
Fire protection — Automatic sprinkler systems —

Part 1: Requirements and test methods for sprinklers

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

Partie 1: Prescriptions et méthodes d'essai des sprinklers





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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 6182-1:2014) which has been technically revised.

The main changes compared to the previous edition are as follows:

- Consolidation of the requirements for early suppression fast response (ESFR) sprinklers (ISO 6182-7:2020), domestic sprinklers (ISO 6182-10:2014) and extended coverage sprinklers (ISO 6182-13:2017) into a single document.
- Increased harmonization of test methods and requirements for the different types of sprinklers.
- Expanded scope to include extended coverage sprinklers for ordinary hazard occupancies and large flow constant, *K*, storage type sprinklers.
- New water distribution and fire test methods as well as requirements for the additional sprinkler technologies.
- New requirements for electrically operated style sprinklers.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This corrected version of ISO 6182-1:2021 incorporates the following corrections:

- Correction of error in column 1, second row of [Table 11](#) and column 1, final row of [Table 12](#).
- First column heading in [Table 22](#) and [Table 23](#) changed from "Flow constant, *K*" to "Nominal flow constant, *K*".

- Corrections to key elements ^a and ^b in [Figure 27](#) (addition of the phrase "divided by 2").
- Correction to key element ^a in [Figure 28](#) (addition of the phrase "divided by 2").
- [Figure 32](#) and [Figure 42](#) reduced in size for formatting purposes.
- Two subfigures added to [Figure 46](#) and key corrected.
- Corrections to whole key of [Figure D.1](#).
- The term "K-factor" replaced by "flow constant, *K*," throughout.

Introduction

This document includes requirements for conventional, spray, flat spray, sidewall, extended coverage, domestic and storage sprinklers, including early suppression fast response (ESFR) sprinklers, electrically activated sprinklers (EAS) and sprinklers with monitoring of activation (SMA).

Conventional sprinklers are the oldest of the fire sprinkler technologies. These sprinklers discharge water in a spherical discharge pattern such that 40 % to 60 % of the total water flow is initially discharged in the downward direction. In general, the use of this sprinkler technology is limited to applications where this discharge characteristic has been determined to be more effective than the spray sprinkler.

Spray sprinklers were developed in the 1950s and are used to provide fire protection for a wide range of fire risks, including those found in light hazard, ordinary hazard and extra hazard occupancies, as well as storage facilities.

Flat spray sprinklers have a wider spray angle than spray sprinklers and are generally limited to use in spaces with low clearances and storage racks in specific geographic regions.

Domestic 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.

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

Extended coverage ordinary hazard sprinklers are intended to provide control of fires in occupancies or portions of occupancies where quantity and/or combustibility of contents is moderate to high, such as mercantile areas.

Storage sprinklers, including ESFR sprinklers, are primarily intended to be used to provide fire protection for storage facilities.

Electrically activated sprinklers make it possible to activate more than one sprinkler simultaneously.

Sprinklers with monitoring of activation make it possible to detect the location of an actuated sprinkler.

Fire protection — Automatic sprinkler systems —

Part 1: Requirements and test methods for sprinklers

1 Scope

This document specifies performance and marking requirements and test methods for conventional, spray, flat spray, sidewall, extended coverage, domestic and storage sprinklers, including early suppression fast response (ESFR), electrically activated sprinklers (EAS) and sprinklers with monitoring of activation (SMA) for use in water-based fire protection systems. This document is not applicable to sprinklers with multiple orifices.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7-1, *Pipe threads where pressure-tight 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) and smoke production rate (dynamic measurement)*

3 Terms and definitions

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

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

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

3.1 General

3.1.1

actual delivered density

ADD

rate at which water is deposited from an operating *sprinkler* (3.1.13) onto the top horizontal surface of a simulated burning combustible array

3.1.2

assembly load

force exerted on the sprinkler body excluding hydrostatic pressure

3.1.3

average design strength

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

3.1.4

coverage length

maximum length of the sprinkler coverage area

3.1.5

coverage width

maximum width of the sprinkler coverage area

3.1.6

design load

force exerted on the release element at the *service load* (3.1.12) of the *sprinkler* (3.1.13)

3.1.7

housing assembly

escutcheon

ornamental or protective component(s) around the hole from which the *sprinkler* (3.1.13) penetrates the plane of the ceiling or the wall

Note 1 to entry: See [Figure 3](#).

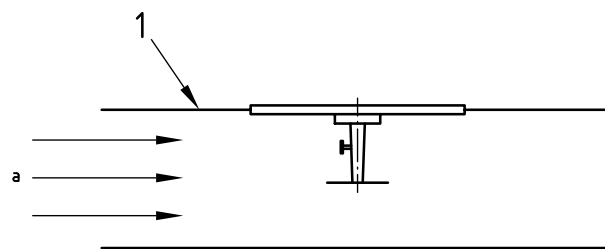
Note 2 to entry: For the purposes of this document, housing applies to recessed and *concealed sprinklers* (3.5.2).

3.1.8

orientation A

orientation with the airflow perpendicular to both the waterway axis and the plane of the frame arms and with the heat responsive element upstream of the frame arms

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



Key

1 tunnel test section (elevation view)

a Airflow.

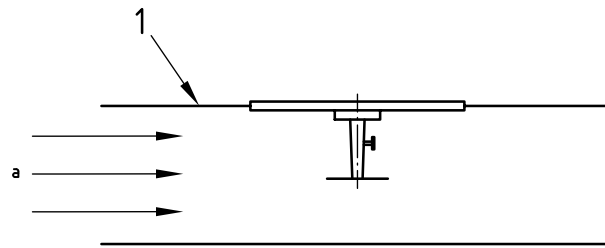
Figure 1 — Orientation A

3.1.9

orientation B

orientation with the airflow perpendicular to both the waterway axis and the plane of the frame arms and with the heat responsive element downstream of the frame arms

Note 1 to entry: See [Figure 2](#).

**Key**

- 1 tunnel test section (elevation view)
 a Airflow.

Figure 2 — Orientation B**3.1.10****protective covers**

protective caps or straps intended to provide temporary protection for *sprinklers* (3.1.13) during shipping, handling and installation

3.1.11**response time index****RTI**

measure of sprinkler sensitivity determined by [Formula \(1\)](#)

$$RTI = t\sqrt{u} \quad (1)$$

where

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

u is the gas velocity, in meters per second.

Note 1 to entry: The response time index is expressed in units of (m·s)^{0.5}.

3.1.12**service load**

combined force exerted on the sprinkler body by the *assembly load* (3.1.2) of the *sprinkler* (3.1.13) and the equivalent force of the rated pressure on the inlet

3.1.13**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

Note 1 to entry: These devices may sometimes be referred to as a sprinkler head.

3.1.14**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 Types of sprinklers according to type of responsive element

3.2.1

electrically activated sprinkler

EAS

sprinkler (3.1.13) that is equipped with an integral means of activation using electricity

3.2.2

sprinklers with monitoring of activation

SMA

sprinkler (3.1.13) that is equipped with an integral means of monitoring of activation using electricity

3.2.3

electrically activated sprinkler with monitoring of activation

EAS-M

sprinkler (3.1.13) that is equipped with an integral means of activation using electricity and monitoring of activation

3.2.4

fusible element sprinkler

sprinkler (3.1.13) that opens under the influence of heat by the melting of a component

3.2.5

glass bulb sprinkler

sprinkler (3.1.13) that opens under the influence of heat by the bursting of the glass bulb through pressure resulting from expansion of the fluid enclosed therein

3.3 Types of sprinklers according to type of water distribution

3.3.1

conventional sprinkler

C

sprinkler (3.1.13) giving spherical water distribution directed downward and at the ceiling for a definite protection area such that 40 % to 60 % of the total water flow is initially directed downward

3.3.2

flat spray sprinkler

F

sprinkler (3.1.13) giving water distribution directed downward for a definite protection area such that 85 % to 100 % of the total water flow is initially directed downward with a wider spray angle than expected with a *spray sprinkler* (3.3.3)

Note 1 to entry: This type of sprinkler is used in storage racks and other shallow areas in some countries.

3.3.3

spray sprinkler

S

sprinkler (3.1.13) giving paraboloid water distribution directed downward for a definite protection area such that 80 % to 100 % of the total water flow is initially directed downward

3.3.4

domestic sprinkler

D

sprinkler (3.1.13) intended to provide control of fire in domestic occupancies

3.3.5

extended coverage sprinkler

EC

sprinkler (3.1.13) with a specified area of coverage which is larger than the standard sprinkler coverage areas

3.3.5.1**extended coverage light hazard sprinkler****ECLH**

sprinkler (3.1.13) having a specified area of coverage which is larger than the standard sprinkler coverage areas and intended for use in occupancies or portions of occupancies where the quantity and/or combustibility of contents is low, such as office spaces

3.3.5.2**extended coverage ordinary hazard sprinkler****ECOH**

sprinkler (3.1.13) having a specified area of coverage which is larger than the standard sprinkler coverage areas and intended for use in occupancies or portions of occupancies where the quantity and/or combustibility of contents is moderate to high

3.3.5.3**extended coverage storage sprinkler****ECSS**

sprinkler (3.1.13) having a specified area of coverage which is larger than the standard sprinkler coverage areas and intended to protect stockpiles of commodities in building structures, such as storage facilities

3.3.6**standard coverage storage sprinkler****SCSS**

sprinkler (3.1.13) having a standard area of coverage (typically 9 m² maximum) and intended to protect stockpiles of commodities in building structures, such as storage facilities

3.3.7**early suppression fast response automatic sprinkler****ESFR**

sprinkler (3.1.13) that is intended to provide early suppression of a fire when protecting stockpiles of commodities in building structures such as storage facilities

3.4 Types of sprinklers according to position**3.4.1****horizontal sidewall sprinkler****H**

sprinkler (3.1.13) arranged such that the orifice directs the water stream horizontally towards the deflector giving a one-sided distribution pattern

3.4.2**pendent sprinkler****P**

sprinkler (3.1.13) arranged such that the orifice directs the water stream downwards towards the deflector

3.4.3**vertical sidewall sprinkler****W**

sprinkler (3.1.13) arranged such that the orifice directs the water stream upwards or downwards towards the deflector giving a one-sided water distribution

3.4.4**upright sprinkler****U**

sprinkler (3.1.13) arranged such that the orifice directs the water stream upwards towards the deflector

3.5 Special types of sprinklers

3.5.1

coated sprinkler

sprinkler (3.1.13) that has a factory-applied coating for corrosion protection

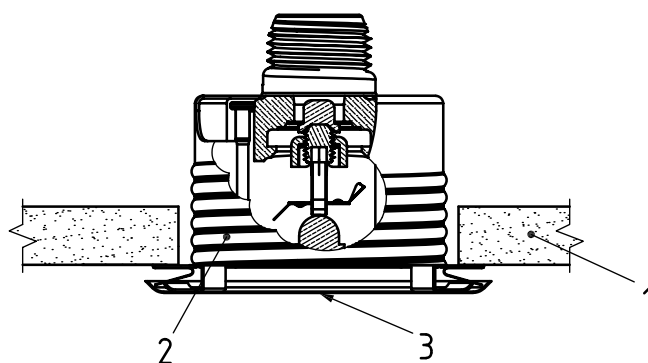
Note 1 to entry: For this document coated sprinkler does not include coatings intended for aesthetic purposes.

3.5.2

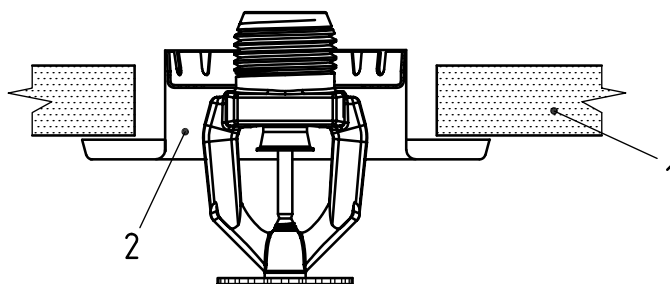
concealed sprinkler

recessed sprinkler (3.5.6) having a cover plate

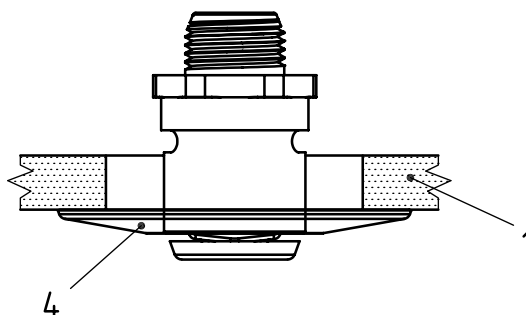
Note 1 to entry: See Figure 3 a).



a) Concealed sprinkler



b) Recessed sprinkler



c) Flush sprinkler

Key

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

Figure 3 — Flush, concealed, and recessed sprinklers

3.5.3**dry sprinkler**

assembly comprising of a *sprinkler* (3.1.13) mounted at the outlet of a special extension with a seal at the inlet that prevents water from entering the extension until it is released by operation of the sprinkler

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

3.5.4**flush sprinkler**

for *pendent sprinklers* (3.4.2), 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; for *sidewall sprinklers*, the sprinkler is within the wall, but the heat-responsive collector projects into the room beyond the plane of the wall

Note 1 to entry: See Figure 3 c).

Note 2 to entry: These are not typically frame arm sprinklers.

[SOURCE: ISO 6182-1:2014, 3.5.4, modified — Notes to entry added]

3.5.5**multiple orifice sprinkler**

sprinkler (3.1.13) having two or more outlet orifices arranged to distribute the water discharge in a specified pattern and quantity for a definite protection area

Note 1 to entry: Multiple orifice sprinklers are not included in the scope of this document.

3.5.6**recessed sprinkler**

sprinkler (3.1.13) of which all or part of the body, other than the thread, is mounted within a recessed housing

Note 1 to entry: See Figure 3 b).

3.5.7**sprinkler with water shield**

sprinkler (3.1.13), intended for use in racks or beneath open grating, which is provided with a water shield mounted above the heat-responsive element to protect it from water discharged by sprinklers at higher elevations

Note 1 to entry: Sprinklers with water shields may be a single unit that is assembled by the manufacturer or a combination of sprinkler and water shield (which in some countries are evaluated separately from the sprinkler approval) assembled on site.

3.6 Types of sprinklers according to sprinkler sensitivity**3.6.1****fast-response sprinkler**

sprinkler (3.1.13) with a *response time index* (3.1.11) $(RTI) \leq 50 \text{ (m}\cdot\text{s)}^{0,5}$ as determined in 6.18 or for *flush* (3.5.4), *concealed* (3.5.2) and *recessed sprinklers* (3.5.6), a maximum response time as determined in 6.19

3.6.2**special-response sprinkler**

sprinkler (3.1.13) with an average *response time index (RTI)* (3.1.11) of between $50 \text{ (m}\cdot\text{s)}^{0,5}$ and $80 \text{ (m}\cdot\text{s)}^{0,5}$

3.6.3

standard-response sprinkler

sprinkler (3.1.13) with a *response time index (RTI)* (3.1.11) of between $80 \text{ (m}\cdot\text{s)}^{0,5}$ and $350 \text{ (m}\cdot\text{s)}^{0,5}$ as determined in 6.18 or for *flush* (3.5.4), *concealed* (3.5.2) and *recessed sprinklers* (3.5.6), a maximum response time as determined in 6.19

4 Product consistency

4.1 Quality control programme

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

4.2 Leak resistance testing

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

4.3 Glass bulb integrity test

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

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

5 Product assembly

5.1 General

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

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 that moves during operation or is in contact with a component that moves during operation.

5.3 Rated pressure

5.3.1 All sprinklers, other than storage and ESFR, shall have a rated pressure of not less than 1,2 MPa (12 bar).

5.3.2 Storage and ESFR sprinklers shall have a rated pressure of 1,2 MPa (12 bar).

5.4 Dry sprinklers

When installed with the intended fittings specified in the manufacturer's installation instructions, dry sprinklers 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 so as not to substantially impact the sprinkler flow constant, K , or pressure loss through the fitting.

5.5 Escutcheons

Escutcheons for sprinklers shall be constructed of a metallic material.

6 Requirements

6.1 General

6.1.1 Electrically activated sprinkler and monitoring of activation

6.1.1.1 Where an activation element or monitoring of activation is required for testing, electrically activated sprinklers shall comply with the requirements described herein with their integral activation element installed.

6.1.1.2 Where sprinkler operation is required as a part of a test, the sprinkler shall be operated in the intended manner using the detection and control equipment or electrical power referenced by the manufacturer as being suitable for use with the electrically activated sprinkler and sprinkler with monitoring of activation.

6.1.1.3 During fire testing, the maximum delay time between the detection of a fire to the release of the sprinkler shall be included into the test parameters.

6.1.1.4 Electrical components used to activate or monitor the sprinkler shall comply with the relevant requirements of ISO 7240.

6.1.1.5 For an electrically activated sprinkler that incorporates a glass bulb or fusible element as a secondary means of operation, the glass bulb or fusible element shall comply with the relevant requirements of this document with the electrical components attached.

6.1.2 Orifice size

6.1.2.1 All sprinklers shall be constructed with a single orifice so that a sphere of diameter 8 mm can pass through the orifice in the sprinkler, with the exceptions specified in [6.1.2.2](#) and [6.1.2.3](#).

6.1.2.2 In those countries where 6 mm or 8 mm orifice automatic sprinklers are acceptable, and the sprinklers are used together with a strainer in the system or in each sprinkler, a 5 mm sphere may be used for checking the size of the orifice.

6.1.2.3 Domestic 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 in accordance with [Table 1](#) and suitable for fittings threaded in accordance with ISO 7-1 in regions where this document is applicable. 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.

Table 1 — Nominal thread sizes

Sprinkler flow constant, <i>K</i> (l/min)/ (bar ^{1/2})	Thread size (mm)
57 ± 3	10 or 15
80 ± 4	15
115 ± 6	15 or 20
160 ± 8	15 or 20
202 ± 10	20
242 ± 12	20
323 ± 16	25
363 ± 18	25
404 ± 20	25
NOTE Dry sprinklers can have thread sizes larger than those shown in this table.	

6.2 Maximum coverage areas and spacing

6.2.1 Pendent and upright domestic, ECLH, and ECOH sprinklers shall have a square area of coverage not exceeding 37,2 m² with sprinkler spacing in nominal 0,5 m increments.

6.2.2 Domestic sprinklers shall be permitted to have a 4,6 m by 4,6 m spacing as described in [7.31.2](#)

6.2.3 Sidewall domestic sprinklers, ECLH, and ECOH shall have an area of coverage not exceeding 37,2 m² with sprinkler spacing in nominal 0,5 m increments.

6.2.4 Pendent and upright ECSS shall have an area of coverage not exceeding 18 m² with sprinkler spacing in nominal 0,5 m increments.

6.3 Temperature ratings and colour coding

The marked nominal temperature rating and colour coding of sprinklers shall be in accordance with [Table 2](#).

NOTE See [8.1](#) for concealed, flush, coated, and plated sprinklers.

Table 2 — 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	Yoke arm colour code
57	orange	57 to 77	uncoloured
68	red	—	—
79	yellow	80 to 107	white
93	green	—	—
107			
121	blue	121 to 149	blue
141			
163	mauve	163 to 191	red
182			

Table 2 (continued)

Glass bulb sprinklers		Fusible element sprinklers	
Marked nominal temperature rating °C	Liquid colour code	Marked nominal temperature rating °C	Yoke arm colour code
204	black	204 to 246	green
227		260 to 302	orange
260		320 to 343	
343			

6.4 Service load and strength of sprinkler body (see 7.4)

6.4.1 The sprinkler body shall comply with the requirements of 6.4.2 or 6.4.3

6.4.2 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 7.4.1 or 7.4.2.

6.4.3 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 7.4.3.

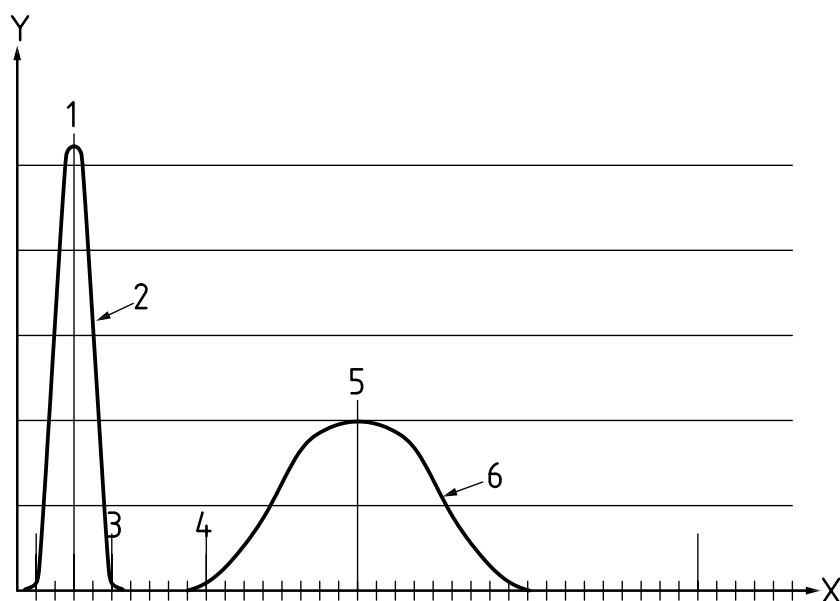
6.4.4 The manufacturer shall specify the average and upper limits of the service or assembly load. These values shall not be exceeded when tested in accordance with 7.4.1, 7.4.2, or 7.4.3 as applicable.

6.5 Strength of heat-responsive element (see 7.5)

6.5.1 Glass bulb elements

When tested in accordance with 7.5, glass bulb elements shall have a design strength lower tolerance limit (LTL) on the strength distribution curve of at least twice the upper tolerance limit (UTL) of the service load distribution curve based on calculations with a degree of confidence (γ) of 0,99 for 99 % of 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.

NOTE See Figure 4.

**Key**

X	load, strength	5	average design strength
Y	frequency	6	design strength curve
1	average service load		
2	service load curve		
3	UTL		
4	LTL		

Figure 4 — Strength curve**6.5.2 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 [7.5](#) for a period of 100 h when tested in accordance with [7.5.2.1](#)

or

- b) demonstrate the ability to sustain the design load when tested in accordance with [7.5.2.2](#)

NOTE See [Annex B](#).

6.6 Leak resistance and hydrostatic strength (see [7.6](#))

6.6.1 A sprinkler shall not show any sign of leakage when tested according to [7.6.1](#).

6.6.2 A sprinkler shall not rupture, operate, or release any parts when tested according to [7.6.3](#).

6.7 Thirty-day leakage resistance (see [7.7](#))

When tested in accordance with [7.7](#), sprinklers shall not leak or sustain any mechanical damage. Following completion of [7.7](#), the sprinklers shall meet the requirement of [6.6.1](#) and show no evidence of distortion or other mechanical damage.

6.8 Vacuum resistance (see 7.8)

Sprinklers shall not exhibit distortion or mechanical damage and shall meet the requirements of 6.6.1 after being subjected to the test in 7.8.

6.9 Water hammer (see 7.9)

Sprinklers shall not leak during or after the pressure surges described in 7.9. After being subjected to the test according to 7.9, they shall show no signs of mechanical damage, shall meet the requirement of 6.6.1, and shall operate when functionally tested to the requirements of 6.20 at a pressure of 0,035 MPa (0,35 bar) only.

6.10 Vibration (see 7.10)

Sprinklers shall be able to withstand the effects of vibration without deterioration when tested in accordance with 7.10. After the vibration test of 7.10, sprinklers shall show no visible deterioration and shall meet the requirements of 6.6.1 and 6.18.1, or be in accordance with 6.19 for flush, concealed and recessed sprinklers.

6.11 Deflector strength (see 7.11)

The deflector and its supporting parts shall not sustain significant damage as a result of the deflector strength test specified in 7.11.

If minor damage is noted, testing in accordance with 6.28 can be carried out to demonstrate conformance.

NOTE In most instances, visual examination of the sprinkler is sufficient to establish conformance with 6.11.

6.12 Water shield rotation (see 7.12)

Rotation of the water shield shall not alter the sprinkler service load when evaluated in accordance with 7.12.

6.13 Impact (see 7.13)

6.13.1 Sprinklers shall show no fracture or deformation and shall meet the requirements of 6.6.1 and 6.18.1 or in accordance with 6.19 for flush, concealed and recessed sprinklers after the impact test of 7.13.1. If the sprinkler is deformed during testing, water distribution testing in accordance with 6.28 shall be required.

6.13.2 The water shield of a water-shield sprinkler shall not separate or bend sufficiently to impair sprinkler function as a result of the impact test in 7.13.2.

6.14 Protective covers (see 7.14)

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

6.14.2 Glass bulb sprinklers equipped with protective covers shall comply with the impact test for protective covers and marking requirements, Section 7.14 and 8.3.

6.14.3 A glass bulb sprinkler, with the protective cover installed, shall not be damaged or leak and the cover shall remain in place when tested as described in 7.14.

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

6.15 Rough usage (see 7.15)

A sprinkler shall withstand the effects of rough usage without deterioration of its performance characteristics. After the test of 7.15, sprinklers shall comply with the leak requirement of 6.6.1 and 6.18.1, or in accordance with 6.19 for flush, concealed and recessed sprinklers.

6.16 Dry sprinkler air tightness (see 7.16)

When tested as described in 7.16.1 and 7.16.2, the connection of the extension nipple to the inlet seal assembly for a dry-type pendent or sidewall sprinkler shall not exhibit leakage at any air pressure from 0 kPa to 100 kPa (0 bar to 1 bar) when the pressure is applied externally to this connection.

6.17 Operating temperature (see 7.17)

Sprinklers shall be verified to operate within a temperature range, in accordance with Formula 2:

$$t = x \pm (0,035x + 0,62) \text{ for temperature ratings of less than } 204 \text{ }^{\circ}\text{C}, \quad (2)$$

or

$$t = x \pm (0,07x + 0,62) \text{ for temperature ratings of } 204 \text{ }^{\circ}\text{C} \text{ or greater.}$$

where

t is the temperature range, rounded to the nearest 0,1 $^{\circ}\text{C}$;

x is the marked nominal temperature rating;

NOTE See Table 2.

6.18 Sensitivity — response time index (RTI) (see 7.18)

6.18.1 Pre-exposure RTI

6.18.1.1 Standard-, special- and fast-response sprinklers shall meet the RTI limits as defined in 3.6.1 through 3.6.3 when tested in the standard orientation in accordance with 7.18.

6.18.1.2 For flush, concealed and recessed sprinklers, see 6.19.

6.18.1.3 ESFR sprinklers shall have an RTI not exceeding $36 \text{ (m}\cdot\text{s)}^{0,5}$ when tested in orientations A and B as described in 7.18.1.3.

An ESFR sprinkler having an RTI greater than $36 \text{ (m}\cdot\text{s)}^{1/2}$ but not exceeding $50 \text{ (m}\cdot\text{s)}^{1/2}$ shall be permitted when fire suppression can be demonstrated through additional large-scale fire tests described in 7.31.7 for the sprinklers utilizing a higher RTI heat responsive element in the as received condition.

6.18.1.4 Domestic and extended coverage sprinklers shall meet the requirements for fast response sprinklers.

6.18.2 Post-exposure RTI

After exposure to the corrosion test according to 6.26.3, 6.26.4, and 6.26.5, sprinklers shall be tested in the standard orientation in accordance with 7.18.1 for sprinklers other than ESFR sprinklers, and orientation A for ESFR sprinklers, to determine the post-exposure RTI. All post-exposure RTI values shall be calculated as in 7.18.2. The values determined shall meet one of the following:

- a) none of the post-exposure RTI values shall exceed the limits referenced in 6.18.1;
- b) the average RTI value shall not exceed 130 % of the average unexposed samples.

6.19 Sensitivity test of flush, concealed and recessed sprinklers (see 7.19)

6.19.1 General

Flush, concealed and recessed sprinklers shall meet the requirements of either 6.19.2 or 6.19.3.

When flush, recessed and concealed sprinklers are not identified as to response type, any of the test methods in 6.19.2 through 6.19.3 may be used.

6.19.2 Room response test (see 7.19.2)

6.19.2.1 When tested in accordance with 7.19.2, standard-response and standard-response ECOH flush, concealed and recessed sprinklers shall operate such that the mean response time and unbiased standard deviation provide computed statistical tolerance limits (see Annex F) with 95 % confidence that 99 % of the sprinklers tested do not exceed the applicable time limit described in Table 3.

6.19.2.2 When tested in accordance with 7.19.2, fast-response, domestic, fast-response ECLH and fast-response ECOH flush, concealed and recessed sprinklers shall operate within the applicable time limit described in Table 3.

Table 3 — Room sensitivity operating time requirements for flush, concealed and recessed sprinklers

Sprinkler type	Sprinkler temperature rating of 77 °C or less	Sprinkler temperature rating of 79 °C to 107 °C
Standard-response	231 s	189 s
Fast-response	75 s	75 s
Domestic	75 s	75 s
Fast-response ECLH	75 s	75 s
Standard-response ECOH	150 s	120 s
Fast-response ECOH	55 s	55 s

6.19.3 Plunge test (see 7.19.3)

6.19.3.1 When tested in accordance with 7.19.3, flush, concealed and recessed sprinklers shall operate such that the mean response time of three samples tested at each of the test conditions specified in

[Table 5](#) does not exceed the theoretical maximum response time ($t_{\max}$) calculated in accordance with [Formula \(3\)](#):

$$t_{\max} = RTI * \frac{\ln\left(1 - \frac{\Delta T_{\text{ea}}}{\Delta T_{\text{g}}}\right)}{\sqrt{u}} \quad (3)$$

where

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

RTI is the maximum permitted RTI taken from [Table 4](#);

ΔT_{ea} is the temperature difference, expressed in degrees Celsius (°C), between the maximum permitted operating temperature of the sprinkler, in accordance with [6.17](#) and the ambient temperature;

ΔT_{g} is the temperature difference, expressed in degrees Celsius (°C), between the gas temperature in the test section of the tunnel, taken from [Table 5](#), and the ambient temperature.

u is the gas velocity in the test section of the tunnel, expressed in metres per second (m/s), taken from [Table 5](#).

6.19.4 After exposure to the corrosion test according to [6.26.3](#), [6.26.4](#), and [6.26.5](#), sprinklers shall be tested in accordance with [7.19](#). The mean time of operation after exposure shall be equal to or less than 1,30 multiple of the mean time of operation of sprinklers not subjected to the corrosion test.

Table 4 — Maximum permitted RTI

Sprinkler response	RTI (m·s) ^{0,5}
Standard	350
Special	80
Fast	50

Table 5 — Sensitivity test conditions for flush, concealed and recessed sprinklers

Test condition	Gas temperature °C	Gas velocity m/s	Applied vacuum mm Hg ^a
1	135	2,6	0,007
2	135	3,5	0,007
3	197	2,6	0,010
4	197	3,5	0,010
5	290	2,6	0,013
6	290	3,5	0,013

^a 1 mm Hg = 133,322 4 Pa

6.20 Lodgement (see [7.20](#))

When tested in accordance with [7.20](#), the sprinkler shall open and any lodgement of released parts shall be cleared within 10 s of release of the heat-responsive element.

6.21 Heat exposure (see [7.21](#))

6.21.1 Glass bulb sprinklers

There shall be no damage to the glass bulb element when the sprinkler is tested according to [7.21.1](#).

6.21.2 All sprinklers

Sprinklers shall withstand exposure to increased ambient temperature without evidence of weakness or failure when tested according to [7.21.2](#).

6.21.3 Coated sprinklers

In addition to meeting the requirement of [6.21.2](#) in an uncoated version, coated sprinklers shall withstand exposure to increased ambient temperatures without evidence of weakness or failure of the coating when tested according to [7.21.3](#).

6.22 Sprinkler coatings (see [7.22](#))

6.22.1 Evaporation of wax and bitumen

Waxes and bitumens used for coating sprinklers shall not contain volatile matter in quantities sufficient to cause shrinkage, hardening, cracking, or flaking of the applied coating. The loss in mass shall not exceed 5 % of that of the original sample when tested according to [7.22.1](#).

6.22.2 Resistance to low temperatures

All coatings used for sprinklers shall not crack or flake when subjected to low temperatures in accordance with [7.22.2](#).

6.23 Thermal shock for glass bulb sprinklers (see [7.23](#))

Glass bulb sprinklers shall not be damaged when tested according to [7.23](#). Following the thermal shock exposure, the sprinkler shall comply with [6.20](#) when tested with an inlet pressure of 0,035 MPa (0,35 bar).

6.24 Resistance to heat (see [7.24](#))

Open sprinklers shall be resistant to high temperatures when tested in accordance with [7.24](#). After exposure, the sprinkler shall not fracture or break. If visual deformation is observed on the sprinkler orifice it shall meet the requirements of [6.27](#). If visual deformation is observed on the sprinkler frame or deflector, it shall meet the requirements of [6.28](#).

6.25 Freezing test (see [7.25](#))

Sprinklers shall be resistant to low temperatures when tested in accordance with [7.25](#). 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 [6.6.1](#) and shall meet the RTI requirements of [6.18.1](#).

6.26 Corrosion (see 7.26)

6.26.1 Stress corrosion for copper-based alloy components (see 7.26.1)

When tested in accordance with 7.26.1, each sprinkler shall not show any cracks, signs of delamination or failure that can affect its ability to function as intended.

6.26.2 Stress corrosion for stainless steel components (see 7.26.2)

Sprinklers having components consisting of stainless steel alloys shall be subjected to 7.26.2. The stainless steel components shall not show evidence of fracture, distortion, or impending separation from the frame when tested as described in 7.26.2.

6.26.3 Sulphur dioxide/carbon dioxide corrosion (see 7.26.3)

Coated and uncoated sprinklers shall be resistant to sulphur dioxide / carbon dioxide saturated with water vapor when conditioned in accordance with 7.26.3.

Following exposure, glass bulb sprinkler samples shall either be:

- a) tested at 0,035 MPa (0,35 bar) in accordance with 6.20; or
- b) meet the requirements of 6.19.4 for concealed and recessed sprinklers or the requirements of 6.18.2 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 6.20 and the remaining samples shall meet the requirements of 6.19.4 for flush, concealed and recessed sprinklers or the requirements of 6.18.2 for other types of sprinklers.

6.26.4 Hydrogen sulphide corrosion (see 7.26.4)

Coated and uncoated sprinklers shall be resistant to hydrogen sulphide saturated with water vapor when conditioned in accordance with 7.26.4.

Following exposure, glass bulb sprinkler samples shall either be:

- a) tested at 0,035 MPa (0,35 bar) in accordance with 6.20; or
- b) meet the requirements of 6.19.4 for flush, concealed and recessed sprinklers or the requirements of 6.18.2 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 6.20 and the remaining samples shall meet the requirements of 6.19.4 for flush, concealed and recessed sprinklers or the requirements of 6.18.2 for other types of sprinklers.

6.26.5 Salt spray loading (see 7.26.5)

Coated and uncoated sprinklers shall be resistant to salt spray when conditioned in accordance with 7.26.5.

Following exposure, glass bulb sprinkler samples shall either be:

- a) tested at 0,035 MPa (0,35 bar) in accordance with 6.20;
- or
- b) meet the requirements of 6.19.4 for flush, concealed and recessed sprinklers or the requirements of 6.18.2 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 [6.20](#) and the remaining samples shall meet the requirements of [6.19.4](#) for flush, concealed and recessed sprinklers or the requirements of [6.18.2](#) for other types of sprinklers.

6.26.6 Moist air exposure (see [7.26.6](#))

Sprinklers shall be resistant to moist air exposure when tested in accordance with [7.26.6](#). Following exposure, the sprinklers shall be functionally tested at 0,035 MPa (0,35 bar) only in accordance with [6.20](#).

6.26.7 Dry-type sprinkler deposit loading (see [7.26.7](#))

Following exposure to a carbon dioxide-sulphur dioxide atmosphere in accordance with [7.26.7.1](#) to [7.26.7.3](#), 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.

6.26.8 Dezincification of brass parts (see [7.26.8](#))

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

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

6.27 Water flow constant (see [7.27](#))

The flow constant, K , for sprinklers is determined by [Formula \(4\)](#):

$$K = q/\sqrt{p} \quad (4)$$

where

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

p is the pressure, expressed in bar.

With the exception domestic sprinklers, the flow constant, K , for sprinklers shall be in accordance with [Table 6](#) when determined by the test method given in [7.27](#).

For domestic sprinklers, 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 [7.27](#). Each flow constant, K , (calculated) shall be within ± 5 % or ± 3 units of the manufacturer's value, whichever is greater.

Table 6 — Flow constant requirements

Sprinkler type	Nominal flow constant, K (l/min)/(bar ^{1/2})	Tolerance for wet type	Tolerance for dry type
Spray	57	±3	±5
	80	±4	±6
	115	±6	±9
Flat	80	±4	±6
	115	±6	±9
NOTE 1(l/min)/(bar ^{1/2}) = 0,003 2 (m ³ /min)/(MPa ^{1/2}).			

Table 6 (continued)

Sprinkler type	Nominal flow constant, K (l/min)/(bar ^{1/2})	Tolerance for wet type	Tolerance for dry type
ECLH	80	±4	±6
	115	±6	±9
	160	±8	±12
	202	±10	±15
ECOH	160	±8	±12
	202	±10	±15
ECSS	242	±12	±18
	363	±18	±27
SCSS	160	±8	±12
	202	±10	±15
	242	±12	±18
	283	±14	±21
	363	±18	±27
ESFR	202	±10	±15
	242	±12	±18
	323	±16	±24
	363	±18	±27
	404	±20	±30
NOTE 1(l/min)/(bar ^{1/2}) = 0,003 2 (m ³ /min)/(MPa ^{1/2}).			

6.28 Water distribution (see 7.28)

6.28.1 General

6.28.1.1 As referenced in [Table 7](#), sprinklers tested in accordance with column 3 shall meet the applicable requirements of column 2.

6.28.1.2 Elements of integral means of activation using electricity and/or monitoring of activation should not interfere with the sprinkler's water distribution characteristics.

Table 7 — Requirements and test methods by sprinkler type

Sprinkler Type	Requirements	Test method
Pendent spray sprinkler, P Upright spray sprinkler, U Dry pendent Dry upright Flat spray, F Conventional, C	See 6.28.2.1 and 6.28.2.2	See 7.28.2.1 and 7.28.2.2
Recessed sprinkler, P Concealed sprinkler Flush pendent	See 6.28.2.1	See 7.28.2.1

Table 7 (continued)

Sprinkler Type	Requirements	Test method
Sidewall spray sprinkler, H Spray sprinkler, W Recessed sprinkler, H Recessed sprinkler, W Dry sidewall Flush sidewall	See 6.28.2.3	See 7.28.2.3
Domestic pendent Domestic upright	See 6.28.3	See 7.28.3.1 , 7.28.3.1.1 and 7.28.3.2
Domestic sidewall	See 6.28.3	See 7.28.3.1 , 7.28.3.1.2 and 7.28.3.2
Pendent extended coverage light hazard (ECLH) Upright extended coverage light hazard (ECLH)	See 6.28.4	See 7.28.4.1 and 7.28.4.3
Sidewall extended coverage light hazard (ECLH)	See 6.28.4	See 7.28.4.2 and 7.28.4.3
Pendent extended coverage ordinary hazard (ECOH) Upright extended coverage ordinary hazard (ECOH)	See 6.28.5	See 7.28.5
ESFR pendent, K-202 ESFR pendent, K-242	See 6.28.6 and 6.28.7	See 7.28.6 and 7.28.7

6.28.2 Spray, flat spray, conventional and dry sprinkler water distribution (see [7.28.2](#))

6.28.2.1 For other than sidewall types, the number of containers having less than 50 % of the water coverage as specified in column 2 of [Table 22](#), shall not exceed the permitted number of containers with a lower content of water, as specified in column 6 of [Table 22](#).

6.28.2.2 The water discharge of sprinklers downward from the deflectors shall be:

- 40 % to 60 % for conventional sprinklers,
- 85 % to 100 % for flat spray sprinklers, and
- 80 % to 100 % for spray sprinklers.

NOTE This requirement does not apply to recessed, flush, concealed, and sidewall sprinklers.

6.28.2.3 In the area between the sidewall sprinklers, the back wall shall be completely wetted from the floor up to 1,2 m below the deflector (see [Figure 26](#)).

The total quantity of water collected along the back wall shall be a minimum of 3,5 % of the total water discharged from the sprinklers during the test.

For sidewall sprinklers having a nominal flow constant, K , of 80 (l/min)/(bar^{1/2}) or less, the water flow rate shall be 57 l/min for each sprinkler. The average water collection rate in the containers shall be not less than 2 mm/min and the minimum water collection rate in any individual pan shall be 1,2 mm/min.

For sidewall sprinklers having a nominal flow constant, K , of 115 (l/min)/(bar^{1/2}), the water flow rate shall be 78 l/min for each sprinkler. The average water collection rate in the containers shall be not less than 2,8 mm/min and the minimum water collection rate in any individual pan shall be 1,2 mm/min.

6.28.3 Domestic sprinkler water distribution (see 7.28.3)

6.28.3.1 Horizontal surfaces

When installed in accordance with the manufacturer's design and installation instructions and tested as described in 7.28.3.1, 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 centreline) of the design area for sidewall sprinklers.

6.28.3.2 Vertical surfaces

When installed in accordance with the design and installation instructions and tested as described in 7.28.3.2, 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 discharging 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 calculated in accordance with Formula (5):

$$A_{\text{col}} = 0,2 \left(\frac{l_w}{l_p} \right) \quad (5)$$

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, i.e. the length of all walls combined, expressed in metres.

6.28.4 Extended coverage light hazard sprinkler water distribution (see 7.28.4)

6.28.4.1 Upright and pendent sprinklers shall be evaluated using one quadrant of the room as shown in Figure 30 and Figure 31. Sidewall sprinkler distributions shall be measured utilizing one half of the floor area as shown in Figure 32. In all cases, a space of 25 mm shall be maintained between all walls and pans.

6.28.4.2 Not more than one pan shall have a collection less than 0,6 mm/minute and it shall not have less than 0,2 mm/minute.

6.28.4.3 The average collection of all the distribution pans for each test shall be a minimum of 1,6 mm/minute.

6.28.4.4 Sprinklers must meet all criteria when tested to the parameters shown in Table 24 and Table 25.

6.28.4.5 When installed as specified by the manufacturer and tested as described in 7.28.4.3, each extended coverage sprinkler shall wet the wall surfaces of the test area to a height within 1,5 m of the ceiling.

6.28.4.6 Coated sprinklers shall be subjected to additional distribution tests if the coating is observed to deform or deteriorate during the sensitivity-RTI test of [6.18](#).

6.28.5 Extended coverage ordinary hazard sprinkler water distribution (see [7.28.5](#))

The water collected in any individual collection pan, the average water collected for all collection pans in the distribution area, and the average water collected for collection pans in any 1,5 m² square area shall comply with the values specified in [Table 8](#) with four sprinklers discharging water at the flows and distances above the collection pans specified in [Table 8](#). The sprinklers shall be tested using the coverage areas specified by the manufacturer.

Table 8 — ECOH water distribution test parameters and requirements

Sprinkler Coverage Area (m)	Number of collection pans	Deflector to pan distance (m)	Water flow per sprinkler (l/min)	Minimum collection in any individual pan (mm/min)	Minimum average collection in any 1,5 m ² square area (mm/min)	Minimum average collection in all pans (mm/min)
4,3 × 4,3	64	2,29	113	3,21	4,71	6,42
	64	2,29	147	4,28	6,42	8,66
	64	0,91	113	1,28	3,42	6,42
	64	0,91	147	1,28	4,71	8,66
4,9 × 4,9	100	2,29	147	3,21	4,71	6,42
	100	2,29	193	4,28	6,42	8,66
	100	0,91	147	1,28	3,42	6,42
	100	0,91	193	1,28	4,71	8,66
5,5 × 5,5	144	2,29	185	3,21	4,71	6,42
	144	2,29	246	4,28	6,42	8,66
	144	0,91	185	1,28	3,42	6,42
	144	0,91	246	1,25	4,71	8,66
6,1 × 6,1	196	2,29	227	3,21	4,71	6,42
	196	2,29	302	4,28	6,42	8,66
	196	0,91	227	1,28	3,42	6,42
	196	0,91	302	1,28	4,71	8,66

6.28.6 K202 and K242 pendent ESFR sprinkler water distribution (see [7.28.6](#))

When tested in accordance with [7.28.6](#) the sprinkler shall meet the requirements of [Table 9](#) for K202 or [Table 10](#) for K242.

Table 9 — ESFR sprinkler water distribution measurement K202

Number of sprinklers under the water collection system	Sprinkler spacing m	Pipe spacing m	Ceiling clearance to water collection pans m	Pressure ^{a,b} MPa (bar)	Minimum 16-pan average density ^c mm/min	Minimum flue space (4 pans) average density ^c mm/min	Minimum 20-pan average density ^c mm/min	Minimum non-flue 10-pan average density ^{c,d} mm/min	Minimum single non-flue pan density ^c mm/min
1	0	0	3,04	0,34 (3,4)	21,2	40,8	NR	NR	NR
1	0	0	4,42	0,34 (3,4)	19,6	36,3	NR	NR	NR
1	0	0	4,42	0,51 (5,1)	NR	69,4	37,1	20,4	10,6
2	3,04	0	1,27	0,34 (3,4)	24,5	NR	NR	NR	NR
2	3,04	0	3,04	0,34 (3,4)	22,0	NR	NR	NR	NR
2	0	3,04	1,27	0,34 (3,4)	23,7	NR	NR	NR	NR
2	0	3,04	3,04	0,34 (3,4)	23,3	NR	NR	NR	NR
2	3,66	0	1,27	0,34 (3,4)	18,0	NR	NR	NR	NR
2	0	3,66	1,27	0,34 (3,4)	18,4	NR	NR	NR	NR
^a All 0,34 MPa (3,4 bar) tests are performed on a system fed from both directions (double-feed).									
^b All 0,51 MPa (5,1 bar) tests are performed on a system fed from one direction (single-feed), except for the two-sprinklers, single-pipe tests which are performed on a double-feed system.									
^c NR = No requirement.									
Average of the ten non-flue pans with the lowest water collection.									

Table 9 (continued)

Number of sprinklers under the water collection system	Sprinkler spacing m	Pipe spacing m	Ceiling clearance to water collection pans m	Pressure ^{a,b} MPa (bar)	Minimum 16-pan average density ^c mm/min	Minimum flue space (4 pans) average density ^c mm/min	Minimum 20-pan average density ^c mm/min	Minimum non-flue 10-pan average density ^{c,d} mm/min	Minimum single non-flue pan density ^c mm/min
2	3,04	0	1,27	0,51 (5,1)	NR	NR	31,4	24,5	8,2
2	0	3,04	1,27	0,51 (5,1)	NR	NR	31,4	24,5	8,2
4	3,04	3,04	1,27	0,34 (3,4)	27,7	NR	NR	NR	NR
4	3,04	3,04	3,04	0,34 (3,4)	35,1	NR	NR	NR	NR
4	2,44	3,6	1,27	0,34 (3,4)	26,9	NR	NR	NR	NR
4	3,04	3,04	1,27	0,51 (5,1)	NR	NR	29,0	24,5	15,1
^a All 0,34 MPa (3,4 bar) tests are performed on a system fed from both directions (double-feed).									
^b All 0,51 MPa (5,1 bar) tests are performed on a system fed from one direction (single-feed), except for the two-sprinklers, single-pipe tests which are performed on a double-feed system.									
^c NR = No requirement.									
^d Average of the ten non-flue pans with the lowest water collection.									

Table 10 — ESFR sprinkler water distribution measurement K242

Number of sprinklers under the water collection system	Sprinkler spacing m	Pipe spacing m	Ceiling clearance to water collection pans m	Pressure ^{a,b} MPa (bar)	Minimum 16-pan average density ^c mm/min	Minimum flue space (4 pans) average density ^c mm/min	Minimum 20-pan average density ^c mm/min	Minimum non-flue 10-pan average density ^{c,d} mm/min	Minimum single non-flue pan density ^c mm/min
1	0	0	3,04	0,24 (2,4)	21,2	40,8	NR	NR	NR
1	0	0	4,42	0,24 (2,4)	19,6	36,3	NR	NR	NR
1	0	0	4,42	0,36 (3,6)	NR	69,4	37,1	20,4	10,6
2	3,04	0	1,27	0,24 (2,4)	24,5	NR	NR	NR	NR
2	3,04	0	3,04	0,24 (2,4)	22,0	NR	NR	NR	NR
2	0	3,04	1,27	0,24 (2,4)	23,7	NR	NR	NR	NR
2	0	3,04	3,04	0,24 (2,4)	23,3	NR	NR	NR	NR
2	3,66	0	1,27	0,24 (2,4)	18,0	NR	NR	NR	NR
2	0	3,66	1,27	0,24 (2,4)	18,4	NR	NR	NR	NR
^a All 0,24 MPa (2,4 bar) tests are performed on a system fed from both directions (double-feed).									
^b All 0,36 MPa (3,6 bar) tests are performed on a system fed from one direction (single-feed), except for the two-sprinklers, single-pipe tests which are performed on a double-feed system.									
^c NR = No requirement.									
Average of the ten non-flue pans with the lowest water collection.									

Table 10 (continued)

Number of sprinklers under the water collection system	Sprinkler spacing m	Pipe spacing m	Ceiling clearance to water collection pans m	Pressure ^{a,b} MPa (bar)	Minimum 16-pan average density ^c mm/min	Minimum flue space (4 pans) average density ^c mm/min	Minimum 20-pan average density ^c mm/min	Minimum non-flue 10-pan average density ^{c,d} mm/min	Minimum single non-flue pan density ^c mm/min
2	3,04	0	1,27	0,36 (3,6)	NR	NR	31,4	24,5	8,2
2	0	3,04	1,27	0,36 (3,6)	NR	NR	31,4	24,5	8,2
4	3,04	3,04	1,27	0,36 (2,6)	27,7	NR	NR	NR	NR
4	3,04	3,04	3,04	0,24 (2,4)	35,1	NR	NR	NR	NR
4	2,44	3,6	1,27	0,24 (2,4)	26,9	NR	NR	NR	NR
4	3,04	3,04	1,27	0,36 (3,6)	NR	NR	29,0	24,5	15,1
^a All 0,24 MPa (2,4 bar) tests are performed on a system fed from both directions (double-feed).									
^b All 0,36 MPa (3,6 bar) tests are performed on a system fed from one direction (single-feed), except for the two-sprinklers, single-pipe tests which are performed on a double-feed system.									
^c NR = No requirement.									
^d Average of the ten non-flue pans with the lowest water collection.									

6.28.7 Thrust force measurements for K202 and K242 pendent ESFR sprinklers (see 7.28.7)

When tested in accordance with 7.28.7, sprinklers shall meet the minimum thrust force requirements shown in Table 11 or Table 12, as appropriate.

Table 11 — Thrust K202

Pressure for sprinklers MPa (bar)	Direction of feed flow	Ceiling clearance to thrust plate m	Minimum required thrust kPa (mbar)
0,34 (3,4)	Double	1,2	0,071 (0,71)
0,34 (3,4)	Double	2,1	0,044 (0,44)
0,51 (5,1)	Single	2,1	0,10 (1,00)

Table 12 — Thrust K242

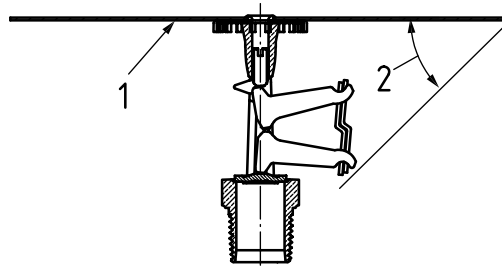
Pressure for sprinklers MPa (bar)	Direction of feed flow	Ceiling clearance to thrust plate m	Minimum required thrust kPa (mbar)
0,24 (2,4)	Double	1,2	0,071 (0,71)
0,24 (2,4)	Double	2,1	0,044 (0,44)
0,36 (3,6)	Single	2,1	0,10 (1,00)

6.29 Lateral discharge (see 7.29)

Sprinklers, other than flat or conventional, shall not prevent the operation of adjacent sprinklers when tested in accordance with 7.29.

6.30 Water shield angle of protection (see 7.30)

Water shields where fitted shall provide an angle of protection of 45° or less in accordance with 7.30. See Figure 5.

**Key**

- 1 water shield
- 2 angle of protection

Figure 5 — Angle of protection**6.31 Fire performance (see 7.31)****6.31.1 General**

As outlined in [Table 13](#), sprinklers tested in accordance with column 3 shall meet the applicable requirements of column 2.

Table 13 — Fire test requirements and test methods by sprinkler type

Sprinkler type	Requirements	Test method
Spray sprinkler, pendent Spray sprinkler, upright Dry spray sprinkler, pendent Dry spray sprinkler, upright Flush pendent Recessed sprinkler, pendent Concealed sprinkler, pendent	See 6.31.2	See 7.31.2
Domestic pendent Domestic upright Domestic sidewall	See 6.31.3	See 7.31.3
Pendent extended coverage light hazard (ECLH) Upright extended coverage light hazard (ECLH) Sidewall extended coverage light hazard (ECLH)	see 6.31.4	see 7.31.4
Pendent extended coverage ordinary hazard (ECOH) Upright extended coverage ordinary hazard (ECOH)	see 6.31.5	see 7.31.5
ESFR pendent, K-202 ESFR pendent, K-242	see 6.31.6	see 7.31.6

Table 13 (continued)

Sprinkler type	Requirements	Test method
Standard coverage storage sprinkler, pendent, all flow constants, K , Standard coverage storage sprinkler, upright, all flow constants, K , Extended coverage storage sprinkler, pendent, all flow constants, K , Extended coverage storage sprinkler, upright, all flow constants, K , ESFR pendent, all other flow constants, K , ESFR upright, all flow constants, K ,	see 6.31.7	see 7.31.7

6.31.2 Spray sprinkler fire performance (see [7.31.2](#))

6.31.2.1 All nominal flow constant, K , sprinklers of 80 (l/min)/(bar^{1/2}) and 115 (l/min)/(bar^{1/2}), except sidewall, flat spray, and conventional sprinklers, shall control crib fires when tested according to [7.31.2](#). For dry-type sprinklers, the shortest length manufactured shall be used for this test.

6.31.2.2 The air temperature at the locations of the thermocouples shall be reduced to less than 275 °C above ambient temperature within the first 5 min of water application.

6.31.2.3 The mean air temperature at the thermocouples shall not exceed 275 °C above ambient temperature for any continuous 3 min period within the remaining test time.

6.31.2.4 The average temperature for the time interval between the time at which the ceiling temperature falls below a temperature of 275 °C above initial ambient and the time at the end of the test shall be computed by comparing the area under the curve determined by the recorded ceiling temperatures with the area beneath a straight line drawn at the temperature point 275 °C above the initial ambient. The area beneath the curve of the recorded ceiling temperatures shall be the lesser of the two areas.

6.31.2.5 The loss in mass of the crib shall not exceed 20 %.

6.31.3 Domestic sprinkler fire performance (see [7.31.3](#))

6.31.3.1 When fire-tested as described in [7.31.3](#), sprinklers shall meet the following requirements:

- Maximum temperature for 76 mm below the ceiling shall not exceed 315 °C.
- Maximum temperature for 1,6 m above the floor shall not exceed 93 °C.
- Temperature at the location described in item b) shall not exceed 54 °C for more than any continuous 2-min period.
- Maximum ceiling material temperature for 6,0 mm behind the finished ceiling surface shall not exceed 260 °C.
- A maximum of two sprinklers shall operate.
- The third sprinkler at the doorway shall not operate.

NOTE See [Figure 43](#) (pendent or upright sprinklers) or [Figure 44](#) and [Figure 45](#) (sidewall sprinklers) for temperature measuring locations.

6.31.4 Extended coverage light hazard sprinkler fire performance (see 7.31.4)

When tested as described in 7.31.4, an extended coverage sprinkler shall limit the average loss of weight of three wood cribs to not more than 35 %.

6.31.5 Extended coverage ordinary hazard sprinkler fire performance (See 7.31.5)

6.31.5.1 When tested as described in 7.31.5, water discharged from the sprinkler shall:

- Not result in the operation of more than the number of sprinklers specified in Table 14 within 45 minutes of the start of the test.
- Result in the ceiling temperature being reduced to a value less than 276 °C above ambient within 5 minutes after the start of water discharge from the third operating sprinkler. Additionally, from the time the temperature initially falls below 276 °C above ambient to the end of the test, the ceiling temperature shall not exceed this value for more than three consecutive minutes and the average temperature for this period shall not exceed 276 °C above ambient.
- The water flow rate for sidewall sprinkler spacing other than those described in Table 14 shall not be less than a flow correlating to an 8 mm/min discharge density.

Table 14 — Extended coverage ordinary hazard sprinkler fire test conditions and criteria

Sprinkler coverage area m	Water flow per sprinkler l/min	Maximum number of sprinklers to permitted operate
6,1 by 6,1	303	5
5,5 by 5,5	247	5
4,9 by 4,9	196	6
4,3 by 4,3	150	8

6.31.6 Nominal K-202 and K-242 pendent ESFR fire performance (see 7.31.6)

Nominal K-202 and K-242 pendent ESFR sprinklers shall meet the minimum average densities shown in Table 15 or Table 16 when measured in accordance with 7.31.6.

Table 15 — ADD measurements K202

Number of sprinklers over the ADD apparatus	Sprinkler spacing m	Pipe spacing m	Ceiling clearance to water collection pans m	Freeburn convective heat release kW	Pressure MPa (bar)	Direction of feed flow	Minimum 16-pan average ADD mm/min	Minimum flue space (4 pans) average ^a mm/min
1	0	0	4,57	1 318	0,34 (3,4)	Double	19,1	60,3
1	0	0	4,57	2 636	0,34 (3,4)	Double	9,7	20,4
2	3,66	0	1,22	2 636	0,34 (3,4)	Single	11,8	NR
2	0	3,66	1,22	2 636	0,34 (3,4)	Double	14,2	NR
^a NR = No requirement.								