

## Loss Prevention Standard

LPS 1039: Issue 5.2

Requirements and testing methods for automatic sprinklers

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## **PARTICIPATING ORGANISATIONS**

This standard was prepared by Technical Panel C of the Loss Prevention Certification Board. The following organisations participated:

Association of British Insurers	(ABI)
British Automatic Sprinkler Association	(BASA)
Confederation of British Industry	(CBI)
Local Government Association	(LGA)
Loss Prevention Council	(LPC)
Risk Engineers Data Exchange Group	(REDEG)

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Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments (see amendments table on page 41)

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

**USERS OF LOSS PREVENTION STANDARDS SHOULD ENSURE THAT THEY POSSESS THE LATEST ISSUE AND ALL AMENDMENTS**

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## FOREWORD

This standard identifies The Loss Prevention Certification Board (LPCB) evaluation and testing practices for the certification and listing of suitable products. Certification is based on the following criteria:

- i. Satisfactory product performance and construction, in accordance with the requirements of the LPCB and the manufacturer's specifications.
- ii. LPCB Certification of the manufacturer's quality management systems in accordance with ISO 9000, Quality Systems.
- iii. Satisfactory product service experience.

Products that conform to the published requirements of the LPCB, but the construction of which is considered improper, may be refused certification and listing.

## NOTES

Compliance with this LPS does not of itself confer immunity from legal obligations. Users of LPSs should ensure that they possess the latest issue and all amendments.

LPCB welcomes comments of a technical or editorial nature and these should be addressed to "the Technical Director" at [enquiries@breglobal.co.uk](mailto:enquiries@breglobal.co.uk).

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## 1. INTRODUCTION

This document specifies the design and performance requirements for fusible element and glass bulb sprinkler heads that are intended for use in Automatic Sprinkler Installations complying with the installation requirements of the LPC.

## 2. SPRINKLER TYPES

Tests are described in this document for sprinkler types commercially in use. Other types of sprinkler may be submitted for Certification which are not described below, but in that case additional and/or alternative tests may be specified.

Tests for the following types of sprinkler are covered in this Standard.

### 2.1 Sprinklers according to release mechanism

#### 2.1.1 Fusible element sprinklers

A fusible element sprinkler is opened under the influence of heat by the melting of a component.

#### 2.1.2 Glass bulb sprinklers

A glass bulb sprinkler is opened under the influence of heat by the bursting of the glass bulb through pressure resulting from expansion of the fluid enclosed therein.

### 2.2 Sprinklers according to type of water discharge

#### 2.2.1 Conventional sprinklers

The conventional sprinkler has a spherical water distribution directed towards the ground and the ceiling over a definite protection area. A conventional sprinkler shall discharge from 40 to 60% of the total water flow initially in a downward direction. Abbreviation: C.

#### 2.2.2 Spray-sprinklers

The spray-sprinkler has a paraboloid water distribution directed towards the ground over a definite protection area. A spray-sprinkler shall discharge from 80 to 100% of the total water flow in a downward direction. Abbreviation: S.

#### 2.2.3 Sidewall sprinklers

The sidewall sprinkler has a one-sided (half-paraboloid) water distribution directed towards the adjacent wall and the ground over a defined protection area. Abbreviation: W

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### 2.3 Sprinklers according to mounting position

#### 2.3.1 Upright sprinklers

Upright sprinklers are designed to give the specified distribution when the jet of water is directed upwards against the deflector. Abbreviation: U

#### 2.3.2 Pendent sprinklers

Pendent sprinklers are designed to give the specified distribution when the jet of water is directed downwards against the deflector. Abbreviation: P

#### 2.3.3 Horizontal sprinklers (sidewall only)

Horizontal sprinklers are designed to give the specified distribution when the jet of water is directed horizontally against the deflector. This applies to sidewall sprinklers only. Abbreviation: H

### 2.4 Special sprinklers

#### 2.4.1 Dry upright sprinklers

Dry upright sprinklers are installed in an upright position on special rise pipes. These pipes are kept free from water. Abbreviation: DU

#### 2.4.2 Dry pendent sprinklers

Dry pendent sprinklers are installed in a pendent position on special drop pipes. These pipes are kept free from water. Abbreviation: DP

#### 2.4.3 Flush sprinklers

Flush sprinklers are installed in a pendent position close to the ceiling, such that part of the body may be above the ceiling line, and the heat sensitive element is completely below the ceiling line. Abbreviation: F or L

#### 2.4.4 Recessed Sprinklers

Recessed sprinklers are installed in a pendent position partly or wholly above the ceiling line. The sprinkler is fitted into a recess cup, the rim of which is flush with the ceiling. Abbreviation: R

#### 2.4.5 Concealed Sprinklers

Concealed sprinklers are installed in a pendent position above the ceiling line. The concealed sprinkler incorporates a recessing cup and ceiling plate which enclose the sprinkler, such that the ceiling plate is flush with the ceiling and conceals the sprinkler. Abbreviation: K or C

#### 2.4.6 Fast Response Sprinklers

In preparation

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#### 2.4.7 Large Drop Sprinklers

In preparation

### 3. SPRINKLER ORIFICE SIZES

3.1 Sprinklers shall comply with the requirements in Table 1.

Table 1

Nominal orifice diameter (mm)	Nominal thread size (inch)
10	3/8
15	1/2
20	3/4

All automatic sprinklers shall allow a sphere of 8mm +0.010, -0.0mm diameter to pass through each waterway of the device.

3.2 Nominal thread sizes shall be suitable for fittings threaded in accordance with ISO 7/1 - 1982.

3.3 Dry and flush sprinklers may have larger thread sizes than specified in 3.1.

### 4. IDENTIFICATION

Each sprinkler, complying with the requirements of this standard shall be marked as follows:

- a. Name or trademark
- b. Model identification
- c. Manufacturer's factory identification, if a manufacturer has more than one production facility
- d. Sprinkler type and mounting position (or abbreviation) <sup>(1, 2)</sup>
- e. Nominal release temperature <sup>(3)</sup>
- f. Nominal year of manufacture <sup>(4)</sup>
- g. Cover plates of concealed sprinklers shall be marked "Do not paint".

<sup>1</sup> The deflectors of sidewall sprinklers shall show the intended direction of discharge with respect to the rear wall. An arrow or similar symbol indicating the direction of spray discharge is acceptable.

<sup>2</sup> Horizontal sidewall sprinklers shall include the word "top" on the deflector to indicate orientation.

<sup>3</sup> Sprinklers shall be marked with the nominal temperature rating in °C or colour coded on a part of the sprinkler remaining after operation.

The nominal release temperature shall be permanently marked on the fusible element assembly of the sprinkler.

The liquid in a glass bulb sprinkler shall be coloured as specified in Table 2A Section 5.



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Where the nominal release temperature is colour coded on the yoke arms of a sprinkler, the coding in Table 2B Clause 5 shall be followed.

- <sup>4</sup> The year of manufacture may include in the last 3 months of preceding year and first 6 months of the following year, and must be given in full.

## 5. NOMINAL RELEASE TEMPERATURES

### 5.1 Glass bulbs

The nominal release temperatures for glass bulbs shall be permanently coloured as indicated in Table 2A with a variability in operating temperatures within the ranges specified in Table 3, Section 7.4.

### 5.2 Fusible elements

The nominal release temperature of fusible element sprinklers shall be specified by the manufacturer and verified using the requirements in Section 7.4.

Nominal release temperatures shall fall within the ranges specified in Table 2B below.

Table 2

A		B	
Glass bulb sprinklers		Fusible element sprinklers	
Nominal release Temperature (°C)	Liquid colour code	Nominal release temperature (°C)	Yoke arm colour code
57	orange	57 to 77	uncoloured
68	red	80 to 107	white
79	yellow	121 to 149	blue
93	green	163 to 191	red
141	blue	204 to 246	green
182	mauve	260 to 302	orange
227	black	320 to 343	black
260	black		

## 6. TESTING CONDITIONS

Unless otherwise stated, all tests will be carried out in an ambient temperature of 25°C ± 10°C.

Unless otherwise stated, specimens shall be conditioned at 25°C ± 10°C for at least 24 hours before test.

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## 7. EXAMINATION AND TESTING REQUIREMENTS

### 7.1 Examination of sprinklers

Sprinklers shall be examined visually for the following points:

- a) Conformance with Section 4 (Identification)
- b) Comparison of sprinkler specimens with manufacturer's drawings and specification
- c) Conformance with Section 3 (Sprinkler orifice sizes)

### 7.2 Leak resistance test

The sprinkler shall not leak when subjected to the test described below.

Sprinklers shall be subjected to a water pressure of 30 bar  $\pm$  1.0 bar. The pressure shall be raised from 0 bar to 30 bar at an average rate of  $\leq$ 1 bar/sec. The pressure of 30 bar shall then be maintained for a period 3 mins +5, -0s and then allowed to fall to 0 bar in not less than 5 seconds. After releasing the pressure, it shall then be raised to 0.5  $\pm$  0.1 bar in not more than 5 seconds. This pressure shall be maintained for 15s +5, -0 seconds.

The pressure shall then be raised to 10 bar +0.5, -0 bar at an average rate of increase of  $\leq$ 1 bar/sec. The 10 bar pressure shall be maintained for 15s +5, -0 seconds.

### 7.3 Functional test

#### 7.3.1 Sprinklers shall operate such that the waterway is cleared when subjected to the test described below.

A sprinkler shall be installed in a test oven pressurised with water (a typical oven in shown in Fig. 2). The air temperature within the oven shall be increased until operation of the sprinkler. Sprinklers too large to be accommodated in the oven shall be operated by a suitable heat source outside the oven.

Concealed flush and recessed sprinklers shall be tested with a simulated false ceiling in the oven.

#### 7.3.2 Sprinklers shall be tested in each normal mounting position at each of the following pressures:

Standing pressure (bar)	Running pressure (bar)
a. 0.35 $\pm$ 0.05	0.15 $\pm$ 0.10
b. 3.5 $\pm$ 0.1	1.70 $\pm$ 0.70
c. 10.0 $\pm$ 0.1	6.50 $\pm$ 2.00

#### 7.3.3 Not more than an average of two glass fragments per 24 sprinklers tested from all the broken glass bulbs in the functional test may be longer than 0.9 times the clear air space between the mountings of the glass bulb.

Note: The measurement of a glass fragment includes only that part of the fragment which would normally be exposed to the clear air space between the mountings; it

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does not include the length of the fragment which normally sits within the bulb mounting.

- 7.3.4 The "lodgement" rate for each deflector pattern shall not exceed each of the following:

A ratio of 1 in 32, for all sprinklers tested at 3.5 and 10 bar for each mounting position.\*

A ratio of 1 in 16 for any one mounting position when tested at 3.5 bar and when tested at 10 bar.

A ratio of 1 in 12 for all sprinklers tested at 0.35 bar.

\*Note: It is assumed that equal numbers are tested at each pressure and mounting position.

A lodgement is considered to have occurred when a part of the release element lodges in the deflector/frame assembly for a period of more than one minute.

- 7.3.5 A delay of not more than 5s between activation of the heat-sensitive element and complete opening of the sprinkler is acceptable.

7.3.6 Functional Testing of Previously Conditioned Sprinklers

Sprinklers which have been subjected to the tests specified in Clauses 7.5, 7.6, 7.7, 7.11.2, 7.11.3, 7.11.4, 7.13 or 7.14 before being functionally tested need not conform with the lodgement rates in Clause 7.3.4, and will not be evaluated to 7.3.3.

7.4 Release temperature tests for glass bulb and fusible sprinklers

The nominal release temperature marked on the sprinkler is to be that verified when the sprinkler is tested as below.

Sprinklers or separate glass bulbs shall be heated from room temperature to 20°C ±2% below their nominal release temperature. The rate of temperature rise shall not exceed 20°C/min. The temperature reached shall be maintained for 10 minutes. The temperature shall then be raised at a constant rate of 0.55°C/min ± 0.15°C/min until the sprinkler opens or the glass bulb bursts.

The test shall be carried out in a bath of distilled water for nominal release temperatures not exceeding 80°C. Refined vegetable oil shall be used for nominal release temperatures above 80°C and less than 301°C. The liquid bath shall be so constructed that the temperature deviation within the test zone does not exceed 1°C.

Operation of glass bulb sprinklers in this test includes any form of rupture of the bulb envelope.

Note: It is important that the glass bulbs tested in accordance with the Clauses 7.4 and 7.6.2 shall be from the same batch at manufacture.

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#### 7.4.1 Fusible Element Sprinklers and Cover Plates of Concealed Sprinklers

These shall open within a temperature range of  
 $t \pm (0.035t + 0.62) ^\circ\text{C}$   
 where t is the nominal release temperature.

#### 7.4.2 Glass bulbs and Glass Bulb Sprinklers

The distribution of operating temperatures for a sample of 50 glass bulbs shall be in accordance with the requirements given in Table 3 for the appropriate temperature rating.

Glass bulb sprinklers shall open within the temperature extremes specified in columns 2 and 5 of Table 3 for the appropriate temperature rating.

Table 3

1	2	3	4	5
Nominal bulb rating ( $^\circ\text{C}$ )	Lowest temperature ( $^\circ\text{C}$ )	25 of the 50 bulbs ( $^\circ\text{C}$ )	40 of the 50 bulbs ( $^\circ\text{C}$ )	50 of the 50 bulbs ( $^\circ\text{C}$ )
57	54	63	68	74
68	65	74	79	86
79	76	87	92	99
93	90	101	106	113
141	138	149	155	163
182	179	190	196	206
227	224	235	242	252
260	257	268	275	286

#### 7.5 Heat exposure test for glass bulb sprinklers

A sprinkler when subjected to the conditioning indicated below shall remain intact and undamaged and shall operate in the subsequent functional test at a pressure of 10 bar.

The test shall be carried out as follows:-

- Heat the sprinkler in a liquid bath from room temperature to  $20^\circ\text{C} \pm 2^\circ\text{C}$  under its normal release temperature at a rate of rise of temperature not exceeding  $20^\circ\text{C}/\text{min}$ .
- The temperature shall then be raised at a rate  $< 1^\circ\text{C}/\text{min}$  to  $7^\circ\text{C} \pm 2^\circ\text{C}$  below the nominal release temperature.
- The sprinkler shall then be removed from the liquid bath and cooled in air, at room temperature, for 2 mins. During the cooling period, the point of the glass bulb (seal end) shall be pointing downwards.

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- d) The sprinkler shall then be returned to the liquid bath, which is maintained at 7°C ± 2°C below the nominal release temperature, for 10 mins +10, -0s.
- e) Repeat operation c) above.
- f) Repeat operations d) and c) two further times.

The test shall be carried out in a bath of distilled water for nominal release temperatures not exceeding 80°C. Refined vegetable oil shall be used for nominal release temperature above 80°C and less than 301°C. The liquid bath shall be so constructed that the temperature deviation within the test zone does not exceed 1°C.

The sprinkler shall then be subsequently tested in accordance with Clause 7.3 at a pressure of 10 bar.

#### 7.6 Ageing test for all sprinklers

- 7.6.1 Sprinklers shall withstand exposure to an increased ambient air temperature without evidence of weakness or failure using the following test method.

Sprinklers shall be exposed for a period of 90 days to an ambient air temperature which is 16°C below the rated operating temperature of the sprinkler, but not less than 48°C. Following the exposure, the sprinklers shall be allowed to cool for not less than two hours, and shall then be subjected to any of the tests 7.2, 7.3, 7.4 or 7.9 as required.

Concealed sprinkler cover plates shall be exposed for a period of 90 days, hung in pendent position ± 45°, to an ambient air temperature which is 16°C below the rated release temperature of the cover plate.

Following exposure, the concealed sprinkler shall be assembled and subjected to the test in Clause 7.3.

- 7.6.2 Glass bulbs shall be subjected to the increased ambient air temperature.

Fifty glass bulbs, from the same manufacturing batch as those tested under Clause 7.4 shall be subjected to 90 day ageing as specified in Clause 7.6.1. Following exposure and cooling the loose glass bulbs shall be tested to determine their operating temperature distribution as specified in Clause 7.4, and meet the requirements of 7.4.2.

#### 7.7 Thermal shock for glass bulb sprinklers

Glass bulb sprinklers shall remain intact and undamaged during thermal conditioning and shall operate in the subsequent functional test at a pressure of 10 bar.

The following procedure shall be carried out.

The glass bulb sprinklers shall be submerged in a liquid bath the temperature of which shall be 10°C ± 2°C below the nominal release temperature of sprinklers. After 10 mins the sprinklers shall be taken out of the heated liquid bath, and with the bulb seal downwards, submerged in a water bath, maintained at a temperature of 10°C ± 1°C, for 10s to 15s. The sprinklers shall then be stabilised at room temperature before being tested in accordance with Clause 7.3 at a pressure of 10 bar.

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## 7.8 Strength of release element

- 7.8.1 The average strength of the bulb release element shall be at least 6 times the average service load of the sprinkler when tested by the method described below.

Bulbs shall be subjected to an increasing force applied at a rate of  $250 \pm 10$  N/s until fracture. The method of mounting of the bulb in the sprinkler shall be utilised when mounting the bulb in the test rig. If necessary the bulb mountings may be reinforced externally to prevent collapse.

- 7.8.2 A fusible heat-responsive element shall comply with either Clause 7.8.2.1 or Clause 7.8.2.2.

7.8.2.1 Fusible heat-responsive elements shall be designed to sustain a load of 15 times its design load corresponding to a maximum service load as determined in Clause 7.9 or that stated by the manufacturer, whichever is the greater, for a period of 100 hours.

7.8.2.2 Fusible heat-responsive elements shall be designed to sustain the design load when tested in accordance with the method.

Sample heat-responsive elements shall be subjected to loads in excess of the design load corresponding to  $L_d$ , the maximum service load, as determined in Section 7.9, which will produce failure at times up to or greater than 1000 hours. At least 10 specimens shall be loaded at different values up to 15 times the design load. A "least squares" full logarithmic regression curve is to be determined from which  $L_o$ , the load at one hour, and  $L_m$ , the load at 1000 hours, are to be calculated. The following condition shall be satisfied:

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

The test samples are to be loaded at a conditioned temperature of  $20 \pm 3^\circ\text{C}$ .

## 7.9 Service load measurement

The service load shall be measured by securely installing the sprinkler at a stable room temperature in a test rig and applying a hydraulic pressure of 12 bar at the inlet. A linear gauge shall be attached to the test machine and a reading shall be taken at the deflector end of the sprinkler frame whilst under the hydraulic pressure.

The hydraulic pressure shall then be released and the heat responsive element of the sprinkler shall be removed. A second reading of the linear gauge shall be taken. A mechanical load shall then be applied to the sprinkler, progressively increasing at a rate not exceeding 1500 N/min until the linear gauge reading at the sprinkler deflector returns to the initial value achieved under hydrostatic load. The mechanical load necessary to achieve this shall be recorded as the service load.

Other methods of measuring the service load may be used if the method described above is not suitable.

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#### 7.10 Strength of frame

The sprinkler frame shall not develop a permanent elongation of more than 0.2% of the distance between the load bearing points, when subjected to twice the service load as determined by the test specified in Clause 7.9.

The load shall be increased progressively at a rate not exceeding 1500 N/min, until twice the service load has been applied. This loading shall be maintained for 10 to 15s. The load shall then be removed and any permanent elongation of the deflector and of the sprinkler frame shall be recorded.

#### 7.11 Corrosion tests

##### 7.11.1 Stress corrosion tests

Sprinklers shall meet the requirements of either the mercurous nitrate or aqueous ammonia stress corrosion tests described in 7.11.1.1 and 7.11.1.2 below. The sprinkler manufacturer may nominate the test to be performed.

##### 7.11.1.1 Mercurous nitrate stress corrosion test

As a result of the test described below copper alloy components used in the construction of sprinklers shall not crack. The specimen for test shall be degreased and then immersed in a solution of 50% distilled water and 50% concentrated nitric acid (s.g.l.42) for between 21 and 24 seconds. The specimen shall then be rinsed in cold water and immersed in a 1 per cent by weight solution of mercurous nitrate in distilled water, to which 1 per cent by volume of concentrate nitric acid (sp. s.g.l.42) has been added. The specimen shall remain in the solution for 30 mins +30, -0 seconds and then be removed, rinsed well in cold water and carefully wiped. The specimen shall be inspected within 5 minutes using a binocular microscope with X10 magnification for signs of cracking. Test specimens shall not be laboratory identified by indenting.

Cover plates, recess cups and escutcheons of concealed recessed and flush sprinklers need not meet the requirements of this test.

Note: Mercurous Nitrate is toxic and should be used with care. Specimens should not be handled with bare hands once contaminated.

##### 7.11.1.2 Aqueous ammonia stress corrosion test

Sprinkler heads shall be subjected to the requirements specified in EN 12259-1 Clause 4.12.1.

##### 7.11.2 Sulphur dioxide corrosion test

Sprinklers shall remain structurally intact and shall operate at 0.35 bar following SO<sub>2</sub> conditioning according to the requirements below. Sprinklers with protective coatings shall be prepared in accordance with Clause 7.11.2.1.

The test equipment shall consist of a 10 litre vessel\* made of heat-resistant glass, with a corrosion-resistant lid of such a shape as to prevent condensation dripping on the sprinklers. The vessel shall be electrically heated through the base, and provided with a cooling coil around the side walls. A thermostat placed 45 ± 5 mm above the bottom of the vessel, shall regulate the heating so that the temperature inside the glass vessel is 45 ± 3°C.

\*Other sizes of vessel may be used with proportionate quantities of chemicals.

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During operation when the heating is switched on, water shall flow through the cooling coil at sufficient rate to keep the discharge temperature below 30°C. This combination of heating and cooling should encourage condensation on the surfaces of the sprinklers.

The sprinklers to be tested shall be suspended in their normal mounting position under the lid inside the vessel and subjected to a corrosive sulphur dioxide atmosphere for 16 days. The corrosive atmosphere shall be obtained by introducing a solution made up by dissolving 40g of sodium thiosulphate crystals in 1 litre of water.

The test shall last two periods of 8 days. Each day 40ml of dilute sulphuric acid consisting of 156ml of normal H<sub>2</sub>SO<sub>4</sub> per litre of water shall be added at a constant rate. After 8 days the sprinklers shall be removed from the container, and the container emptied and cleaned. The procedure described above shall then be repeated for the second period of 8 days. After 16 days the sprinklers shall be removed from the container and allowed to dry for 24 hours at a temperature not exceeding 35°C with a relative humidity not greater than 70%, before being functionally tested to 7.3 at 0.35 bar.

Note: For concealed heads, they shall be positioned to prevent collection of moisture on the plate.

#### 7.11.2.1 Corrosion-resistant sprinklers

Sprinklers that are designed and manufactured for corrosive environments shall be prepared for the corrosion test by screwing the sprinkler in and out of the standard pipe connection threaded in accordance with ISO 7/1:1982 using a purpose made sprinkler spanner. After the corrosion test, the sprinklers shall be examined for corrosion and detachment of the coatings, and tested in accordance with Clause 7.3 at a pressure of 0.35 bar. The corrosion resistant coating shall remain intact.

Note: This test should not be expected to determine a suitable degree of corrosion resistance for all environments. Special requirements may be necessary in some instances.

#### 7.11.3 Salt mist corrosion test

Sprinklers shall remain structurally intact and shall operate at 0.35 bar following salt mist conditioning according to the requirements below. Sprinklers with protective coatings shall be prepared in accordance with Clause 7.11.2.1.

Sprinklers shall be subjected to the salt mist test described in BS 2011: Part 2.1Kb:1987, Severity 1. The sprinklers shall then be examined, and tested in accordance with Clause 7.3 at a pressure of 0.35 bar.

#### 7.12 Sprinkler coating tests

Sprinkler coatings shall maintain their integrity when subjected to elevated temperatures and shall not age unduly. The coatings shall be tested as specified below.



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#### 7.12.1 Wax and bitumen evaporation test

Waxes and bitumen for coating sprinklers shall not lose more than 5% of the weight of the original sample, when tested as below.

A 50ml  $\pm$  5ml sample of wax or bitumen shall be placed in a metal or glass cylindrical container having an open top, a flat bottom, an inside diameter of 55mm  $\pm$  1mm and an inside height of 35mm  $\pm$  1mm.

The sample shall be subjected to a temperature of 16°C below the nominal release temperature of the sprinkler to which it is intended to be applied but not less than 50°C for a period of 90 days.

The test sample shall be weighed before and after the 90 days' exposure to determine loss of weight.

#### 7.12.2 Coating low temperature test

All coatings used for sprinklers must be capable of resisting cracking or flaking when coated sprinklers are subjected to low temperatures.

Sprinklers coated by normal production methods, whether by wax, bitumen or by metallic plating etc shall be conditioned at a temperature of -10°C  $\pm$  3°C for a period of 24 hours. On removal from the low temperature they are to be allowed to stabilise at room temperature for 24 hours before examination of the coating for flaking, cracking and detachment.

#### 7.12.3 Coating high temperature test

Coated sprinklers shall be conditioned at a temperature of 30°C below the rated operating temperature of the sprinklers for a period of 90 days.

On removal from the high temperature the sprinklers are to be allowed to stabilise at room temperature for 24 hours before examination of the coating for flaking, cracking and detachment.

#### 7.13 Water immersion test

Sprinklers with ferrous parts shall pass the following test. Before the test, sprinklers shall be degreased. Sprinklers shall be partially immersed in tap water for 60 days, such that the water/air interface occurs at the ferrous part(s). After the test the sprinkler shall be examined for corrosion, and tested in accordance with Clause 7.3 at a pressure of 0.35 bar. No corrosion of the ferrous parts is permissible.

#### 7.14 Resistance to vibration

Assembled sprinklers shall be able to withstand the effects of vibration that they may sustain in service, without deterioration.

A sprinkler shall be mounted in its normal operating position and secured by its normal fixings. The sprinkler shall be subjected to sinusoidal vibrations in a vertical direction. The frequency of vibration shall be swept from 5Hz to 60Hz at a rate of 1.8 octaves/h  $\pm$  0.2 octaves/h. A single such sweep shall be made.

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The maximum acceleration ( $\text{ms}^{-2}$ ) of the sprinkler at its point of installation shall be

$$0.7 \times \sqrt{(f \pm 10\%)}$$

where f is the instantaneous frequency in Hz. The test shall be repeated in the two other rectilinear planes.

The sprinklers shall then be tested in accordance with Section 7.2, leak resistance test, followed by Clause 7.3, functional test at 0.35 bar.

#### 7.15 Heat resistance test

A sprinkler in its operated condition shall not show deformation or breakage when submitted to the heat resistance test.

An open sprinkler shall be heated in a furnace having a temperature of 800°C for a period of 15 minutes while standing on its threaded inlet. After this the sprinklers shall be removed by holding the thread inlet portion and shall be submerged in a water bath having a temperature of 20°C ± 10°C.

Shrouds around concealed and recessed sprinklers and rosettes of flush sprinklers do not require testing if made of metal or thermosetting plastic.

#### 7.16 Resistance to applied forces

In preparation

#### 7.17 Deflector Strength

17.7.1 Sprinkler deflectors shall be capable of withstanding a force of 190N without permanent deformation. The force shall be applied at a rate of <30N/s by means of a rigid flat metal edge and where possible shall form a line contact at least 15mm long with the deflector.

Distortion of a tine or tines, by a force of less than 190N applied at any point or direction, is acceptable providing the distortion does not impair the release of the sprinkler operating mechanism, and the distribution test requirements specified in Section 7.19 are satisfied.

#### 17.7.2 Component attachment test

There shall be no deterioration of the sprinkler performance after a continuous water flow through the open sprinkler at a supply pressure of 10 bar ± 1 bar, for 90 mins +5, -0 minutes. Sprinklers with detached components shall be capable of satisfying the distribution tests specified in Clause 7.19 after the test.

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### 7.18 Water flow test

Ambient test conditions  $20^{\circ}\text{C} \pm 15^{\circ}\text{C}$  the water flow (Q) of the sprinkler is calculated by the formula

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

where Q is expressed in  $\text{dm}^3/\text{min}$  and P is expressed in bar. The K-factor is a flow constant.

Sprinkler K-factors shall have the following values as specified in Table 4.

Table 4

Designated nominal orifice diameter (mm)	K	K for dry sprinklers
10	$57 \pm 3$	$57 \pm 5$
15	$80 \pm 4$	$80 \pm 6$
20	$115 \pm 6$	$115 \pm 9$

The sprinkler, minus deflector and yoke arms, (with dry drop or rise if appropriate) shall be mounted, together with a pressure gauge, on a supply pipe (see Fig.1). The water flow shall be measured at pressures between 0.5 bar and 6.5 bar at intervals of 1 bar. Two sets of measurements shall be taken, with pressures increasing from zero and with pressures reducing from above 6.5 bar. An average value of the K-factor shall be calculated from each set of readings, i.e. rising pressure and falling pressure. In each case the K-factor shall conform to the values specified in Table 4.

Pressures are to be corrected for differences in height between the gauge and sprinkler outlet orifice.

### 7.19 Water distribution tests

#### 7.19.1 Conventional, spray and dry sprinklers

Ambient conditions  $20^{\circ}\text{C} \pm 15^{\circ}\text{C}$ .

Distribution tests shall be carried out using square arrays of 4 sprinklers as detailed below.

The number of low content containers shall not exceed that stipulated in column 6 of Table 5. A low content container is one having less than 50% of the actual water coverage.

In a test room having a size of  $7.5\text{m} \pm 0.5\text{m}$  and a height of  $3.2\text{m} \pm 25\text{mm}$ , 4 sprinklers of the same type shall be installed, arranged in a square array, on piping constructed for this purpose. The arrangement of the piping and measuring containers is shown in figures 3 to 6. The yoke arms of the sprinklers shall be in line with the range pipes. The distance between the ceiling and the centre of the range pipe shall be  $165\text{mm} \pm 20\text{mm}$ . Flush, concealed and recessed sprinklers shall be mounted in a simulated false ceiling.

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The size of the protected area and the density of coverage for each of the three nominal sizes of sprinkler are specified in Table 5.

Table 5

1 Designated nominal orifice diameter (mm)	2 Water coverage  (mm/min)	3 Nominal flow rate per sprinkler (dm <sup>3</sup> /min)	4 Nominal protected area  (m <sup>2</sup> )	5 Sprinkler spacing  (m)	6 Allowable low content containers
10	2.5	50.6	20.25	4.5	8
15	5.0	61.3	12.25	3.5	5
	15.0	135.0	9	3	4
20	10.0	90.0	9	3	4
	30.0	187.5	6.25	2.5	3

The water distribution shall be collected in square containers of side measuring 0.5m ± 10mm. The distance between the ceiling and the upper edge of the containers shall be 2.7m ± 25mm. The containers shall be positioned centrally in the room under the 4 sprinklers.

#### 7.19.2 Sidewall sprinklers (15mm)

The sprinkler shall be considered to have a satisfactory distribution if not more than 10 per cent of the bounded area receives less than 1.125mm/min. In addition, wetting of the adjacent and opposite walls shall be achieved to a height of 1m below the level of the sprinkler deflector.

The tests shall be made in a room measuring 3.75m x 7.0m x 3.21m high. One sprinkler shall be mounted in an appropriate position on a distribution pipe passing through one wall so that the sprinkler centre line is situated 50mm from that wall and at a distance of 1.8m from an adjacent wall. For an upright sprinkler the deflector shall be 100 ± mm below the ceiling and for a pendent sprinkler 150 ± mm below the ceiling (see Figures 7 and 8). Water shall be collected in cans having square open tops measuring 0.5m x 0.5m arranged in the form of a 3m x 5m array with its edges 1m from the adjacent wall and 10mm from the sprinkler mounting wall.

With the sprinkler discharging at 60dm<sup>3</sup>/min the discharge density into each collecting can shall be determined and the height of the boundary between the wetted and unwetted parts of the absorbent strip shall be measured.

The distribution of water and wall wetting in an area bounded by two sprinklers 3.7m apart is derived by overlapping two identical wall wetting profiles and distributions obtained from one test using a single sprinkler.

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7.19.3 Water distribution above and below the deflector.  
(Sidewall sprinklers will not be subjected to this test).

The water discharge of sprinklers downwards from the deflectors shall be

- \* Conventional sprinklers 40 to 60%
- Spray sprinklers 80 to 100%

Sprinklers shall be installed horizontally in a testing rig, the important features of which are shown in Figure 9.

The deflector is positioned within the apparatus such that a theoretical dividing line between the two collecting volumes intersects a point on the axis of the sprinkler where the water spray is travelling substantially parallel to the plane of the partition.

\*Note: The results shall be given assuming that the conventional sprinkler is mounted in the upright position.

Sprinklers shall be tested in the following flow conditions

Table 6

Designated nominal orifice diameter (mm)	Sprinkler water flow rate (dm <sup>3</sup> / min)
10	50
15	60
20	90

7.20 Response test for ceiling flush, recessed and concealed sprinklers

7.20.1 Sprinklers shall operate within the times specified in section 7.20.3 when tested in accordance with Clause 7.20.2

7.20.2 The sprinkler to be tested shall be installed in a ceiling panel in the centre of a closed room with floor dimensions of 4.57m ± 0.1m x 4.57m ± 0.1m and ceiling height of 2.4m ± 0.1m, as shown in Fig.10. The heat source shall consist of a propane gas pot burner, positioned in a corner with its centre 450mm ± 25mm from two adjacent walls and its top surface 560mm ± 25mm above the floor. Adequate ventilation shall be provided for the burner.

The room temperature shall be monitored 180mm from the centre of the room and 30mm ± 2mm below the ceiling. For the duration of the test the room temperature at the measuring point shall conform to the time/temperature curve in Fig. 11. The temperature shall also be monitored 5mm ± 1mm below the ceiling.

At the start of the test the room shall have been preconditioned to 30°C ± 5°C with a ceiling structure temperature of between 25°C and 40°C, and the specimens shall have been preconditioned to 20°C ± 5°C for at least 24 hours. The specimen shall be installed, the burner ignited, and the time of operation recorded. For concealed sprinklers, the time for detachment of the cover plate shall also be recorded.

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7.20.3 The statistical limit in seconds is calculated using the expression:

$$\bar{\chi} + 3.47 \sqrt{s} n$$

where:  $\bar{\chi}$  is the arithmetic mean response time of specimens tested

$\sqrt{s} n$  = standard deviation for specimens tested.

3.47 = constant, used where 10 specimens are tested.

The following requirements shall be met:-

Sprinkler nominal temperature rating (°C)	Statistical limit of operating times (seconds)
≤78	170
≤79	212
80 - 100	285

#### 7.21 Temperature cycling test

For dry pendent and dry upright sprinklers

In preparation.

## 8. **REQUIREMENTS AND TESTING METHODS FOR THE DETERMINATION OF AUTOMATIC SPRINKLER SENSITIVITY**

### 8.1 Introduction

This standard details the testing requirements to determine the thermal sensitivity of automatic sprinkler heads. Two different techniques are used; namely the plunge test and rate of rise test. The plunge test is used for two reasons:

- It efficiently determines the variations in sensitivity due to orientation.
- It provides a sensitivity performance record to enable efficient quality assurance and follow up testing.

The rate of rise test is used to determine the sensitivity performance characteristic of sprinklers to determine their suitability for use in applications specifying particular performance criteria.

This standard should be used in conjunction with LPS 1039 when evaluating for recognition.

### 8.2 Scope

This standard specifies the thermal sensitivity requirements for automatic sprinklers having an external primary heat sensitive element which will normally be positioned not closer than 5mm to any mounting surface. This standard does not define test

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methods for determining the sensitivity of ceiling flush, recessed or concealed sprinkler types.

### 8.3 Testing requirements

Sprinklers shall operate satisfactorily and the time of operation shall be measured and recorded when tested using the "plunge test" and "rate of rise" test.

Sprinklers having an  $RTI_p$  (metric) of less than 100 when measured in the fastest orientation in accordance with the requirement of Clause 8.3.1 shall be classified as "fast response" sprinklers.

#### 8.3.1 Plunge test

8.3.1.1 Sprinkler samples of each temperature rating shall be tested. Each sprinkler shall be mounted in a test jig (see Fig 12) and shall be stabilised at  $30^{\circ}\text{C} \pm 2^{\circ}\text{C}$ .

8.3.1.2 The jig mounted sprinklers shall be inserted in a wind tunnel with an airflow at a constant temperature and velocity, to determine the times to operate from insertion. The tunnel conditions at the test section shall be in accordance with Table 6.

(A supervisory air pressure of not less than 0.35 bar shall be applied at the sprinkler inlet.)

8.3.1.3 Sprinklers shall be tested with the waterway axis perpendicular to the airflow, in the orientations detailed below:

Sprinklers symmetrical about the waterway axis shall be tested with:

- a) Frame arms normal to the airflow (such that the thermal element is fully exposed to the airflow) (see Fig 13a).
- b) Frame arms in line with the airflow (see Fig 13b).

Sprinklers which are asymmetric about the waterway axis shall be additionally tested with:

- c) Frame arms rotated  $180^{\circ}$  about the waterway axis from position a).
- d) The centre of the heat collector directly downstream of a frame arm.

8.3.1.4 The following numbers of sprinklers shall be tested for each rating and orientation:-

- i) Fusible element sprinklers - 2
- ii) Glass bulb sprinklers - 3

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### 8.3.2 Rate of rise test

8.3.2.1 Sprinkler specimens shall be suitably mounted in a test jig. At the start of each test the test jig and sprinkler shall be inserted in the tunnel test section and shall be stabilised at a temperature of  $30^{\circ}\text{C} \pm 2^{\circ}\text{C}$  before commencement of the heating rate of rise cycle.

8.3.2.2 Sprinklers shall be tested in the following appropriate positions and orientations in relation to the wind tunnel test section.

a) All sprinkler types

Sprinklers shall be tested with the waterway axis perpendicular to the airflow in the orientation which resulted in the longest mean time to operate when tested in accordance with 8.3.1.3 a), b), c), or d).

b) Sprinklers for in-rack use

i) Pendent spray and conventional sprinkler types shall be tested with the waterway axis parallel to the airflow direction with the sprinkler waterway inlet down-stream relative to the airflow (see Fig 13c).

ii) Upright spray and conventional sprinklers shall be tested with the waterway axis parallel to the airflow direction with the waterway inlet upstream relative to the airflow (see Fig 13d).

8.3.2.3 Prior to the start of the test the sprinkler pipework shall be fitted with a specified volume of water above the sprinkler inlet.

8.3.2.4 Sprinkler specimens of each rating shall be tested in the wind tunnel in the appropriate positions and orientations described at Clause 8.3.2.2 and shall be subjected to a steadily increasing airstream temperature at a constant mass flow. Tests shall be undertaken at the following rates of temperature rise:

- a)  $2^{\circ}\text{C}/\text{min}$
- b)  $12^{\circ}\text{C}/\text{min}$
- c)  $20^{\circ}\text{C}/\text{min}$

The sprinkler operating time shall be measured from initiation of the rate of rise, starting at a stable condition of  $30^{\circ}\text{C}$ .

8.3.2.5 The following numbers of sprinklers shall be tested for each temperature rating, position and rate of rise.

- i) Fusible element sprinklers - 2
- ii) Glass bulb sprinklers - 3

## 8.4 Analysis of test results

### 8.4.1 Plunge test results analysis

8.4.1.1 The arithmetic mean time to operate for each sprinkler rating at each orientation shall be determined.



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8.4.1.2 The time constant for each sprinkler rating at any orientation may be determined by the formula:

$$\Upsilon_p = -t_r / \ln(1 - \Delta Y_i / \Delta Y_g)$$

where:

- $\Upsilon_p$  = Time constant
- $t_r$  = Time to operate
- $\Delta Y_i$  = Sprinkler nominal rating - starting temperature
- $\Delta Y_g$  = Tunnel temperature - starting temperature

8.4.1.3 The  $RTI_p$  shall then be determined by the formula

$$RTI_p = \Upsilon_p V^{1/2}$$

where:  $V$  = airstream velocity in test section.

#### 8.4.2 Rate of rise test analysis

The time constant ( $\Upsilon$ ) and the effective operating temperature shall be determined for each sprinkler orientation and temperature rating. The values may be determined graphically by plotting tunnel air temperature at operation ( $\theta_g$ ) against rate of rise ( $\beta$ ).

A graphical plot of  $\theta_g$  against  $\beta$  will describe a line with a slope equal to the time constant  $\Upsilon$  having an intercept at the  $\theta_g$  axis (at  $\beta=0$ ) equal to the effective operating temperature  $\theta_e$  for the sprinkler rating and orientation.

Figure 14 Graphical method for determining time constant ( $\Upsilon$ ) and effective operating temperature  $\theta_e$ .

### 8.5 Test apparatus

#### 8.5.1 Plunge test

A wind tunnel with approximate test section dimensions of 240mm width x 150mm depth, shall be capable of developing the conditions at the test section in accordance with Table 6.

#### 8.5.2 Rate of rise test

A wind tunnel with approximate test section dimensions of 240mm width x 150mm depth shall be capable of developing the conditions at the test section in accordance with Table 7.

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Table 6 Plunge Test Tunnel Conditions

Sprinkler nominal temperature rating (°C)	Tunnel temperature at test section <sup>1</sup> (°C)	Airstream velocity at test section <sup>2</sup> (m/s)
57 to 107	197 ± 5	2.5 ± 0.2
121 to 149	291 ± 7	2.5 ± 0.2

<sup>1</sup> Monitored at the inlet to the working section using a sheathed type K (Cr/Al) thermocouple 0.5mm O.D.

<sup>2</sup> Measured at the working section using a pitostatic tube connected to a micro manometer calibrated for measuring velocity at airstream temperatures up to 800°C. Checked between runs using a vane anemometer in the open end of the tunnel.

Table 7 Rate of Rise Test Tunnel Conditions

Start temperature (°C)	Rate of temperature rise (°C/min)	Maximum temperature (°C)	Temperature variation from ideal ramp (°C)	Airstream velocity in test section at 25°C (m/s)
30 ± 2	2	250	±3	1.0 ± 0.1
30 ± 2	12	250	±3	1.0 ± 0.1
30 ± 2	20	250	±3	1.0 ± 0.1

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FIGURES

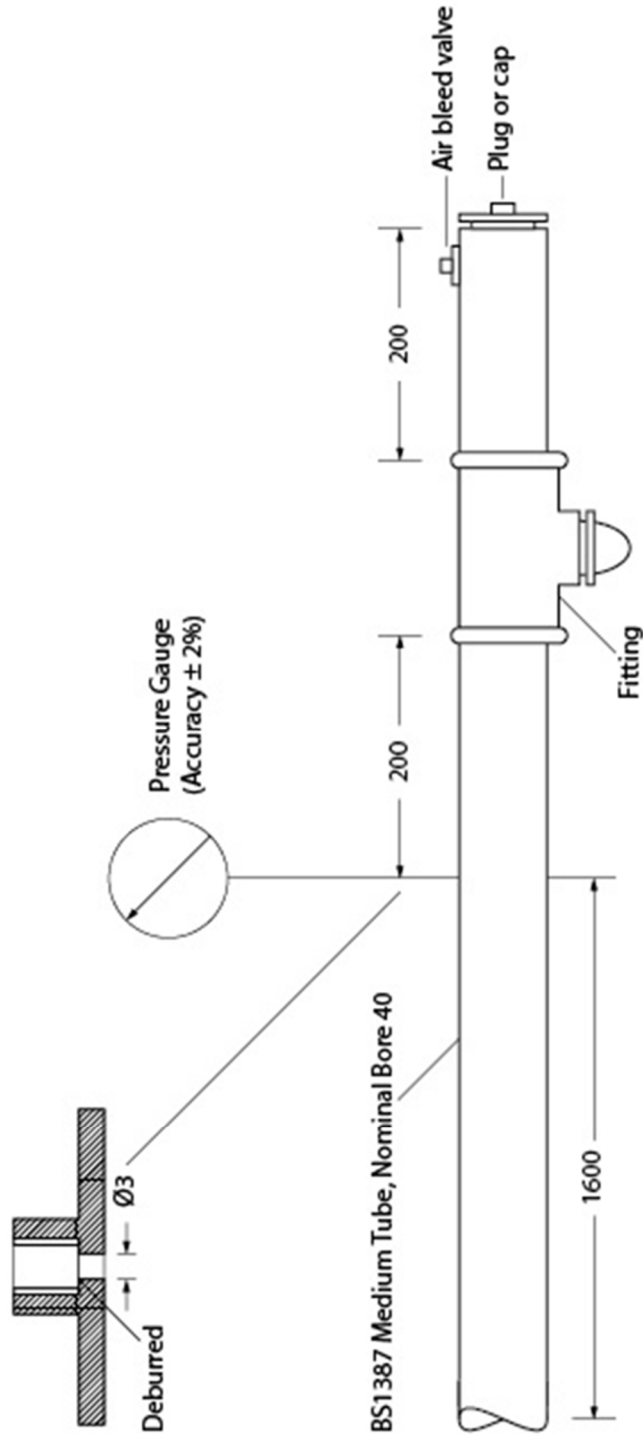
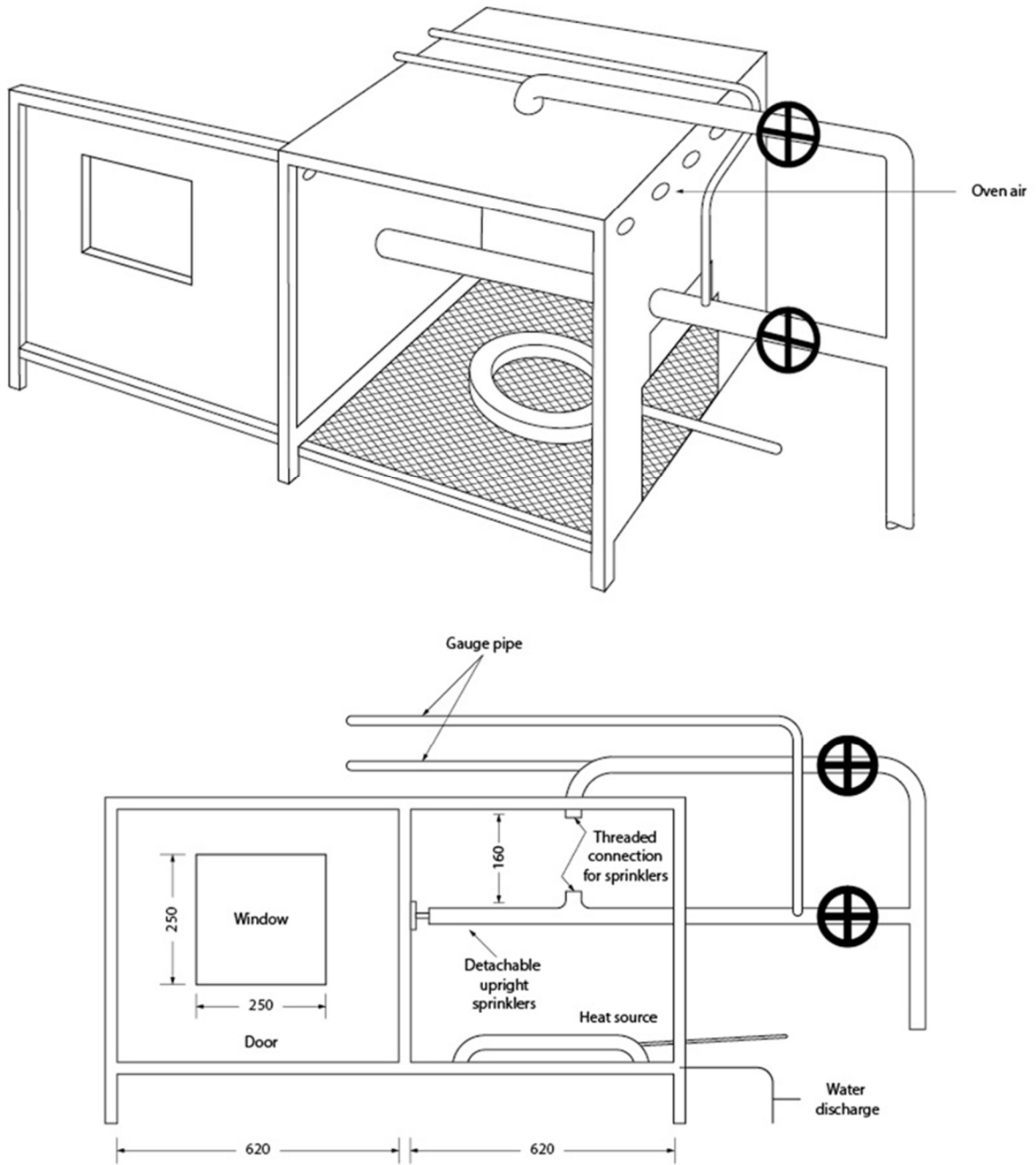


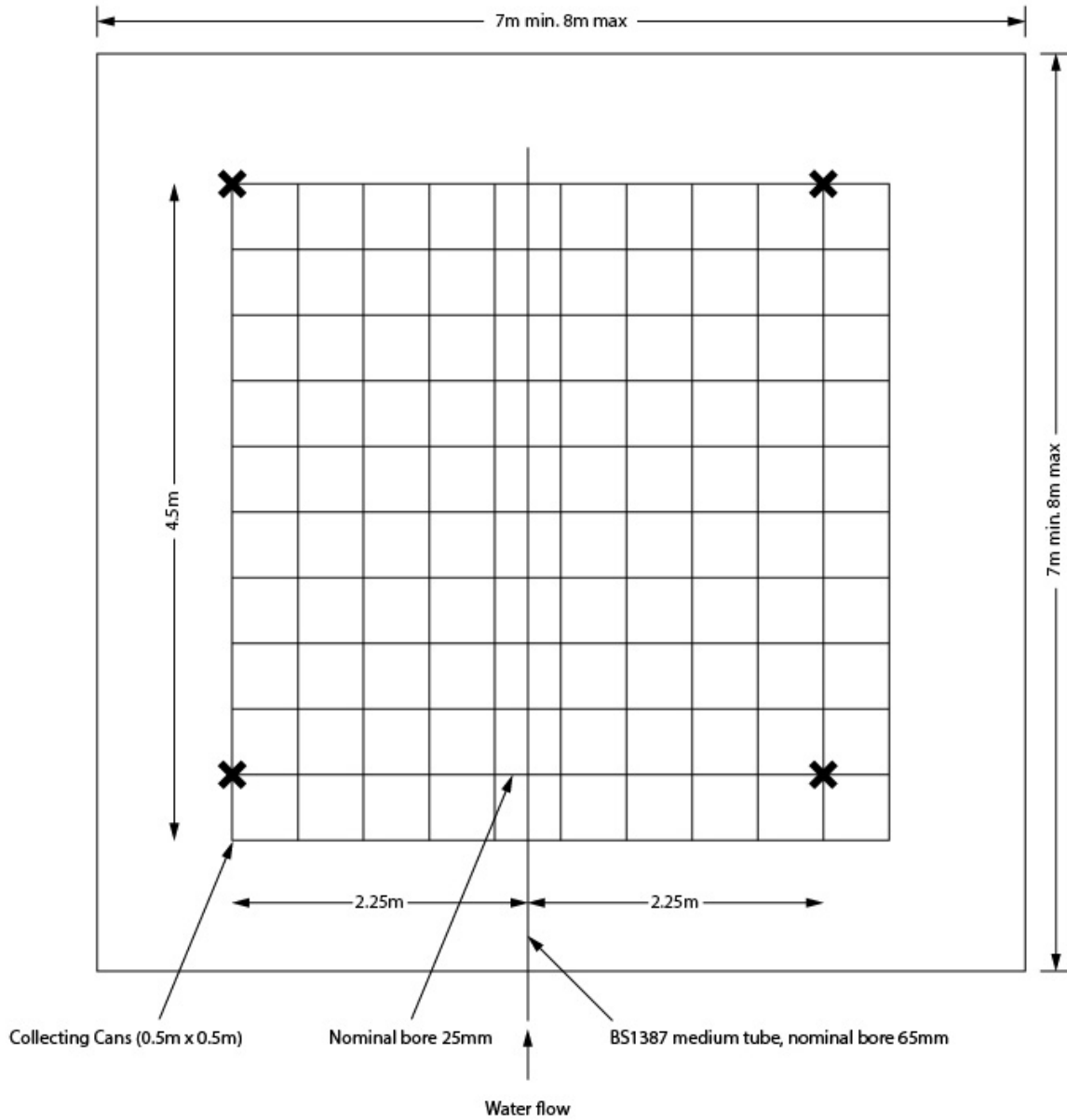
Figure 1: Test Apparatus for the Water Flow

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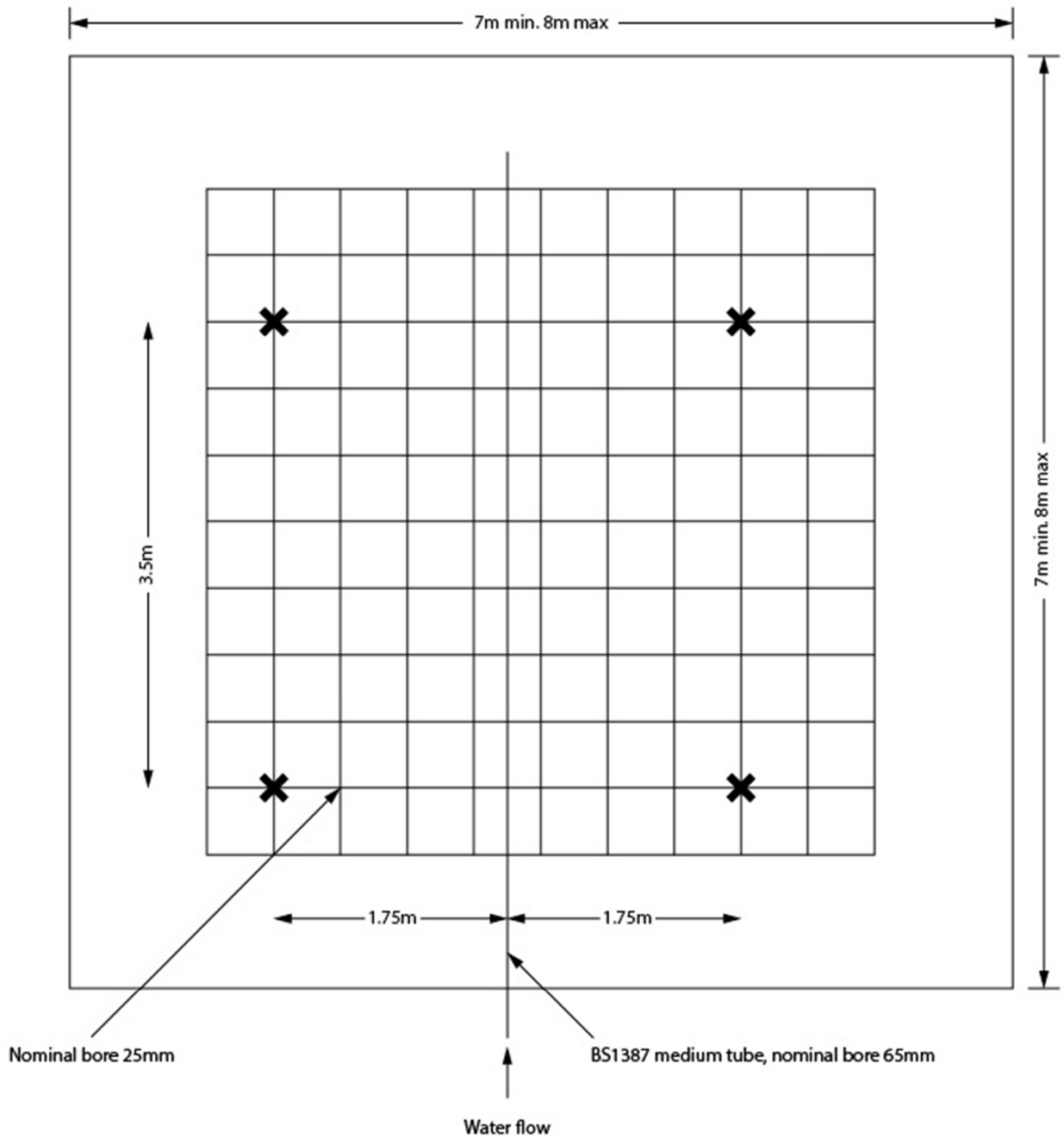
**Figure 2: Functional Test (test oven)**  
 Note: Given dimensions are typical

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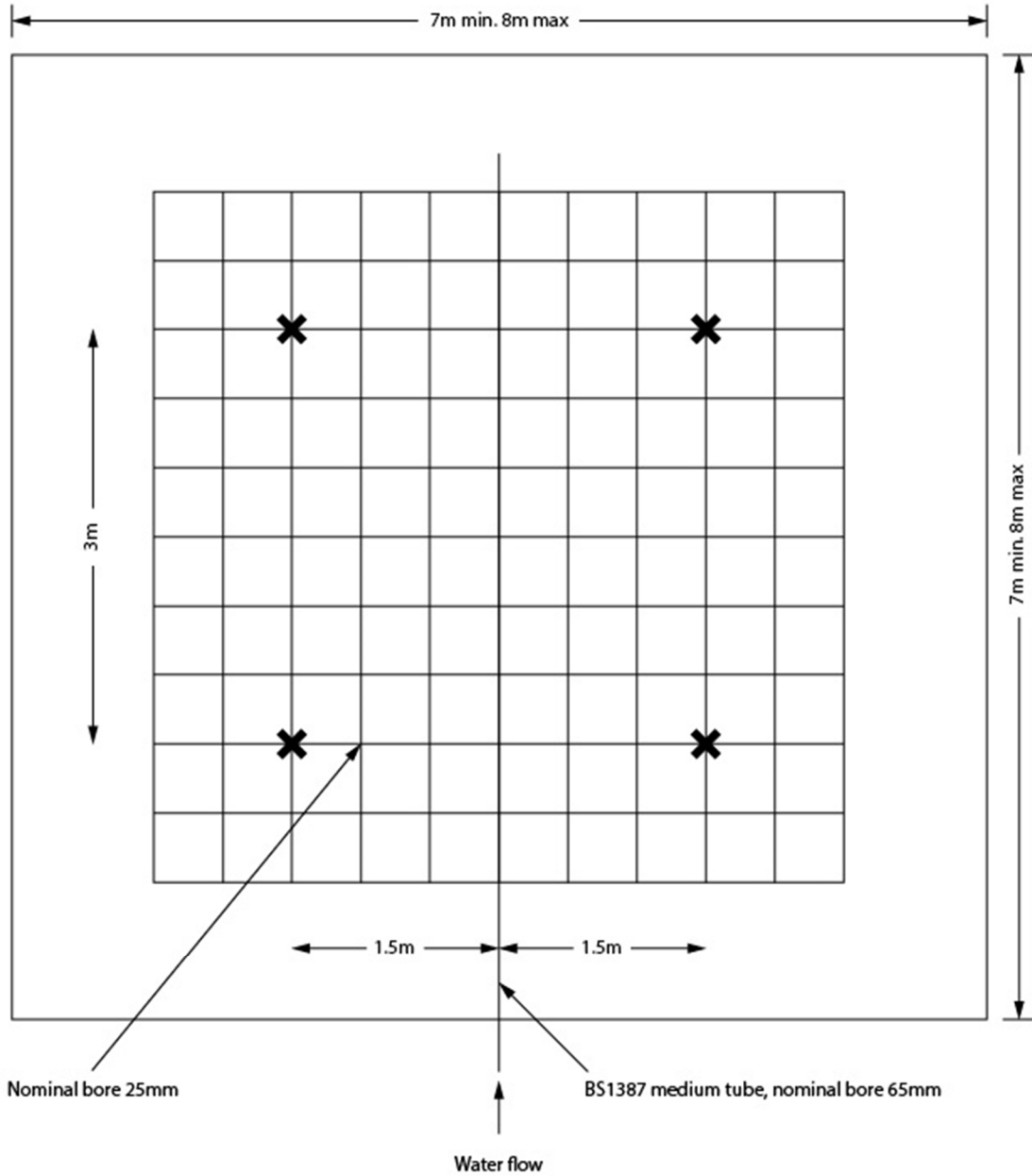
**Figure 3: Layout of distribution collection room**  
Measured area: 20.25m<sup>2</sup>

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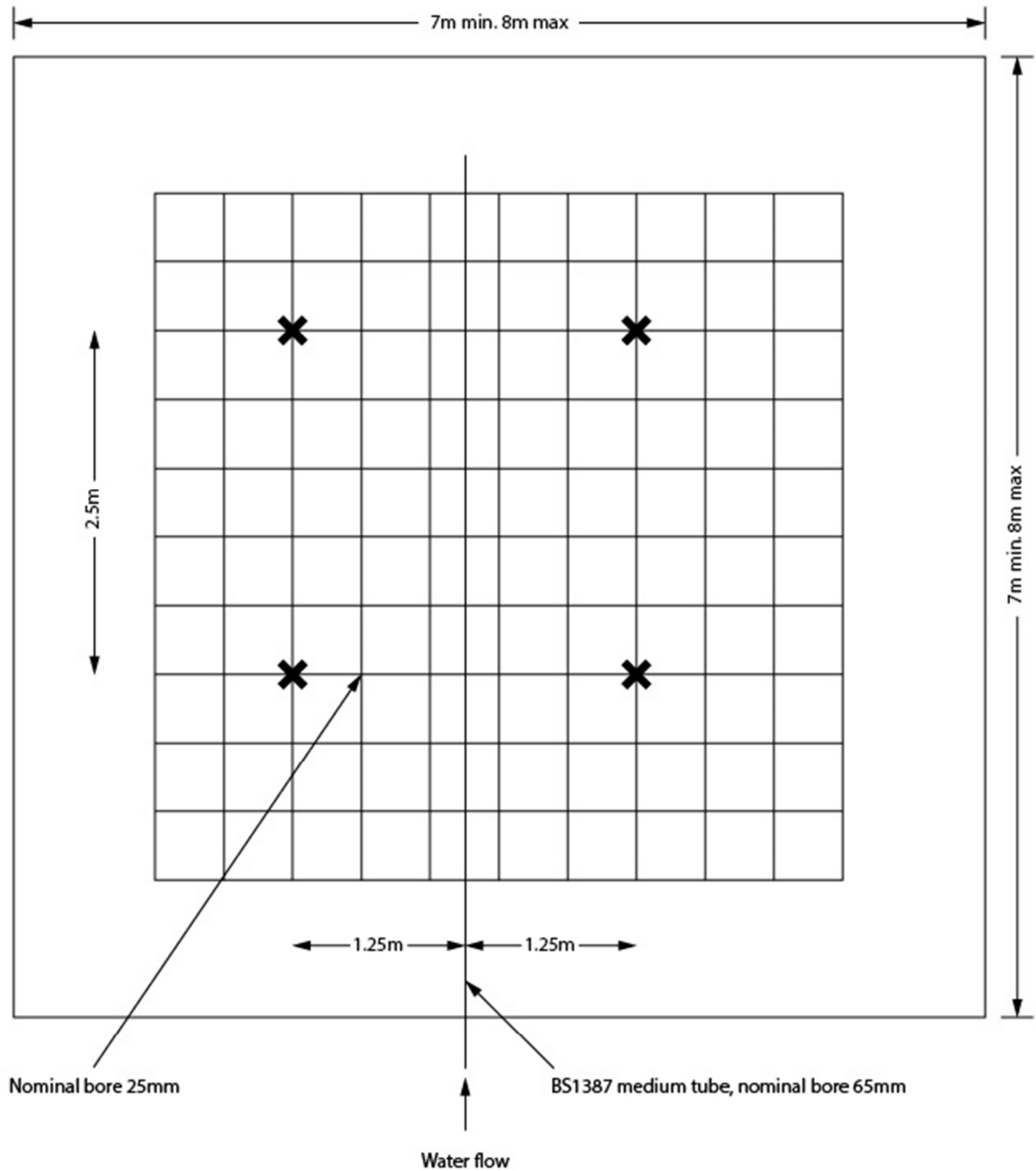
**Figure 4: Layout of water distribution collection room**  
Measured area: 12.25m<sup>2</sup>

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**Figure 5: Layout of water distribution collection room**  
Measured area: 9m<sup>2</sup>

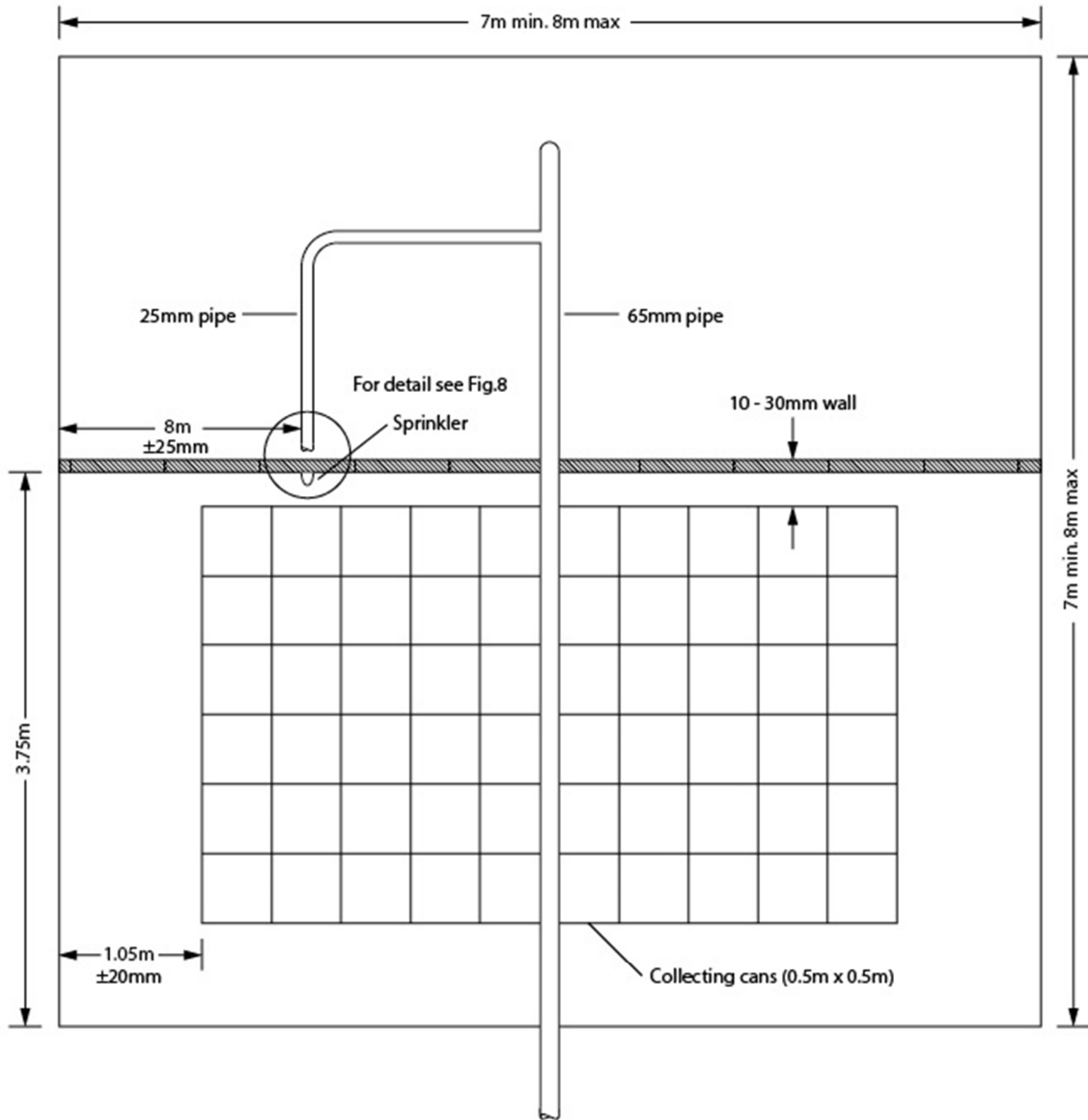
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**Figure 6: Layout of water distribution collection room**  
Measured area: 6.25m<sup>2</sup>



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**Figure 7: Sprinkler distribution room - sidewall**  
 Note: Pipe sizes indicated are nominal to ISO 55 (medium series)

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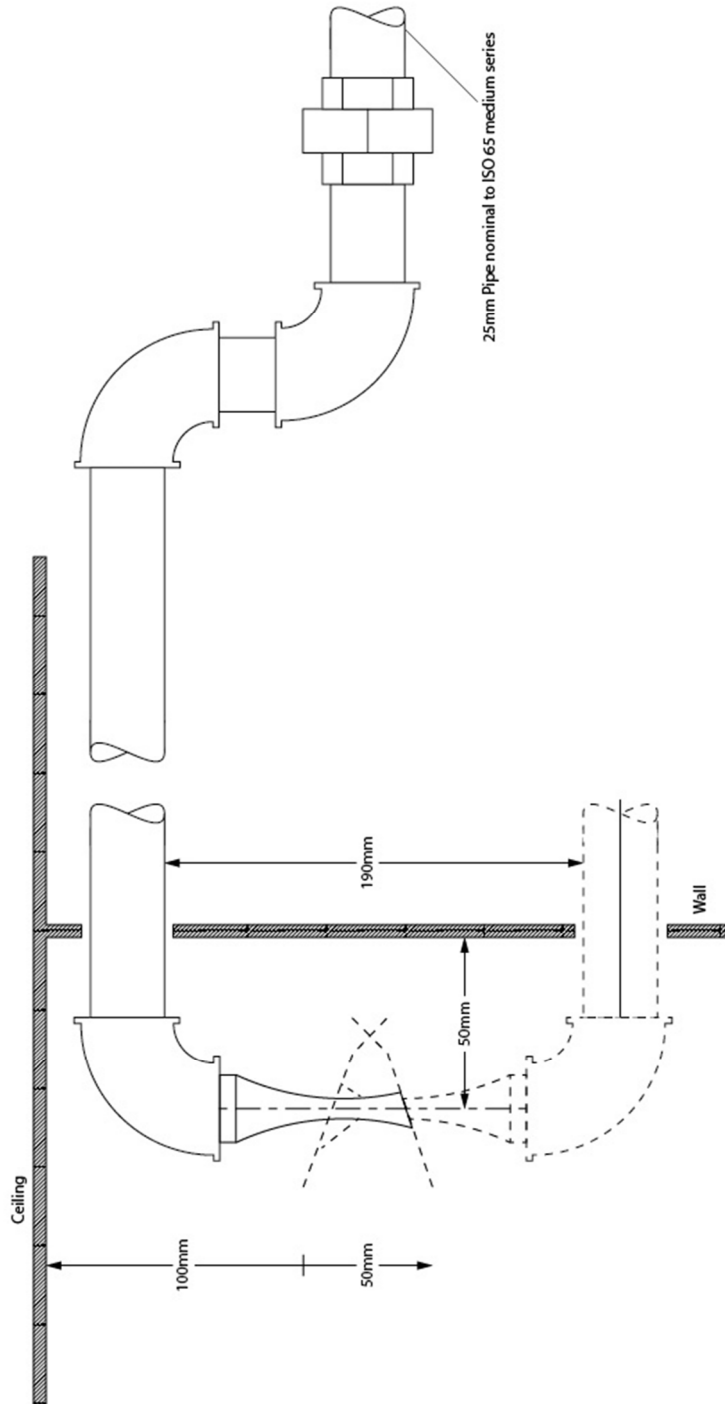
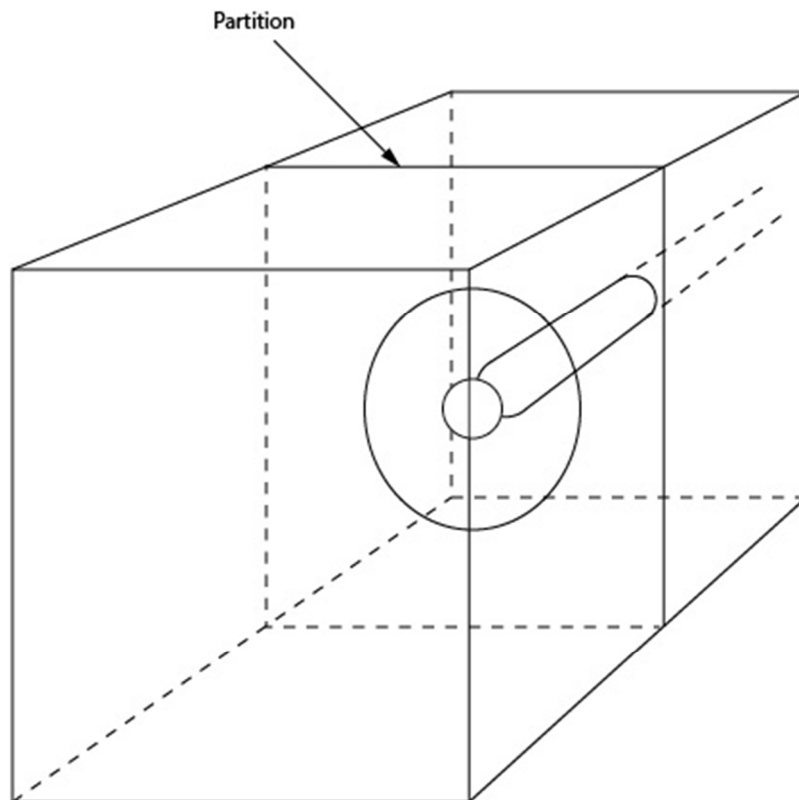
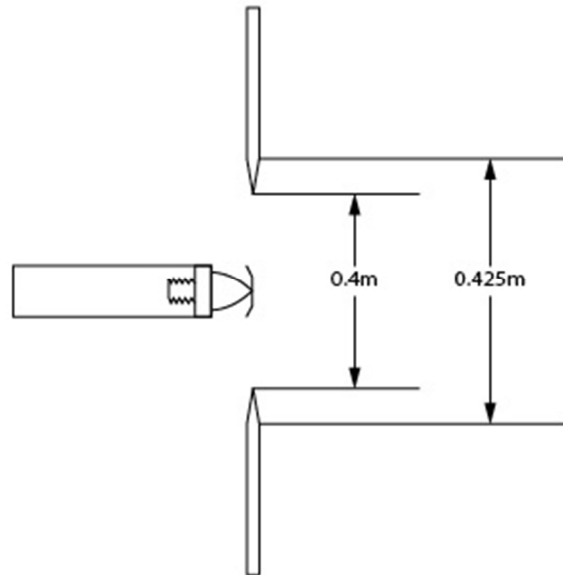


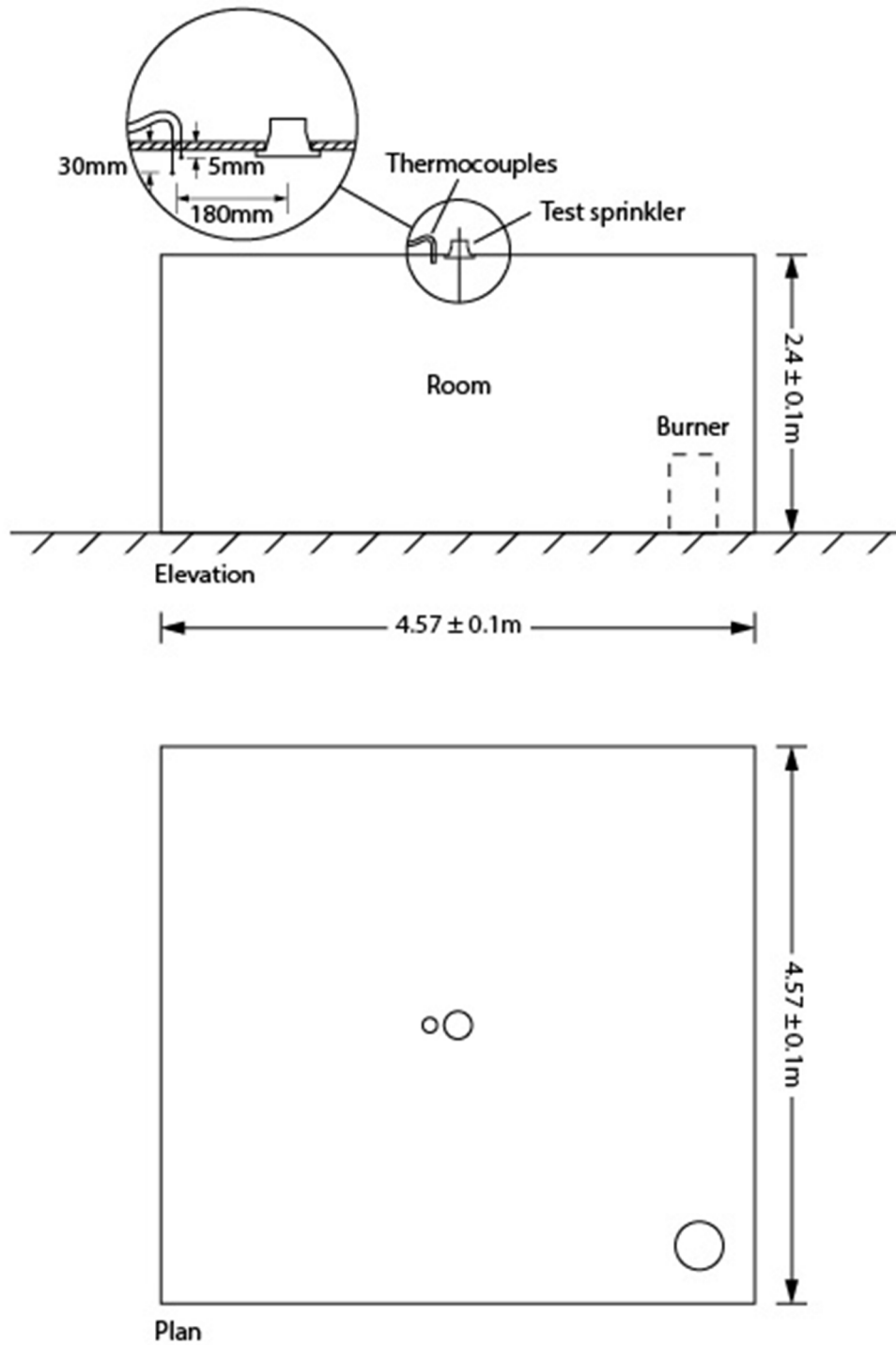
Figure 8: Mounting of sidewall sprinklers - distribution

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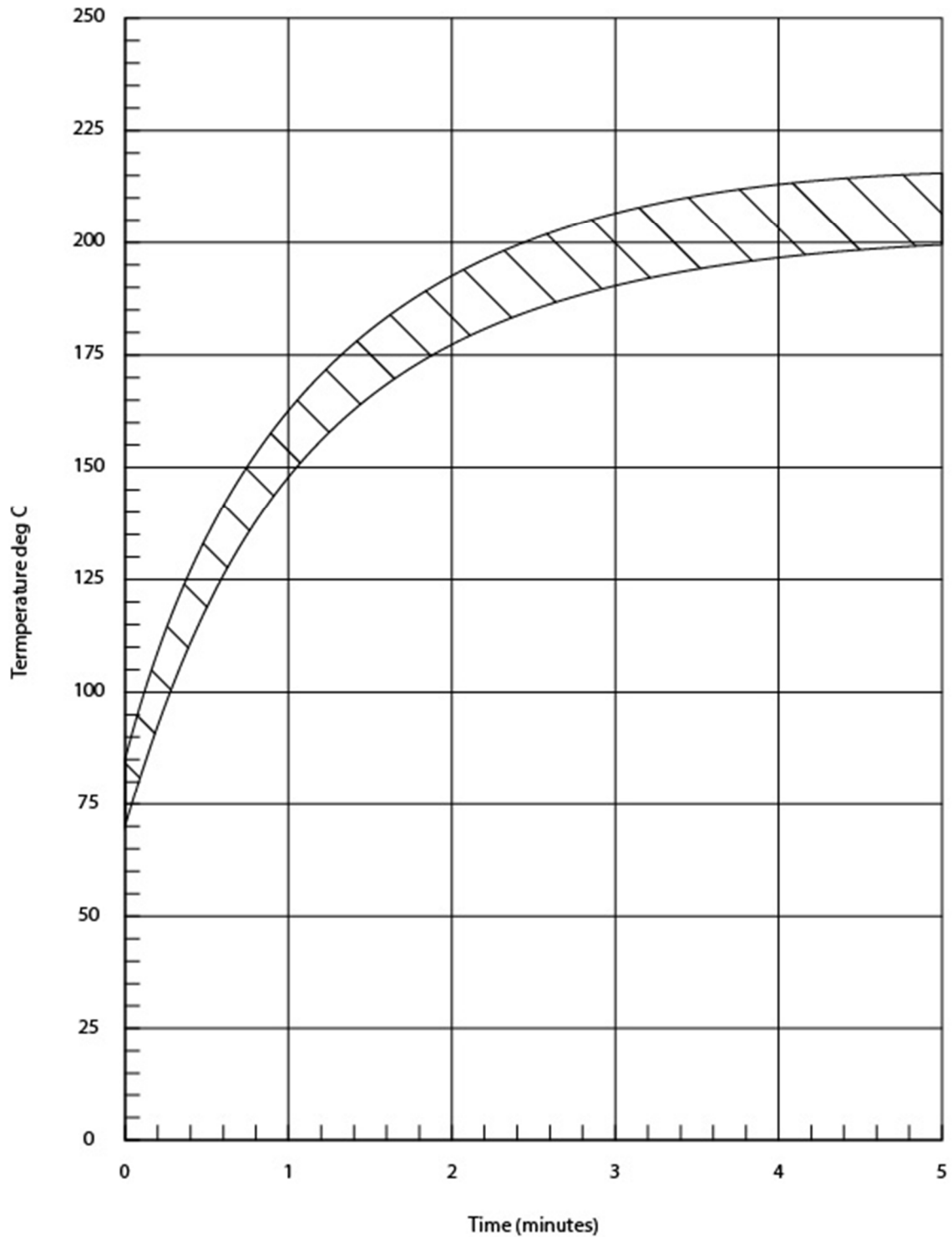
**Figure 9: Apparatus for determining water distribution above and below the deflector**

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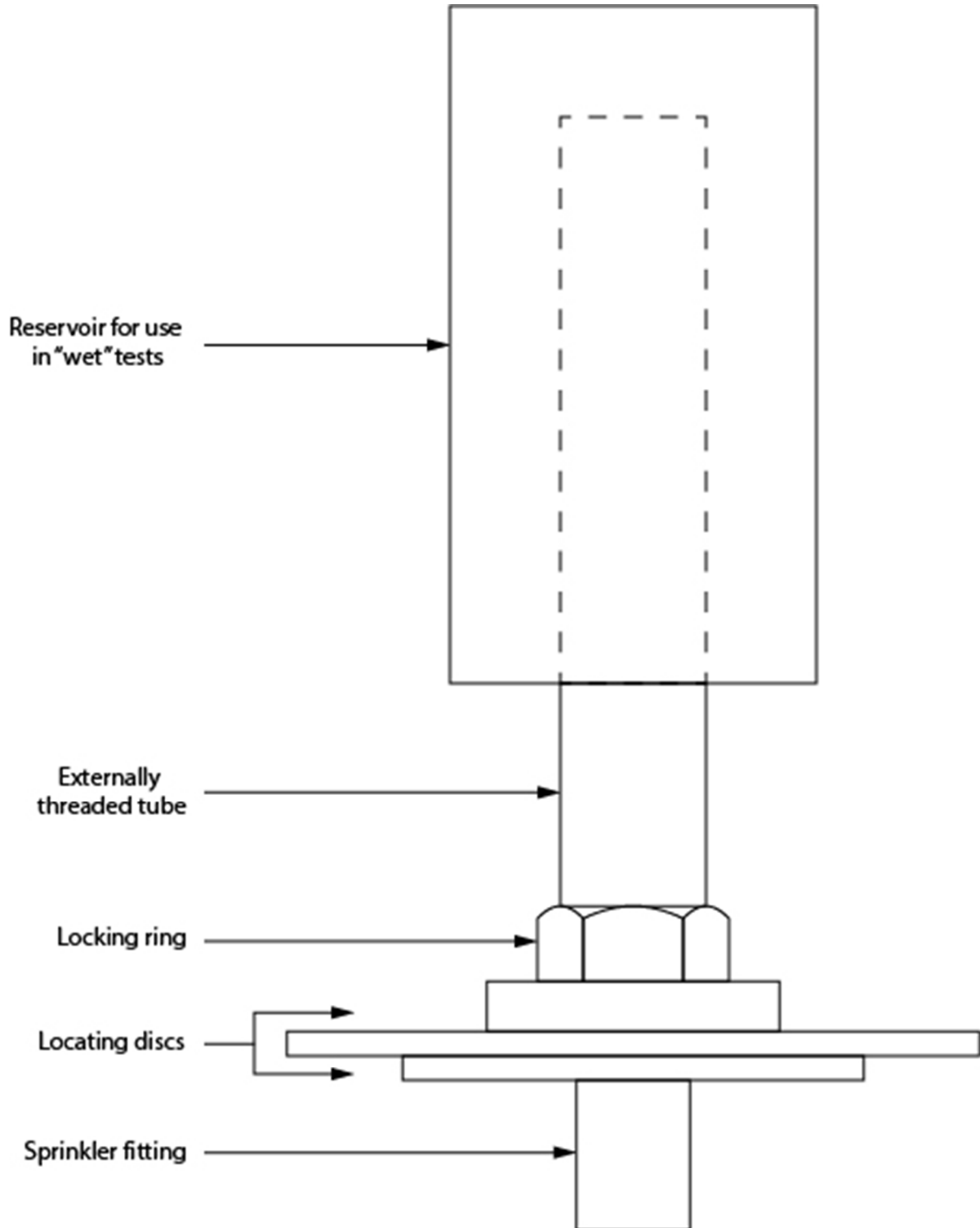
**Figure 10: Response test room layout**

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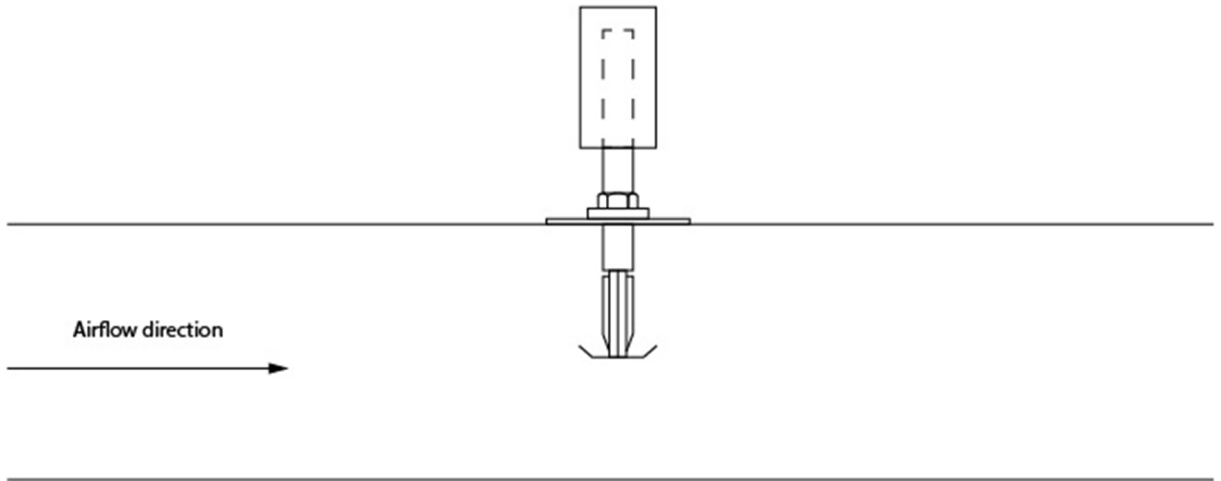
**Figure 11: Time/temperature relationship for room response test**

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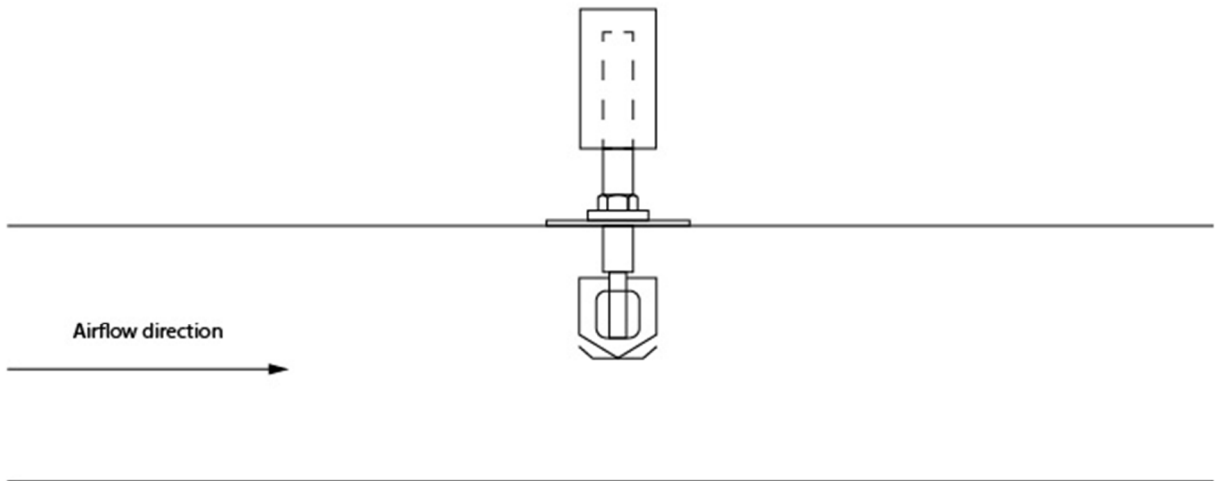


**Figure 12: Sprinkler mounting jig**

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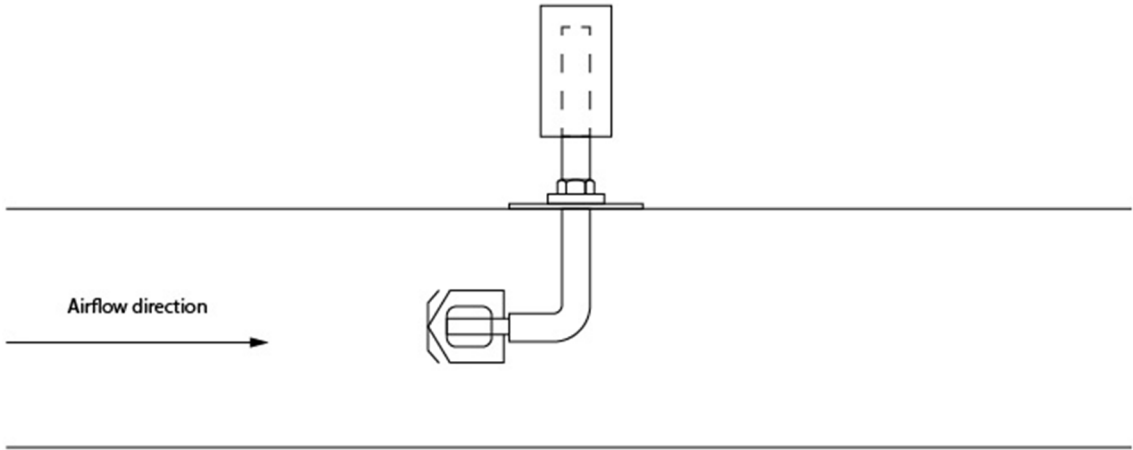


**Figure 13a: Wind tunnel test section (Frame arms normal to the airflow)**

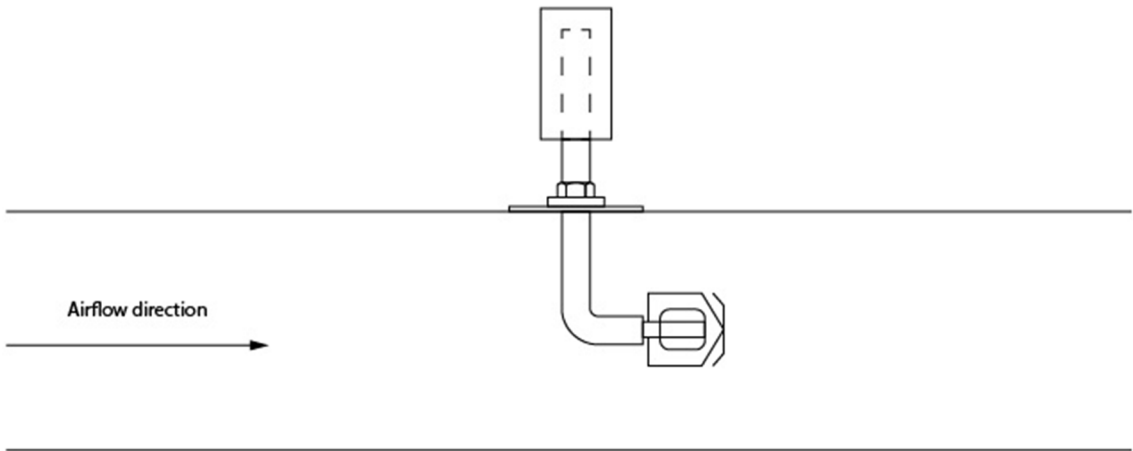


**Figure 13b: Wind tunnel test section (Frame arms in line with the airflow)**

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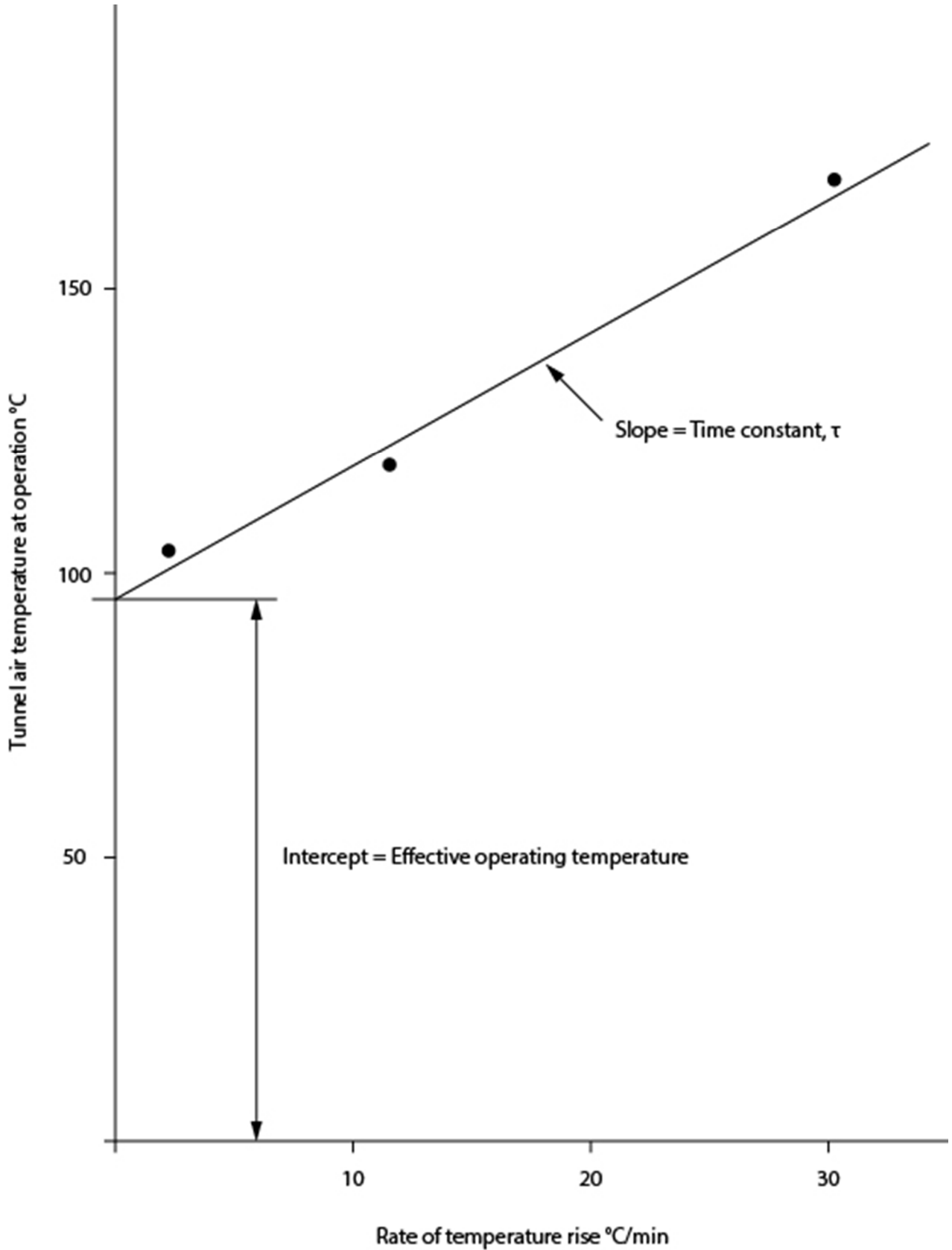
**Figure 13c: Wind tunnel test section (Frame arms parallel to the airflow)**



**Figure 13d: Wind tunnel test section (Frame arms parallel to the airflow)**



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**Figure 14: Graphical method for determining time constant,  $\tau$  and effective operating temperature,  $\theta$**

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TITLE

ISO 9001	Quality Systems - Model for quality assurance in design, development, production, installation and servicing.
ISO 9001	Quality Systems - Model for quality assurance in production, installation and servicing.
BS 2011: Part 2.1 Kb: 1987	Basic environmental testing procedures.
ISO 7/1: 1982	Pipe threads where pressure-tight joints are made on the threads - Part 1: Designation, dimensions and tolerances.

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Amendments Issued Since Publication

DOCUMENT NO.	AMENDMENT DETAILS	SIGNATURE	DATE
LPS 1039-5	Copyright and address changes	CJA	07/11/01
LPS 1039-5	Further copyright change	CJA	29/07/02
LPS 1039-5.1	Further copyright change	CJA	16/09/05
LPS 1039-5.2	Change of the front cover Header updated Table of Contents (Index) amended and moved to Page 1 'Revision of Loss Prevention Standards' added to Page 2 Web address updated on Page 2 'Notes' added to Page 3 Correction to Note numbers (Clause 4) Amendment details moved to last page Formatting: Font change to 'Arial' throughout Repagination Change to copyright information Update of references to ISO standards	DC	Jan. 2014

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