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(पहला पुनरीक्षण)

Indian Standard

SPECIFICATION FOR AUTOMATIC SPRINKLER HEADS FOR FIRE PROTECTION SERVICE

(First Revision)

ICS 13.220.10

BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

A sprinkler system consists of a water supply and one or more sprinkler installations; each installation consisting of a set of installation control valve and a pipe array fitted with sprinkler heads. The sprinkler heads are fitted at specified locations at the roof or ceiling, and where necessary between racks, below shelves, and in ovens or stoves.

The sprinklers operate at pre-determined temperatures to discharge water over the affected part of the area below, the flow of water through the installation control valve initiating a fire alarm. The operating temperature is generally selected to suit ambient temperature conditions. Only the sprinklers in the vicinity of the fire, that is, those which become sufficiently heated, operate.

A sprinkler has two functions to perform. It must first detect a fire, and must then provide an adequate distribution of water to control or extinguish it. Each function is performed separately and one is independent of the other except insofar as early detection makes extinction easier because the fire has not grown large.

A sprinkler head is, in essence, a thermally operated valve which when it opens acts as a distributor of water over a specified area. It consists of a body which screws into a pressurized pipe, and which contains a discharge orifice. The orifice is normally sealed by a valve assembly which is held in place by a thermally sensitive fusible element or glass bulb. The latter will separate or burst when its operating temperature is reached. The other end of the fusible element or glass bulb is supported by the yoke arms, which also serve to support the deflector plate. On operation, the element or the bulb falls away and allows the valve to open under the pressure of water, which is ejected from the orifice and strikes the deflector plate thus distributing the water over a pre-determined area beneath the sprinkler. This standard has been formulated so as to cover the requirements of automatic sprinkler heads of both fusible element and glass bulb types.

This standard was first published in 1981 and since then there has been a revolution in the industry worldwide in respect of fire protection particularly in sprinkler installation. Several new types of sprinklers have been developed and testing procedures for the sprinklers have been drastically changed keeping in view of the variety of fire protection requirements. Hence this standard is being revised in tune with the international trends.

In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field of this country. Considerable assistance has been provided by the Tariff Advisory Committee.

The composition of the Committee responsible for formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SPECIFICATION FOR AUTOMATIC SPRINKLER HEADS FOR FIRE PROTECTION SERVICE

(First Revision)

1 SCOPE

This standard covers the mechanical properties and performance requirements of automatic sprinkler heads for installation in fire protection service.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards which are as follows :

IS No.	*Title*
1239 (Part 1) : 1990	Mild steel tubes, tubulars and other wrought steel fittings : Part 1 Mild steel tubes (*fifth revision*)
2643	Dimensions for pipe threads for fastening purposes:
(Part 1) : 1975	Basic profile and dimensions (*first revision*)
(Part 2) : 1975	Tolerances (*first revision*)
(Part 3) : 1975	Limits of sizes (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Cut off Sprinkler

A sprinkler protecting a door and/or window between two areas of which only one is protected by sprinklers.

3.2 Detector Sprinkler

A sealed sprinkler mounted on a pressurized pipeline used to control a deluge valve. Operation of this sprinkler causes loss of air pressure and water pressure which opens the deluge valve.

3.3 Discharge Co-efficient

The co-efficient of discharge of a sprinkler (K) is given by the formula given below:

$$K = QP^{-\frac{1}{2}}$$

where

K = the co-efficient of discharges of a sprinkler,

Q = flow of water through the orifice of sprinkler in l/min, and

P = pressure of water in kg/cm^2.

3.4 Heat Responsive Element

That portion of the sprinkler assembly that breaks, melts or otherwise functions to initiate the automatic operation of the sprinkler when exposed to sufficient heat.

3.5 Lodgement

Lodgements occur when a sprinkler operates and discharges water, but operating parts intended to fall away do not do so, but lodge in the sprinkler yoke or deflector, thus impairing water distribution.

3.6 Operating Temperature

The temperature at which the heat responsive element of a sprinkler operates when subjected to a 0.5° C /min temperature rise while immersed in a liquid bath.

3.7 Orifice

The opening that controls the amount of water discharged from a sprinkler at a given pressure.

3.8 Rosette

A plate covering the gap between the shank or body of a sprinkler projecting through a suspended ceiling and the ceiling.

3.9 Service Load

Service load shall be considered as the average assembly load or the average load withstood by the frame and the heat responsive element under an installation pressure of 10 bar, whichever is greater. The average is normally ascertained from tests on 4 sprinklers.

3.10 Sprayer

A sprinkler that gives a downward conical pattern discharge.

3.11 Sprinkler

A temperature sensitive sealing device which is intended to open automatically by operation of a heat-responsive element that maintains the discharge orifice closed by means, such as the exertion of pressure on a cap (button or disc). A sprinkler is installed on a pressurized piping so that a spray of water discharge of a specified pattern is achieved for the suppression or control of a fire.

3.12 Yoke

The part of a sprinkler that retains the heat responsive element in load bearing contact with the sprinkler head valve.

4 TYPES OF SPRINKLERS

Sprinklers of the following types are covered under this standard.

4.1 Sprinklers According to Release Mechanism

4.1.1 *Fusible Element Sprinklers*

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

4.1.2 *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.

4.2 Sprinklers According to Type of Discharge

4.2.1 *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 percent of the total water flow initially in a downward direction.

4.2.2 *Spray Sprinklers*

The spray sprinkler has a parabolaidal water distribution directed towards the ground over a definite protection area. A spray sprinkler shall discharge from 80 to 100 percent of the total water flow in a downward direction.

4.2.3 *Sidewall Sprinklers*

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

4.3 Sprinklers According to Mounting Pattern

4.3.1 *Pendent Sprinkler*

A sprinkler intended to be installed so that its deflector is located below the orifice and the water flows downward through the orifice.

4.3.2 *Upright Sprinkler*

A sprinkler intended to be installed so that its deflector is located above the orifice and the water flows upward through the orifice.

4.3.3 *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.

4.3.4 *Ceiling Sprinklers*

Ceiling sprinklers are in which part of the body of the sprinkler (other than shank) may be mounted above the lower plane of the ceiling.

4.4 Special Sprinklers

4.4.1 *Dry Upright Sprinklers*

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

4.4.2 *Dry Pendent Sprinklers*

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

4.4.3 *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 responsive element is completely below the ceiling line.

4.4.4 *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.

4.4.5 *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.

4.4.6 *Intermediate Sprinklers*

A sprinkler installed below, and in addition to roof sprinklers with a specific purpose.

4.4.7 *Detector Sprinkler*

A sealed sprinkler mounted on a pressurized pipeline used to control a deluge valve. Operation of this sprinkler causes loss of air pressure and water pressure which opens the deluge valve.

4.4.8 *Extended Coverage (EC) Sprinklers*

A sprinkler intended :

a) for use at greater than standard spacing,
b) operation of heat responsive element and release mechanism at standard spacings are equal to or less than standard sprinkler,
c) to discharge water over a specified coverage area having a ceiling without obstructions at a specified water flow rate, and
d) for use only in light hazard occupancies. The classification of an EC sprinkler specifies coverage area dimensions, minimum operating water flow rate, orifice size and the *K* factor.

4.4.9 *Flow Control (FC) Sprinklers*

A sprinkler that is intended to control water flow by automatically cycling open and closed within a specified temperature range.

4.4.10 *Fast Response Sprinkler*

A sprinkler that complies with the applicable requirements for such sprinklers in the sensitivity tests and that is intended to be installed at standard spacings.

5 GENERAL REQUIREMENTS

All the sprinklers shall comply with the various requirements specified below.

5.1 Orifice Sizes

5.1.1 The sizes shall comply with Table 1.

Table 1 Orifice Sizes
(*Clauses* 5.1.1 *and* 5.1.4)

Nominal Orifice Diameter mm	Nominal Thread Size inch
(1)	(2)
10	3/8
15	1/2
20	3/4

5.1.2 All automatic sprinklers shall allow a sphere of 8 mm + 0.010 mm size to pass through each waterway of the device.

5.1.3 Nominal thread sizes for fittings shall be according to IS 2643 (Parts 1 to 3).

5.1.4 Dry and flush sprinklers may have larger thread sizes than specified in Table 1.

5.2 Nominal Release Temperatures and Colour Coding

5.2.1 *Glass Bulbs*

The nominal temperature for glass bulbs shall be permanently coloured as indicated in Table 2 with a variability in operating temperatures within the ranges specified.

Table 2 Colour Code for Glass Bulbs
(*Clause* 5.2.1)

Nominal Release Temperature in °C	Liquid Colour Code
(1)	(2)
57	Orange
68	Red
79	Yellow
93	Green
141	Blue
182	Mauve
227	Black
260	Black

5.2.2 *Fusible Elements*

The nominal temperature for fusible elements shall be permanently coloured as indicated in Table 3 with a variability in operating temperatures within the ranges specified.

Table 3 Colour Code for Fusible Elements
(*Clause* 5.2.2)

Nominal Release Temperature in °C	Yoke Arm Colour Code
(1)	(2)
57 to 77	Uncoloured
80 to 107	White
121 to 149	Blue
163 to 191	Red
204 to 246	Green
260 to 302	Orange
320 to 343	Black

6 PERFORMANCE TESTS

6.0 In all, 60 sprinklers of each type shall be selected from the production line for the purpose of testing. The sequence of testing and the number of sprinklers require to be tested under each test as well as those require to be re-used for other tests are given in **8**.

6.1 Examination of Sprinklers

Sprinklers shall be examined visually for the following points :

a) Comparison of sprinkler specimens with manufacturer's drawings and detailed specification, and
b) Conformance with orifice size (*see* **5.1**) and colour coding (*see* **5.2**).

6.2 Leak Resistance Test

Sprinklers shall not leak when subjected to the following tests.

6.2.1 *Leakage Test*

Sprinklers shall be subjected to a water pressure of 30 bars ± 1 bar. The pressure shall be raised from 0 bar to 30 bar at an average rate of ≤ 1 bar/ s. The pressure of 30 bar shall then be maintained for a period of 3 min + 5 s and then allowed to fall to 0 bar in not less than 5 s. After releasing the pressure, it shall be then raised to 0.5 bar ± 0.1 bar in not more than 5 s. This pressure shall be maintained for 15 + 5 s.

The pressure shall then be raised to 10 bar + 0.5 bar at an average rate of increase of ≤ 1 bar/s. The 10 bar pressure shall be maintained for 15 + 5 s.

6.2.2 *30-Day Leakage Test*

Sprinklers when tested as per the following procedures shall

a) experience no leakage when subjected to a hydrostatic pressure of 20 bars for 30 days. Five samples shall be tested and the same shall be checked every week for evidence of leakage;
b) not leak when subjected to a pressure of 35 bars for one minute following the 30 days. The pressure shall be increased at a rate not exceeding 20 bars per minute. Similarly after the test, the pressure shall be brought down to 0 bar at a rate not exceeding 20 bars /min; and
c) show no distortion or other mechanical damage following the leakage testing, as determined by visual examination.

6.3 Functional Test

All operating parts of the sprinklers shall release with sharp and positive action and these shall be thrown clear of the sprinkler frames and the deflectors so as not to impair the water distribution pattern.

6.3.1 A sprinkler shall be installed in a test oven pressurized with water (a typical sketch of the arrangement is shown in Fig. 1). The air temperature within the oven shall be increased until the sprinkler is activated.

NOTES

1 Sprinkler too large to be accommodated within the oven shall be operated by a suitable heat source outside the oven.

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

6.3.2 Sprinklers shall be tested in each normal mounting position at each of the pressures shown in Table 4.

6.3.3 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 0.75 times the clear air space between the mountings of the glass bulbs.

NOTE—The measurement of a glass fragment includes only that part of the fragment which would be normally exposed to the clear air space between the bulb mountings. It does not include that length of the fragment which normally sits within the bulb mountings.

Table 4 Functional Test

(*Clause* 6.3.2)

Static Pressure (bar)	Running Pressure (bar)
(1)	(2)
0.35 ± 0.05	0.15 ± 0.10
3.50 ± 0.10	1.70 ± 0.70
10.00 ± 0.10	6.50 ± 2.00

6.3.4 The lodgement rate for each deflector pattern shall not exceed each of the following:

a) A ratio of 1:32 for all sprinklers tested at 3.5 and 10 bars for each mounting position[1)].
b) A ratio of 1:16 for any one mounting position when tested at 3.5 bars and when tested at 10 bars.
c) A ratio of 1:12 for all sprinklers tested at 0.35 bars.

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

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

6.3.6 Sprinklers which have been subjected to the tests specified in **6** before being functionally tested need not conform with the lodgement rates in **6.3.4** and will not be evaluated to **6.3.3**.

6.4 Release Temperature Test (Operating Temperature)

An automatic sprinkler shall operate within a range having a maximum temperature not in excess of either 5 °C or 107 percent of the minimum temperature of the range, whichever is greater.

Sprinklers or separate glass bulbs shall be heated from room temperature to 20 °C ± 2 percent below their normal marked temperature. The rate of temperature rise shall not exceed 20 °C/min. The temperature reached shall be maintained for 10 minutes. The temperature shall be then raised at a constant rate of 0.55 ± 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

1) It is assumed that equal numbers are tested at each pressure.

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. (It is important that the glass bulb tested in accordance with this clause shall be from the same).

6.4.1 *Fusible Element Sprinklers and Cover Plates of Concealed Sprinklers*

These sprinklers shall open within a temperature range of :

$$T \pm (0.035\,T + 0.62)\ ^\circ C$$

where

T is the nominal operating temperature.

6.4.2 *Glass Bulbs and Glass Bulb Sprinklers*

The distribution of operating temperature for a sample of 50 glass bulbs shall be in accordance with the requirements given in Table 5 for the appropriate temperature rating. Glass bulb sprinklers shall open within the temperature extremes specified in col 2 and 5 of Table 5 for appropriate temperature rating.

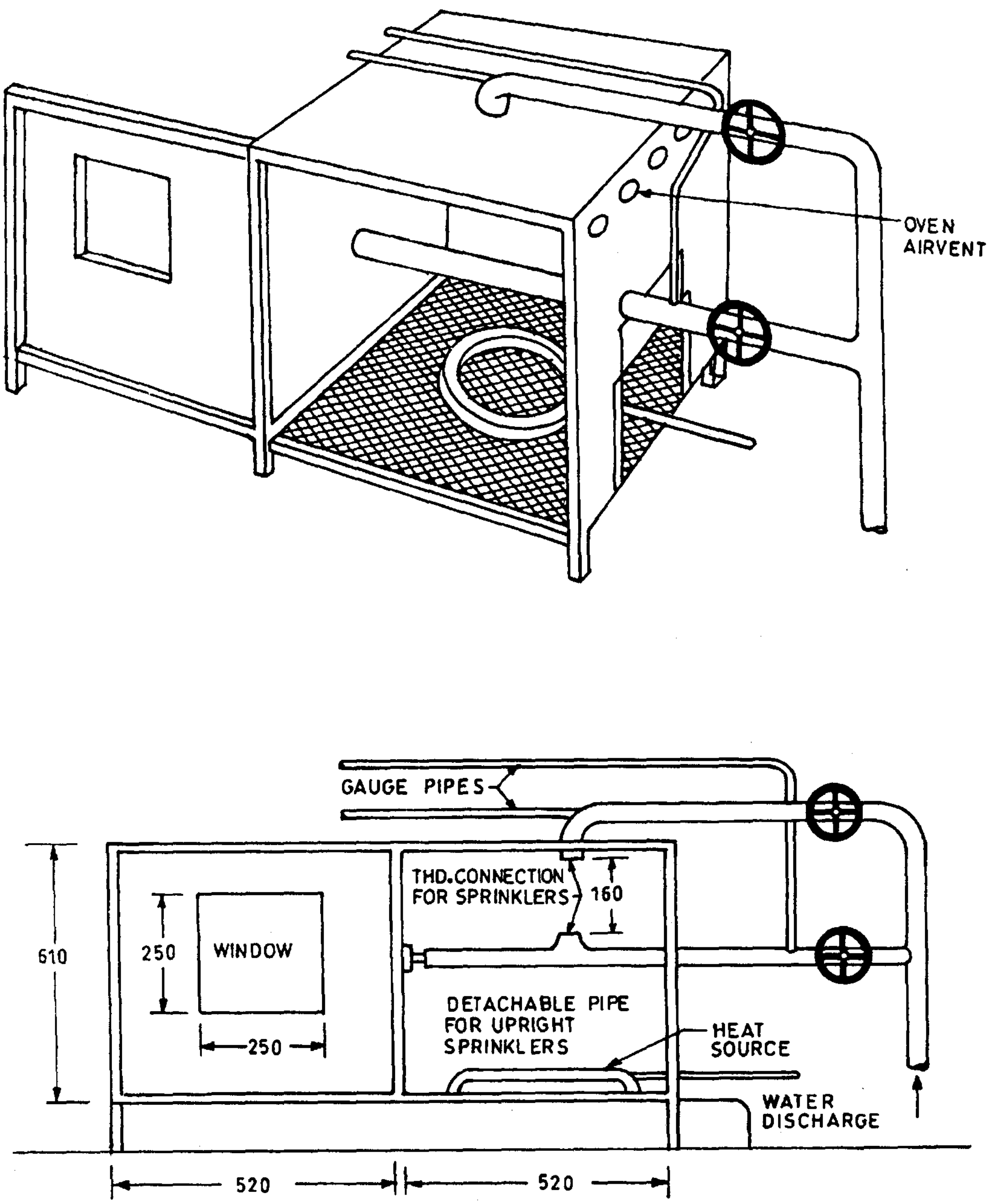


FIG. 1 FUNCTIONAL TEST (TEST OVEN)

Table 5 Release Temperature Test
(*Clause* 6.4.2)

Nominal Bulb Rating °C	Lowest Temperature °C	25 of the 50 Bulbs °C	40 of the 50 Bulbs °C	50 Out of the 50 Bulbs °C
(1)	(2)	(3)	(4)	(5)
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

NOTE — All bulbs in the sample shall be shown as operated. If the sample concerned fails to comply with the limits of col 3 to 5, repeat test shall be necessary so that col 3 to 5 shall apply to 50, 80 and 90 of 100 samples respectively.

6.5 Heat Exposure Test (For Glass Bulb Sprinklers)

A sprinkler when subjected to fatigue conditions as indicated below shall remain intact and undamaged so that it can be subjected to satisfactory functional test thereafter.

The sequence of the test is as follows.

6.5.1 Heat the sprinkler in a liquid bath from room temperature to 20 °C ± 2 °C under its normal release temperature at a rate of rise of temperature not exceeding 20 °C/min.

6.5.2 The temperature shall then be raised at a rate of 1 to 7 °C ± 2 °C below the normal release temperature (bubble disappears).

6.5.3 The sprinkler shall then be removed from the liquid bath and cooled in air at room temperature for two minutes. During the cooling period, the point of the glass bulb (seal end) shall be pointing downwards (bubble reappears).

6.5.4 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 min + 10 s.

6.5.5 Repeat the action specified in **6.5.3**.

6.5.6 Repeat the actions specified in **6.5.3** and **6.5.4** twice.

The test shall be carried out in a bath of distilled water for nominal temperatures not exceeding 80°C. Refined vegetable oil shall be used for nominal temperatures above 80°C and below 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 **6.3** at a pressure of 10 bars.

6.6 High Ambient Temperature (Ageing) Test for All Sprinklers

Sprinklers shall withstand exposure to an increased ambient air temperature without evidence of weakness or failure.

6.6.1 Sprinklers shall be exposed for a period of 90 days to an ambient temperature which is 16°C below the 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 2 hours, and shall then be subjected to any of the tests under **6.2, 6.3, 6.4** or **6.9** as required.

Concealed sprinkler cover plates shall be exposed for a period of 90 days, hung in pendent position, to an ambient 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 test as given in **6.3**.

6.6.2 Glass bulbs shall also be subjected to the increased ambient air temperature as enumerated in **6.6.2.1**.

6.6.2.1 Fifty glass bulbs from the same manufacturing batch shall be subjected to 90 day ageing as specified in **6.6.1**. Following exposure and cooling, the loose glass bulbs shall be tested to determine their operating temperature distribution as specified in **6.4** and meet the requirements of **6.4.2** thereof.

6.7 Thermal Shock Test (for Glass Bulb Sprinklers)

Glass bulb sprinklers shall remain intact and undamaged during thermal conditioning and shall pass functional test thereafter.

Following procedure shall be carried out for the test specified in **6.7**.

6.7.1 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 the sprinklers. After 10 minutes, 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 10 to 15 s. The sprinklers shall then be stabilized at room temperature before being tested in accordance with **6.3** at a pressure as stated therein.

6.8 Strength of Heat Sensitive Element Test

The heat sensitive elements, that is, glass bulbs or fusible elements shall withstand the maximum design load for a specified period without any damage or repairs.

6.8.1 *Glass Bulb Sprinklers*

The average strength of the bulb release element shall be at least 6 times the average service load of the sprinkler when tested as specified in **6.8.1.1**.

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

6.8.2 *Fusible Element Sprinklers*

Fusible heat responsive element shall be designed to sustain a load of 15 times its design load corresponding to a maximum service load as determined in **6.9** or that stated by the manufacturer, whichever is greater, for a period of 100 hours.

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 **6.9** which will produce failure for times up to or greater than 1 000 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 100 hours are to be calculated. The following condition shall be satisfied:

$$L_m \geq .99\,(L_o - L_d)^{0.5}$$

The test samples are to be loaded at a conditioned temperature of 20°C ± 3°C.

6.9 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 bars 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 of not exceeding 1 500 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 a service load.

6.10 Strength of Frame Test

The sprinkler frame shall not develop a permanent elongation of more than 0.2 percent of the distance between the load bearing points when subjected to mechanical loads.

The load on the sprinkler shall be increased progressively at a rate not exceeding 1 500 N/min, until twice the service load (*see* **6.9**) has been reached. This loading shall be maintained for 10 to 15 s. The load shall then be removed and any permanent elongation of the deflector and of the sprinkler frame shall be recorded.

6.11 Deflector Strength Test

Sprinkler deflectors shall be capable of withstanding a force without permanent deformation.

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

Distortion by tine or tines by a force of less than 190 N applied at any point of direction, is acceptable providing the distortion does not impair the release of the sprinkler operating mechanism, and the distribution test requirements specified in **6.13**.

6.11.2 There shall be no deterioration of the sprinkler performance after a continuous water flow through the open sprinkler at a supply pressure of 10 bars ± 1 bar for 90 min ± 5 min. Sprinklers with detached components shall be capable of satisfying the distribution tests specified in **6.13** after the test.

6.12 Water Flow Test

6.12.1 *Water Flow Test (Normal)*

The discharge coefficient or K factor of a sprinkler shall have the values as given in Table 6.

Table 6 Water Flow Test
(*Clause* 6.12.1)

Designated Nominal Orifice Diameter (mm)	Discharge Coefficient K	K Factor for Dry Sprinklers
(1)	(2)	(3)
10	57 ± 3	57 ± 5
15	80 ± 4	80 ± 9
20	15 ± 6	115 ± 9

At ambient temperature conditions, the water flow of the sprinkler is calculated by the formula

$$Q = KP^{0.5}$$

where

Q = water flow (l/min),
P = pressure (bars), and
K = flow constant.

The sprinkler minus deflector and yoke arms shall be mounted, together with a pressure gauge, on a supply pipe (*see* Fig. 2). The water flow shall be measured at pressures between 0.5 bar and 6.5 bars 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 bars. An average value of K factor shall be measured from each set of readings, that is, rising pressure and falling pressure. In each case the K factor shall conform with the values given in Table 6. It is acceptable to adjust the pressures for differences in height between the gauge and the sprinkler outlet orifice. The flow test shall be carried out at ambient temperature ± 5°C.

6.12.2 *Water Flow Endurance Test*

An automatic sprinkler shall withstand for 30 min, without evidence of cracking, deformation, or separation of any part, a water flow at a pressure equal to the maximum rated pressure plus 1.5 bars. One sample of an automatic sprinkler shall be installed on an elbow in a pressurized system. The heat responsive element of the sprinkler shall be activated, and the sprinkler subjected to water flow at the above specified pressure for 30 min.

6.13 Water Distribution Test

6.13.1 *Conventional, Spray and Dry Sprinklers*

Distribution tests shall be carried out using square arrays of 4 sprinklers over 100 equal sized pans at ambient conditions of 20 °C ± 15 °C. In a test room of a size 7.5 m ± 0.5 m and a height of 3.2 m ± 25 mm, 4 sprinklers of the same type shall be installed, arranged in a square array, on piping constructed for the purpose. The arrangement of the piping and measuring containers is shown in Fig. 3, 4, 5 and 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 mm ± 20 mm. Flush, recessed and concealed sprinklers shall be mounted in a simulated false ceiling.

The size of the protected area and the density of the coverage for each of the three nominal sizes of sprinkler are specified in Table 7. The number of low content containers shall not exceed that stipulated in col 6 of Table 7 .

Table 7 Water Distribution Test
(*Clause* 6.13.1)

Nominal Orifice Diameter, mm	Water Coverage, l/m/m^2	Nominal Flow Rate per Sprinkler, l/m	Nominal Protected Area , m^2	Sprinkler Spacing m	Allowable Low Content Container
(1)	(2)	(3)	(4)	(5)	(6)
10	2.5	50.6	21	4.5	8
15	5.0	61.3	12	3.5	5
15	15.0	135.0	9	3.0	4
20	10.0	90.0	9	3.0	4
20	30.0	187.5	6.25	2.5	3

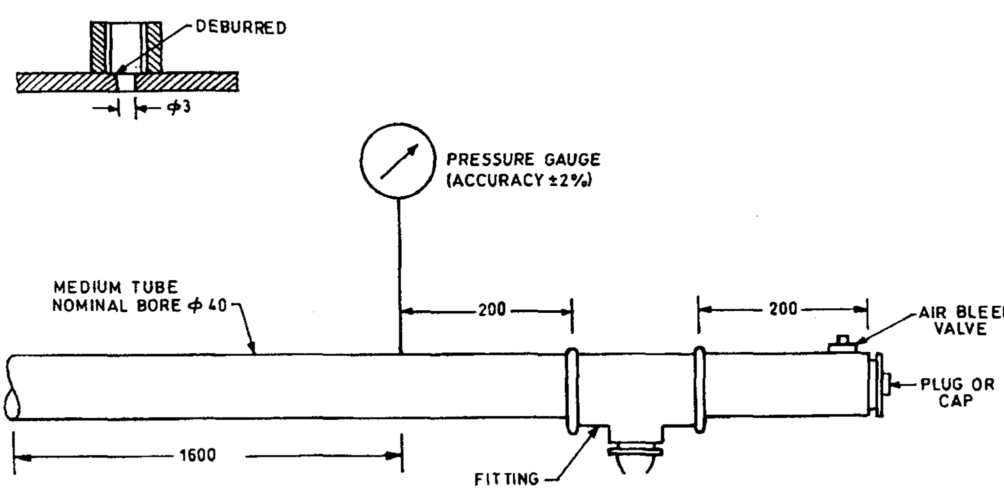


FIG. 2 TEST APPARATUS FOR WATER FLOW

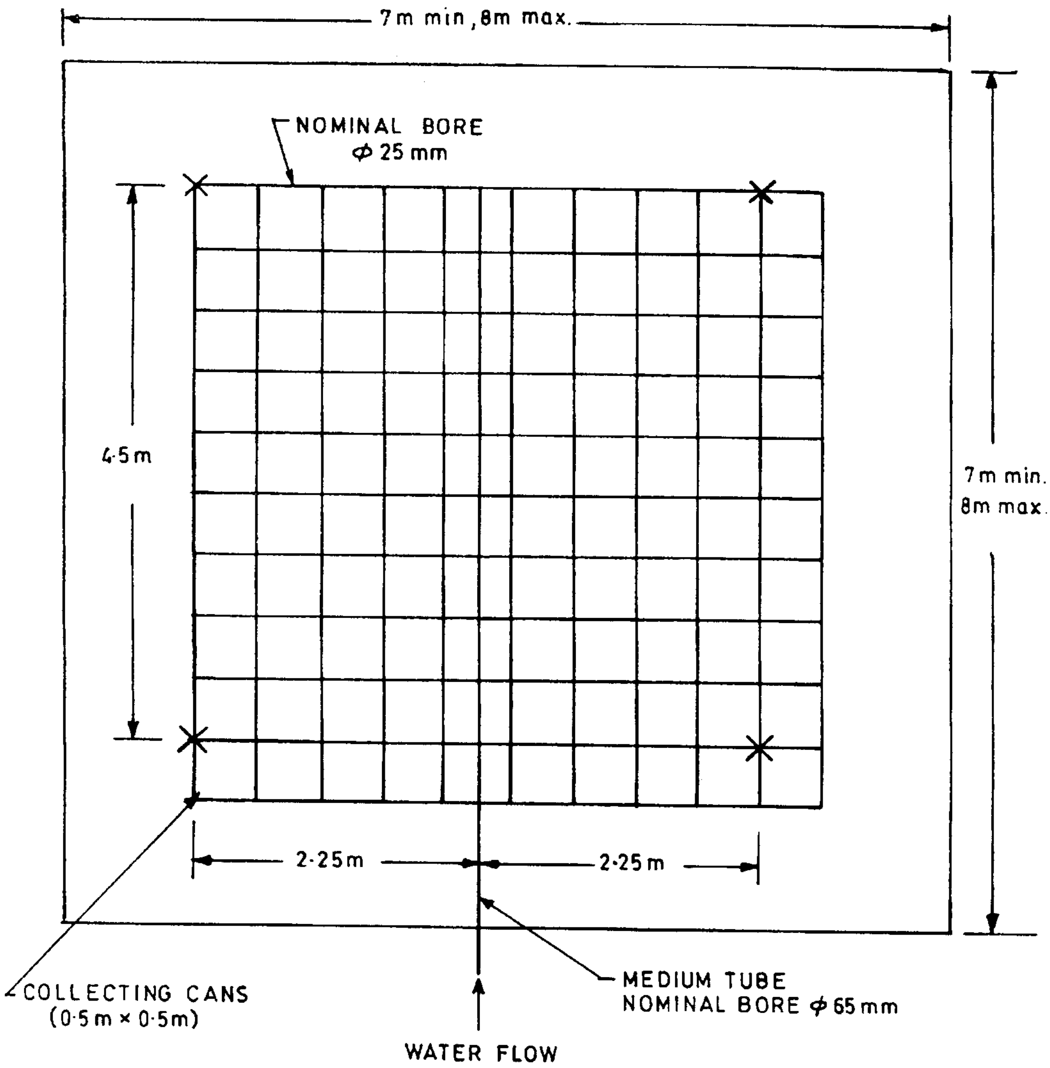


FIG. 3 LAYOUT FOR WATER DISTRIBUTION COLLECTION ROOM (MEASURED AREA 20.25m^2)

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

6.13.2 *Sidewall Sprinklers* (15 mm)

The tests shall be made in a room measuring 3.75 m × 7.0 m × 3.21 m. 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 50 mm from that wall and at a distance of 1.8 m from an adjacent wall. For an upright sprinkler, the deflector of the sprinkler shall be 100 mm below the ceiling and for a pendent sprinkler 150 mm below the ceiling (*see* Fig. 7 and 8). Water shall be collected in cans having square open tops measuring 0.5 m × 0.5 m array with its edges 1 m from the adjacent wall and 10 mm from the sprinkler mounting wall. With the sprinkler discharging at 60 l/min, the discharge density into each can shall be determined and the height of the boundary between the wetted and the unwetted parts of the absorbent strip shall be measured. The distribution of water and wall wetting in an area bounded by two sprinklers 3.7 m apart is derived by overlapping two identical wall wetting profiles and distributions obtained from one test using single sprinkler.

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

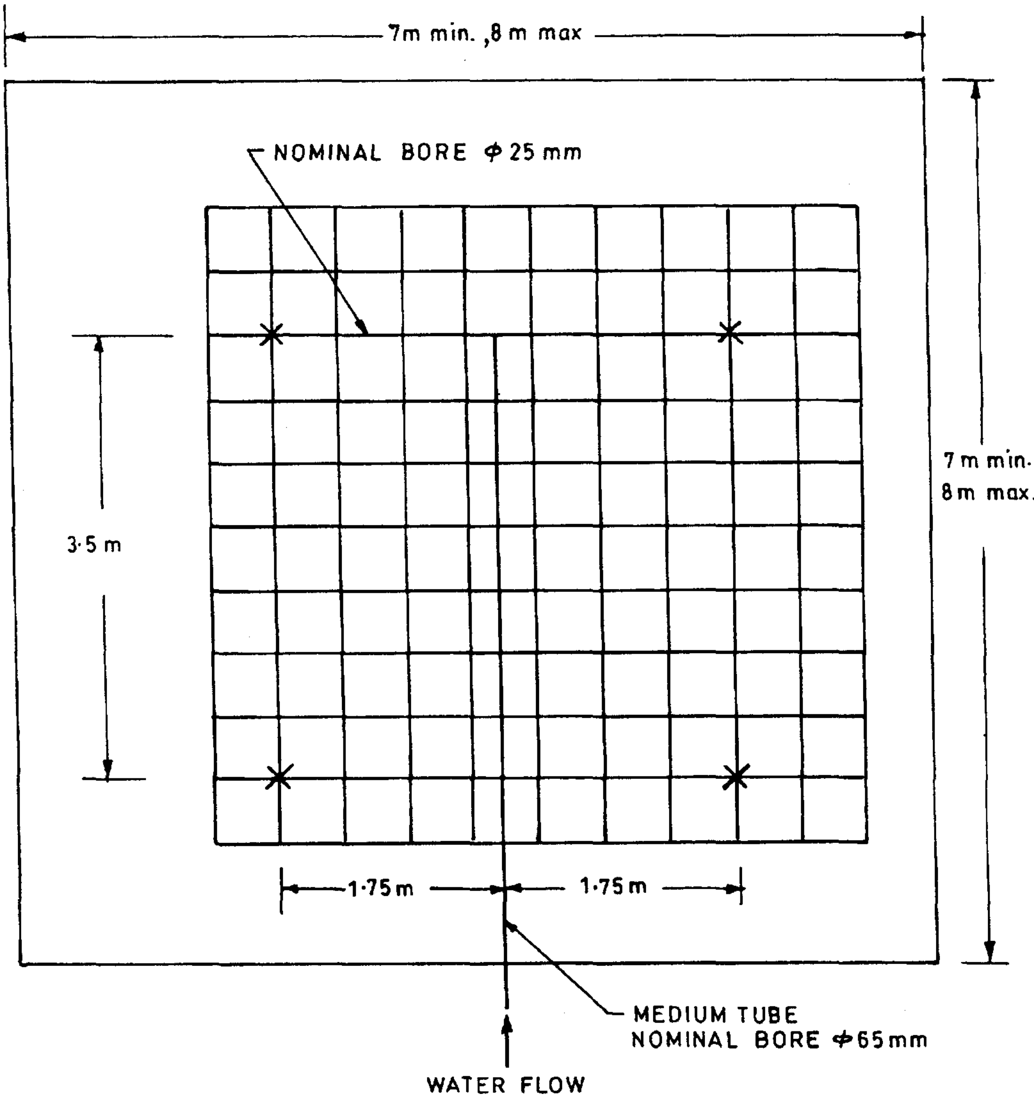


FIG. 4 LAYOUT OF WATER DISTRIBUTION COLLECTION ROOM (MEASURED AREA 12.25m^2)

6.13.3 *Water Distribution Above and Below the Sprinkler Deflector (Not Applicable to Sidewall Sprinklers)*

The water discharge of sprinklers downwards from the deflectors shall be 40 percent to 60 percent for conventional sprinklers and 80 percent to 100 percent for spray sprinklers. Sprinklers shall be installed horizontally in a testing rig and the features of which are shown in Fig 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. (The results shall be given assuming that the conventional sprinkler is mounted in the upright position).

Sprinklers shall be tested under flow conditions as shown in Table 8.

Table 8 Flow Condition for Water Distribution Test
(*Clause* 6.13.3)

Nominal Orifice Diameter, mm	Sprinkler Water Flow Rate, l/m
(1)	(2)
10	50
15	60
20	90

6.14 Water Hammer Test

When tested as detailed in the procedure below, the sprinkler shall :

a) experience no leakage when subjected to 3 000 applications of a pressure surge increasing rapidly from 3.5 bars to 35 bars;
b) not leak when subjected to a pressure of 35 bars for one minute, following 3 000 cycles of water hammer; and

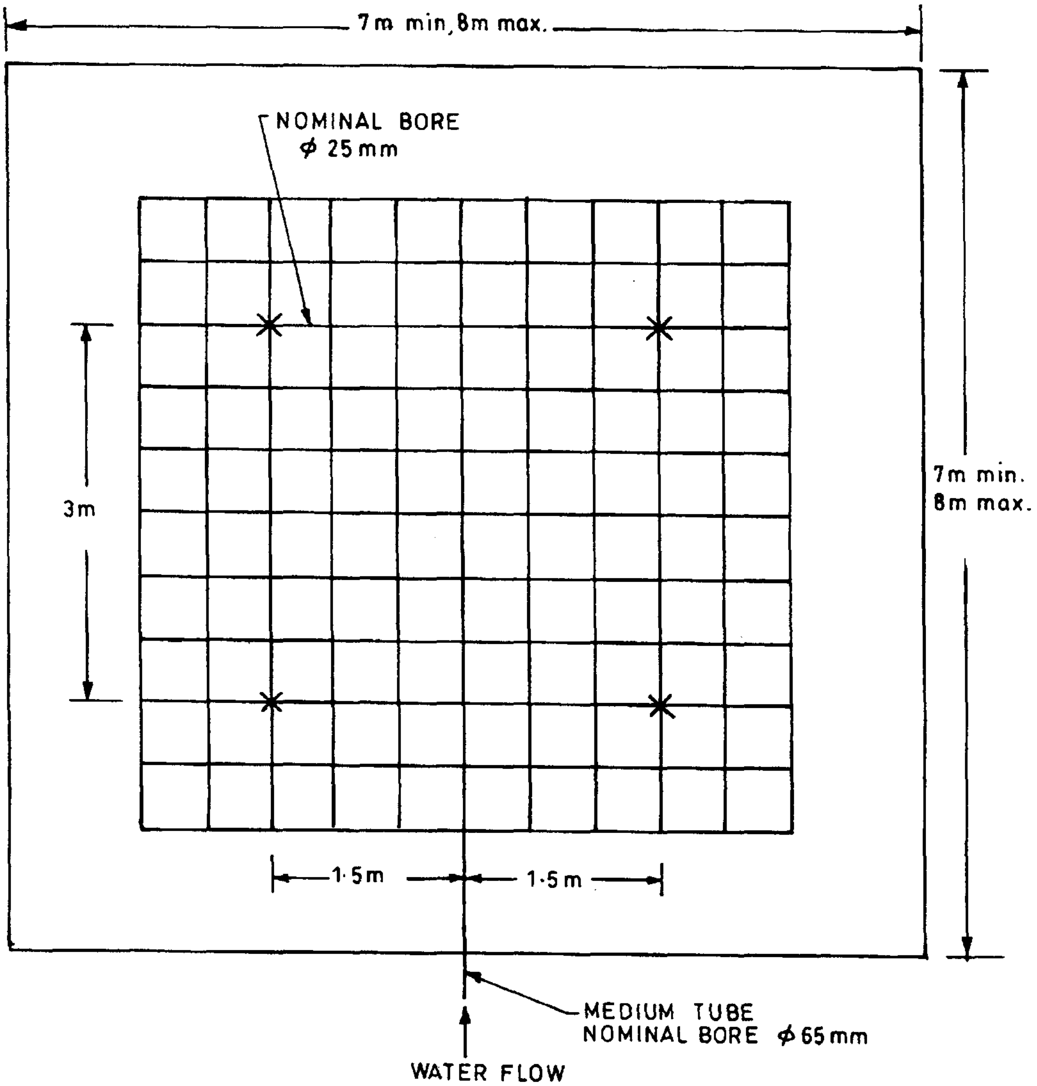


FIG. 5 LAYOUT OF WATER DISTRIBUTION COLLECTION ROOM (MEASURED AREA 9.0 m^2)

c) show no distortion or other physical damage following the water hammer testing as determined by visual examination.

6.14.1 Sprinkler samples shall be installed in a water filled test line connecting with a small motor operated piston pump that produces a rapid rise in discharge pressure from 3.5 to 35 bars at the rate of 60 cycles /min. The test piping shall be filled so that there is water at the sprinkler seat, and the pump is to be placed in operation and adjusted to produce the specific test pressure cycle.

6.14.2 During pressure cycling, observations shall be made for the evidence for leakage, if any.

6.14.3 Following the completion of the pressure cycling, the samples are to be tested to verify that they do not leak at 35 bars pressure. The pressure shall be increased to 35 bars at a rate not exceeding 20 bars a minute. The pressure shall be maintained at 35 bars for a minute and then released at a rate not exceeding 20 bars a minute to 0. The samples shall then be physically checked to verify evidence of distortion.

6.15 Vibration Test

6.15.1 Automatic sprinklers shall withstand the effects of vibration without deterioration of its performance characteristics. The sprinkler shall be subjected to a vibration of 1mm amplitude for 120 hours at a frequency that is continuously varied between 18 to 37 Hz. However, if the sprinklers exhibit resonance at a frequency within this range, the resonant frequency shall be used throughout the test period. Following the vibration test, the sprinkler shall comply with leakage test as specified in **6.2**.

6.15.2 This test shall be conducted with the test sprinklers unpressurized.

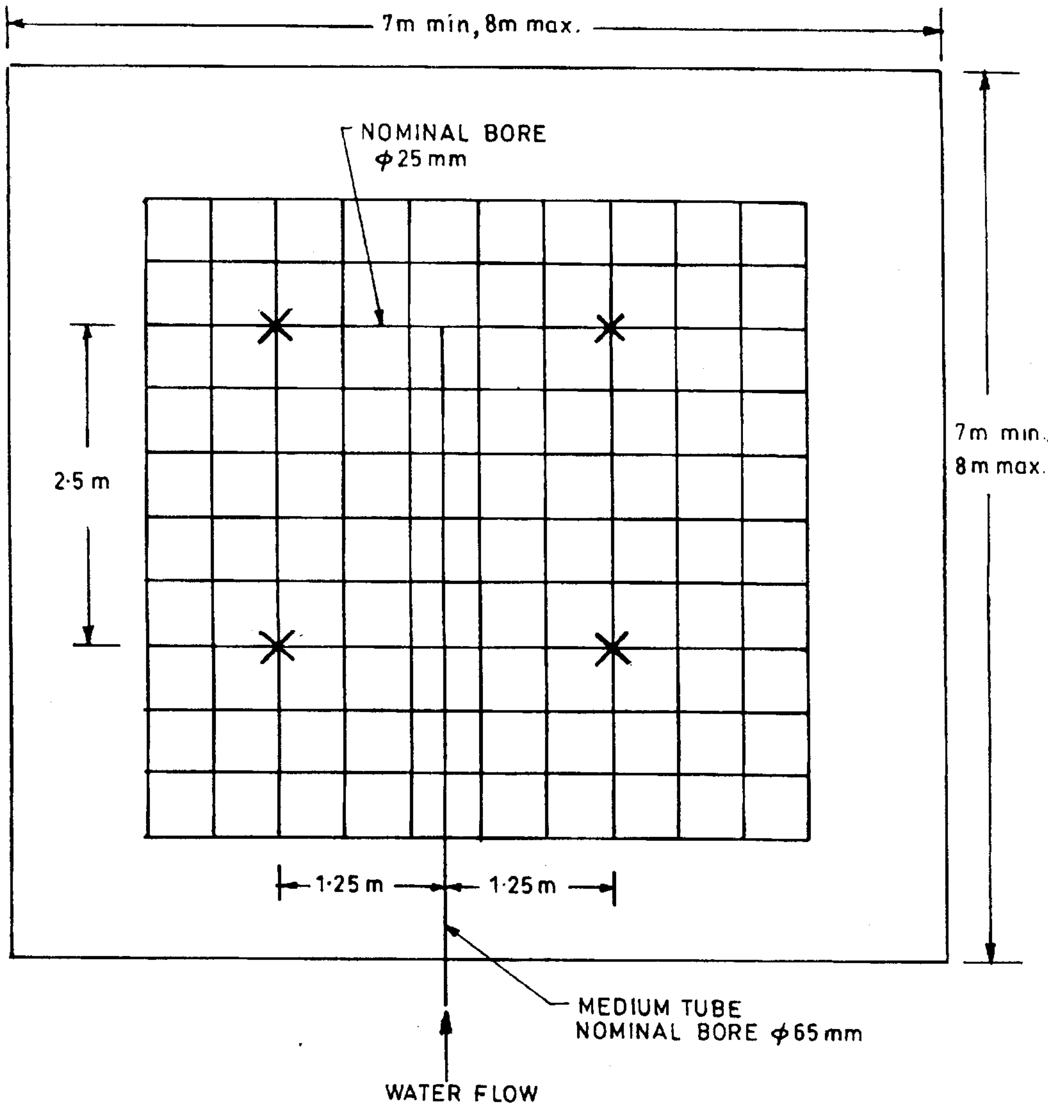


FIG. 6 LAYOUT FOR WATER DISTRIBUTION COLLECTION ROOM (MEASURED AREA 6.25 m^2)

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

6.16 Calibration Test

Sprinkler sample shall be flow tested first at a pressure of 0.5 bar and then at 0.7 bar. Following this, the pressure is to be increased in 0.5 bar increments up to 3.5 bars, in 0.7 bar increments upto 7 bars, decreased in 0.7 bar increments down to 3.5 bar, in 0.5 bar increments down to 0.7 bar and then decreased to 0.5 bar. The flow at each increment of pressure is to be measured by a flow measuring device having an accuracy of within 2 percent of the actual flow. The discharge coefficient shall be calculated using the equation $K = QP^{-0.5}$ (*see* **6.12.1**) and the average value of K shall be calculated. The value of K shall be as per the details given in Table 6.

The details of the equipment for the above test is shown in Fig. 10.

6.17 Corrosion Tests

6.17.1 *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 the test shall be degreased and then immersed in a solution of 50 percent distilled water and 50 percent concentrated nitric acid for between 21 to 24 s. The specimen shall then be rinsed in cold water and immersed in one percent by weight solution of mercurous nitrate in distilled water to which one percent by volume of concentrated nitric acid has been added. The specimen shall remain in the

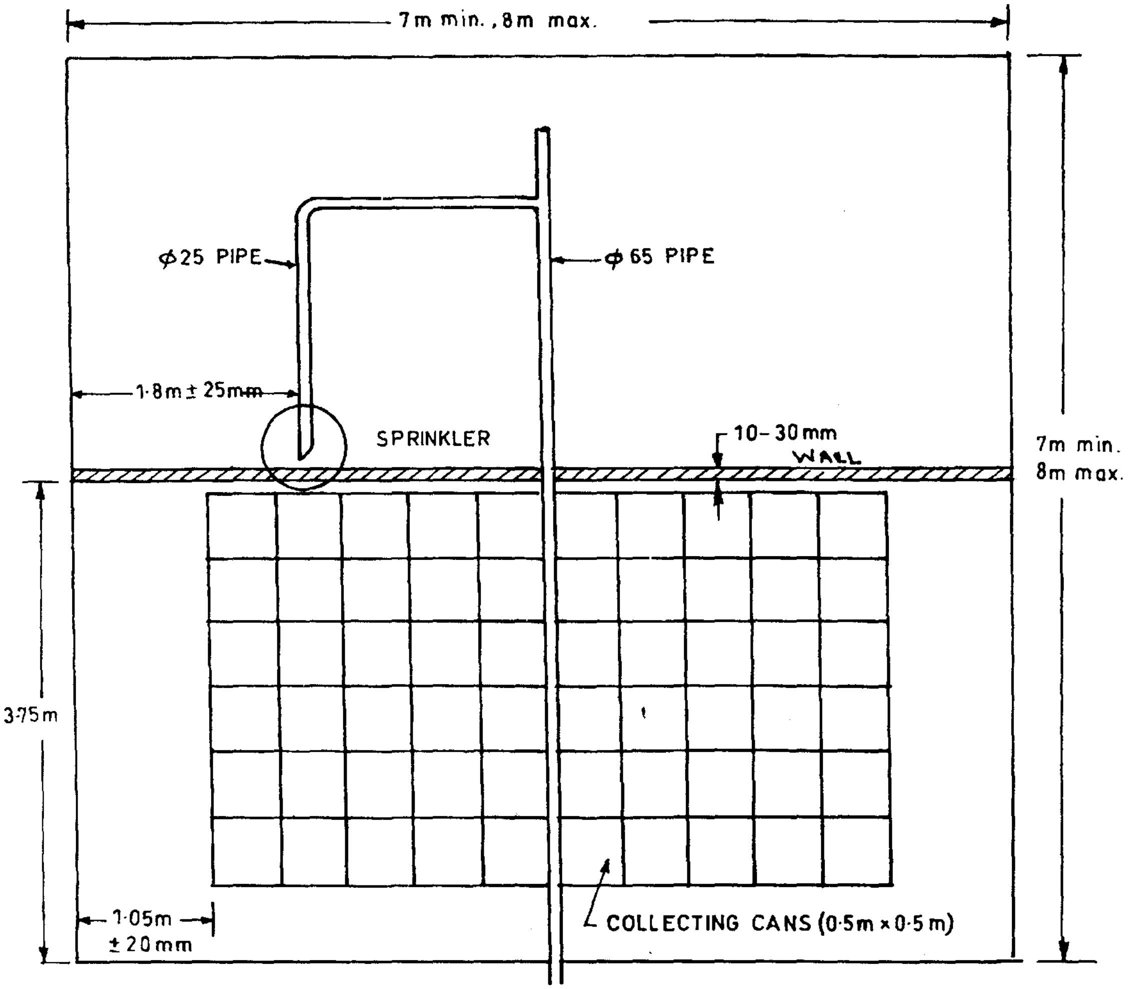


FIG. 7 SPRINKLER DISTRIBUTION ROOM — SIDEWALL

solution for 30 min + 0.05 min and then be removed, rinsed well in cold water and carefully wiped. The specimen shall be inspected immediately for signs of cracking. 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 shall be carefully used. Specific gravity of nitric acid shall be 1.42.

6.17.2 *Sulphur Dioxide Corrosion Test*

Sprinklers shall remain structurally intact and shall operate at 0.35 bar following SO_2 conditioning according to the requirements given below:

The test equipment shall consist of a 10 litre vessel (other sizes of the vessel may be used with proportionate quantities of chemicals) made of heat resistant glass, with a corrosion resistant lid of such a shape as to prevent condensates dripping on the sprinklers. The vessel shall be electrically heated through the bas, 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. During the 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 SO_2 atmosphere for 16 days. The corrosive atmosphere shall be obtained by introducing a solution made up by dissolving 40 g of sodium thiosulphate crystals in one litre of water.

The test shall last two periods of 8 days. Each day 40 ml of dilute sulphuric acid consisting of 156 ml of normal H_2SO_4/l 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 enumerated 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 of not

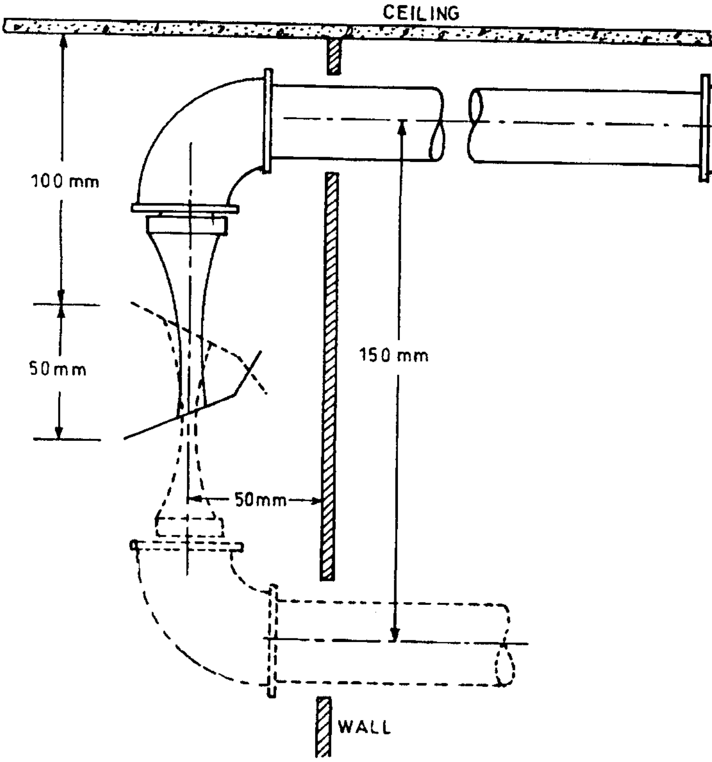


FIG. 8 MOUNTING OF SIDEWALL SPRINKLERS — DISTRIBUTION

exceeding 35 °C with a relative humidity of not more than 70 percent before being functionally tested as given in **6.3** at 0.35 bar.

6.18 Stress Corrosion Cracking Test

6.18.1 *For Sprinklers with Brass Parts*

A sprinkler having brass parts shall:

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

b) demonstrate acceptable performance after being subjected for 10 days to a moist ammonia exposure.

Samples of sprinklers shall be degreased and then exposed for 10 days to a moist ammonia air mixture maintained in a glass chamber approximately 300 mm × 300 mm × 300 mm having a glass cover. A small amount of aqueous ammonia having a specific gravity of 0.94 is to be maintained in the bottom of the chamber, approximately 38 mm below the bottom of the samples. The moist ammonia air mixture in the chamber is to be maintained at essentially atmospheric pressure with the temperature constant at approximately 35 °C. The aqueous ammonia, temperature and pressure provide approximately 33.4 percent by volume of ammonia and 3.9 percent by volume of water vapour above the liquid in chamber, the remaining 62.7 percent by volume being air.

After the exposure period, the test samples are to be examined using a microscope having a magnification of 25 × for any cracking, delamination or other degradation as a result of the test exposure. Operating parts exhibiting degradation as a result of the test exposure described as above shall withstand without any leakage a hydrostatic pressure of 12 bars or one equivalent to their maximum design pressure whichever is greater for one minute and operate at 0.5 bar when exposed to a uniform application of heat. If the samples have any cracking, delamination, or degradation of non operating parts as a result of the test exposure, they shall withstand a flowing pressure of 12 bars for 30 min.

6.18.2 *For Sprinklers With Stainless Steel Parts*

A sprinkler having stainless steel parts shall:

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

b) demonstrate acceptable performance after being subjected to boiling magnesium chloride solution.

Samples shall be degreased prior to the exposure to boiling magnesium chloride solution. Parts used in the sprinklers shall be placed in a 500 ml flask that is fitted with a thermometer and a wet condenser approximately 750 mm long. The flask is to be filled about one-half full with a 42 percent by weight magnesium chloride solution, placed on a thermostatically controlled electrically heated mantel

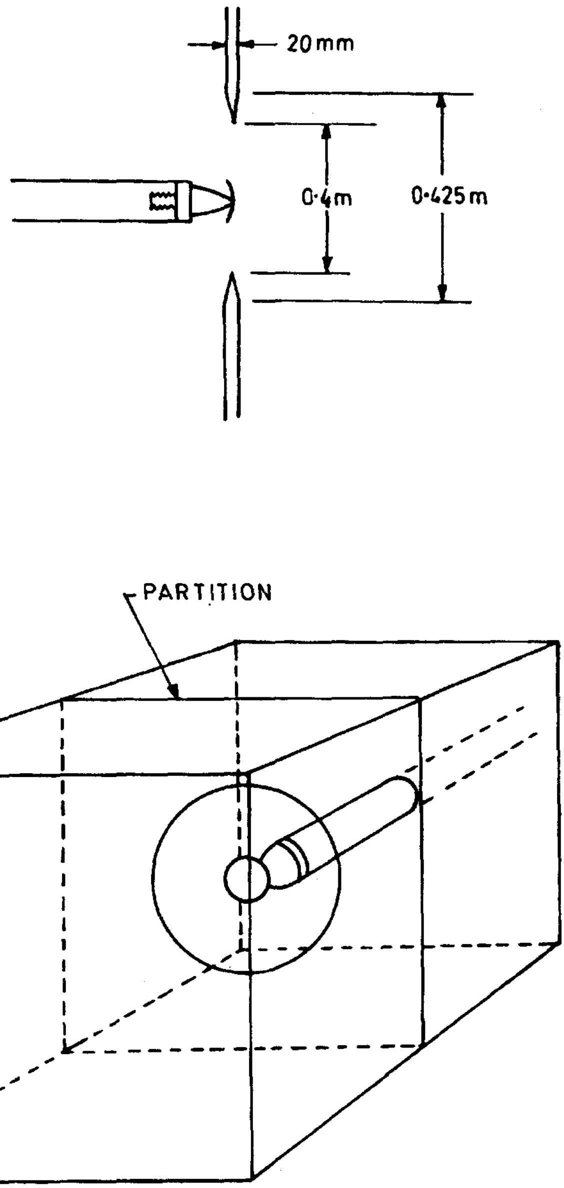


FIG. 9 APPARATUS FOR DETERMINING WATER DISTRIBUTION ABOVE AND BELOW THE DEFLECTOR

and maintained at a boiling temperature of 150 °C ± 1 °C. The parts are to be unassembled, that is, not contained in a sprinkler assembly. The exposure is to last for 150 h in case of sprinklers to be used in non corrosive atmosphere and for 500 h in case of sprinklers to be used in corrosive atmosphere.

After the exposure period, the test samples shall be removed from the boiling magnesium chloride solution and rinsed in de-ionized water.

After the exposure period, the test samples are to be examined using a microscope having a magnification of 25 × for any cracking, delamination or other degradation as a result of the test exposure. Test samples not exhibiting degradation are to be considered acceptable without further test.

Operating parts exhibiting degradation shall be tested further by assembling five new sets of parts in sprinkler frames made of materials that do not alter the corrosive effects of the magnesium chloride solution on the stainless steel parts. These samples shall be tested in the same fashion as specified above and after the test the samples shall withstand without any leakage a hydrostatic pressure of 12 bars or one equivalent to their maximum design pressure whichever is greater for one minute and operate at 0.5 bar when exposed to a uniform application of heat. If the samples have any cracking, delamination, or degradation of non-operating parts as a result of the test exposure, they shall withstand a flowing pressure of 12 bars for 30 min.

The same type of repetitive tests are also applicable for non-operating parts that exhibit degradation.

6.19 Determination of Time Constant

The sprinklers shall be tested in each designed operating position. The sprinklers shall be mounted in the test section of the wind tunnel (*see* Fig. 11) in such a way that the release element is exactly in the middle of the tunnel. The air mass flow rate in the tunnel is adjusted to the equivalent of 80 cm/s at 20°C and is maintained at this figure as the temperature of the air in the tunnel is raised in uniform steps in the range of 1°C/min to 30°C/min. The temperature inside the tunnel is stabilized prior to the start of the test. The sprinklers shall be charged to a pressure of 0.35 bar during the test. The response time of the sprinklers is noted for each rate of rise of temperature. Then the time to operate t against rate of rise curve is plotted which comes to a straight line. The intercept of the straight line is a measure of time constant T. If the rate of rise of temperature in °C/min is α and the temperature rating in °C is β, then the following equation will apply:

$$t = (\beta/\alpha) + T$$

The value of T thus calculated shall be always less than 150 s.

6.20 Response Test for Ceiling, Flush, Recessed and Concealed Sprinklers

6.20.1 Sprinklers shall operate within the times specified in **6.20.3** when tested in accordance with **6.20.2**.

6.20.2 The sprinkler to be tested shall be installed in a ceiling panel in the centre of a closed room with floor dimensions of 4.57 m ± 0.1 m × 4.57 + 0.1 m and ceiling height of 2.4 m ± 0.1 m as shown in Fig. 12. The heat source shall consist of a propane gas pot burner, positioned in a corner with its centre 450 ± 25 mm from two adjacent walls and its top surface 560 ± 25 mm above the floor. Adequate ventilation shall be provided for the burner.

The room temperature shall be monitored 180 mm from the centre of the room and 30 ± 2 mm 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. 13. The temperature shall also be monitored 5 ± 1mm below the ceiling.

At the start of the test the room shall have been preconditioned to 30 + 5 °C with a ceiling structure temperature of between 25 °C and 40 °C, and the specimens shall have been preconditioned to 20 + 5 °C for atleast 24 h. 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.

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

$$x + 3.47\,\sigma n$$

where

x	=	arithmetic mean response time of specimens tested,
3.47	=	constant, used where 10 specimens tested, and
σn	=	standard deviation for specimens tested.

The following requirements shall be met as specified in Table 9.

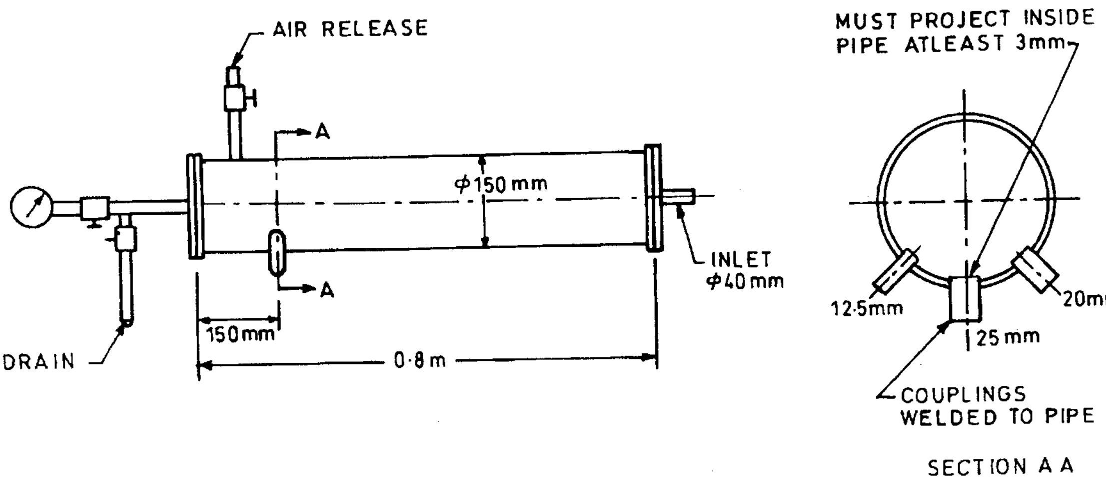


FIG. 10 CALIBRATION TEST EQUIPMENT

Table 9 Response Test
(*Clause* 6.20.2)

Sprinkler Nominal Temperature Rating, °C	Statistical Limit of Operating Time, s
(1)	(2)
Up to and including 78	170
79	212
80-100	285

6.20.3 *Impact Resistance Test*

An automatic sprinkler shall not be damaged or leaked when tested for impact resistance as below (*see* also Fig. 14 for the testing apparatus) :

Sprinklers shall be tested by dropping a cylindrical mass equivalent to the mass of the sprinkler to the nearest 15 g increment from a height of 1 m onto the geometric centre of the deflector or, if this is not practicable, onto the butt end of the sprinkler. The mass shall not be allowed to impact on the sprinkler more than once. Following the impact, the sprinkler shall be removed and tested to other performance tests like leakage resistance etc.

7 REQUIREMENT AND TESTING METHODS FOR THE DETERMINATION OF AUTOMATIC SPRINKLER HEAT SENSITIVITY

7.1 The automatic sprinklers having an external primary heat sensitive element which will normally be positioned not closer than 5 mm to any mounting surface shall be subjected to the tests as described in **7.2.1** and **7.2.2**. These test methods are not applicable for determining the sensitivity of ceiling flush, recessed or concealed sprinkler types.

7.2 Test 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 requirements of **7.2.1** shall be classified as Fast Response Sprinklers.

7.2.1 *Plunge Test*

It determines the variations in sensitivity due to orientation and it provides sensitivity performance record to enable efficient quality assurance.

7.2.1.1 Sprinkler samples of each temperature rating shall be tested. Each sprinkler shall be mounted in a test jig (*see* Fig. 15) and shall be stabilized at 30 °C ± 2°C.

7.2.1.2 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 10 (a supervisory air pressure of not less than 0.35 bar shall be applied at the sprinkler outlet).

7.2.1.3 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. 16a), and
b) frame arms in line with the airflow (*see* Fig. 16b).

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

1) frame arms rotated 1 800 about the waterway axis from position a, and
2) the centre of the heat collector directly downstream of a frame arm.

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

a) Fusible element sprinklers — 2
b) Glass bulb sprinklers — 3

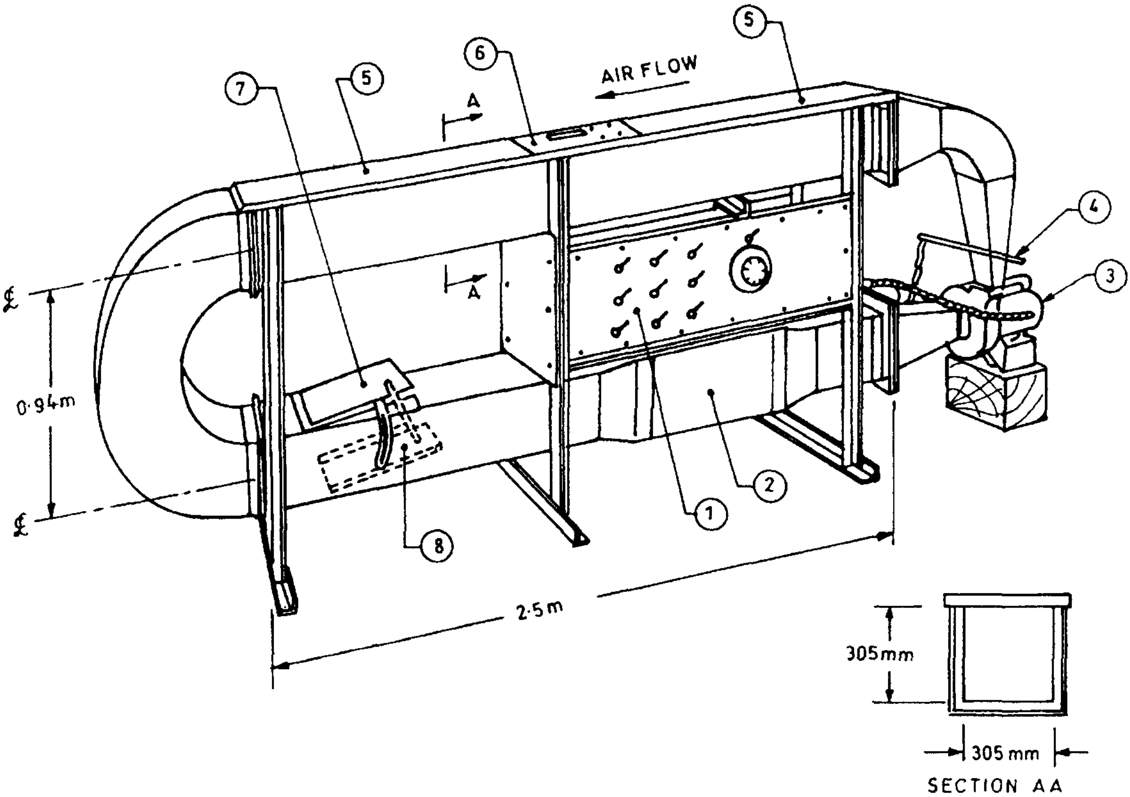
7.2.2 *Rate of Rise Test*

It determines the sensitivity performance characteristic of sprinklers to determine their suitability for use in applications specifying particular performance criteria.

7.2.2.1 Sprinkler specimens shall be suitably mounted in a test jig. At the start of each test the test jig and the sprinkler shall be inserted in the tunnel test section and shall be stabilized at a temperature of 30°C ± 2°C, before commencement of the heating rate of rise cycle.

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

a) *All sprinklers 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 **7.2.1.3**.
b) *Sprinklers for in-rack use*
   1) Pendant spray and conventional sprinkler types shall be tested with the waterway axis parallel to the airflow direction with the sprinkler waterway inlet downstream relative to the airflow (*see* Fig. 16c).



1. Control panel with nine switches for coarse control and autotransformer for fine control of heaters in 2.
2. Heater compartment with ten 1 kW heater elements.
3. 74.6 W 2 850 rev/min motor blower.
4. Manual control for shutter controlling air flow.
5. Removalable asbestos sheet covers.
6. Cover of sprinkler test compartment with glass inspection window.
7. Exhaust port.
8. Inlet port coupled to exhaust port to facilitate rapid cooling.

FIG. 11 WIND TUNNEL

2) 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. 16d).

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

7.2.2.4 Sprinkler specimens of each rating shall be tested in the wind tunnel in the appropriate positions and orientations described at **7.2.2.2** 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° C/min,
b) 12° C/min, and
c) 20° C/min.

The sprinkler operating time shall be measured from initiation of the rate of rise, starting at a stable condition of 30°C.

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

a) Fusible bulb sprinklers —2
b) Glass bulb sprinklers —3

7.3 Analysis of Test Results

7.3.1 *Plunge Test Results Analysis*

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

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

$$T_p = \frac{t_r}{l_n\ (1 - \Delta\ T_i / \Delta\ T_g)}$$

where

T_p = time constant,

t_r = time to operate,

T_i = sprinkler nominal rating — starting temperature, and

ΔT_g = tunnel temperature — starting temperature.

7.3.1.3 The *RTIp* shall then be determined by the following formula:

$$RTI_p = T_p\ V^{0.5}$$

where

V = airstream velocity in test section.

7.3.2 *Rate of Rise Analysis*

The time constant T and the effective operating temperature θ_e shall be determined for each sprinkler

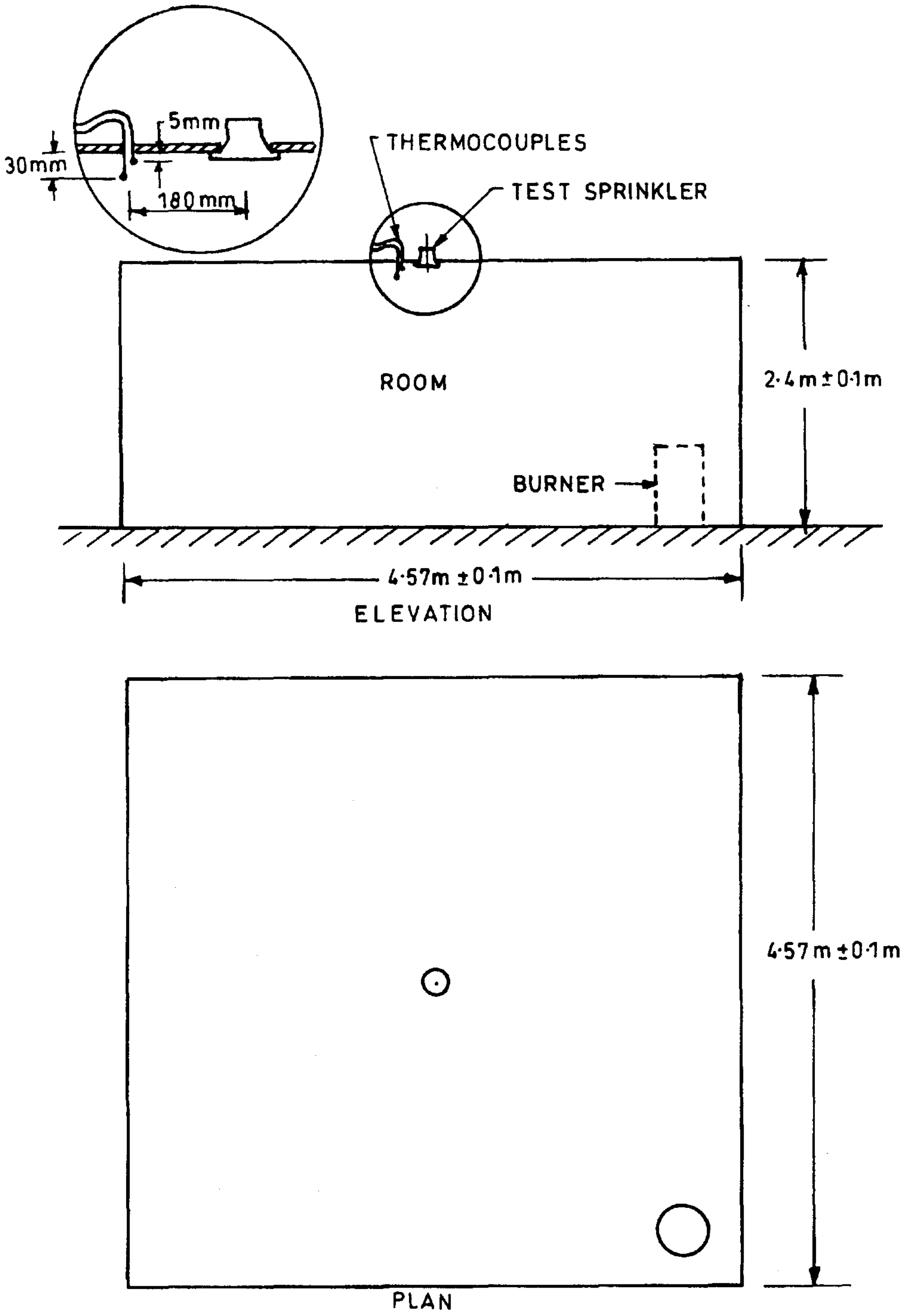


FIG. 12 RESPONSE TEST ROOM LAYOUT

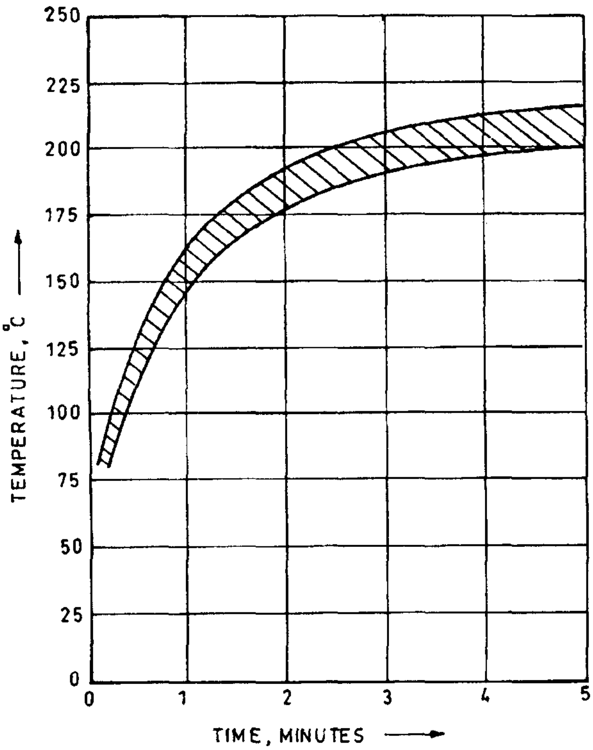


FIG. 13 TIME TEMPERATURE RELATIONSHIP FOR ROOM RESPONSE TEST

orientation and temperature rating. The values may be determined graphically by plotting tunnel air temperature at operation θ_g against the rate of rise β.

A graphical plot of θ_g against β will describe a line with slope equal to the time constant T having an intercept at the θ_g axis (at $\beta = 0$) equal to the effective operating temperature θ_e for the sprinkler rating and orientation (*see* Fig. 17).

7.4 Test Apparatus

7.4.1 *Plunge Test*

A wind tunnel with approximate test section dimensions of 305 mm width x 305 mm depth shall be capable of developing the conditions at the test sections in accordance with Table 10.

7.4.2 *Rate of Rise Test*

A wind tunnel with approximate test section dimensions of 240 mm width x 150 mm depth shall be capable of developing the conditions at the test sections in accordance with Table 11.

8 TESTING PROCEDURE

8.1 The complete type testing of the sprinkler heads involves evaluation through all the tests enumerated in **6**. However, for the evaluation of both types of sprinklers, that is, fusible element and glass bulb types, at least 60 sprinklers from each type shall be tested as per the following scheme for various requirements and sprinklers shall be reused for subsequent tests in certain cases as detailed in Annex A.

Table 10 Plunge Test Tunnel Conditions
(*Clauses* 7.2.1.2 *and* 7.4.1)

Sprinkler Nominal Temperature Rating, °C	Tunnel Temperature at Test Section[1)] °C	Airstream Velocity @ Test Section[2)] m/s
(1)	(2)	(3)
57 to 107	197 ± 5	2.5 ± 0.2
121 to 149	291 ± 7	2.5 ± 0.2

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

[2)] 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.

9 ROUTINE TESTING PROCEDURES IN PRODUCTION LINE

The testing programme suggested in **8** is applicable for the evaluation of the prototype sprinklers in the initial stage and also at the time of renewal of the acceptance by the authorities having jurisdiction. However, during the production of sprinklers the following testing requirements shall be met for all the sprinklers in the production line:

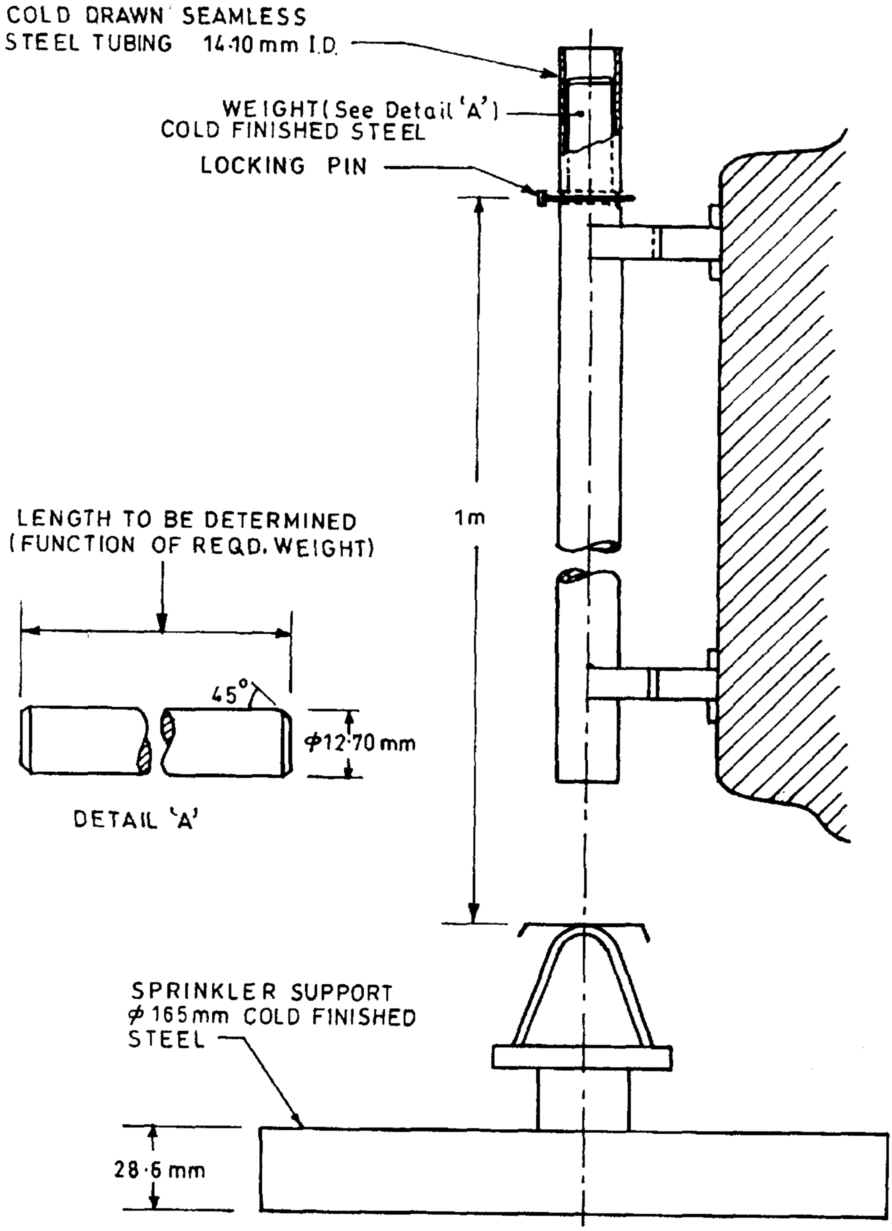


FIG. 14 IMPACT TEST APPARATUS

a) Examination of sprinklers as specified in **6.1**, and
b) Each automatic sprinkler shall be subjected to hydrostatic test at 35 bars pressure and the pressure shall be maintained for a period of not less than 5 s. There shall be no leakage during the test.

10 TEST FACILITIES EXPECTED AT THE MANUFACTURERS WORKS

10.1 The manufacturer shall provide regular production control, inspection and tests to maintain the quality of the sprinklers produced from time to time. For this purpose, it is necessary to provide at least the following facilities so that these tests can be carried out at regular intervals:

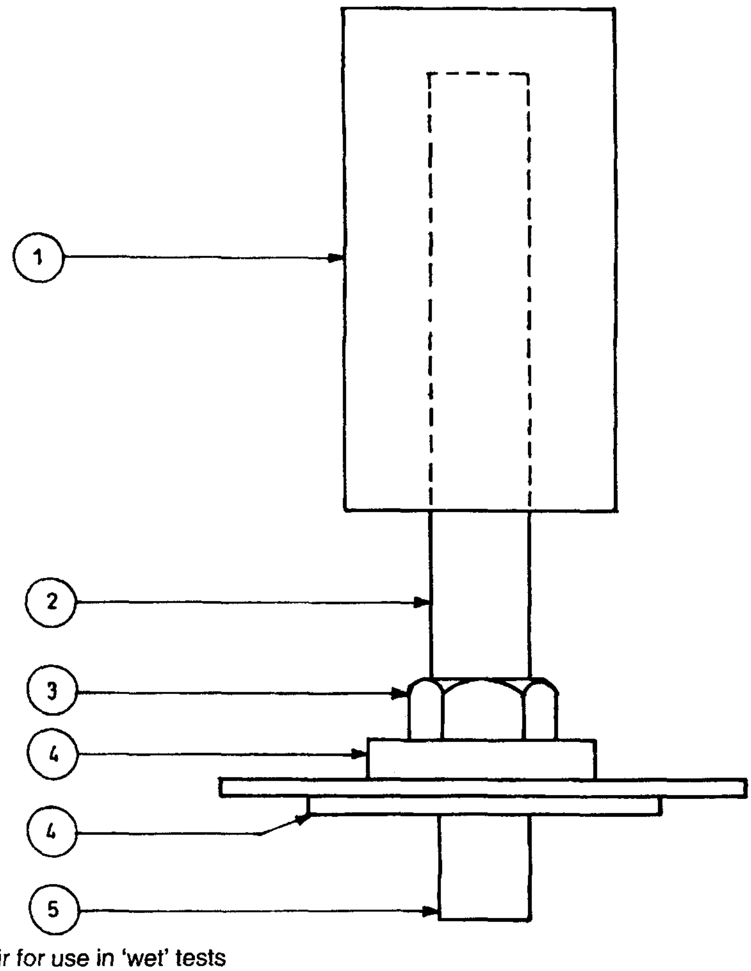
a) Leak resistance test (*see* **6.2**),
b) Functional test (*see* **6.3**),
c) Release temperature test (*see* **6.4**),
d) Strength of frame test (*see* **6.10**),
e) Water flow test (*see* **6.12**),
f) [1]Distribution test (*see* **6.13**),
g) [1]Calibration test (*see* **6.16**),
h) [1]Response test (*see* **6.20**), and
j) [1]Sensitivity test (*see* **7**).

11 MARKING

11.1 Each sprinkler shall be legibly and indelibly marked with the following :

a) Manufacturer's name or trade-mark.

[1]These tests are optional.



1. Reservoir for use in 'wet' tests
2. Externally threaded tube
3. Locking ring
4. Locating discs
5. Sprinkler fitting

FIG. 15 SPRINKLER MOUNTING JIG

b) Model identification to be used in conjunction with the manufacturer's catalogue. The manufacturer's catalogue identification must define uniquely the design size, distribution type and mounting position. In particular, the identification symbol used must be changed where there is any significant alteration in the shape, materials or method of manufacture.

c) Year of manufacture.

d) Nominal release temperature.

e) Cover plates of the concealed sprinklers shall be marked 'Do not Paint'.

f) Sprinklers shall be marked with the nominal temperature rating in °C or colour code on a part of the sprinkler after operation.

Table 11 Rate of Rise Test Tunnel Conditions

(*Clause* 7.4.2)

Start Temp °C	Rate of Temp Rise °C/min	*Max* Temp °C	Temperature Variation from Ideal Ramp °C	Airstream Velocity in Test Section at 25°C
(1)	(2)	(3)	(4)	(5)
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

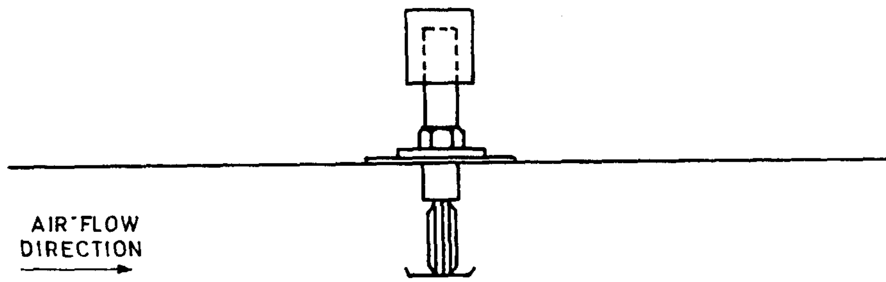


FIG. 16A FRAME ARMS NORMAL TO AIRFLOW

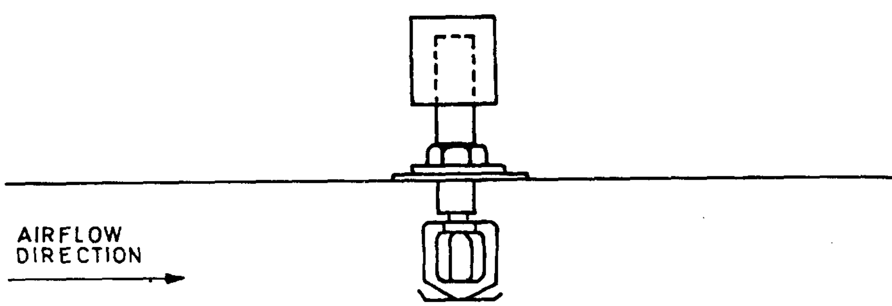


FIG. 16B FRAME ARMS IN LINE WITH THE AIRFLOW

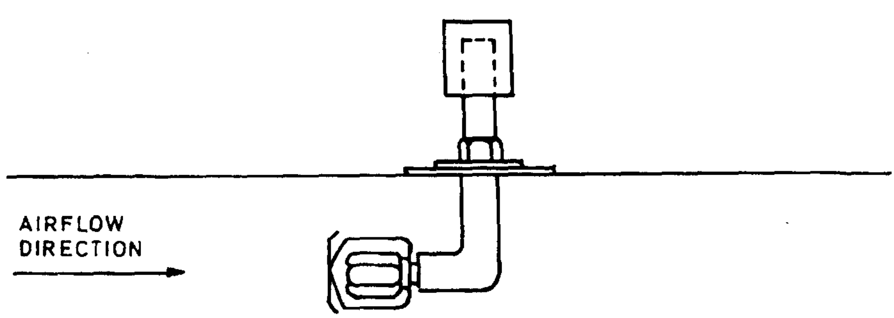


FIG. 16C FRAME ARMS PARALLEL TO AIR FLOW

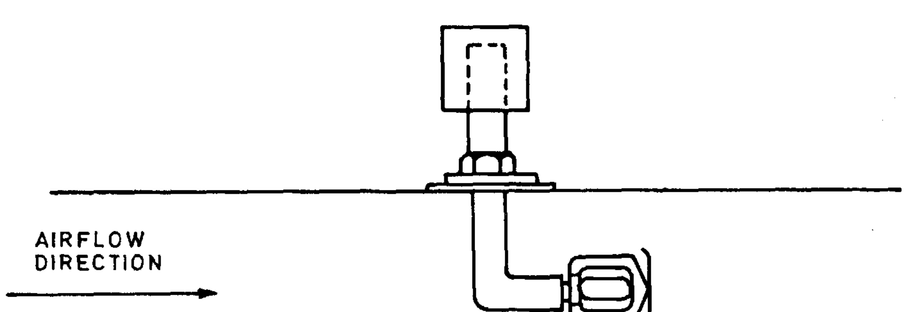


FIG. 16D FRAME ARMS PARALLEL TO AIRFLOW

FIG. 16 WIND TUNNEL TEST SECTION

g) The liquid in a glass bulb sprinkler shall be coloured as specified in Table 2.
h) Where the nominal release temperature in colour coded on the yoke arms of a sprinkler, the coding as specified in Table 3 shall be followed.

11.2 BIS Certification Marking

The sprinkler head may also be marked with the Standard Mark.

11.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

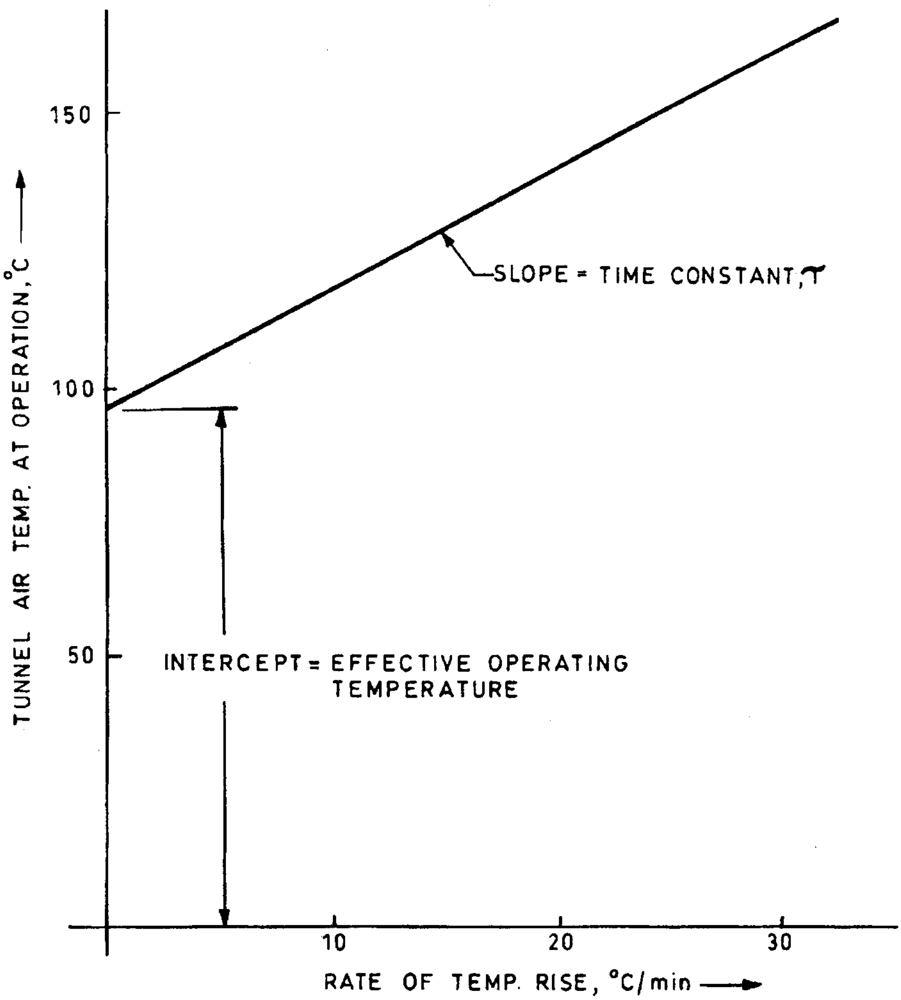


FIG. 17 GRAPHICAL METHOD FOR DETERMINING TIME CONSTANT, τ AND EFFECTIVE OPREATING TEMPERATURE, θ_e

ANNEX A

(*Clause* 8)

QUANTITY OF SAMPLES OF SPRINKLER

No. of Sprinklers Required

Sl No.	Type of Test	Clause	Universal	Upright	Pendent
1	Time constant evaluation	6.19	1 to 4	1 to 4	1 to 4
2	Release temperature	6.4	50 bulbs	50 bulbs	50 bulbs
3	Service load measurement	6.9	5 to 8	5 to 8	5 to 8
4	Strength of sprinkler frames	6.10	5 to 8	5 to 8	5 to 8
5	Strength of glass bulbs	6.8	9 to 12	9 to 12	9 to 12
6	Thermal shock	6.7	13, 14	13, 14	13, 14
7	Heat exposure (fatigue)	6.5	15, 16	15, 16	15, 16
8	High ambient temperature (ageing)	6.6	17 to 24	17 to 24	17 to 24
9	Water hammer test	6.14	19 to 21	19 to 21	19 to 21
10	Vibration test	6.15	15, 16, 22	15, 16, 22	15, 16, 22
11	Stress corrosion cracking	6.18	23, 24	23, 24	23, 24
12	Impact resistance	6.20.3	15, 23, 24	15, 23, 24	15, 23, 24
13	Leak resistance	6.2.1	15 to 24	15 to 24	15 to 24
14	Leak resistance (30 days)	6.2.2	17, 18	17, 18	17, 18
15	Corrosion tests	6.17	25 to 28	25 to 28	25 to 28
16	Functional test:	6.3			
	0.35 bars upright position	—	13, 17, 18, 25, 29 to 32	13, 15, 17, 18, 25, 26, 29, 30	—
	3.50 bars upright position	—	15, 19, 27, 33 to 37	14, 16, 19, 20, 27, 28, 31, 32	—
	7.00 bars upright position	—	20, 38 to 44	21 to 24, 33 to 36	—
	0.35 bars pendent position	—	14, 21, 22, 26, 45 to 48	—	13, 15, 17, 18, 25, 26, 29, 30
	3.50 bars pendent position	—	16, 23, 28, 49 to 53	—	14, 16, 19, 20, 27, 28, 31, 32
	7.00 bars pendent position	—	24, 54 to 60	—	21 to 24, 33 to 36
17	Water flow test (normal)	6.12.1	33 to 36	33 to 36	33 to 36
18	Water flow test (endurance)	6.12 .2	33 to 36	33 to 36	33 to 36
19	Deflector strength test	6.11	34 and 35	34 and 35	34 and 35
20	Water distribution test	6.13.1 and 6.13.2	29 to 32	29 to 32	29 to 32
21	Water distribution test	6.13.3	30 and 31	30 and 31	30 and 31
22	Calibration test	6.16	any three	any three	any three
23	Response test	6.20	1, 5, 12, 14 16, 22, 23, 27, 30, 34	1, 5, 12, 14 16, 22, 23 27, 30, 34	1, 5, 12, 14 16, 22, 23 27, 30, 34
24	Sensitivity and determination of RTI index	7	Optional (any 10)	Optional (any 10)	Optional (any 10)

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Fire Fighting Sectional Committee, CED 22

Organization	*Representative(s)*
Fire Advisor, Ministry of Home Affairs, New Delhi	SHRI OM PRAKASH (***Chairman***)
Avon Services Pvt Ltd, Mumbai	MANAGING DIRECTOR TECHNICAL EXECUTIVE (*Alternate*)
Bhabha Atomic Research Centre, Mumbai	CHIEF FIRE OFFICER
Bombay Fire Brigade, Mumbai	CHIEF FIRE OFFICER DEPUTY CHIEF FIRE OFFICER (*Alternate*)
Central Building Research Institute (CSIR), Roorkee	DR T. P. SHARMA DR A. K. GUPTA (*Alternate*)
Central Industrial Security Force, New Delhi	SHRI R. C. SHARMA SHRI S. L. NAGARKAR (*Alternate*)
Central Public Works Department, New Delhi	CHIEF ENGINEER (E)
Chief Fire Officer, State Bank of India, Mumbai	SHRI J. S. GAHLAUT
Concord Arai Pvt Ltd, Chennai	SHRI R. RAMAKRISHNAN
Controller of Quality Assurance, Pune	SHRI J. D. KALE LT-COL S. C. AGARWAL (*Alternate*)
Defence Research and Development Organization, New Delhi	DIRECTOR DEUPTY DIRECTOR (*Alternate*)
Delhi Fire Service, New Delhi	SHRI S. K. DHERI SHRI SURINDER KUMAR (*Alternate*)
Directorate General of Supplies and Disposals, New Delhi	SHRI M. GANGARAJU SHRI V. K. VERMA (*Alternate*)
Engineer-in-Chief's Branch, New Delhi	SHRI S. K. KALIA SHRI M. K. BANSAL (*Alternate*)
Eureka Firetech Pvt Ltd, Mumbai	SHRI S. M. DESAI SHRI E. S. DESAI (*Alternate*)
Fire and Safety Appliances Co, Kolkata	SHRI S. N. KUNDU
Home Department (Fire Service), Chennai	DIRECTOR DEPUTY DIRECTOR (*Alternate*)
Home (Police Department), Government of Andhra Pradesh, Hyderabad	SHRI SWARANJIT SEN DEPUTY DIRECTOR (*Alternate*)
Indian Rayon, New Delhi	SHRI S. K. SUREKA
Kooverji Devshi and Co (P) Ltd, Mumbai	SHRI P. H. SETHNA SHRI N. T. PANJWANI (*Alternate*)
K.V. Fire Chemicals, Mumbai	SHRI H. M. SABADRA
Loss Prevention Association India, Mumbai	MANAGING DIRECTOR SHRI D. K. SARKAR (*Alternate*)
MECON, Ranchi	SHRI SUNIL DAS SHRI R. N. CHACHRA (*Alternate*)
Ministry of Home Affairs, New Delhi	SHRI D. K. SHAMI
Ministry of Defence, New Delhi	SHRI P. K. CHATTERJEE SHRI H. S. KAPARWAN (*Alternate*)
National Airport Authority, New Delhi	DIRECTOR OF EQUIPMENT DEPUTY DIRECTOR (*Alternate*)
Newage Industries, Gujarat	SHRI B. J. SHAH SHRI A. M. SHAH (*Alternate*)
Oil & Natural Gas Commission, Dehra Dun	SHRI R. P. SAXENA SHRI NEERAJ SHARMA (*Alternate*)
Oil Industries Safety Directorate, Ministry of Petroleum and Natural Gas, New Delhi	SHRI SANJEEVI GANESAN K. SHRI D. K. VARSHNEY (*Alternate*)
Railway Board, New Delhi	ASSISTANT SECURITY COMMISSIONER (FIRE)
Real Value Appliances, Mumbai	SHRI ASHUTOSH MANGAL
Safex Fire Services, Mumbai	SHRI JITENDRA SHAH
Steelage Industries Ltd, Chennai, New Delhi	SHRI SHIV NATH SHRI V. KAMALANATHA (*Alternate*)
Steel Authority of India Ltd, Rourkela	SHRI B. N. DAS SHRI B. P. DAS (*Alternate*)
Steel Authority of India Ltd, Bokaro	SHRI A. RAUTELAU SHRI C. P. SINGH (*Alternate*)
Surex Prodution and Sales Pvt Ltd, Kolkata	SHRI TARIT SUR SHRI D. NEOGI (*Alternate*)
Tariff Advisory Committee, Ahmedabad/New Delhi	SHRI J. N. VAKIL SHRI T. R. A .KRISHNAN (*Alternate*)

(*Continued on page* 27)

(*Continued from page* 26)

Organization	*Representative(s)*
The Institution of Fire (India), New Delhi	PRESIDENT GENERAL SECRETARY (*Alternate*)
Vijay Fire Protection System Pvt Ltd, Mumbai	SHRI HARISH SALOT
West Bengal Fire Service, Kolkata	SHRI B. PATHAK
In Personal Capacity (House No. 33/2965A, Vennala High School Road, Cochin)	SHRI G. B. MENON
In Personal Capacity (B-1/64, Sector-16, Rohini, New Delhi)	SHRI P.N. PANCHAL
BIS Directorate General	SHRI S.K. JAIN, Director and Head (Civ Engg) [Representing Director General (*Ex-officio Member*)]

Member Secretary

SHRI S. CHATURVEDI
Joint Director (Civ Engg), BIS

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