
**Fire protection — Automatic sprinkler
systems —**

**Part 13:
Requirements and test methods for
extended-coverage sprinklers**

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

*Partie 13: Prescriptions et méthodes d'essai des sprinklers couvrant
une surface plus étendue que la normale*



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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 5, *Fixed firefighting systems using water*.

A list of all parts in the ISO 6182 series can be found on the ISO website.

Introduction

Extended coverage sprinklers are intended provide fire control in occupancies or portions of occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected. Examples of occupancies where these sprinklers may be installed include offices, restaurant seating areas, educational facilities and other areas having similar fire challenges.

These sprinklers have a relatively flat spray pattern compared to the sprinklers described in ISO 6182-1. This allows the sprinklers to effectively distribute water over a larger area; thus permitting the sprinklers to be spaced greater distances from each other, as well as from the walls of the compartment. Obstructions can pose a greater challenge to extended coverage sprinklers because of the flat spray pattern. Extended coverage sprinkler installation guidelines need to account for the flat spray pattern when considering the distances between obstructions and the sprinkler.

Product standards, such as this one, can provide a minimum level of safety in the built environment, as well as a level of quality to the products on the market.

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Fire protection — Automatic sprinkler systems —

Part 13:

Requirements and test methods for extended-coverage sprinklers

1 Scope

This document specifies performance and marking requirements and test methods for extended coverage sprinklers.

These sprinklers are intended to provide control of fires in occupancies or portions of occupancies where quantity and/or combustibility of contents is low such as office spaces.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 points are made on the threads — Part 1: Dimensions, tolerances and designation*

ASTM G36, *Standard Practice for Evaluating Stress-Corrosion-Cracking Resistance of Metals and Alloys in a Boiling Magnesium Chloride Solution*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 General

3.1.1 assembly load

force exerted on the sprinkler body excluding hydrostatic pressure

3.1.2

average design strength

glass bulb supplier's specified lowest average axial design strength of any batch of 50 bulbs

3.1.3

design load

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

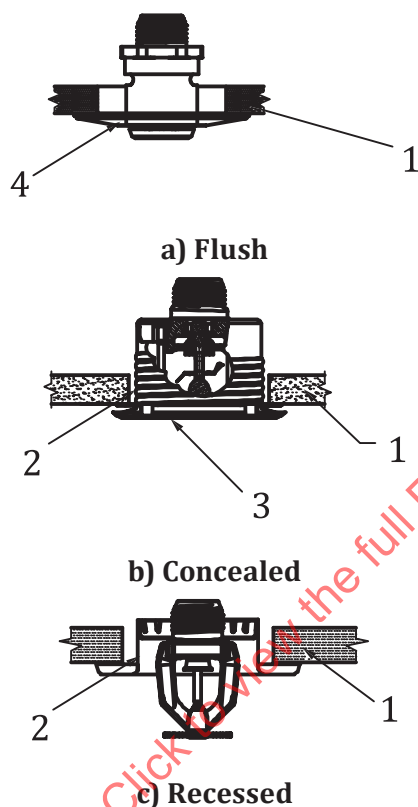
3.1.4

housing assembly/escutcheon

ornamental or protective component(s) around the hole from which the sprinkler penetrates the plane of the ceiling or the wall

Note 1 to entry: See [Figure 1](#).

Note 2 to entry: For the purposes of this document, housing applies to recessed and concealed sprinklers.



Key

- 1 ceiling
- 2 housing assembly
- 3 cover plate
- 4 escutcheon

Figure 1 — Concealed, recessed, flush

3.1.5

protective covering

protective caps or straps intended to provide temporary protection for sprinklers during shipping, handling and installation

3.1.6

response time index, RTI

measure of sprinkler sensitivity

$$RTI = t\sqrt{u}$$

where

t is equal to the time constant, expressed in seconds, of the heat-responsive element;

u is the gas velocity, expressed in meters per second.

Note 1 to entry: The response time index is expressed in units of $(\text{m}\cdot\text{s})^{0,5}$.

3.1.7

service load

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

3.1.8

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

3.1.8.1

extended coverage sprinkler

sprinkler having a specified area of coverage larger than 21 m²

Note 1 to entry: See 3.3 for additional detail.

Note 2 to entry: For the purposes of this document, sprinkler is intended to refer to extended coverage sprinklers.

3.1.9

standard orientation

orientation that produces the shortest response time with the axis of the sprinkler inlet perpendicular to the air flow

Note 1 to entry: In the case of symmetrical heat-responsive elements, standard orientation is with the air flow perpendicular to both the axis of the waterway and the plane of the frame arms. In the case of non-symmetrical heat-responsive elements, it is with the air flow perpendicular to both the waterway axis and the plane of the frame arms which produces the shortest response time.

3.2 Types of sprinkler 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 through pressure resulting from expansion of the fluid enclosed therein

3.3 Types of sprinkler according to position

3.3.1

pendent extended coverage sprinkler

extended coverage sprinkler that is arranged in such a way that the water stream is directed initially downwards against the deflector

Note 1 to entry: This sprinkler has a square area of coverage not exceeding 36 m² with sprinkler spacings in 0,5 m increments. The maximum spacing between sprinklers is 6,0 m.

3.3.2

sidewall extended coverage sprinkler

extended coverage sprinkler giving a one-sided (half-paraboloid) water distribution over a definite protection area

Note 1 to entry: The axis of the sprinkler waterway may be either horizontal or vertical. This sprinkler has an area of coverage not exceeding 36 m², with sprinkler spacings in 0,5 m increments, with no dimension exceeding 7 m.

3.3.3

upright extended coverage sprinkler

extended coverage sprinkler that is arranged in such a way that the water stream is directed initially upwards against the deflector

Note 1 to entry: This sprinkler has a square area of coverage not exceeding 36 m² with sprinkler spacings in 0,5 m increments. The maximum spacing between sprinklers is 6,0 m.

3.4 Special types of extended coverage sprinklers

3.4.1

coated sprinkler

sprinkler that has a factory-applied coating for corrosion protection

Note 1 to entry: For this document, coated sprinkler does not include coatings intended for aesthetic purposes.

3.4.2

concealed sprinkler

recessed sprinkler having a cover plate

Note 1 to entry: See [Figure 1](#).

3.4.3

dry sprinkler

assembly comprising of a sprinkler mounted at the outlet of a special extension with a seal at the inlet that prevents water from entering the extension until it is released by operation of the sprinkler

Note 1 to entry: These sprinklers may consist of pendent, sidewall or other types.

3.4.4

flush sprinkler

for pendent sprinklers, all or part of the body is mounted above the lower plane of the ceiling, but all of the heat-responsive collector is below the lower plane of the ceiling

Note 1 to entry: See [Figure 1](#).

Note 2 to entry: For sidewall sprinklers, the sprinkler is within the wall, but the heat-responsive collector projects into the room beyond the plane of the wall.

Note 3 to entry: These are not typically frame arm sprinklers.

3.4.5

recessed sprinkler

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

Note 1 to entry: See [Figure 1](#).

4 Product consistency

4.1 Quality control program

It shall be the responsibility of the manufacturer to implement a quality control program to ensure that production continuously meets the requirements of this document.

4.2 Leak resistance testing

Every manufactured sprinkler shall pass a leak resistance test equivalent to a hydrostatic pressure of at least twice the rated pressure for at least 2 s.

4.3 Glass bulb integrity test

Each glass bulb sprinkler assembly shall be evaluated for glass bulb cracking, breaking, or other damage as indicated by the loss of fluid. The test shall be conducted after the leakage test.

The bubble in each glass bulb shall be examined at room ambient temperature. The sprinkler shall then be heated in a circulating air oven or liquid bath to 5 °C below the minimum operating temperature range of the sprinkler. The bubble shall then be examined to determine the bubble size has been reduced in accordance with the glass bulb manufacturer's specifications. After cooling, the bubble size shall again be examined to determine the bubble returned to the original size within the tolerance allowed by the glass bulb manufacturer.

5 Product assembly

5.1 General

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

This requirement does not apply to units intended for assembly/adjustment on site, e.g. combinations of sprinkler and housing assemblies/escutcheons or the assembly of the cover plate to concealed sprinklers.

5.2 Dynamic O-ring seals

The closure of the water way 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.)

5.3 Rated Pressure

Sprinklers shall have a rated pressure of not less than 1,2 MPa (12 bar).

5.4 Dry Sprinklers

When installed with the intended fittings specified in the manufacturer's installation instructions, dry sprinklers installed in dry systems shall be constructed to minimize the potential to accumulate water, scale, and sediment on the sprinkler inlet. The sprinkler inlet shall also be constructed not to substantially impact the sprinkler k-factor or pressure loss through the fitting.

6 Requirements

6.1 Dimensions

6.1.1 Orifice size

All sprinklers shall be constructed so that a sphere of diameter 8 mm can pass through each water passage in the sprinkler.

6.1.2 Nominal thread sizes

Nominal thread sizes shall be suitable for fittings threaded in accordance with ISO 7-1. The dimensions of all threaded connections should conform to International Standards where applied or shall conform to national standards where International Standards are not applicable.

6.2 Temperature ratings and colour coding

The marked nominal temperature rating and colour coding of sprinkler shall be in accordance with [Table 1](#).

Table 1 — Nominal temperature rating and colour coding

Glass bulb sprinklers		Fusible element sprinklers
Marked nominal temperature rating, °C	Liquid colour code	Marked nominal temperature rating, °C
57	orange	57 to 77
68	red	
79	yellow	80 to 107
93, 107	green	
121, 141	blue	121 to 149

6.3 Operating temperature (see [7.3](#))

Sprinklers shall be verified to operate within a temperature range given in [Formula \(1\)](#):

$$t = x \pm (0,035x + 0,62) \quad (1)$$

where

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

x is the marked nominal temperature rating (see [Table 1](#)).

6.4 Water flow constant (see [7.4](#))

The flow constant, K , for sprinklers is given in [Formula \(2\)](#):

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

where

p is the pressure, expressed in megapascals (MPa);

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

K-factor for sprinklers according to this document shall be in accordance with [Table 2](#) when determined by the test method given in [7.4](#).

Table 2 — Flow constant requirements

Flow constant K (l/min)/(bar ^{1/2})	Flow constant K for dry sprinklers (l/min)/(bar ^{1/2})
80 ± 4	80 ± 6
115 ± 6	115 ± 9
160 ± 8	160 ± 12
202 ± 10	200 ± 15
NOTE 1 (l/min)/(bar ^{1/2}) = 0,003 2 (m ³ /min)/(MPa ^{1/2}).	

6.5 Water distribution (see 7.5)

6.5.1 When tested as described in 7.5, extended coverage sprinklers shall meet the requirements of 6.5.2 to 6.5.4.

6.5.2 For each test, not more than one pan shall have a collection less than 0,6 mm/min and the pan shall not have a collection less than 0,2 mm/min.

6.5.3 For each test, the average collection of all pans shall be a minimum of 1,6 mm/min.

6.5.4 Coated sprinklers shall be subjected to additional distribution tests if the coating is observed to deform or deteriorate during the dynamic heating test of 6.15.

Table 3 — Distribution testing parameters for upright and pendent sprinklers

Nominal flow constant, K [l/m/(bar) ^{0,5}]	Nominal room dimensions (width × length) (m × m)	Deflector to ceiling distance (mm)	Nominal flow rate (l/min)
80	5,0 × 5,0	100	102
80	5,5 × 5,5	100	123
80	6,0 × 6,0	100	147
115	5,0 × 5,0	100	102
115	5,5 × 5,5	100	123
115	6,0 × 6,0	100	147
160	5,0 × 5,0	100	111
160	5,5 × 5,5	100	123
160	6,0 × 6,0	100	147
202	5,0 × 5,0	100	139
202	5,5 × 5,5	100	139
202	6,0 × 6,0	100	147

Table 4 — Distribution testing parameters for sidewall sprinklers

Nominal flow constant, K [l/m/[(bar) ^{0,5}]	Nominal room dimensions [width × length] (m × m)	Deflector to ceiling distance (mm)	Nominal flow rate (l/min)
80	5,0 × 5,0	100	102
80	5,0 × 5,0	300	102
80	5,0 × 5,5	100	112
80	5,0 × 5,5	300	112
80	5,0 × 6,0	100	122
80	5,0 × 6,0	300	122
115	5,0 × 5,0	100	127
115	5,0 × 5,0	300	127
115	5,0 × 5,5	100	140
115	5,0 × 5,5	300	140
115	5,0 × 6,0	100	153
115	5,0 × 6,0	300	153
115	5,0 × 6,5	100	165
115	5,0 × 6,5	300	165
115	5,0 × 7,0	100	178
115	5,0 × 7,0	300	178

6.6 Function (see 7.6)

6.6.1 Lodgement (see 7.6.1)

When tested in accordance with 7.6.1, the sprinkler shall open and, any lodgement of released parts shall be cleared within 10 s of release of the heat-responsive element.

6.6.2 Deflector strength (see 7.6.2)

The deflector and its supporting parts shall not sustain significant damage as a result of the deflector strength test specified in 7.6.2.

If minor damage is noted, testing in accordance with 6.5 can be done to demonstrate compliance.

NOTE In most instances, visual examination of the sprinkler will be sufficient to establish conformance with 6.6.2

6.7 Service load and strength of sprinkler body (see 7.7)

6.7.1 The sprinkler body shall comply with the requirements of 6.7.1.1 or 6.7.1.2.

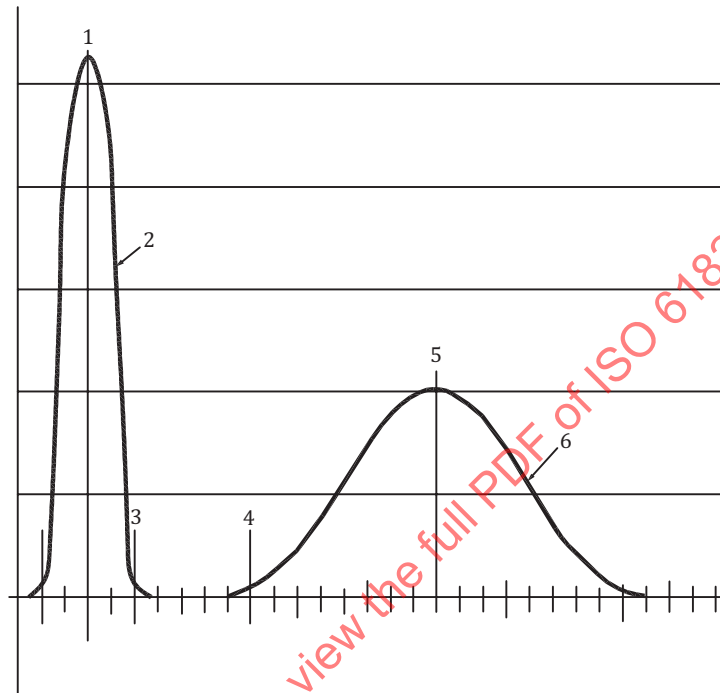
6.7.1.1 The sprinkler body shall not show permanent elongation of more than 0,2 % between the load-bearing points of the sprinkler body after being subjected to twice the service load as measured according to 7.7.1 or 7.7.2.

6.7.1.2 The sprinkler body shall not show permanent elongation of more than 50 % of the sprinkler body with the design load being applied after being subjected to twice the assembly load as measured according to 7.7.3.

6.7.2 The manufacturer shall specify the average and upper limit of the service or assembly load.

6.8 Strength of heat-responsive element (see 7.8)

6.8.1 When tested in accordance with 7.8.1, glass bulb elements shall have a design strength lower tolerance limit (LTL) on the strength distribution curve of at least twice the upper tolerance limit (UTL) of the service load distribution curve, based on calculations with a degree of confidence (γ) of 0,99 for 99 % of samples (P), based on normal or Gaussian distribution except where other distribution can be shown to be more applicable due to manufacturing or design factors (see Figure 2).



Key

- 1 average service load
- 2 service load curve
- 3 UTL
- 4 LTL
- 5 average design strength
- 6 design strength curve

Figure 2 — Strength curve

6.8.2 A fusible heat-responsive element in the ordinary temperature range shall be designed to:

- a) sustain a load of 15 times its design load corresponding to the maximum service load measured according to 7.8 for a period of 100 h when tested in accordance with 7.8.2.1, or
- b) demonstrate the ability to sustain the design load when tested in accordance with 7.8.2.2 (see Annex A).

6.9 Leak resistance and hydrostatic strength (see 7.9)

6.9.1 A sprinkler shall not show any sign of leakage when tested according to 7.9.1.

6.9.2 A sprinkler shall not rupture, operate or release any parts when tested according to 7.9.2.

6.10 Heat exposure (see 7.10)

6.10.1 Glass bulb sprinklers

There shall be no damage to the glass bulb element when the sprinkler is tested according to 7.10.1.

6.10.2 Uncoated sprinklers

Sprinklers shall withstand exposure to increased ambient temperature without evidence of weakness or failure when tested according to 7.10.2.

6.10.3 Coated sprinklers

In addition to meeting the requirement of 6.10.2 in an uncoated version, coated sprinklers shall withstand exposure to increased ambient temperatures without evidence of weakness or failure of the coating when tested according to 7.10.3.

6.11 Thermal shock for glass bulb sprinklers (see 7.11)

Glass bulb sprinklers shall not be damaged when tested according to 7.11. Following the thermal shock exposure, the sprinkler shall comply with 6.6.1 when tested with an inlet pressure of 0,035 MPa (0,35 bar).

6.12 Corrosion

6.12.1 Stress corrosion for copper-based alloy components (see 7.12.1)

When tested in accordance with 7.12.1, each sprinkler shall not show any cracks, signs of delamination or failure that can affect its ability to function as intended.

6.12.2 Sulfur dioxide/carbon dioxide corrosion (see 7.12.2)

NOTE In some countries, this test is not mandatory.

Coated and uncoated sprinklers shall be resistant to sulfur dioxide/carbon dioxide saturated with water vapour when conditioned in accordance with 7.12.2.

Following exposure, glass bulb sprinkler samples shall either be

- a) tested at 0,035 MPa (0,35 bar) in accordance with 6.6.1, or
- b) meet the requirements of 6.25 for concealed and recessed sprinklers or the requirements of 6.15.2 for other types of sprinklers.

Following exposure, half of the fusible element sprinkler samples shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with 6.6.1 and the remaining samples shall meet the requirements of 6.25 for concealed and recessed sprinklers or the requirements of 6.15.2 for other types of sprinklers

6.12.3 Hydrogen sulfide corrosion (see 7.12.3)

Coated and uncoated sprinklers shall be resistant to hydrogen sulfide saturated with water vapour when conditioned in accordance with 7.12.3.

Following exposure, glass bulb sprinkler samples shall either be

- a) tested at 0,035 MPa (0,35 bar) in accordance with 6.6.1, or

- b) meet the requirements of [6.25](#) for concealed and recessed sprinklers or the requirements of [6.15.2](#) for other types of sprinklers.

Following exposure, half of the fusible element sprinkler samples shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with [6.6.1](#) and the remaining samples shall meet the requirements of [6.25](#) for concealed and recessed sprinklers or the requirements of [6.15.2](#) for other types of sprinklers.

6.12.4 Salt spray loading (see [7.12.4](#))

NOTE In some countries, the salt spray corrosion test ([6.12.6](#)) is conducted instead of the salt spray loading test.

Coated and uncoated sprinklers shall be resistant to salt spray when conditioned in accordance with [7.12.4](#).

Following exposure, glass bulb sprinkler samples shall either be

- a) tested at 0,035 MPa (0,35 bar) in accordance with [6.6.1](#), or
- b) meet the requirements of [6.25](#) for concealed and recessed sprinklers or the requirements of [6.15.2](#) for other types of sprinklers.

Following exposure, half of the fusible element sprinkler samples shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with [6.6.1](#) and the remaining samples shall meet the requirements of [6.25](#) for concealed and recessed sprinklers or the requirements of [6.15.2](#) for other types of sprinklers.

6.12.5 Moist air exposure (see [7.12.5](#))

Sprinklers shall be resistant to moist air exposure when tested in accordance with [7.12.5](#). Following exposure, the sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with [6.6.1](#).

6.12.6 Stainless Steel Components (See [7.12.6](#))

Sprinklers having components consisting of stainless steel alloys shall be subjected to [7.30](#). The stainless steel components shall not show evidence of fracture, distortion or impending separation from the frame unless tested as described in [7.12.6.1.3](#).

NOTE In some countries, this test is not mandatory.

6.13 Coated sprinklers (see [7.13](#))

6.13.1 Evaporation of wax and bitumen

Waxes and bitumens used for coating sprinklers shall not contain volatile matter in quantities sufficient to cause shrinkage, hardening, cracking or flaking of the applied coating. The loss in mass shall not exceed 5 % of that of the original sample when tested according to [7.13.1](#).

6.13.2 Resistance to low temperatures

All coatings used for sprinklers shall not crack or flake when subjected to low temperatures in accordance with [7.13.2](#).

6.14 Water hammer (see [7.14](#))

Sprinklers shall not leak during or after the pressure surges described in [7.14](#). After being subjected to the test according to [7.14](#), they shall show no signs of mechanical damage, shall meet the requirement of

[6.9.1](#) and shall operate when functionally tested to the requirements of [6.6.1](#) at a pressure of 0,035 MPa (0,35 bar) only.

6.15 Dynamic heating test (see [7.15](#))

6.15.1 Plunge Test

Extended coverage sprinklers shall meet an RTI of $50 \text{ (m}\cdot\text{s)}^{1/2}$ or less.

For concealed and recessed sprinklers, see [6.25](#).

6.15.2 Post-exposure RTI

After exposure to the corrosion test according to [6.12.2](#), [6.12.3](#), and [6.12.4](#), sprinklers shall be tested in the standard orientation in accordance with [7.15.1](#) to determine the post-exposure RTI. All post-exposure RTI values shall be calculated as in [7.15.1](#). The values determined shall meet one of the following:

- a) none of the post-exposure RTI values shall exceed the limits of [6.15.1](#), or
- b) the average RTI value shall not exceed 130 % of the pre-exposure average value.

6.16 Resistance to heat (see [7.16](#))

Open sprinklers shall be resistant to high temperatures when tested in accordance with [7.16](#). After exposure, the sprinkler shall not fracture or break. If visual deformation is observed on the sprinkler orifice, it shall meet the requirements of [6.4](#). If visual deformation is observed on the sprinkler frame or deflector, it shall meet the requirements of [6.5](#).

6.17 Vibration (see [7.17](#))

Sprinklers shall be able to withstand the effects of vibration without deterioration when tested in accordance with [7.17](#). After the vibration test of [7.17](#), sprinklers shall show no visible deterioration and shall meet the requirements of [6.9.1](#) and [6.15.1](#).

6.18 Impact (see [7.18](#))

6.18.1 Sprinklers shall show no fracture or deformation, and shall meet the requirements of [6.9.1](#) and [6.15.1](#) after the impact test of [7.18](#). If the sprinkler is deformed during testing, water distribution testing in accordance with [6.5](#) shall be required.

6.19 Rough usage (see [7.19](#))

A sprinkler shall withstand the effects of rough usage without deterioration of its performance characteristics. Following 3 min of tumbling as described in [7.19](#), the sprinkler shall comply with the leak requirement of [6.9.1](#) and the requirement of [6.15.1](#), or in accordance with [6.25](#), the requirement for recessed and concealed sprinklers.

6.20 Lateral discharge (see [7.20](#))

Upright and pendent spray sprinklers and sidewall sprinklers shall not prevent the operation of adjacent sprinklers when tested in accordance with [7.20](#).

6.21 Wall wetting (see [7.21](#))

When installed as specified by the manufacturer and tested as described in [7.21](#), each extended coverage sprinkler shall wet the wall surfaces of the test area to a height within 1,5 m of the ceiling.

6.22 Room fires (see 7.22)

When tested as described in 7.22, an extended coverage sprinkler shall limit the average loss of weight of three wood cribs to not more than 35 %.

6.23 Thirty-day leakage resistance (see 7.23)

When tested in accordance with 7.23 sprinklers shall not leak or sustain any mechanical damage. Following exposure, the sprinklers shall meet the requirement of 6.9.1.

6.24 Vacuum resistance (see 7.24)

Sprinklers shall not exhibit distortion or mechanical damage and shall meet the leakage requirements of 6.9.1 after being subjected to the test in 7.24.

6.25 Thermal response of extended coverage sprinklers (see 7.25)

6.25.1 Thermal response test (see 7.25)

6.25.1.1 Extended coverage sprinklers including the concealed and recessed types shall meet the requirements of either 6.25.1.2 or 6.25.1.3.

6.25.1.2 When tested in accordance with 7.25.1 to 7.25.5, extended coverage sprinklers shall operate within 75 s or less.

6.25.1.3 When tested in accordance with 7.25.6 and 7.25.7, concealed and recessed sprinklers shall operate such that the mean response time of three samples tested at each of the test conditions specified in Table 6 does not exceed the maximum response time ($t_{\max}$) calculated utilizing Formula (3):

$$t_{\max} = RTI \times \ln \left[1 - \Delta T_{\text{ea}} / \Delta T_g \right] / \sqrt{u} \quad (3)$$

where

$t_{\max}$ is the maximum permitted response time, expressed in seconds;

RTI is the maximum permitted RTI taken from Table 5;

u is the gas velocity in the test section of the tunnel, expressed in meters per second (m/s), taken from Table 6;

ΔT_{ea} is the temperature difference, expressed in degrees Celsius (°C), between the maximum permitted operating temperature of the sprinkler, in accordance with 6.3, and the ambient temperature;

ΔT_g is the temperature difference, expressed in degrees Celsius (°C), between the gas temperature in the test section of the tunnel, taken from Table 6, and the ambient temperature.

Table 5 — Maximum permitted RTI

RTI (m-s) ^{0,5}	Offset angle (°)
50	0
125	25

Table 6 — Dynamic heating test apparatus conditions for concealed and recessed sprinklers

Gas temperature °C	Gas velocity m/s	Applied vacuum mm Hg ^a
135	2,6	0,007
135	3,5	0,007
197	2,6	0,010
197	3,5	0,010
^a 1 mm Hg = 133,322 4 Pa.		

6.25.1.4 After exposure to the corrosion test according to 6.12.2, 6.12.3, and 6.12.4, sprinklers shall be tested in accordance with 7.25. The mean time of operation after exposure shall be equal to or less than a 1,30 multiple of the mean time of operation of sprinklers not subjected to the corrosion test.

6.26 Freezing test (see 7.26)

Sprinklers shall be resistant to low temperatures when tested in accordance with 7.26. After exposure, the sprinkler shall either be visibly damaged, leak subsequent to thawing at a pressure not exceeding 0,05 MPa (0,5 bar), or be undamaged. Sprinklers not visibly damaged or leaking at a pressure not exceeding 0,05 MPa (0,5 bar) shall meet the requirements of 6.9.1 and shall meet the RTI requirements of 6.15.1.

6.27 Dry-type sprinkler deposit loading (see 7.27)

Following exposure to a carbon dioxide-sulfur dioxide atmosphere in accordance with 7.27, the internal components of a dry-type sprinkler shall function as intended when 0,05 Mpa (0,5 bar) air pressure is applied to the sprinkler inlet and the heat responsive element is operated.

6.28 Dry sprinkler air tightness (see 7.28)

When tested as described in 7.28.1 and 7.28.2, the connection of the extension nipple to the inlet seal assembly for a dry-type pendent or sidewall sprinkler shall not exhibit leakage at any air pressure from 0 kPa to 100 kPa (0 bar to 1 bar) when the pressure is applied externally to this connection.

In some countries, this test is not mandatory, although the construction of the connection of the extension nipple to the inlet seal should be air tight.

6.29 Dezincification of Brass Components (see 7.29)

Sprinkler components that are made of a copper alloy containing more than 15 % zinc and normally exposed to system water shall not exhibit the following after exposure to a copper chloride solution for 144 h:

- a) an average dezincification depth exceeding 100 µm;
- b) an individual reading of dezincification depth exceeding 200 µm.

NOTE In some countries, this test is not mandatory.

6.30 Protective Covers (see 7.30)

NOTE In some countries, it is required to use the protective covers as described in this subclause.

6.30.1 Sprinklers may be equipped with protective covers that are designed to remain in place during installation and be removed before the sprinkler system is placed in service.

6.30.2 Glass bulb sprinklers equipped with protective covers shall comply with the impact test for protective covers and marking requirements, [7.30](#) and [8.3](#).

6.30.3 A glass bulb sprinkler, with the protective cover installed, shall not be damaged or leak and the cover shall remain in place when tested as described in [7.30](#).

6.30.4 Protective covers shall be designed not to allow damage to the sprinkler and the heat-sensing element during assembly of the sprinkler, installation of the sprinkler and removal of the cover. Removal shall be possible without tools unless specified by the manufacturer.

7 Test methods

7.1 General

The following tests shall be conducted for each type of sprinkler. Before testing, precise drawings of parts and the assembly shall be submitted together with the appropriate specifications (using SI units). Tests shall be conducted at a room temperature of $(20 \pm 5) ^\circ\text{C}$, 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 B](#) shall apply.

7.2 Examination

7.2.1 Preliminary examination

The construction shall be examined to ensure that it is in accordance with [Clauses 4](#) and [5](#).

7.2.2 Visual examination

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

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

7.3 Operating temperature test (see [6.3](#))

7.3.1 Test of static operation

Ten sprinklers shall be heated from a temperature of $(20 \pm 5) ^\circ\text{C}$ to a temperature of $(20^{+2}_{-0}) ^\circ\text{C}$ below their nominal operating temperature. The rate of increase in temperature shall not exceed $20 ^\circ\text{C}/\text{min}$ and the temperature shall be maintained for 10 min. The temperature shall then be increased at a rate of $(0,5 \pm 0,1) ^\circ\text{C}/\text{min}$ until the sprinkler operates.

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

The test shall be conducted in a liquid bath. Sprinklers having nominal operating temperatures of $\leq 80 ^\circ\text{C}$ 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 totally immersed under a liquid cover of at least 5 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 not be less than 35 mm below the liquid surface level. The temperature deviation within the test zone shall be within $\pm 0,25$ °C.

NOTE It is preferred to have the test zone at (40 ± 5) mm below the liquid surface level.

Any rupture of a glass bulb within the prescribed temperature range constitutes an operation. Partial or complete operation of any heat responsive element within the prescribed temperature range shall constitute an operation. Partial fracture of any glass bulb or incomplete operation of any heat responsive element shall necessitate verification of function through an additional 50 samples being tested in accordance with [7.3.2](#).

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, shall be used to determine temperatures of liquids in bath tests and the operating temperature. The bulb of the thermometer shall be held level with the sprinkler operating parts by a support member. To control the temperature in the thermal bath, a PT100 IEC 60751 resistance thermometer or equivalent, may be used.

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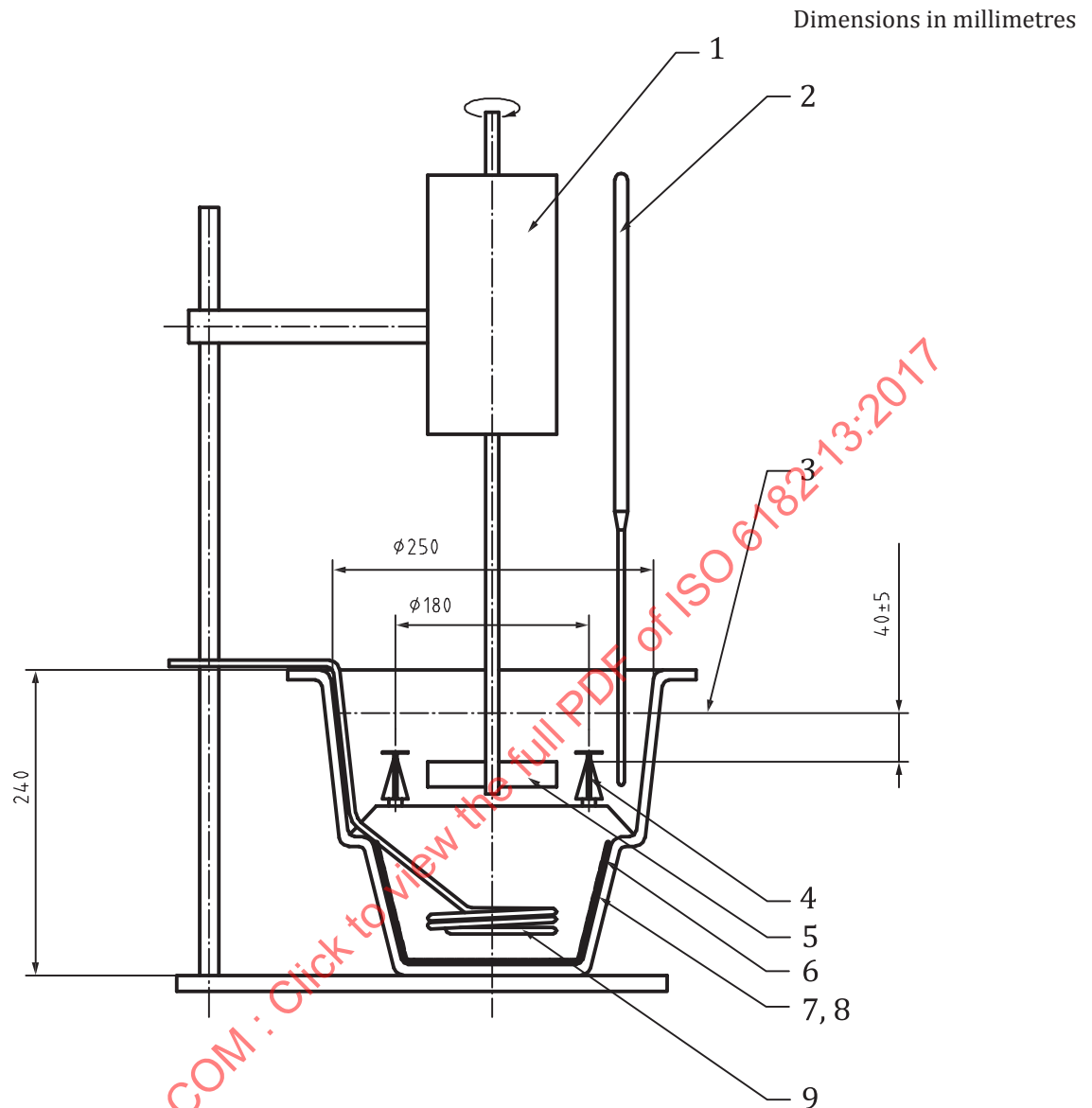


Figure 3 — Example of a liquid bath test apparatus

7.3.2 50 previously untested sprinklers shall be placed on their threaded inlets in a programmable oven circulating air at ambient temperature. The temperature in the oven shall be steadily raised to $(11,1 \pm 1,1) ^\circ\text{C}$ below the nominal temperature rating of the sprinklers over a 20 min period. Once this temperature is reached, the oven shall be maintained at constant temperature for a period of at least 20 min. The temperature shall then be raised at a constant rate of $0,5 ^\circ\text{C} \pm 0,3 ^\circ\text{C}$ per minute until all

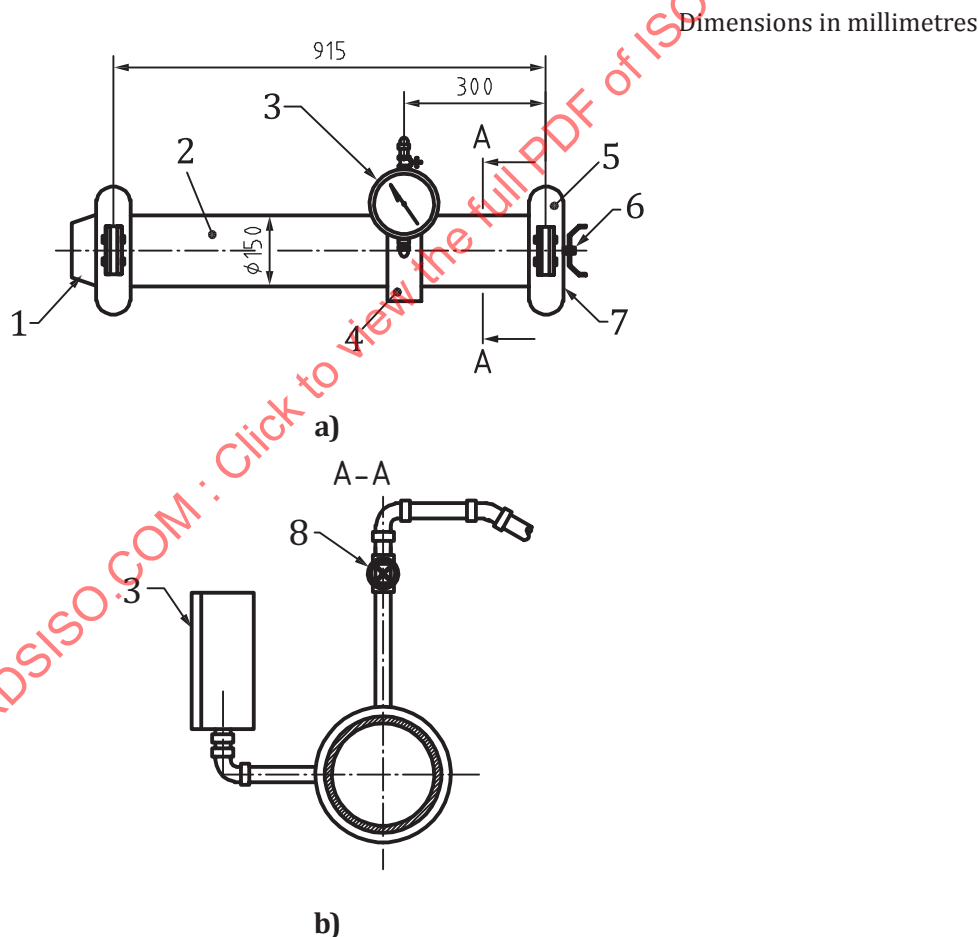
sprinklers operate. Partial fracture of a glass bulb or partial operation of a fusible element, i.e. strutting, shall be deemed a failure.

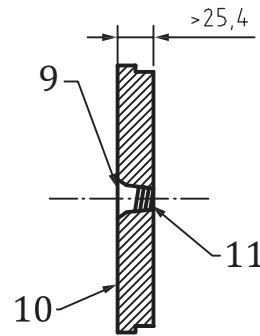
NOTE It is not necessary to meet the operating temperature limits of 6.3 in this test.

7.4 Water flow constant (see 6.4)

The sprinkler shall be mounted with a pressure gauge on a supply pipe an example of which is shown in Figure 4. Four sprinklers shall be tested. The frame arms and deflector of sprinklers shall be removed to facilitate testing. The water flow shall be measured at pressures of 0,10 MPa (1,0 bar) to 0,52 MPa (5,2 bar) less than the rated pressure at intervals of 0,1 MPa (1 bar). In one series of tests, the pressure shall be increased to each interval, and, in the other series, the pressure shall be decreased from 0,52 MPa (5,2 bar) to each interval. The K-factor shall be calculated for each flowing pressure and the K-factor shall be averaged for each series of readings. Each calculated K-factor and the average K-factor for each series shall be within the limits specified in 6.4. During the test, pressures shall be corrected for differences in height between the gauge and the outlet orifice of the sprinkler.

Dry type sprinklers of the shortest and longest lengths manufactured shall be tested.





c) Section of item 7 grooved end cap

Key

- 1 water source inlet
- 2 pipe
- 3 pressure gauge
- 4 piezometer ring
- 5 flexible coupling (typical)
- 6 sprinkler
- 7 grooved end cap
- 8 valve for air relief
- 9 inlet of tapped hole with a nominal 12 mm radius
- 10 flat surface of end cap
- 11 appropriate tapped 20 mm npt

Figure 4 — Example of a water flow test apparatus**7.5 Water distribution tests (see 6.5)****7.5.1 Sprinklers other than sidewall types**

In a test chamber of minimum dimensions 7 m × 7 m, install one sprinkler on piping prepared for this purpose. The dimensions of the ceiling shall not be less than the measured area of coverage.

The sprinklers shall be fitted directly into the horizontal pipe work by means of "T" or elbow fittings or a nominal 25 mm pipe nipple exceeding 150 mm in length with a reducing fitting. The yoke arms of the sprinklers shall be parallel to the supply pipes.

Dry type sprinklers of the shortest manufactured length shall be tested.

The distance between the ceiling and the deflector of the sprinkler shall be 100 mm. In cases where adjustment of the distance between the deflector and the ceiling is possible, (i.e. concealed, flush, and recessed sprinklers), distribution tests shall be conducted at both extremes of deflector position.

Upright and pendent sprinklers shall be evaluated by collecting water in one quadrant of the room as shown in Figure 5. The collection pans are to be positioned 25 mm from adjacent walls.

Tests shall be conducted in each nominal room size at the corresponding nominal flow rate given in Table 3.

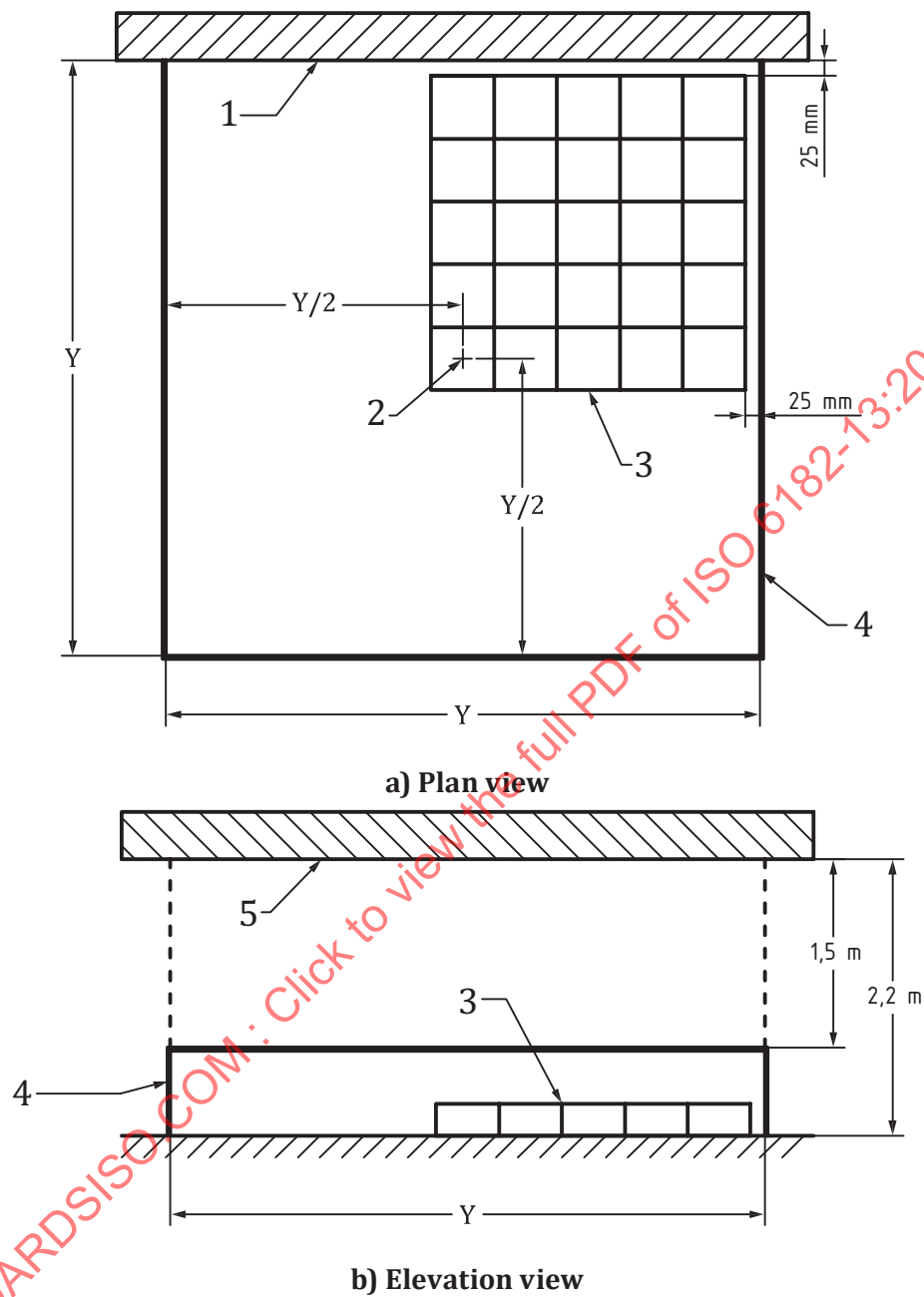
The water distribution in the protected area shall be measured by means of square collection pans 500 mm on a side. The distance between the ceiling and the upper edge of the pans shall be 2,2 m.

The water shall be collected for at least 6 min.

The wall wetting test (7.21) may be performed concurrently with this test.

Table 7 — Distribution testing parameters for upright and pendent sprinklers

Nominal flow constant, K [l/m/(bar) ^{0,5}]	Nominal room dimensions (width × length) (m × m)	Nominal flow rate (l/min)
80	5,0 × 5,0	100
80	5,5 × 5,5	125
80	6,0 × 6,0	150
115	5,0 × 5,0	100
115	5,5 × 5,5	125
115	6,0 × 6,0	150
160	5,0 × 5,0	115
160	5,5 × 5,5	125
160	6,0 × 6,0	150
202	5,0 × 5,0	140
202	5,5 × 5,5	140
202	6,0 × 6,0	150

**Key**

- 1 test chamber wall
- 2 sprinkler location
- 3 collection pans
- 4 wall structure supporting paper
- 5 test chamber ceiling
- Y room dimensions

Figure 5 — Water distribution and wall wetting test setup for upright and pendent sprinklers

7.5.2 Sidewall sprinklers

In a test chamber of minimum dimensions 7 m × 9 m, install one sprinkler in a wall on piping prepared for this purpose. The wall shall not be less than 2,4 m high and 5,5 m in length. The dimensions of the ceiling shall not be less than the measured area of coverage.

The sprinkler shall be fitted directly into the horizontal pipe work by means of “T” or elbow fittings or a nominal 25 mm pipe nipple exceeding 150 mm in length with a reducing fitting.

Dry type sprinklers of the shortest manufactured length shall be tested.

The sprinkler shall be tested with ceiling-to-distribution-plate distances of 100 mm and 300 mm. In cases where adjustment of the distance between the deflector and the ceiling is possible, (i.e. concealed, flush and recessed sprinklers), distribution tests shall be conducted at both extremes of deflector position.

Sidewall sprinklers shall be evaluated by collecting water in one half of the room as shown in [Figure 6](#). The collection pans are to be positioned 25 mm from adjacent walls.

Tests shall be conducted in each nominal room size at the corresponding nominal flow rate given in [Table 4](#).

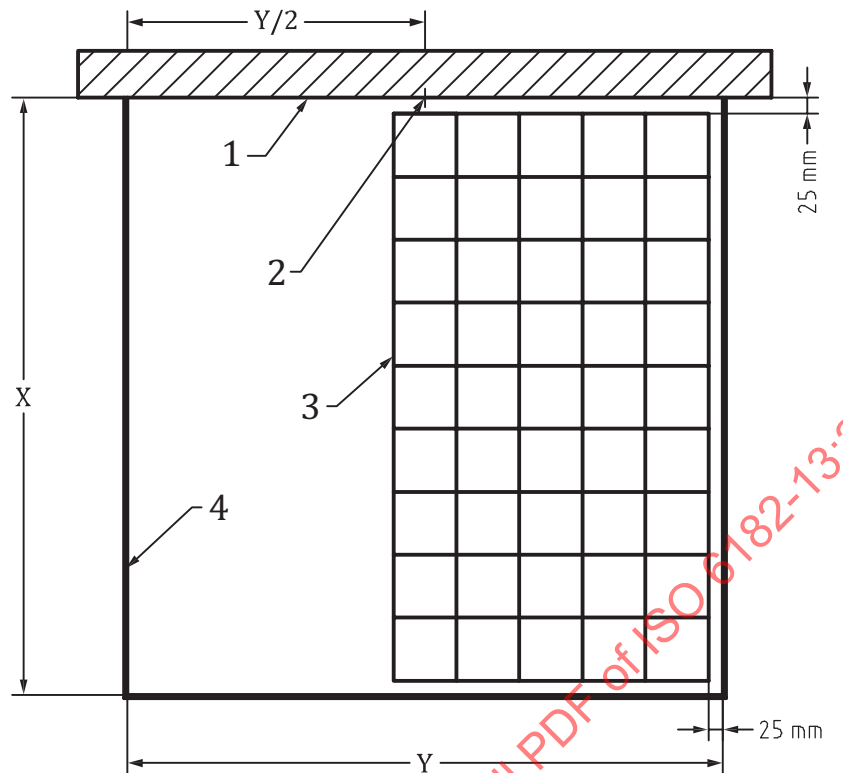
The water distribution in the protected area shall be measured by means of square collection pans 500 mm on a side. The distance between the ceiling and the upper edge of the pans shall be 2,2 m. The water shall be collected for at least 6 min.

The wall wetting test (see [7.21](#)) may be performed concurrently with this test.

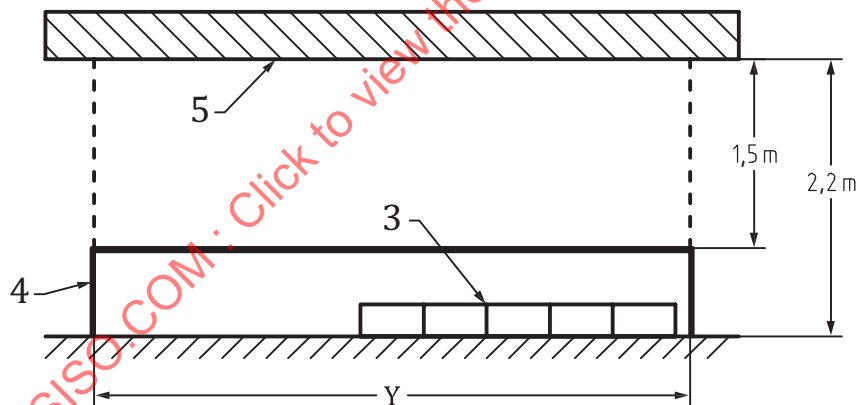
Table 8 — Distribution testing parameters for sidewall sprinklers

Nominal flow constant, K [l/m/(bar) ^{0,5}]	Nominal room dimensions (width × length) (m × m)	Nominal flow rate (l/min)
80	5,0 × 5,0	100
80	5,0 × 5,5	115
80	5,0 × 6,0	125
115	5,0 × 5,0	120
115	5,0 × 5,5	135
115	5,0 × 6,0	150
115	5,0 × 6,5	165
115	5,0 × 7,0	180

NOTE If the collection area does not have the number of collection fields shown above, the measurements can be performed in two sequences.



a) Plan view



b) Elevation view

Key

- 1 test chamber wall
- 2 sprinkler location
- 3 collection pans
- 4 wall structure supporting paper
- 5 test chamber ceiling
- X room length
- Y room width

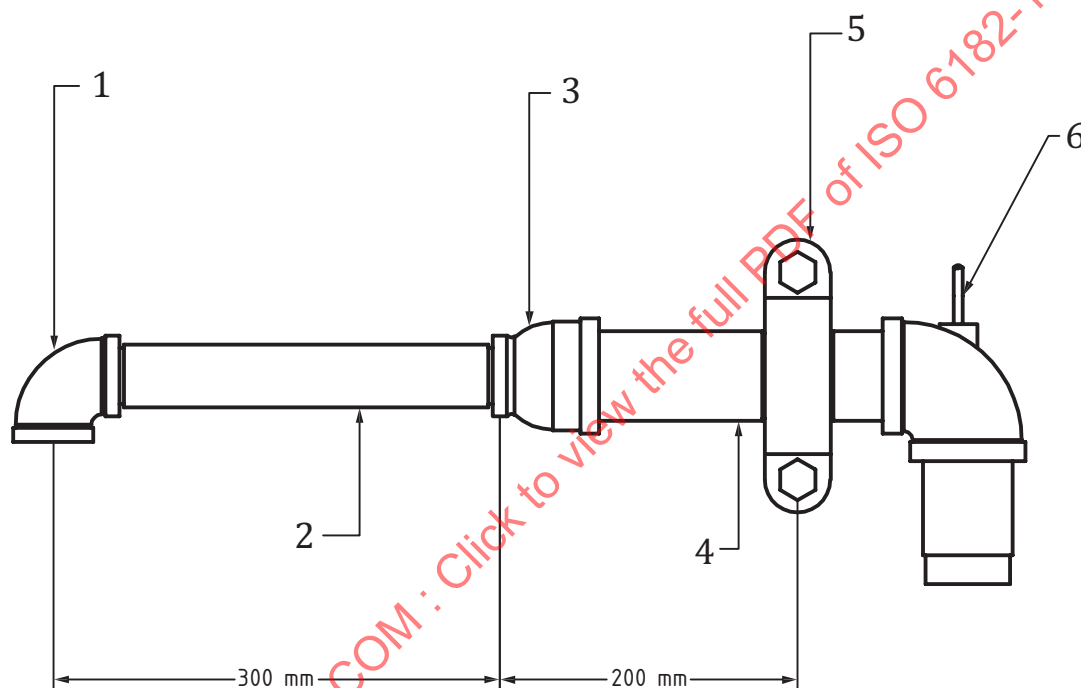
Figure 6 — Water distribution and wall wetting test setup for sidewall sprinklers

7.6 Functional test (see 6.6)

7.6.1 Lodgement test (see 6.6.1)

7.6.1.1 Automatic sprinklers and dry-type automatic sprinklers in the shortest length of any temperature rating are to be individually tested. Each sample is to be installed in its intended installation position on a rigid piping arrangement and supplied with flowing water. Tests are to be conducted using a single-feed (see Figure 7) and a double-feed (see Figure 9) water supply arrangement. The test pressures and number of samples tested at each pressure using each water supply configuration are specified in Table 7. Each sample is to be operated by exposing the heat responsive element to a uniform application of heat. The service pressure and the action of the operating parts, when releasing, are to be observed to determine compliance with these requirements.

The flowing pressure shall be at least 75 % of the initial operating pressure.



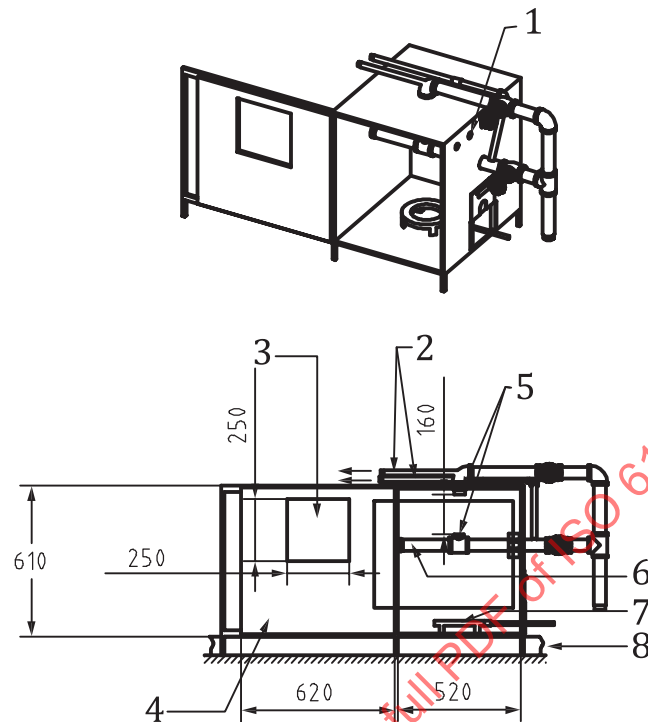
Key

- 1 32 mm nominal elbow (outlet as required)
- 2 32 mm nominal steel pipe
- 3 32 mm × 50 mm nominal reducer
- 4 50 mm nominal steel pipe
- 5 50 mm nominal grooved coupling
- 6 bleed line

NOTE All dimensions are nominal size.

Figure 7 — Typical single feed lodgement test arrangement

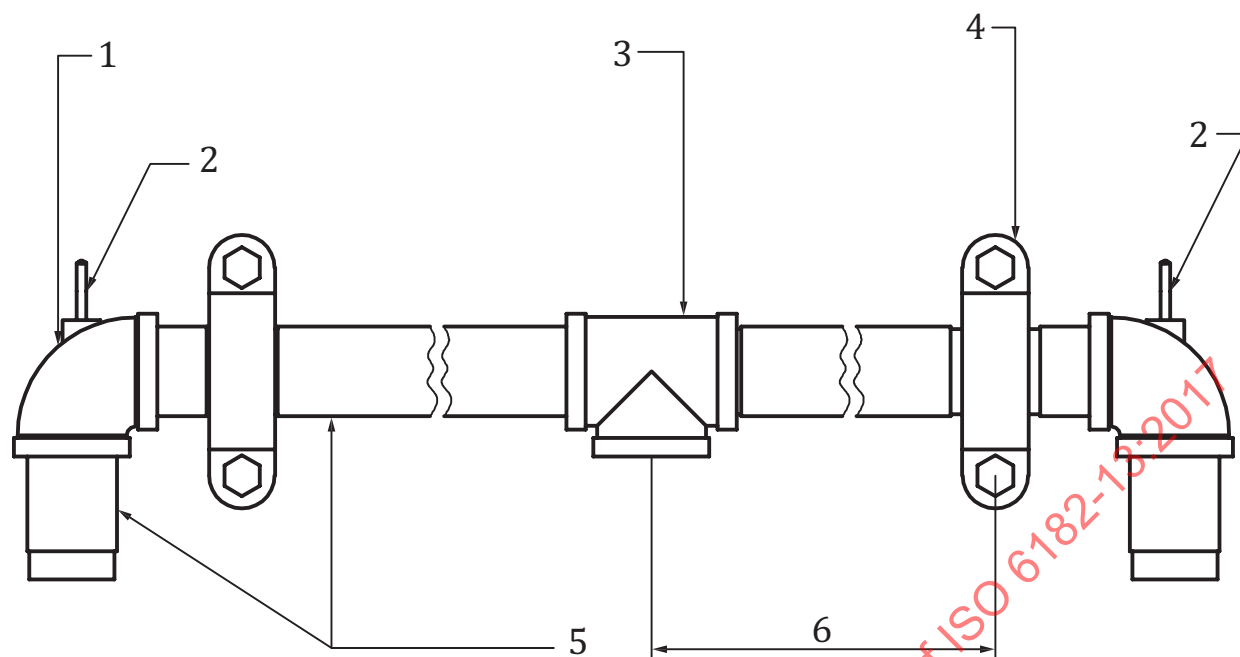
Dimensions in millimetres



Key

- 1 oven air vents
- 2 gauge pipe
- 3 window
- 4 door
- 5 threaded connection to sprinklers
- 6 detachable pipe for upright sprinklers
- 7 heat source
- 8 water discharge

Figure 8 — Typical function test oven



Key

- 1 50 mm nominal elbow
- 2 bleed line
- 3 50 mm nominal grooved coupling (typical)
- 4 50 mm nominal tee (outlet as required)
- 5 50 mm nominal steel pipe (typical)
- 6 50 mm (typical)

Figure 9 — Typical double feed lodgement test arrangement

Table 9 — Lodgement test pressures and number of test samples

Test pressure ^c		Water supply arrangement	Number of test samples ^d
MPa	Bar		
0,035 or 0,005	0,35 or 0,5 ^a	Single Feed	5
0,035 or 0,05	0,35 or 0,5 ^a	Double Feed	5
0,17	1,7	Single Feed	5
0,17	1,7	Double Feed	5
0,35	3,5	Single Feed	5
0,35	3,5	Double Feed	5
0,52	5,2	Single Feed	5
0,52	5,2	Double Feed	5

^a For dry upright sprinklers, the starting test pressure is 0,09 MPa (0,9 bar).

^b If the sprinkler is rated for a pressure of greater than 1,2 MPa (12 bar), sprinklers are to be tested in 0,17 MPa (1,7 bar) increments from 1,37 MPa (13,7 bar) to the rated pressure.

^c Mandatory test pressures include 0,035 MPa (0,35 bar) or 0,05 MPa (0,5 bar), 0,35 MPa (3,5 bar), and the maximum rated pressure.

^d Testing using each temperature rating may be required in some countries.

Table 9 (continued)

Test pressure ^c		Water supply arrangement	Number of test samples ^d
MPa	Bar		
0,69	6,9	Single Feed	5
0,69	6,9	Double Feed	5
0,86	8,6	Single Feed	5
0,86	8,6	Double Feed	5
1,0	10	Single Feed	5
1,0	10	Double Feed	5
1,2	12	Single Feed	5
1,2	12	Double Feed	5
Incremental 0,17 ^b	Incremental 1,7 ^b	Single Feed	5 at each pressure
Incremental 0,17 ^b	Incremental 1,7 ^b	Double Feed	5 at each pressure
^a For dry upright sprinklers, the starting test pressure is 0,09 MPa (0,9 bar). ^b If the sprinkler is rated for a pressure of greater than 1,2 MPa (12 bar), sprinklers are to be tested in 0,17 MPa (1,7 bar) increments from 1,37 MPa (13,7 bar) to the rated pressure. ^c Mandatory test pressures include 0,035 MPa (0,35 bar) or 0,05 MPa (0,5 bar), 0,35 MPa (3,5 bar), and the maximum rated pressure. ^d Testing using each temperature rating may be required in some countries.			

7.6.1.2 To determine that the internal parts of a dry sprinkler do not restrict the intended flow rate, a flow meter is to be connected to the water supply piping. Prior to operation of the test samples in 7.6.1, an operated sample that has demonstrated acceptable K-factor results in the water flow constant test, 7.4, shall be installed in the operational test fixture. Water is to be flowed at each of the pressures noted in 7.6.1.1 and the K-factor at each pressure is to be recorded. Dry-type sprinkler samples are to be tested as described in 7.6.1. After sprinkler operation, the flow at each pressure specified in 7.6.1.1 is to be recorded. The discharge coefficient K-factor is then to be calculated as specified in 7.4. The K-factor value shall be within 5 % of previously tested K-factor samples.

7.6.1.3 Lodgement is considered to have occurred when one or more of the released parts lodge in the deflector frame assembly.

7.6.2 Deflector strength test (see 6.6.2)

In order to check the strength of the deflector, three sprinklers shall be submitted to the function test in each normal mounting position at a pressure not less than the rated pressure. The water shall be allowed to flow at a residual pressure not less than the rated pressure for a period of 30 min.

7.7 Service load and strength of sprinkler body test (see 6.7)

7.7.1 Test Option 1

7.7.1.1 The service load shall be measured on a minimum of 10 sprinklers by securely installing each sprinkler, at room temperature, in a tensile/compression test machine and applying the equivalent of a hydraulic pressure equal to the rated pressure at the inlet.

7.7.1.1.1 Alternatively, the service load may be determined by measuring the assembly load and adding a calculated or measured value of the force equivalent to a hydrostatic pressure equal to the rated pressure at the inlet.

7.7.1.2 An indicator capable of reading deflection to an accuracy of 0,001 mm shall be used to measure any change in length of the sprinkler between the load bearing points of the sprinkler body. Movement

of the sprinkler shank thread in the threaded bushing of the test machine shall be avoided or taken into account.

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

7.7.1.3.1 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. Record the mechanical load necessary to achieve this as the service load.

7.7.1.3.2 Increase the applied load progressively at a rate not exceeding 500 N/min until twice the average service load has been applied. Maintain this load for (15 ± 5) s.

7.7.1.3.3 Remove the load and compare the permanent elongation with the requirement of [6.7.1](#).

7.7.2 Test Option 2

A minimum of 10 samples shall be individually mounted into a solid fixture and the pipcap/seat, spring, and frame for orientation purposes shall be marked to record the original assembled position. A dial indicator shall be located on the bottom of the sprinkler, through the waterway and in contact with the bottom of the pipcap/seat. The indicator gage shall be indexed to zero reading.

The glass bulb element shall be fractured and removed using pliers or another mechanical device. The compression screw shall then be removed from the sprinkler. The components (spring and pipcap/seat) shall be reassembled in the waterway. A hydraulic ram (or other device) shall be set with a load cell on the top of the sprinkler with an extended ram through the setscrew hole and in contact with the pipcap/seat. A load shall then be applied to the pipcap/seat so as to compress the spring to its original position and held for 10 min. After which the load that the cell is reporting shall be recorded and is considered the assembly load. After the reading is taken, apply additional load to the pipcap/seat to verify that the spring is not in the flat position.

Springs used in this test shall have been preloaded to the nominal assembly load.

If this test methodology is used to calculate the assembly load, then preloaded springs shall be used in production of the sprinklers.

7.7.3 Test Option 3

7.7.3.1 The assembly load shall be measured on a minimum of 10 sprinklers by securely installing each sprinkler at room temperature in a tensile/compression test machine.

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

7.7.3.3 Remove the heat-responsive element of the sprinkler by a suitable method. When the sprinkler is at room temperature, make a second measurement using the indicator.

7.7.3.4 Mechanical load shall be applied progressively to the sprinkler at a rate not exceeding 500 N/min until the indicator reading at the first measurement point of the sprinkler returns to the initial value achieved. Record the mechanical load necessary to achieve this as the assembly load.

7.7.3.5 Increase the load progressively at a rate not exceeding 500 N/min until twice the average of assembly load has been applied. Maintain this load for (15 ± 5) s.

7.7.3.6 Remove the load and take a third measurement. Compare the permanent elongation with the requirement of [6.7.1.2](#).

NOTE An amount of change in the length of sprinkler body while applying its assembly load will be the difference between the first and second measurements. The amount of permanent elongation will be the difference between the second and third measurements.

7.8 Strength of heat responsive element test (see [6.8](#))

7.8.1 Glass Bulbs

7.8.1.1 At least 55 glass bulbs 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 ± 25) N/s in the test machine until the glass bulb fails.

7.8.1.2 Each test shall be conducted with the bulb mounted in new seating parts. The seating parts may be reinforced externally or manufactured from hardened steel (Rockwell Hardness C 44 ± 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.

7.8.1.3 Using the lowest 50 measured bulb strength results, calculate the average strength and the lower tolerance limit (LTL) for bulb strength (see [Annex C](#)). Using the values of service load recorded in [7.8.1](#), calculate the upper tolerance limit (UTL) for the sprinkler release element service load (see [Annex C](#)). Verify compliance with [6.8.1](#).

7.8.2 Fusible elements

7.8.2.1 Determine compliance with the requirements of [6.8.2 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, valid results from at least 10 samples shall be obtained..

7.8.2.2 Determine compliance with the requirements of [6.8.2 b\)](#) by subjecting fusible heat-responsive elements to loads in excess of the maximum design load, which will produce failure within and after 1 000 h (see [Annex C](#)). At least 10 samples shall be subjected to different loads up to 15 times the maximum design load. Abnormal failures shall be rejected; however, valid results from at least 10 samples 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, using [Formula \(4\)](#):

$$L_d \leq 1,02 L_M^2 / L_0 \quad (4)$$

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.

7.8.2.3 The tests of [7.8.2.1](#) and [7.8.2.2](#) shall be conducted at an ambient temperature of (20 ± 3) °C.

7.9 Leak resistance and hydrostatic strength tests (see 6.9)

7.9.1 20 sprinklers shall be tested. They shall be subjected to a water pressure equal to two times the rated pressure but not less than 3,0 MPa (30 bar).

Increase the pressure from 0 MPa (0 bar) to the value noted above at a rate of $(0,1 \pm 0,03)$ MPa/s [$(1 \pm 0,3)$ bar/s], maintain the pressure for a period of 3 min and then allow it to fall to 0. After the pressure has dropped to 0, increase it to 0,05 MPa (0,5 bar) within not more than 5 s. Maintain this pressure for 15 s and then increase it to 1 MPa (10 bar) at a rate of increase of $(0,1 \pm 0,03)$ MPa/s [$(1 \pm 0,25)$ bar/s], and maintain it for 15 s. Each sprinkler shall meet the requirement of 6.9.1.

7.9.2 Following the test of 7.9.1, the 20 sprinklers shall be subject to a water pressure equal to four times the rated pressure. Fill the sprinkler inlet with water at (20 ± 5) °C and vent it of air. Increase the pressure to four times the rated pressure at a rate not exceeding 0,1 MPa/s (1 bar/s). Maintain at four times the rated pressure for 1 min. The sprinkler shall meet the requirements of 6.9.2.

7.10 Heat exposure test (see 6.10)

7.10.1 Glass bulb sprinklers (see 6.10.1)

Four glass bulb sprinklers having nominal release temperatures of ≤ 80 °C shall be heated in a water bath (preferably distilled water) from (20 ± 5) °C to (20 ± 2) °C below their nominal operating temperature. The rate of increase in temperature shall not exceed 20 °C/min. A suitable fluid 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.

7.10.2 Uncoated sprinklers (see 6.10.2)

12 uncoated sprinklers shall be exposed for a period of 90 d to a high ambient temperature that is 11 °C below the nominal rating or at the temperature given in Table 8 whichever is lower, but not less than 49 °C. After exposure, four of the sprinklers shall be subjected to the requirements of 6.9.1 and 6.15.1, four sprinklers to the requirements of 6.6.1 [two at 0,035 MPa (0,35 bar) and two at 1 MPa (10 bar)] and four sprinklers to the requirements of 6.3. 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.

7.10.3 Coated sprinklers (see 6.10.3)

In addition to the test exposure of 7.10.2 in an uncoated version, 12 coated sprinklers shall be exposed to the test of 7.10.2 using the temperatures given in Table 8 for wax coated sprinklers and for all other coatings.

The test shall be conducted for 90 d. After the 90-d exposure, four of the sprinklers shall be subjected to the requirements of 6.9.1, four sprinklers to the requirements of 6.6.1 [two at 0,035 MPa (0,35 bar) and two at 1 MPa (10 bar)] and four sprinklers to the requirements of 6.3. 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.

Table 10 — Test temperatures for sprinklers

Marked nominal temperature rating, °C	Test temperature °C	Wax coated sprinkler test temperature °C
57 to 60	49	38
61 to 77	52	38
78 to 107	79	66
108 to 149	121	66

7.11 Thermal shock test for glass bulb sprinklers (see 6.11)

7.11.1 Before starting the test, condition at least five sprinklers at (20 ± 5) °C for at least 30 min.

7.11.2 Sprinklers having nominal operating temperatures less than or equal to 80 °C shall be tested in a bath of de-mineralized water. Sprinklers with higher-rated elements shall be tested in a bath of suitable fluid. 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 sprinklers. After 5 min, remove the sprinklers from the bath and immerse them immediately in another bath of liquid (de-mineralized water), with the bulb seal downwards, at a temperature of $(10 \pm 0,5)$ °C. Then test the sprinklers in accordance with 6.6.1 at 0,035 MPa (0,35 bar).

7.12 Corrosion tests (see 6.12)

7.12.1 Stress corrosion test for copper-based alloy components (see 6.12.1)

Five sprinklers without any plating or coating shall be subjected to the following aqueous ammonia test. The inlet of each sample shall be sealed with a nonreactive (e.g. plastic) cap.

Degrease the samples to be tested and then expose them for 10 d to a moist ammonia-air mixture in a glass container.

An aqueous ammonia solution, having a density of 0,94 g/cm³, 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 ml/cm³ 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 ± 2) °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 dripping condensate. The glass container shall be placed in an enclosure which shall be heated uniformly to prevent condensate on the test sample.

After exposure, rinse and dry the sprinklers, and conduct 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 rated pressure for 1 min and to the function test at 0,035 MPa (0,35 bar) only. See 6.9.1 and 6.6.1.

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 equal to the rated pressure for 30 min.

7.12.2 Sulfur dioxide/carbon dioxide corrosion test (see 6.12.2)

Subject eight sprinklers to the following moist sulfur-dioxide/carbon-dioxide corrosion test. Fill the inlet of each sample with deionized water and seal it with a non-reactive cap, for example, plastic.

Use test equipment consisting of a vessel made of non-reactive material, with a lid of such a shape as to prevent condensate dripping on the sprinklers. Regulate the heating of the vessel so as to maintain the temperature inside the vessel at $(25 \pm 3) ^\circ\text{C}$. Shield specimens from dripping condensate.

Suspend the sprinklers to be tested in their normal mounting position under the lid inside the vessel. Sulfur dioxide and carbon dioxide are to be supplied to the test chamber from commercial cylinders. Introduce an amount of sulfur dioxide equivalent to 1 % of the volume of the test chamber, and an equal volume of carbon dioxide, into the chamber each working day. Maintain a small amount of potable or de-mineralized water at the bottom of the chamber.

Conduct the test for a period of 10 d. After a total of 10 d, remove the samples from the container and allow them to dry for 1 d to 5 d at a temperature not exceeding $35 ^\circ\text{C}$ with a relative humidity no greater than 70 %.

After the drying period, the samples shall be tested as described in [6.12.2](#).

7.12.3 Hydrogen-sulfide corrosion test (see [6.12.3](#))

Subject eight sprinklers to the following moist hydrogen-sulfide corrosion test. Fill the inlet of each sample with deionized water and seal it with a non-reactive cap, e.g. plastic.

Use test equipment consisting of a vessel made of non-reactive material, with a lid of such a shape as to prevent condensate dripping on the sprinklers. Regulate the heating of the vessel so as to maintain the temperature inside the vessel at $(25 \pm 3) ^\circ\text{C}$. Shield specimens from dripping condensate.

Suspend the sprinklers to be tested in their normal mounting position under the lid inside the vessel. Hydrogen-sulfide is to be supplied to the test chamber from a commercial cylinder. Introduce an amount of hydrogen-sulfide equivalent to 1 % of the volume of the test chamber into the chamber each working day. Maintain a small amount of water at the bottom of the chamber.

Conduct the test for a period of 10 d. After a total of 10 d, remove the samples from the container and allow them to dry for 1 d to 5 d at a temperature not exceeding $35 ^\circ\text{C}$ with a relative humidity no greater than 70 %.

After the drying period, the samples shall be tested in accordance with [6.12.3](#).

7.12.4 Salt spray loading test (see [6.12.4](#))

7.12.4.1 Sprinklers for normal atmospheres

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 (e.g. plastic) cap.

During the corrosive exposure, the inlet thread orifice shall be sealed by a nonreactive cap after the sprinklers have been filled with deionized water. The salt solution shall be a 20 %-by-mass sodium chloride solution in deionized water. The pH shall be between 6,5 and 7,2 and the density between 1,126 g/ml and 1,157 g/ml when atomized at $35 ^\circ\text{C}$. 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 $0,43 \text{ m}^3$, in which the exposure zone shall be maintained at a temperature of $(35 \pm 2) ^\circ\text{C}$. Salt solution shall be supplied from a recirculating reservoir through air-aspirating nozzles, at a pressure of 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 dripping condensate.

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^2 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 $(20 \pm 1) \%$ 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 $(20 \pm 5) ^\circ\text{C}$ in an atmosphere having a relative humidity not greater than 70 %. After the drying period, the samples shall be tested in accordance with [6.12.4](#).

7.12.4.2 Sprinklers for corrosive atmospheres

Sprinklers intended to be used in corrosive atmospheres shall be subjected to the tests specified in [7.12.4.1](#), except that the duration of the salt spray exposure shall be extended from 10 d to 30 d.

7.12.5 Moist air exposure (see 6.11.5)

Five sprinklers shall be exposed to a high temperature-humidity atmosphere consisting of a relative humidity of $98 \% \pm 2 \%$ and a temperature of $94 ^\circ\text{C} \pm 2 ^\circ\text{C}$. For evaluation of dry type sprinklers, the shortest length manufactured shall be used.

The sprinklers shall be installed on a pipe manifold containing deionized 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 requirements of [6.6.1](#) at a pressure of 0,035 MPa (0,35 bar) only.

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.

7.12.6 Stainless steel components (see [6.12.6](#))

7.12.6.1 Stress corrosion — magnesium chloride test

7.12.6.1.1 Four sets of uncoated or unplated stainless steel components and four previously untested sprinklers shall be degreased and then exposed to a boiling magnesium chloride solution for a period of 150 (+12, -0) h as described below, and in accordance with ASTM G36. Special fixtures or elevated temperature operating elements may be employed to simulate assembly loading on parts, where appropriate and necessary.

7.12.6.1.2 Samples are to be placed in a flask fitted with a wet condenser. The flask shall be filled approximately one-half full with a nominal 44 % by weight magnesium chloride solution, placed on a thermostatically-controlled electrically-heated mantle, and maintained at a boiling temperature of $150 ^\circ\text{C} \pm 2 ^\circ\text{C}$.

7.12.6.1.3 Following exposure, the samples shall be removed and rinsed in potable water. Following a 2-d to 4-d drying period, visual examination of the samples shall be made.

7.12.6.1.4 The stainless steel components that show no evidence of cracking, delamination, or degradation shall not need further testing. Stainless steel components that show evidence of stress corrosion shall be permitted to be reassembled and subjected to the tests in [7.30.2](#).

7.12.6.1.5 The sprinklers tested shall not weep or leak at, or below, 1,2 MPa (12,1 bar) when hydrostatically tested for 1 min. Subsequently, half of the samples shall exhibit positive operation and release of all operating parts when tested in accordance with the functional test at 0,05 MPa (0,5 bar). The remaining samples shall not show evidence of separation of permanently attached parts when subjected to the water flow at rated pressure for 30 min.

7.13 Tests for sprinkler coatings (see 6.13)

7.13.1 Evaporation of wax and bitumen test (see 6.13.1)

A 50 cm³ sample of wax or bitumen shall be placed in a metal or glass cylindrical container having a flat bottom, an internal diameter of 55 mm and an internal height of 35 mm. The container, without lid, shall be placed in an automatically controlled electric, constant-ambient-temperature oven with air circulation. The temperature in the oven shall be controlled at 16 °C below the nominal release temperature of the sprinkler, but at not less than 50 °C. The sample shall be weighed before and after 90-d exposure to determine any loss of volatile matter; the sample shall meet the requirements of 6.13.1.

7.13.2 Low-temperature test (see 6.13.2)

Five sprinklers, coated by normal production methods, whether with wax, bitumen or a metallic coating, shall be subjected to a temperature of minus 10 °C for a period of 24 h. On removal from the low temperature cabinet, the sprinklers shall be allowed to return to normal ambient temperature for at least 30 min before examination of the coating to the requirements of 6.13.2.

7.14 Water-hammer test (see 6.14)

7.14.1 Five sprinklers shall be connected to the test equipment. After purging the air from the sprinklers and the test equipment, 100 000 cycles of pressure varying from $(0,4 \pm 0,05)$ MPa [$(4 \pm 0,5)$ bar] to twice the rated pressure but not less than $(3,0 \pm 0,1)$ MPa [(30 ± 1) bar] shall be generated. The pressure shall be raised at a minimum rate of 4 MPa/s (40 bar/s) with no more than 60 cycles of pressure per minute shall be generated. The pressure shall be measured electronically with a pressure transducer.

7.14.2 Visually examine each sprinkler for leakage during the test. After the test, each sprinkler shall meet the leak resistance requirements of 6.9.1 and the functional requirement of 6.6.1 at a pressure of 0,035 MPa (0,35 bar) only.

7.15 Dynamic heating test (see 6.15)

7.15.1 Plunge Test

Subject ten sprinklers in each nominal temperature rating to the plunge test in the standard orientation. Calculate the RTI as described in 7.15.1.2.

7.15.1.1 Test conditions

Conduct the plunge tests using a brass sprinkler mount. Apply 1 wrap to 1,5 wraps of PTFE sealant tape to the sprinkler threads of the sprinkler under test. Screw the sprinkler into a mount to a torque of (15 ± 3) N.m. Mount each sprinkler on a tunnel test section cover and maintain the sprinkler and cover at ambient temperature for a period of no less than 30 min.

At least 25 ml of water, conditioned to ambient temperature, shall be introduced into the sprinkler inlet prior to testing. Test all sprinklers with the inlet end of each sample connected to a source of pressure at $(0,035 \pm 0,005)$ MPa [$(0,35 \pm 0,05)$ bar].

NOTE In some countries, the water at the inlet is not required to perform the test.

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.

A tunnel shall be used with air velocity and temperature conditions at the test section (sprinkler location) selected from the appropriate range of conditions given Table 9. Select the tunnel conditions so as to limit maximum anticipated equipment error to 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 $\pm 3\%$ of calculated RTI values.

The range of permissible tunnel operating conditions is given in [Table 9](#). The selected operating condition shall be maintained for the duration of the test with the tolerances as specified by the footnotes in [Table 9](#).

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

Table 11 — Range of plunge test conditions at test section (sprinkler location)^a

Nominal operating temperatures °C	Air temperature ^b °C	Velocity range m/s
57 to 77	129 to 141	2,4 to 2,6
79 to 107	191 to 203	2,4 to 2,6

^a Where results are shown to be equivalent, testing laboratories may use other conditions.

^b The selected air temperature shall be known and maintained constant within the test section throughout the test to an accuracy of $\pm 1\text{ °C}$ for the air temperature range of 129 °C to 141 °C within the test section and $\pm 2\text{ °C}$ for all other air temperatures.

7.15.1.2 Calculation of RTI Value

$$RTI = \frac{-t_r \sqrt{u}}{\ln(1 - \Delta T_{ea} / \Delta T_g)} \quad (5)$$

where

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

u is the actual air velocity, expressed in metres per second (m/s), in the test section of the tunnel taken from [Table 6](#);

ΔT_{ea} is the temperature difference, expressed in degrees Celsius (°C), between the mean liquid-bath operating temperature of the sprinkler and the ambient temperature;

ΔT_g is the temperature difference, expressed in degrees Celsius (°C), between the actual air temperature in the test section, corrected for radiation effects on the temperature sensing device, and the ambient temperature.

7.16 Resistance to heat test (see [6.16](#))

One sprinkler body shall be heated in an oven at $770\text{ °C} \pm 10\text{ °C}$ for a period of 15 min, with the sprinkler in on its inlet thread. The sprinkler body shall then be removed, holding it by the threaded inlet, and shall be promptly immersed in a water bath at a temperature of approximately 15 °C .

NOTE In some countries, 650 °C is used instead of 770 °C for this test.

7.17 Vibration test (see [6.17](#))

7.17.1 Five sprinklers shall be fixed vertically to a vibration table and subjected at room temperature to sinusoidal vibrations. The direction of vibration shall be along the axis of the connecting thread. When dry sprinklers are tested, they shall be of the longest manufactured length.

7.17.2 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.

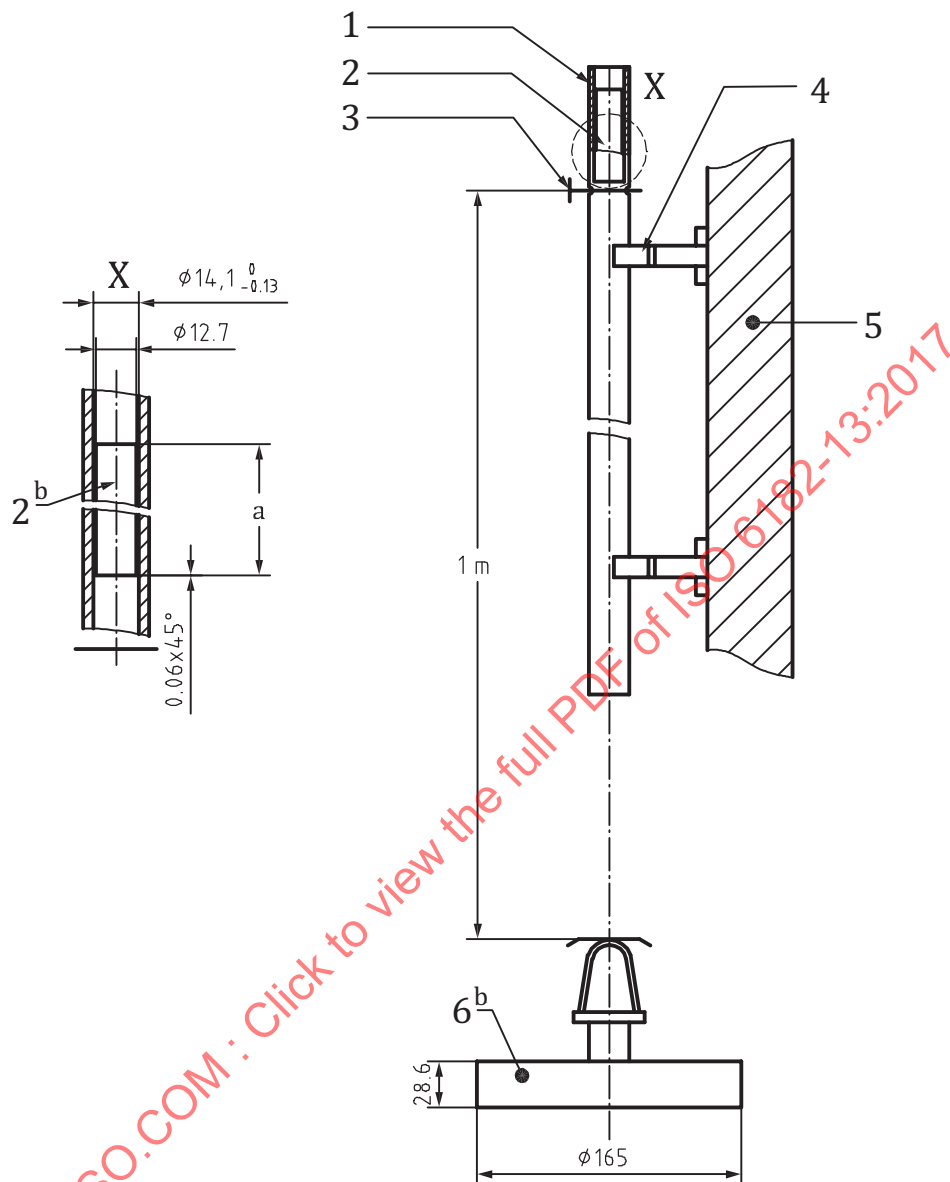
7.17.3 After vibration, each sprinkler shall be subjected to the leak resistance requirement of [6.9.1](#) and the function requirement of [6.6.1](#) at a pressure of 0,035 MPa (0,35 bar) only.

7.18 Impact test (see [6.18](#))

Five sprinklers, other than dry type, shall be impact-tested by dropping a mass onto the deflector end of the sprinkler along the axial centerline of the waterway. Sprinklers provided with protective covers, which are intended for removal only after completion of the sprinkler installation, shall be impact tested with the caps in place. The mass equivalent to that of a sprinkler shall be dropped from a height of 1 m (see [Figure 10](#)). In a sprinkler with water shield, the dropped weight shall be equivalent to the weight of the test sprinkler without the water shield. The dropped weight shall be prevented from impacting more than once upon each sample. After the impact test, each sprinkler shall meet the requirements of [6.18.1](#).

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Dimensions in millimetres

**Key**

- 1 cold drawn seamless steel tubing
- 2 mass
- 3 latching pin
- 4 adjustable brackets (2)
- 5 rigid support
- 6 sprinkler support
- a Length to be determined (length of required mass).
- b Cold finished steel.

Figure 10 — Impact test apparatus**7.19 Rough usage test (see 6.19)**

Five sample sprinklers are to be tested. The sprinklers shall be permitted to be tested with a protective covers in place if the cover 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.

EXCEPTION Dry sprinklers are not required to be subjected to this test. In addition, concealed sprinklers are tested without their coverplate assembly.

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 in 6.9.1 and to the RTI requirements of 6.15.1, or in accordance with 6.25.1 for recessed, and concealed sprinklers.

7.20 Lateral discharge test (see 6.20)

7.20.1 While discharging water at a service pressure of 0,52 MPa (5,2 bar) less than the rated pressure, an open upright, pendent, or sidewall spray sprinkler shall not prevent the operation of a 57 °C to 77 °C temperature-rated automatic sprinkler of the same type and response located the minimum distance permitted by the installation instructions on an adjacent pipeline in the same horizontal plane.

7.20.2 Upright and pendent spray sprinklers

An upright or pendent spray automatic sprinkler having a nominal temperature rating as specified in 7.20.1, shall be installed the minimum distance permitted by the installation instructions (centre-to-centre) from a second open sprinkler of the same type. The sprinklers shall be on separate parallel pipelines with the frame arms parallel to the pipe and the sprinkler deflectors located 560 mm below a flat ceiling.

7.20.3 Sidewall sprinklers

For sidewall sprinklers, an automatic sprinkler having a nominal temperature rating as specified in 7.20.1, and an open sprinkler are to be installed on the same pipe line with the sprinklers located 2,5 m apart or the minimum distance between sprinklers as specified in the installation instructions, to discharge water perpendicular to the pipe line. One test is to be conducted with the sprinklers located 150 mm below a flat ceiling and 150 mm away from a back wall. The second test is to be conducted with the sprinklers located 300 mm below a flat ceiling and 150 mm away from a back wall.

7.20.4 After water flow is established for both 7.20.2 and 7.20.3, the automatic sprinkler is to be exposed to the heat and flame from a 300 mm × 300 mm pan, 100 mm deep containing 0,5 l of heptane and 0,5 l of water. The top of the pan shall be located 150 mm below the heat responsive element of the automatic sprinkler. In all test conditions, the automatic sprinkler shall operate before the heptane is consumed.

7.21 Wall wetting test (see 6.21)

The wall wetting tests shall be conducted in a test chamber large enough to contain a room of the maximum size permitted for the sprinkler type and orifice size (see Table 3 for upright and pendent sprinklers and Table 4 for sidewall sprinklers). A wall structure supporting a paper wall shall be erected in the chamber to simulate a room of the appropriate size as shown in Figures 5 or 6, as applicable.

Upright and pendent sprinklers shall be tested with a ceiling-to-deflector distance of 100 mm. Sidewall sprinklers shall be tested with ceiling-to-distribution-plate distances of 100 mm and 300 mm. In cases where adjustment of the distance between the deflector and the ceiling is possible, (i.e. concealed, flush and recessed sprinklers), distribution tests shall be conducted at both extremes of deflector position.

Dry type sprinklers of the shortest manufactured length shall be tested. Tests shall be conducted in each nominal room size at the corresponding nominal flow rate given in Tables 3 or 4. Each test shall be conducted for 6 min. After the test duration each wall of the room shall be examined to verify compliance with 6.21.

The water distribution test (7.5) may be performed concurrently with this test.

7.22 Room fires (see 6.22)

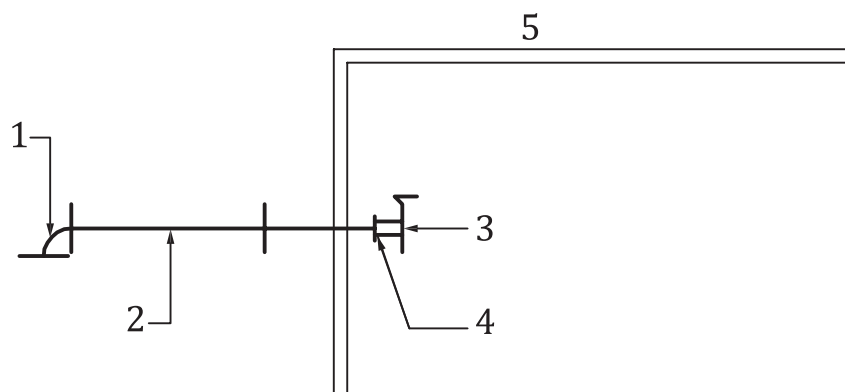
7.22.1 For upright or pendent sprinklers, the fire tests are to be conducted in a room having the dimensions of 6 m × 6 m using a nominal flow of 147 l/min. For sidewall sprinklers, the fire tests are to be conducted in a room having the largest dimensions for the nominal flow constant as shown in Table 4 using the nominal flow for the room size. In addition, for sprinklers having a pressure rating greater than 1,2 MPa (12 bar), tests are to be conducted at the maximum spacing using a flow corresponding to a pressure of 0,5 MPa (5 bar) less than the rated pressure.

7.22.2 Recessed or concealed sprinklers with vented housings/escutcheons are to be installed in a manner that does not inhibit air flow through the housing/escutcheon (unblocked).

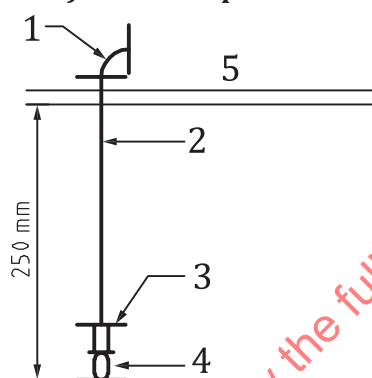
7.22.3 Sprinklers other than sidewall types are to be installed in their intended installation position with the deflector 250 mm below the ceiling, unless specifically designed for other positions (such as concealed, flush or recessed) (see Figure 11).

7.22.4 For a sidewall sprinkler, two series of tests are to be conducted; one series with the sprinkler installed 100 mm below the ceiling and a second series with the sprinkler installed 300 mm below the ceiling. The base of a horizontal type sprinkler is to be installed adjacent to the wall. The deflector of an upright or pendent type sidewall sprinkler is to be mounted at the minimum clearance to the wall. A sidewall type sprinkler is to be installed using a 250 mm long, 25 mm nominal diameter pipe nipple with a reducing coupling installed with its axis perpendicular to the wall (see Figure 11).

7.22.5 Water distribution measurements, for the purposes of determining the crib fire locations only, are to be conducted in an enclosed room with an open sprinkler discharging water at the minimum flow rate and maximum area of coverage as specified in Tables 3 or 4, as appropriate. Water collection pans that are 300 mm × 300 mm and 300 mm deep are to be located on the floor of the enclosed room in the areas of the eleven crib locations as shown in Figure 12. The distribution data are to be recorded and used in determining the specific positions of the wood cribs as required for the second and third fire tests in the fire test series.



a) Sidewall sprinkler



b) Sprinklers other than sidewall types

Key

- 1 25 mm × 25 mm 90 °EL
- 2 25 mm nominal pipe 250 mm long
- 3 25 mm × 12 mm reducing coupling
- 4 sprinkler

Figure 11 — Piping arrangements for the fire tests

7.22.6 Three fire tests are to be conducted using automatic sprinklers. For the first test, a wood crib is specified in 7.22.7 is to be located at Crib Location 1 of the test enclosure (see Figure 12). For the second fire test, the wood crib is to be located at Crib Location 2, 3, 4, 5, 6, or 7 (see Figure 12), whichever location had the least amount of water collected during the distribution determinations. However, when Crib Location 5, 6, or 7 had the least amount of water collected, then

- a) a sprinkler other than a sidewall type is to be rotated 180° and the fire placed in Crib Location 1, 3, or 4, whichever is opposite the crib location that had the least amount of water collect, and
- b) a sidewall type sprinkler is to be installed on the wall near Crib Location 2.

For the third fire test, the wood crib is to be located in the centre of one of the four quadrants of the test room (see Figure 12, Crib Locations 8, 9, 10, or 11), whichever had the least amount of water collected during the distribution determination. However, when Crib Location 8 or 9 had the least amount of water collected, then

- a) a sprinkler other than a sidewall type is to be rotated 180° and the fire placed in Crib Location 10 or 11, whichever is opposite the crib location that had the least amount of water collect, and

- b) a sidewall type sprinkler is to be installed on the wall near Crib Location 2.

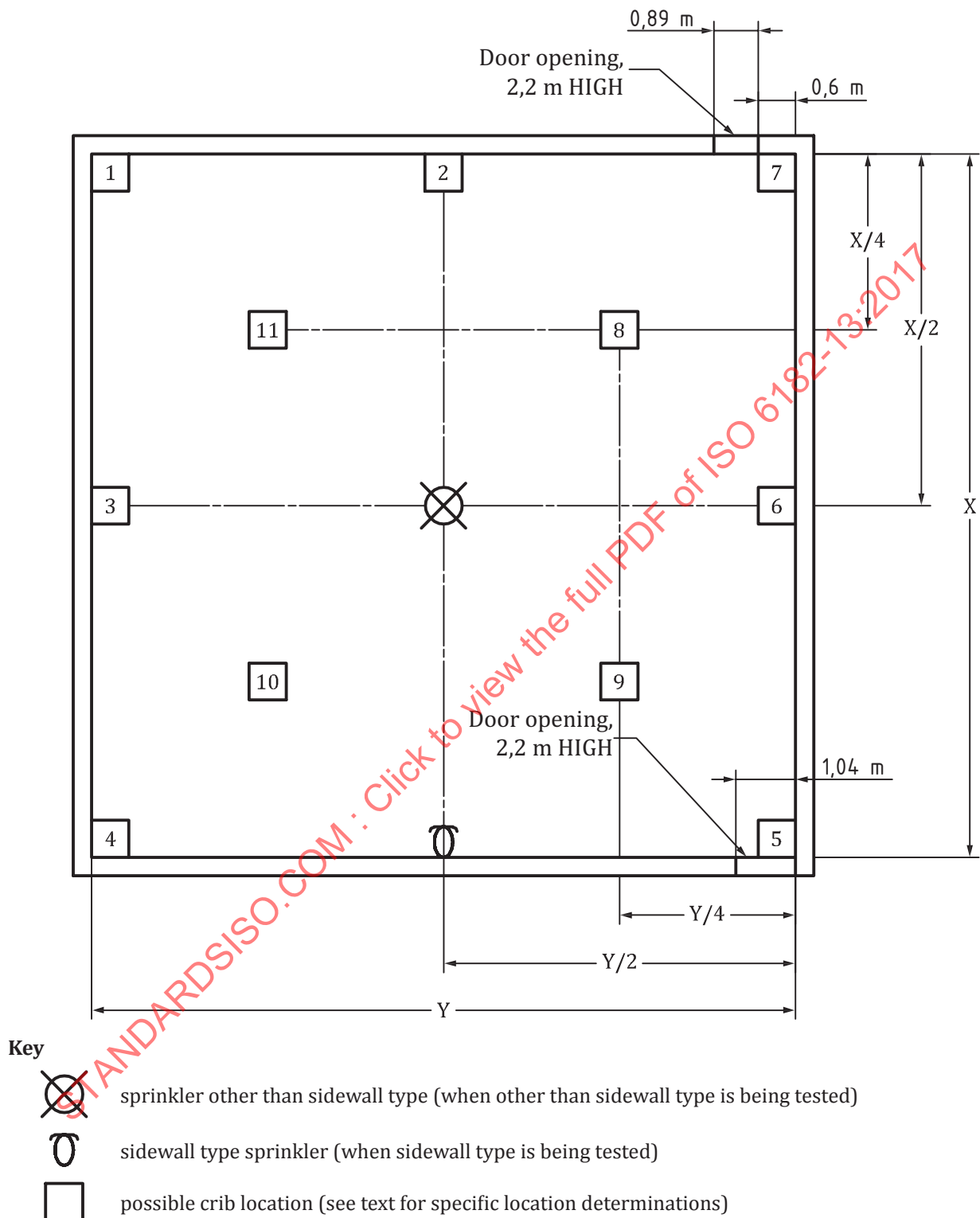


Figure 12 — Location of fire test cribs for the fire tests

7.22.7 The wood crib is to be dimensioned 500 mm × 500 mm × 380 mm high and weigh 15 kg ± 1 kg. The wood crib is to consist of ten alternate layers of five nominal 38 mm × 38 mm kiln-dried spruce or fir lumber 500 mm long. The alternate layers of 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 to the adjacent members. After the wood crib is assembled, it is to be conditioned at a temperature of $49\text{ °C} \pm 5\text{ °C}$ for not less than 16 h. Following the conditioning, the moisture content of the crib is to be measured with a probe type moisture meter. The moisture content of the crib at any measurement location is not to exceed five percent prior to weighing the crib for the fire test.

7.22.8 For each test, the crib is to be placed on four bricks, one at each corner of the crib, that are contained in a 530 mm × 530 mm × 100 mm deep steel pan filled with 1,0 l of heptane on a 25 mm layer of water. When the crib position is in a corner, the edge of the crib is to be positioned 12 mm from both walls.

7.22.9 The test room enclosure and sprinkler sample are to be maintained at a temperature of $24\text{ °C} \pm 8\text{ °C}$ prior to each test. The room is not to have provisions for ventilation other than that provided by the two door openings as shown in [Figure 12](#).

7.22.10 The water flow for the sprinkler is to be preset for the minimum flow rate specified in [Table 3](#) or [Table 4](#), as appropriate. The test room doors are to be fully open. The heptane is ignited. The test is to be conducted for 10 min after the ignition of the heptane. Ten minutes after ignition, the water for the sprinkler is to be turned off. When the fire in the crib has not been extinguished, it is to be carefully extinguished to prevent further destruction of the crib. The crib is to be removed from the test enclosure and is to be conditioned at a temperature of $49\text{ °C} \pm 5\text{ °C}$ for not less than 16 h. Following the conditioning, the moisture content of the crib at any measurement location is not to exceed 5 % prior to weighing the crib to determine the crib weight loss.

7.23 Thirty-day leakage test (see [6.23](#))

7.23.1 Five sprinklers shall be installed on a water-filled test line maintained under a constant pressure of 1,67 times the rated pressure for 30 d at an ambient temperature of $(20 \pm 5)\text{ °C}$.

7.23.2 The sprinklers shall be inspected visually at least weekly for leakage. Following the 30-day period, all samples shall meet the leak resistance requirement specified in [6.9.1](#) and show no evidence of distortion or other mechanical damage.

7.24 Vacuum test (see [6.24](#))

Three sprinklers shall be subjected to a gradually increasing vacuum of up to 460 mm Hg applied to a sprinkler inlet for 1 min at an ambient temperature of $(20 \pm 5)\text{ °C}$. 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 requirement specified in [6.9.1](#).

NOTE Millimetres of mercury. This is a deprecated unit. 1 mm Hg = 133,322 4 Pa.

7.25 Thermal response of extended coverage sprinklers (see [6.25](#))

7.25.1 Sprinklers of each type are to be installed in the test room in the following position and orientation:

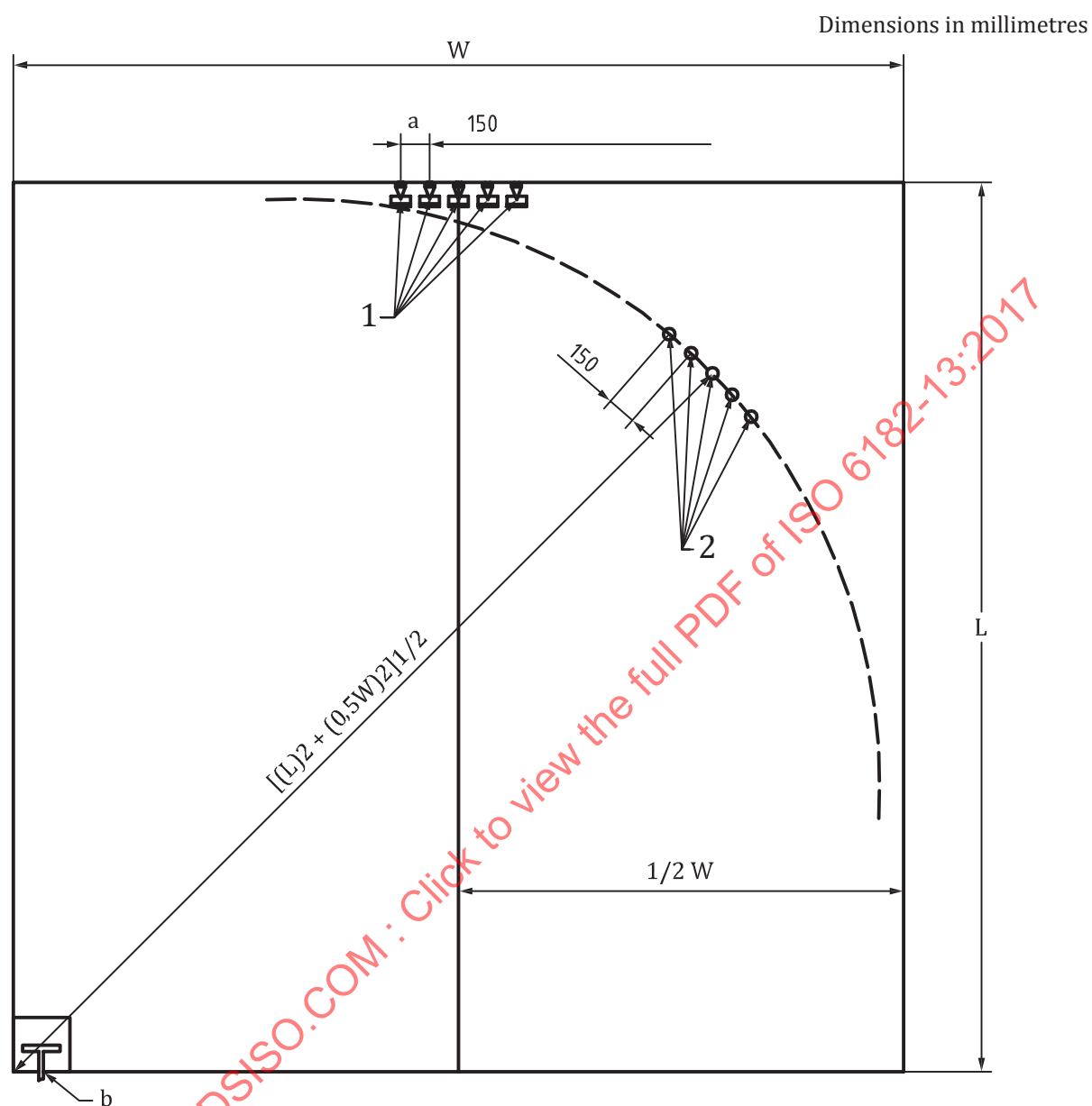
- a) For pendent concealed and recessed sprinklers without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, 10 samples are to be installed in their intended position at the ceiling.
- b) For pendent concealed and recessed sprinklers with or without frame arms and incorporating unsymmetrical heat responsive elements, 10 samples are to be orientated with the heat responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source. The samples are to be in their intended position at the ceiling.

- c) For pendent concealed and recessed sprinklers incorporating frame arms with symmetrical heat responsive elements, 10 samples are to 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 at the ceiling.
- d) For upright sprinklers, 10 samples are to be installed in the pendent position.
- e) For sidewall concealed and recessed sprinklers, 10 samples are to be installed in their intended position with the deflector located 102 mm below the ceiling and the maximum distance below the ceiling if intended for distances greater than 152 mm.

If the intended installation position is greater than 152 mm below the ceiling, 10 additional samples shall be tested at the maximum distance below the ceiling.

7.25.2 At least 10 samples of each sprinkler style shall be tested in groups of five in a closed room having dimensions equal to the width and length, and subjected to the heat from a sand burner (see [Figure 14](#)) located on the floor in one corner of the room with the sprinklers located 15 cm apart as described in [Figure 13](#). Each sprinkler shall be filled with water at $(20 \pm 5) ^\circ\text{C}$ either with no pressure or with the inlet connected to a source of pressure at 0,05 MPa (0,5 bar). Concealed and recessed sprinklers shall be installed in the maximum recessed position. Concealed and recessed sprinklers with vented housing units shall be installed and tested in a manner that will not inhibit airflow through the housing/escutcheon. Concealed and recessed sprinklers with vented housing units which are specified for use in ceilings not permitting airflow shall be installed and tested with the openings blocked. For the evaluation of dry sprinklers, the shortest length manufactured shall be used.

For concealed and recessed sprinklers with vented housings the manufacturer's installation manual shall state whether the sprinklers are allowed to be installed in ceilings not permitting airflow through the housing.

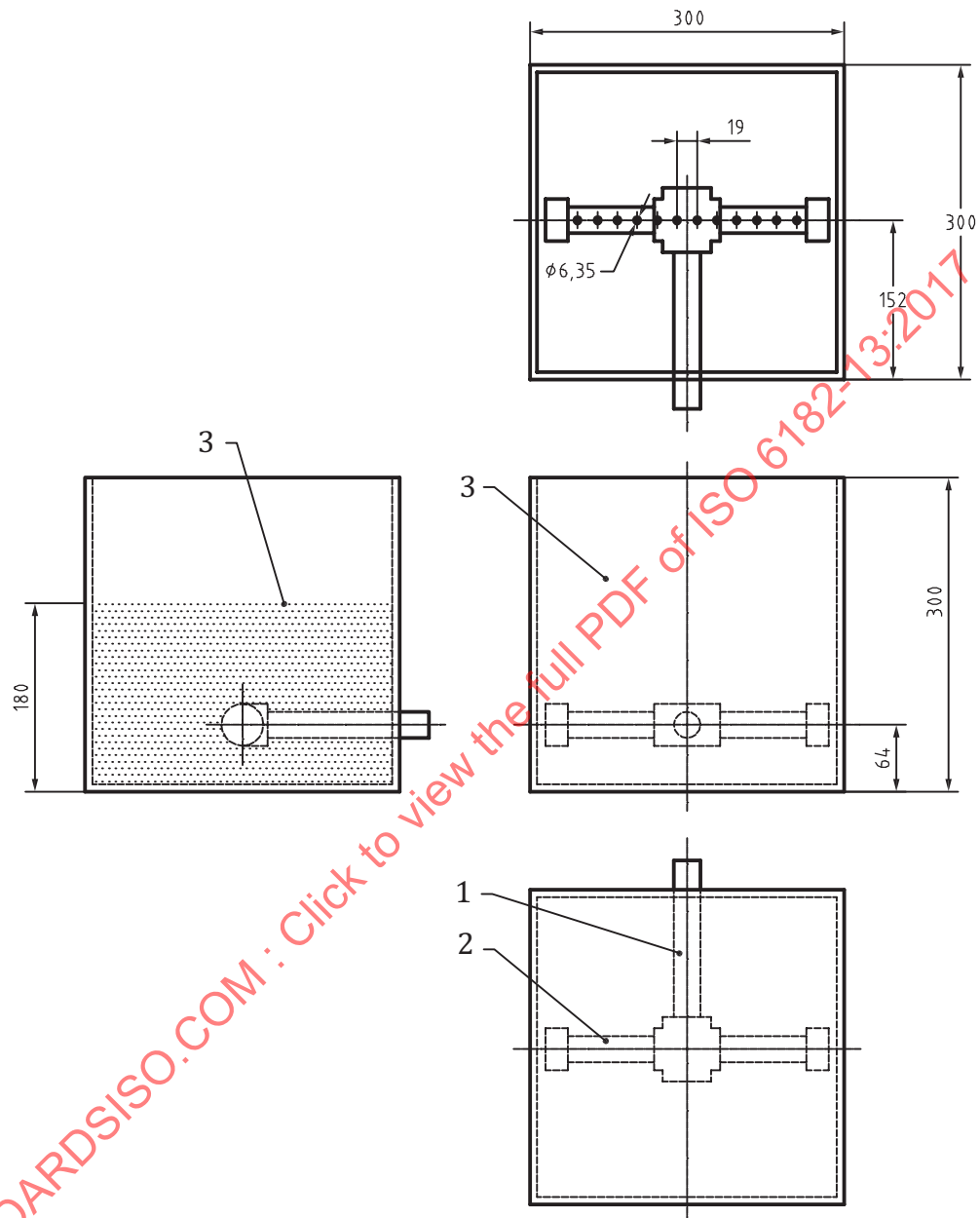


Key

- 1 sidewall sprinkler locations
- 2 pendent sprinkler locations
- a Typical dimension.
- b Sand burner.

Figure 13 — Plan view of room heat test

ISO/FDIS 6182-1:2013(E)



Key

- 1 nominal pipe Ø 25 mm
- 2 nominal pipe Ø 40 mm
- 3 sand

NOTE Materials:

- steel plate box, welded
- steel piping and fittings, with 12 6,35 holes
- mason grade sand.

Figure 14 — Details of sand burner

7.25.3 The test room shall be constructed of nominal 1,2 cm thick plywood. The ceiling shall be constructed of nominal 1,2 cm thick gypsum wallboard or similar ceiling material. A non-combustible wall covering may be installed in the corner of the room with the sand burner.

7.25.4 A flow of natural gas or methane shall be established through the sand burner as follows:

- a) 14,2 m³/h for fast response sprinklers having a temperature rating of 77 °C or less;
- b) 17 m³/h for fast response sprinklers having a temperature rating of 79 °C to 107 °C.

NOTE Gases having a higher heat content can be used provided that the heat output obtained is made equivalent by adjusting the flow rate.

7.25.5 The response test shall be started when the ambient temperature measured in the centre of the room 254 mm below the ceiling is:

- a) (31 ± 1) °C for sprinklers having a temperature rating not exceeding 77 °C, or
- b) $(49 \pm 1,7)$ °C for sprinklers having a temperature rating between 79 °C and 107 °C.

The operating time of each sprinkler is to be recorded.

7.25.6 Using maximum RTI values and test conditions from [Tables 3](#) and [4](#) calculate the maximum permitted response times. For calculations that return valid results, three samples shall be tested at the corresponding test conditions/offset angle. Calculations that return an invalid result shall be disregarded.

Each sprinkler under test shall have one to 1,5 wraps of PTFE sealant tape applied to the sprinkler threads. Each sample shall be screwed into the test plate (see [Figure 15](#)) to a torque of (15 ± 3) N·m and maintained at ambient temperature for a period of not less than 30 min. The sprinkler shall be installed in the test plate such that the sprinkler's heat-sensitive element is at the minimum protrusion (as permitted by the sprinkler design) into the dynamic heating apparatus laminar gas stream.

7.25.7 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. Unless the sprinkler design prevents it, a vacuum (as noted in [Table 4](#)) shall be applied to the upper enclosure of the test plate and maintained throughout the test.

Record the operating time of each sprinkler.