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Second edition
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Fire protection — Automatic sprinkler systems —

Part 10: Requirements and test methods for domestic sprinklers

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

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

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Foreword

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

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 5, *Fixed fire fighting systems using water*.

This second edition cancels and replaces the first edition (ISO 6182-10:2006), of which it constitutes a minor revision.

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

— *Part 1: Requirements and test methods for sprinklers*

— *Part 2: Requirements and test methods for wet alarm valves, retard chambers and water motor alarms*

— *Part 3: Requirements and test methods for dry pipe valves*

— *Part 4: Requirements and test methods for quick-opening devices*

— *Part 5: Requirements and test methods for deluge valves*

— *Part 6: Requirements and test methods for check valves*

— *Part 7: Requirements and test methods for early suppression fast response (ESFR) sprinklers*

— *Part 8: Requirements and test methods for pre-action dry alarm valves*

— *Part 9: Requirements and test methods for water mist nozzles*

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

— *Part 11: Requirements and test methods for pipe hangers*

— *Part 12: Requirements and test methods for grooved-end components for steel pipe systems*

Introduction

Domestic sprinklers are primarily intended for use in dwelling units. These sprinklers are specifically designed to discharge water in a manner that is expected to prevent flashover within the compartment of fire origin and improve the chance for occupants to escape or be evacuated in dwelling units such as homes, apartments, condominiums, and hotel sleeping rooms. While domestic sprinklers are designed to protect against injury and loss of life, the use of these sprinklers has demonstrated the ability to provide property protection as well. Other types of sprinklers are addressed in the separate parts of the ISO 6182 series.

These sprinklers characteristically have a very flat spray pattern. This allows for the sprinklers to wet the walls of the compartment which reduces the potential for the vertical surfaces to substantially contribute to a flashover condition. These sprinklers also discharge water in a manner that provides a relatively uniform distribution of water on the protected floor area. Obstructions can pose a significant obstacle to domestic sprinklers because of the flat spray pattern. Domestic 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.

Fire protection — Automatic sprinkler systems —

Part 10: Requirements and test methods for domestic sprinklers

1 Scope

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

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

2 Normative references

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

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

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

ASTM G36-94, *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.

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 suppliers' specified and assured lowest average design strength of any batch of 50 bulbs

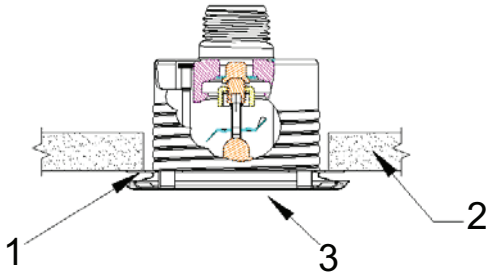
3.1.3
design length
maximum length of the sprinkler coverage area

3.1.4
design load
force exerted on the release element at the service load of the sprinkler

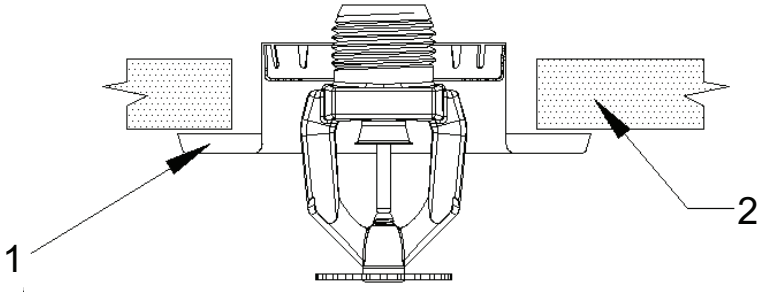
3.1.5
design width
maximum width of the sprinkler coverage area

3.1.6
housing assembly
escutcheon
ornamental or protective component(s) around the hole from which the sprinkler penetrates the plane of the ceiling or the wall

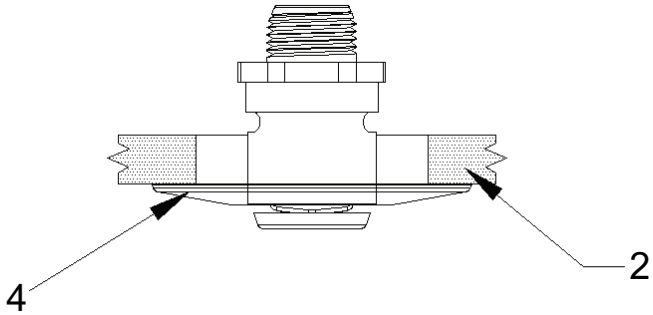
Note 1 to entry: For the purposes of this part of ISO 6182, housing assembly applies to recessed and concealed sprinklers. See Figure 1.



a) Concealed sprinkler



b) Recessed sprinkler



c) Flush sprinkler

Key
1 housing assembly
2 ceiling
3 cover plate
4 escutcheon

Figure 1 — Concealed, recessed, and flush sprinklers

3.1.7
response time index
RTI
measure of sprinkler sensitivity

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

where

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

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

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

3.1.8
service load
combined force exerted on the sprinkler body by the assembly load of the sprinkler and the equivalent force of the rated pressure on the inlet

3.1.9
sprinkler
thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and quantity over a designated area

3.1.9.1
domestic sprinkler
sprinkler intended to provide control of fire in domestic occupancies

3.1.10
standard orientation
orientation that produces the shortest response time with the axis of the sprinkler inlet perpendicular to the airflow

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

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

3.2.1
fusible element sprinkler
sprinkler that opens under the influence of heat by the melting of a component

3.2.2
glass bulb sprinkler
sprinkler that opens under the influence of heat by the bursting of the glass bulb through pressure resulting from expansion of the fluid enclosed therein

3.3 Type of sprinklers according to type of water distribution and orientation

3.3.1
horizontal sprinkler
sprinkler, arranged such that the water stream is directed horizontally against the distribution plate

3.3.2
pendent sprinkler
sprinkler, arranged such that the water stream is directed downwards against the distribution plate

3.3.3
sidewall sprinkler
sprinkler giving a one-sided water distribution over a definite protection area

3.3.4
upright sprinkler
sprinkler, arranged such that the water stream is directed upwards against the distribution plate

3.4 Special types of sprinklers

3.4.1
concealed sprinkler
recessed sprinkler having a cover plate

Note 1 to entry: See Figure 1.

3.4.2
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 might consist of pendent, sidewall, or other types.

3.4.3
flush sprinkler (1)
<pendent sprinkler> sprinkler in which 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: These are not typically frame arm sprinklers.

Note 2 to entry: See Figure 1.

3.4.4
flush sprinkler (2)
<horizontal sprinkler> sprinkler which is within the wall, but the heat-responsive collector projects into the room beyond the plane of the wall

Note 1 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 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 part of ISO 6182.

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.

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

NOTE 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 Coverage area

This sprinkler shall have an area of coverage not exceeding 37,2 m^2.

6.1.2 Orifices

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

6.1.3 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 rating and colour coding (see 7.2)

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 to 107
79	Yellow	—
93, 107	Green	—

6.3 Operating temperatures (see 7.2)

Sprinklers shall be verified to operate within the temperature range of:

$$t = x \pm (0{,}035x + 0{,}62)°C \quad (1)$$

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 and distribution (see 7.3 and 7.4)

6.4.1 Water flow constant (see 7.3)

6.4.1.1 The flow constant, K, for sprinklers is given by 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.

6.4.1.2 The value of the nominal flow constant, K, published in the manufacturer's design and installation instructions shall be verified using the test method of 7.3. Each flow constant, K, (calculated) shall be within ±5 % or ±3 units of the manufacturer's value, whichever is greater.

6.4.2 Water distribution (see 7.4)

6.4.2.1 General

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

6.4.2.2 Horizontal surfaces

When installed in accordance with the manufacturer's design and installation instructions and tested as described in 7.4.1.1 to 7.4.1.4, a sprinkler shall distribute water over a horizontal surface, such that, the discharge density collected in any single 300 mm × 300 mm collection pan within the design area shall be at least 0,8 mm/min, except that

a) no more than four collection pans in each quadrant shall be allowed to be at least 0,6 mm/min for upright and pendent sprinklers, and

b) no more than eight collection pans shall be allowed to be at least 0,6 mm/min for each half (split along the sprinkler centerline) of the design area for sidewall sprinklers.

6.4.2.3 Vertical surfaces

When installed in accordance with the design and installation instructions and tested as described in 7.4.2, a sprinkler shall distribute water over vertical surfaces as follows:

a) Walls within the coverage area shall be wetted to at least 700 mm of the ceiling with one sprinkler operating at the specified design flow rate.

b) For square coverage areas, each wall within the coverage area shall be wetted with at least 5 % of the sprinkler flow; for rectangular coverage areas, each wall within the coverage area shall be wetted with a proportional water amount based on 20 % of the total sprinkler discharge in accordance with Formula (3):

$$A_{\mathrm{col}} = 0{,}2\frac{l_{\mathrm{W}}}{l_{\mathrm{P}}} \tag{3}$$

where

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

l_{W} is the wall length, expressed in metres;

l_{P} is the total perimeter of coverage area e.g. the length of all walls combined, expressed in metres.

6.5 Function (see 7.5)

6.5.1 Lodgement

When tested in accordance with 7.5.1, the sprinkler shall open and, any lodgement of released parts shall be cleared within 10 s of release of the heat-responsive element.

6.5.2 Deflector strength

The deflector and its supporting parts shall not sustain significant damage as a result of the deflector strength test specified in 7.5.2.

If minor damage is noted, testing in accordance with 6.4.2 can be done to demonstrate compliance.

NOTE In most instances, visual examination of the sprinkler will be sufficient to establish conformance with 6.5.2.

6.6 Service load and strength of sprinkler body (see 7.6)

6.6.1 The sprinkler body shall comply with the requirements of 6.6.1.1 or 6.6.1.2

6.6.1.1 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 7.6.1 or 7.6.2.

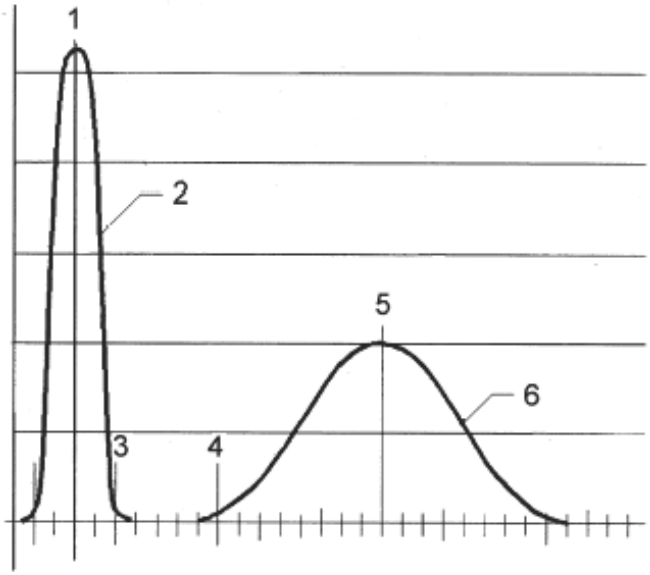
6.6.1.2 The sprinkler body shall not show permanent elongation of more than 50 % of the sprinkler body with the design load being applied after being subjected to twice the assembly load as measured according to 7.6.3.

6.6.2 The manufacturer shall specify the average and upper limit of the service or assembly load. These values shall not be exceeded when tested in accordance with 7.6.1, 7.6.2, or 7.6.3 as applicable

6.7 Strength of heat-responsive element (see 7.7)

6.7.1 Glass bulb elements

When tested in accordance with 7.7, 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 (y) of 0,99 for 99 % of the samples (P). Calculations will be based on normal or Gaussian distribution, except where another distribution can be shown to be more applicable due to manufacturing 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

6.7.2 Fusible elements

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 7.7, for a period of 100 h when tested in accordance with 7.7.2.1, or

b) demonstrate the ability to sustain the design load when tested in accordance with 7.7.2.2 (see Annex B).

6.8 Leak resistance and hydrostatic strength (see 7.8)

6.8.1 A sprinkler shall not show any sign of leakage when tested according to 7.8.1.

6.8.2 A sprinkler shall not rupture, operate, or release any parts when tested according to 7.8.2.

6.9 Heat exposure (see 7.9)

6.9.1 There shall be no damage to the glass bulb element when the sprinkler is tested by the method specified in 7.9.1.

6.9.2 Sprinklers shall withstand exposure to increased ambient temperature without evidence of weakness or failure when tested by the method specified in 7.9.2.

6.10 Thermal shock for glass bulb sprinklers (see 7.10)

Glass bulb sprinklers shall not be damaged when tested according to 7.10. Following the thermal shock exposure, the sprinkler shall comply with 6.5.1 when tested with an inlet pressure of 0,035 MPa (0,35 bar).

6.11 Corrosion (see 7.11)

6.11.1 Stress corrosion for copper-based alloy components (see 7.11.1)

When tested in accordance with 7.11.1, each sprinkler shall not show any cracks, signs of delamination or failure that can affect its ability to function as intended.

6.11.2 Sulfur dioxide/carbon dioxide corrosion (see 7.11.2)

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 7.11.2.

Following exposure, glass bulb sprinkler samples shall either be

a) tested at 0,035 MPa (0,35 bar) in accordance with 6.5.1, or

b) meet the requirements of 6.22 for concealed and recessed sprinklers, or the requirements of 6.13.2 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 6.5.1 and the remaining samples shall meet the requirements of 6.22 for concealed and recessed sprinklers or the requirements of 6.13.2 for other types of sprinklers.

6.11.3 Hydrogen sulfide corrosion (see 7.11.3)

NOTE In some countries, this test is not mandatory.

Coated and uncoated sprinklers shall be resistant to hydrogen sulfide saturated with water vapour when conditioned in accordance with 7.11.3.

Following exposure, glass bulb sprinkler samples shall either be

a) tested at 0,035 MPa (0,35 bar) in accordance with 6.5.1, or

b) meet the requirements of 6.22 for concealed and recessed sprinklers, or the requirements of 6.13.2 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 6.5.1 and the remaining samples shall meet the requirements of 6.22 for concealed and recessed sprinklers or the requirements of 6.13.2 for other types of sprinklers.

6.11.4 Salt spray corrosion (see 7.11.4)

Coated and uncoated sprinklers shall be resistant to salt spray when conditioned in accordance with 7.11.4.

Following exposure, glass bulb sprinkler samples shall either be

a) tested at 0,035 MPa (0,35 bar) in accordance with 6.5.1, or

b) meet the requirements of 6.22 for concealed and recessed sprinklers, or the requirements of 6.13.2 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 6.5.1 and the remaining samples shall meet the requirements of 6.22 for concealed and recessed sprinklers or the requirements of 6.13.2 for other types of sprinklers.

6.11.5 Moist air exposure (see 7.11.5)

Sprinklers shall be resistant to moist air exposure when tested in accordance with 7.11.5. Following exposure, the sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with 6.5.1.

6.12 Water hammer (see 7.12)

Sprinklers shall not leak during or after the pressure surges described in 7.12. After being subjected to the test according to 7.12, they shall show no signs of mechanical damage, shall meet the requirement of 6.8.1 and shall operate when functionally tested to the requirements of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only.

6.13 Dynamic heating (see 7.13)

6.13.1 Standard orientation

Sprinklers shall have an RTI not exceeding 50 $(m \cdot s)^{0,5}$ when tested in the standard orientation in accordance with 7.13.

For concealed and recessed sprinklers, see 6.22.

6.13.2 Post-exposure RTI

After exposure to the corrosion test according to 6.11.2, 6.11.3, and 6.11.4, sprinklers shall be tested in the standard orientation in accordance with 7.13.1 to determine the post-exposure RTI. All post-exposure RTI values shall be calculated as in 7.13.2. The values determined shall meet one of the following:

a) none of the post-exposure RTI values shall exceed the limits referenced in 6.13.1;

b) the average RTI value shall not exceed 130 % of the pre-exposure average value.

6.14 Resistance to heat (see 7.14)

Open sprinklers shall be resistant to high temperatures when tested in accordance with 7.14. After exposure, the sprinkler shall not fracture or break. If visual deformation is observed on the sprinkler orifice, it shall meet the requirements of 6.4.1. If visual deformation is observed on the sprinkler frame or deflector, it shall meet the requirements of 6.4.2.

6.15 Vibration (see 7.15)

Sprinklers shall be able to withstand the effects of vibration without deterioration when tested in accordance with 7.15. After the vibration test of 7.15, sprinklers shall show no visible deterioration and shall meet the requirements of 6.8.1 and 6.13.1.

6.16 Impact (see 7.16)

Sprinklers shall show no fracture or deformation, and shall meet the requirements of 6.8.1 and 6.13.1 after the impact test of 7.16. If the sprinkler is deformed during testing, water distribution testing in accordance with 6.4.2 shall be required.

6.17 Rough usage test (see 7.17)

A sprinkler shall withstand the effects of rough usage without deterioration of its performance characteristics. Following 3 min of tumbling as described in 7.17, the sprinkler shall comply with the leak requirement of 6.8.1 and the RTI requirement of 6.13.1 in standard orientation only, or in accordance with 6.22 a), the requirement for recessed and concealed sprinklers.

6.18 Fire performance (see 7.18)

When fire-tested as described in 7.18, sprinklers shall meet the following requirements:

a) Maximum temperature for 76 mm below the ceiling shall not exceed 315 °C.

b) Maximum temperature for 1,6 m above the floor shall not exceed 93 °C.

c) Temperature at the location described in item b) shall not exceed 54 °C for more than any continuous 2-min period.

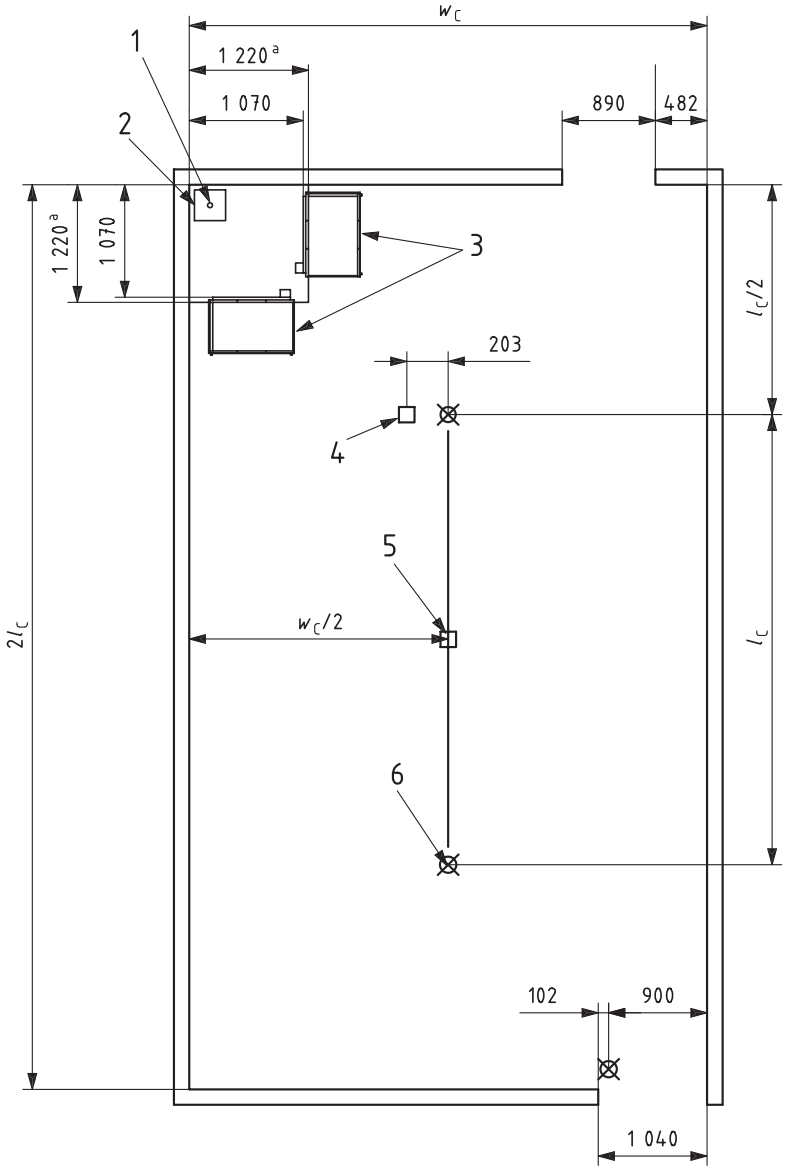
d) Maximum ceiling material temperature for 6,0 mm behind the finished ceiling surface shall not exceed 260 °C.

e) A maximum of two sprinklers shall operate.

f) The third sprinkler at the doorway shall not operate.

See Figure 3 (pendent or upright sprinklers) or Figures 4 and 5 (sidewall sprinklers) for temperature measuring locations.

Dimensions in millimetres

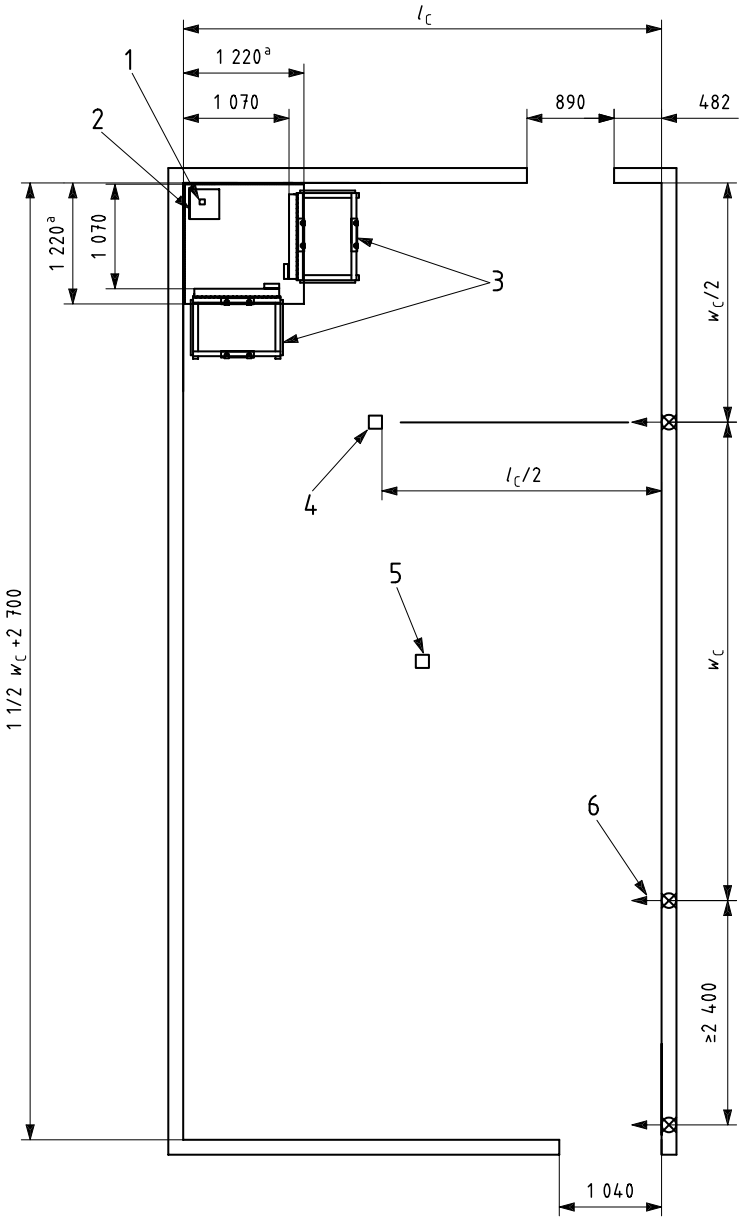


Key

1 thermocouple, 6 mm above ceiling and 254 mm diagonally from the corner
2 wood crib
3 simulated furniture
4 thermocouple, 76 mm below ceiling and 1 600 mm above the floor
5 thermocouple, 76 mm below ceiling (room centre)
6 sprinkler (typical)
a plywood
w_C coverage width
l_C coverage length

Figure 3 — Fire test arrangement — Pendent and upright

Dimensions in millimetres

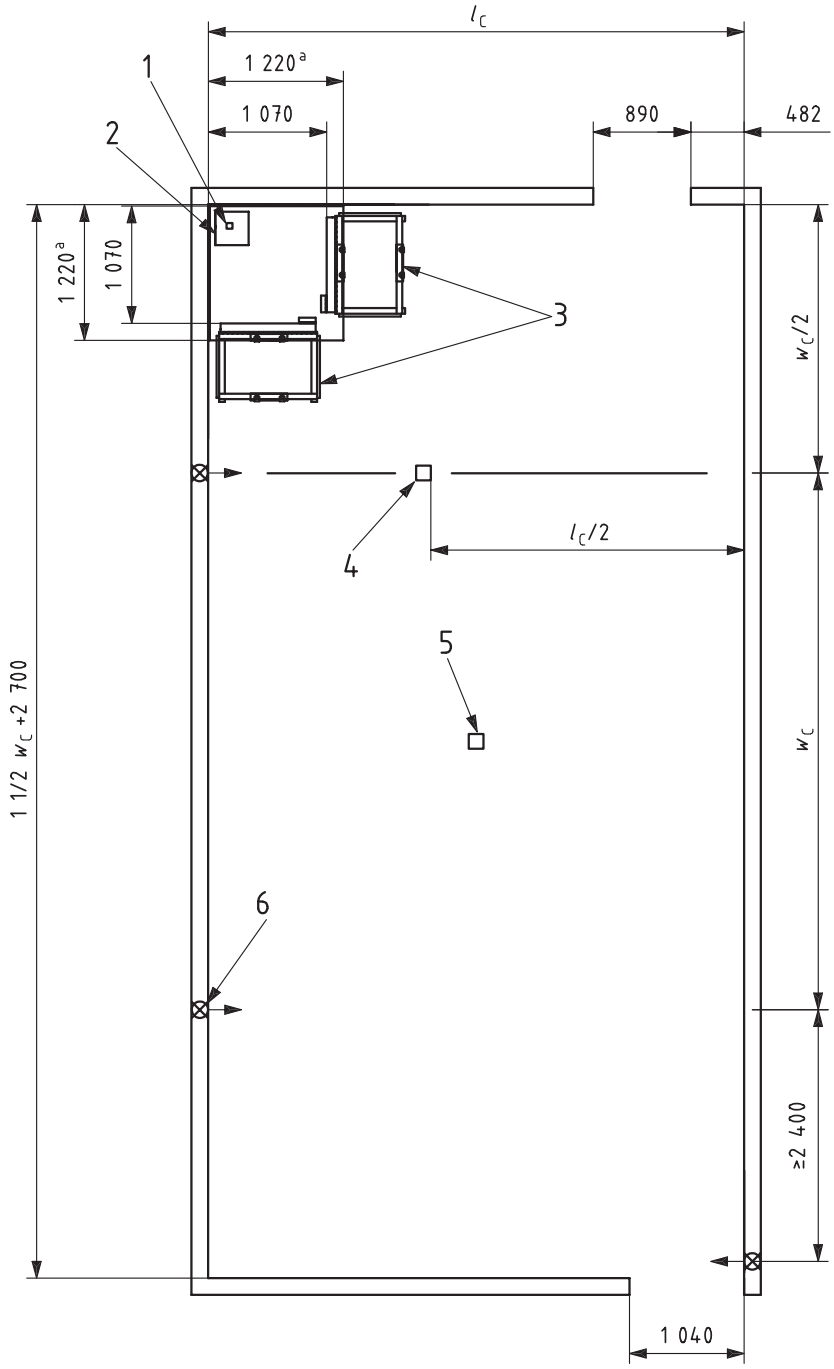


Key

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

Figure 4 — Fire test arrangement 1 — Sidewall

Dimensions in millimetres



Key

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

Figure 5 — Fire test arrangement 2 — Sidewall

6.19 Lateral discharge (see 7.19)

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

6.20 30-day leakage resistance (see 7.20)

When tested in accordance with 7.20, sprinklers shall not leak or sustain any mechanical damage. Following exposure, the sprinklers shall meet the requirement of 6.8.1.

6.21 Vacuum resistance (see 7.21)

Sprinklers shall not exhibit distortion or mechanical damage and shall meet the leakage requirements of 6.8.1 after being subjected to the test in 7.21.

6.22 Room response (see 7.22)

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

a) 75 s or less for each sprinkler when subjected to the test described in 7.22;

b) mean time equal to or less than a 1,30 multiple of the mean time of the sprinklers tested in accordance with item a) after being subjected to the exposure test specified in 6.9.2, 6.11.2, 6.11.3, and 6.11.4.

6.23 Freezing test (see 7.23)

Sprinklers shall be resistant to low temperatures when tested according to 7.23. 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 6.8.1 and shall meet the RTI requirements of 6.13.1.

6.24 Dry-type sprinkler deposit loading (see 7.24)

NOTE In some countries, this test is not mandatory.

Following exposure to a carbon dioxide-sulfur dioxide atmosphere in accordance with 7.24.1 to 7.24.3, 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.

6.25 Dry sprinkler air tightness (see 7.25)

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

When tested as described in 7.25.1 and 7.25.2, the connection of the extension nipple to the inlet seal assembly for a dry-type sprinkler shall not exhibit leakage at any air pressure from 0 kPa to 100 kPa (0 to 1 bar) when the pressure is applied externally to this connection.

6.26 Protective covers (see 7.26)

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

6.26.1 Sprinklers might 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.

6.26.2 Sprinklers equipped with sprinkler covers shall comply with the impact test for protective covers and marking requirements, see 7.26 and 8.3.

6.26.3 A sprinkler, with the protective cover installed, shall not be damaged or leak and the cover shall remain in place when tested as described in 7.26.

6.26.4 Protective covers shall be designed not to allow damage to the sprinkler and the heat responsive 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.

6.27 Dezincification of brass parts (see 7.27)

NOTE In some countries, this test is not mandatory.

Sprinkler parts 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.

6.28 Stress corrosion – magnesium chloride (see 7.28)

NOTE In some countries, this test is not mandatory.

Sprinklers having components consisting of stainless steel alloys shall be subjected to 7.28. The stainless steel components shall not show evidence of fracture, distortion, or impending separation from the frame unless tested as described in 7.28.4.

7 Test methods

7.1 Examination

7.1.1 Preliminary examination

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

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

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

7.1.2 Visual examination

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

a) marking;

b) conformity of the sprinklers with the manufacturer's drawings and specification;

c) obvious defects.

7.2 Operating temperature tests (see 6.3)

7.2.1 Test of static operation

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

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

The test shall be conducted in a liquid bath. Sprinklers having nominal operating temperatures of ≤ 80 °C shall be tested in a bath of demineralized water. Sprinklers with higher rated elements shall be tested in a bath of glycerine, vegetable oil, or synthetic oil.

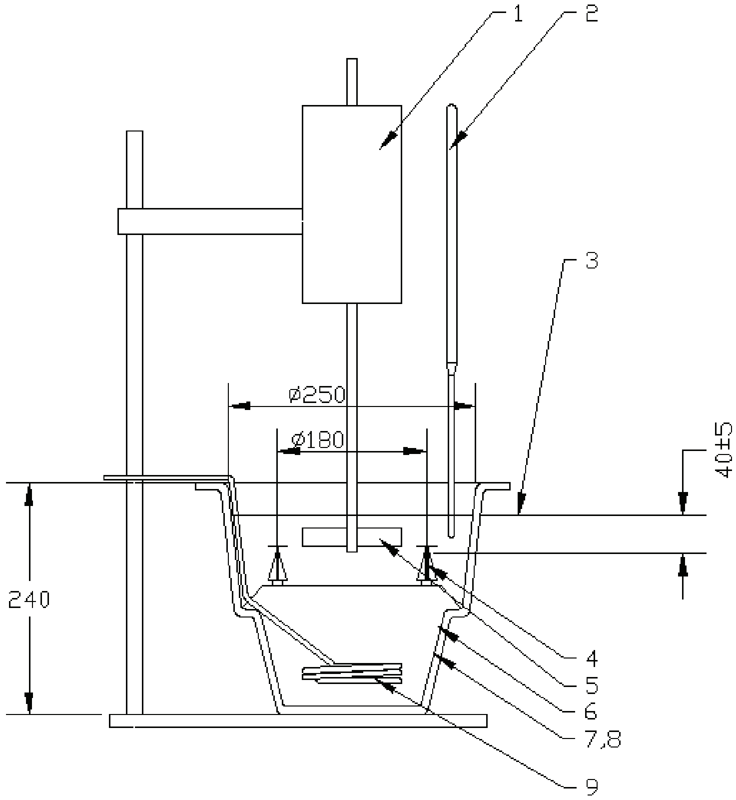
The sprinklers shall be located in the liquid bath in a vertical position and totally immersed under a liquid cover of at least 5 mm. The test zone is located at a distance, below the liquid surface, level with the geometric centre of the glass bulb or fusible element. The test zone shall not be less than 35 mm below the liquid surface level. The temperature deviation within the test zone shall be within ±0,25 °C.

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 7.2.2.

An example of a standardized liquid bath is shown in Figure 6. 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, an IEC 60751 thermocouple or equivalent can be used.

Dimensions in millimetres



Key

1 agitator motor (150 rpm)

2 thermometer calibrated for 40 mm immersion and either PT-100 or thermocouple

3 liquid level

4 ring to support sprinklers

5 double wing agitator (100 mm × 20 mm)

6 mesh screen

7 standard glass vessel

8 desiccators, Ø250 mm, liquid volume of approximately 7 l

9 immersion heater

Figure 6 — Example of a liquid bath test apparatus

7.2.2 Fifty 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 ± 1,1) °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 ± 0,3) °C/min 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.

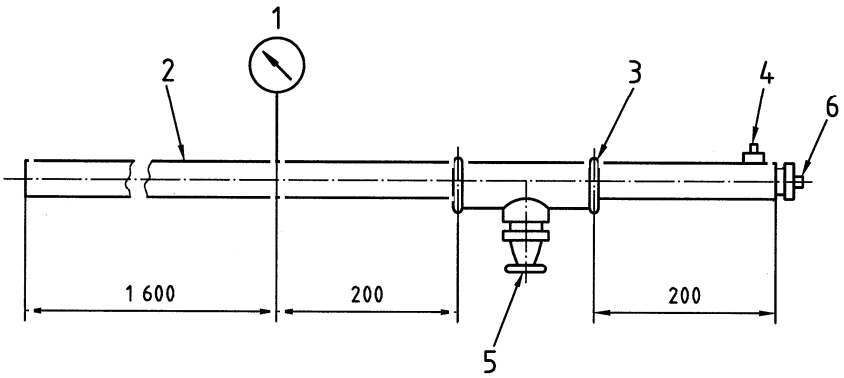
NOTE It is not necessary to meet the operating temperature limits of 6.3 in this test.

7.3 Water flow constant test (see 6.4.1)

The sprinkler shall be mounted with a pressure gauge on a supply pipe, an example of which is shown in Figure 7. Four sprinklers shall be tested. Dry-type sprinklers of the shortest and longest lengths

manufactured 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). The measurements shall be taken with both increasing and decreasing pressure over the range of test pressures. 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 6.4.1.2. During the test, pressures shall be corrected for differences in height between the gauge and the outlet orifice of the sprinkler.

Dimensions in millimetres



Key

1 pressure gauge
2 steel tube, nominal internal diameter 40 mm, medium mass (in accordance with ISO 65)
3 fitting, 10 mm, 15 mm, 20 mm, 25 mm, or 32 mm (in accordance with ISO 49)
4 air bleed valve
5 sprinkler
6 plug or cap

NOTE Accuracy: pressure gauge ±2 %; weighing machine ±1 %.

Figure 7 — Example of a water flow test apparatus

7.4 Water distribution tests (see 6.4.2)

7.4.1 Horizontal surfaces (see 6.4.2.1)

7.4.1.1 General

Tests are to be conducted on an individual sprinkler using design flow rates specified in the manufacturer's design and installation instructions that simulate one sprinkler in a system operating. For sprinklers having a pressure rating greater than 1,2 MPa (12 bar), tests shall be conducted using flows corresponding to a pressure of 0,5 MPa (5 bar) less than the rated pressure at the maximum coverage area. The water distribution test is to be conducted for 20 min.

Dry type sprinklers of the shortest manufactured length shall be tested. If the K-factor for the longest length deviates by more than 5 % from the shortest length, then the longest length shall also be tested.

7.4.1.2 Open sprinkler

An open sprinkler is to be installed in its intended position in a pipe fitting having a 25 mm inlet and an outlet the same size as the sprinkler inlet, and is to be supplied with water through 25 mm piping. The sprinkler deflector is to be located in its intended position as specified in the manufacturer's design and

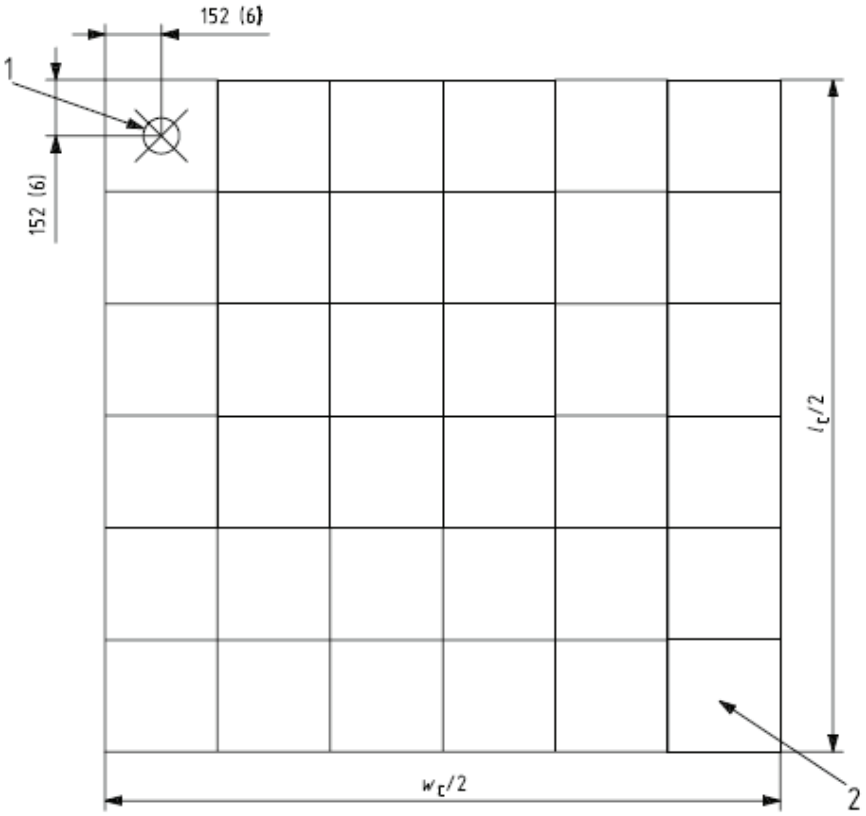
installation instructions. A pendent or upright sprinkler is to be tested after being rotated 90° about its vertical axis after being tested as initially installed.

7.4.1.3 Upright and pendent sprinkler

Collector pans measuring 300 mm × 300 mm are to be placed on the floor in one quadrant of the sprinkler's discharge pattern; see Figure 8. The tops of the pans are to be 2,4 m below the ceiling.

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

Dimensions in millimetres (inches)



Key

1 sprinkler

2 collector pans, 300 mm × 300 mm

$w_{C/2}$ coverage width divided by 2

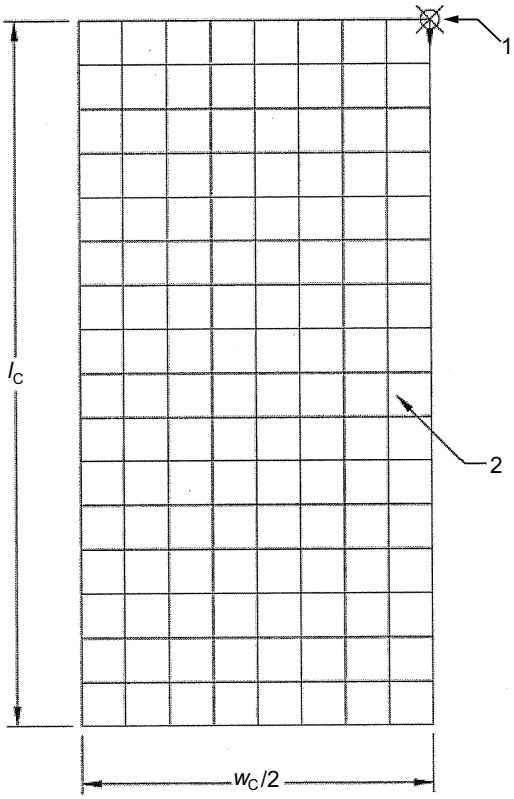
$l_{C/2}$ coverage length divided by 2

Figure 8 — Water collection for upright, pendent, recessed pendent, and ceiling sprinklers

7.4.1.4 Sidewall sprinkler (see 6.4.2.1)

Collector pans measuring 300 mm × 300 mm are to be placed as shown in Figure 9. The tops of the pans are to be 2 m below the ceiling.

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



Key

1 sidewall sprinkler

2 collector pans, 300 mm × 300 mm

w_C coverage width

l_C coverage length

Figure 9 — Water collection for sidewall sprinklers

7.4.2 Vertical surfaces (see 6.4.2.3)

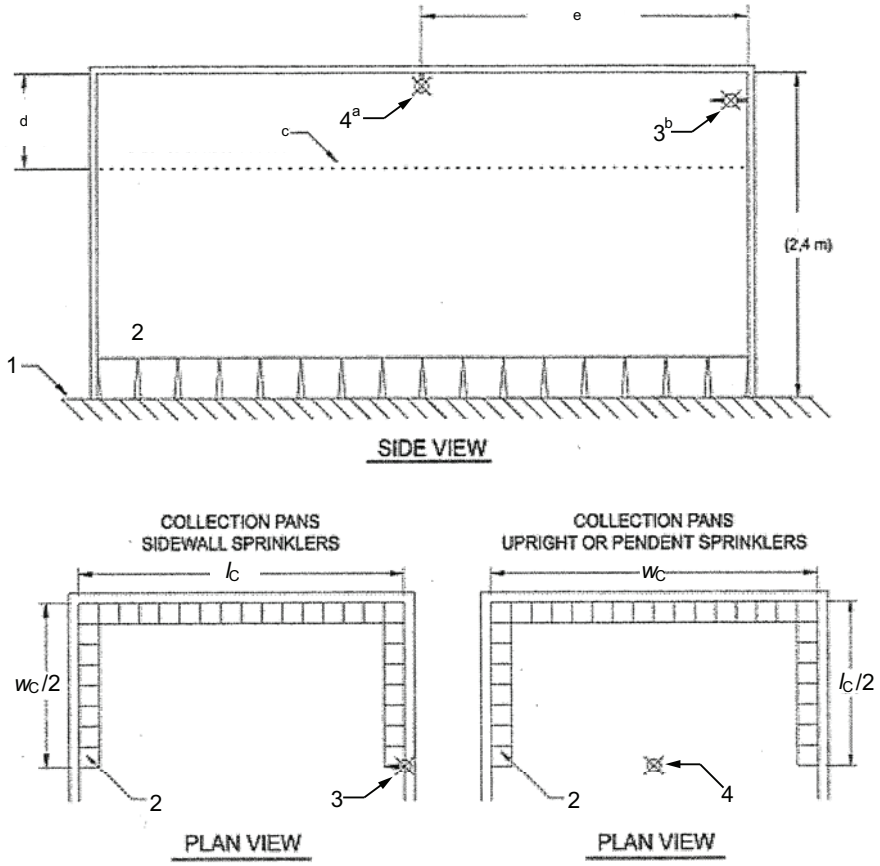
Tests are to be conducted on an individual sprinkler using design flow rates specified in the manufacturer's design and installation instructions that simulate one sprinkler in a system operating. For sprinklers having a pressure rating greater than 1,2 MPa (12 bar), tests shall be conducted using flows corresponding to a pressure of 0,5 MPa (5 bar) less than the rated pressure at the maximum coverage area. Each water distribution test is to be conducted for a minimum of 10 min.

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

Collector pans are to be used to determine that at least 5 % of the sprinkler flow is discharged onto each wall; see 7.4.1.4. The walls of the test room are to be nonporous or have a nonporous covering so that water impinging on the walls can be collected and measured.

The collector pans measure 300 mm × 300 mm and are placed on the floor against the walls for the length and width of specified coverage. The tops of the pans are located 2 m below the ceiling. Means shall be provided to prevent sprinkler discharge from directly entering the pans; see Figure 10.

Dry type sprinklers of the shortest manufactured length shall be tested. If the K-factor for the longest length deviates by more than 5 % from the shortest length, then the longest length shall also be tested.



Key

1 floor
2 collector pans
3 sidewall sprinkler
4 pendent or upright sprinkler
w_C coverage width
l_C coverage length
a For upright or pendent sprinkler only.
b For sidewall sprinkler only.
c Maximum wall wetting distance from ceiling.
d 0,7 m.
e $l_C/2$ or $w_C/2$.

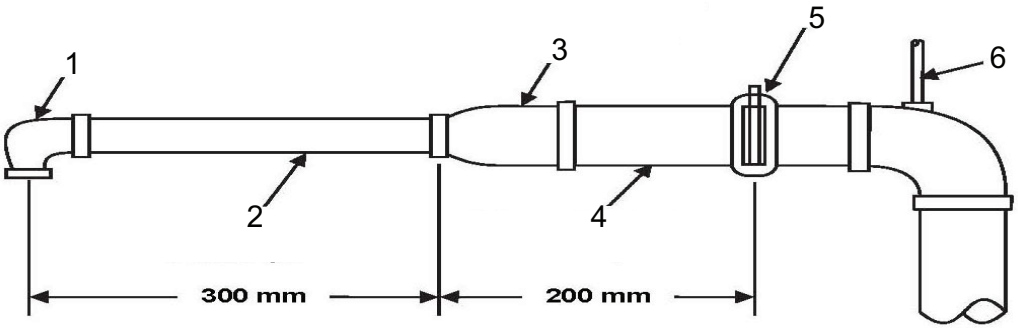
Figure 10 — Water collection

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

7.5 Functional test (see 6.5)

7.5.1 Lodgement test

7.5.1.1 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 11 or 12) and a double feed (see Figure 13) water supply arrangement. The test pressures and number of samples tested at each pressure using each water supply configuration are specified in Table 2. 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.

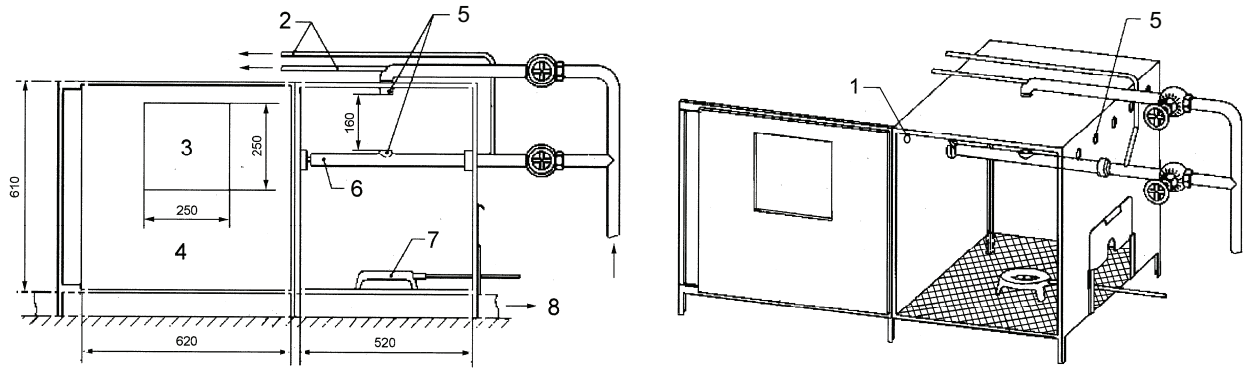


Key

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

Figure 11 — Typical single feed lodgement test arrangement

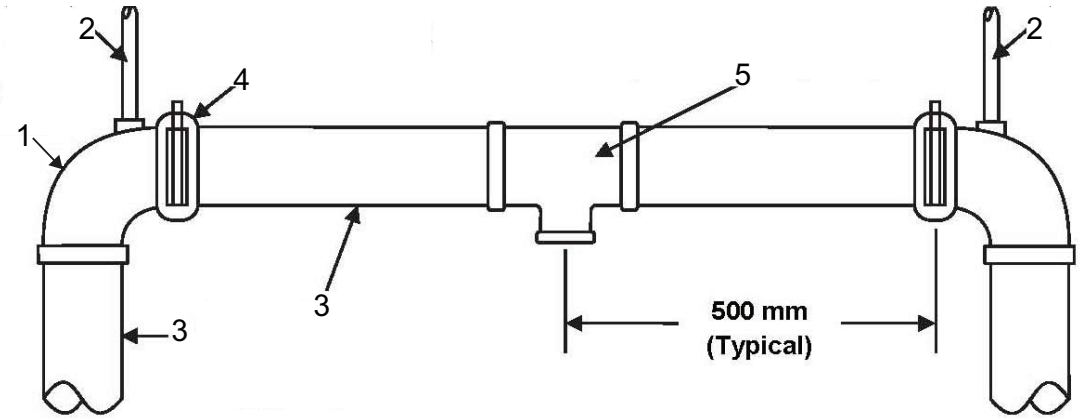
Dimensions in millimetres



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 12 — Typical function test oven



Key

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

Figure 13 — Typical double feed lodgement test arrangement

Table 2 — Lodgement test pressures and number of test samples

Test pressure[c]		Water supply arrangement	Number of test samples[d]
MPa	bar		
0,035 or 0,05	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
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 or 0,05 MPa (0,35 or 0,5 bar), 0,35 MPa (3,5 bar), and the rated pressure.

[d] Testing using each temperature rating might be required in some countries.

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

7.5.1.2 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 7.5.1, 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 7.5.1.1 and the K-factor at each pressure is to be recorded. Dry-type sprinkler samples are to be tested as described in 7.5.1. After sprinkler operation, the flow at each pressure specified in 7.5.1.1 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.

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

7.5.2 Deflector strength test

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.

7.6 Service load and strength of sprinkler body test (see 6.6)

7.6.1 Test option 1

7.6.1.1 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.

7.6.1.1.1 Alternatively, the service load can 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.

7.6.1.2 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.

7.6.1.3 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.

7.6.1.3.1 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.

7.6.1.3.2 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.

7.6.1.3.3 Remove the load and compare the permanent elongation with the requirement of 6.6.1.

7.6.2 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.

7.6.3 Test option 3

7.6.3.1 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.

7.6.3.2 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.

7.6.3.3 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.

7.6.3.4 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.

7.6.3.5 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.

7.6.3.6 Remove the load and take a third measurement. Compare the permanent elongation with the requirement of 6.6.1.2.

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.

7.7 Strength of heat-responsive element test (see 6.7)

7.7.1 Glass bulbs

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

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

Using the lowest 50 measured bulb strength results, calculate the average strength and the lower tolerance limit (LTL) for bulb strength (see Annex A). Using the values of service load recorded in 7.6.1, calculate the upper tolerance limit (UTL) for the sprinkler release element service load. Verify compliance with 6.7.1.

7.7.2 Fusible elements

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

7.7.2.2 Determine compliance with the requirements of 6.7.2(b) by subjecting fusible heat-responsive elements to loads in excess of the maximum design load, which will produce failure within and after 1 000 h (see Annex B). At least 10 samples shall be subjected to different loads up to 15 times the maximum design load. Abnormal failures shall be rejected; however, at least 10 valid 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.

7.7.2.3 The tests of 7.7.2.1 and 7.7.2.2 shall be conducted at an ambient temperature of (20 ± 3) °C.

7.8 Leak resistance and hydrostatic strength tests (see 6.8)

7.8.1 Twenty 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 ± 0,03) MPa/s [(1 ± 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 ± 0,03) MPa/s [(1 ± 0,25) bar/s], and maintain it for 15 s. Each sprinkler shall meet the requirement of 6.8.1.

7.8.2 Following the test of 7.8.1, 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 6.8.2.

NOTE In some countries, the hydrostatic strength test in 7.8.2 is not mandatory.

7.9 Heat exposure test (see 6.9)

7.9.1 Glass bulb sprinklers (see 6.9.1)

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.

7.9.2 All sprinklers (see 6.9.2)

Twelve sprinklers shall be exposed for a period of 90 d to a high ambient temperature that is 11 °C below the nominal rating or at the temperature given in Table 3 whichever is lower, but not less than 49 °C. After exposure, four of the sprinklers shall be subjected to the requirements of 6.8.1 and 6.13.1, four sprinklers to the requirements of 6.5.1 [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 3 — Test temperatures for sprinklers

Marked nominal temperature rating °C	Test temperature °C
57 to 60	49
61 to 77	52
78 to 107	79

7.10 Thermal shock test for glass bulb sprinklers (see 6.10)

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

7.10.2 Sprinklers having nominal operating temperatures less than or equal to 80 °C shall be tested in a water bath. Sprinklers with higher-rated elements shall be tested in a bath of suitable fluid. The temperature of the bath shall be (10 ± 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 ± 0,5) °C. Then test the sprinklers in accordance with 6.5.1 at 0,035 MPa (0,35 bar).

7.11 Corrosion tests (see 6.11)

7.11.1 Stress corrosion test for copper-based alloy components

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

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

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

The moist ammonia–air mixture shall be maintained as closely as possible at atmospheric pressure, with the temperature maintained at (34 ± 2) °C. Provision shall be made for venting the chamber via a capillary tube to avoid the increase 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 samples.

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 6.8 and 6.5.1.

Sprinklers showing cracking, delamination or failure of any non-operating part shall not show evidence of separation of permanently attached parts when subjected to a flowing pressure of rated pressure for 30 min.

7.11.2 Sulfur dioxide/carbon dioxide corrosion test (see 6.11.2)

Subject 8 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, 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 ± 3) °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 °C with a relative humidity no greater than 70 %.

After the drying period, the samples shall be tested as described in 6.13.2.

7.11.3 Hydrogen-sulfide corrosion test (see 6.11.3)

Subject 8 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 ± 3) °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 °C with a relative humidity no greater than 70 %.

After the drying period, the samples shall be tested in accordance with 6.13.2.

7.11.4 Salt spray corrosion test (see 6.11.4)

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

7.11.4.2 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 5 % by-mass sodium chloride solution in distilled 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 °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 m3, in which the exposure zone shall be maintained at a temperature of (35 ± 2) °C. The temperature shall be recorded at least once per day, at least 7 h. 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 (5 ± 1) % by mass.

The sprinklers shall withstand exposure to the salt spray for a period of 10 d. After this period, the sprinklers shall be removed from the fog chamber and allowed to dry for 4 d to 7 d at a temperature not exceeding (20 ± 5) °C in an atmosphere having a relative humidity not greater than 70 %. After the drying period, the samples shall be tested in accordance with 6.13.2.

7.11.5 Moist air exposure test (see 6.11.5)

Five sprinklers shall be exposed to a high temperature-humidity atmosphere consisting of a relative humidity of (98 ± 2) % and a temperature of 94 °C ± 2 °C. For evaluation of dry type sprinklers, the shortest length manufactured shall be used.

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

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

7.12 Water hammer test (see 6.12)

7.12.1 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 ± 0,05) MPa [(4 ± 0,5) bar] to twice the rated pressure but not less than (3,0 ± 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.

7.12.2 Visually examine each sprinkler for leakage during the test. After this test, each sprinkler shall meet the leak resistance requirements of 6.8.1 and the functional requirement of 6.5.1 at a pressure of 0,035 MPa (0,35 bar) only.

7.13 Dynamic heating test (see 6.13)

7.13.1 Plunge test

Subject 10 sprinklers in each nominal temperature rating to the plunge test in the standard orientation. Calculate the RTI as described in 7.13.2.

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 ± 0,005) MPa [(0,35 ± 0,05) bar].

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

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

A tunnel shall be used with airflow and temperature conditions at the test section (sprinkler location) selected from the appropriate range of the conditions given in Table 4 to minimize radiation exchange between the sensing element and the boundaries confining the flow, the test section of the apparatus shall be designed to limit radiation effects to within ±3 % of calculated RTI values.

Tunnel conditions shall be selected to limit maximum anticipated equipment error to 3 %.

The range of permissible tunnel operating conditions is given in Table 4. The selected operating condition shall be maintained for the duration of the test with the tolerances as specified by Footnotes a and b to Table 4.

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

Table 4 — Range of plunge test conditions at test section (sprinkler location)

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 can 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 ±1 °C for the air temperature range of 129 °C to 141 °C within the test section and ±2 °C for all other air temperatures.

7.13.2 RTI value calculation

The formula used to determine the RTI value is as follows:

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

where

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

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

ΔT_{ea} is the mean liquid bath operating temperature of the sprinkler minus the ambient temperature, expressed in degrees Celsius (see 7.13.1);

ΔT_g is the actual air temperature in the test section minus the ambient temperature in degrees Celsius;

7.14 Heat resistance test (see 6.14)

One sprinkler body shall be heated in an oven at 770 °C ± 10 °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.

7.15 Vibration test (see 6.15)

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

7.15.2 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

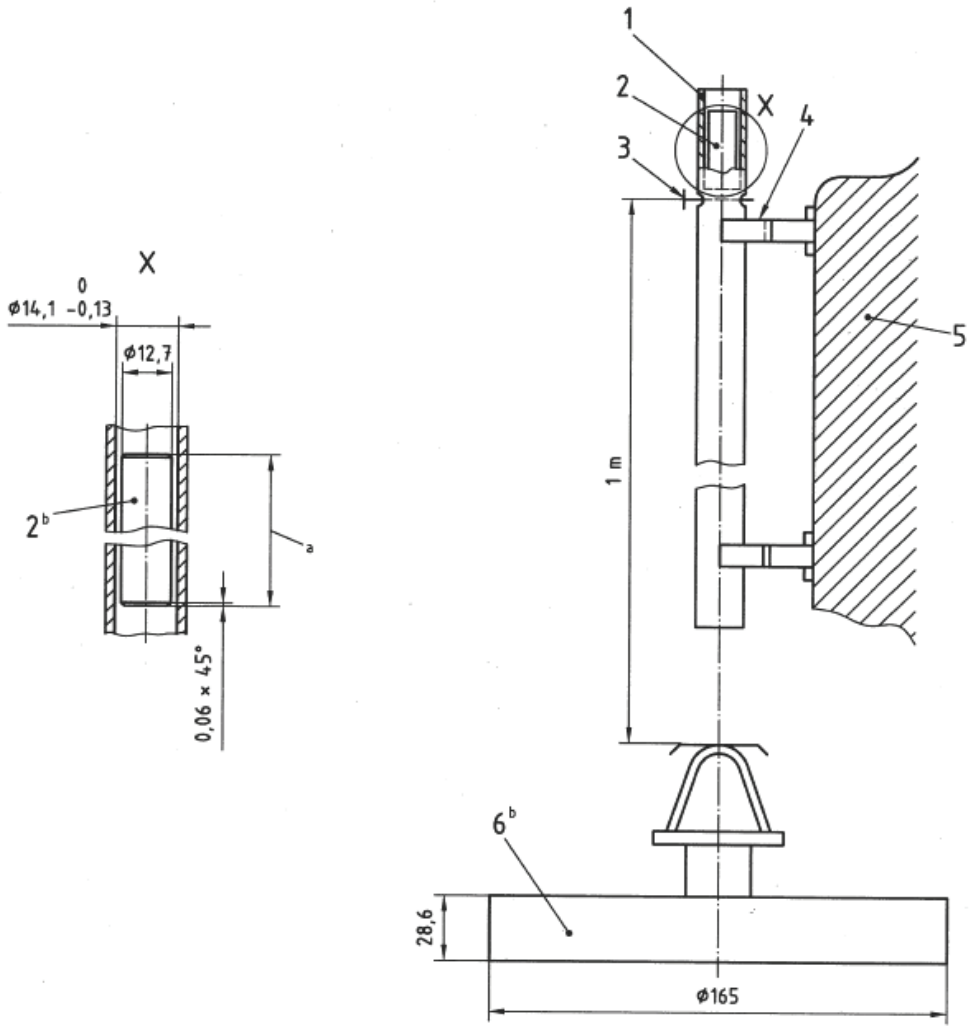
number of resonances. If no resonances are detected, the vibration from 5 Hz to 40 Hz shall be continued for 120 h.

7.15.3 After vibration, each sprinkler shall then be subjected to the leakage resistance test (see 6.8.1) and to the RTI requirements of 6.13.1, or in accordance with 6.22 a) for recessed and concealed sprinklers.

7.16 Impact test (see 6.16)

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 covers in place. The mass equivalent to that of a sprinkler shall be dropped from a height of 1 m (see Figure 14). 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 6.16.

Dimensions in millimetres



Key

1 cold drawn seamless steel tubing
2 mass (see detail "A")
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 14 — Impact test apparatus

7.17 Rough usage test (see 6.17)

Five sample sprinklers are to be tested. The sprinklers shall be permitted to be tested with a protective cover 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.

NOTE Dry sprinklers are not required to be subjected to this test. In addition, concealed sprinklers are tested without their cover plate 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 (see 6.8.1) and to the RTI requirements of 6.13.1, or in accordance with 6.22 a) for recessed and concealed sprinklers.

7.18 Fire performance test (see 6.18)

7.18.1 Sprinklers in each temperature rating are to be subjected to the tests specified in 7.18.2 to 7.18.20. Dry type sprinklers of the shortest manufactured length shall be tested. If the K-factor for the longest length deviates by more than 5 % from the shortest length, then the longest length shall also be tested.

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

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

7.18.4 The test room shall have provision for ventilation through two door openings on opposite test room walls. Each opening shall be 2,2 m high, which provides for a 200 mm lintel above the openings. The door widths shall be as specified in Figures 3 to 5.

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

Table 5 — Test methods

Property	Test method	Range
Flame spread index	ANSI/UL 723:1993	130 ± 30
Critical heat flux	ISO 5660-1	15 ± 3 kW/m^2
Thermal response parameter	ISO 5660-1	220 ± 50 kW·(s$^{1/2}$) m^2

7.18.6 The fire source is to consist of a wood crib and simulated furniture. The wood crib is ignited with a pan of heptane and the simulated furniture is ignited using two 150 mm long by 6,4 mm diameter cotton wicks soaked in heptane (see Figure 3 for pendent or upright sprinklers and Figures 4 and 5 for sidewall sprinklers) for placement of the fire source. See Figure 15 for details of the fuel package.

Dimensions in millimetres

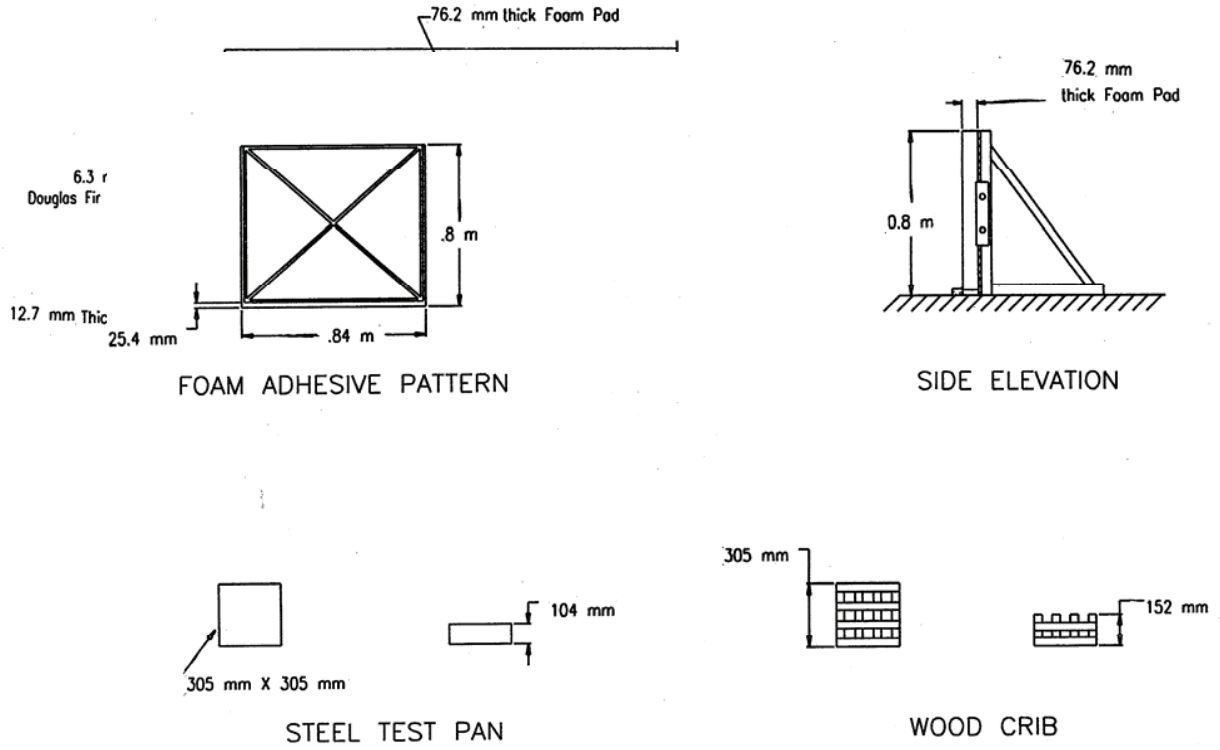


Figure 15 — Fire test crib and simulated furniture fuel package

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

— minimum initial boiling point: 88 °C;

— maximum dry point: 100 °C;

— specific gravity, 15,6 °C/15,6 °C: 0,68 – 0,73.

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

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

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

— peak heat release rate (HRR): (230 ± 50) kW/m^2;

— heat of combustion: (22 ± 3) kJ/g.

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

7.18.12 Three sprinklers are to be installed in the test room for each fire test. Two are to be installed at their maximum length and width coverage dimensions, and the third is to be installed near the doorway farthest from the fire; see Figures 3 to 5. Pendent and upright sprinklers are to be installed with their deflectors located 76 mm below the ceiling unless another distance is specified in the installation instructions. A pendent sprinkler also intended to be installed as a recessed sprinkler shall be tested in the most recessed position in lieu of 76 mm below the ceiling. Flush and concealed sprinklers are to be installed in their intended location as specified in the manufacturer's installation instructions. Sidewall sprinklers are to be installed with their deflectors located 100 mm below the ceiling and at the maximum distance below the ceiling as specified in the installation instructions if the maximum exceeds 152 mm below the ceiling; see 7.18.13 for sprinkler pipe sizes. The third sprinkler in near the door shall have the same heat-responsive element and temperature rating as the other sprinklers within the room. For pendent, upright, flush recessed pendent and concealed pendent sprinklers, the third sprinkler is to be located 51 mm below the ceiling. For sidewall sprinklers, the third sprinkler shall be located 102 mm below the ceiling.

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

7.18.14 Recessed and concealed sprinklers having vented housing assemblies are to be installed in the most recessed position and tested in a manner that does not inhibit airflow through the housing assembly (unblocked) and tested in a manner that does inhibit airflow through the escutcheons (blocked) by placing a 200 mm thick R-25 fibreglass, or equivalent, insulating batt entirely around and over the portion of the sprinkler that is located above the ceiling or behind the wall.

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

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

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

7.18.18 Sprinklers intended for use in dry systems shall be tested with the water discharge delayed 15 s after the first sprinkler operates.

7.18.19 The fire test shall be conducted for 30 min after the ignition of the wood crib, unless after 10 min, all the combustibles are extinguished or only the wood crib is sustaining combustion at which

point the test shall be terminated. The water flow rate for the test shall be the minimum specified in the manufacturer's installation instructions for each sprinkler coverage area tested and not less than the flow values specified in Table 6. In addition, the water flow rate shall be the same for single and multiple operating sprinklers.

7.18.20 Pendent or upright sprinklers shall be subjected to the fire test arrangement shown in Figure 3, and sidewall sprinklers shall be subjected to both fire test arrangements shown in Figures 4 and 5.

7.18.21 When sprinkler coverage areas exceed 3,6 m × 3,6 m, and the sprinkler has not been investigated for a 3,6 m × 3,6 m area using the same or a lesser flow rate as the next larger rated coverage area, the test specified in 7.18.1 to 7.18.21 shall be repeated in a room size corresponding to a 3,6 m × 3,6 m coverage area, using a water flow rate corresponding to the minimum flow rate required for the next larger coverage area.

7.18.22 For sprinklers having a pressure rating greater than 1,2 MPa (12 bar), tests are to be conducted at the maximum rated spacing using a flow corresponding to a pressure of 0,5 MPa (5 bar) less than the rated pressure.

7.19 Lateral discharge test (see 6.19)

7.19.1 While discharging water at a service pressure of 0,52 MPa (5,2 bar) less than the rated pressure, an open upright or pendent 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 2,4 m distant on an adjacent pipeline in the same horizontal plane.

7.19.2 Upright and pendent sprinklers

7.19.2.1 An upright or pendent spray automatic sprinkler having a nominal release temperature of 57 °C to 77 °C shall be installed on piping 2,4 m distant (centre-to-centre) from a second open sprinkler of the same type. The sprinklers shall be on separate parallel pipelines with the frame arms parallel to the pipe and the sprinkler deflectors located 102 mm below a flat ceiling. Water shall be discharged from the open sprinkler at a service pressure of 0,52 MPa (5,2 bar) less than the rated pressure. After water flow is established, the automatic sprinkler shall be exposed to the heat and flame from a 305 mm square pan 102 mm deep containing 0,47 l of heptane. The top of the pan shall be located 152 mm below the heat-responsive element.

7.19.2.2 Locate the sprinkler deflectors 102 mm below the flat ceiling and repeat both tests.

7.19.3 For sidewall sprinklers, an automatic and open sprinkler are to be installed on the same pipe line with the sprinklers located 2,4 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 102 mm below a flat ceiling and 152 mm away from a back wall. The second test is to be conducted only when the maximum distance below a flat ceiling specified by the manufacturer's installation instructions exceeds 152 mm below the ceiling. In this case, the sprinklers shall be located at that maximum distance below the ceiling and 152 mm away from a back wall.

7.19.4 Water is to be discharged from the open sprinkler at a service pressure of 0,52MPa (5,2 bar) less than the rated pressure. Under this condition, the automatic sprinkler is to be exposed to the heat and flame from a 305-mm^2 pan, 102 mm deep containing 0,47 l of heptane and 0,47 l of water, with the top of the pan located 152 mm below the heat-responsive element of the automatic sprinkler. Observations are to be made for operation of the automatic sprinkler.

7.19.5 In all test conditions, the automatic sprinkler shall operate before the heptane is consumed.

7.20 30-day leakage test (see 6.20)

7.20.1 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 ± 5) °C.

7.20.2 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 6.8.1 and show no evidence of distortion or other mechanical damage.

7.21 Vacuum test (see 6.21)

Three sprinklers shall be subjected to a gradually increasing vacuum of up to 460 mmHg[1)] applied to a sprinkler inlet for 1 min at an ambient temperature of (20 ± 5) °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 6.8.1.

7.22 Room response test (see 6.22)

7.22.1 Recessed and concealed sprinklers having vented housing assemblies are to be installed in the most recessed position and tested in a manner that will not inhibit airflow through the housing assembly (unblocked). A recessed or concealed sprinkler indicated in the installation instructions as being unvented is to be installed and tested in a manner that will inhibit airflow through the housing assembly (blocked). A pendent sprinkler also intended to be installed as a recessed sprinkler shall be tested in the most recessed position in lieu of the maximum distance below the ceiling when maximum intended installation distance below the ceiling is 76 mm or less.

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

a) For pendent-type and ceiling-type sprinkler designs without frame arms and incorporating symmetrical heat-responsive elements and symmetrical sprinkler bodies, 10 samples shall be installed in their intended position at the ceiling.

b) For pendent-type and ceiling-type sprinkler designs with or without frame arms and incorporating unsymmetrical heat-responsive elements, 10 samples shall be oriented with the heat-responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source. The samples shall be in their intended position.

c) For pendent-type and ceiling-type sprinkler designs incorporating frame arms with symmetrical heat-responsive elements, 10 samples shall be orientated with the frame arms in a plane parallel to the direction of the fire source. The samples are to be installed in their intended position.

d) For upright sprinklers having configurations referenced in items a), b), and c), 10 samples shall be installed in their pendent positions.

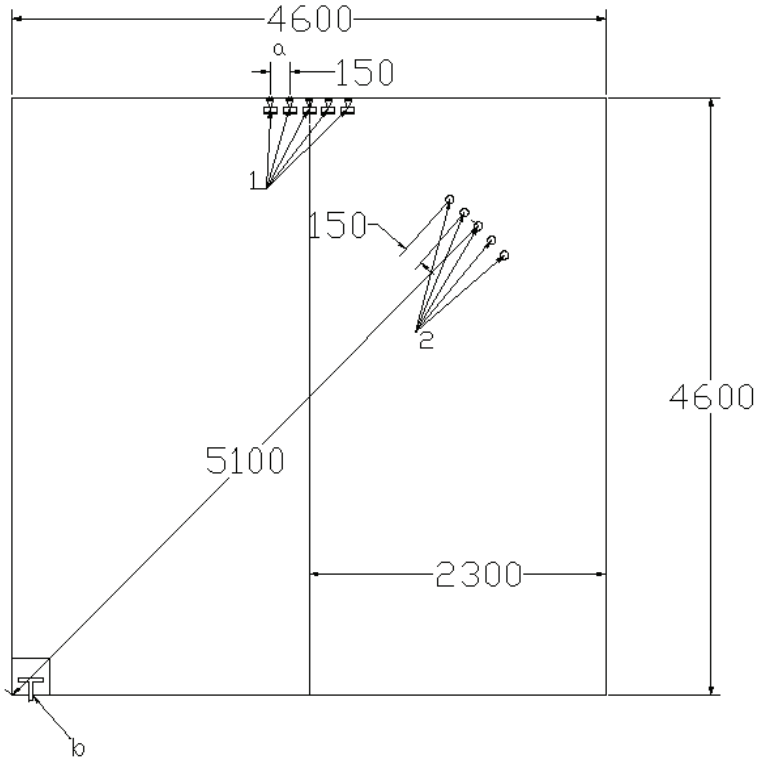
e) For sidewall sprinkler designs, 10 samples are to be installed with the deflector 102 mm below the ceiling and the maximum distance below the ceiling. If the intended installation position is greater than 152 mm below the ceiling, 10 additional samples shall be tested at the maximum distance below the ceiling.

7.22.3 The sprinkler shall be mounted as specified in 7.22.2 on a ceiling or a wall of a closed 4,6 m × 4,6 m room having a 2,4 m high ceiling. The sprinkler inlet waterway shall be filled with water having a temperature of (21 ± 1,6) °C. The water shall be pressurized to (0,03 ± 0,003) MPa [(0,3 ± 0,03) bar] for sprinklers requiring pressure to operate.

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

7.22.4 The fire source is to consist of a 300 mm × 300 mm × 300 mm sand burner (see Figure 16) located in one corner of the room, with a flow of natural gas or methane of 14,6 m^3/h. A pendent-type, upright-type, or ceiling-type sprinkler is to be installed along a diagonal line on the ceiling at a distance of 5,1 m from the corner of the room where the sand burner is located (see Figure 15). A sidewall sprinkler is to be installed on the midpoint of a wall opposite the corner having the sand burner. The gas burner shall be ignited when the ambient temperature has been reduced from a preheated room condition to (31 ± 1) °C, as measured in the centre of the room, 25 mm below the ceiling. The operation time of the sprinkler is to be recorded starting with ignition of the burner.

Dimensions in millimetres

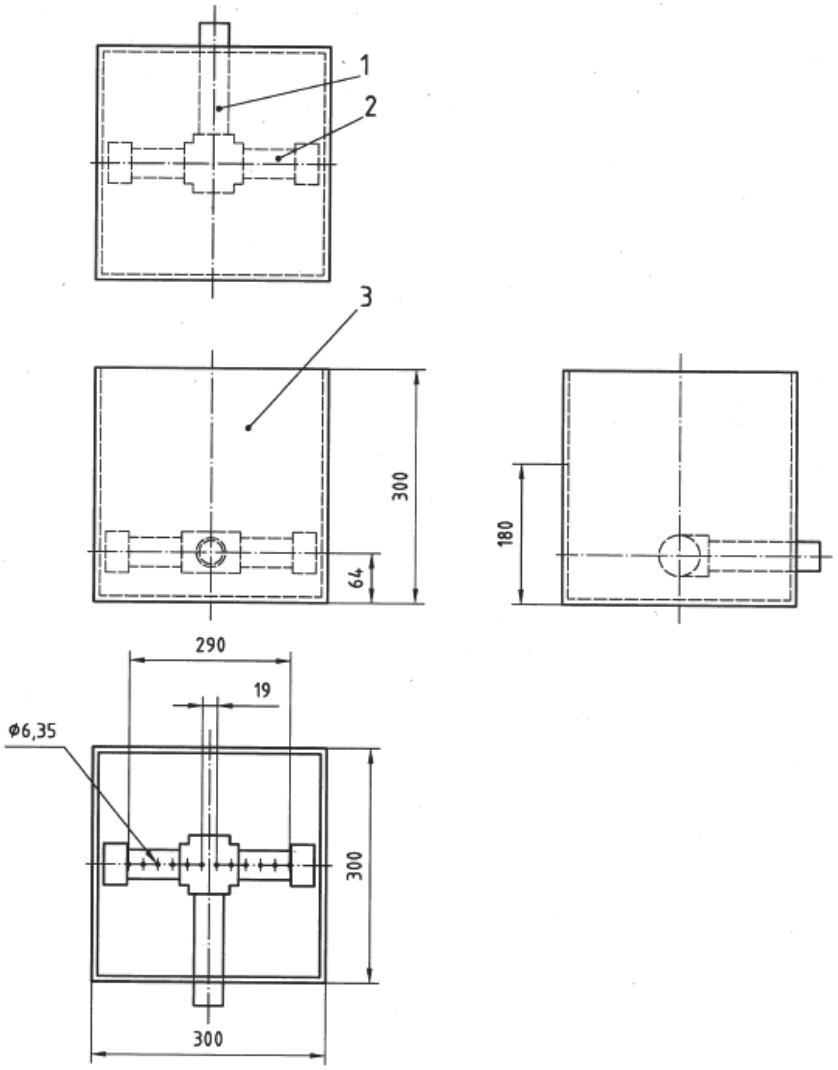


Key

1 sidewall sprinkler locations
2 pendent sprinkler locations
a typical dimension
b sand burner

Figure 16 — Plan view of room heat test for concealed and recessed sprinklers

Dimensions in millimetres



Key

1 nominal pipe, Ø 25 mm; steel plate box, welded

2 nominal pipe, Ø 40 mm; steel piping and fittings, with 12 6,35 holes

3 sand; mason grade sand

Figure 17 — Details of sand burner

7.23 Freezing test (see 6.23)

Five samples shall be individually attached to one end of a 100 mm length of 25 mm nominal diameter steel pipe using an appropriate fitting. A pipe coupling shall be attached to the opposite end of each pipe. Each assembly shall then be filled to capacity with water and sealed using a pipe plug. The assemblies shall be exposed to a temperature of (−30 ± 5) °C for a period of 24 h. After exposure, the sprinklers shall be allowed to thaw at room temperature and shall be hydrostatically tested at 0,05 MPa (0,5 bar) for 15 s. Sprinklers that do not leak shall be tested according to 6.8.1 and 6.13.1.

7.24 Dry-type sprinkler deposit loading test (see 6.24)

7.24.1 Two groups, each consisting of five sample sprinklers in the lowest temperature rating and the minimum length to be produced, are to be assembled. If lubricant is required to facilitate sprinkler assembly, the minimum amount required to assemble the test samples shall be used. One group is to be exposed with the sprinkler in the vertical position with the inlet up and the second group with the sprinkler inlet down.

7.24.2 The samples are to be exposed to a moist carbon dioxide-sulfur dioxide air mixture in a closed chamber maintained at (35 ± 2) °C for a period of 30 d. The samples are to be supported in a manner to permit the internal and external sprinkler parts to be exposed to the gases, such as by placing test samples on polymeric light diffuser trays with nominal 13 mm by 13 mm openings. All test samples shall be supported at only one elevation level within the chamber. On five days out of every seven, an amount of carbon dioxide equivalent to 1.0 % of the volume of the chamber, plus an amount of sulfur dioxide equivalent to 1.0 % of the volume are to be introduced. Prior to each introduction of gas, the remaining gas-air mixture from the previous day is to be thoroughly purged from the chamber. On the two days out of every seven that this does not occur, the chamber is to remain closed and no purging or introduction of gas is to be provided. A small amount of water (10 ml/0,003 m^3 of chamber volume) is to be maintained at the bottom of the chamber for humidity. This water is to be replaced weekly.

7.24.3 After the carbon dioxide-sulfur dioxide exposure, the samples are to be dried at (49 ± 3) °C in an automatically-controlled, circulating-type, constant temperature oven for not less than 24 h or more than 72 h. Each sample is then to be stored at (21 ± 3) °C for at least 4 h prior to installation onto piping in the pendent position and supplied with air at a service pressure of 0,05 MPa (0,5 bar). Each sprinkler is then to be activated by exposing the heat-responsive element to a uniform application of heat or by removing the heat-responsive element if it is degraded by the moist carbon dioxide-sulfur dioxide exposure. The water seal assembly and other internal parts shall clear the waterway as intended.

CAUTION — Sulfur dioxide is a toxic gas. This gas shall be stored, transferred, and used only with gas-tight systems. Adequate ventilation shall also be provided to handle leakage. Presence of this gas is readily noticeable. Due to its unpleasant odour and irritant effect, it gives warning of its presence.

7.25 Dry sprinkler air tightness test (see 6.25)

7.25.1 Five samples are to be individually tested. The assembly is to be installed in an air leakage test fixture in such a manner that the extension nipple connection to the inlet seal assembly can be fully pressurized with air. See Figure 18.

7.25.2 The assembly is to be immersed in water and orientated so that air bubbles indicating leakage past the extension nipple and inlet seal assembly connection point are allowed to freely escape from internal waterway of the dry sprinkler assembly. The air pressure applied to the connection point is then to be increased from 0 kPa to 100 kPa (0 bar to 1 bar) within 30 s and then held at 100 kPa (1 bar) for 30 s. Observations shall be made for leakage as evidenced by any air bubbles escaping from the internal portion of the dry sprinkler assembly.

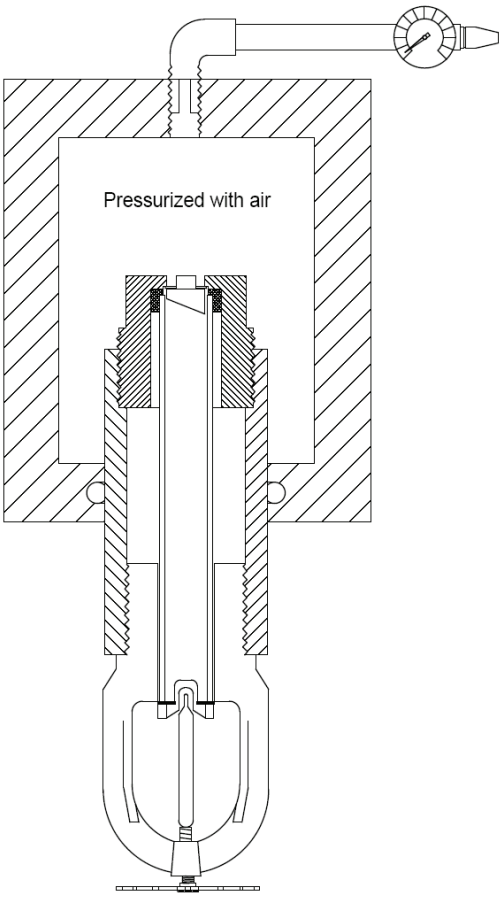
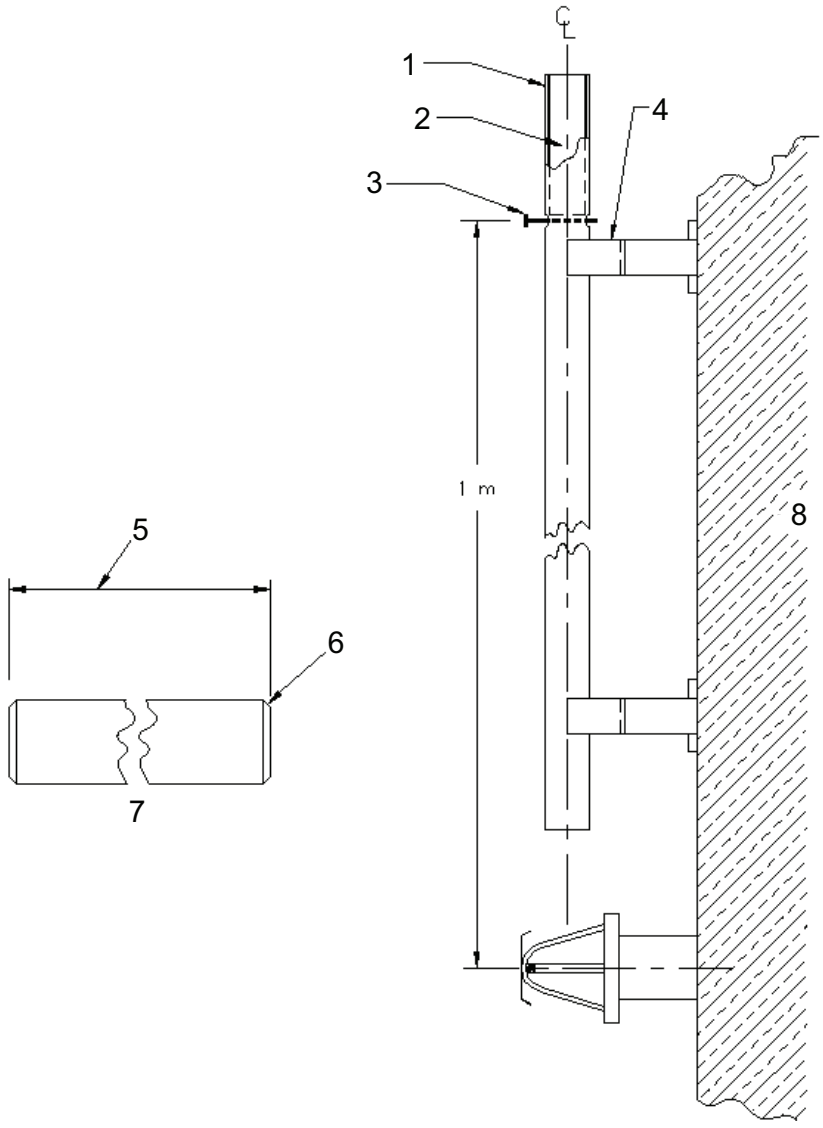


Figure 18 — Dry sprinkler air tightness test apparatus (typical)

7.26 Protective cover impact test for glass bulb sprinklers (see 6.26)

7.26.1 Five sample sprinklers with their protective covers are to be mounted in the horizontal position (see Figure 19) and impacted with a cylindrical mass equivalent to the mass of the sprinkler to the nearest 15-g increment from a height of 1 m onto the geometric centre of the heat-responsive element. Five additional samples are to be tested with the impact applied to the opposite side of the sprinkler if the cover is designed to provide unsymmetrical protection. If the heat-responsive element extends beyond the perimeter of the sprinkler deflector, an additional five sample sprinklers are to be mounted in the vertical position and impacted with the same cylindrical mass from a height of 1 m onto the geometric centre of the heat-responsive element. The mass is to be prevented from impacting more than once upon each sample.

7.26.2 Following the impact, each sprinkler is to be visually examined and there shall be no evidence of cracks, breaks, or any other damage to the glass bulb. Each sample sprinkler shall comply with the leak resistance requirements of 6.8.1 and then shall meet the requirements of 6.13.1 in the standard orientation only.



Key

1 cold drawn seamless steel tubing inside diameter 14,10 mm + 0 −0,13 mm
2 mass (see detail "A")
3 latching pin
4 adjustable brackets (2)
5 length to be determined (function of required weight)
6 break corner 0,06 mm × 45°
7 detail "A" mass 12,70 mm diameter AISI C1018 cold finished steel
8 rigid support

Figure 19 — Impact test apparatus for protective covers

7.27 Dezincification of brass parts test (see 6.27)

7.27.1 Reagent

A test solution is to be prepared by dissolving 12,7 g of copper (II) chloride dihydrate ($CuCl_2 2H_20$) in distilled water and then making up the volume to 1000 ml. Fresh solution is to be used for each test.

7.27.2 Pieces

Three test pieces are to be taken from the sprinkler part. These pieces are to be cut in such a way, for example, by sawing and grinding with light pressure, that the properties of the materials are unaffected. The area of each test piece to be exposed shall be approximately 100 mm^2.

Each test piece is to be embedded in a thermoset resin having minimal shrinkage characteristics and the test surface ground using wet abrasive paper, finishing with 500 grade or finer. The test surfaces are to be cleaned with ethanol prior to testing.

7.27.3 Method

Each test piece is to be placed in the middle of the beaker containing the copper (II) chloride solution so that the test surface is vertical and at least 15 mm above the bottom of a glass beaker covered with suitable plastic foil, for example polyethylene, secured with elastic thread or another method of sealing using non-metallic compound. A total of 250 ml (+50 ml, −10 ml) of the copper (II) chloride solution is required per 100 mm^2 of exposed surface of the test piece.

The beaker containing the test piece is to be placed in the thermostatically controlled oven or oil bath with the temperature maintained at (75 ± 2) °C. The test piece is to be exposed continuously for 144 h. At the end of this period, they are to be removed from the beaker, washed in water, rinsed in the ethanol, and allowed to dry.

Microscopic examination of the test piece is to be conducted as soon as possible after the exposure. If the test pieces are stored before microscopic examination, they are to be kept in a desiccator. Each test piece is to be sectioned at right angles to the exposed test surface, and the remaining thermoset resin attached to the section that is to be removed. The cross-sectioned piece is then to be re-embedded in a thermoset resin having minimal shrinkage, and the area to be viewed is to be ground and polished for microscopic examination. The total length of section through the exposed surface is not to be less than 5 mm. If the dimensions of the test piece make this impossible, the section is to be taken to provide the maximum possible total length.

The dezincification depth measurements are to be made at five evenly spaced locations and the average calculated. The dezincification depth is to be measured from the post exposed test surface and is not to include the sample edge. The maximum dezincification is to be recorded and the average depth calculated. Magnification is to be used to provide the greatest accuracy of measurement.

7.28 Stress corrosion – magnesium chloride test (see 6.28)

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) hours as described below, and in accordance with ASTM G36-94. Special fixtures or elevated temperature operating elements can be employed to simulate assembly loading on parts, where appropriate and necessary.

7.28.1 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 °C ± 2 °C.

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

7.28.3 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 7.28.4.

7.28.4 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.

8 Marking

8.1 Sprinklers

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

a) manufacturer's factory identification (if the manufacturer has more than one sprinkler manufacturing facility);

b) nominal year of manufacture, which can include the last three months of the preceding year and the first six months of the following year;

c) nominal operating temperature.

8.1.2 In addition to the requirements of 8.1, each sprinkler shall be permanently marked on a non-operating part with either 8.1.2.1 or 8.1.2.2.

8.1.2.1 A sprinkler identification number (SIN) shall be used. All sprinklers shall be permanently marked with a one or two character manufacturer symbol, followed by up to four numbers, so as to identify a unique model of sprinkler for every change in orifice size or orifice shape, deflector characteristic, thermal sensitivity, and pressure rating. The manufacturer symbol shall be registered with the International Fire Sprinkler Association.

NOTE The International Fire Sprinkler Association maintains a registry of manufacturer symbols at www.sprinklerworld.org

8.1.2.2 The following items shall be marked as indicated in 8.1.2:

a) trademark or manufacturer's name;

b) abbreviation of the type of sprinkler (see 8.1.3) and the mounting position (see 8.1.4);

c) the nominal flow constant;

d) the pressure rating if other than 1,2 MPa (12 bar).

8.1.3 The following abbreviations, or combinations thereof, shall be marked, as applicable, on a non-operating part of the sprinkler where required by 8.1.2.2.

DOM or RES Domestic Sprinkler

8.1.3.1 No additional markings are required for the following sprinklers:

a) concealed;

b) flush;

c) recessed;

d) dry.

8.1.4 For deflectors of non-horizontal sidewall sprinklers, there shall be a clear indication of their intended orientation, relative to the direction of flow. If an arrow is employed, it shall be accompanied by

the word “flow”. Horizontal sidewall sprinklers shall include the word “top” on the deflector to indicate their orientation.

8.1.5 Sprinklers using glass bulbs from more than one supplier shall have permanently coded marking on a non-operating part of the sprinkler identifying the individual supplier of the glass bulb used in that specific sprinkler.

8.2 Sprinkler housing assemblies and concealed sprinkler cover plates

8.2.1 Recessed housing assemblies (escutcheons) and concealed-sprinkler cover plates shall be marked for use with the corresponding sprinklers, unless the housing is a non-removable part of the sprinkler.

8.2.2 Concealed-sprinkler cover plates shall be permanently marked with the words “Do not paint” on the exterior surface.

8.3 Protective covers

Protective covers shall be orange in colour and shall be marked to indicate that the cover shall be removed before the sprinkler system is placed in service. The marking shall be placed on the cover so it is visible after sprinkler installation (see 7.26).

9 Installation instructions

9.1 Manufacturer’s installation instructions shall be available.

9.2 Those instructions shall include the following where applicable:

a) flow constant;

b) coverage area dimensions;

c) installation position;

d) maximum and minimum distances of sprinkler deflector from ceiling and/or wall;

e) venting requirements for recessed and concealed sprinklers;

f) sprinkler identification in accordance with 8.1.2;

g) manufacturer approved installation tool(s);

h) a statement requiring removal of protective cover;

i) statement indicating that the maximum delay for water discharge of dry systems shall be 15 s.

9.3 In addition the manufacturer’s installation, instructions for dry sprinklers shall include information on the appropriate types and sizes of fittings that are compatible with the sprinkler (see 5.4).

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

Table 6 — Minimum rated sprinkler flow rates

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

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

Annex A
(normative)

Tolerance limit calculation methods

A.1 General

The calculation methods for determining compliance with the tolerance limit requirements specified in 6.7.1 is described in A.2 to A.4.

A.2 Unbiased standard deviation

The sample unbiased standard deviation, S, is calculated from Formula (A.1):

$$S = \sqrt{\frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}{n-1}} \tag{A.1}$$

where

$\overline{X}$ is sample mean;

X_i is individual value of the tested sample i;

n is number of samples tested.

A.3 Determination of the constant, K

Determine the K-factor from Table A.1 as a function of n.

A.4 Calculation of the tolerance limits

In order to determine compliance with the requirements specified in 6.7.1, the tolerance limits are calculated. The value of the lower tolerance limit, FLTL, for the bulb strength is calculated in accordance with Formula (A.2):

$$F_{\mathrm{LTL}} = \overline{X}_1 - K_1 S_1 \tag{A.2}$$

where

$\overline{X}_1$ is the mean bulb strength, expressed in kilograms;

S_1 is the sample unbiased standard deviation for $\overline{X}_1$;

K_1 is the bulb strength factor from Table A.1 for Γ = 0,99 and P = 0,99.

The value of the upper tolerance limit, F_{UTL}, for the sprinkler assembly load is calculated in accordance with Formula (A.3):

$$F_{UTL} = \bar{X}_2 + K_2 S_2 \quad \text{(A.3)}$$

where

$\bar{X}_2$ is the mean assembly load, expressed in kilograms;

S_2 is the sample unbiased standard deviation for $\bar{X}_2$;

K_2 is the assembly load factor from Table A.1 for Γ = 0,99 and P = 0,99.

A sample datum is acceptable if $F_{LTL} > 2 \cdot F_{UTL}$.

Table A.1 — K factors for one-sided tolerance limits for normal distributions

Factors for the strength of heat-responsive element test for frangible bulb types			
N	K[a]	n	K[a]
10	5,075	21	3,776
11	4,828	22	3,727
12	4,633	23	3,680
13	4,472	24	3,638
14	4,336	25	3,601
15	4,224	30	3,446
16	4,124	35	3,334
17	4,038	40	3,250
18	3,961	45	3,181
19	3,893	50	3,124
20	3,832		

[a] For Γ = 0,99 and P = 0,99; 99 samples (see 6.7.1).

Table A.2 — Example worksheet for strength of heat-responsive element test for frangible bulb types (see 6.7.1)

Sample bulb strength values N	Sprinkler assembly load values N

Annex B
(informative)

Analysis of the strength test for fusible element

Formula (4) is based on the intention of providing fusible elements that are not susceptible to failure caused by creep stresses during a reasonable period of service. As such, the duration of 876 600 h (100 years) was selected only as a statistical value with an ample safety factor. No other significance is intended, as many other factors govern the useful life of a sprinkler.

Loads causing failure by creep, and not by an unnecessarily high initial distortion stress, are applied and the times noted. The given requirement then approximates to the extrapolation of the full logarithmic regression curve by means of the following analysis.

The observed data are used to determine, by means of the method of least squares, the load at 1 h, L_O and the load at 1 000 h, L_M. One way of stating this is that, when plotted on full logarithmic paper, the slope of the line determined by L_M and L_0 shall be equal to or greater than the slope determined by the maximum design load at 100 years, L_d, and L_0 or as given in Formula (B.1):

$$(\ln L_M - \ln L_O)/\ln 1\,000 \geq (\ln L_d - \ln L_O)/\ln 876\,600 \tag{B.1}$$

This is then reduced as follows:

$$\ln L_M \geq (\ln L_d - \ln L_O)\frac{\ln 1\,000}{\ln 876\,600} + \ln L_O$$

$$\geq 0{,}5048(\ln L_d - \ln L_O) + \ln L_O$$

$$\geq 0{,}5048 \ln L_d + 0{,}4952 \ln L_O$$

With an error of approximately 1 %, the formula can be approximated by

$$\ln L_M \geq 0{,}5(\ln L_d + \ln L_O) \tag{B.2}$$

or, compensating for errors

$$L_M \geq 0{,}99(L_d + L_O)^{0{,}5} \text{ or } L_M \geq 1{,}02 L_d^2/L_O \tag{B.3}$$

Annex C
(normative)

Tolerances

Unless otherwise stated, the following tolerances shall apply:

— angle ± 2 degrees;

— frequency ± 5 % of the value, expressed in hertz;

— length ± 2 % of the value;

— volume ± 5 % of the value;

— pressure ± 3 % of the value;

— temperature ± 5 % of the value;

— time, seconds: $^{+5}_{0}$;

— time, minutes: $^{+0,1}_{0}$;

— time, hours: $^{+0,1}_{0}$;

— time, days: $^{+0,25}_{0}$.

Bibliography

[1] IEC 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

[2] ANSI/UL 723:2003, Test for surface burning characteristics of building materials

ICS 13.220.20

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