48 bar) at a rate not exceeding 2,0 MPa/s (20 bar/min). The pressure shall be maintained at 4,8 MPa (48 bar) for 1 min. The sprinkler shall meet the requirements of 6.8.2.

## 7.5 Functional test (see 6.5.1)

**7.5.1** Domestic sprinklers shall be heated in air at a rate that permits operation within 1 min. While being heated, they shall be subjected to each of the water pressures specified in 7.5.2, applied to their inlet.

**7.5.2** Eight sprinklers shall be tested in each normal mounting position and at each of the following pressures (a total of 24 sprinklers):

- a) 0,035 MPa (0,35 bar);
- b) 0,35 MPa (3,5 bar);
- c) 1,2 MPa (12 bar).

The flowing pressure shall be at least 75 % of the initial operating pressure. The oven temperature shall be measured local to the sprinkler.

**7.5.3** If lodgement occurs at any pressure level and mounting position, 24 more sprinklers shall be tested in that mounting position and at that pressure. The total number of sprinklers in which lodgement occurs shall not exceed 1 in the 32 sprinklers tested at that pressure and in that mounting position.

**7.5.4** A lodgement shall be considered to have occurred when one or more of the released parts lodges in the deflector frame assembly for more than 10 s in such a way as to cause the water distribution requirement to be altered.

**7.5.5** In order to check the strength of the deflector, three sprinklers shall be submitted to the functional test in each normal mounting position at a pressure of 1,2 MPa (12 bar). The water shall be allowed to flow at a running pressure of 1,2 MPa (12 bar) for a period of 15 min.

## **7.6 Operating temperature test (see 6.3)**

### **7.6.1 Test of static operation**

Fifty glass bulb sprinklers or ten fusible element sprinklers shall be heated from room temperature to 20 °C to 22 °C below their nominal operating temperature. The rate of increase of temperature shall not exceed 20 °C/min and the temperature shall be maintained for 10 min. The temperature shall then be increased at a rate between 0,4 °C/min and 0,7 °C/min until the sprinkler operates.

The nominal operating temperature shall be ascertained with equipment having an accuracy of  $\pm 0,35$  % of the nominal temperature rating or  $\pm 0,25$  °C, whichever is greater.

The test shall be carried out in a water bath (preferably distilled water) for sprinklers having nominal operating temperatures less than or equal to 80 °C. A suitable oil shall be used for higher-rated elements. The liquid bath (see Figure 4) shall be constructed in such a way that the temperature deviation within the test zone does not exceed 0,5 %, or 0,5 °C, whichever is the greater.

Fifty glass bulb sprinklers or ten fusible element sprinklers shall be heated from a temperature of  $20^{+5}_0$  °C to a temperature of  $20^{+2}_0$  °C below their nominal operating temperature. The rate of increase of temperature shall not exceed 20 °C/min and the temperature shall be maintained for 10 min. The temperature shall then be increased at a rate of  $(0,5 \pm 0,1)$  °C/min until the sprinkler operates.

The nominal operation temperature shall be ascertained with equipment having an accuracy of  $\pm 0,25$  % of the nominal temperature rating.

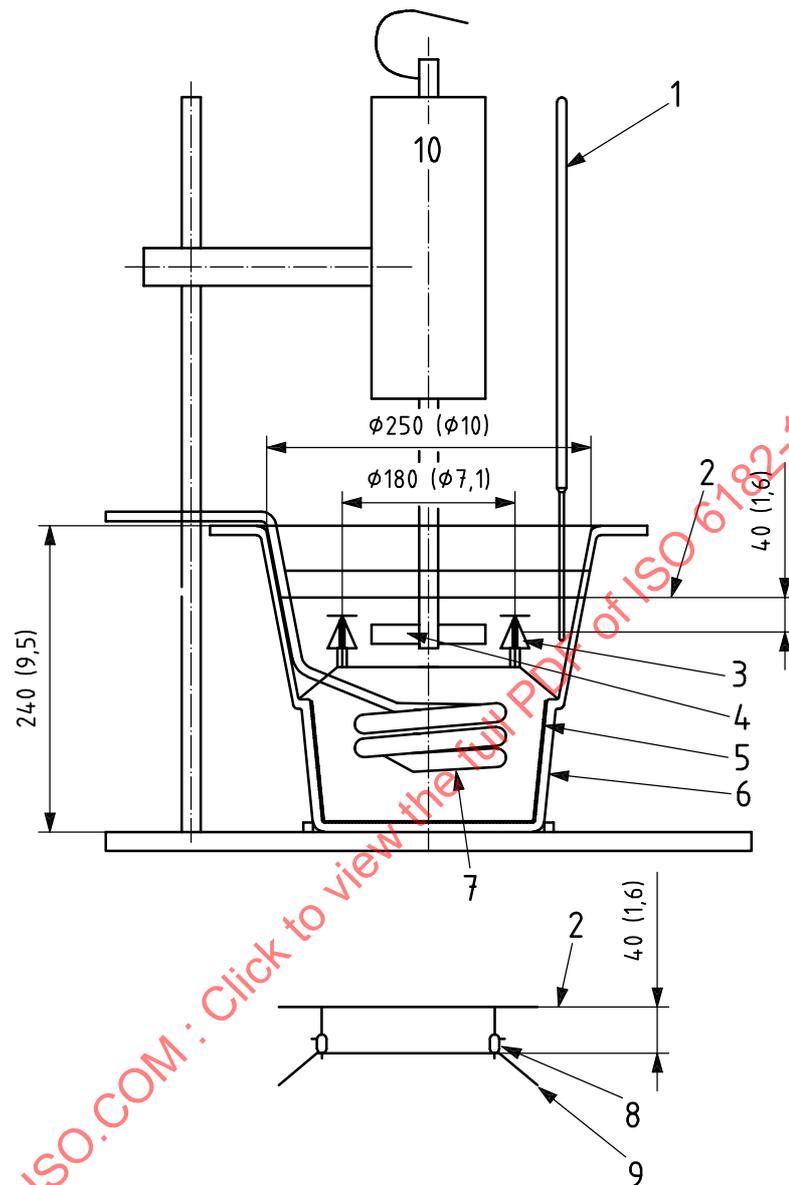
The test shall be carried out in a liquid bath. Sprinklers having nominal operating temperatures less than or equal to 80 °C shall be tested in a bath of demineralized water. Sprinklers with higher-rated elements shall be tested in a bath of glycerine vegetable oil or synthetic oil.

The sprinklers shall be located in the liquid bath in a vertical position and with the sprinklers totally immersed with the liquid cover of  $5^{+3}_0$  mm. The test zone is located at a distance, below the liquid surface, level with the geometric centre of the glass bulb or fusible element. The test zone shall be at, if possible, but not less than,  $40^{+5}_0$  mm below the liquid surface level. The temperature deviation within the test zone shall be between 0 °C and 0,25 °C.

Any rupture of a glass bulb within the prescribed temperature rate constitutes an operation. Partial fracture of glass bulb that does not result in sprinkler operation shall necessitate an additional functional test (see 6.5.1).

An example of a standardized liquid bath is shown in Figure 3. A laboratory temperature measuring device, calibrated to a depth of 40 mm immersion, is to be used to determine temperatures of liquids in bath tests and operation temperature. The bulb of the thermometer is to be held level with the sprinkler operating parts by a support member. To control the temperature in the thermal bath, a PT100 DIN EN 60751 can be used.

Dimensions in millimetres (inches)



**Key**

- 1 thermometer calibrated for 40 mm (1,6 in) immersion and PT-100
- 2 liquid level
- 3 ring to support 10 sprinklers 3/4" or 15 sprinklers 1/2"
- 4 1 double wing 100 mm × 20 mm (3,9 × 0,8)
- 5 mesh screen
- 6 standard glass vessel extractor-desiccator  $\varnothing$  250 (10); liquid volume about 7 liters
- 7 immersion heater
- 8 glass bulbs
- 9 ring to support 50 glass bulbs
- 10 speed agitator 150 rpm

**Figure 4 — Example of a liquid bath test apparatus**

7.6.2 Dynamic heating test (see 6.14)

7.6.2.1 Plunge test

Using a single temperature rating, ten plunge tests shall be performed at the standard and worst case orientations as defined in 3.1.10 to 3.1.12. If a single sprinkler design is submitted in multiple temperature ratings, the worst-case orientation and the *C*-factor shall be determined by testing one temperature rating only. Ten additional samples shall be plunge-tested at the 25 offset orientation. The RTI is calculated as described in 7.6.2.3 and 7.6.2.4 for each orientation, respectively. For all remaining temperature ratings, 10 samples of each temperature rating shall be tested in the standard orientation.

The plunge tests are to be conducted using a brass sprinkler mount, designed such that the mount or water temperature rise (as measured by a thermocouple heatsinked and embedded in the mount of not more than 8 mm radially outward from the root diameter of the internal thread or by a thermocouple located in the water at the centre of the sprinkler inlet) does not exceed 2 °C for the duration of an individual plunge test.

The sprinkler under test shall have 1 to 1,5 wraps of PTFE sealant tape applied to the sprinkler threads. It shall be screwed into a mount to a torque of (15 ± 3) N·m. Each sprinkler is to be mounted on a tunnel test section cover and maintained in a conditioning chamber to allow the sprinkler and cover to reach ambient temperature for a period of not less than 30 min.

At least 25 ml of water, conditioned to ambient temperature, shall be introduced into the sprinkler inlet prior to testing.

All sprinklers are to be tested with the inlet end of each sample connected to a source of pressure at 0,035 MPA (0,35 bar).

A timer accurate to ± 0,01 s with suitable measuring devices to sense the time between when the sprinkler is plunged into the tunnel and the time it operates shall be utilized to obtain the response time.

A tunnel shall be utilized with airflow and temperature conditions at the test section (sprinkler location) selected from the appropriate range of conditions shown in Table 3. To minimize radiation exchange between the sensing element and the boundaries confining the flow, the test section of the apparatus shall be designed to limit radiation effects to within ± 3 % of the calculated RTI values.

The range of permissible tunnel operating conditions is shown in Table 4.

NOTE A suggested method for determining radiation effects is by conducting comparative plunge tests on a blackened (high emissivity) metallic test specimen and polished (low emissivity) metallic test specimen.

The selected air temperature shall be known and maintained constant within the test section throughout the test to an accuracy of ± 1 °C for the air temperature range between 129 °C and 141 °C within the test section and within ± 2 °C for the range 191 °C and 203 °C. The selected air velocity shall be known and maintained constant throughout the test to an accuracy of ± 0,03 m/s for velocities between 1,65 m/s and 1,85 m/s.

**Table 3 — Range of plunge test conditions at test section (sprinkler location)**

Nominal operating temperatures °C	Air temperature ratings °C	Velocity ranges m/s
57 to 77	129 to 141	1,65 to 1,85
79 to 107	191 to 203	1,65 to 1,85

7.6.2.2 Determination of conductivity factor, *C*

The conductivity factor, *C*, shall be determined using the prolonged plunge test (see 7.6.2.2.1) or the prolonged exposure ramp test (see 7.6.2.2.2).

### 7.6.2.2.1 Prolonged plunge test

The prolonged plunge test is an iterative process to determine  $C$  and may require up to twenty sprinkler samples. A new sprinkler sample shall be used for each test in this section even if the sample does not operate during the prolonged plunge test.

The sprinkler under test shall have 1 to 1,5 wraps of PTFE sealant tape applied to the sprinkler threads. It shall be screwed into a mount to a torque of  $(15 \pm 3)$  N·m. Each sprinkler is to be mounted on a tunnel test section cover and maintained in a conditioning chamber to allow the sprinkler and cover to reach ambient temperature for a period of not less than 30 min.

At least 25 ml of water, conditioned to ambient temperature, shall be introduced into the sprinkler inlet prior to testing.

All sprinklers are to be tested with the inlet end of each sample connected to a source of pressure at 0,035 MPa (0,35 bar).

A timer accurate to  $\pm 0,01$  s with suitable measuring devices to sense the time between when the sprinkler is plunged into the tunnel and the time it operates shall be utilized to obtain the response time.

The mount temperature shall be maintained at  $(20 \pm 0,5)$  °C for the duration of each test. The air velocity in the tunnel test section at the sprinkler location shall be maintained with  $\pm 2$  % of the selected velocity. Air temperature shall be selected and maintained during the test as specified in Table 4.

To determine  $C$ , the sprinkler shall be immersed in the test stream at various air velocities for a maximum of 15 min. Velocities shall be chosen such that actuation is bracketed between two successive test velocities. That is, two velocities shall be established such that at the lower velocity ( $u_L$ ) actuation does not occur in the 15-min test interval. At the next higher velocity ( $u_H$ ), actuation must occur within the 15-min time limit. If the sprinkler does not operate at the highest velocity, select an air temperature from Table 5 for the next higher temperature rating.

**Table 4 — Range of test conditions for conductivity factor  $C$  determination at test section (sprinkler location)**

Nominal operating temperature °C	Air temperature °C	Maximum variation of air temperature during test from selected temperatures °C
57	85 to 91	$\pm 1,0$
58 to 77	124 to 130	$\pm 1,5$
79 to 107	193 to 201	$\pm 3,0$

Test velocity selection shall ensure that

$$\left(\frac{u_H}{u_L}\right)^{0,5} \leq 1,1 \quad (4)$$

The  $C$ -factor shall be the average of the values calculated at the two velocities using Equation (5):

$$C = \left(\frac{\Delta T_g}{\Delta T_{ea}} - 1\right) u^{0,5} \quad (5)$$

where

$\Delta T_g$  is the actual gas (air) temperature minus the mount temperature ( $T_m$ ), expressed in degrees Celsius (see 7.6.2.1);

$\Delta T_{ea}$  is the mean liquid bath operating temperature minus the mount temperature ( $T_m$ ), expressed in degrees Celsius (see 7.6.1 and 7.6.2.1);

$u$  is the actual air velocity in the test section, expressed in metres per second.

The sprinkler  $C$ -factor shall be determined by repeating the bracketing procedure three times and calculating the numerical average of the three  $C$  values. This sprinkler  $C$  value shall be used to calculate all standard orientation RTI values for determining compliance with 6.14.

If the  $C$ -factor is determined to be less than  $0,5 \text{ (m}\cdot\text{s)}^{0,5}$ , a  $C$ -factor of  $0,25 \text{ (m}\cdot\text{s)}^{0,5}$  shall be assumed for calculating RTI values.

For sample calculation, see Annex C.

#### 7.6.2.2.2 Prolonged exposure ramp test

The prolonged exposure ramp test for the determination of the  $C$ -factor shall be carried out in the test section of a wind tunnel and with the requirements for the temperature in the sprinkler mount as described for the dynamic heating test. A preconditioning of the sprinklers is not necessary.

Ten samples shall be tested of each sprinkler type, all sprinklers positioned in standard orientation. The sprinklers shall be plunged into an air stream of a constant velocity of  $(1 \pm 0,10) \text{ m/s}$  and an air temperature at the nominal operating temperature of the sprinkler at the beginning of the test.

The air temperature shall then be increased at a rate of  $(1 \pm 0,25) \text{ }^\circ\text{C/min}$  until the sprinkler operates. The air temperature, velocity and mount temperature shall be controlled from the initiation of the rate of rise and shall be measured and recorded at sprinkler operation.

The  $C$  value is determined as the average of the ten test values using Equation (5).

This method is suitable for sprinklers of all nominal operating temperatures.

#### 7.6.2.2.3 RTI value calculation

Use Equation (6) to determine the RTI value,  $X_{RTI}$ , as follows:

$$X_{RTI} = \frac{-t_r (u)^{0,5} \left( 1 + \frac{C}{u^{0,5}} \right)}{\ln \left[ \frac{1 - \Delta T_{ea} \left( 1 + \frac{C}{u^{0,5}} \right)}{\Delta T_g} \right]} \quad (6)$$

where

$t_r$  is the response time of sprinkler, expressed in seconds;

$u$  is the actual air velocity in the test section of the tunnel from Table 4, expressed in metres per second;

- $\Delta T_{ea}$  is the mean liquid bath operating temperature of the sprinkler minus the ambient temperature, expressed in degrees Celsius (see 7.6.2.1);
- $\Delta T_g$  is the actual air temperature in the test section minus the ambient temperature, expressed in degrees Celsius;
- $C$  is the conductivity factor as determined in 7.6.2.2.

For sample calculation, see Annex C.

### 7.6.2.3 Determination of worst-case orientation RTI

The calculation of RTI for the worst-case orientation requires the use of the  $C$ -factor for the worst case orientation that is larger than the  $C$ -factor for the standard orientation by a multiplier. This multiplier is equal to the ratio of the average RTI for the worst-case orientation to the average RTI for the standard orientation. The plunge test expression, therefore, becomes implicit for the RTI in the worst-case orientation, which can be solved iteratively; see C.2.2.

For sample calculation, see Annex C.

## 7.7 Heat exposure test (see 6.9)

**7.7.1** Four glass bulb sprinklers having nominal release temperatures less than or equal to 80 °C shall be heated in a water bath (preferably distilled water) from a temperature of  $(20 \pm 5)$  °C to  $(20 \pm 2)$  °C below their nominal operating temperature. The rate of increase of temperature shall not exceed 20 °C/min. Glycerine, vegetable oil or synthetic oil shall be used for higher-rated release elements.

This temperature shall then be increased at a rate of 1 °C/min to the temperature at which the gas bubble dissolves, or to a temperature 5 °C lower than the lower limit of the tolerance range of the operating temperature, whichever is lower. Remove the sprinkler from the liquid bath and allow it to cool in air until the gas bubble has formed again. During the cooling period, the pointed end of the glass bulb (seal end) shall be pointing downwards. This test shall be performed four times on each of four sprinklers.

**7.7.2** Twelve sprinklers shall be exposed for a period of 90 d to a high ambient temperature that is 11 °C below the nominal rating but not less than 49 °C. If the service load is dependent on the service pressure, sprinklers shall be tested under a pressure of 1,2 MPa (12 bar). After exposure, four of the sprinklers shall be subjected to the requirements of 6.8.1, four sprinklers to the requirements of 6.5.1 [two at 0,35 MPa (3,5 bar) and two at 1,0 MPa (10 bar)] and four sprinklers to the requirements of 6.14 or 6.22 b) for concealed, flush and recessed sprinklers. If a sprinkler fails a test, eight additional sprinklers shall be tested as described above and subjected to the test in which the failure was recorded. All eight sprinklers shall pass the test.

## 7.8 Thermal shock test for glass bulb sprinklers (see 6.10)

**7.8.1** Before starting the test, condition at least five sprinklers at  $(20 \pm 5)$  °C for at least 30 min.

**7.8.2** Domestic sprinklers having nominal operating temperatures less than or equal to 80 °C shall be tested in a bath of demineralized water. Domestic sprinklers with higher-rate elements shall be tested in a bath of glycerine, vegetable oil or synthetic oil. The temperature of the bath shall be  $(10 \pm 0,5)$  °C below the lower limit of the tolerance range of the operating temperature of the domestic sprinklers. After 5 min, remove the sprinklers from the bath and immerse them immediately in another bath of liquid (demineralized water), with the bulb seal downwards, at a temperature of  $(10 \pm 0,5)$  °C. Then test the domestic sprinklers in accordance with 6.5.1.

## 7.9 Strength test for release elements (see 6.7)

### 7.9.1 Glass bulbs

At least 55 glass bulbs of the same design of each bulb type shall be positioned individually in a test fixture using the sprinkler seating parts. Each bulb shall then be subjected to a uniformly increasing force at a rate of  $(250 \pm 25)$  N/s in the test machine until the glass bulb fails.

Each test shall be conducted with the bulb mounted in new seating parts. The seating parts may be reinforced externally or can be manufactured from hardened steel (Rockwell Hardness C44  $\pm$  6) in accordance with the specifications of the sprinkler manufacturer to prevent collapse, but in a manner which does not interfere with bulb failure. Record the crush force for each bulb.

Using the lowest 50 measured bulb strength results, calculate the average strength and the lower tolerance limit (LTL) for bulb strength (see Annex A). Using the values of service load recorded in 7.3.1, calculate the upper tolerance limit (UTL) for the sprinkler release element service load. Verify compliance with 6.7.1.

### 7.9.2 Fusible elements

The tests of 7.9.2.1 and 7.9.2.2 shall be conducted at an ambient temperature of  $(20 \pm 3)$  °C.

**7.9.2.1** Determine compliance with the requirements of 6.7.2 a) by subjecting at least 10 samples to 15 times the maximum design load for 100 h. Abnormal failures, those not related to evaluation of the fusible material, shall not be used, however, at least 10 valid data points shall be obtained.

**7.9.2.2** Determine compliance with the requirements of 6.7.2 b) by subjecting fusible heat-responsive elements to loads in excess of the maximum design load  $L_d$ , which will produce failure within and after 1 000 h (see Annex B). At least 10 samples shall be subjected to different loads up to 15 times the maximum design load. Abnormal failures shall be rejected, however, at least 10 valid data points shall be obtained. Plot a full logarithmic regression curve using the method of least squares, and from this calculate the load at 1 h, and the load at 1 000 h, as given in Equation (7):

$$L_d \leq 1,02 \frac{L_M^2}{L_0} \quad (7)$$

where

$L_d$  is the maximum design load;

$L_M$  is the load at 1 000 h;

$L_0$  is the load at 1 h.

### 7.10 Water flow test (see 6.4.1)

The sprinkler shall be mounted with a pressure gauge on a supply pipe. Four sprinklers shall be tested. The frame arms and deflector shall be permitted to be removed to facilitate testing. The water flow shall be measured at pressures of 0,05 MPa to 0,65 MPa (0,5 bar to 6,5 bar) at intervals of 0,1 MPa (1 bar). In one series of tests, the pressure shall be increased to each value, and, in the other series, the pressure shall be decreased from 0,65 MPa (6,5 bar) to each value. The flow constant shall be calculated for each flowing pressure and the flow constant shall be averaged for each series of readings. The average flow constant for each series shall be within the limits specified in 6.4.1.2. During the test, pressures shall be corrected for differences in height between the gauge and the outlet orifice of the sprinkler.

## 7.11 Water distribution test (see 6.4.2)

### 7.11.1 Horizontal surfaces (see 6.4.2.1)

#### 7.11.1.1 General

Tests are to be conducted on an individual sprinkler using design flow rates specified in the manufacturer's design and installation instructions that simulate one sprinkler in a system operating. The water distribution test is to be conducted for 20 min.

#### 7.11.1.2 Open sprinkler

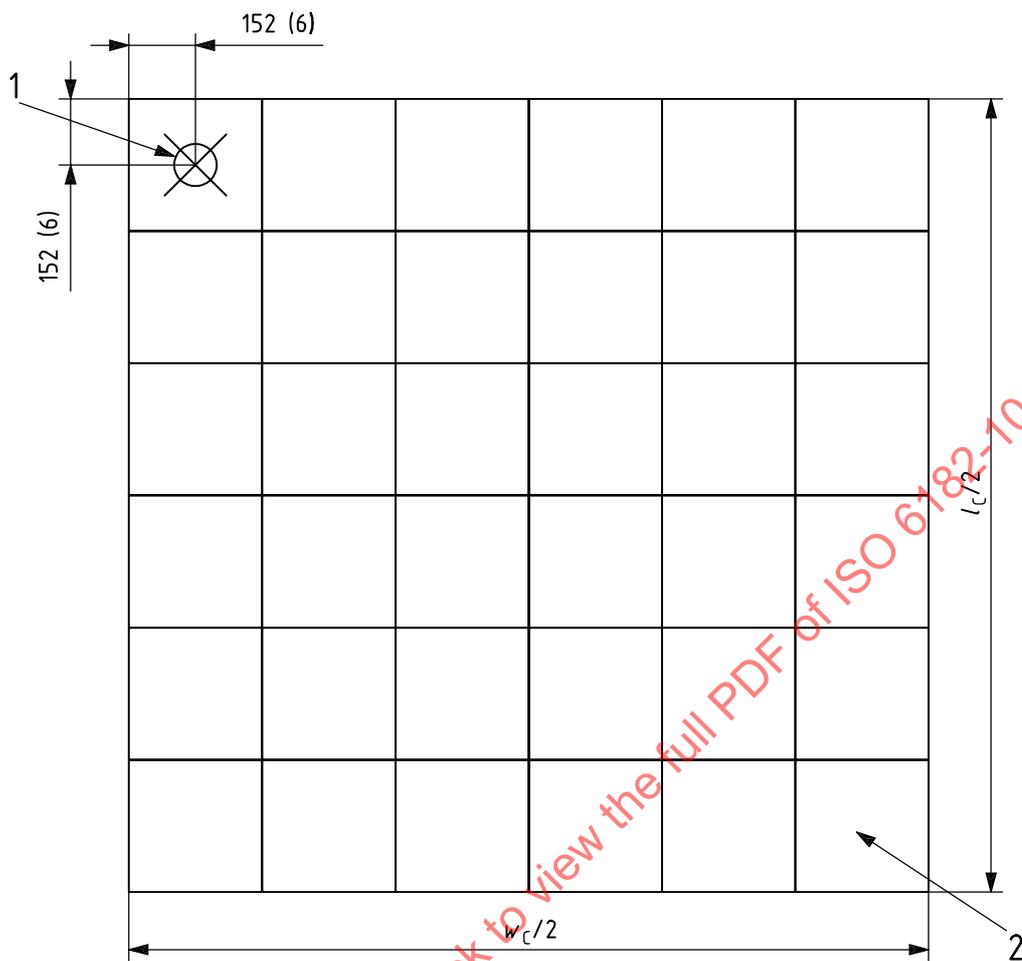
An open sprinkler is to be installed in its intended position in a pipe fitting having a 25 mm inlet and an outlet the same size as the sprinkler inlet, and is to be supplied with water through 25 mm piping. The sprinkler deflector is to be located in its intended position as specified in the manufacturer's design and installation instructions. A pendent or upright sprinkler is to be tested after being rotated 90° about its vertical axis after being tested as initially installed.

#### 7.11.1.3 Upright and pendent Sprinkler

Collector pans measuring 300 mm × 300 mm are to be placed on the floor in one quadrant of the sprinkler's discharge pattern; see Figure 5. The tops of the pans are to be 2,4 m below the ceiling.

The specified water flow rate is to be established and the test is to be conducted for 20 min. At the completion of water flow, the water collected is measured to verify compliance with the requirements of 6.4.2.2 a) and b) with the sprinkler as installed and after being rotated 90°.

Dimensions in millimetres (inches)



**Key**

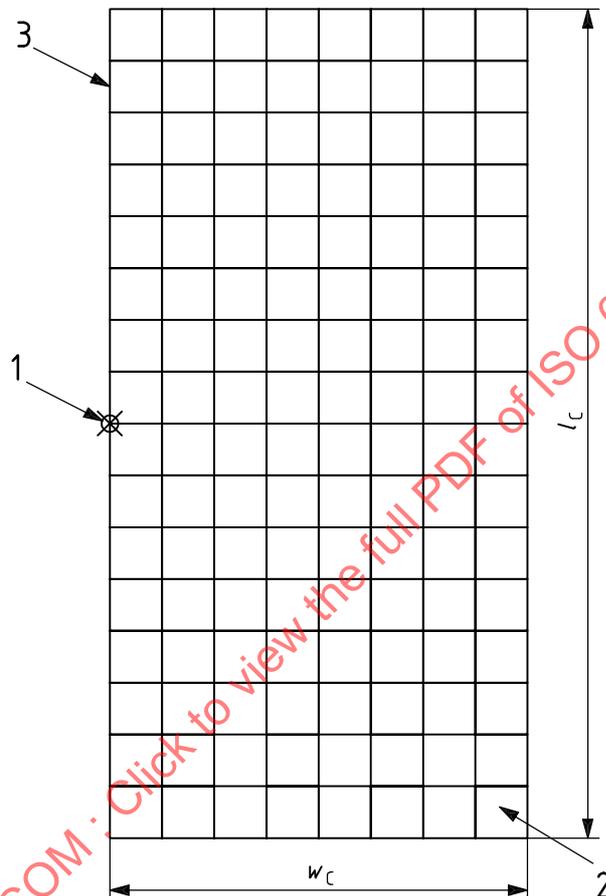
- 1 sprinkler
- 2 collector pans, 300 mm × 300 mm (12 in × 12 in)
- $w_c/2$  coverage width divided by 2
- $l_c/2$  coverage length divided by 2

**Figure 5 — Water collection for upright, pendent, recessed pendent and ceiling sprinklers**

#### 7.11.1.4 Sidewall sprinkler (see 6.4.2.1)

Collector pans measuring 300 mm × 300 mm are to be placed as shown in Figure 6. The tops of the pans are to be 2 m below the ceiling.

The specified water flow rate is to be established and the test is to be conducted for 20 min. At the completion of water flow, the water collected is to be measured to verify compliance with the requirements in 6.4.2.2.



#### Key

- 1 sidewall sprinkler
- 2 collector pans, 300 mm × 300 mm (12 in × 12 in)
- 3 wall
- $w_c$  coverage width
- $l_c$  coverage length

**Figure 6 — Water collection for sidewall sprinklers**

#### 7.11.2 Vertical surfaces (see 6.4.2.3)

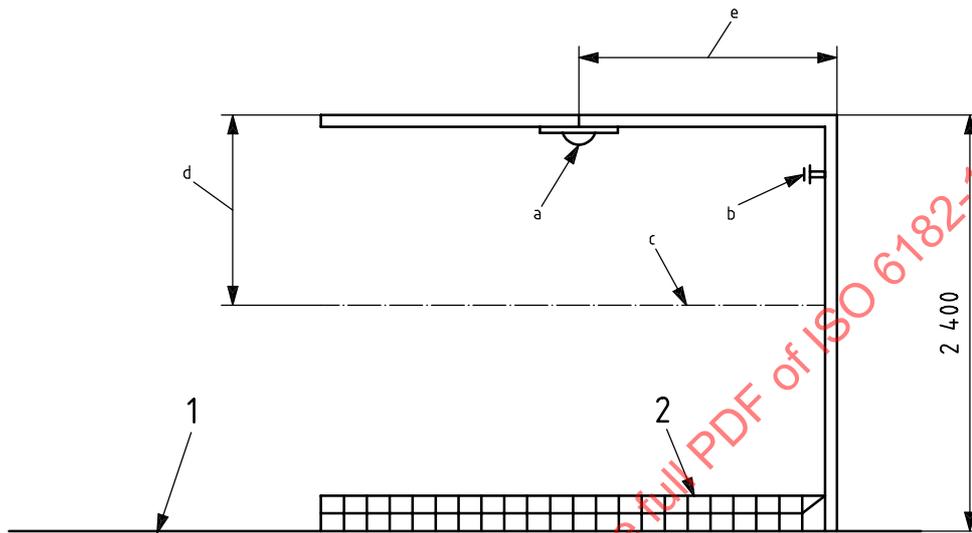
Tests are conducted on an individual sprinkler using flows simulating one sprinkler in a system operating. Each water distribution test is to be conducted for a minimum of 10 min.

An open domestic sprinkler is to be installed in its intended position in a pipe fitting having a 25 mm inlet and an outlet the same size as the sprinkler inlet, and is to be supplied with water through 25 mm piping. The sprinkler deflector is to be located in its intended position as specified in the installation instructions. A pendent or upright sprinkler is to be tested at a 90° rotation after being tested as initially installed.

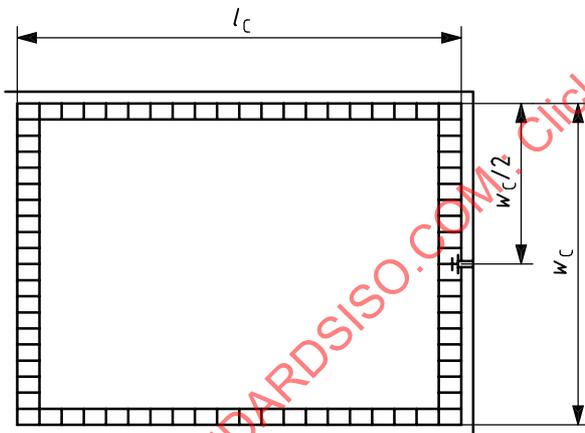
Collector pans are to be used to determine that at least 5 % of the sprinkler flow is discharged onto each wall; see 7.11.2.4. The walls of the test room are to be nonporous or have a nonporous covering so that water impinging on the walls can be collected and measured.

The collector pans measure 300 mm × 300 mm and are placed on the floor against the walls for the length and width of specified coverage. The collector pans are located 2 m below the ceiling. Means shall be provided to prevent sprinkler discharge from directly entering the pans; see Figure 7.

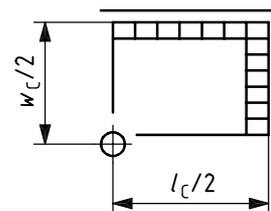
Dimensions in millimetres



a) Wall dimensions



b) Collector pans for sidewall sprinklers



c) Collector pans for upright or pendent sprinklers

**Key**

- 1 floor
- 2 collector pans
- a For upright or pendent sprinkler only.
- b For sidewall sprinkler only.
- c Maximum wall wetting distance from ceiling.
- d 0,7 m or 0,9 m minimum.
- e L/2 or W/2.

**Figure 7 — Water collection**

The specified water flow rate is to be established and the test is to be conducted for 10 min. At the completion of the test, the water collected and the height of wall wetting is measured to determine compliance with the requirements in 6.4.2.2.

## 7.12 Corrosion tests (see 6.11.1)

### 7.12.1 Stress corrosion test with aqueous ammonia solution

Five sprinklers shall be subjected to the following aqueous ammonia test. The inlet of each sample shall be filled with water and sealed with a nonreactive cap, e.g. plastic.

Degrease the samples to be tested and then expose them for 10 d to a moist ammonia-air mixture in a glass container of volume  $(0,02 \pm 0,01) \text{ m}^3$ .

An aqueous ammonia solution, having a density of  $0,94 \text{ g/cm}^3$ , shall be maintained in the bottom of the container, approximately 40 mm below the bottom of the samples. A volume of aqueous ammonia solution corresponding to  $0,01 \text{ ml/cm}^3$  of the volume of the container will give approximately the following atmospheric concentrations: 35 % ammonia, 5 % water vapour, and 60 % air.

The moist ammonia-air mixture shall be maintained as closely as possible at atmospheric pressure, with the temperature maintained at  $(34 \pm 2) \text{ }^\circ\text{C}$ . Provision shall be made for venting the chamber via a capillary tube to avoid the build-up of pressure. Specimens shall be shielded from condensate drippage. The glass container shall be placed in an enclosure that shall be heated uniformly to prevent condensate on the test samples.

After exposure, rinse and dry the sprinklers, and carry out a detailed examination. If a crack, delamination or failure of any operating part is observed, the sprinkler(s) shall be subjected to a leak resistance test at 1,2 MPa (12 bar) for 1 min and to the functional test at 0,035 MPa (0,35 bar) only: see 6.8 and 6.5.1.

Sprinklers showing cracking, delamination or failure of any non-operating part shall not show evidence of separation of permanently attached parts when subjected to a flowing pressure of 1,2 MPa (12 bar) for 30 min.

### 7.12.2 Sulfur dioxide corrosion test (see 6.11.2)

Ten sprinklers shall be subjected to the following sulfur dioxide corrosion test. For evaluation of dry type sprinklers, the shortest length manufactured shall be used. The inlet of each sample shall be filled with water and sealed with a nonreactive cap, e.g. plastic.

The test equipment shall consist of a 5 l vessel (instead of a 5 l vessel, other volumes up to 15 l may be used (in which case the quantities of chemicals given below shall be increased in proportion) made of heat-resistant glass, with a corrosion-resistant lid of such a shape as to prevent condensate dripping on the sprinklers. The vessel shall be electrically heated through the base, and provided with a cooling coil around the side walls. A temperature sensor placed centrally  $160 \text{ mm} \pm 20 \text{ mm}$  above the bottom of the vessel shall regulate the heating so that the temperature inside the glass vessel is  $(45 \pm 3) \text{ }^\circ\text{C}$ . During the test, water shall flow through the cooling coil at a sufficient rate to keep the temperature of the discharge water below  $30 \text{ }^\circ\text{C}$ . This combination of heating and cooling should encourage condensation on the surfaces of the sprinklers. Specimens shall be shielded from condensate drippage.

The sprinklers tested shall be suspended in their normal mounting position under the lid inside the vessel. Uncoated sprinklers shall be subjected to a sulfur dioxide atmosphere for 8 d. Coated sprinklers shall be subjected to the sulfur dioxide atmosphere for 16 d. The sulfur dioxide atmosphere shall be obtained by introducing a solution made up by dissolving 20 g of sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ) crystals in 500 ml of water.

The test shall last one period of 8 d.

For at least 6 d of each 8 d period, 20 ml of dilute sulfuric acid consisting of 156 ml of normal  $\text{H}_2\text{SO}_4$  ( $0,5 \text{ mol/l}$ ) diluted with 844 ml of water shall be added at a constant rate. After 8 d, the sprinklers shall be

removed from the vessel. This procedure shall be repeated for the second period of 8 d for coated sprinklers after the vessel has been emptied and cleaned.

After a total of 8 d, the samples shall be removed from the container and allowed to dry for 4 d to 7 d at a temperature not exceeding 35 °C with a relative humidity not greater than 70 %.

After the drying period, five sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) in accordance with 6.5.1, and five sprinklers shall be subjected to the dynamic heating test in accordance with 6.14.2 or in accordance with 6.22 b) for recessed, flush and concealed sprinklers.

### 7.12.3 Salt spray corrosion test (see 6.11.3)

**7.12.3.1** Ten sprinklers shall be exposed to a salt spray within a fog chamber. For evaluation of dry-type sprinklers, the shortest length manufactured shall be used. The inlet of each sample shall be filled with water and sealed with a nonreactive cap, e.g. plastic.

**7.12.3.2** During the corrosive exposure, the inlet thread orifice is to be sealed by a plastic cap after the sprinklers have been filled with water. The salt solution shall be a 5 % by mass sodium chloride solution in distilled water. The pH shall be between 6,5 and 7,2. Suitable means of controlling the atmosphere in the chamber shall be provided. The specimens shall be supported in their normal operating position and exposed to the salt spray (fog) in a chamber having a volume of at least 0,43 m<sup>3</sup>, in which the exposure zone shall be maintained at a temperature of (35 ± 2) °C. The temperature shall be recorded at least once per day, at least 7 h apart (except weekends and holidays when the chamber normally would not be opened). Salt solution shall be supplied from a recirculating reservoir through air-aspirating nozzles, at a pressure between 0,07 MPa (0,7 bar) and 0,17 MPa (1,7 bar). Salt solution runoff from exposed samples shall be collected and shall not return to the reservoir for recirculation. Specimens shall be shielded from condensate dripage.

Fog shall be collected from at least two points in the exposure zone to determine the rate of application and salt concentration. The fog shall be such that for each 80 cm<sup>2</sup> of collection area, 1 ml to 2 ml of solution shall be collected per hour over a 16 h period and the salt concentration shall be (5 ± 1) % by mass.

The sprinklers shall withstand exposure to the salt spray for a period of 10 d. After this period, the sprinklers shall be removed from the fog chamber and allowed to dry for 4 d to 7 d at a temperature not exceeding (20 ± 5) °C in an atmosphere having a relative humidity not greater than 70 %. After the drying period, five sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with 6.5.1, and five sprinklers shall be subjected to the dynamic heating test in accordance with 6.14.2 or in accordance with 6.22 b) for recessed, flush and concealed sprinklers.

### 7.12.4 Moist air exposure (see 6.11.4)

Ten sprinklers shall be exposed to a high temperature-humidity atmosphere consisting of a relative humidity of (98 ± 2) % and a temperature of (95 ± 4) °C.

The sprinklers are to be installed on a pipe manifold containing water. The entire manifold is to be placed in the high temperature-humidity enclosure for 90 d. After this period, the sprinklers shall be removed from the high temperature-humidity enclosure and allowed to dry for 4 d to 7 d at a relative humidity not greater than 70 %. Following the drying period, five sprinklers shall meet the functional requirement of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only, and five sprinklers shall meet the requirement of 6.14.2 or in accordance with 6.22 b) for recessed, flush and concealed sprinklers.

At the manufacturer's option, additional samples may be furnished for this test to provide early evidence of failure. The additional samples may be removed from the test chamber at 30 d intervals for testing.

## 7.13 Rough usage tests

Five sample sprinklers are to be tested. The sprinklers shall be permitted to be tested with a shipping cap in place if the cap is intended to be removed from the sprinkler after the sprinkler is installed, and reference to this removal requirement is made in the manufacturer's design and installation instructions.

Five samples are to be individually placed in a vinyl-lined right hexagonal prism-shaped drum designed to provide a tumbling action. The drum is to have an axis rotation of 250 mm. The distance between opposite sides is to be 300 mm. For each test, one sample and five 38 mm hardwood cubes are to be placed in the drum. The drum is to be rotated at 1 rev/s for 3 min. The sample is to be removed from the drum, examined for signs of damage, and then subjected to the leakage resistance test (see 6.8.1) and to the RTI requirements of 6.14.1 in the standard orientation only, or in accordance with 6.22 b) for recessed, flush and concealed sprinklers.

#### 7.14 Heat-resistance test (see 6.15)

One sprinkler body shall be heated in an oven at 800 °C for a period of 15 min with the sprinkler in its normal installed position. The sprinkler body shall then be removed by holding it by the threaded inlet, and shall be promptly immersed in a water bath at a temperature of approximately 15 °C.

#### 7.15 Water-hammer test (see 6.13)

Five sprinklers shall be connected, in their normal operating position, to the test equipment. After purging the air from the sprinklers and the test equipment, 100 000 cycles of pressure varying from  $(0,4 \pm 0,2)$  MPa [ $(4 \pm 2)$  bar] to 3,0 MPa (30 bar) shall be generated. The pressure shall be raised from 0,4 MPa (4 bar) to 3,4 MPa (34 bar) at a rate of  $(10 \pm 1,0)$  MPa/s [ $(100 \pm 10)$  bar/s]. At least 30 cycles of pressure per minute shall be generated. The pressure shall be measured with an electrical pressure transducer.

Visually examine each sprinkler for leakage during the test.

#### 7.16 Vibration test (see 6.16)

**7.16.1** Five sprinklers shall be fixed vertically to a vibration table. They shall be subjected at room temperature to sinusoidal vibrations. The direction of the vibration shall be along the axis of the connecting thread.

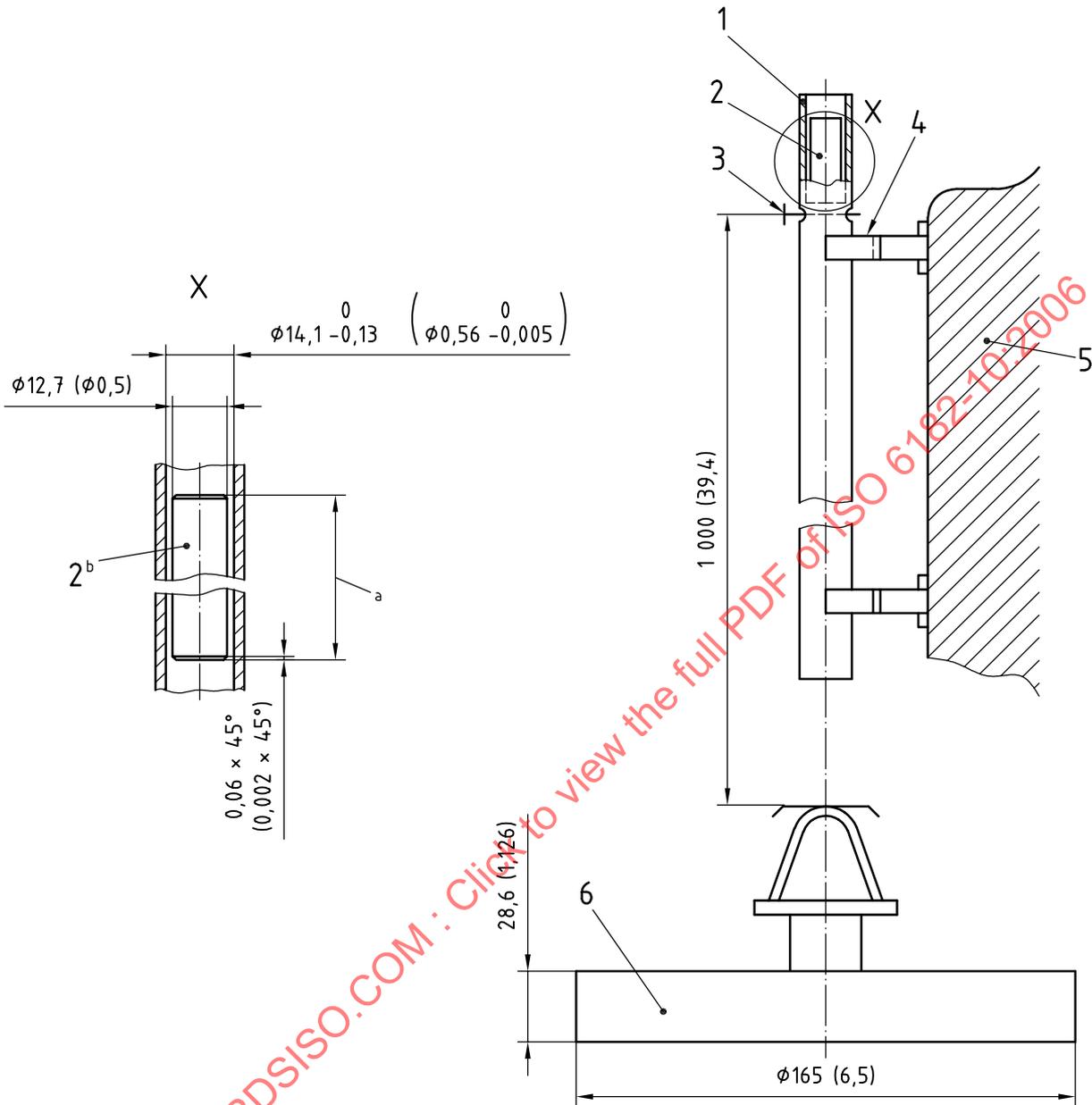
**7.16.2** The sprinklers shall be vibrated continuously from 5 Hz to 40 Hz at a maximum rate of 5 min/octave and an amplitude of 1 mm (1/2 peak-to-peak value). If one or more resonant points are detected, the sprinklers, after coming to 40 Hz, shall be vibrated at each of these resonant frequencies for 120 h per number of resonances. If no resonances are detected, the vibration from 5 Hz to 40 Hz shall be continued for 120 h.

**7.16.3** After vibration, each sprinkler shall be subjected to the leak resistance requirement of 6.8.1 and the functional test of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only.

#### 7.17 Impact test (see 6.17)

Five sprinklers shall be impact-tested by dropping a mass onto the deflector end of the sprinkler along the axial centreline of the waterway. Sprinklers provided with shipping caps, which are intended for removal only after completion of the sprinkler installation, shall be impact-tested with the caps in place. The kinetic energy of the dropped mass at the point of impact shall be equivalent to a mass equal to that of the test sprinkler dropped from a height of 1 m; see Figure 8. The dropped mass shall be prevented from impacting more than once upon each sample.

Dimensions in millimetres (inches)



**Key**

- 1 cold drawn seamless steel tuning, ID 14,1  $_{-0,13}^0$  (0,56  $_{-0,005}^0$ )
- 2 mass (see detail "A")
- 3 latching pin
- 4 adjustable brackets (2)
- 5 rigid support
- 6 nozzle support, diameter 165 (6,5), ANSI C1018 cold finished steel

<sup>a</sup> Length is determined as a function of the required mass; 12,70 (0,5), C 1018 cold finished steel.

<sup>b</sup> Break corner 0,06 × 45° (0,002 0 × 45°).

**Figure 8 — Impact apparatus**

## 7.18 Fire test (see 6.18)

**7.18.1** Residential sprinklers in each temperature rating are to be subjected to the tests specified in 7.18.2 through 7.18.21.

**7.18.2** The test room dimensions for upright, pendent, flush, recessed and concealed sprinklers shall be the maximum sprinkler coverage width by twice the maximum sprinkler coverage length by a 2,4 m high ceiling. The test room dimensions for sidewall sprinklers shall be the maximum sprinkler coverage length by 1 1/2 times the maximum sprinkler coverage width plus a 2,7 m × 2,4 m high ceiling. For each test, new acoustical panels shall be installed in the 1,2 m × 1,2 m area directly over the fire source.

**7.18.3** The test room ceiling shall be covered with cellulosic acoustical panels or gypsum board, attached to furring strips. The acoustical panels shall measure 600 mm × 1 200 mm, × 12,7 mm thick, shall have a density of  $(216 \pm 24)$  kg/m<sup>3</sup>, and shall have a maximum flame spread index rating of 25.

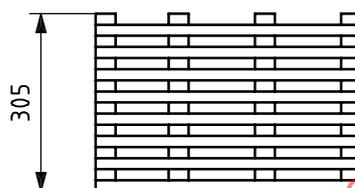
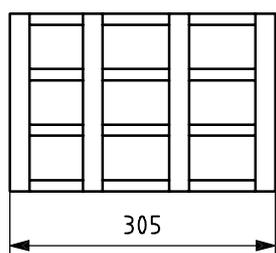
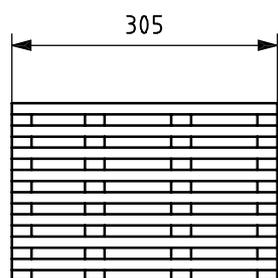
**7.18.4** The test room shall have provision for ventilation through two door openings on opposite test room walls. Each opening shall be 2,2 m high, which provides for a 200 mm lintel above the openings. The door widths shall be as specified in Figures 1 through 3.

**7.18.5** Douglas fir 3-ply panels measuring 1,2 m × 2,4 m shall be placed on two of the test room walls extending out 1,2 m from a common corner. The panels shall be approximately 6,4 mm thick. The plywood panels shall be conditioned at  $(21 \pm 3)$  °C and  $(50 \pm 10)$  % relative humidity for at least 72 h prior to the test. They shall be placed on the walls by being attached to 12,7 mm thick wood furring strips. The Douglas fir plywood panels shall have the burning characteristic properties specified in Table 5.

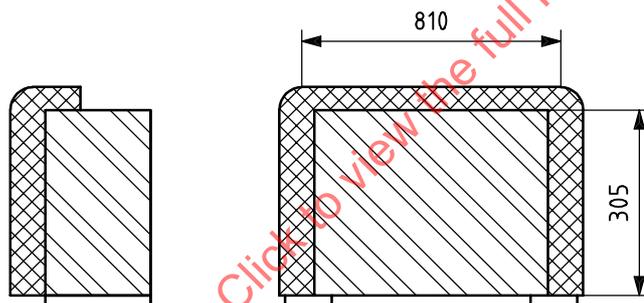
**Table 5 — Test methods**

Property	Test Method	Range
Flame spread index	ANSI/UL 723:1993	130 ± 30
Critical heat flux	ISO 5660-1:2002	15 ± 3 kW/m <sup>2</sup>
Thermal response parameter	ISO 5660-1:2002	220 ± 50 kW·(s <sup>1/2</sup> ) m <sup>2</sup>

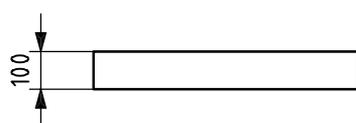
**7.18.6** The fire source is to consist of a wood crib and simulated furniture. The wood crib is ignited with a pan of heptane and the simulated furniture is ignited using two 150 mm long by 6,4 mm diameter cotton wicks soaked in heptane (see Figure 1 for pendent or upright sprinklers and Figures 2 and 3 for sidewall sprinklers) for placement of the fire source. See Figure 9 for details of the fuel package.



a) Wood crib



b) Simulated furniture



c) Test pan

Figure 9 — Fire test crib and simulated furniture fuel package

**7.18.7** The heptane shall be commercial grade having the following distillation characteristics:

— initial boiling point	90 °C;
— 50 %	93 °C;
— dry point	96,5 °C;
— specific gravity, 15,6 °C/15,6 °C (60 °F/60 °F)	0,719;
— Reid vapour pressure	0,015 MPa (0,15 bar);
— Research octane rating	60;
— Motor octane rating	60.

**7.18.8** The wood crib is to weigh 2,5 kg to 3,2 kg and is to be dimensioned 305 mm × 305 mm × 152 mm high. The crib is to consist of four alternate layers of four trade size 38,1 mm × 38,1 mm kiln-dried spruce or fir lumber 305 mm long. The alternate layers of the lumber are to be placed at right angles to the adjacent layers. The individual wood members in each layer are to be evenly spaced along the length of the previous layer of wood members and stapled.

**7.18.9** After the wood crib is assembled, it is to be conditioned at a temperature of  $104 \pm 5$  °C for not less than 24 h or more than 72 h. Following the conditioning, the crib is to be placed in a plastic bag and stored at room temperature for at least 4 h before being used in a test. The wood crib is to be placed on top of a nominal 300 mm × 200 mm × 100 mm high, 6 mm thick, steel test pan positioned on the floor in a corner of the test enclosure. The wood crib is to be positioned 5 mm from each wall.

**7.18.10** The simulated furniture is to consist of two 76 mm thick uncovered pure polypropylene oxide polyol, polyether foam cushions having a density of 27,2 to 30,4 kg/m<sup>3</sup> measuring 810 mm × 760 mm. The polyether foam shall have the following burning characteristic properties, average of five samples, when tested in accordance with ISO 5660-1 at a 30 kW/m<sup>2</sup> heat flux:

— peak heat release rate (HRR):	$230 \pm 50$ kW/m <sup>2</sup> ;
— Heat of Combustion:	$22 \pm 3$ kJ/g.

**7.18.11** Each foam cushion is to be glued to a 840 mm × 790 mm × 12,7 mm thick plywood backing using an aerosol urethane foam adhesive. The foam pad is glued to the plywood backing leaving a 12,7 mm space on both sides and a 25 mm space along the bottom. The foam cushion and plywood backing assembly shall be conditioned at  $21 \text{ °C} \pm 2,8 \text{ °C}$  and  $(50 \pm 10)$  % relative humidity for at least 24 h prior to test. The foam and plywood backing assembly is to be placed in a steel frame to provide support for holding each assembly in the vertical orientation. The entire fire test package is to be placed on top of a nominal 6 mm thick cement board sheathing or equivalent noncombustible sheathing material having dimensions of 1,2 m × 1,2 m. For each test, new or dried sheathing shall be used.

**7.18.12** Three domestic sprinklers are to be installed in the test room for each fire test. Two are to be installed at their maximum length and width coverage dimensions, and the third is to be installed near the doorway farthest from the fire; see Figures 1 through 3. Pendent and upright sprinklers are to be installed with their deflectors located 76 mm below the ceiling unless another distance is specified in the installation instructions. Flush and concealed sprinklers are to be installed in their intended location as specified in the manufacturers installation instructions. Sidewall sprinklers are to be installed with their deflectors located 100 mm below the ceiling or at the maximum distance below the ceiling as specified in the installation instructions if the maximum exceeds 152 mm below the ceiling; see 7.18.14 for sprinkler pipe sizes.

**7.18.13** The domestic sprinklers are to be installed in pipe fittings having a 25 mm inlet and an outlet the same size as the sprinkler inlet, and are to be supplied with water through 25 mm piping. Pendent, upright, flush, recessed pendent and concealed sprinklers are to be tested in two orientations. One test is to be conducted such that the sprinkler frame arms or deflector pins are parallel to the short wall and a second test is to be conducted with the sprinkler frame arms or deflector pins rotated 90°.

**7.18.14** Recessed and concealed sprinklers having vented escutcheons are to be installed and tested in a manner that does not inhibit air flow through the escutcheons (unblocked) and tested in a manner that does inhibit air flow through the escutcheons (blocked) by placing a 910 mm × 390 mm × 200 mm R-25 fiberglass, or equivalent, insulating batt over the sprinkler.

**7.18.15** The test room is to have an ambient temperature of  $(27 \pm 3)$  °C measured at the thermocouple located 76 mm below the ceiling. All water from previous testing shall be removed such that there is no visible water on the floor, ceiling or walls.

**7.18.16** The temperatures at each thermocouple location shall be continuously recorded during the test using 0,8 mm diameter chromel-alumel thermocouples or thermocouples providing equivalent temperature measuring results. The thermocouples shall be shielded from impingement of water from the sprinklers.

**7.18.17** The wood crib shall be ignited with a pan of heptane and the simulated furniture is to be ignited with two 150 mm long by 6,4 mm diameter cotton wicks soaked in heptane. One half liter of water and 0,25 l of heptane shall be placed in the pan directly below the wood crib. The heptane in the pan located beneath the crib shall be ignited and the heptane soaked cotton wicks shall be ignited immediately following the heptane pan ignition.

**7.18.18** The fire test shall be conducted for 30 min after the ignition of the wood crib, unless after 10 min, all the combustibles are extinguished or only the wood crib is sustaining combustion at which point the test shall be terminated. The minimum water flow rate for the area coverage determined in 7.18.13 shall be the same for single and multiple operating sprinklers as specified in the manufacturers installation instructions.

**7.18.19** Pendent or upright sprinklers shall be subjected to the fire test arrangement shown in Figure 1, and sidewall sprinklers shall be subjected to both fire test arrangements shown in Figures 2 and 3.

**7.18.20** When sprinkler coverage areas exceed 3,6 m × 3,6 m, and the sprinkler has not been investigated for a 3,6 m × 3,6 m area using the same or a lesser flow rate as the next larger rated coverage area, the test specified in 7.18.1 through 7.18.20 shall be repeated in a room size corresponding to a 3,6 m × 3,6 m coverage area, using a water flow rate corresponding to the minimum flow rate required for the next larger coverage area.

## **7.19 Lateral discharge test (see 6.19)**

**7.19.1** While discharging water at a service pressure of 0,69 MPa (6,9 bar), an open domestic sprinkler shall not prevent the operation of a 57 °C to 77 °C temperature rated domestic sprinkler of the same type located 2,4 m distant on an adjacent pipeline in the same horizontal plane.

**7.19.2** A domestic sprinkler having a nominal release temperature of 57 °C to 77 °C shall be installed on piping 2,4 m distant (centre-to-centre) from a second open sprinkler of the same type. The sprinkler deflectors shall be located at the minimum and maximum distances below the ceiling that are permitted in the manufacturer installation instructions. Water shall be discharged from the open sprinkler at a service pressure of 0,69 MPa (6,9 bar). After water flow is established, the automatic sprinkler shall be exposed to the heat and flame from a 300-mm square pan that is 100 mm deep containing 0,47 l of heptane. The top of the pan shall be located 150 mm below the heat-responsive element. In all test conditions, the domestic sprinkler shall operate before the heptane is consumed.

**7.19.3** For sprinklers other than sidewall type, the test shall be repeated with the sprinkler frame arms rotated 90°.

## **7.20 30-day leakage test (see 6.20)**

Five sprinklers are to be installed on a water-filled test line maintained under a constant pressure of 2,0 MPa (20 bar) for 30 d at an ambient temperature of  $(20 \pm 5)$  °C.

The sprinklers shall be inspected visually at least weekly for leakage. Following completion of this 30-d test, all samples shall meet the leak-resistance requirements specified in 6.8.1. Examine all samples to verify that there is no evidence of distortion or other mechanical damage.

### 7.21 Vacuum test (see 6.21)

Five sprinklers shall be subjected to a gradually increasing vacuum of up to 460 mm of mercury applied to the sprinkler inlet for 1 min at an ambient temperature of  $(20 \pm 5) ^\circ\text{C}$ . Following this test, each sample shall be examined to verify that no distortion or mechanical damage has occurred and then shall meet the leak resistance requirements specified in 6.8.1.

### 7.22 Room response (see 6.22)

**7.22.1** Recessed and concealed sprinklers having vented escutcheons are to be installed and tested in a manner that will not inhibit airflow through the escutcheons (unblocked) and in a manner that will inhibit airflow through the escutcheons (blocked). A recessed or concealed sprinkler indicated in the installation instructions as being unvented is to be installed and tested in a manner that will inhibit airflow through the escutcheon (blocked).

**7.22.2** Sprinklers of each type shall be installed in a test room in the following position and orientation.

- a) For pendent- and ceiling-type sprinkler designs without frame arms and incorporating symmetrical heat-responsive elements and symmetrical sprinkler bodies, 10 samples shall be installed in their intended position at the ceiling.
- b) For pendent- and ceiling-type sprinkler designs with or without frame arms and incorporating unsymmetrical heat-responsive elements, 10 samples shall be oriented with the heat-responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source. The samples shall be in their intended position.
- c) For pendent- and ceiling-type sprinkler designs incorporating frame arms with symmetrical heat-responsive elements, 10 samples shall be orientated with the frame arms in a plane parallel to the direction of the fire source. The samples are to be installed in their intended position.
- d) For upright sprinklers having configurations referenced in items a), b), and c), 10 samples shall be installed in their pendent positions.
- e) For sidewall sprinkler designs, 10 samples are to be installed in their intended position with the deflector located below the ceiling.

**7.22.3** The sprinkler shall be mounted as specified in 7.22.2 on a ceiling or a wall of a closed  $4,6 \text{ m} \times 4,6 \text{ m}$  room having a  $2,4 \text{ m}$  high ceiling. The sprinkler inlet waterway shall be filled with water having a temperature of  $(21 \pm 1,6) ^\circ\text{C}$ . The water shall be pressurized to  $(0,03 \pm 0,003) \text{ MPa}$  [ $(0,3 \pm 0,03) \text{ bar}$ ].

**7.22.4** The fire source is to consist of a  $300 \text{ mm} \times 300 \text{ mm} \times 300 \text{ mm}$  sand burner located in one corner of the room with a flow of natural gas or methane of  $14,6 \text{ m}^3/\text{h}$ . A pendent-, upright-, or ceiling-type sprinkler is to be installed along a diagonal line on the ceiling at a distance of  $5,1 \text{ m}$  from the corner of the room where the sand burner is located. A sidewall sprinkler is to be installed on the midpoint of a wall opposite the corner having the sand burner. The gas burner shall be ignited when the ambient temperature has been reduced from a preheated room condition to  $(31 \pm 1) ^\circ\text{C}$ , as measured in the centre of the room  $25 \text{ mm}$  below the ceiling. The operation time of the sprinkler is to be recorded starting with ignition of the burner.

### 7.23 Freezing test (see 6.23)

Five samples shall be individually attached to one end of a  $100 \text{ mm}$  length of  $5 \text{ mm}$  nominal diameter steel pipe using an appropriate fitting. A pipe coupling shall be attached to the opposite end of each pipe. Each assembly shall then be filled to capacity with water and sealed using a pipe plug. The assemblies shall be exposed to a temperature of  $(-30 \pm 5) ^\circ\text{C}$  for a period of  $24 \text{ h}$ . After the freezer test, each sprinkler shall meet the requirements of 6.23.

## 8 Installation instructions

8.1 Each carton of domestic sprinklers shall be provided with the manufacturer's design and installation instructions that shall include the following:

- a) coverage area dimensions;
- b) minimum water discharge rate (see 8.2);
- c) flow constant;
- d) minimum distance between sprinklers when the minimum distance exceeds 2,4 m;
- e) installation position;
- f) maximum and minimum distances of sprinkler deflector from ceiling and/or wall;
- g) venting requirements for recessed and concealed domestic sprinklers, if appropriate; and
- h) sprinkler identification marking.

8.2 The minimum specified water discharge rates in 8.1 b) shall not be less than those specified in Table 6. The minimum flow rating for a sprinkler shall be the same for single and multiple sprinklers.

**Table 6 — Minimum rated sprinkler flow rates**

Upright, pendent, recessed pendent, flush, and concealed sprinklers		Sidewall sprinklers <sup>a</sup>	
Spacing m	Minimum flow l/min	Spacing m	Minimum flow l/min
3,7 × 3,7	28	3,7 × 3,7	28
4,3 × 4,3	37	4,3 × 4,3	37
4,9 × 4,9	49	4,9 × 4,9	49
5,5 × 5,5	62	5,5 × 5,5	62
6,1 × 6,1	76	6,1 × 6,1	76
		4,9 × 5,5	55
		4,9 × 6,1	61
		5,5 × 6,1	69

<sup>a</sup> The minimum rated flow for a sidewall sprinkler spacing other than those specified in this table shall not be less than a flow correlating to a 2mm/min discharge density.

## 9 Marking

### 9.1 Sprinklers

Each sprinkler shall be permanently marked on a non-operating part as follows.

- a) Sprinkler identification: All sprinklers shall be permanently marked with a one or two character manufacturer symbol, followed by up to four numbers, so as to identify a unique model of sprinkler for every change in orifice size or shape, deflector characteristic, thermal sensitivity, or pressure rating. The manufacturer symbol shall be registered.

NOTE One such registration site is <http://www.sprinklernet.org>.