BS 9252:2011

BSI Standards Publication

# Components for residential sprinkler systems – Specification and test methods for residential sprinklers

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## Publishing and copyright information



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# Contents

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**Summary of pages**

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 50, an inside back cover and a back cover.

# Foreword

## Publishing information

This British Standard is published by BSI and came into effect on 25 May 2011. This British Standard was prepared by Subcommittee FSH/18/2, *Sprinkler systems*, under the authority of Technical Committee FSH/18, *Fixed firefighting systems*. A list of organizations represented on this committee can be obtained on request to its secretary.

## Supersession

This British Standard supersedes DD 252:2002, which is withdrawn.

## Relationship with other publications

This British Standard specifies requirements for the construction and performance, and testing of fire sprinklers for use specifically in residential and domestic occupancies. Requirements for the construction, performance and testing or fire sprinklers for other buildings and industrial plant are specified in BS EN 12259-1.

## Information about this document

This document converts DD 252 into a full British Standard. The principal changes are further development of the test methods.

Domestic and residential sprinklers are for use in fire sprinkler systems and are designed to provide an additional degree of protection of life and property, above that already achieved by the building design and the installation of smoke and/or fire detectors and systems. This British Standard presumes that the sprinkler protection will form part of an integrated fire safety system.

*Product certification/inspection/testing*. Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Appropriate conformity attestation arrangements are described in BS EN ISO 9001. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

This British Standard is intended for the use of designers, engineers, architects, surveyors, contractors, installers and authorities having jurisdiction.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

## Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall". Its methods are expressed as a set of instructions, a description, or in sentences in which the principal auxiliary verb is "shall".

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

## Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard cannot confer immunity from legal obligations.**

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# 1 Scope

This British Standard specifies requirements for the construction and performance of sprinklers which are operated by a change of state of an element or bursting of a glass bulb under the influence of heat, for use in residential and domestic automatic sprinkler systems conforming to BS 9251. Test methods and a recommended test schedule for type approval testing are also given.

*NOTE All pressure data in this standard are given as gauge pressures in bar* [1)].

# 2 Normative references

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

BS 9251, *Sprinkler systems for residential and domestic occupancies – Code of practice*

BS EN 12259-1, *Fixed firefighting systems – Components for sprinkler and water spray systems – Part 1: Sprinklers*

BS EN 13238, *Reaction to fire tests for building products – Conditioning procedures and general rules for selection of substrates*

BS EN 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

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 tube suitable for screwing in accordance with ISO 7-1*

# 3 Terms, definitions and abbreviations

For the purposes of this British Standard, the terms, definitions and abbreviations in BS EN 12259-1 and the following apply.

## 3.1 automatic sprinkler

nozzle with a thermally sensitive sealing device which opens to discharge water for firefighting

## 3.2 coated sprinkler

sprinkler with a coating, applied for the purpose of reducing the effects of corrosive environments, excluding decorative paint or painted finishes

## 3.3 concealed sprinkler

recessed sprinkler with a cover plate that disengages when heat is applied

## 3.4 conductivity factor (C)

measure of the conductance between the sprinkler's heat responsive element and the water-filled fitting, expressed in $m/s^{1/2}$.

## 3.5 design lower tolerance limit (DLTL)

lowest lower tolerance limit (LTL) for glass bulbs specified and assured by the glass bulb supplier

[1)] 1 bar = $10^5$ $N/m^2$ = 100 kPa.

**3.6 design upper tolerance limit (DUTL)**
highest upper tolerance limit (UTL) for sprinklers specified and assured by the sprinkler supplier

**3.7 dry sprinkler**
sprinkler and dry drop pipe with a valve, at the head of the pipe, held closed by a device maintained in position by the sprinkler head valve

**3.8 dry upright sprinkler**
sprinkler and dry rise pipe with a valve, at the base of the pipe, held closed by a device maintained in position by the sprinkler head valve

**3.9 flush pattern sprinkler**
pendent sprinkler for fitting partly above, but with the temperature sensitive element below, the lower plane of the ceiling

**3.10 fusible link sprinkler**
sprinkler which opens when an element provided for that purpose melts

**3.11 glass bulb sprinkler**
sprinkler which opens when a liquid-filled glass bulb bursts

**3.12 horizontal sprinkler**
sprinkler in which the nozzle directs the water horizontally

**3.13 lower tolerance limit (LTL)**
lowest strength of a glass bulb determined by testing and statistical analysis of a batch of 55 or more bulbs

**3.14 mean design bulb strength**
lowest mean bulb strength, specified and assured by the glass bulb supplier, for any batch of 55 or more bulbs

**3.15 mean design service load**
highest mean service load, specified and assured by the sprinkler supplier, for any batch of 10 or more sprinklers

**3.16 pendent sprinkler**
sprinkler in which the nozzle directs the water downwards

**3.17 recessed sprinkler**
sprinkler in which all or part of the thermally sensitive element is above the plane of the ceiling

**3.18 residential sprinkler**
sprinkler for use in domestic and residential occupancies

**3.19 response time index (RTI)**
measure of the thermal sensitivity of the fusible or frangible element in the sprinkler

*NOTE The response time index is expressed in* $m \cdot s^{1/2}$.

**3.20 sidewall pattern sprinkler**
sprinkler that gives an outward half paraboloid pattern of water discharge

**3.21 spray pattern sprinkler**
sprinkler which gives a downward paraboloid pattern of water discharge

**3.22 upper tolerance limit (UTL)**
highest service load of a sprinkler determined by testing and statistical analysis of a batch of 20 or more sprinklers

**3.23 upright sprinkler**
sprinkler in which the nozzle directs the water upwards

# 4 Construction and performance

## 4.1 Product assembly

Sprinklers shall be assembled in the original equipment supplier's factory, in such a way that any subsequent adjustment or dismantling will result in destruction of an element of construction.

## 4.2 Dimensions

**4.2.1** Nominal thread sizes shall be ¾ in or ½ in and suitable for fittings threaded in accordance with ISO 7-1.

*NOTE Flush pattern sprinklers may have larger thread sizes.*

**4.2.2** It shall be possible for:

a) a sphere of ($8\ ^{+0.01}_{0}$) mm diameter to pass through each water passage in the sprinkler; or

b) a sphere of ($6\ ^{+0.01}_{0}$) mm diameter to pass through each water passage in the sprinkler, where the water supply gives a pressure of not less than 3 bar at the sprinkler.

## 4.3 Nominal operating temperature

**4.3.1** The nominal operating temperatures of glass bulb sprinklers shall be in accordance with Table 1.

**4.3.2** The nominal operating temperature ranges of fusible link sprinklers shall be in accordance with Table 1.

**4.3.3** Glass bulb sprinklers and non-plated and non-coated fusible link sprinklers shall be colour coded according to the nominal operating temperature as given 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 | **Yoke arms colour code** |
| 57 | Orange | 57 to 77 | Uncoloured |
| 68 | Red | 80 to 107 | White |
| 79 | Yellow | — | — |
| 93 | Green | — | — |
| 100 | Green | — | — |

## 4.4 Operating temperatures

When tested in accordance with Annex A, sprinklers shall operate at a temperature within the range:

$[t \pm (0.035\ t + 0.62)]$ °C

where $t$ is the nominal operating temperature.

## 4.5 Water flow and distribution

### 4.5.1 *K*-factor

When determined in accordance with Annex B, the *K*-factor, the orifice coefficient of the sprinkler, shall be within the range given in Table 2.

Table 2 ***K*-factor tolerance**

| **Nominal *K*-factor** | ***K*-factor tolerance** | |
|---|---|---|
| | $l \cdot min^{-1} \cdot bar^{-1/2}$ | |
| <80 | ±3 | ±5 |
| >80 | ±4 | ±6 |

### 4.5.2 Water distribution

#### 4.5.2.1 Sprinklers other than sidewall sprinklers

When sprinklers are tested in accordance with Annex C (**C.1** and **C.2**), using the parameters given in Table 3 and Table 4, the minimum conditions specified in Table 4 shall be achieved and the minimum operating pressure at any sprinkler shall not be less than 0.5 bar.

Sprinklers shall distribute water over a horizontal surface such that the discharge density collected in not more than four collection pans shall be at least 0.6 mm/min. All other collection pans within the measurement area shall be at least 0.8 mm/min.

Each wall defining the collection area shall be wetted with water to within 0.7 m of the ceiling and when collected in the containers at the base of the wall shall not be less than the volume defined in the equation for each wall:

$$V = 0.2 \times Q \times \frac{L}{Z}$$

where:

$V$ is the volume of water collected at the base of the wall ($dm^3$);

$Q$ is the total flow from the sprinkler ($dm^3$);

$L$ is the wall length (m);

$Z$ is the perimeter of sprinkler coverage area (m).

#### 4.5.2.2 Sidewall sprinkler

When sprinklers are tested in accordance with Annex C (**C.2** and **C.3**), using the parameters given in Table 3 and Table 4, the minimum conditions specified in Table 4 shall be achieved and the minimum operating pressure at any sprinkler shall not be less than 0.5 bar.

Sprinklers shall distribute water over a horizontal surface such that the discharge density collected in any eight collection pans shall be not less than 0.6 mm/min. All other collection pans within the design area shall be at least 0.8 mm/min.

Each wall defining the collection area shall be wetted to within 0.7 m of the ceiling with water from the sprinkler and when collected in the containers at the base of the wall shall not be less than the volume defined in the equation for each wall (see **4.5.2.1**).

Table 3 **Allowable spacings ($S$, $L_c$, $W_c$)**

| **Sprinkler head selection** | **Spacing ($S$)** m | **Length ($L_c$)** m | **Width ($W_c$)** m |
|---|---|---|---|
| Sprinklers other than sidewall | 3.7 × 3.7 | — | — |
| | 4.3 × 4.3 | — | — |
| | 4.9 × 4.9 | — | — |
| | 5.5 × 2.5 [A)] | — | — |
| Sidewall | — | 3.7 | 3.7 |
| | — | 4.3 | 4.3 |
| | — | 4.9 | 4.9 |
| | — | 5.5[A)] | 2.5[A)] |

[A)] Sprinkler spacing permissible in corridors only.

## 4.6 Function

**4.6.1** When tested in accordance with Annex D (**D.1**), the sprinkler shall open and within 5 s of release of the thermally sensitive element shall operate satisfactorily and shall conform to the requirements specified in **4.5.1**. Any lodgement of released parts shall be cleared within 60 s of the release of the thermally sensitive element and the sprinkler shall conform to the requirements specified in **4.5.2**.

**4.6.2** When tested in accordance with Annex D (**D.2**), the deflector and its supporting parts shall conform to the requirements specified in **4.5.2**.

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

## 4.7 Strength of sprinkler body and deflector

**4.7.1** When tested in accordance with Annex E (**E.1**), 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.

**4.7.2** When tested in accordance with Annex E (**E.2**), the sprinkler deflector and its supporting parts shall withstand an applied force of 70 N without permanent deformation.

Table 4 **Water distribution parameters**

| **Column 1** | **Column 2** | **Column 3** | **Column 4** | **Column 5** | **Column 6** | **Column 7** | **Column 8** | **Column 9** |
|---|---|---|---|---|---|---|---|---|
| **Test condition** | **Nominal water coverage** A) | **Flow rate per sprinkler** B) | **No of sprinklers under test** | **Minimum test duration** | **Minimum collection value** D) | **Not more than 4 pans per plane below** | **Not more than 8 pans per plane below** | **Figure reference** |
| | mm/min | l/min | | s | mm/min | mm/min | mm/min | |
| Floor (horizontal) collection (non-sidewall) | 2.8 | $2.8 \times S^2$ | 1 C) | 360 | 0.8 | 0.6 | — | C.1 |
| Vertical distribution test (non-sidewall) | 2.8 | $2.8 \times S^2$ | 1 C) | 360 | See **4.5.2.1** | — | — | C.3 |
| Floor (horizontal) collection (sidewall) | 2.8 | $2.8 \times L_c \times W_c$ | 1 | 360 | 0.8 | — | 0.6 | C.4 |
| Vertical distribution test (sidewall) | 2.8 | $2.8 \times L_c \times W_c$ | 1 | 360 | See **4.5.2.2** | — | — | C.2 |

A) Test shall be conducted at either 2.8 mm/min or the value specified by the supplier, whichever is the greater.

B) $S$ (or $L_c \times W_c$ in the case of sidewall sprinklers) is the maximum allowable spacing specified by the supplier and constrained by Table 3. Distribution test to be undertaken at each of the maximum allowable spacings.

C) Repeat test having rotated sprinkler frame arms through 90°.

D) Except the four pans allowed by column 7.

## 4.8 Strength of release element

### 4.8.1 Glass bulb sprinklers

When evaluated and tested in accordance with Annex F (**F.1**), 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;

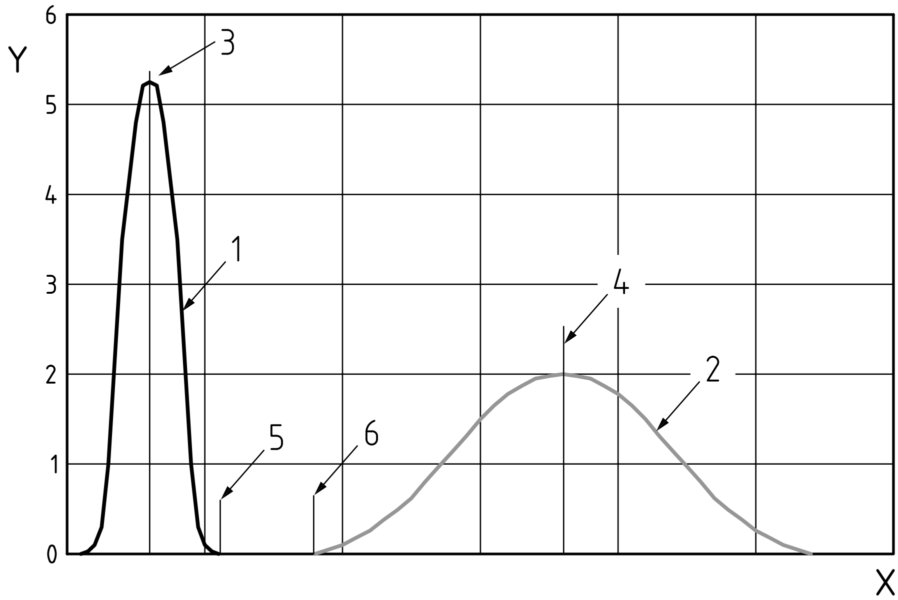
c) a mean service load not more than the mean design service load;

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).

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




**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)
X Strength, in newtons (N)
Y Number of samples

### 4.8.2 Fusible link sprinklers

When tested in accordance with Annex F (**F.2**), fusible link sprinklers shall meet one of the following requirements:

a) the temperature sensitive elements shall 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 shall be not less than 876 600 h at the design load.

*NOTE For further information on the strength test for fusible link elements, see Annex G.*

## 4.9 Leak resistance

When tested in accordance with Annex H, sprinklers shall not show any sign of leakage.

## 4.10 Heat exposure

### 4.10.1 Sprinklers

When tested in accordance with Annex I (see **I.1**), the sprinklers shall not operate during the exposure period. When subjected to the additional tests specified in **I.1**, the sprinklers shall meet the following requirements:

a) when tested in accordance with **D.3**, the sprinklers shall operate such that the waterway is cleared; any lodgements shall be disregarded;

b) when tested in accordance with Annex H, the sprinklers shall conform to the requirements specified in **4.9**;

c) when tested in accordance with Annex A, the sprinklers shall conform to the requirements specified in **4.4**.

### 4.10.2 Glass bulb sprinklers

When glass bulb sprinklers are tested in accordance with Annex I (**I.2**), there shall be no damage to the glass bulb.

## 4.11 Thermal shock

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

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

b) remain intact, i.e. after immersion, when subjected to a function test in accordance with **D.3**, they shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

## 4.12 Corrosion

### 4.12.1 Stress corrosion

Concealed sprinklers shall be tested with and without their cover plates assembled. When sprinklers are subjected to a stress corrosion test in accordance with Annex K, then those sprinklers in which cracks, delamination or failure of an operating part is observed, other than the cover plate, shall show no evidence of leakage in the leak resistance test described in Annex H.

After exposure all sprinklers shall be subjected to a function test in accordance with **D.3**. The sprinklers shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded. In the case of concealed sprinklers, the three complete assemblies and the three sprinklers without cover plates shall be tested.

Those sprinklers which show evidence of cracking, delamination or failure of a non-operating part shall show no visible evidence of separation of permanently attached parts when subjected to the flowing test described in **K.1.3**.

### 4.12.2 Sulphur dioxide corrosion

Concealed sprinklers shall be tested with and without their cover plates assembled. When sprinklers are subjected to a sulphur dioxide corrosion test in accordance with **K.2**, then after exposure, when subjected to a function test in accordance with **D.3**, the sprinkler shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

### 4.12.3 Salt mist corrosion

Concealed sprinklers shall be tested with and without their cover plates assembled. When sprinklers are subjected to a salt mist corrosion test in accordance with **K.3**, then after exposure, when subjected to a function test in accordance with **D.3**, the sprinkler shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

### 4.12.4 Moist air exposure

When sprinklers are subjected to moist air exposure in accordance with **K.4**, then after exposure, when subjected to a function test in accordance with **D.3**, the sprinkler shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

## 4.13 Integrity of sprinkler coatings (coating resistance to low temperature)

When coated sprinklers are tested in accordance with Annex L, any coating (other than decorative coatings) on the sprinkler shall not crack or flake.

## 4.14 Water hammer

When subjected to pressure surges in accordance with Annex M, sprinklers shall not leak. After the test, when subjected to a function test in accordance with **D.3**, the sprinkler shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

## 4.15 Thermal response – wind tunnel

### 4.15.1 Response in the standard orientation

When tested in accordance with Annex N (**N.1** to **N.4**), in the standard orientation [see Figure N.1a)], sprinklers shall fall within the response time index (RTI) and conductivity factor (*C*) limits as shown in Figure 2.

For sprinklers which are not conducive to testing in the wind tunnel, equivalence of sensitivity shall be determined by the fire test (**4.21**) and a room test (**4.16**).

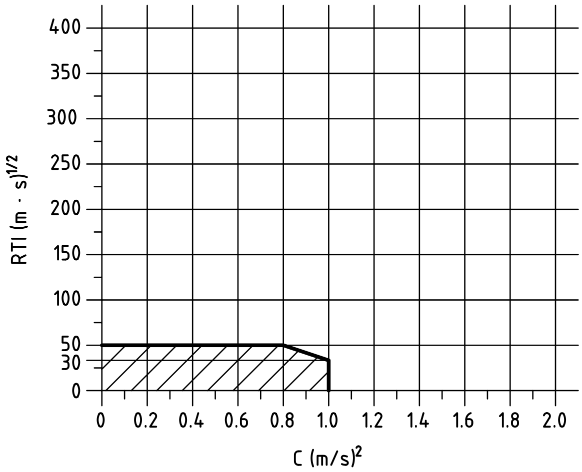
*NOTE 1 A test for sprinklers that are not conducive to testing in the existing wind tunnel is in the course of preparation.*

*NOTE 2 Typical examples of sprinklers which are not conducive for testing in a wind tunnel are concealed, recessed and sidewall sprinklers.*

### 4.15.2 Response in the unfavourable orientation

In the unfavourable orientation, the influence of any yoke arm shadow effect shall be limited to a nominal angle of 25° each side of the yoke arm (e.g. maximum 104° of the 360°) as shown in Figure N.1b). When tested in accordance with Annex N (**N.1** to **N.4**) in the unfavourable orientation, the average RTI values shall not exceed 110% of the relevant limits given in Figure 2. When calculating the RTI in the unfavourable orientation, the *C* factor from the standard orientation test shall be used.

Figure 2 **Standard orientation RTI and *C* factor limits**




**Key**

Residential sprinkler thermal sensitivity limits

## 4.16 Thermal response – room test

When tested in accordance with Annex N (**N.5**), sprinklers which are not conducive to testing in a wind tunnel (see Note 2 to **4.15.1**) shall operate within 75 s.

## 4.17 Resistance to heat

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

## 4.18 Resistance to vibration

After being subjected to a vibration test in accordance with Annex P, the sprinkler shall show no visible evidence of damage, and shall conform to **4.8** and **4.9**, and when tested in accordance with **D.3** shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

## 4.19 Resistance to impact

After being subjected to the impact test in accordance with Annex Q, the sprinkler shall conform to **4.9** and shall function satisfactorily when tested in accordance with **D.3**.

## 4.20 Resistance to low temperature

The sprinkler shall not operate before the function test, when tested in accordance with Annex R. After the test the sprinkler shall show no visible evidence of damage. Following examination, when subjected to a function test in accordance with **D.3**, the sprinkler shall operate in such a way that the waterway is cleared; any lodgements shall be disregarded.

## 4.21 Fire test

When tested in accordance with Annex S, sprinklers shall be capable of controlling the test fires for a period of 10 min, measured from sprinkler operation. Temperatures shall be limited to the values indicated in Table 5. The third sprinkler shall not operate.

Table 5 **Fire test maximum temperatures**

| Thermocouple location | Maximum allowable temperature °C | |
|---|---|---|
| 75 mm below the underside of the ceiling, above centre of crib | 320 | |
| Ceiling temperature (6.5 mm above the underside of the ceiling), above centre of crib | 260 | |
| 1.6 m above the floor, directly beneath sprinklers [A)] | 95 | |
| 1.6 m above the floor, directly beneath sprinklers [A)] | 55 | (for not more than any 120 s interval) |

[A)] For sidewall sprinklers the thermocouple locations remain as if standard sprinkler heads were used (see Figures S.7 and S.8).

# 5 Marking

## 5.1 General

Sprinklers shall be marked with the following:

a) A four- to six-character identification number. The number shall be cast or stamped on the sprinkler deflector or on a visible non-operating part, which is not used to install the sprinkler.

*NOTE 1 The identification number for decorative ceiling sprinklers 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 shall consist of one or two characters which identify the manufacturer, followed by three or four digits to identify the sprinkler orifice size, type, pressure rating and thermal sensitivity classification.

b) Nominal operating temperature. The nominal operating temperature shall be stamped, cast, engraved or colour-coded in such a way that it is recognizable after sprinkler operation.

c) The letters "RES".

d) Year of manufacture of the full form "2000", or short form "00".

*NOTE 2 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.*

e) Factory of origin, if manufacture is at two or more factories.

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

## 5.2 Sidewall sprinklers

### 5.2.1 General

The deflectors of sidewall sprinklers shall be marked with a clear indication of their intended orientation, relative to the direction of flow. If an arrow is employed, it shall be accompanied by the word "flow".

### 5.2.2 Horizontal sidewall sprinklers

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

## 5.3 Concealed sprinklers

The cover plate of a concealed sprinkler shall be impressed with the words “Do not paint”.

## 5.4 Removable recessed housing

Recessed housings shall be marked to indicate the sprinkler with which they are to be used unless the housing is a non-removable part of the sprinkler.

# 6 Instruction charts

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

# 7 Conditions for testing and type approval testing

Except where specified, tests shall be carried out at (20 ± 10) °C.

Sprinklers shall be examined for obvious defects before testing.

# 8 Evaluation of conformity

## 8.1 General

The conformity of a sprinkler to the requirements of this British Standard shall be demonstrated by:

a) initial type testing;

b) factory production control by the manufacturer;

c) audit testing.

## 8.2 Initial type testing

Initial type testing shall be performed on the first application of this British Standard.

*NOTE Tests previously performed in accordance with the provisions of this British Standard may be taken into account.*

In addition, initial type testing shall be performed at the beginning of the production of a product type or at the beginning of a new method of production (where these might affect the stated properties).

All characteristics given in Clause **4** shall be subject to initial type testing.

## 8.3 Factory production control (FPC)

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market conform with the stated performance characteristics. The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product, and shall be sufficiently detailed to ensure that the conformity of the product is apparent.

*NOTE An FPC system conforming with the requirements of the relevant part(s) of BS EN ISO 9000, and made specific to the requirements of this standard, is deemed to satisfy the above requirements.*

The results of inspections, tests or assessments requiring action shall be recorded, as shall any action taken. The action to be taken when control values or criteria are not met shall be recorded.

# Annex A (normative) Test to determine operating temperatures of fusible link sprinklers and glass bulb sprinklers

## A.1 Apparatus

**A.1.1** *Laboratory temperature measuring device*, having an accuracy of +0.25% of the nominal rating, calibrated to a depth of 40 mm immersion, for determining temperatures of liquids in bath tests and operating temperatures. The thermally sensitive part of the sensor (e.g. bulb of a thermometer) shall be held level with the centre of the sprinkler operating parts (glass bulb or fusible element). To control the temperature in the thermal bath, a PT100, sensor conforming to BS EN 60751 or equivalent shall be used.

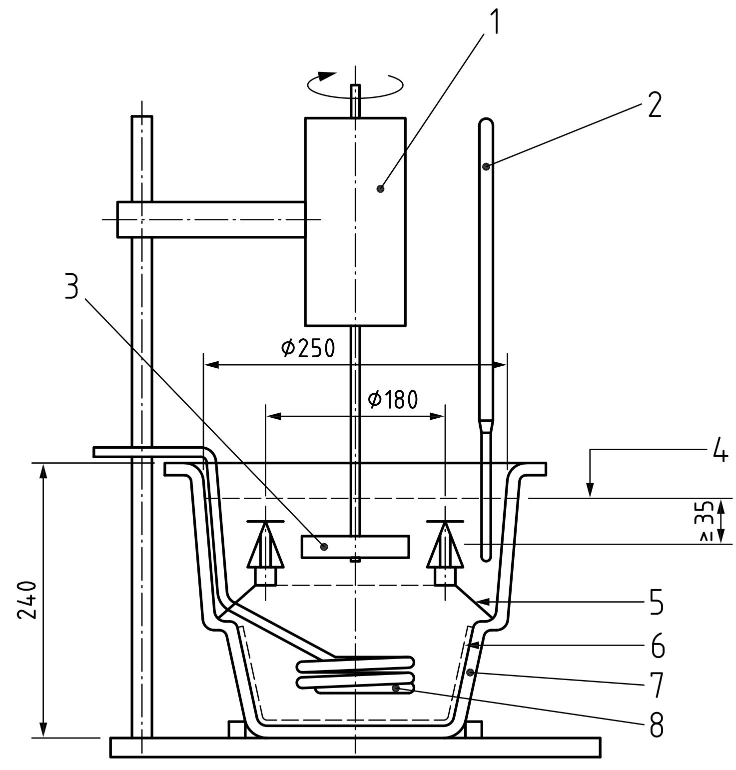
**A.1.2** *Liquid bath*, of demineralized water, for sprinklers having nominal operating temperatures less than or equal to 80 °C.

*NOTE An example of a typical bath is given in Figure A.1.*

**A.1.3** *Liquid bath*, of glycerine, vegetable oil or synthetic oil, for sprinklers with higher rated elements.

Figure A.1 **A typical liquid bath**

Dimensions in millimetres




**Key**

1 Speed agitator (150 rev/min)
2 Temperature measuring device calibrated for immersion at the test level
3 Double wing 100 mm × 20 mm
4 Liquid level
5 Ring to support 10 or 15 sprinklers
6 Mesh screen
7 Typical glass vessel (7 l)
8 Immersion heater

## A.2 Procedure

Test a total of 30 glass bulb sprinklers or 30 fusible element sprinklers. Heat glass bulb sprinklers or fusible element sprinklers in a liquid bath from a temperature of (20 ±5) °C to an intermediate temperature of $(20\ ^{+2}_{-0})$ °C below their nominal operating temperature. The rate of temperature increase shall not exceed 20 °C·min$^{-1}$. Maintain the intermediate temperature for $(10\ ^{+1}_{-0})$ min, then increase the temperature at a rate of (0.5 ±0.1) °C·min$^{-1}$ until the sprinklers operate or up to 2.0 °C above the upper operating limit.

Determine the nominal operating temperature with temperature measuring device having an accuracy of ±0.25% of the nominal temperature rating.

The sprinklers shall be located in the vertical position and totally covered by the liquid to a depth of at least 5 mm. The geometric centre of the glass bulb or fusible element shall be located not less than 35 mm below the liquid surface and in alignment with the temperature sensing device.

*NOTE 1 The temperature deviation within the test zone should be within 0.25 °C.*

*NOTE 2 The preferred location of the geometric centre of the glass bulb or fusible element and temperature measuring device should be (40 ±5) mm below the liquid surface.*

Any rupture of a glass bulb within the prescribed temperature range shall constitute an operation.

If the service load is not totally released, additional functional tests shall be carried out (see **4.6.1** and Table D.1, column 2 for the number of samples) using sprinklers having the nominal operating temperature with which the failure to release occurred.

# Annex B (normative) Water flow test

## B.1 Water flow test

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 the equation:

$$K = \frac{Q}{\sqrt{P}}$$

where:

*P* is the pressure in bar;

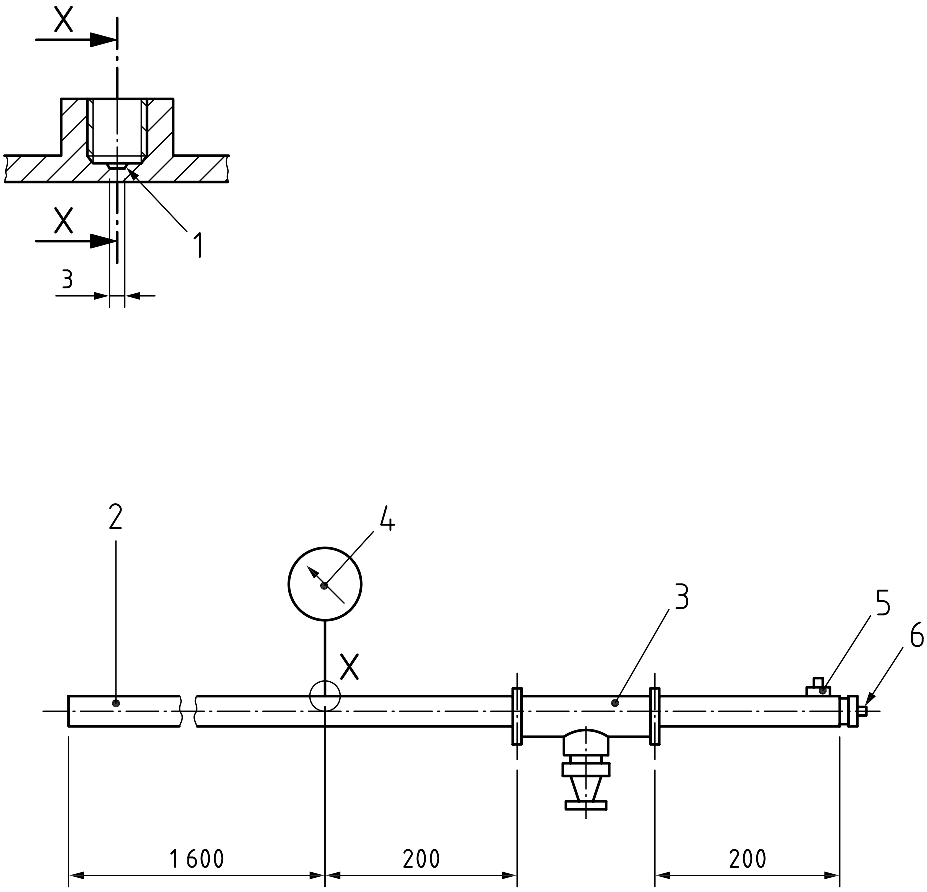
*Q* is the flow rate in litres per minute;

*K* is the K-factor.

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

Figure B.1 **Water flow test apparatus**

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, 25, mm, 20 mm or 32 mm (in accordance with ISO 49)
4 Pressure gauge
5 Air bleed valve
6 Plug or cap

Accuracies: Pressure gauge ±2%, weighing machine ±1%.

# Annex C (normative) Water distribution tests

## C.1 Floor distribution tests (except sidewall sprinklers)

### C.1.1 Apparatus

**C.1.1.1** *Test ceiling*, of minimum dimensions 6 000 mm square.

**C.1.1.2** *Sufficient square measuring containers*, with sides of $(300\ ^{+0}_{-20})$ mm, positioned with a distance of (2 500 ±50) mm between the ceiling and the upper edge of the measuring containers, to cover one quadrant of the test ceiling plus two additional rows as shown on Figure C.1.

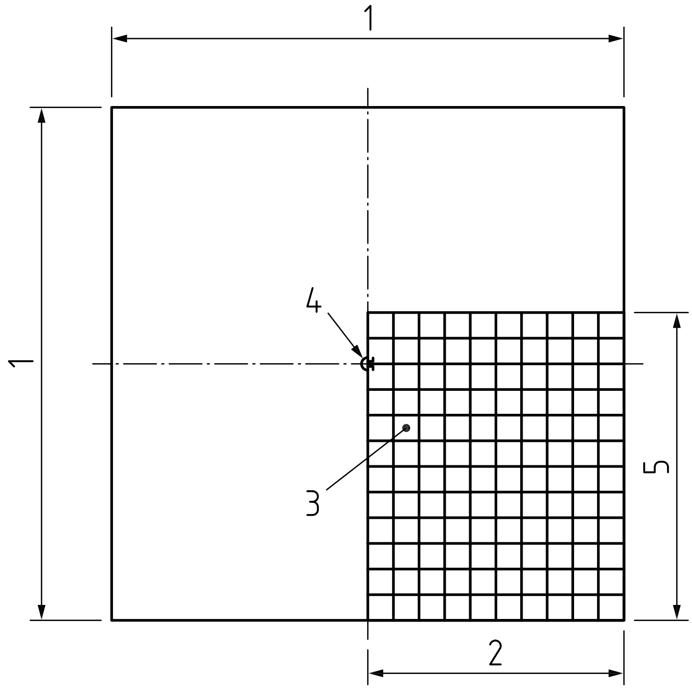
### C.1.2 Procedure

Install a single sprinkler in the test ceiling of the dimensions shown in Figure C.1, on piping prepared for this purpose. Use an arrangement of DN 25 supply piping and containers shown in Figure C.1.

Position sprinklers relative to the ceiling in accordance with the supplier's product data sheet. Frame arms shall be aligned with the long edge of the collection array. Repeat the test having rotated the sprinkler frame arms through 90°.

Flow water through the sprinkler in accordance with Table 3, for a period of not less than 360 s. Measure or calculate the volume or mass of water distributed over the measurement area, by means of square measuring containers.

Figure C.1 **Layout of water distribution test chamber**




**Key**
1 Test ceiling minimum 6 000 mm
2 At least *S*/2 containers
3 Measuring containers ($300\,^{+0}_{-20}$) mm
4 Sprinkler (in midpoint of ceiling)
5 At least *S*/2 containers + 2 ($300\,^{+0}_{-20}$) mm

## C.2 Vertical distribution tests

### C.2.1 Apparatus

**C.2.1.1** *Test cell*, of dimensions ($L_c$ ±50) mm and ($W_c$ ±50) mm.

**C.2.1.2** *Square measuring containers*, with sides of length ($300\,^{+0}_{-20}$) mm.

### C.2.2 Procedure

The test shall be conducted on an individual sprinkler using design flow rates specified in the manufacturer's design and installation instructions that simulate one sprinkler in a system operating.

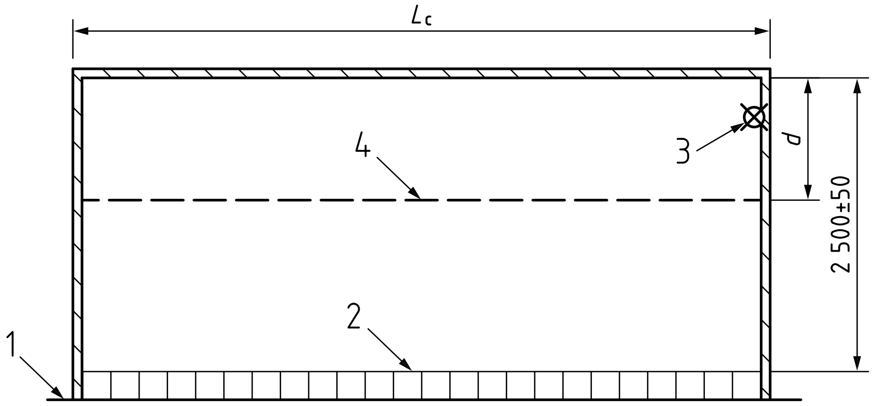
Install a single sprinkler in the appropriate test cell of the dimensions shown in Figure C.2 and Figure C.3, on piping prepared for this purpose. Position sprinklers relative to the ceiling in accordance with the supplier's product data sheet. Frame arms shall be aligned with an edge of the collection array. Repeat the test having rotated the sprinkler frame arms through 90° (do not do this repeat test with sidewall sprinklers).

The walls of the test room shall be non-porous or have a non-porous covering so that water impinging on the walls can be collected and measured. The collector pans shall be placed on the floor against the walls for the length and width of specified coverage. The collector pans shall be (2 500 ±50) mm below the ceiling. Means shall be provided to prevent sprinkler discharge from directly entering the pans and to ensure all water run-down passes in to the collector pans.

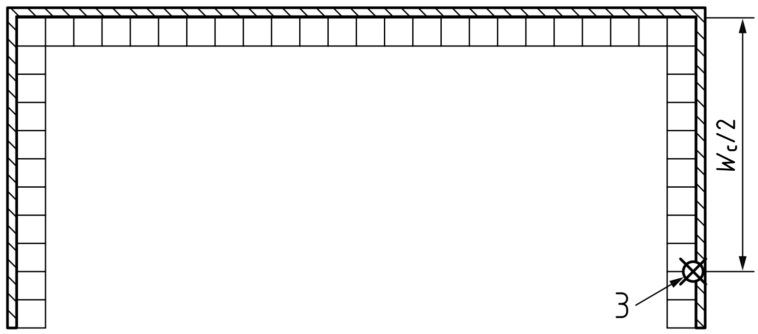
Each specified design water flow rate shall be established and water flowed through the sprinkler for a period of not less than 360 s for each flow rate. At the completion of water flow, the water collected and the height of wall wetting shall be measured.

Figure C.2 **Vertical water collection and wall wetting (sidewall sprinklers)**

Dimensions in millimetres




a) Wall dimensions (elevation)



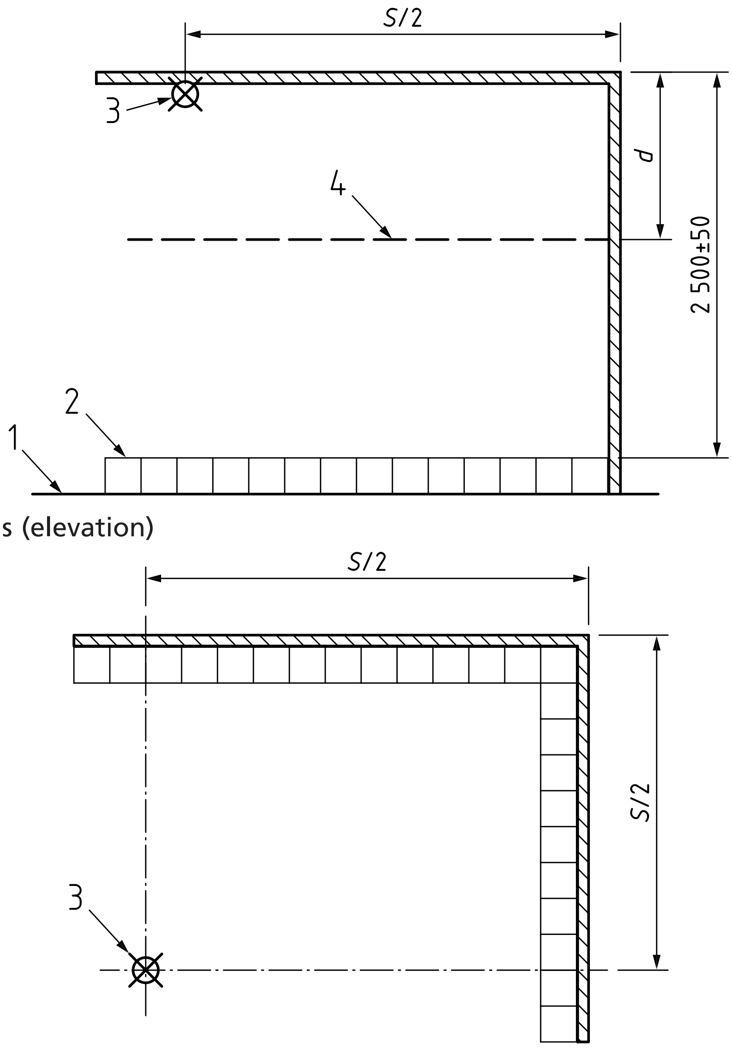

b) Collector pans (plan view)

**Key**

1 Floor
2 Collector pans
3 Sidewall sprinkler [depth below ceiling of sprinkler axis $(100\,^{+10}_{-0})$ mm, vertical displacement from wall as specified by manufacturer's installation documentation]
4 Maximum permissible depth of unwetted wall
*d* Depth not more than 0.7 m
$L_c$ Length of coverage area
$W_c$ Width of coverage area

Figure C.3 **Vertical water collection and wall wetting (upright and pendent sprinklers)**

Dimensions in millimetres




a) Wall dimensions (elevation)

b) Collector pans (plan view) – Upright and pendent sprinklers only

**Key**

1 Floor
2 Collector pans
3 Upright or pendent sprinkler
4 Maximum permissible depth of unwetted wall
*d* Depth not more than 0.7 m
*S* Allowable spacing

## C.3 Floor distribution test (sidewall sprinklers)

### C.3.1 Apparatus

**C.3.1.1** *Test cell*, of dimensions ($L_c$ ±50) mm and ($W_c$ ±50) mm.

**C.3.1.2** *Square measuring containers*, with sides of ($300^{+0}_{-20}$) mm positioned with a distance of (2 500 ±50) mm between the ceiling and the upper edge of the measuring containers and as shown on Figure C.4.

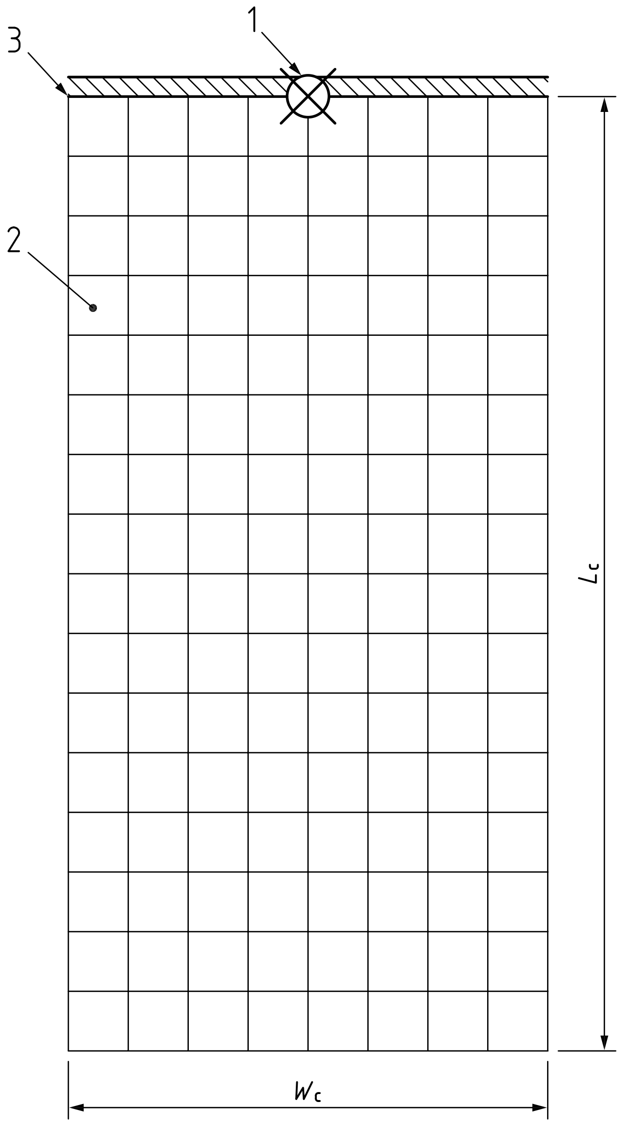
### C.3.2 Procedure

Install a single sprinkler in the test wall as shown in Figure C.4, on piping prepared for this purpose. Use an arrangement of DN 25 supply piping and containers shown in Figure C.4.

Position sprinklers relative to the wall in accordance with the supplier's product data sheet. Frame arms shall be aligned with the long edge of the collection array Repeat the test having rotated the sprinkler frame arms through 90°.

Flow water through the sprinkler in accordance with Table 4, for a period of not less than 360 s. Measure or calculate the volume or mass of water distributed over the measurement area, by means of square measuring containers.

Figure C.4 **Water collection for sidewall sprinklers (plan view)**




**Key**

1 Sidewall sprinkler
2 Collector pans
3 Wall
$W_c$ Coverage width
$L_c$ Coverage length

# Annex D (normative) Functional test

## D.1 Function of thermal sensitive element

Heat the sprinklers in the functional test oven shown in Figure D.1. Whilst the sprinklers are being heated, subject the inlet to water pressure as specified in Table D.1. Increase the temperature at the sprinkler at a rate equivalent to (400 ±20) °C in not more than 3 min.

Continue heating until the sprinkler has operated.

Test every sprinkler type and size in each normal mounting position and at the pressure specified in Table D.1. Not less than 11 sprinklers of each temperature rating shall be tested.

Table D.1 **Functional test parameters**

| **Test pressure**<br>bar | **Minimum quantity tested** | **Minimum for each operating temperature** | **Maximum lodgement rate** |
|---|---|---|---|
| 0.35 ±0.05 | 12 | 3 | 1 per 12 |
| 3.5 ±0.1 | 16 | 4 | 1 per 32 |
| 12.0 ±0.1 | 16 | 4 | 1 per 32 |

Ensure that the flowing pressure is at least 75% of initial operating pressure. Measure the oven temperature local to the sprinkler.

Lodgement shall be deemed to have occurred when one or more of the released parts lodge in the deflector frame assembly in such a way as to cause the water distribution to be significantly impeded for a period of more than 1 min.

## D.2 Deflector strength

To check the strength of the deflector, submit sprinklers to a flow test at a pressure of (12 ±0.1) bar. Allow the water to flow at a running pressure of (12 ±0.1) bar for a period of ($45^{+1}_{0}$) min.

## D.3 Verification functional test

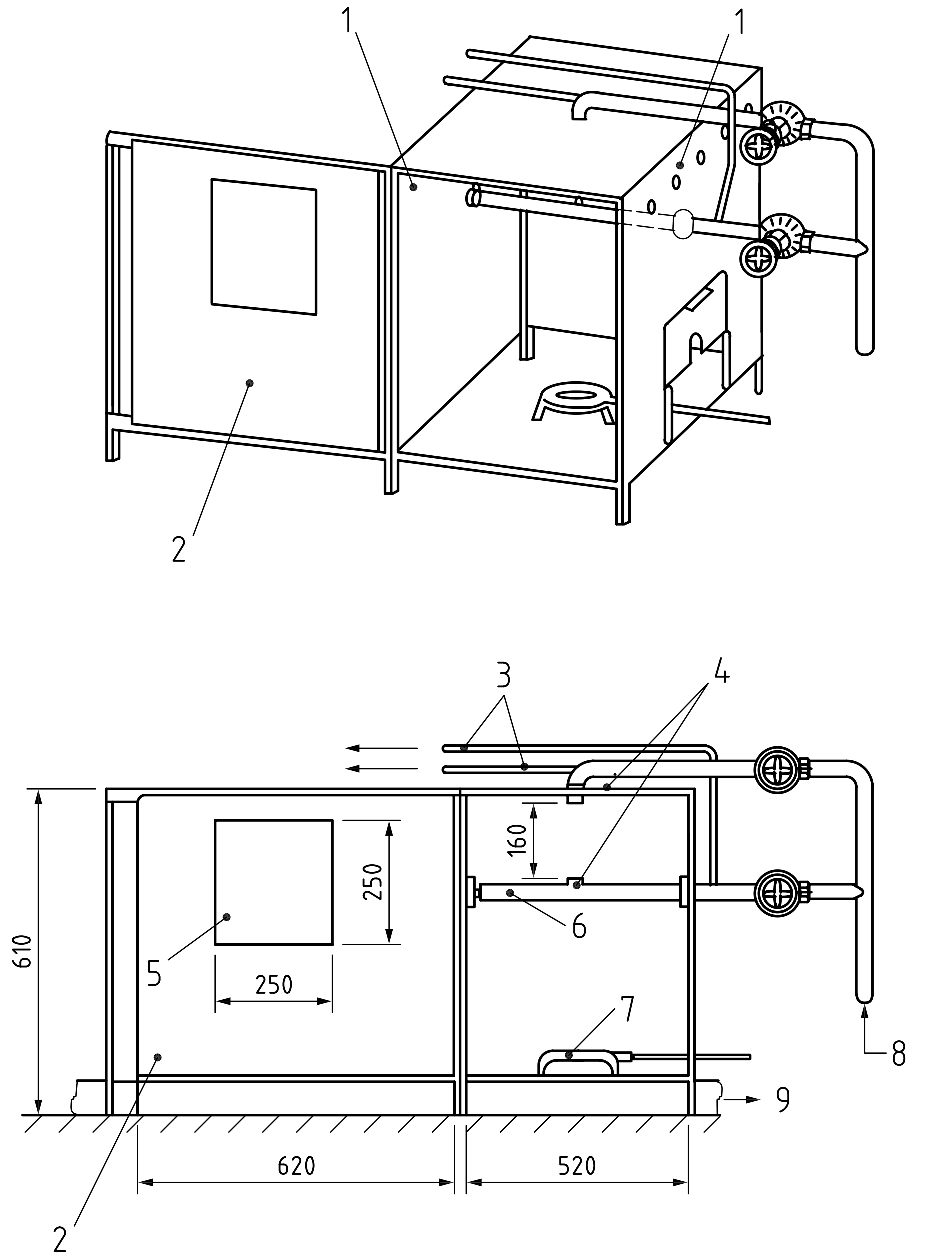
Heat sprinklers, including dry sprinklers that can be accommodated in the functional test oven shown in Figure D.1. Increase the temperature at the sprinkler at a rate equivalent to (400 ±20) °C in not more than 3 min.

Whilst the sprinkler is being heated, subject the sprinkler inlet to a water pressure of (0.35 ±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.

Figure D.1 **Example of functional test oven**

Dimensions in millimetres




**Key**

1 Vent
2 Sliding or swinging door
3 Gauge pipe
4 Threaded connection for sprinklers
5 Window
6 Detachable pipe for upright sprinklers
7 Heat source
8 Water supply
9 Water discharge

# Annex E (normative) Strength of sprinkler body and deflector tests

## E.1 Procedure

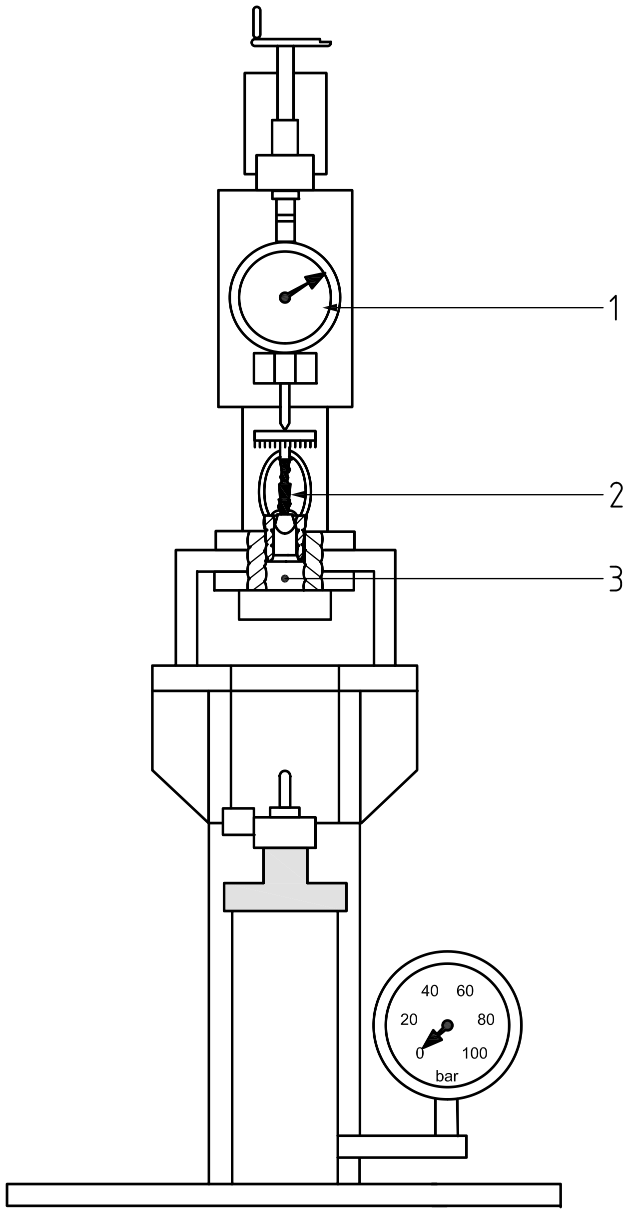
### E.1.1 Body

Measure the service load by securely installing the sprinkler in a tensile/compression test machine and apply an equivalent of a hydraulic pressure of (12 ±0.1) bar at the inlet.

Use the deflector gauge 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.

Set the deflector gauge to zero (see Figure E.1).

Figure E.1 **Example of a tensile/compression test machine**




**Key**

1 Deflector gauge, capable of reading deflection to an accuracy of 0.001 mm

2 Sprinkler

3 Sprinkler fixture [sprinkler inlet pressure (12 ±0.1) bar]

Release the hydraulic pressure and remove the heat responsive element of the sprinkler without damaging the sprinkler. 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 5 000 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 5 000 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.

### E.1.2 Deflector

#### E.1.2.1 Mechanical test

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 $(15\ ^{+10}_{\ \ 0})$ mm, and examine the deflector for permanent deformation.

*NOTE This force should not be applied exclusively to the tines.*

#### E.1.2.2 Water test

To check the strength of the deflector, submit sprinklers to a flow test at a pressure of (12 ±0.1) bar. Allow the water to flow at a running pressure of (12 ±0.1) bar for a period of $(45\ ^{+1}_{\ 0})$ min.

## Annex F (normative) Strength of release elements test

### F.1 Glass bulbs test

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

*NOTE 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 suppliers' specification.*

If the sprinkler suppliers' 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 sprinkler bulbs using the following equation:

$$\bar{x}_1 = \frac{\sum_{1}^{n} x_i}{n}$$

where:

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

$x_i$ is the individual glass bulb sample strength test values;

$n$ is the number of samples tested.

Calculate the unbiased standard deviation as follows:

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

where:

$S_1$ is the unbiased standard deviation, in newtons (N).

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

$$\text{LTL} = \bar{x}_1 - Y_1 S_1$$

where:

$Y_1$ is the $Y$ factor for normal distributions appropriate to the number of glass bulb samples tested (see Table F.1).

Table F.1 ***Y* factors for normal distributions to determine one sided tolerance limits**

| *n* | *Y* |
|---|---|
| 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 Y factor values for glass bulbs for a confidence level of 0.99 for 99% of samples.*

Using the values of the service load recorded in **E.1**, calculate the mean service load using the equation:

$$\bar{x}_2 = \frac{\sum_{1}^{n_2} x_2}{n_2}$$

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 equation:

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

where:

$S_2$ is the service load standard deviation.

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

$$\text{UTL} = \bar{x}_2 + Y_2 S_2$$

where:

$Y_2$ is the $Y$ factor for normal distributions appropriate to the number of service load samples tested (see Table F.1).

## F.2 Fusible links test

Subject fusible links to a constant load in excess of the design load ($L_d$), producing failure at approximately 1 000 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 1 000 h ($L_m$), where:

$$L_d \leq 1.02\frac{L_m^{\ 2}}{L_o}$$

Condition the test samples at (20 ±3) °C prior to loading and maintain within these temperature limits throughout the test.

# Annex G (informative) Notes on strength test for fusible link release elements

The formula given in **F.2** is based on the intention of providing fusible elements that are not susceptible to creep stress failure during a reasonable period of service. The duration of 876 600 h (100 years) was selected only as a statistical value with an ample safety factor. No other significance is intended, as many other factors govern the useful life of a sprinkler.

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

The observed data is used to determine, by means of the method of least squares, the load causing failure at 1 h, $L_o$, and the load causing failure at 1 000 h, $L_m$ i.e. when plotted on log log paper, the slope of the line determined by $L_m$ and $L_o$ is greater than or equal to the slope determined by the design load at 100 years, $L_d$, and $L_o$; or:

$$\frac{\ln L_m - \ln L_o}{\ln 1\ 000} \geq \frac{\ln L_d - \ln L_o}{\ln 876\ 000}$$

This is reduced as follows:

$$\frac{\ln L_m - \ln L_o}{\ln 1\ 000} \geq \frac{\ln L_d - \ln L_o}{\ln 876\ 000}$$

$$\geq 0.504\ 8\ (\ln L_d - \ln L_o) + \ln L_o$$

$$\geq 0.504\ 8\ [\ln L_d + \ln L_o\ (1 - 0.504\ 8)]$$

$$\geq 0.504\ 8 \ln L_d + 0.495\ 2 \ln L_o$$

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

$$\ln L_m \geq 0.5\ (\ln L_d + \ln L_o)$$

or, compensating for errors:

$$L_m \geq 0.99\sqrt{L_d - L_o}$$

$$L_d \geq 1.02\frac{L_m^{\ 2}}{L_o}$$

# Annex H (normative) Leak resistance test

Subject at least four sprinklers to water pressure of (30 ±1) bar at the inlet.

Increase the pressure from zero to (30 ±1) bar at a rate not exceeding 1 bar/s, maintain the pressure at (30 ±1) bar for a period of ($3^{+1}_{0}$) min and then allow it to fall to 0 bar.

After the pressure has dropped to 0 bar, increase it to (0.5 ±0.1) bar in not more than 5 s.

Maintain this pressure for ($15^{+5}_{0}$) s, and then increase it to (10 ±0.5) bar at a rate not exceeding 1 bar/s and maintain it for ($15^{+5}_{0}$) s.

Examine the sprinkler for evidence of leakage during the test.

# Annex I (normative) Heat exposure

## I.1 Uncoated sprinklers

### I.1.1 Apparatus

**I.1.1.1** *Oven*, accurate to $^{+2}_{0}$ °C.

### I.1.2 Procedure

Expose 12 uncoated sprinklers for a period of ($90^{+1}_{0}$) days in an oven at a temperature that is ($11^{+2}_{0}$) °C below the nominal operating temperature or at the test temperature shown in Table I.1, whichever is lower, but not less than 49 °C. If the service load is dependent on the service pressure, apply an inlet pressure of (12 ±0.1) bar during the test. After exposure, cool the sprinklers to ambient temperature; then test four sprinklers in accordance with each of the test procedures in **D.2**, Annex A and Annex H. If one or more sprinklers fail a test, expose at least eight additional sprinklers and subject them to the test in which the failure occurred. All of the additional sprinklers shall pass the test.

Table I.1 **Heat exposure test**

| **Nominal operating temperature** °C | **Test temperature** °C |
|---|---|
| 57 to 60 | 49 |
| 61 to 77 | 52 |
| 78 to 107 | 79 |

## I.2 Glass bulb sprinklers

### I.2.1 Apparatus

**I.2.1.1** *Liquid bath*, containing water (preferably distilled) for sprinklers with a nominal operating temperature of 80 °C or less, or refined oil for sprinklers with a nominal operating temperature above 80 °C.

### I.2.2 Procedure

Place four sprinklers in a liquid bath. 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 $(5\ ^{+2}_{0})$ °C lower than the nominal temperature, whichever occurs first. 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 that the pointed end of the glass bulb (seal end) is pointing downwards. Execute the test four times on each of four sprinklers.

# Annex J (normative) Glass bulb sprinkler thermal shock test

## J.1 Apparatus

**J.1.1** *Liquid bath*, containing water (preferably distilled) for sprinklers with a nominal operating temperature of 80 °C or less, or refined oil for sprinklers with a nominal operating temperature above 80 °C.

## J.2 Procedure

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

Immerse four sprinklers in a liquid bath, at a temperature of (10 ±2) °C below the nominal operating temperature of the sprinklers. After $(5\ ^{+1}_{0})$ min, remove the sprinklers from the bath and immerse them immediately in another liquid bath 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 that the valve parts are free to move. Subject any unreleased sprinklers to a functional test in accordance with **D.3**.

# Annex K (normative) Corrosion tests

## K.1 Stress corrosion test

### K.1.1 Reagents

**K.1.1.1** *Aqueous ammonia solution*, density 0.94 g/cm$^3$.

### K.1.2 Apparatus

**K.1.2.1** *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

Pour aqueous ammonia solution 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.

Test six sprinklers. In the case of concealed sprinklers, test three samples with cover plate assembled and three with cover plates separate and included in the test chamber.

Degrease the sprinklers, seal the inlet of each sprinkler with a cap of non-reactive material, e.g. plastics, and place them in the container, supporting them approximately 40 mm above the surface of the ammonia solution.

Seal the container and maintain at a temperature of (34 ±2) °C for $(10\ ^{+0.25}_{0})$ days. Top up the ammonia solution at intervals to maintain the level.

After exposure, rinse in water and dry the sprinklers, and carry out a detailed visual examination. If cracks, delamination or failure of any operating part are observed, subject the sprinkler(s) to a leak resistance test in accordance with Annex H at (12 ±0.1) bar for ($1\,^{+0.25}_{0}$) min. After the leak resistance test, subject the sprinklers to a function test in accordance with **D.3** at an inlet water pressure of (0.35 ±0.05) bar.

Subject sprinklers showing cracking, delamination or failure of any non-operating part, after removal of the operating parts, to a flowing pressure of (12 ±0.1) bar for ($1\,^{+0.25}_{0}$) min, and examine for visible evidence of separation of permanently attached parts.

## K.2 Sulphur dioxide corrosion test

### K.2.1 Reagents for apparatus of 5 l volume

**K.2.1.1** *(500 ±5) ml of aqueous solution of sodium thiosulfate*, of (0.161 ±0.001) M concentration.

*NOTE This may be prepared using (20 ±0.1) g of analytical grade sodium thiosulfate pentahydrate crystals ($Na_2S_2O_3 \cdot 5H_2O$) made up to 500 ml distilled or deionized water in a volumetric flask at 20 °C.*

**K.2.1.2** *(1 000 ±5) ml of dilute aqueous sulfuric acid*, of (0.078 ±0.005) M concentration.

*NOTE This may be prepared using (156 ±1) ml analytical grade 0.5 M sulfuric acid solution made up to 1 000 ml with distilled or deionized water in a volumetric flask at 20 °C.*

### K.2.2 Apparatus

**K.2.2.1** *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, the volumes of sodium thiosulfate and sulfuric acid given in **K.2.1** should be doubled.*

### K.2.3 Procedure

Expose six sprinklers for two periods of 8 days each. In the case of concealed sprinklers test three samples with the cover plate assembled and three without their cover plates.

Place the sodium thiosulfate 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.*

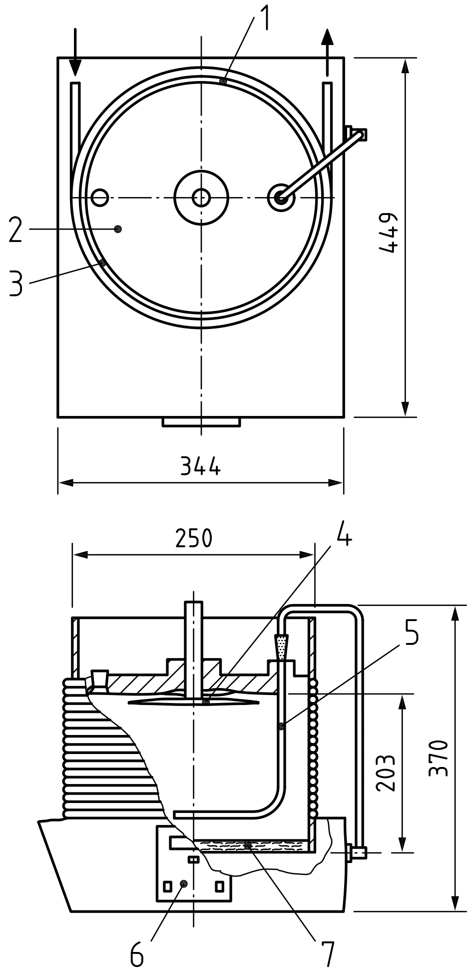
Add (20 ±0.5) ml of dilute sulfuric acid to the vessel each day. After ($8\,^{+0.25}_{0}$) days, remove the sprinklers from the vessel and empty and clean the vessel. Repeat the above procedure for a second period of ($8\,^{+0.25}_{0}$) days.

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 **D.3**.

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

Dimensions in millimetres




**Key**
1 Glass vessel
2 Polymethylmethacrylate (PMMA) lid
3 Cooling coil
4 Adjustable polymethylmethacrylate (PMMA) specimen mounting plate
5 Platinum resistance probe
6 Temperature indicator and set point controller
7 Heating element

## K.3 Salt mist corrosion test

### K.3.1 Reagents

**K.3.1.1** *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

**K.3.2.1** *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 six sprinklers. In the case of concealed sprinklers, test three samples with cover plate assembled and three with cover plates separate and included in the test chamber. 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.

After exposure, remove sprinklers from the fog chamber and allow to dry for $(7\,^{+0.25}_{\ 0})$ days at a temperature not exceeding 35 °C and at a relative humidity not greater than 70%. After the drying period, subject the sprinklers to a functional test in accordance with **D.3**.

### K.4 Moist air atmosphere test

Test a minimum of six sprinklers (see Note). Concealed sprinklers shall be tested without their cover plates.

The sprinkler samples shall have heat responsive elements which withstand the elevated test temperature.

Install the sprinklers on a pipe manifold containing deionized water. Place the entire manifold in an enclosure at a temperature of (95 ±4) °C and a relative humidity of (98 ±2)% for $(90\,^{+1}_{\ 0})$ days.

After this period, remove the sprinklers and subject them to a functional test in accordance with **D.3**.

*NOTE At the suppliers' option additional samples may be furnished for this test to provide early evidence of failure. Such additional samples may be removed from the test chamber at (30 ±1) day intervals and tested.*

## Annex L (normative) Sprinkler coatings low temperature test

Test five sprinklers, coated by normal production methods. Place the sprinklers in a refrigerated cabinet with an automatic temperature control, accuracy to ±3 °C. Control the temperature to (–10 ±3) °C for a period of $(24\,^{+1}_{\ 0})$ h. On removal from the cabinet, allow the sprinklers to return to ambient temperature and visually examine the coating.

# Annex M (normative) Water hammer test

Test five sprinklers, installing each sprinkler on the water hammer test apparatus in their 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 $(3\,000\ ^{+100}_{0})$ 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 **D.3**.

# Annex N (normative) Thermal response tests

## N.1 Apparatus – wind tunnel

**N.1.1** *Wind tunnel*, with test section dimensions of (270 ±40) mm width × (150 ±10) mm depth.

*NOTE The design of the wind tunnel should 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.*

**N.1.2** *Polytetrafluoroethylene (PTFE) sealant tape*, used to wrap around the threads of each sprinkler.

**N.1.3** *Mounting jig*.

**N.1.4** *Timer*, accurate to ±0.1 s.

**N.1.5** *Measuring devices* (see Table N.1 for tolerances).

## N.2 Procedure – wind tunnel

Test five sprinklers in accordance with **N.3** and a second batch of five sprinklers in accordance with **N.4**, in each orientation described, in a wind tunnel with test section dimensions of (270 ±40) mm width × (150 ±10) mm depth.

Wrap polytetrafluoroethylene (PTFE) sealant tape around the threads of each sprinkler and screw into a mounting jig with a torque of (15 ±3) N·m. Prime the mounting jig and sprinkler orifice with water.

## N.3 Prolonged exposure ramp test – wind tunnel

Maintain the mount temperature at (30 ±2) °C for the duration of each test. Insert the sprinkler in the standard orientation [see Figure N.1a)] into the wind tunnel test section, which has been preset to a stabilized air stream velocity of (1 ±0.1) m/s and an initial air temperature corresponding to the nominal operating temperature of the sprinkler.

Increase the air temperature at a nominal rate of rise of 1 °C/min, with temperature variation from the ideal ramp of not more than ±3 °C. Monitor and record the air temperature, velocity and mount temperature from the initiation of the test until the sprinkler operates.

Calculate the *C* factor of the sprinkler using the following equation:

$$C = (\Delta T_g / \Delta T_{ea} - 1) u^{1/2}$$ where:

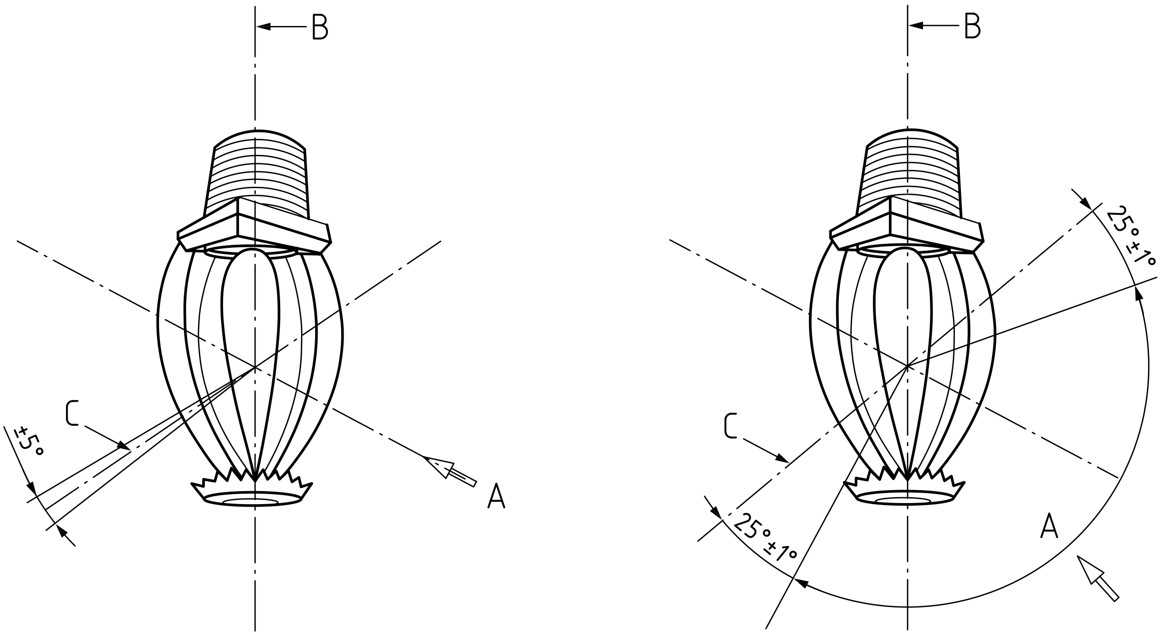
$\triangle T_g$ is the actual gas (or air) temperature in the test section minus the mount temperature ($T_m$) in degrees Celsius (°C), at the time the sprinkler operates;

$\triangle T_{ea}$ is the mean operating temperature of the sprinkler determined in accordance with Annex A minus the mount temperature in degrees Celsius (°C) at the time the sprinkler operates;

*u* is the actual gas (or air) velocity in the test section in metres per second (m/s), at the time the sprinkler operates.

Use the mean of the five *C* factor values for calculation of the standard orientation RTI values in **N.4**.

Figure N.1 **Standard orientation and unfavourable orientation**




a) Standard orientation

b) Unfavourable orientation

**Key**

A Air flow orientation

B Waterway axis

C Yoke arm orientation

## N.4 Plunge test – wind tunnel

Condition the sprinkler, water and mounting jig assembly, prior to the tests to a temperature of (30 ±2) °C for a period of at least 30 min. Maintain the temperature of the water within these limits for the duration of the test, measure the temperature by use of a thermocouple located in the water at the centre of the sprinkler orifice.

Test sprinklers with the waterway axis perpendicular to the airflow in the following orientations (see Figure N.1):

a) standard orientation, yoke arms normal ±5° to the airflow such that the heat responsive element is fully exposed to the airflow [see Figure N.1.a)];

b) unfavourable orientation, yoke arms rotated (25 ±1)° out of alignment with the airflow [see Figure N.1.b)].

Additionally test sprinklers which are asymmetric about the axis of the waterway as follows:

c) yoke arms rotated 180° about the axis of the waterway from a).

Test all other sprinklers where the influence other than yoke arm shadows can be encountered, in different orientations to establish that the total angle of acceptable operation is >256°.

Plunge the sprinkler into the wind tunnel test section, which has a constant airstream velocity and air temperature corresponding to the values specified in Table N.1.

Table N.1 **Wind tunnel conditions for plunge test**

| **Nominal operating temperature** | **Quick response sprinkler type** | |
|---|---|---|
| | **Air temperature** A) | **Velocity** B) |
| °C | °C | m/s |
| 57 to 77 | 129 to 141 | 1.65 to 1.85 |
| 79 to 107 | 191 to 203 | 1.65 to 1.85 |

A) The selected air temperature shall be known and maintained constant within the test section throughout the test to an accuracy of ±1 °C for the air temperature range 129 °C to 141 °C and to an accuracy of ±2 °C for all other temperatures.

B) The selected air velocity shall be known and maintained constant within the test section throughout the test to an accuracy of ±0.03 m/s for velocities of 1.65 m/s to 1.85 m/s and 2.4 m/s to 2.6 m/s and ±0.04 m/s for velocities of 3.4 m/s to 3.6 m/s.

Maintain the selected air velocity throughout the test and use the timer and measuring devices to determine the time between plunging of the sprinkler into the wind tunnel and operation of the sprinkler, in order to establish the response time.

Monitor and record the air temperature, velocity and mount temperature from the initiation of the test until the sprinkler operates.

Calculate the RTI of the sprinkler by using the following equation:

$$\mathrm{RTI} = \left[ \frac{-t_\mathrm{r}\sqrt{u}}{\ln\left\{1 - \Delta T_\mathrm{ea}\left(1 + C/\sqrt{u}\right)/\Delta T_\mathrm{g}\right\}} \right]\left(1 + C/\sqrt{u}\right)$$

where:

$t_r$ is the response time of the sprinkler in seconds (s);

$u$ is the actual gas (or air) velocity in the test section in metres per second (m/s), at the time the sprinkler operates;

$\Delta T_{ea}$ is the mean operating temperature of the sprinkler determined in accordance with Annex A minus the mount temperature in degrees Celsius (°C), at the time the sprinkler operates;

$\Delta T_g$ is the actual gas (or air) temperature in the test section minus the mount temperature in degrees Celsius (°C) at the time the sprinkler operates;

$C$ is the conductivity factor determined in accordance with **P.2** in (metres/second)$^{1/2}$;

ln is the natural logarithm.

Calculate the mean of the RTI values from each of the orientation tests.

## N.5 Room response

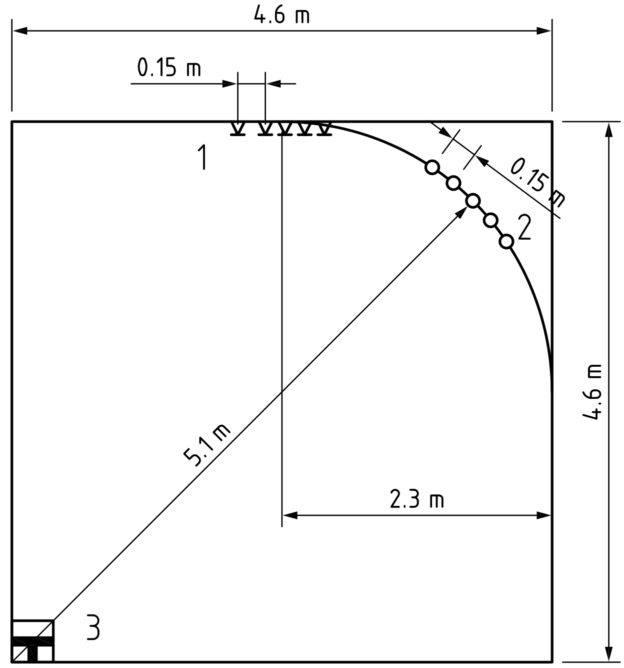
### N.5.1 Apparatus – Room response

**N.5.1.1** *Test room*. An enclosed test room as shown in Figure N.2 shall have the following internal dimensions:

- length: (4.6 ±0.05) m;
- width: (4.6 ±0.05) m;
- ceiling height: (2.4 ±0.05) m.

The test room ceiling shall be covered by 8 mm ceramic fibre board.

Figure N.2 **Room response test room layout**




**Key**
1 Sidewall sprinkler locations
2 Pendent, upright, flush, recessed and concealed sprinkler locations
3 Sand burner

**N.5.1.2** *Sprinklers*. Sprinklers shall be installed such that the inlet waterway is filled with water having temperature (20 ±5) °C pressurized to 0.3 bar.

Pendent, upright including flush, recessed and concealed type sprinklers shall be installed along an arc at a spacing of 150 mm at the ceiling, a distance of 5.1 m from the corner of the room where the burner is located, as shown in Figure N.2.

Recessed, flush or concealed sprinklers with adjustable depths shall be tested in the most recessed position.

Recessed or concealed sprinklers which incorporate venting shall be tested such that the vents are unblocked.

Sidewall sprinklers shall be installed at the midpoint of the wall opposite the sand burner (see Figure N.2).

The following number of sprinklers shall be tested.

a) For pendent, flush, recessed and concealed type sprinklers without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, two tests each of five samples shall be installed in their intended position at the ceiling and run.

b) For pendent, flush, recessed and concealed type sprinklers with or without frame arms and incorporating unsymmetrical heat responsive elements, two tests each of five samples orientated with the heat-responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source shall be run. The samples are to be in their intended position at the ceiling.

c) For pendent, flush, recessed and concealed type sprinklers incorporating frame arms with symmetrical heat responsive elements, two tests each of five samples orientated with the frame arms in a plane parallel to the direction of the fire source shall be run. The samples shall be installed in their intended position at the ceiling.

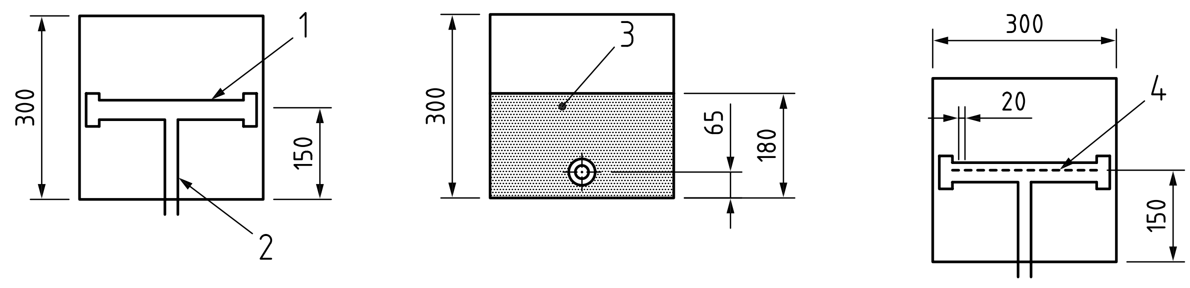
d) For upright sprinklers having the configurations specified in a) to c) above, two tests each of five samples installed in the pendent position shall be run.

e) For sidewall sprinkler designs, two tests each of five samples installed in their intended position with the deflector located 100 mm below the ceiling and the maximum distance below the ceiling if intended for distances greater than 150 mm shall be run.

**N.5.1.3** *Fire source*. The fire source shall consist of a sand burner as shown in Figure N.3 of dimensions 300 mm x 300 mm x 300 mm with a flow of natural gas of 14.6 $m^3$/h. The sand burner shall be situated flush with the corner of the room as shown in Figure N.2.

Figure N.3 **Sand burner apparatus**

Dimensions in millimetres




a) Top view b) Side view c) Bottom view

**Key**

1 Nominal 25 mm piping
2 Nominal 32 mm or 40 mm piping
3 Sand
4 6.35 mm diameter holes (typical)

## N.5.2 Test procedure

The ambient temperature in the test room shall be (30 ±1) °C as measured using a 1.5 mm stainless steel sheathed type K thermocouple located 250 mm below the ceiling in the centre of the room.

The sand burner shall be ignited and the stopwatch started. The time taken for all sprinklers to operate shall be recorded.

# Annex O (normative) Heat-resistance test

Heat a sprinkler test sample in an oven at (770 ±10) °C for a period of $(15\ ^{+1}_{0})$ 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.

# Annex P (normative) Vibration test

## P.1 Apparatus

**P.1.1** *Vibration table*.

## P.2 Procedure

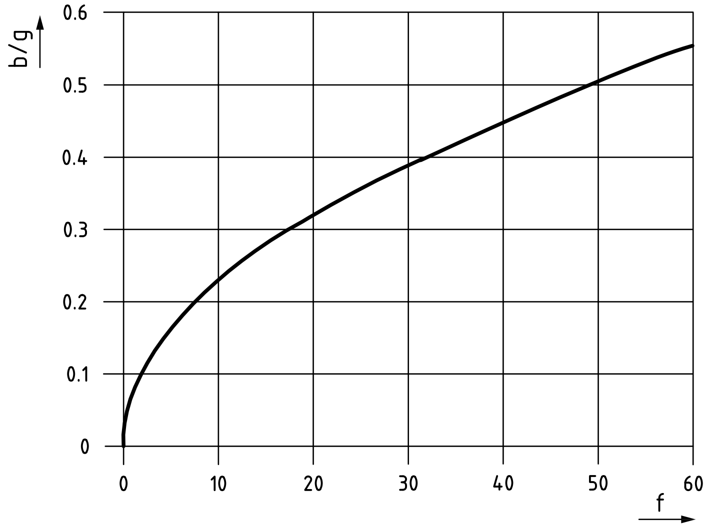
Fix three sprinklers vertically to a vibration table. Test concealed sprinklers with the cover plate in place but ignore any displacement of the cover plate. Subject the sprinklers to sinusoidal vibrations in accordance with the test curve shown in Figure P.1. Vibrate in the direction of the axis of the connecting thread.

Follow the test curve continuously from 5 Hz to 60 Hz at a rate of 1 octave/30 min if one or more resonance points can be clearly detected. After coming to the end of the curve, vibrate the sprinkler at each of these resonant frequencies for $(1\ ^{+0.1}_{0})$ h at the peak values for vibration acceleration deduced from Figure P.1.

If no resonant frequency is found, subject the sprinkler to vibration at (35 ±1) Hz for a period of $(120\ ^{+1}_{0})$ h at an amplitude of (1 ±0.1) mm.

Inspect the sprinklers for damage, then subject each sprinkler to one of three tests; a leakage test in accordance with Annex H, a strength of release elements test in accordance with **F.2** or **F.3** as appropriate, and a functional test in accordance with **D.3**.

Figure P.1 **Vibration test curve**




**Key**

$b/g = 0.228\ (f/10)^{1/2}$

where:

*f* is the frequency in hertz;

*b* is the amplitude of acceleration in $m/s^2$;

*g* is the acceleration due to gravity (9.81 $m/s^2$).

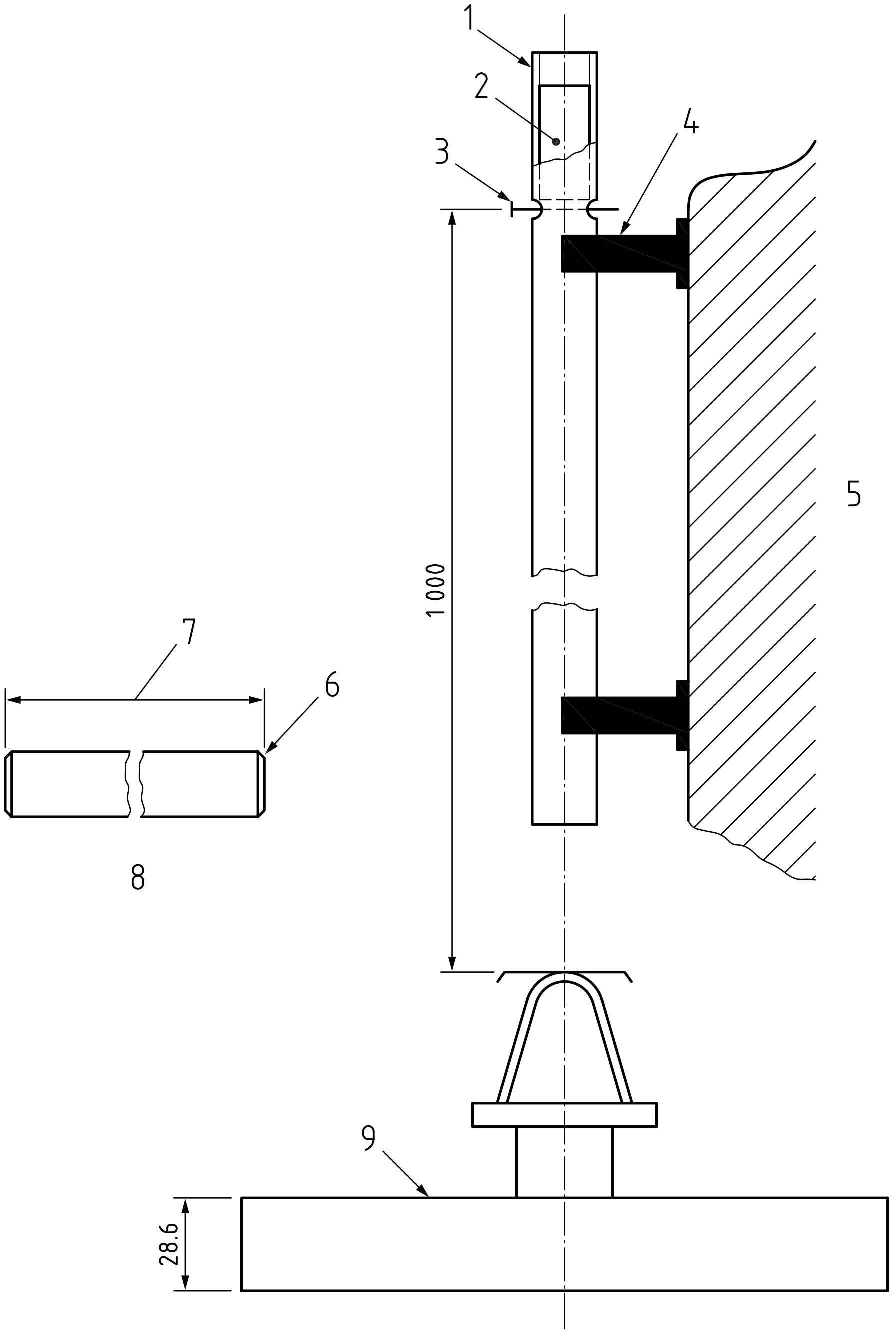
## Annex Q (normative) Impact test

Test five sprinklers by dropping a weight (see Figure Q.1) on to the deflector of the sprinkler along the axial centre line of the waterway. The kinetic energy of the dropped weight at the point of impact shall be equivalent to that of a weight of the same mass as the test sprinkler dropped from a height of 1 m. Prevent the weight from impacting more than once upon each sample. Test for leakage in accordance with Annex H and carry out a functional test in accordance with **D.3**.

Sprinklers supplied with shipping caps, which are intended for removal after installation, shall be impact tested with the caps in place.

Figure Q.1 **Impact test apparatus**

Dimensions in millimetres




**Key**

1 Cold drawn seamless steel tubing inside diameter ($14.10\,^{0}_{-13}$) mm
2 Weight (see detail "A")
3 Latching pin
4 Adjustable brackets (×2)
5 Rigid support
6 Break corner 0.06 mm × 45°
7 Length to be determined
8 Detail "A" weight 12.70 mm diameter, cold finished steel
9 Sprinkler support 165 mm diameter, cold finished steel

Annex R (normative)

# Resistance to low temperature test

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 **D.3**.

Annex S (normative)

# Fire tests

## S.1 Apparatus

**S.1.1** *Test room*, with the following internal dimensions:

- length: twice the maximum sprinkler spacing (2 × *S*) m (see Table 3);
- width: the maximum sprinkler spacing (*S*) m (see Table 3);
- ceiling height: (2.45 ±0.05) m;
- doorway height (2.2 ±0.05) m.

The test room ceiling shall be covered by 8 mm ceramic fibre board. Two walls shall be covered, floor to ceiling, by 12 mm thick plywood panels covering (2.4 ±0.1) m in length (see Figure S.1 and Figure S.2).

*NOTE Consistency of the flammability properties of the panels is essential for the repeatability of this test.*

**S.1.2** *Pipework*. The test arrangement shall ensure predictable flow rates when one or two sprinklers (8 on Figure S.3) operate in a fire test, and Figures S.3 and S.4 give examples of how this can be achieved. If the pipework arrangement as in Figure S.3 and Figure S.4 is used, the following procedure shall be used.

a) Before fire testing, prime the system pipework with water by running the pump (2). Initially open the control valve – sprinkler (6) and the control valve – return line (3). Fully open one of the pair of test valves (9.2 on Figure S.4) and allow water to flow to waste through one of the orifices (9.3). Adjust valves (3) and (6) until a flow rate equivalent to the flow required for a single sprinkler operating is achieved, and note the valve settings. Repeat the procedure with two test valves (9.2) open and adjust valves (3 and 6) until a flow rate equivalent to two sprinklers operating is achieved.

b) Repeat the process until the appropriate flow transitions between no sprinklers operating, a single sprinkler operating and two sprinklers operating can be achieved within 30 s.

c) After setting the control valve (6) and the cistern return valve (3), close both test valves (9.2) whilst the pump is running to ensure that the sprinkler pipework is completely water filled and air bled prior to the fire test.

d) At the start of the fire test, the control valves (3 and 6) shall be partially open and adjusted to give the correct flow for a single sprinkler operating. Both test valves (9.2) shall be closed. The pump (2) shall be running. If the pump is a variable speed pump it shall be appropriately adjusted to deliver the correct flow for a single sprinkler operating. On operation of the first sprinkler, check the flow rate once the flow has stabilised and adjust the control valves (3 or 6) if necessary.

   *NOTE When a second sprinkler operates the appropriate flow rate can usually be achieved by partially closing control valve (3) on the return line to the cistern.*

e) Where any other piping arrangement is used, the pipework system shall be bled of air, prior to the test.

f) The sprinkler distribution pipework shall be located above the rig. All distribution pipework shall be at least 25 mm nominal internal diameter, and drop pipes to sprinklers shall be 20 mm nominal internal diameter.

**S.1.3** *Ignition package*, consisting of a square tray of internal dimensions 300 mm × 300 mm × 100 mm deep made from 12 gauge steel containing 200 ml of commercial grade heptane floated on water of 25 mm minimum depth.
A wood crib consisting of eight layers of wood sticks of pinus silvestris, with four sticks per layer, spaced 50 mm apart, shall be placed on top of the steel tray.

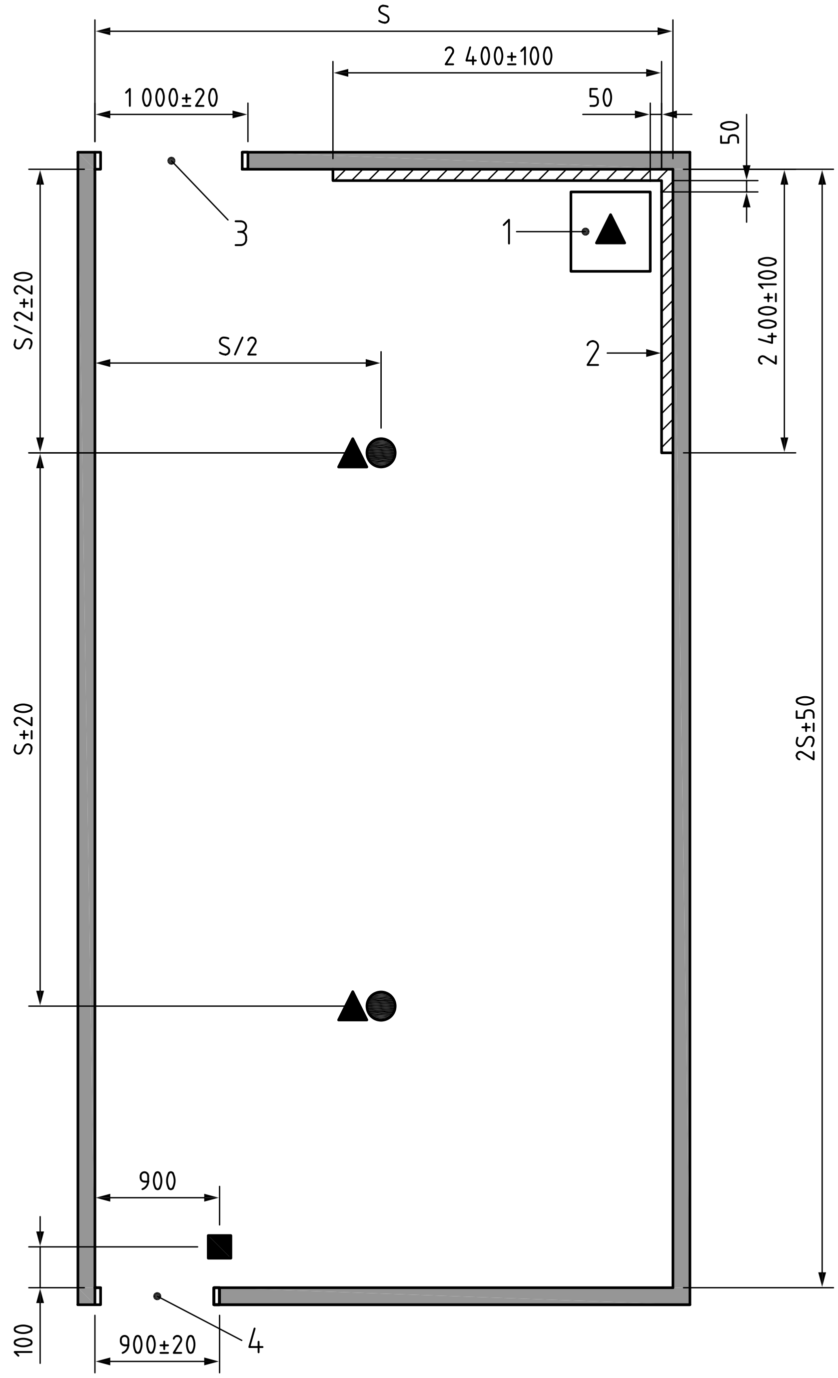
*NOTE An optional lip can be added to the steel tray to provide stability to the crib.*

The wood sticks shall be 38 mm × 38 mm cross-section by 305 mm long (actual) and plane finish. The complete wood crib shall have the nominal dimensions of 305 mm × 305 mm × 305 mm and shall weigh (8 250 ±250) g (see Figure S.1, Figure S.2, Figure S.5, Figure S.6 and Figure S.7). Two cotton wicks, each 250 mm long, shall be soaked in 100 ml of heptane, and 150 mm of each wick shall be placed on a fire brick and laid along the edge of the foam sheets with the remaining 100 mm exposed.

**S.1.4** *Fuel package*, consisting of two sheets of polyether foam 775 mm × 865 mm × 75 mm having a density of 20 kg/m$^3$. Each sheet shall be glued to a sacrificial backing board using an aerosol urethane foam adhesive in accordance with Figure S.6, 775 mm x 865 mm x 12 mm, which shall be attached to a wooden supporting frame (see Figure S.5, Figure S.6 and Figure S.7). The foam sheets shall be flush with the top and sides of the sacrificial board and frame.

Figure S.1 **Fire test 1: room corner layout**

Dimensions in millimetres

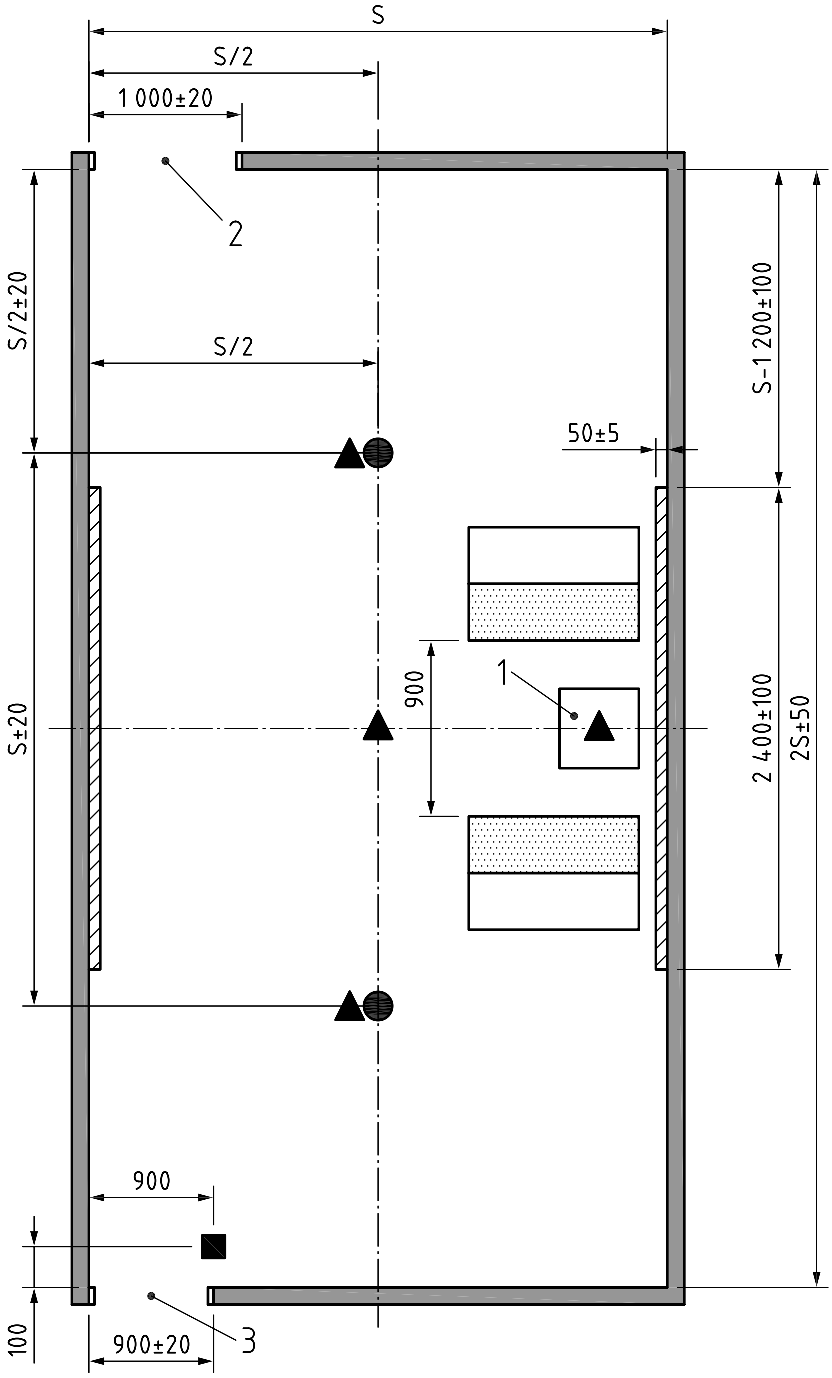



**Key**

| | |
|---|---|
| 1 | Corner fire test ignition and fuel package (see Figure S.5) |
| 2 | Plywood panels |
| 3 | Door, 1 000 mm wide |
| 4 | Door, 900 mm wide |
| | Test room wall |
| | Full room height plywood panels |
| ▲ | Thermocouple |
| ● | Sprinkler (connected to water supply) |
| ■ | Sprinkler (connected to water-filled pipe) |

Figure S.2 **Fire test 2: wall layout**

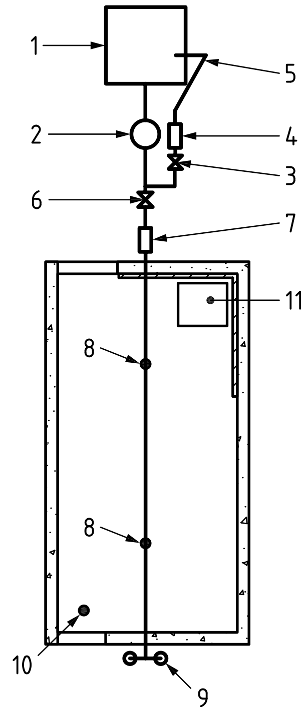
Dimensions in millimetres




**Key**

1 Fire test ignition and fuel package (see Figure S.7)
2 Door, 1 000 mm wide
3 Door, 900 mm wide
Test room wall
Full room height plywood panels
Thermocouple
Sprinkler (connected to water supply)
Sprinkler (connected to water-filled pipe)
Fuel package – simulated furniture, foam plastic on a supporting frame (see Figure S.5)

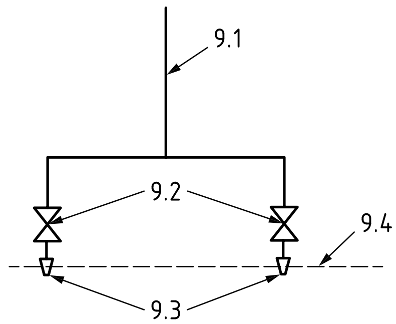
Figure S.3 **Typical sprinkler test arrangement**




**Key**

| | | | |
|---|---|---|---|
| 1 | Water storage cistern | 7 | Flow meter |
| 2 | Pump | 8 | Sprinkler |
| 3 | Control valve – return line to cistern | 9 | Drain test valves and orifices (see Figure S.4) |
| 4 | Flow meter (optional) | 10 | Sprinkler (not connected to water supply) |
| 5 | Return line to cistern | 11 | Corner fire test ignition and fuel package |
| 6 | Control valve – sprinkler flow | | |

Figure S.4 **Drain test valves and orifices**

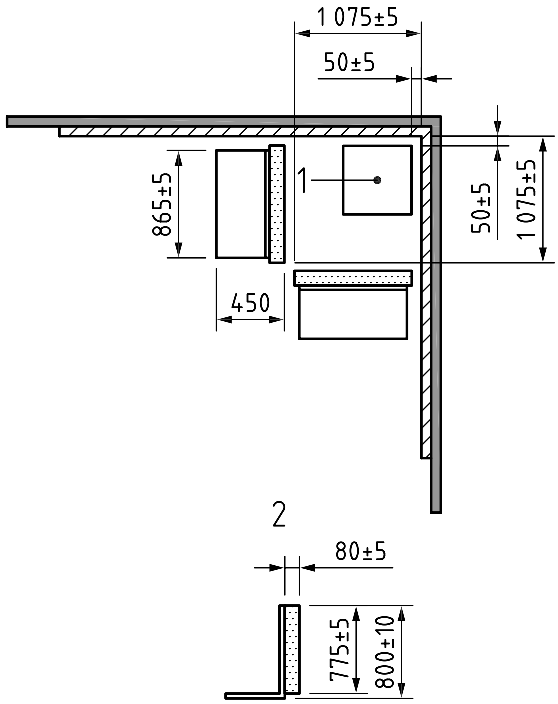



**Key**

9.1 Sprinkler distribution pipe connection
9.2 Test valves
9.3 Orifices with same k factor as sprinklers under test
9.4 Orifices at approximately same height as sprinklers under test

Figure S.5 **Corner fire test ignition and fuel package**

Dimensions in millimetres




**Key**

1 Steel pan, 300 mm × 300 mm, with heptane on water and wood crib above

2 Side view

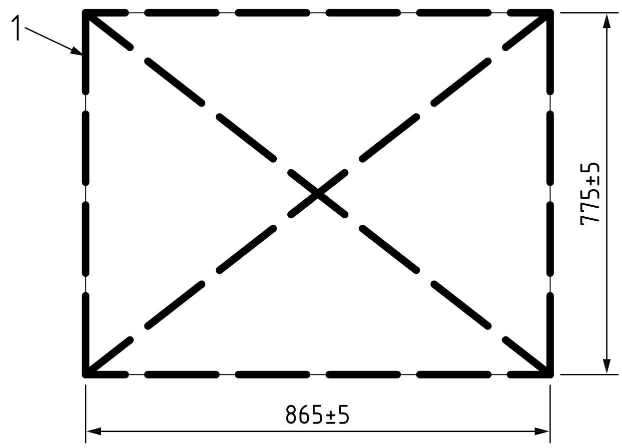
Test room wall

Full room height plywood panels

Foam

Figure S.6 **Foam adhesive pattern**

Dimensions in millimetres

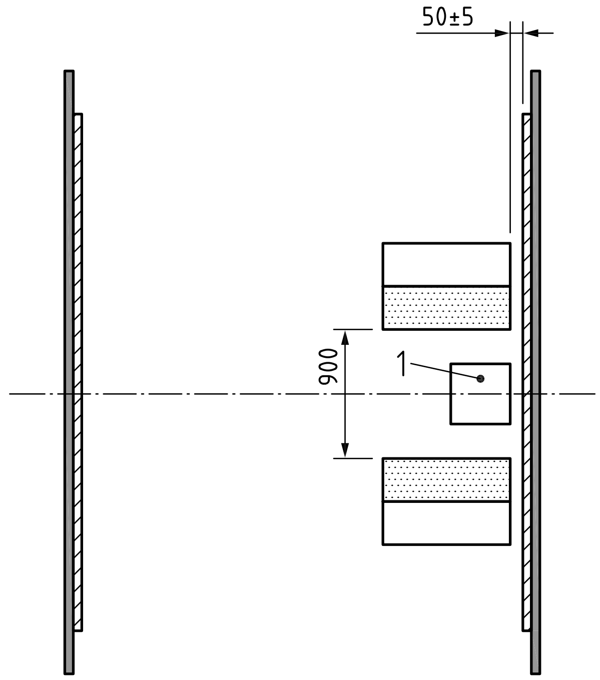



**Key**

1 Foam adhesive pattern

Figure S.7 **Wall fire test ignition and fuel package**

Dimensions in millimetres




**Key**

1 Steel pan, 300 mm × 300 mm, with heptane on water and wood crib above

Test room wall

Full room height plywood panels

Fuel package – simulated furniture, foam plastic on a supporting frame (see Figure S.5)

## S.2 Preparation

Sprinklers of each temperature rating shall be fire tested once, for each of the two arrangements shown in Figure S.1 and Figure S.2.

Install two sprinklers of the same type, with their yoke arms or deflector attachment pins perpendicular to the length of the room, where applicable, at their maximum sprinkler spacing *S*, in a test room of the dimensions shown in Figure S.1 and S.2. Install a third sprinkler of the same type, inside the test room near the open doorway. This third sprinkler shall be installed on an open length of vertical pipe work which is filled with a minimum of 70 ml of water. The sprinklers shall be installed in accordance with the manufacturer's instructions, and as shown in Figure S.3 and Figure S.4.

The plywood sheets, sacrificial boards, wooden frames, foam sheets and wood crib sticks shall be conditioned at a temperature of (23 ±2) °C and a relative humidity of (50 ±5)% for the conditioning periods recommended by BS EN 13238.

The crib shall be conditioned before the test, such that the moisture content is (10 ±2)%, 3 mm below the wood stick surface.

Before the start of each test, the room temperature shall be (25 ±5) °C. The room, wall panels, floor, fuel packages and contents shall be dry and the room relative humidity shall be not more than 70%.

Fuel packages and ignition packages shall be placed in the test room as shown in Figure S.5 and Figure S.6.

Recessed and concealed sprinklers having vented recessed housings shall be installed and tested:

a) in a manner that does not inhibit air flow through the recessed housing (i.e. with the holes in the recessed housing unobstructed);

b) in a manner which inhibits air flow through the recessed housing, by placing a 200 mm thick fibreglass insulating sheet around and over the top of the sprinkler; and

c) with the sprinkler set at the maximum recessed distance within the recessed housing in accordance with the manufacturer's specifications.

## S.3 Procedure

Ignite the heptane in the steel tray and the cotton wicks simultaneously. Record thermocouple temperatures and sprinkler operating time(s) from ignition to 10 min after the operation of the first sprinkler. Pressure at the sprinklers shall conform to that shown on the manufacturer's data sheet and shall be not lower than 0.5 bar. The flow of water through the first sprinkler to operate shall be sufficient to provide a nominal discharge density of not less than 4.0 mm/min over the single sprinkler area of coverage. The nominal discharge density for two operating sprinklers shall be not less than 2.85 mm/min. Calculate the nominal density using the equation:

$$D = \frac{Q}{a}$$

where:

$D$ is the nominal discharge density (mm/min);

$Q$ is the flow into area of coverage (l/min);

$a$ is the area of coverage under consideration ($m^2$).

Measure and record any flow of water through each of the two room sprinklers at intervals not exceeding 1 Hz.

The fuel packages shall be positioned as described in Figure S.1, Figure S.2 and Figure S.5.

## S.4 Sidewall sprinklers

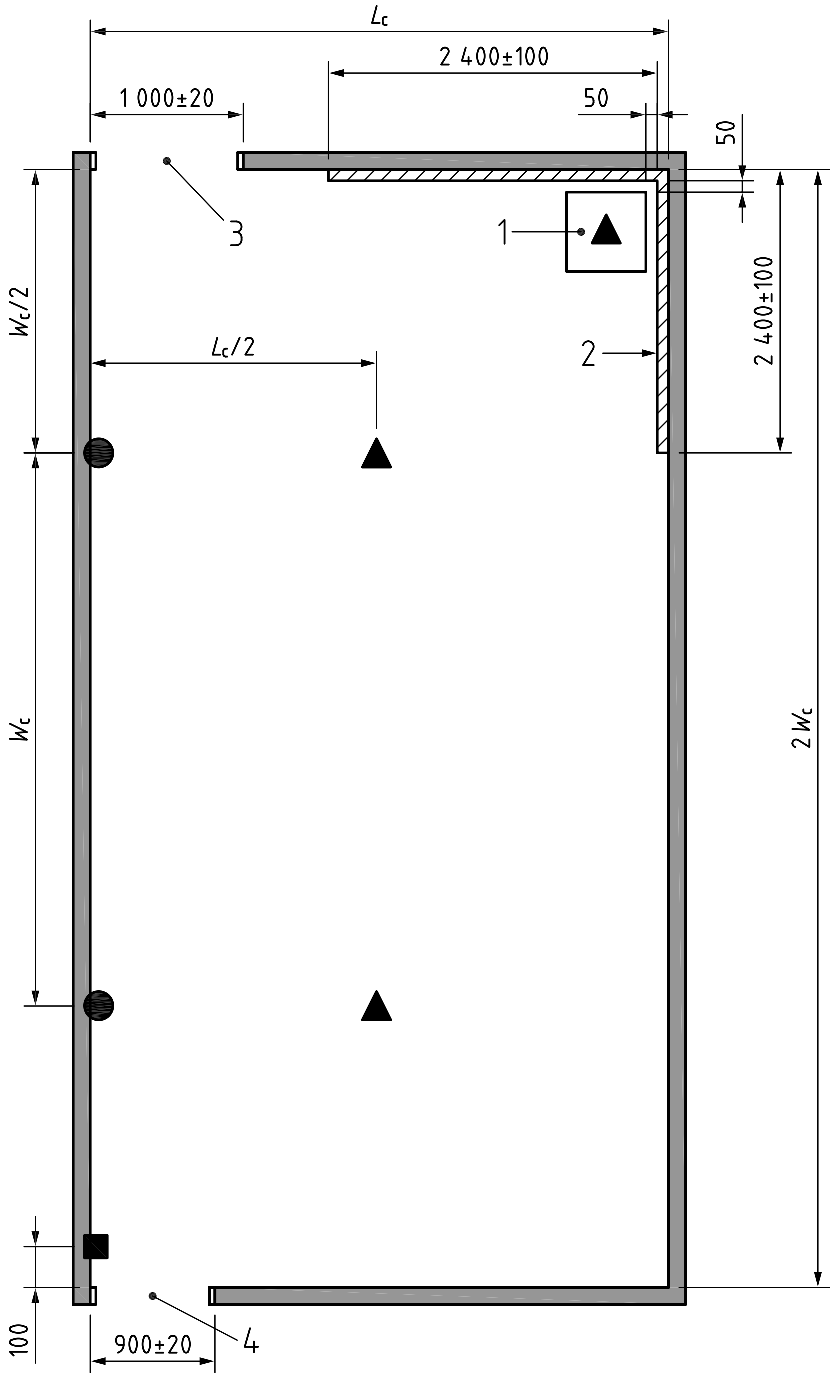
Sidewall sprinkler heads shall be tested as specified in **S.1** to **S.3**, with the exception of the necessary differences detailed below, which are due to the different location and orientation of the heads.

Sprinklers of each temperature rating shall be fire tested once, for each of the two arrangements shown in Figure S.8 and Figure S.9.

Install two sidewall sprinklers with their deflectors located 100 mm below the ceiling, or at the maximum distance below the ceiling as specified in the installation instructions if the maximum exceeds 152 mm below the ceiling.

Figure S.8 **Sidewall sprinkler fire test arrangement, sprinklers on opposite wall to fire load**

Dimensions in millimetres




**Key**

1 Corner fire test ignition and fuel package (see Figure S.5)
2 Full room height plywood panels
3 Door, 1 000 mm wide
4 Door, 900 mm wide
5 Test room

Test room wall

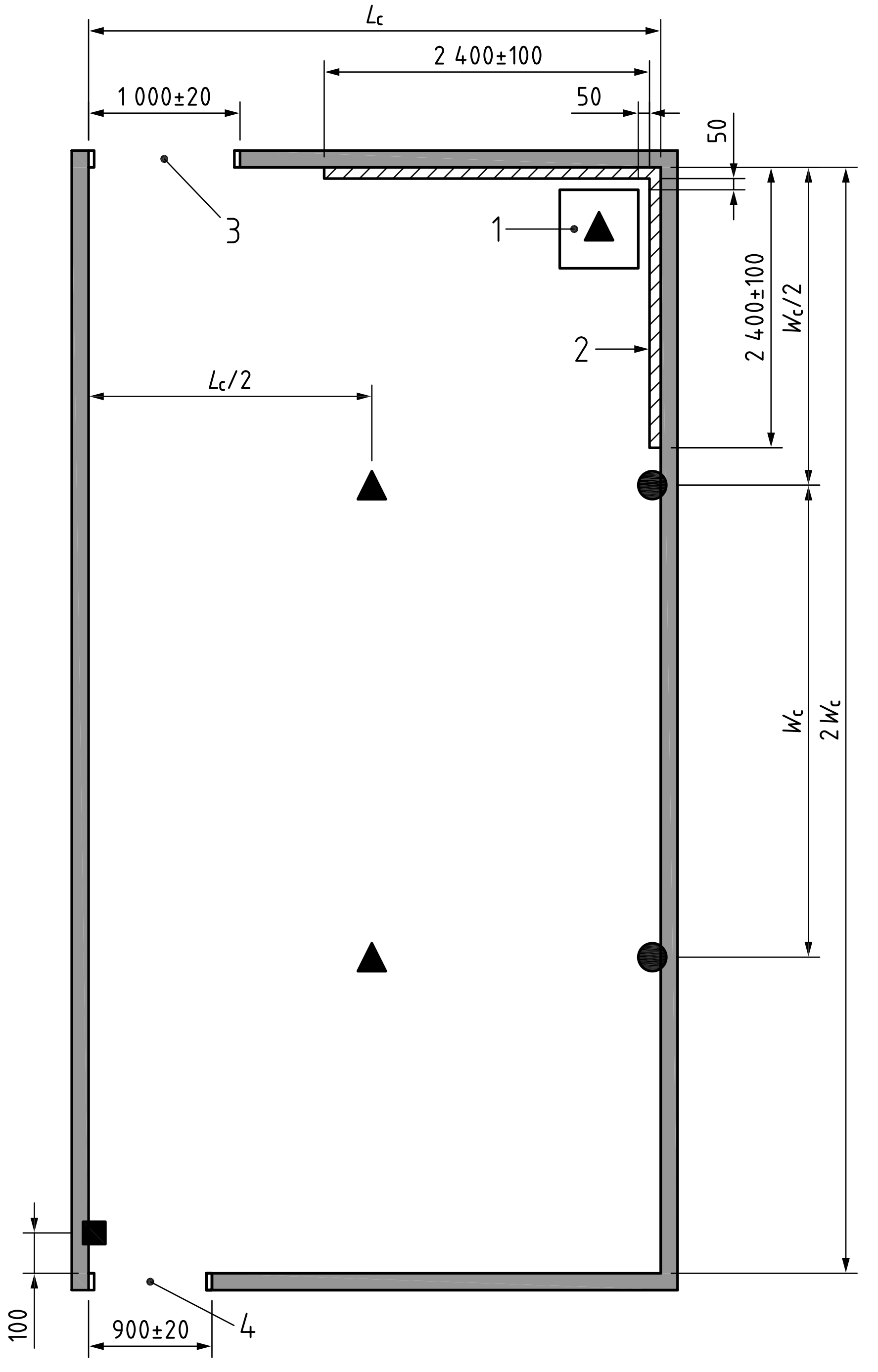
Thermocouple

Sprinkler (connected to water supply)

Sprinkler (connected to water-filled pipe)

Figure S.9 **Sidewall sprinkler fire test arrangement, sprinklers on same wall to fire load**

Dimensions in millimetres




**Key**

| | |
|---|---|
| 1 | Corner fire test ignition and fuel package (see Figure S.5) |
| 2 | Full room height plywood panels |
| 3 | Door, 1 000 mm wide |
| 4 | Door, 900 mm wide |
| 5 | Test room |
| [wall symbol] | Test room wall |
| ▲ | Thermocouple |
| ● | Sprinkler (connected to water supply) |
| ■ | Sprinkler (connected to water-filled pipe) |

# Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN ISO 9000, *Quality management systems – Fundamentals and vocabulary*

BS EN ISO 9001, *Quality management systems – Requirements*

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