BS EN 12259-14:2020+A2:2024
Incorporating corrigendum September 2024

Fixed firefighting systems — Components for sprinkler and water spray systems

Part 14: Sprinklers for residential applications

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National foreword

This British Standard is the UK implementation of EN 12259-14:2020+A2:2024. It supersedes BS EN 12259-14:2020+A1:2022, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by !A1 "!.

The UK participation in its preparation was entrusted to Technical Committee FSH/16/2, Sprinkler Systems.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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31 August 2022	Implementation of CEN amendment A1:2022
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EUROPEAN STANDARD

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Fixed firefighting systems - Components for sprinkler and water spray systems - Part 14: Sprinklers for residential applications

Installations fixes de lutte contre l'incendie - Composants des systèmes d'extinction du type sprinkleur et à pulvérisation d'eau - Partie 14: Sprinkleurs pour applications résidentielles

Ortsfeste Brandbekämpfungsanlagen - Bauteile für Sprinkler- und Sprühwasseranlagen - Teil 14: Sprinkler für die Anwendung im Wohnbereich

This European Standard was approved by CEN on 4 November 2019 and includes Amendment 1 approved by CEN on 13 March 2022 and Amendment 2 approved by CEN on 14 July 2024.

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Contents

European foreword

This document (EN 12259-14:2020+A2:2024) has been prepared by Technical Committee CEN/TC 191 "Fixed firefighting systems", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2025, and conflicting national standards shall be withdrawn at the latest by February 2025.

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

This document includes Amendment 1 approved by CEN on 13 March 2022 and Amendment 2 approved by CEN on 14 July 2024.

This document supersedes [A1] EN 12259-14:2020+A1:2022 [/A1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [/A1] and [A2] [/A2].

[A2] In comparison with EN 12259-14:2020, technical modifications have been made to clarify the types of sprinkler seal that are covered by this document in Amendment 1. In Amendment 2 the pressure values in C.1.1 and C.2.1 were corrected as well as the unit for the force increase in G.1. [/A2]

It is included in a series of European Standards planned to cover:

— automatic sprinkler systems (EN 12259 and EN 12845);

— gas extinguishing systems (EN 12094);

— powder systems (EN 12416);

— foam systems (EN 13565);

— hydrant and hose reel systems (EN 671);

— smoke and heat control systems (EN 12101).

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

[A1] This document specifies requirements for the construction and performance of residential sprinklers as well as test methods for their type approval, which are operated by a change of state of an element or bursting of a glass bulb under the influence of heat and incorporating the following types of water seals:

— conical metal spring with a PTFE gasket or coating;

— metal cap or disc with PTFE gasket or coating;

— copper gasket, with or without a PTFE coating.

Sprinklers in accordance with this document are only used in automatic sprinkler systems for domestic and residential applications as defined in EN 16925. [A1]

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.

[A1] EN 12259-1:1999+A1:2001[1] [A1], *Fixed firefighting systems — Components for sprinkler and water spray systems — Part 1: Sprinklers*

EN 13501-1, *Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests*

EN 16925, *Fixed firefighting systems - Automatic residential sprinkler systems - Design, installation and maintenance*

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

ISO 49, *Malleable cast iron fittings threaded to ISO 7-1*

ISO 65, *Carbon steel tubes suitable for screwing in accordance with ISO 7-1*

ISO 5658-2:2006, *Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building and transport products in vertical configuration*

ISO 5660-1:2015, *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)*

UL 723, *Standard for test for surface burning characteristics of building materials*

3 Terms and definitions

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

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

— IEC Electropedia: available at https://www.electropedia.org/

[1] [A1] As impacted by EN 12259-1:1999+A1:2001/A2:2004 and EN 12259-1:1999+A1:2001/A3:2006. [A1]

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
concealed sprinkler
unit (pre-assembled or assembled on site) consisting of a nozzle with a thermally sensitive sealing device, a housing and a cover plate, that ensures that the sprinkler will be installed with all or part of the thermally sensitive element behind the plane of the ceiling

3.2
recessed sprinkler
unit (pre-assembled or assembled on site) consisting of a nozzle with a thermally sensitive sealing device and a housing, that ensures that the sprinkler will be installed with all or part of the thermally sensitive element above the plane of the ceiling

3.3
discharge coefficient
known as K-factor

coefficient of discharge in the formula,

$$Q = K\sqrt{p} \quad (1)$$

where

Q is the flow in litres per minute, and

p is the pressure in bar

3.4
dry-type sprinkler
nozzle with a thermally sensitive sealing device secured in an extension nipple that has a seal at the inlet end to prevent water from entering the nipple until the sprinkler operates

3.5
flush sprinkler
unit consisting of a nozzle with a thermally sensitive sealing device and housing, that ensures that the sprinkler will be installed partly behind, but with the temperature sensitive element before, the finished plane of the ceiling or wall

3.6
heat responsive element
portion of a sprinkler that breaks, melts, or otherwise functions to initiate the automatic operation of the sprinkler when exposed to sufficient heat

3.7
heptane
commercial grade heptane having the following characteristics:

a) minimum Initial Boiling Point of 88 °C;

b) maximum Dry Point of 100 °C; and

c) specific Gravity (15,6 °C/15,6 °C) of 0,68 - 0,73.

3.8
orifice
opening that controls the amount of water discharged from a sprinkler at a given pressure

3.9
pendent sprinkler
nozzle with a thermally sensitive sealing device intended to be installed so that its deflector is located below the orifice and the water flows downward through the orifice

3.10
residential sprinkler
nozzle with a thermally sensitive sealing device intended to be installed only in residential occupancies as defined in EN 16925

3.11
sidewall sprinkler
nozzle with a thermally sensitive sealing device intended for installation on or near the wall

3.12
upright sprinkler
nozzle with a thermally sensitive sealing device intended to be installed so that its deflector is located above the orifice

3.13
response time index
RTI
measure of the thermal sensitivity of the sprinkler expressed in (meters.seconds)^{½} (m×s)^{½}

Note 1 to entry: Unlike in EN12259–1, the RTI value is calculated without considering the conductivity factor

3.14
design lower tolerance limit
DLTL
glass bulb supplier’s specified and assured lowest lower tolerance limit

3.15
design upper tolerance limit
DUTL
sprinkler supplier’s specified and assured highest upper tolerance limit

3.16
fusible link sprinkler
nozzle with a thermally sensitive sealing device which opens when an element provided for that purpose melts

3.17
glass bulb sprinkler
nozzle with a thermally sensitive sealing device which opens when a liquid-filled glass bulb bursts

3.18
mean design service load
sprinkler supplier’s specified and assured highest mean service load for any batch of 10 or more sprinklers

3.19
mean design strength
glass bulb supplier's specified and assured lowest mean bulb strength for any batch of 55 or more bulbs

3.20
horizontal sprinkler
nozzle with a thermally sensitive sealing device in which the nozzle directs the water horizontally

3.21
lower tolerance limit
LTL
glass bulb lowest strength determined by test and statistical analysis of a batch of 55 or more bulbs

3.22
supplier
company responsible for the design, manufacture and quality assurance of a product

3.23
upper tolerance limit
UTL
highest service load determined by test and statistical analysis of a batch of 20 or more sprinklers

3.24
frame arms
part of a sprinkler that maintains the thermally sensitive element in load bearing contact with the sprinkler head valve

4 Construction and performance

4.1 General

Sprinklers shall only be assembled in such a way that adjustment or dismantling will result in destruction of an element of construction.

It shall be possible to remove the cover of a concealed sprinkler without having to use special tools, e.g. for visual inspections.

4.2 Dimensions and pressure rating

4.2.1 Dimensions

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

It shall be possible for a sphere of (5,0 +0,01/-0) mm diameter to pass through the orifice of the sprinkler.

4.2.2 Pressure ratings

A residential sprinkler shall have a maximum operating pressure of at least 12 bar.

4.3 Nominal operating temperature

When tested in accordance with "Test to determine operating temperatures of fusible link sprinklers and glass bulb sprinklers" of ⟦A1⟩ EN 12259-1:1999+A1:2001 ⟨A1⟧, sprinklers shall operate at a temperature within the range:

$T_{test} = [t \pm (0{,}035\ t + 0{,}62)]\ ^{o}C$

where

t is the nominal operating temperature.

When cover plates are tested in accordance with the "Test to determine operating temperatures of fusible link sprinklers and glass bulb sprinklers" of ⟨A1⟩ EN 12259-1:1999+A1:2001 ⟨A1⟩, cover plates shall operate at a temperature within the range:

$T_{test} = [t_{cover} \pm (0{,}035\ t + 0{,}62)]\ ^{o}C$

where

t_{cover} is the nominal operating temperature of the cover.

This temperature t_{cover} shall be 8 °C to 20 °C lower than the nominal operating temperature of its sprinkler head.

4.4 Operating temperatures

The temperature classification, temperature rating, and colour coding of a residential sprinkler shall be as specified in Table 1.

Table 1 — Nominal operating temperatures and colour codes

Glass bulb sprinklers		Fusible link sprinklers	
Nominal operating temperature °C	Liquid colour code	Nominal operating temperature within range °C	Frame arms colour code
57	Orange	57 to 77	uncoloured
68	Red	80 to 107	white
79	Yellow		
93	Green		
100	Green		

4.5 Water flow and distribution

4.5.1 K-factor

The nominal K-factor shall be specified by the supplier. The K-factor of the sprinklers shall be within the nominal value ± 5 % for other than dry sprinklers and ± 8 % for dry sprinklers, when determined in accordance with Annex B.

4.5.2 Water distribution

4.5.2.1 Water distribution test – Horizontal surface

When installed in accordance with the installation instructions and tested as described in C.1 a residential sprinkler shall distribute water over a horizontal surface so that the discharge density for any pan within the design area (the maximum area the sprinkler is intended to protect) shall be at least 0,8 mm/min except that:

a) no more than 2 pans (0,5 m × 0,5 m) or not more than 4 pans (0,3m × 0,3m) for each quadrant shall be allowed to be at least 0,6 mm/min for upright and pendant sprinklers; and

b) no more than 8 pans (0,3 m × 0,3 m) or 3 pans (0,5 m × 0,5 m) shall be allowed to be at least 0,6 mm/min for each half (split along the sprinkler centreline) of the maximum area a sidewall sprinkler is intended to protect

4.5.2.2 Water distribution test – Vertical surface

When installed in accordance with the installation instructions and tested as described in C.2, a residential sprinkler shall distribute water in a uniform manner over vertical surfaces as follows:

a) walls within the coverage area shall be completely wetted to at least within 711 mm of the ceiling with one sprinkler discharging water 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 the following formula

$$WW - 20\ \%\ (D / P) \qquad (2)$$

where

WW is required amount of water collected on a wall, in %;

D is wall length, in m;

P is total perimeter of coverage area, in m.

4.5.3 Water Impingement Test

When tested in accordance with Annex C and while discharging water at a service pressure of 5,2 bar less than the maximum operating pressure, a residential sprinkler shall not prevent the operation of an adjacent residential sprinkler.

4.6 Function

When tested in accordance with Annex E each of the residential sprinklers shall operate at service pressures of 0,5 bar to the maximum operating pressure. The sprinkler shall open and within 5 s of release of the thermally sensitive element shall operate satisfactorily. Any lodgement of released parts shall be cleared within 60 s of the release of the thermally sensitive element. After testing in accordance with Annex E the sprinkler shall conform to the requirements of 4.5.2.

NOTE In most instances visual examination of the equipment will be sufficient to establish conformity with the requirements of 4.5.2.

4.7 Fire Test

When fire tested as described in Annex D a residential sprinkler shall limit temperatures as specified below when tested at each spacing referenced in the installation instructions. Additionally, a maximum of two residential sprinklers shall operate and the third sprinkler, located near the 1 000 mm wide doorway, shall not operate. The sprinklers shall limit temperatures as follows:

a) The maximum temperature measured 76 mm below the ceiling at locations 4 and 5 as illustrated in Figure D.1, Figure D.2 and Figure D.3 shall not exceed 316 °C.

b) The maximum temperature measured 1,6 m above the floor at location 4 shall not exceed 93 °C.

c) The temperature at the location described in (b) shall not exceed 54 °C for more than any continuous 2 min period.

d) The maximum ceiling material temperature measured 6 mm behind the finished ceiling surface shall not exceed 260 °C.

NOTE The thermocouple 76 mm below the ceiling, located above the fire source, is for reference purposes only.

See Figure D.1, (pendant, upright, flush, recessed pendant, and concealed sprinklers) or Figure D.2 and Figure D.3 (sidewall sprinklers) for temperature measuring locations.

4.8 Strength of sprinkler body and deflector

4.8.1 Strength of frame

The sprinkler body shall not show permanent elongation of more than 0,2 % between the load-bearing parts when subjected to twice the average service load when tested in accordance with F.1.

4.8.2 Flow endurance

A residential sprinkler shall withstand for 30 min, without evidence of cracking, deformation, or separation of any part when tested in accordance with F.2.

4.8.3 Strength of deflector

The sprinkler deflector and its supporting parts shall withstand an applied force of 70 N without permanent deformation when tested in accordance with F.3.

4.9 Strength of release element

4.9.1 Glass bulb sprinklers

When evaluated and tested in accordance with Annex G, glass bulb sprinklers shall have:

a) a mean design bulb strength of at least six times the mean design service load;

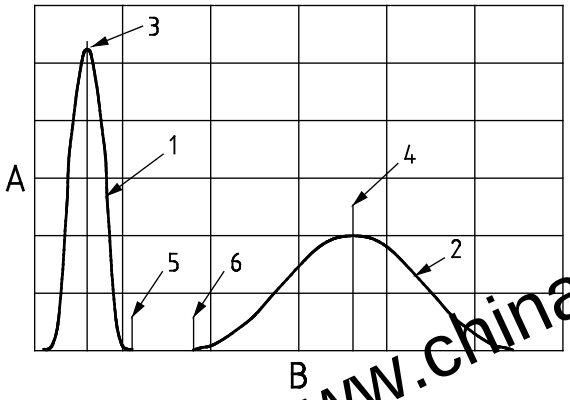
b) a mean bulb strength not less than the mean design bulb strength;

c) a mean service load not more than the mean design service load;

d) a design lower tolerance limit (DLTL) on the distribution curve of at least two times the design upper tolerance limit (DUTL) of the service load distribution curve;

e) an upper tolerance limit (UTL) less than or equal to the design upper tolerance limit (DUTL);

f) a lower tolerance limit (LTL) greater than or equal to the design lower tolerance limit (DLTL) see Figure 1.



Key

1 service load distribution curve
2 bulb strength distribution curve
3 mean service load
4 mean bulb strength
5 upper tolerance limit (UTL)
6 lower tolerance limit (LTL)
A number of samples
B strength (N)

Figure 1 — Graph of service load and bulb strength distribution curves

4.9.2 Fusible link sprinklers

It shall be determined that:

a) the temperature sensitive elements withstand a load of 15 times the maximum design load for a period of 100 h, without failure; or

b) the estimated time to failure of temperature sensitive elements is not less than 876 600 h at the design load, when tested in accordance with Annex G.

4.10 Leak resistance and hydrostatic strength

Twenty residential sprinklers shall be tested and not leak when tested in accordance with H.1 and, subsequently, shall not rupture, operate or release, when tested in accordance with H.2.

4.11 Heat exposure

4.11.1 General

A residential sprinkler shall withstand for 90 days, without evidence of weakness or malfunction, an exposure to the high-ambient temperature in accordance with I.1.

After the exposure period four sprinklers shall be tested in accordance with E.2; the sprinklers shall operate such that the waterway is cleared. Any lodgements shall be disregarded. Four sprinklers shall be leak tested in accordance with H.1. Four sprinklers shall be tested in accordance with "Test to determine operating temperatures of fusible link sprinklers and glass bulb sprinklers" of ⟦A1⟩ EN 12259-1:1999+A1:2001 ⟨A1⟧.

Additionally, after the exposure period four recessed, concealed and flush sprinklers shall be tested in accordance with M.2. Their mean operating time shall be equal to or less than a 1,30 multiple of the mean operating time of the sprinkler tested in accordance with M.2 for compliance with 4.14.2.

4.11.2 Additional heat exposure of glass bulb sprinklers

There shall be no damage to the glass bulb when sprinklers are tested in accordance with I.2.

[A1⟩ *deleted text* ⟨A1]

4.11.3 Thermal shock

When glass bulb sprinklers are tested in accordance with Annex J, the glass bulbs shall either:

— break correctly on cooling such that the waterway is cleared; or

— remain intact. After immersion when subjected to a function test in accordance with E.2, the sprinkler shall operate in such way that the waterway is cleared; any lodgements shall be disregarded.

4.12 Corrosion

4.12.1 Stress corrosion

After being subjected for 10 days to a moist ammonia exposure as described in K.1 a residential sprinkler having copper alloy parts shall:

a) show no evidence of cracking, delamination, or degradation; and

b) perform as intended when tested as described in K.1.

If the application of a 12 bar water pressure to the inlet of the sprinkler increases the assembly load by more than 10 %, the additional load is to be applied during the moist ammonia-air mixture exposure specified in K.1.

4.12.2 Sulphur dioxide corrosion

Residential sprinklers shall be subjected to a sulphur dioxide corrosion test in accordance with K.2. After exposure, when subjected to a function test in accordance with E.2 the sprinkler shall operate such that the waterway is cleared; any lodgements shall be disregarded.

4.12.3 Salt mist corrosion

Residential sprinklers shall be subjected to a salt mist corrosion test in accordance with K.3. After exposure, when subjected to a function test in accordance with E.2, the sprinkler shall operate such that the waterway is cleared; any lodgements shall be disregarded.

4.12.4 Moist air

Residential sprinklers shall withstand an exposure to moist air atmospheres when tested in accordance with K.4.

4.13 Water hammer

Sprinklers shall not leak when subjected to pressure surges in accordance with Annex L. After the test, when subjected to a function test in accordance with E.2, the sprinkler shall operate such that the waterway is cleared; any lodgements shall be disregarded.

4.14 Thermal response

4.14.1 Oven test

When tested in accordance with M.1, upright, pendent and horizontal sprinklers, other than flush, recessed and concealed sprinklers, shall release within a maximum time which is to be calculated from the formula in M.1, based on a response time index (RTI) 50.

4.14.2 Room response test

When tested in accordance with M.2, flush, recessed and concealed sprinklers shall release within 75 s.

4.15 Resistance to vibration

A residential sprinkler shall withstand the effects of vibration without deterioration of its performance characteristics when tested in accordance with Annex N.

4.16 Resistance to impact

A residential sprinkler, except for dry-type sprinklers, shall be tested as described in Annex O and shall not be damaged or leak.

4.17 Resistance to low temperature

The sprinkler shall not operate before the function test, when tested in accordance with Annex P. After the low temperature exposure it shall show no visible evidence of damage. Following examination, when subjected to a function test in accordance with E.2, the sprinkler shall operate such that the waterway is cleared; any lodgements shall be disregarded.

4.18 Resistance to heat

When tested in accordance with Annex Q, the sprinkler body, deflector and its supporting parts shall show no significant deformation or breakage.

4.19 Test conditions

For sprinkler testing conditions, see Annex A.

5 Marking

5.1 General

Sprinklers shall be marked with the name or trade mark of the supplier.

An identification number as defined in 5.2 is considered to satisfy this requirement.

5.2 Identification number

A four- to six-character identification number, with no intervening spaces, should be used to identify the supplier and sprinkler operating characteristics. The number, if used, shall be cast or die-stamped on the sprinkler deflector or on a visible non-operating part, which is not used to install the sprinkler. The identification number is permitted to be located behind the cover plate which is removable with common tools, provided the number will be visible after the sprinkler is installed and the cover plate is removed.

The identification number, if used, shall consist of one or two characters which identify the supplier, followed by three or four digits to identify a unique sprinkler identification for orifice size or shape, deflector characteristic, pressure rating and thermal sensitivity classification.

5.3 Nominal operating temperature and year of manufacture

A residential sprinkler shall be permanently marked on a visible non-operating part with the temperature rating and year of manufacture.

Exception: The nominal operating temperature may be marked on a visible operating part instead of being marked on a visible non-operating part.

A sprinkler produced in the last 3 months of a calendar year may be marked with the following year as the date of manufacture, and one produced in the first 6 months of a calendar year may be marked with the preceding year as the date of manufacture.

The frame arms of residential sprinklers of the various nominal operating temperatures shall be coloured in accordance with the colour code designated in Table 1.

Exception No. 1: Frame arm colour identification is not required for painted sprinklers, flush sprinklers, or similar decorative types.

Exception No. 2: Frame arm colour identification is not required for sprinklers having frangible bulb heat responsive elements colour coded in accordance with Table 1.

5.4 Manufacturing location

If a supplier produces sprinklers at more than one factory, each sprinkler shall have a distinctive marking to identify it as the product of a particular factory.

5.5 Heat sensitive element supplier

When sprinklers are made with more than one supplier of the heat sensitive element, i.e. the glass bulb or the fusible link, each sprinkler shall have a distinctive marking to identify the heat sensitive element supplier.

5.6 Protective covers

Protective covers, if used, shall be 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 protective cover so that it is visible after sprinkler installation.

5.7 Sidewall sprinklers

5.7.1 General

The deflector of a sidewall sprinkler shall clearly show its intended orientation with regard to the direction of flow. If an arrow is employed, it shall indicate the direction of flow and be accompanied by the word “FLOW.”

5.7.2 Horizontal sidewall sprinklers

A residential sprinkler intended for horizontal sidewall installation shall be marked with the word “TOP.”

5.8 Concealed sprinklers

The cover plate for a concealed sprinkler shall be marked with the words: “Do not paint” on the exterior surface.

Any housing intended for installation with concealed sprinkler assemblies and not attached by the supplier shall be marked as follows: “FOR USE WITH [SPRINKLER IDENTIFICATION description].”

5.9 Removable recessed housing

An escutcheon intended for installation with recessed and concealed type sprinkler assemblies and not attached by the supplier shall be marked as follows: “FOR USE WITH [SPRINKLER IDENTIFICATION NUMBER(S) AND SPRINKLER TEMPERATURE RATING(S)].”

6 Instruction charts

6.1 General

An instruction chart, giving the recommended method of installation and instructions on care and replacement, shall be available with each type of sprinkler.

6.2 Installation Instructions

Each package of residential sprinklers shall be provided with installation instructions that shall include the following:

a) coverage area dimensions;

b) minimum water flow rate in accordance with Table 2;

c) K-factor;

d) minimum distance between sprinklers;

e) installation position;

f) distance of sprinkler deflector from ceiling and / or wall;

g) minimum operating pressure;

h) distance between the sprinkler and obstructions;

i) indication as to whether a recessed or concealed sprinkler is vented or unvented;

j) indication whether concealed sprinklers are allowed to be installed in concrete or other solid materials;

k) a reference to EN 16925 for design and installation; and

l) a statement that the minimum flow for each sprinkler shall be such that both the associated length and width spacings given in the supplier’s table shall be equal to or greater than the sprinkler’s length and width spacings in the actual installation.

If the installation instructions do not only refer to EN 16925, it shall be clearly indicated which clauses, parts and values relate to EN 16925.

Guidance for locating sprinklers away from obstructions shall be provided.

For dry-type sprinklers intended to be installed in dry systems, information shall be provided on the appropriate sprinkler-fitting compatibility, to minimize the potential to accumulate water, scale, and sediment of the sprinkler inlet and provide for an unobstructed flow path upon operation.

The minimum water flow rates shall not be less than those given in Table 2 for typical spacings. The minimum flow rate for a sprinkler shall be the same for single and multiple operating sprinklers.

Table 2 — Minimum sprinkler flow rates for typical spacings

Upright, pendant, recessed pendant, flush, and concealed sprinklers		**Sidewall sprinklers**	
Typical spacing m	Minimum flow l/min	Typical spacing m	Minimum flow l/min
3,7 × 3,7	28	3,7 × 3,7	28
4,3 × 4,3	38	4,3 × 4,3	38
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
[A1] *deleted text* [A1] The maximum spacing shall not be more than 37,2 m^2. If another spacing as stated above is used, the minimum flow shall not be less than that required to provide a minimum design discharge density of 2,1 mm/min.			

Annex A
(normative)

Conditions for tests

See 4.19 for the corresponding requirement.

Except where specified otherwise, carry out tests at (20 ± 10) °C. Examine sprinklers for visually obvious defects before testing.

Annex B
(normative)

Water flow test

See 4.5.1 for the corresponding requirement. Mount the sprinkler on a supply pipe together with a means of pressure measurement (see Figure B.1). Bleed the air from the pipe assembly using the bleed valve. Measure the flow rate, by direct measurement of flow rate or by collecting and measuring the weight or volume of water discharged, for water pressures of 0,5 bar to 6,5 bar at the sprinkler head at intervals of (1 ± 2 %) bar. The maximum permissible error of the flow measuring device shall be ± 2 % of the value measured. Calculate the K-factor for each pressure interval from Formula (1):

$K = Q / \sqrt{P}$

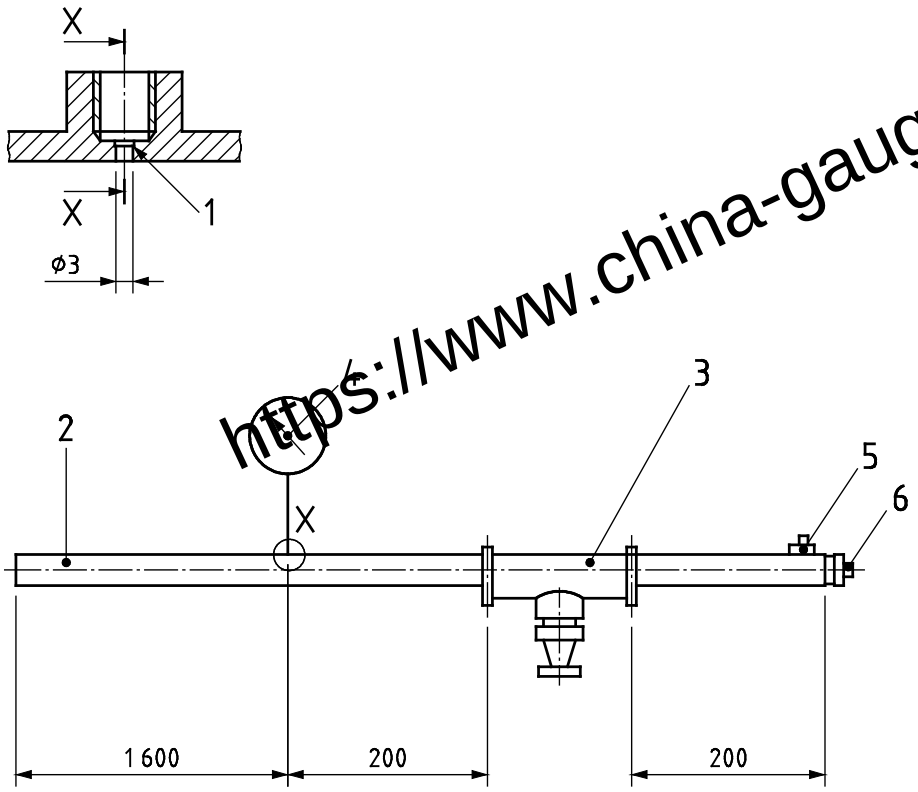
where

P is the pressure in bar (bar)

Q is the flow rate in litres per minute (l/min)

During the test, pressures should be corrected for difference in height between the gauge and the outlet orifice of the sprinkler.

Dimensions in millimetres



Key

1 deburred orifice

2 steel tube nominal internal diameter 40 mm, medium weight (in accordance with ISO 65)

3 fitting 10 mm, 15 mm, 20 mm, 25 mm or 32 mm (in accordance with ISO 49)

4 pressure gauge

5 air bleed valve

6 plug or cap

NOTE Tolerances: Pressure gauge ± 2 % or 0,04 bar whichever is the greater, weighing machine ± 1 %.

Figure B.1— Water flow test apparatus

Annex C
(normative)

Water distribution test

C.1 Water distribution test – Horizontal surface

C.1.1 General

See 4.5.1.2 for the corresponding requirement.

Tests are to be conducted on an individual sprinkler using minimum flow rates specified in the installation instructions. [A1] In addition, for sprinklers having a pressure rating greater than 12 bar, tests shall be conducted at the maximum spacing specified in the installation instructions using a flow corresponding to a pressure of 5 bar less than the maximum operating pressure. [A2] The water distribution test is to be conducted for 20 min at each flow rate, except a shorter duration can be used if a pan within the collected area has reached its capacity.

Dry-type sprinklers are to be tested using the shortest available length and the longest available length, if the K-factor for the longest length deviates by more than 5 % from the shortest available length.

An open horizontal sidewall residential sprinkler is to be installed in its intended position in a reducing 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 DN25 piping. The minimum nipple length leading to the sprinkler fitting shall not be less than 250 mm. The sprinkler is to be installed under a smooth, flat ceiling extending at least over the water collection pans. The sprinkler deflector is to be located in its intended minimum position as specified in the installation instructions.

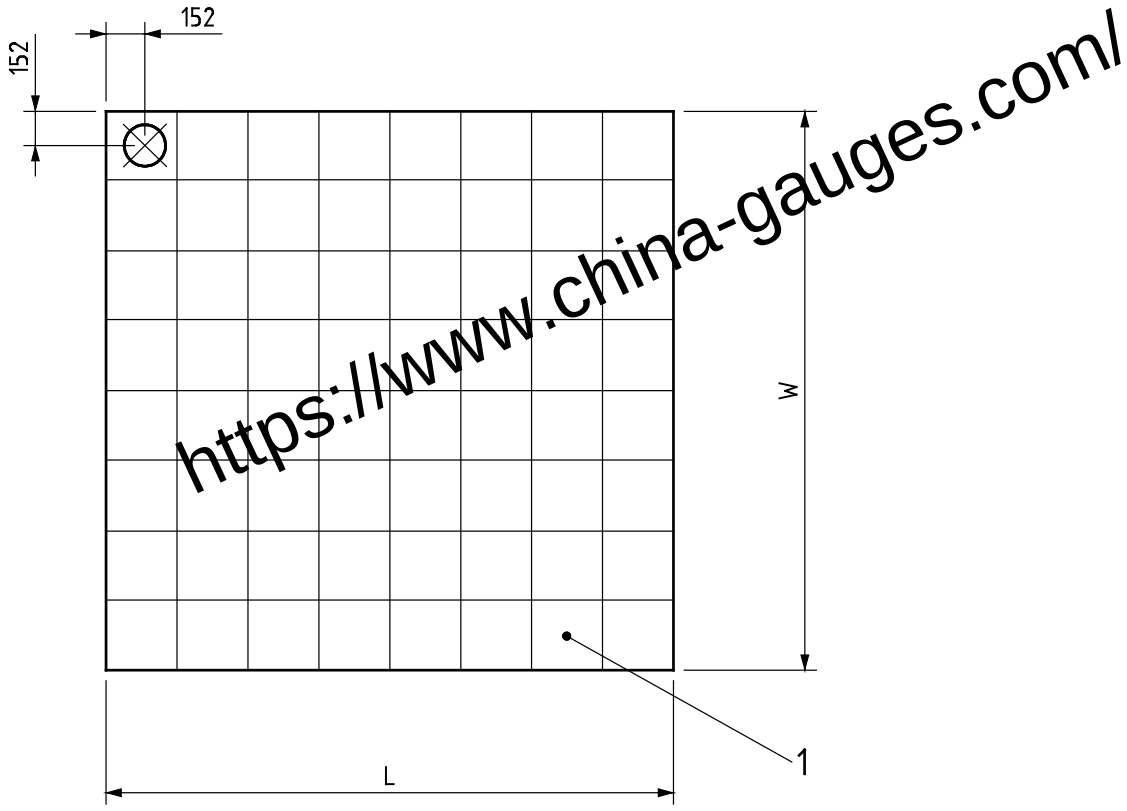
An open pendant, recessed pendant, flush pendant, concealed pendant, or upright residential sprinkler is to be installed in its intended position as specified in the installation instructions in a reducing pipe fitting having a 25 mm inlet and an outlet the same size as the sprinkler inlet, and is to be supplied with water through DN25 piping. Recessed, flush, and concealed sprinklers are to be installed in their intended position, including their ventilation conditions, as specified in the installation instructions under a minimum 1,2 m by 1,2 m square, smooth, flat ceiling area. The sprinkler deflector is to be located in its minimum position as specified in the installation instructions. A pendant, upright, flush, or concealed sprinkler is also to be tested after being rotated 90 degrees about its vertical axis after being tested as initially installed. A concealed sprinkler shall be tested with its cover plate released, but with the cover plate support installed.

C.1.2 Upright, pendant, flush, recessed and concealed sprinklers

Collector pans measuring 0,3m x 0,3m for sprinklers with spacings in 0,3 m increments and 0,5 m × 0,5 m for sprinklers with spacings in 0,5m increments are to be placed on the floor in one quadrant of the sprinkler's discharge pattern (see Figure C1). The tops of the pans are to be 2,4 m below the ceiling.

At the completion of water flow, the water collected is to be measured to verify compliance with the requirements in 4.6.

Dimensions in millimetres



Key

pendant or upright sprinkler, positioned centrally above the corner pan

W coverage width / 2

L coverage length / 2

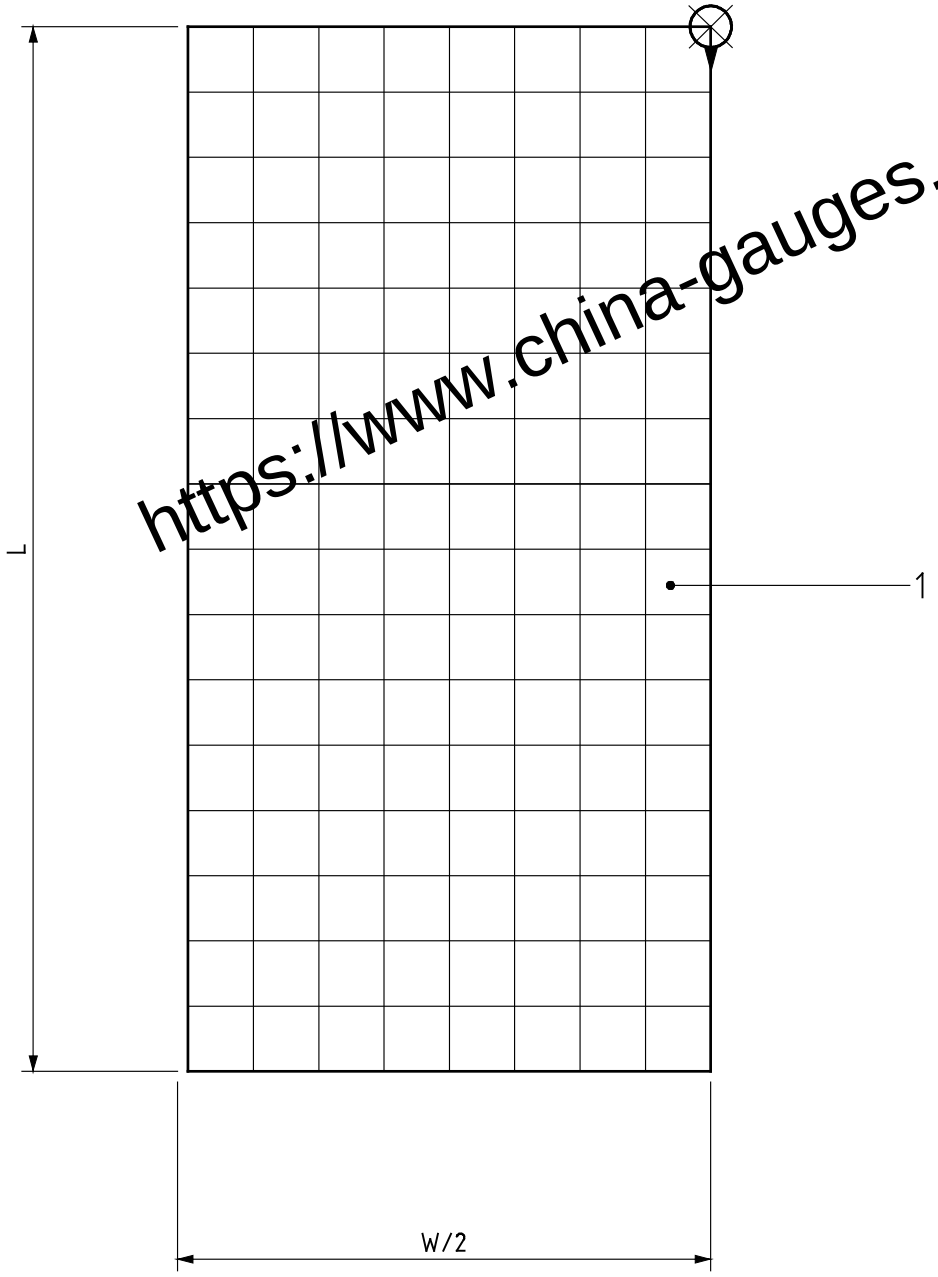
1 collector pans

Figure C.1 — Horizontal surface water collection for upright and pendant sprinklers

C.1.3 Sidewall Sprinklers

Collector pans measuring 0,3m x 0,3m for sprinklers with spacings in 0,3m increments and 0,5 m × 0,5 m for sprinklers with spacings in 0,5m increments are to be placed as shown in Figure C2. The tops of the pans are to be 2,1 m below the ceiling (see Figure C2).

At the completion of water flow, the water collected is to be measured to verify compliance with the requirements in 4.5.2.1.



Key

	sidewall sprinkler
W	coverage width
L	coverage length
1	collector pans

Figure C.2 — Horizontal surface water collection for sidewall sprinklers

C.2 Water distribution test – vertical surface

C.2.1 Test method

See 4.5.2.2 for the corresponding requirement.

Tests are to be conducted on an individual sprinkler using flow rates specified in the installation instructions. [A2] In addition, for sprinklers having a pressure rating greater than 12 bar, tests shall be conducted at the maximum spacing using a flow corresponding to a pressure of 5 bar less than the maximum operating pressure. [A2] Each water distribution test is to be conducted for a minimum of 10 min, except a shorter duration can be used if a pan within the collected area has reached its capacity.

Dry-type sprinklers are to be tested using the shortest available length and the longest available length, if the K-factor for the longest length deviates by more than 5 % from the shortest available length.

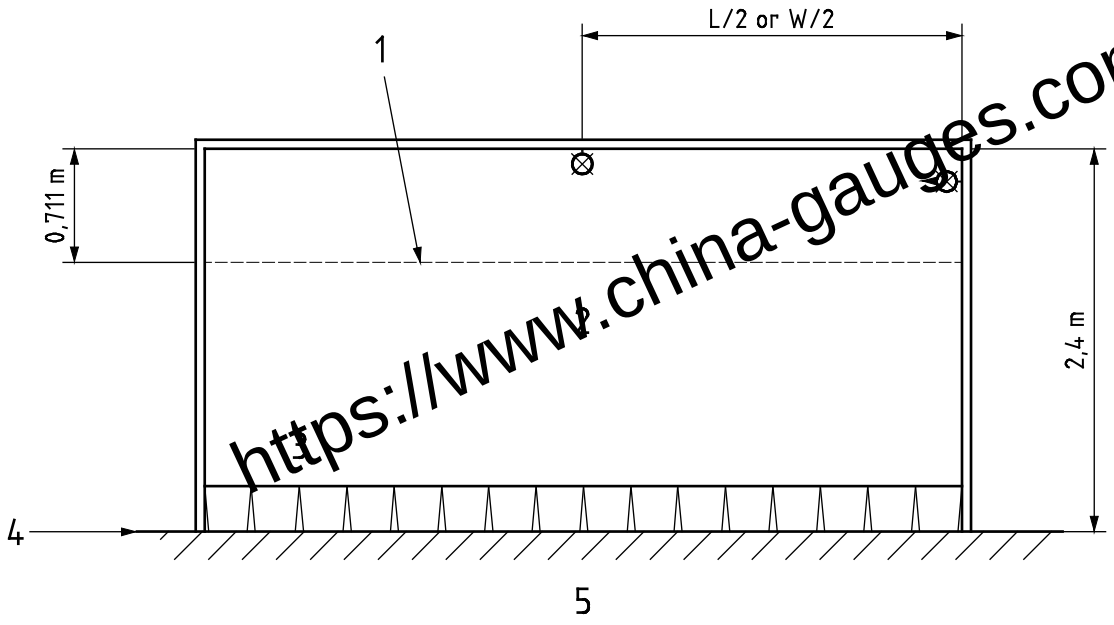
An open residential sprinkler is to be installed in its intended position in a pipe fitting having a DN25 inlet and an outlet the same size as the sprinkler inlet, and is to be supplied with water through DN25 piping. The sprinkler deflector is to be located in its intended minimum position as specified in the installation instructions. A pendant 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. 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.

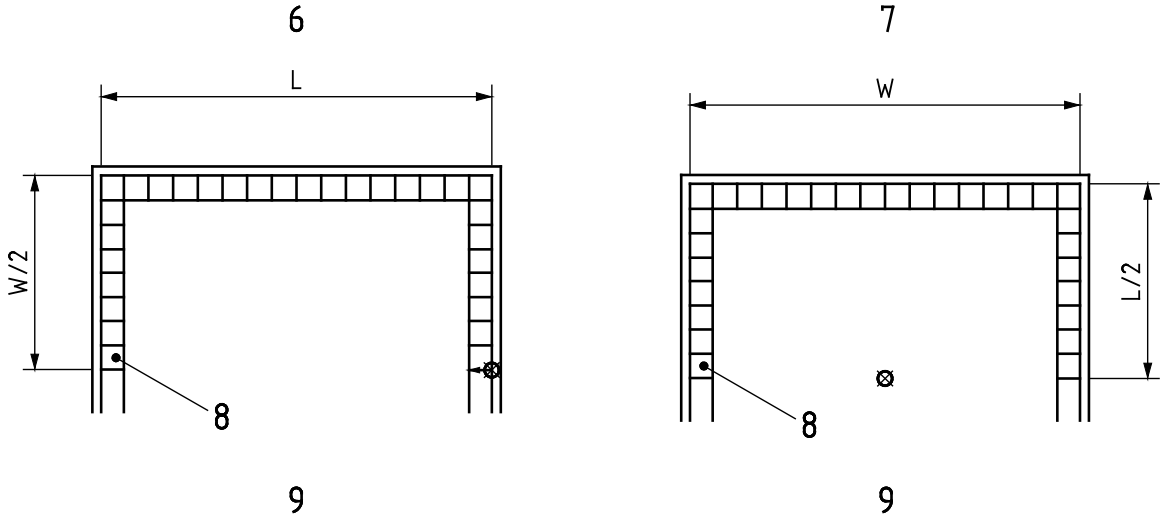
The collector pans are to measure 0,3 m × 0,3 m or 0,5 m × 0,5 m and are to be placed on the floor against the walls for the length and width of specified coverage, so that the water sprayed onto the wall will flow into the pans. They are to be 2,1 m below the ceiling and are to be baffled to prevent sprinkler flow from directly entering the pans (see Figure C.3).

The specified water flow rate is to be established and the test is to be conducted for a minimum of 10 min or until a pan is filled with water, whichever comes first. At the completion of the test, the volume of water collected and the height of wall wetting are to be measured to determine compliance with the requirements in 4.5.2.2.

Dimensions in metres



a) Side view



b) Plan view (sidewall sprinkler) **c) Plan view (sprinkler pendant/upright)**

Key

W	coverage width	4	floor
L	coverage length	5	side view
	sidewall sprinkler	6	collection pans – sidewall sprinklers
	pendant or upright sprinkler	7	collection pans – upright or pendant sprinklers
1	maximum wall-wetting distance from ceiling	8	collector pans
2	for upright, pendant or sidewall sprinklers	9	plan view
3	collector pans		

Figure C.3 — Vertical water collection

C.3 Water impingement test

See 4.5.3 for the corresponding requirement.

A residential sprinkler with the lowest nominal operating temperature provided, intended for installation at a minimum distance of 2,4 m between sprinklers is to be installed on piping 2,4 m, centre to centre, from a second identical sprinkler. The second sprinkler is to be open. The sprinklers are to be on separate parallel pipelines, with the frame arms parallel to the pipeline. The sprinkler deflector for pendant style sprinklers shall be located at the min and the max. distance from the ceiling as per the installation instructions. The sprinkler deflector for sidewall sprinklers shall be located at the minimum and the maximum distance below the ceiling as referenced in the installation instructions. For concealed and flush style sprinklers, the sprinklers are to be installed in the intended position within the ceiling and the sprinkler located above the fire is to be fitted with the cover plate in case of concealed sprinklers. Dry-type sprinklers are to be tested using the shortest available length. Water is to be discharged from the open sprinkler at a service pressure of 5,2 bar less than the maximum operating pressure. The closed sprinkler is then to be exposed to the heat and flame from a 305-mm-square pan, 100 mm deep, containing 0,5 l of heptane and 0,5 l of water, with the top of the pan located 305 mm below the heat responsive element of the sprinkler. The test sprinkler shall operate before the fuel is consumed.

Residential sprinklers intended for installation at a minimum distance of greater than 2,4 m are to be subjected to the test described above except that they are to be installed in accordance with the minimum distance between sprinklers as specified in the installation instructions, see 6.2.

Annex D
(normative)

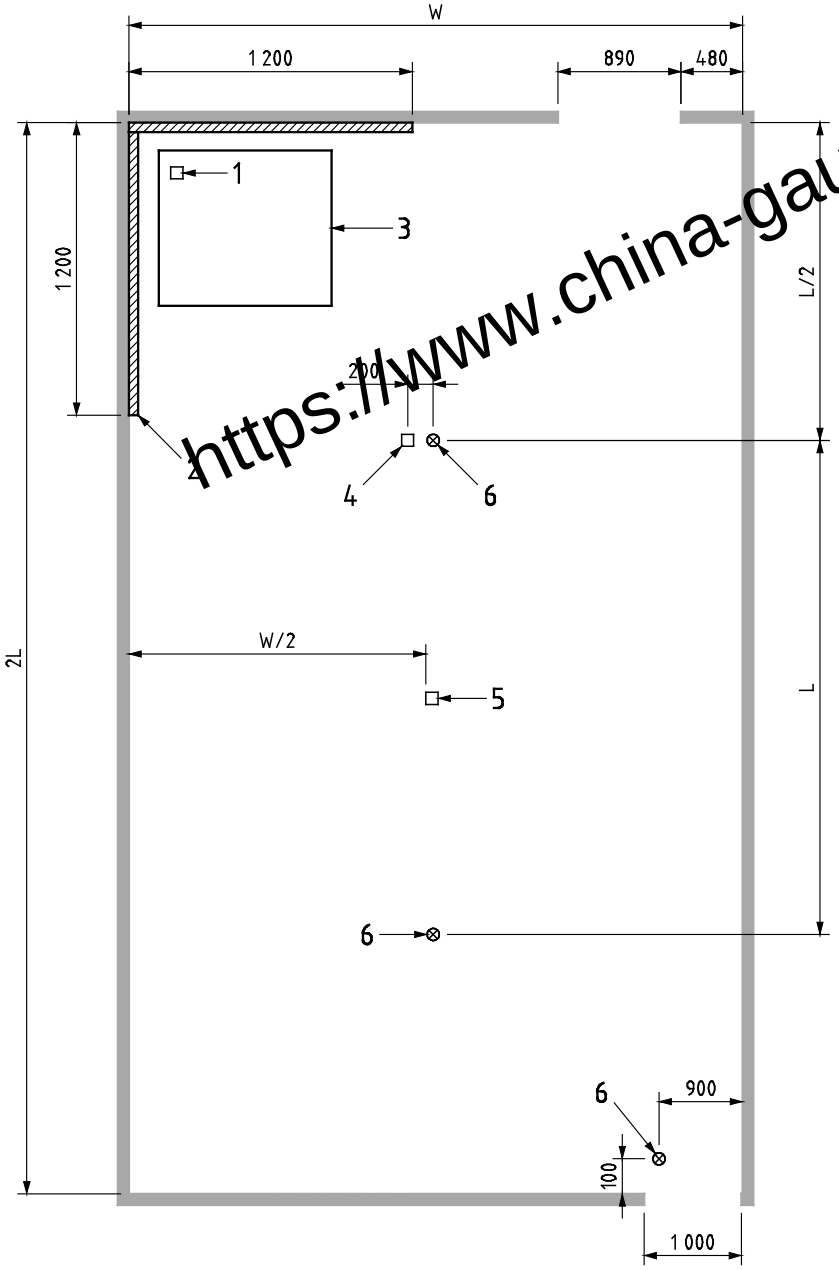
Fire test

D.1 Extent of testing

See 4.7 for the corresponding requirement.

All residential sprinklers in each temperature rating are to be subjected to the tests specified in D.2 and D.3. Pendant, upright, flush, recessed pendant and concealed pendent sprinklers are to be subjected to the fire test arrangement in Figure D.1 and sidewall sprinklers (including concealed sidewall sprinklers) are to be subjected to both fire test arrangements in Figure D.2 and Figure D.3. Sprinklers intended to be used at a coverage above 3,7 m x 3,7 m shall additionally be subjected to the tests specified in D.4.

Dimensions in millimetres



Key

1 thermocouple 6 mm above underside of ceiling and another thermocouple 76 mm below ceiling, both 250 mm diagonally from the near corner of the room

2 plywood(1200 × 2400 × 6) mm fixed to furring strips in 4 places equally spaced

3 corner fire test ignition and fuel package

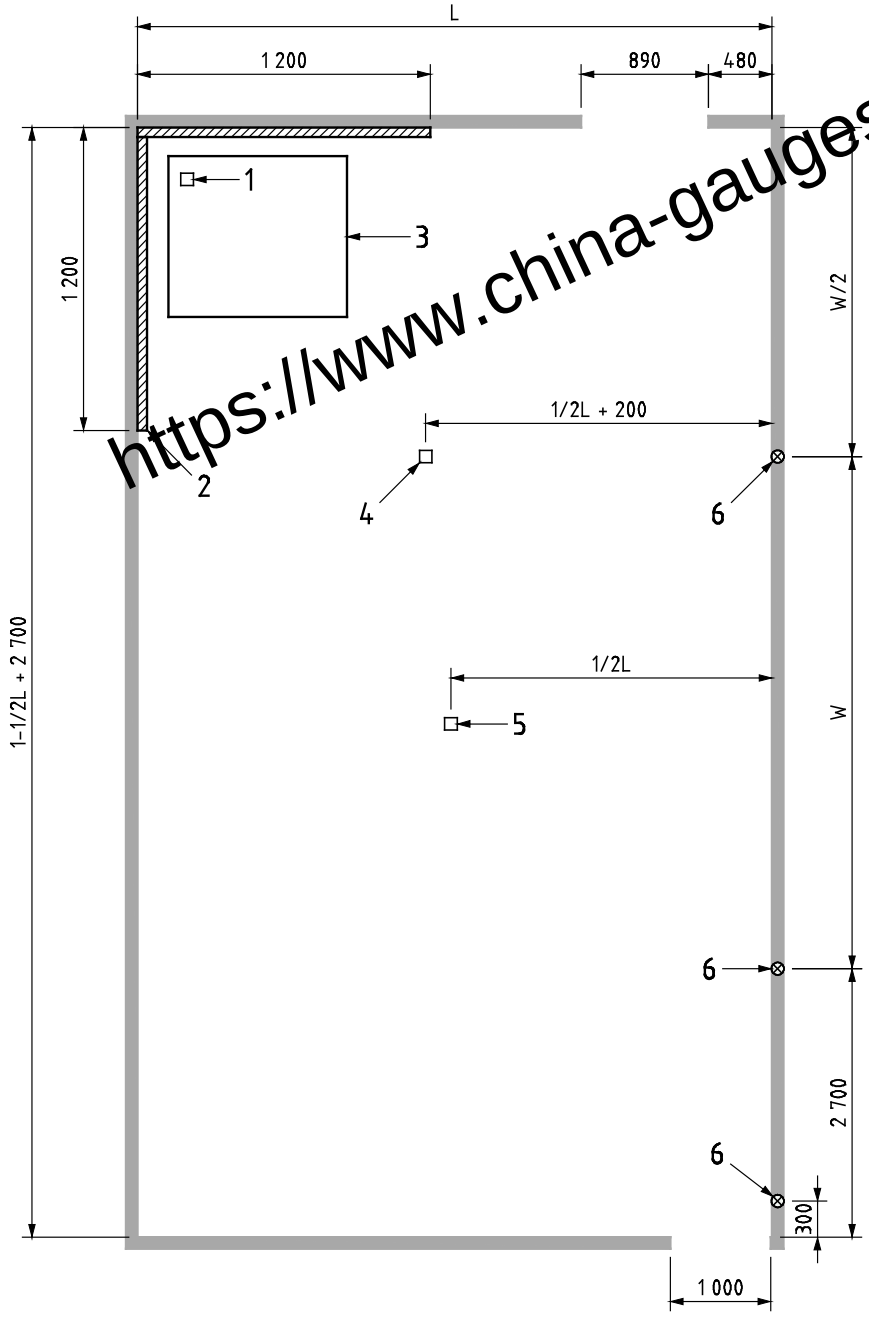
4 thermocouples 76 mm below underside of the ceiling and 1,6 m above floor

5 thermocouple 76 mm below underside of ceiling in the centre of the room

6 sprinkler

Figure D.1 — Fire test arrangement – pendant, upright, flush, recessed pendant, and concealed sprinklers

Dimensions in millimetres



Key

1 thermocouple 6 mm above underside of ceiling and another thermocouple 76 mm below ceiling, both 250 mm diagonally from the near corner of the room

2 plywood (1200 × 2400 × 6) mm fixed to furring strips in 4 places equally spaced

3 corner fire test ignition and fuel package

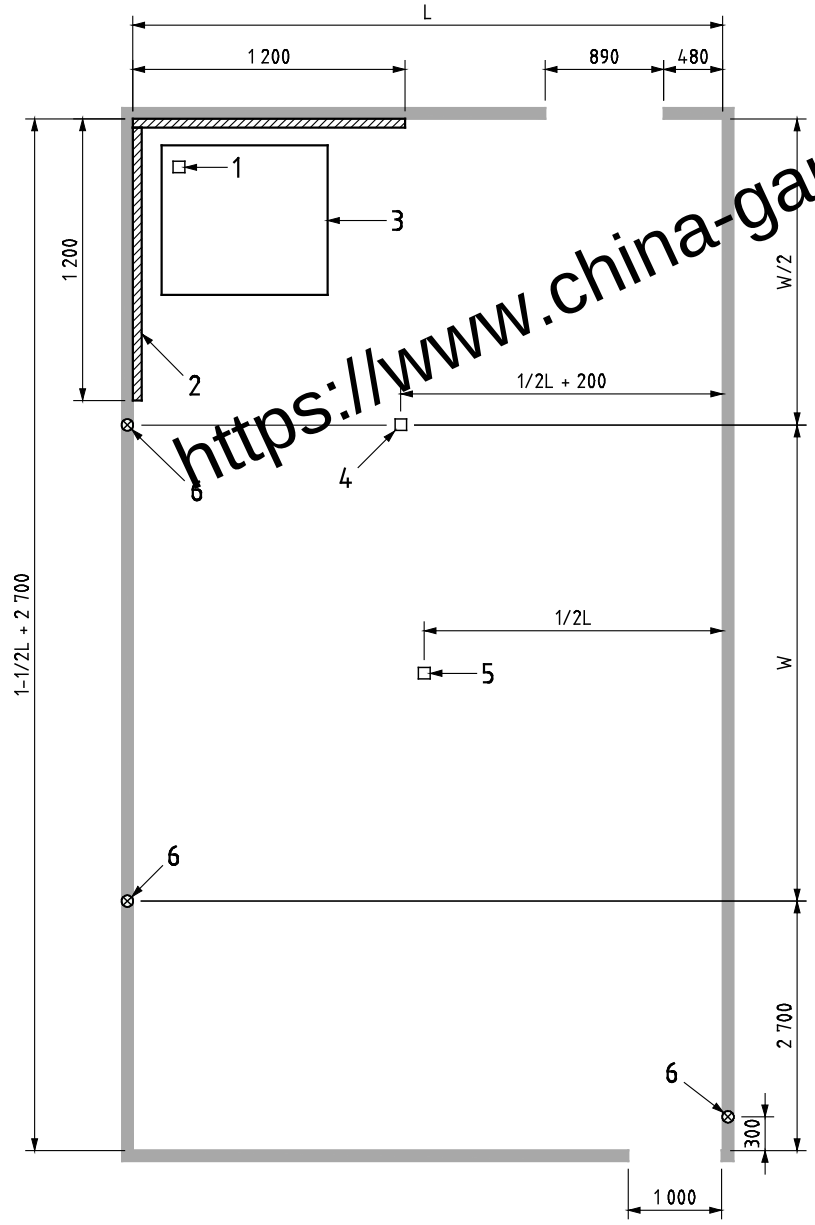
4 thermocouples 76 mm below underside of the ceiling and 1,6 m above floor

5 thermocouple 76 mm below underside of ceiling in the centre of the room

6 sprinkler

Figure D.2 — Fire test arrangement – sidewall sprinklers, test arrangement No. 1

Dimensions in millimetres



Key

1 thermocouple 6 mm above underside of ceiling and another thermocouple 76 mm below ceiling, both 250 mm diagonally from the near corner of the room

2 plywood (1200 × 2400 × 6) mm fixed to furring strips in 4 places equally spaced

3 corner fire test ignition and fuel package

4 thermocouples 76 mm below underside of the ceiling and 1,6 m above floor

5 thermocouple 76 mm below underside of ceiling in the centre of the room

6 sprinkler

Figure D.3 — Fire test arrangement – sidewall sprinklers, test arrangement No. 2

D.2 Test arrangement

D.2.1 Test room

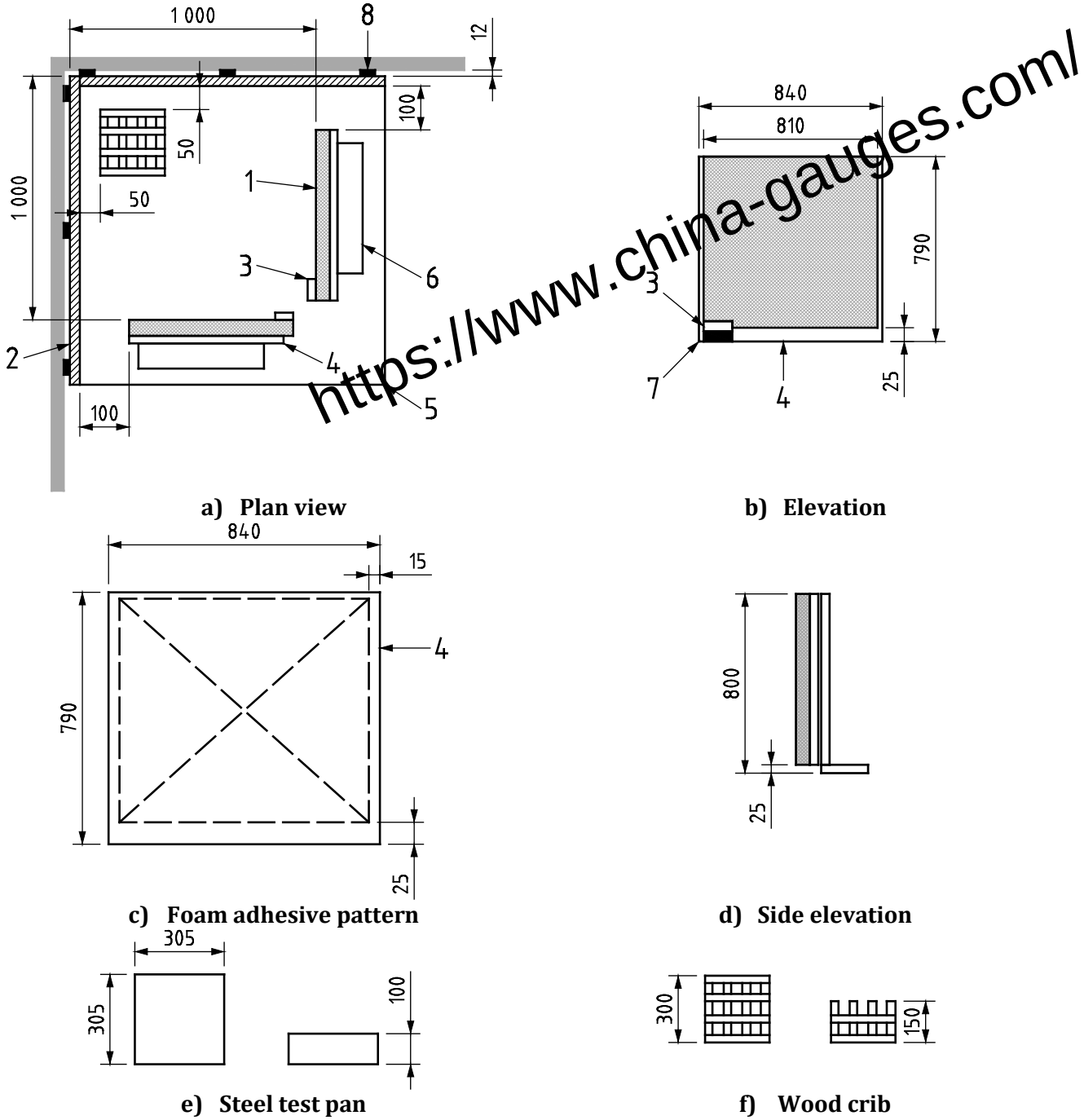
The test room dimensions for pendant, upright, flush, recessed pendant, and concealed sprinklers are to be the sprinkler coverage width by twice the coverage length by a nominal 2,4 m high ceiling. The test room dimensions for sidewall sprinklers are to be the sprinkler coverage length by 1-1/2 times the sprinkler coverage width plus 2,7 m by a nominal 2,4 m high ceiling. See Figures D.1, D.2 and D.3.

The test room ceiling is to be covered with acoustic panels or gypsum board attached to furring strips. Acoustic panels shall be used in the 1,2 m x 1,2 m area directly over the fire source are be 12 mm thick, have a density of (216 ± 24) kg/m^3, and shall be Euroclass A2, S2, d0 according to EN 13501-1 or better or have a maximum flame spread index of 25 when tested in accordance with ANSI UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. For each test, new acoustic panels in the 1,2 m x 1,2 m area directly over the fire source are to be installed.

The test room is to have provisions for ventilation through two door openings on opposite test room walls. Each opening is to be 2,2 m high, which provides for a 200 mm lintel above the openings. The door widths are to be as specified in Figures D.1, D.2 and D.3.

Douglas fir, 3-ply panels measuring 1,2 m by 2,4 m are to be placed on two of the test room walls extending out from a common corner. One panel is to be placed on each wall. See Figure D.4. The panels are to be 6 mm thick with each ply constructed of Douglas fir. The plywood panels are to be conditioned at (21 ± 2,8) °C and (50 ± 10) % relative humidity for at least 72 h prior to test. They are to be placed on the walls by being attached to (150 ± 15) mm wide and 12 mm thick softwood furring strips, conditioned as above. The Douglas fir plywood panels shall have the burning characteristic properties specified in Table D.1.

Dimensions in millimetres



a) Plan view

b) Elevation

c) Foam adhesive pattern

d) Side elevation

e) Steel test pan

f) Wood crib

Key

1 76 mm thick foam pad
2 6 mm thick Douglas Fir plywood (typical)
3 cotton wick 6 mm x 150 mm
4 12 mm thick plywood
5 non-combustible sheathing
6 3 mm thick angle arm frame
7 (152,4 × 50,8 × 31,75) mm brick
8 Furring strip, (150 ± 15) mm wide and 12 mm thick
〚A1〛 *deleted text* 〚A1〛

Figure D.4 — Corner fire test ignition and fuel package

Table D.1 — Plywood burning characteristics

Property	Test Method	Range
Flame Spread Index	ANSI/UL 723, Standard for Test for Surface Burning Characteristics of Building Materials	130 ± 30
	Spread of flame – Lateral spread on building and transport products in vertical configuration, ISO 5658-2:2006	7 ± 3
Critical Heat Flux	Use of Cone Calorimeter at radiant heat fluxes between 10 kW/m^2 and 20 kW/m^2 ISO 5660-1:2015	15 ± 3 kW/m^2
Thermal Response Parameter	Use of Cone Calorimeter at radiant heat fluxes of 25 kW/m^2, 35 kW/m^2, 50 kW/m^2 ISO 5660-1:2015	220 ± 50 kW·s$^{1/2}$/m^2
Note Plywood samples shall be 6 mm thick. Critical heat flux shall be determined by trial and error with repeated tests in search of the heat flux for no ignition occurring within 15 min duration. It shall first be determined to a coarse resolution of 2 kW/m^2 and then more finely to 1 kW/m^2. Determine the lowest value of heat flux at which sustained ignition is achieved, and the highest value at which ignition is not achieved. The critical heat flux is the average between the lowest heat flux at which there is ignition and the highest heat flux at which there is no ignition. For example, if the specimen ignites at 18 kW/m^2 within 15 min then repeat the same procedure at 16 kW/m^2, 14 kW/m^2 and 12 kW/m^2 (in that order) until there is no ignition for 15 min. If test results show a crossover (the lowest heat flux at which ignition occurs is lower than the highest heat flux at which no ignition was found) it is necessary to carry out triplicate tests for each determination and average the results. The average of the (already averaged) highest heat fluxes for non-ignition and the averaged lowest heat fluxes for ignition is the reported value for critical heat flux.		

The timber surface spread of flame characteristics shall be specified by ANSI UL 723, ISO 5658-2 or by EN 13501-1, where equivalence can be demonstrated. In all cases the ANSI UL 723 characteristic shall be predominant.

D.2.2 Fire source

The fire source is to consist of a wood crib and simulated furniture. The wood crib is to be ignited with a pan of heptane and the simulated furniture is to be ignited with two 150 mm long by 6 mm diameter cotton wicks soaked in heptane. See Figure D.1 (pendant, upright, flush, recessed pendant, and concealed sprinklers) or Figure D.2 and Figure D.3 (sidewall sprinklers) for placement of the fire source in the test room.

The wood crib is to weigh 2,5 kg to 3,2 kg and is to be dimensioned approximately 300 mm by 300 mm by 150 mm. The crib is to consist of four alternate layers of nominal 38 mm by 38 mm kiln-dried spruce or fir lumber 300 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.

After the wood crib is assembled, it is to be conditioned at a temperature of (104 ± 5) °C for at least 24 h and no 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 by 300 mm by 100 mm, 2,5 mm thick steel test pan (see Figure D.4) positioned on the floor in a corner of the test enclosure. The wood crib is to be

50 mm from each wall. See Figure D.1 (pendant, upright, flush, recessed pendant, and concealed sprinklers) or Figure D.2 and Figure D.3 (sidewall sprinklers).

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 and measuring 810 mm by 760 mm. Each foam cushion is to be glued to an 840 mm by 790 mm, nominal 12 mm thick plywood backing using an adhesive, which will ensure that the foam does not fall away during the test.

NOTE Aerosol urethane foam adhesives have proven to be suitable.

The foam cushion is to be glued on the plywood to provide for a 12 mm space along the sides and a 25 mm space at the bottom as illustrated in Figure D.4. The foam cushion and plywood backing assembly is to be conditioned at (21 ± 2,8) °C and (50 ± 10) % relative humidity for at least 24 h prior to test. Prior to each 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 polyether foam shall have the burning characteristic properties specified in Table D.2.

Table D.2 — Polyether foam burning characteristics

Property	Test Method	Range
Peak heat release rate (HRR) (average of 5 samples)	ISO 5660-1:2015, Test method for heat and visible smoke release rates for materials and products using oxygen consumption calorimeter, at 30 kW/m^2 heat flux	320 ± 50 kW/m^2
Heat of combustion (average of 5 samples)	ISO 5660-1:2015, Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using Oxygen Consumption Calorimeter, at 30 kW/m^2 heat flux	22 ± 3 kJ/g
Note Samples shall be 25 mm (±2mm) thick and weigh 8 g (±1 g).		

The entire fire test package is to be placed on top of a 6 mm thick cement board sheathing or equivalent non-combustible sheathing material having dimensions of 1,2 m by 1,2 m. For each test, a new or dried sheathing shall be used. See Figure D.4.

D.2.3 Sprinkler installation

Three residential sprinklers are to be installed in the test room for each fire test. Two are to be installed at the length and width coverage dimensions, and the third is to be installed near the doorway furthest from the fire. For all sprinkler styles, the third sprinkler installed near the doorway shall be as follows:

a) the same heat responsive element and temperature rating as the other sprinklers within the room; and

b) installed so that the centre of the heat responsive element is:

   i) 50 mm below the ceiling for pendant, upright, flush, recessed pendant, and concealed sprinklers, and

   ii) 100 mm below the ceiling and 50 mm from the wall for sidewall sprinklers.

c) The frame arms or deflector pins shall be parallel to the room short wall.

The two residential sprinklers nearest the fire source are to be installed in reducing pipe fittings having a 25 mm inlet and an outlet the same size as the sprinkler inlet and supplied with water through 25 mm piping. The minimum nipple length leading to the sprinkler fitting shall not be less than 250 mm. Dry-type sprinklers are to be tested using the shortest available length and the longest available length, if

the K-factor for the longest length deviates by more than 5 % from the shortest available length. See Figure D.1, Figure D.2 and Figure D.3.

Pendant and upright sprinklers are to be installed with their deflectors located 76 mm below the ceiling or as specified in the installation instructions if other than 76 mm is specified. A pendant sprinkler also intended to be installed as a recessed pendant 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 installation instructions. Pendant, upright, flush, recessed pendant and concealed sprinklers are to be tested in two orientations. One test is to be orientated such that the sprinkler frame arms or deflector pins are parallel to the short room wall and a second test is to be conducted with the sprinkler frame arms or deflector pins rotated 90 degrees.

Recessed and concealed sprinklers having vented escutcheons are to be installed in the most recessed position and tested in a manner that does not inhibit airflow through the escutcheons (unblocked) and in a manner that inhibits airflow through the escutcheons (blocked) by placing an 200 mm thick, fibreglass insulating batt entirely around and over the top of the sprinkler, and against the ceiling in such a manner that the air flow through the escutcheon vents are inhibited by the insulation. If concealed sprinklers are allowed to be installed in concrete or other solid materials, this shall be addressed in the installation instructions and such sprinklers shall be tested with all vents completely blocked.

A sidewall sprinkler shall be tested, using both test arrangements referenced in Figure E.1 and Figure D.3, in a manner as follows:

a) with its deflector located 100 mm below the ceiling (for sprinklers intended to be installed at maximum distances of 150 mm from the ceiling); and

b) with its deflector located at the maximum distance below the ceiling as specified in the installation instructions if the maximum distance exceeds 150 mm below the ceiling.

D.3 Test method

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

The test room is to have an ambient air temperature of (27 ± 3) °C measured at the thermocouple located 76 mm below the ceiling. See Figure D.1, Figure D.2 and Figure D.3. All water from previous testing shall be removed such that there is no visible water on the floor, ceiling, or walls.

The temperatures at each thermocouple location are to be continuously recorded during the test using 0,5 mm chromel-alumel thermocouples or thermocouples providing equivalent temperature measuring results. If water impingement impacts the thermocouple measurement, the thermocouples are to be shielded from water impingement using metallic tape attached to the wire. The tape is to be formed into an umbrella shape, large enough to protect the thermocouple ends.

Care shall be taken to measure the ceiling material temperature in case of the thermocouple embedded in the ceiling,

0,5 l of water and 0,24 l of heptane are to be placed in a pan directly below the wood crib located 50 mm from the wall panels.

The heptane in the pan located beneath the crib is to be ignited and the heptane soaked cotton wicks placed on bricks are to be ignited immediately following the heptane pan ignition.

The fire test is to 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 is to be terminated. The water flow to the sprinklers is to be the minimum flow rate specified in the installation instructions for the sprinkler coverage area tested. In addition, for sprinklers having a pressure rating greater than 12 bar, tests are to be conducted at the maximum spacing using a flow corresponding to a pressure of 5 bar less than the maximum operating pressure.

D.4 Supplementary test

When sprinkler coverage areas exceed 3,7 m by 3,7 m, and the sprinkler has not been investigated for a 3,7 m by 3,7 m area using the same or a lesser flow rate as the next larger coverage area, the tests specified in D.2 and D.3 are to be repeated in a room size corresponding to a 3,7 m by 3,7 m coverage area, using a water flow rate corresponding to the minimum flow rate required for the next larger coverage area.

Annex E
(normative)

Function test

E.1 Function test

Follow E.1 of EN 12259-1:1999+A1:2001, except

- Test pressure 0,5 ± 0,05bar instead of 0,35 ± 0,05bar;
- Additional test pressure equal to the maximum operating pressure in incremental steps of 2 bar up to the rated working pressure, where in excess of 12 bar;
- Maximum lodgement rate 0 per 12 and 0 per 32.

E.2 Verification function test

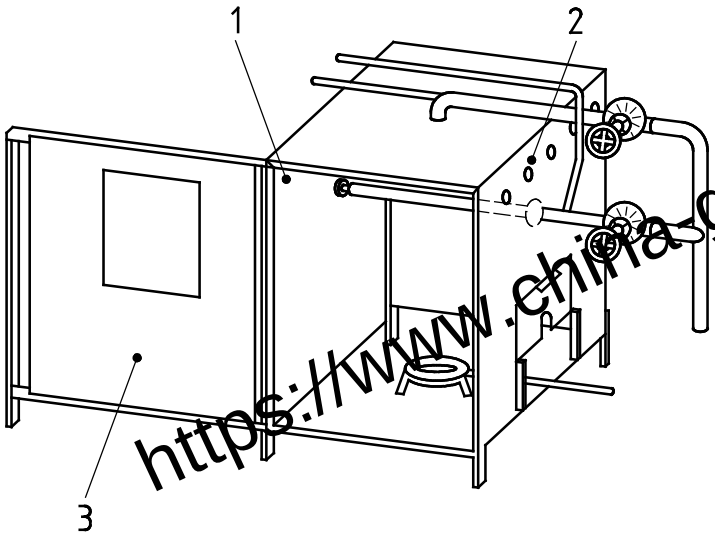
Heat sprinklers, including dry sprinklers that can be accommodated in the functional test oven shown in Figure E.1. Increase the temperature at the sprinkler at a rate equivalent to (400 ± 20) °C in not more than 3 min.

Heat those dry sprinklers that cannot be accommodated in the test oven using a suitable heat source. Continue heating until the sprinkler has operated.

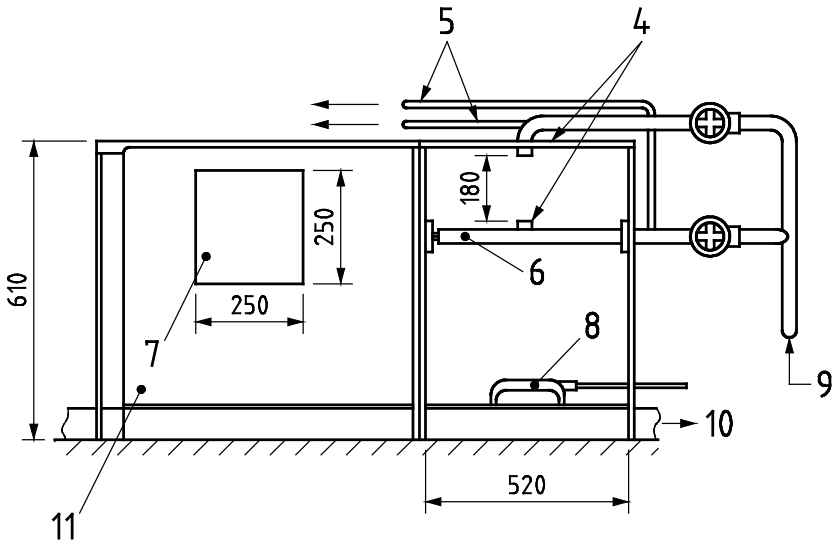
Whilst the sprinkler is being heated, subject the sprinkler inlet to a water pressure of (0,5 ± 0,05) bar unless stipulated otherwise in the appropriate test procedure.

Test the type, size and number of sprinklers specified in the appropriate test procedure and establish that the pass criteria are achieved.

Dimensions in millimetres



a) Side view



b) section

Key

1 vent
2 vent
3 sliding or swinging door
4 threaded connection for sprinklers
5 gauge pipe
6 detachable pipe for upright sprinklers
7 window
8 heat source
9 water supply
10 water discharge
11 sliding or swinging door

Figure E.1 — Example of functional test oven

Annex F
(normative)

Strength of sprinkler body and deflector

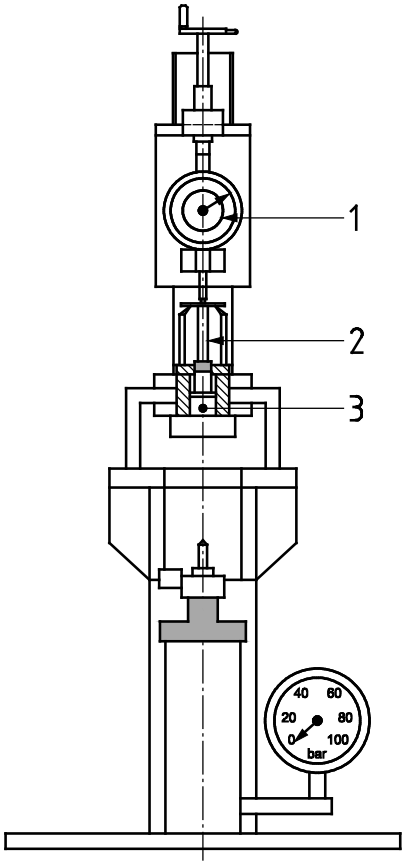
F.1Strength of sprinkler bod

See 4.8.1 for the corresponding requirement.

Measure the service load by securely installing the sprinkler in a tensile/compression test machine and apply an equivalent of a hydraulic pressure of the maximum operating pressure ± 0,1 bar at the inlet.

Use an indicator capable of reading deflection to an accuracy of 0,001 mm to measure any change in length of the sprinkler body between the load bearing points. Preferably avoid or take into account movement of the sprinkler shank thread in the threaded bush of the test machine.

Zero the deflection measuring indicator, see Figure F.1.



Key

1 deflector gauge
2 sprinkler
3 sprinkler fixture (Sprinkler inlet pressure maximum operating pressure in bar ± 0,1 bar)

Figure F.1 — Example of a tensile/compression test machine

Release the hydraulic pressure 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.

Then apply an increasing mechanical load to the sprinkler, at a rate not exceeding 5000 N/min, until the indicator reading at the deflector end of the sprinkler returns to the zero value achieved under the hydrostatic load. Record the mechanical load necessary to achieve this as the service load. Conduct this test on five sprinklers and take the arithmetic mean of the results as the average service load.

Increase the applied load progressively at a rate not exceeding 5000 N/min until twice the average service load has been applied. Maintain this load for (15 ± 5) s.

Remove the load and measure any permanent elongation of the sprinkler body.

F.2Flow endurance test

See 4.8.2 for the corresponding requirement.

One sample of a residential sprinkler is to be installed on an elbow or tee in a pressurized water system. The heat responsive element of the sample is to be activated, and the sample subjected to waterflow at the maximum operating pressure plus 1,7 +1,0/-0 bar for 30 min.

F.3Deflector strength test

See 4.8.3 for the corresponding requirement.

Apply a force of 70 +10/-0 N to the deflector by means of a flat metal plate, having a contact edge of at least 15 +5/-0 mm, and examine the deflector for permanent deformation.

This force should not be applied exclusively to the tines.

Annex G
(normative)

Strength of release elements test

G.1 Glass bulbs

See 4.9.1 for the corresponding requirement.

At least 55 glass bulbs of the same batch, design and type shall be positioned individually in a fixture using the sprinkler parts. [A2] 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 [A2].

The bulb seating parts may be reinforced externally or may be manufactured from hardened steel of Rockwell Hardness 44 ± 6 HRC in a manner which does not influence bulb failure and in accordance with the sprinkler supplier's specification. If the sprinkler supplier's standard seating parts are used, new seating parts shall be used for each bulb strength test.

Use the lowest 50 values of the 55 measurements. Calculate the mean bulb strength of the sprinklers using the following formula:

$$\bar{x}_1 = \frac{\sum x_1}{n}$$

where

$\bar{x}_1$ is the mean bulb strength

x_1 is the individual glass bulb sample strength test values

n is the number of samples tested

Calculate the unbiased standard deviation as follows:

$$S_1 = \sqrt{\frac{\sum_{1=1}^{n} (x_1 - \bar{x}_1)^2}{n-1}}$$

where

S1 is the unbiased standard deviation in Newtons (N)

Calculate the bulb strength lower tolerance limit (LTL) using the formula:

$$LTL = \bar{x}_1 - K_1 S_1$$

where

K_1 is the K factor for normal distributions appropriate to the number of glass bulb samples tested, see Table G.1.

Table G.1 — K factors for normal distributions to determine one sided tolerance limits

n	K
10	5,075
15	4,224
20	3,832
25	3,601
30	3,446
35	3,334
40	3,250
45	3,181
50	3,124
NOTE K factor values for glass bulbs for a confidence level of 99 % for 99 % of samples.	

Using the values of the service load recorded in G.1, calculate the mean service load using the formula:

$$\bar{x}_2 = \frac{\sum x_2}{n_2}$$

where

$\bar{x}_2$ is the mean service load

x_2 is the individual service load test values

n_2 is the number of service load samples tested

Calculate the service load standard deviation using the formula:

$$S_2 = \sqrt{\frac{\sum_{1=1}^{n2} (x_2 - \bar{x}_2)^2}{n_2 - 1}}$$

where:

S2 is the service load standard deviation

Calculate the service load upper tolerance limit (UTL) using the formula:

$$UTL = \bar{x}_2 + K_2 S_2$$

where

K2 is the K factor for normal distributions appropriate to the number of service load samples tested, see Table G.1

Verify compliance with 4.9.1.

G.2 Fusible links

See 4.9.2 for the corresponding requirement.

Subject fusible links to a constant load in excess of the design load (L_d), producing failure at approximately 1000 h. Undertake the test with at least 10 links at different constant loads for loads not exceeding 15 times the maximum design load, rejecting abnormal failures. Using the times to failure/load values produced by the tests, plot a full logarithmic regression curve using the method of least squares, and from this calculate the loads to failure at 1 h (L_o) and 1000 h (L_m), where:

$$L_d \leq 1,02 \frac{L_m^2}{L_o}$$

Condition the test samples at (20 ± 5) °C prior to loading and maintain within these temperature limits throughout the test.

Annex H
(normative)

Leak resistance tests

H.1 Leak Test

See 4.10 for the corresponding requirement.

A residential sprinkler shall withstand, for 1 min, without leakage, an internal hydrostatic pressure equal to the leakage test pressure shown in Table H.1.

The sprinkler inlets are to be filled with water and vented of air. The pressure is to be increased from 0 to the leakage test pressure at a rate not exceeding 20 bar per minute. The pressure is to be maintained for one minute. The sample shall not leak during the pressure increase nor while being maintained at the test pressure for one minute.

H.2 Hydrostatic Strength Test

See 4.10 for the corresponding requirement.

A residential sprinkler shall withstand, for one minute, without rupture, an internal hydrostatic pressure equal to the hydrostatic test pressure shown in Table H.1.

Table H.1 — Test pressures for the leakage and hydrostatic tests

Maximum operating pressure	Leakage test pressure	Hydrostatic test pressure
bar	bar	bar
12	34,5	48
17	34,5	69
21	41	83

The sprinkler inlets are to be filled with water and vented of air. The pressure is to be increased from 0 to the hydrostatic test pressure at a rate not exceeding 20 bar per minute. The pressure is to be maintained for one minute. The sample shall not rupture, operate, or release any of its operating parts during the pressure increase nor while being maintained at the test pressure for one minute.

Annex I
(normative)

Heat exposure

I.1 High temperature test

See 4.11.1 for the corresponding requirement.

A residential sprinkler shall withstand for 90 days, without evidence of weakness or malfunction, an exposure to the high temperature in accordance with Table I.1 or 11 °C below the nominal operating temperature of the samples (whichever is the lower temperature), but not less than 49 °C. To evaluate weakness and malfunction following the exposure, the sprinkler shall conform to the Leakage Test as specified in Annex H. After being subjected to the Leakage Test, a recessed sprinkler (without escutcheon) shall then be subjected to the Oven Heat Test as specified in M.1 and a concealed sprinkler is to be subjected to the Room Heat Test as specified in M.2. Each sample shall be operable, and the mean time of operation shall be equal to or less than a 1,30 multiple of the mean operating time of the sprinkler tested in accordance with 4.14.

Table I.1 — High temperature test conditions

Sprinkler temperature rating	**Test temperature**
°C	°C
57 – 60	49
63 – 77	52
79 – 107	79

I.2 Additional testing of glass bulb sprinklers

See 4.11.2 for the corresponding requirement.

Place four sprinklers in a liquid bath. Sprinklers having a nominal temperature less than or equal to 80 °C shall be tested in a bath of demineralized water. Sprinklers with higher nominal operating temperature elements shall be tested in a bath of glycerine, vegetable oil or synthetic oil.

Raise the temperature of the liquid bath from (20 ± 5) °C to (20 ± 5) °C below the nominal operating temperature of the sprinklers at a rate not exceeding 20 °C /min.

Then increase the temperature at a rate of not more than 1 °C /min to the temperature at which the gas bubble in the glass bulb dissolves, or to a temperature (5 + 2/-0) °C lower than the lowest allowable operating temperature as calculated by 4.3, whichever is the lowest.

Remove the sprinkler from the liquid bath and allow it to cool in air until the gas bubble is formed again. During the cooling period, ensure the pointed end of the glass bulb (seal end) is pointing downwards. Execute the test four times on each of four sprinklers.

〚A1〉 *deleted text* 〈A1〛

Annex J
(normative)

Glass bulb sprinkler thermal shock test

See [A1] 4.11.3 [A1] for the corresponding requirement.

Before starting the test ensure the sprinklers attain equilibrium at a temperature of (20 ± 5) °C.

Immerse 4 sprinklers in a bath of liquid, at a temperature of (10 ± 0,5) °C below the lowest allowable operating temperature as calculated by 4.3. Sprinklers having a nominal temperature less than or equal to 80 °C shall be tested in a bath of demineralized water. Sprinklers with higher nominal operating temperature elements shall be tested in a bath of glycerine, vegetable oil or synthetic oil.

After (5 +1/-0) min, remove the sprinklers from the bath and immerse them immediately in another bath of liquid at a temperature of (10 ± 1) °C with the bulb seal downwards.

Examine the released sprinklers for proper operation. Examine sprinklers with broken glass bulbs to ensure the valve parts are free to move. Subject any unreleased sprinklers to a functional test in accordance with E.2.

Annex K
(normative)

Exposure and corrosion tests

K.1 Stress corrosion

K.1.1 Sample preparation

See [A1] 4.12.1 [A1] for the corresponding requirement.

Five samples without any plating or coating are to be degreased and then exposed for 10 days to a moist ammonia–air mixture maintained in a glass chamber having a glass cover.

K.1.2 Apparatus

Glass container, of volume 0,01 m^3 to 0,03 m^3 with a sealable lid, containing a means of supporting the sprinklers under test and a means of preventing condensate dripping onto them, and fitted with a capillary tube, venting to atmosphere, to prevent the build-up of pressure.

K.1.3 Procedure

Put aqueous ammonia solution having a specific gravity of 0,94 into the container, using 0,01 ml/cm^3 of container volume to give an atmosphere in the container consisting of approximately 35 % ammonia, 5 % water vapour and 60 % air, to be maintained during the test. The samples are to be positioned (38+13/-0) mm above the liquid surface supported by the inert tray. The moist ammonia-air mixture in the chamber is to be maintained at essentially atmospheric pressure with the temperature constant at (34 ± 1) °C.

After the exposure period, the samples are to be examined for cracks or other signs of stress corrosion using a microscope having a magnification of 25X. Operating parts exhibiting degradation as a result of the test exposure shall withstand, without leakage, a hydrostatic test pressure of 12 bar or one equivalent to their maximum design pressure, whichever is greater, for 1 min, and operate at 0,5 bar when exposed to a uniform application of heat. Non-operating parts exhibiting degradation as a result of the test exposure shall withstand flowing water at the maximum operating pressure for 30 min.

K.2 Sulphur dioxide corrosion

K.2.1 Reagents for apparatus of 5 l volume

See 4.12.2 for the corresponding requirement.

a) (500 ± 5) ml of aqueous solution of sodium thiosulphate of (0,161 ± 0,001) M concentration.

This may be prepared using (20 ± 0,1) g of analytical grade sodium thiosulphate pentahydrate crystals ($Na_2S_2O_3 \cdot 5H_2O$) made up to 500 ml with distilled or deionised water in a volumetric flask at 20 °C.

b) (1000 ± 5) ml of dilute aqueous sulphuric acid of (0,078 ± 0,005) M concentration.

This may be prepared using (156 ± 1) ml analytical grade 0,5 M sulphuric acid solution made up to 1000 ml with distilled or deionised water in a volumetric flask at 20 °C.

K.2.2 Apparatus

Glass vessel, as shown in Figure K.1, of 5 l or 10 l volume, made of heat-resistant glass with a corrosion-resistant lid, shaped such that the condensate does not drip onto the sprinklers during the test, fitted with a cooling coil to cool the side walls of the vessel, as shown in Figure K.1 and an electrical heating device regulated by a temperature sensor placed centrally (160 ± 20) mm above the bottom of the vessel.

NOTE If a 10 l vessel is used, it is essential that the volumes of sodium thiosulphate and sulphuric acid given in K.2.1 are doubled.

K.2.3 Procedure

Expose six sprinklers for two periods of eight days each. Place the sodium thiosulphate solution in the vessel. Seal the inlet of each sprinkler with a cap of non-reactive material e.g. plastics, and suspend the sprinklers freely in the normal mounting position inside the vessel under the lid. Adjust the temperature inside the vessel to (45 ± 3) °C and the flow of water through the cooling coil to give a temperature at the outflow below 30 °C. Maintain these temperatures throughout the test.

NOTE This combination of temperatures is intended to encourage condensation on the surfaces of the sprinklers.

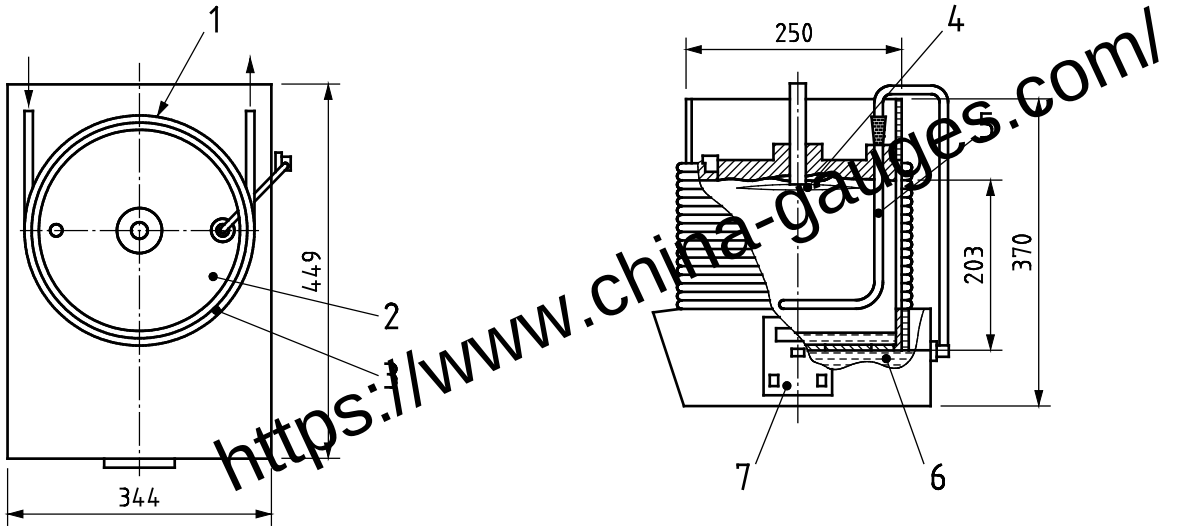
Add (20 ± 0,5) ml of dilute sulphuric acid to the vessel each day. After (8 +0,25/-0) days remove the sprinklers from the vessel and empty and clean the vessel. Repeat the above procedure for a second period of (8 +0,25/-0) days.

After a total of (16 +0,5/-0) days remove the sprinklers from the vessel and allow them to dry for

(7 +0,25/-0) days at a temperature not exceeding 35 °C and a relative humidity not greater than 70 %.

After the drying period, subject the sprinklers to a functional test in accordance with E.2.

Dimensions in millimetres



a) Top view **b) Side view**

Key

1 glass vessel
2 Polymethylmethacrylate(PMMA) lid
3 cooling coils
4 adjustable Polymethylmethacrylate(PMMA) specimen mounting plate
5 platinum resistance probe
6 heating element
7 temperature indicator and set point controller

Figure K.1 — Typical vessel for sulphur dioxide corrosion test

K.3 Salt mist corrosion

K.3.1 Reagents

See 4.12.3 for the corresponding requirement.

Sodium chloride solution, consisting of (20 ± 1) % (m/m) sodium chloride in distilled water, pH between 6,5 and 7,2 and having a density between 1,126 g/ml and 1,157 g/ml at (35 ± 2) °C.

K.3.2 Apparatus

Fog chamber, of minimum volume 0,43 m^3, fitted with a recirculating reservoir and aspirating nozzles to deliver a salt spray, and means for sampling and controlling the atmosphere in the chamber.

K.3.3 Procedure

Test five sprinklers. Fill each sprinkler with deionized water and seal the inlet by means of a plastic cap. Support the sprinklers in the fog chamber in their normal operating position, and expose them to a salt spray by supplying the sodium chloride solution through the nozzles at a pressure of between 0,7 bar and 1,7 bar, while maintaining the temperature in the exposure zone at (35 ± 2) °C. Ensure that solution running off the sprinklers is collected and not returned to the reservoir for recirculation.

Collect salt mist from at least two points in the exposure zone and measure the rate of application and the salt concentration. Ensure, for each 80 cm^3 of collection area, a collection rate of 1 ml/h to 2 ml/h over a period of (16 +0,25/-0) h.

Expose sprinklers intended for installation in normal atmospheres for a period of (10 +0,25/-0) days. Expose sprinklers intended for installation in corrosive atmospheres for a period of (30 +0,5/-0) days.

Not more than 5 days nor less than 1 day after the exposure, a sprinkler other than a recessed or concealed type is to be subjected to the Oven Heat Test specified in M.1 and a recessed or concealed type sprinkler is to be subjected to the Room Heat Test specified in M.2.

Each sample shall be operable, and the mean time of operation shall be equal to or less than a 1,30 multiple of the mean operating time of the sprinkler tested for compliance with 4.14. During the corrosive exposure, the inlet thread orifice is to be sealed by a plastic cap after the sprinkler has been filled with de-ionized water.

K.4 Moist Air

K.4.1 Performance criteria

See 4.12.4 for the corresponding requirement.

A residential sprinkler shall withstand an exposure to high temperature–humidity in accordance with K.4.2 for 90 days. Following the exposure, each test sample shall operate at a service pressure not exceeding 0,5 bar within 5 s after operation of the heat responsive element.

K.4.2 Procedure

Install five samples on a pipe manifold that contains water and place the entire manifold in a temperature–humidity chamber for 90 days. The temperature of the chamber shall be (95 ± 1) °C and the humidity shall be (98 ± 2) %. The sprinkler samples for the moist air test are to have heat responsive elements to withstand the elevated temperature.

After this period, remove the sprinklers and subject them to a functional test in accordance with E.2.

Annex L
(normative)

Water hammer test

See 4.13 for the corresponding requirement.

Test five sprinklers, installing each sprinkler on the test apparatus in its normal mounting position. Fill the test apparatus with water and purge all the air, making sure that air is not trapped in the sprinkler bores. Subject the sprinklers to a pressure cycle, rising from (4 ± 2) bar to (25 +5/-0) bar at a rate of (45 +10/-5) bar/s; after which the pressure shall be returned to (4 ± 2) bar. The pressure cycles shall be repeated (3000 +100/-0) times at a rate of (15 +5/-0) cycles per minute. Measure and record the pressure changes against time. Visually examine each sprinkler for leakage. Then test the five sprinklers in accordance with E.2.

Annex M
(normative)

Thermal response test

M.1 Oven heat test

See 4.14.1 for the corresponding requirement.

Sprinklers of each style are to be tested in the sensitivity test oven in the pendant position with the heat responsive element located at least 25 mm away from the inside surfaces of the oven as follows:

a) for sprinkler designs incorporating asymmetrical heat responsive elements or asymmetrical body designs, ten samples are to be orientated in the pendant position with the heat responsive element upstream of the axis of the sprinkler body;

b) for sprinkler designs with symmetrical heat responsive elements, ten samples are to be orientated in the pendant position with the frame arms in a plane perpendicular to the direction of air flow.

The samples are to be conditioned at (24 ± 5) °C for at least 2 h. The inlet end of each sprinkler sample is to be connected to a source of air pressure at 0,3 ± 0,07 bar and quickly plunged into the sensitivity test oven in a pendant position. The operating time is to be measured using a timer capable of measuring 0,01 s and accurate to within (0,01 ± 0,01) s. Each sprinkler is to be observed to determine if operation occurs as intended within the time specified in 4.14.1.

A constant air velocity of (2,54 ± 0,01) m/s and an air temperature as specified in Table M.1 for the nominal operating temperature of the sprinkler are to be established. Air velocity is to be measured using an orifice plate and a manometer or a bidirectional probe and a velometer. The air temperature is to be measured by use of a 30 AWG (0,05 mm^2) thermocouple centred upstream from the sprinkler as shown in Figure M.1.

The design of the wind tunnel shall be such that the influence of thermal radiation does not change the measured RTI values by more than 3 % for sprinklers with a nominal operating temperature up to 74 °C.

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

The required sprinkler operating time values specified in 4.14.1 shall be calculated by using the following formula:

$$t_o = \frac{-\mathrm{RTI} * \ln\left[1 - \left[\frac{\left(T_m - T_u\right)}{T_g - T_u}\right]\right]}{\sqrt{u}}$$

where

RTI is Response Time Index [$(m \cdot s)^{1/2}$]

t_o is Operating time of the sprinkler [s]

u is actual gas velocity in the test section of the wind tunnel [m/s]

T_m is Nominal operating temperature of the sprinkler [°C]

T_g is actual gas temperature in test section in Table M.1 [°C]

T_u is actual ambient air temperature [°C].

Table M.1 — Sensitivity oven temperatures

Sprinkler temperature rating	Oven temperature
(°C)	(°C ± 1 °C)
(57 – 77)	(135)
(79 – 107)	(191)

M.2 Room heat test

M.2.1 Flush, recessed or concealed sprinklers

See 4.14.2 for the corresponding requirement.

A flush, recessed or concealed sprinkler is to be installed in the most recessed position and tested in an unblocked manner, that is, in a manner that will not inhibit airflow through the escutcheon. A pendant sprinkler also intended to be installed as a recessed sprinkler shall be tested in the most recessed position in lieu of the maximum distance when below the ceiling when the intended installation distance below the ceiling is 102 mm or less.

M.2.2 Sprinkler location and orientation

Install sprinklers of each type in a test room (see Figure M.2) in the following position and orientation:

a) For pendant and ceiling type sprinkler designs without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, install five samples in their intended position at the ceiling.

b) For pendant and ceiling type sprinkler designs with or without frame arms and incorporating asymmetrical heat responsive elements, five samples shall be orientated with the heat responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source. The samples shall be in their intended position at the ceiling.

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

d) For upright sprinklers having configurations referenced in (a) – (c), five samples shall be installed in the pendant position.

e) For sidewall sprinkler designs, five samples shall be installed in their intended position with the deflector located 102 mm below the ceiling and the maximum distance below the ceiling if intended for distances greater than 152 mm.

M.2.3 Room dimensions and water supply

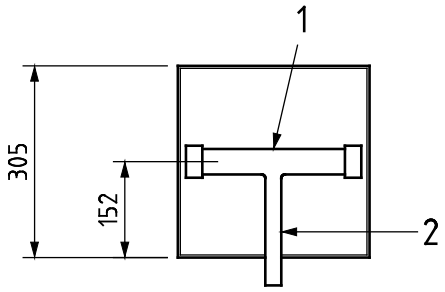
The sprinkler is to be mounted as specified in M.2.2 on a ceiling or a wall of a closed 4,6 m by 4,6 m room having a nominal 2,4 m high ceiling. The sprinkler inlet waterway is to be filled with water having a temperature of (21 ± 1,6) °C. The water is to be pressurized to 3,1 ± 3 bar for sprinklers requiring pressure to operate.

M.2.4 Fire source and distance to sprinkler

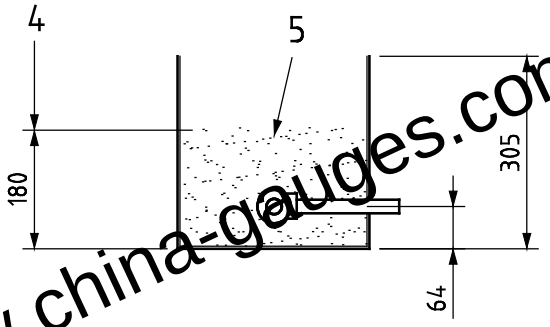
The fire source shall consist of a 305 by 305 by 305 mm sand burner located in one corner of the room with a flow of natural gas of 14,6 m^3 per hour (see Figure M.1 for an example of the sand burner apparatus). Propane gas with a minimum purity of 94 % shall be deemed as equivalent.

A pendant, upright, or ceiling type sprinkler shall 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. A sidewall sprinkler shall be installed on the midpoint of a wall opposite the corner having the sand burner (see Figure M.1). The test shall be started when the ambient temperature is (31 ± 1) °C as measured in the centre of the room 250 mm below the ceiling. The gas burner shall be ignited, and the operation time of the sprinkler shall be recorded.

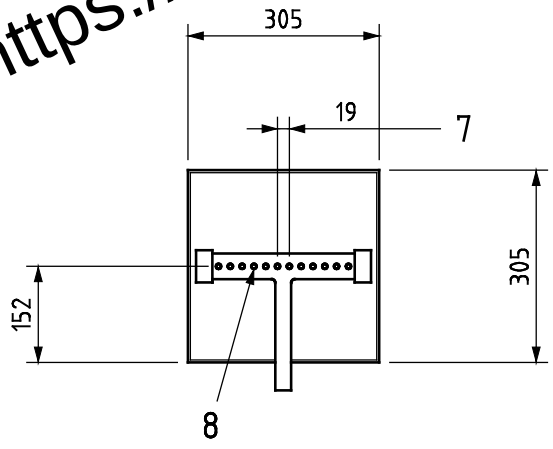
Dimensions in millimetres



a) Top view



b) Side view



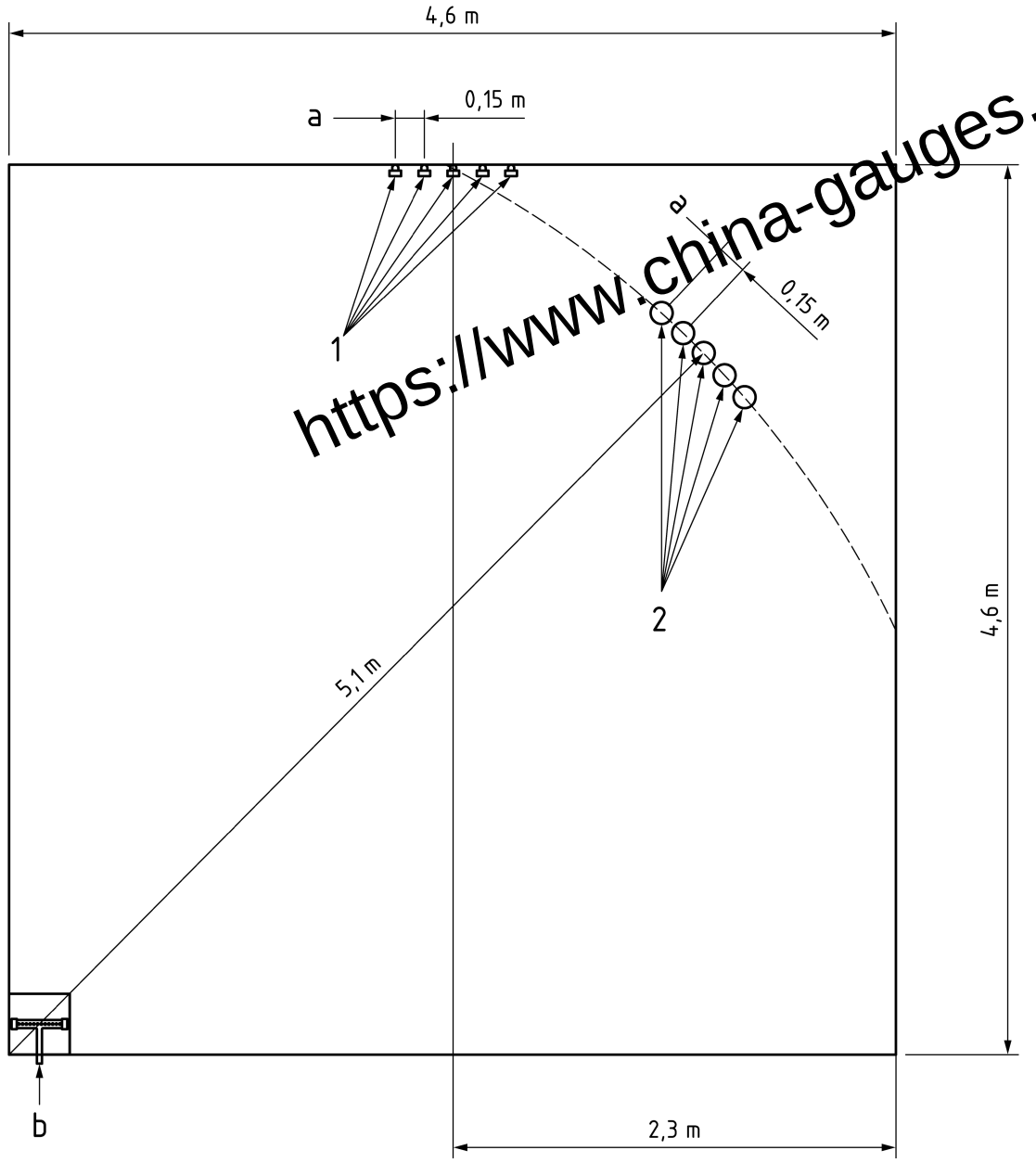
c) Burner

Key

1 nominal 25 mm piping
2 nominal 32 mm or 40 mm pipe
3 top view
4 sand depth
5 sand
6 side view
7 distance between holes 19 mm (typical)
8 6 mm diameter holes (typical)
9 bottom view

Figure M.1 — Typical sand burner apparatus

Dimensions in metres



Key

1 sidewall sprinkler locations

2 pendant sprinkler locations

a typical dimension

b sand burner

Figure M.2 — Plan view of room heat test for residential sprinklers

Annex N
(normative)

Vibration test

N.1 Sample preparation and performance criteria

See 4.15 for the corresponding requirement.

Five samples are to be attached to a steel mounting plate in any convenient fashion and the plate is to be bolted to the table of a vibration machine so that the samples are mounted vertically. The samples are to be vibrated in the vertical direction while unpressurized. For dry-type sprinklers, samples of the maximum available length are to be tested. If the sprinklers exhibit resonance at any frequency within the tested ranges, the resonant frequency (frequencies) is to be used for the entire test period.

N.2 Procedure

The sprinkler is to be subjected to vibration at the frequency, duration, and amplitude indicated in Table N.1. Following the vibration, the sprinkler shall conform to the requirements in the Leakage Test as specified in H.1. After being subjected to the leakage test, the sprinkler shall then be subjected to the verification function test as specified in E.2.

For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from position of rest to one-half of the total table displacement; resonance is defined as the maximum magnification of the applied vibration.

Table N.1 — Vibration test

Amplitude (mm)	**Displacement** (mm)	**Frequency** (hertz)	**Duration** (h)
(1,02)	(2,03)	18 to 37	120

Annex O
(normative)

Impact test

See 4.16 for the corresponding requirement.

Five sample sprinklers are to be tested by dropping a cylindrical mass equivalent to the mass of the sprinkler, to the nearest 15 g increment, from a height of one meter onto the geometric centre of the deflector. The mass is to be prevented from impacting more than once upon each sample.

Following the impact, each sprinkler is to be visually examined and there shall be no evidence of cracks, breaks, or any other damage. Each sample sprinkler shall then withstand a 30 bar hydrostatic pressure for 1 min without leakage. In addition, each sample shall then be subjected to the oven heat test, see M.1.

Annex P
(normative)

Resistance to low temperature test

See 4.17 for the corresponding requirement.

Subject four sprinklers to a temperature of (−20 ± 2) °C for a period of (24 +1/-0) h. Then allow the sprinklers to stand for at least 2 h at room temperature. Examine the sprinklers and subject them to a functional test in accordance with E.2.

Annex Q
(normative)

Resistance to high temperature test

See 4.18 for the corresponding requirement.

Heat a sprinkler test sample in an oven at (770 ± 10) °C for a period of 15 min, with the sprinkler test sample held in its normal installation position. Remove the sprinkler test sample from the oven, holding it by the threaded inlet, and promptly immerse it in a water bath at a temperature of (20 ± 10) °C. Examine the sprinkler test sample for deformation and breakage.

Bibliography

EN 12845, *Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance*

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