IS 15105 (2002): Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems - Code of Practice [CED 22: Fire Fighting]

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भारतीय मानक

जड़ित स्वचलित स्प्रिंकलर अग्निशमन तंत्र के डिजाइन और संस्थापन की रीति संहिता

Indian Standard

DESIGN AND INSTALLATION OF FIXED AUTOMATIC SPRINKLER FIRE EXTINGUISHING SYSTEMS — CODE OF PRACTICE

ICS 13.220.10

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 14

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 (or supplies) and one or more sprinkler installations; each installation consists of a set of installation control valves 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, inside ovens or stoves or below obstructions. The main elements of a typical installation is shown in Fig. 1.

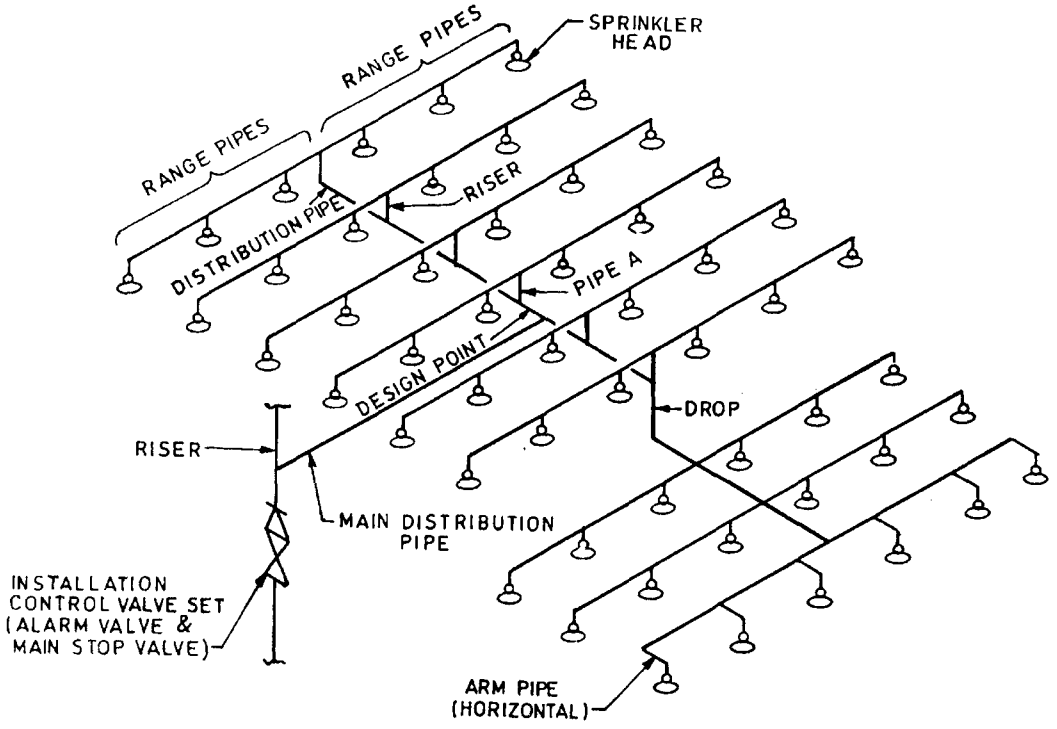


FIG. 1 MAIN ELEMENTS OF A SPRINKLER INSTALLATION

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. The classic use of the sprinkler is in the hot gas layer which forms beneath the ceiling of an enclosure in which a fire is developing.

The sprinklers operate at pre-determined temperatures to discharge water over the affected part of the area below, the flow of water through the alarm valve initiating a fire alarm. The operating temperature is generally selected to suit ambient temperature conditions. Only sprinklers in the vicinity of the fire, *i.e.*, those which become sufficiently heated, operate. It should not be assumed that the provision of sprinkler system entirely obviates the need for other means of fighting fires and it is important to consider the fire precautions in the premises as a whole.

Structural fire resistance, escape routes, fire alarm systems, particular hazards needing other fire protection methods, provision of hose reels and fire hydrants and portable fire extinguishers, etc, safe working and good handling methods, management supervision and good housekeeping all need consideration. It is essential that sprinkler systems should be properly maintained to ensure operation when required. This routine is reliable to

(Continued on third cover)

Indian Standard

DESIGN AND INSTALLATION OF FIXED AUTOMATIC SPRINKLER FIRE EXTINGUISHING SYSTEMS — CODE OF PRACTICE

1 SCOPE

This standard lays down the requirements for the design and installation of fixed automatic sprinkler fire extinguishing system.

2 REFERENCES

The Indian Standards listed in Annex A 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 given in Annex A.

3 DEFINITIONS

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

3.1 Alarm Test Valve — A valve through which water may be drawn to test the operation of the water motor firm alarm and/or of any associated electric fire alarm.

3.2 Alarm Valve — A check valve, of the wet, dry or composite type, that also initiates the water motor fire alarm when the sprinkler installation operates.

3.3 Alarm Valve, Pre-action — An alarm valve suitable for a pre-action installation.

3.4 Alarm Valve, Recycling — An alarm valve suitable for a recycling installation.

3.5 Alarm Valve, Wet — An alarm valve suitable for a wet installation.

3.6 Arm Pipe — A pipe, other than the last section of a range pipe, feeding a single sprinkler.

3.7 Assumed Maximum Area of Operation, Hydraulically Most Favourable Location — The location in a sprinkler array of an AMAO of specified shape at which the water flow is the maximum for a specific pressure.

3.8 Assumed Maximum Area of Operation, Hydraulically Most Unfavourable Location — The location in a sprinkler array of an AMAO of specified shape at which the water supply pressure is the maximum needed to give the specified design density.

3.9 Cut-Off Sprinkler — A sprinkler protecting a door or window between two areas only one of which is protected by the sprinkler.

3.10 Design Density — The minimum density of discharge, in mm/min of water, for which a sprinkler installation is designed, determined from the discharge of a specified group of sprinklers, in l/min, divided by the area covered, in m^2.

3.11 Design Point — A point on a distribution pipe of a pre-calculated installation, downstream of which pipework is sized from tables and upstream of which pipework is sized by hydraulic calculation.

3.12 Distribution Pipe — A pipe feeding either a range pipe directly or a single sprinkler on a non-terminal range pipe more than 300 mm long.

3.13 Distribution Pipe Spur — A distribution pipe from a main distribution pipe, to a terminal branched pipe array.

3.14 Drencher — A sprayer used to distribute water over a surface to provide protection against fire exposure.

3.15 Drop — A vertical pipe feeding a distribution or range pipe.

3.16 End-Side Array — A pipe array with range pipes on one side only of a distribution pipe (*see* Fig. 2 and 3).

3.17 End-Centre Array — A pipe with range pipes on both sides of a distribution pipe (*see* Fig. 4 and 5).

3.18 Fastener — A device for attaching pipe hanger components to a building structure or racking.

3.19 Fire Door — A door and frame of specified fire resistance conforming to IS 3614 (Part 1) and IS 3614 (Part 2).

3.20 Fire Resistance — The ability of a component or the construction of a building to satisfy for a stated

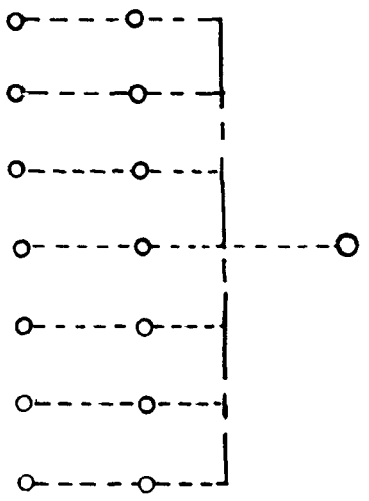


FIG. 2 TWO END-SIDE WITH CENTRAL FEED

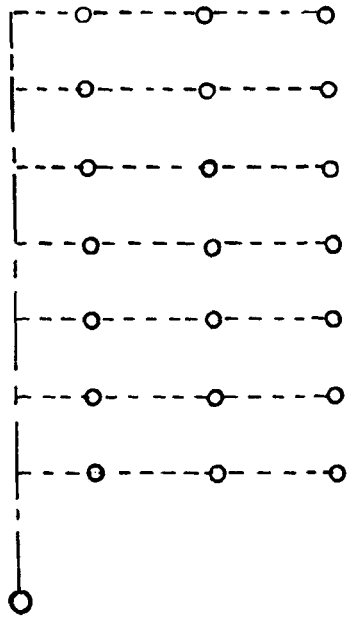


FIG. 3 THREE END-SIDE WITH END FEED

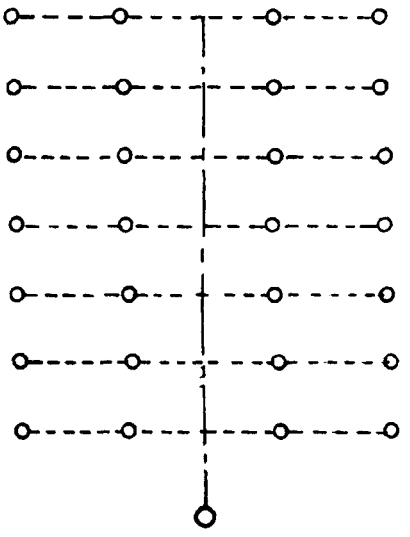


FIG. 4 TWO END-CENTRE WITH END FEED

period of time the appropriate criteria specified in IS 3809.

3.21 Fire Shutter — A shutter and frame of specified fire resistance complying with IS 3614 with respect to stability and integrity.

3.22 Fully Hydraulically Calculated — A term applied to pipework sized as specified in **4.5.2** or an installation in which all the pipework downstream of the main installation control valve set is sized.

3.23 Hanger — An assembly for suspending pipework from the elements of building structure.

3.24 High-Rise System — A sprinkler system in which the highest sprinkler is more than 45 m above the lowest sprinkler or the sprinkler pumps whichever is the lower.

3.25 Hydraulic Alarm, Intermittent — Sounding of a hydraulic water motor alarm gong for intervals totalling less than the alarm period.

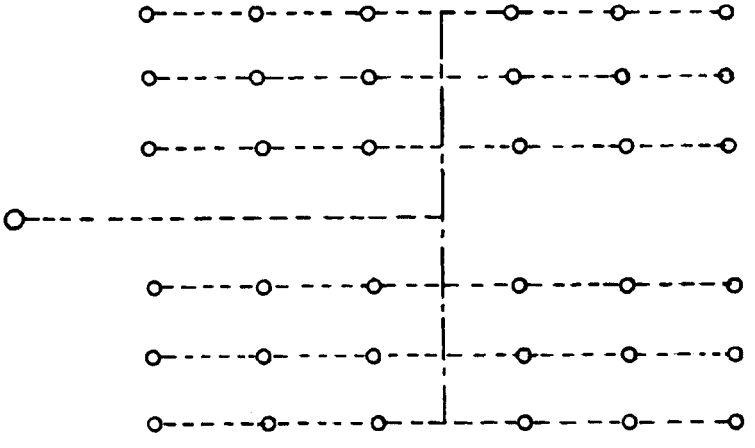


FIG. 5 THREE END-CENTRE WITH CENTRE FEED END FEED

3.26 Installation Sprinkler Installation — Part of a sprinkler system comprising a set of installation main control valves, the associated downstream pipes and sprinklers.

3.27 Installation, Pre-action — A dry installation in which the alarm valve can be opened by an independent fire detection system in the protected area.

3.28 Installation, Recycling — A pre-action installation in which the alarm valve can be opened and closed repeatedly by a heat detection system.

3.29 Installation, Wet Pipe — An installation in which the pipework is always charged with water.

3.30 Jockey Pump — A small pump used to replenish minor water loss to avoid starting an automatic suction or booster pump unnecessarily.

3.31 Low-Rise System — A sprinkler system in which the highest sprinkler is not more than 45 m above ground level or the sprinkler pumps.

3.32 Main Distribution Pipe — A pipe feeding a distribution pipe.

3.33 Node — A point in pipework at which pressure and flow(s) are calculated; each node is a datum point for the purpose of hydraulic calculations in the installation.

3.34 Precalculated — A term applied to pipework sized as specified in **4.5.1** or an installation in which pipe downstream of the design point is sized.

3.35 Range Pipe — A pipe feeding sprinkler directly or via arm pipes of restricted length.

3.36 Riser — A vertical pipe feeding a distribution or range pipe.

3.37 Rosette Sprinkler Rosette — A plate covering the gap between shank or the body of a sprinkler projecting through a suspended ceiling, and the ceiling.

3.38 Section — The part (which may be one or more zones) of an installation on a particular floor fed by a particular riser.

3.39 Sling Rod — A rod with a sling eye or screwed ends for supporting pipe clips, rings, band hangers, etc.

3.40 Sprinkler, Ceiling or Flush Pattern — A pendent sprinkler for fitting partly above but with the temperature sensitive element below, the lower plane of the ceiling.

3.41 Sprinkler Concealed — A recessed sprinkler with a cover plate that disengages when the heat is applied.

3.42 Sprinkler Conventional Pattern — A sprinkler that gives a spherical pattern of water discharge.

3.43 Sprinkler Glass Bulb — A sprinkler which opens when a liquid filled glass bulb bursts.

3.44 Sprinkler Horizontal — A sprinkler in which the nozzle directs the water horizontally.

3.45 Sprinkler Intermediate — A sprinkler installed below, and additional to the roof or ceiling sprinklers.

3.46 Sprinkler Pendent — A sprinkler in which the nozzle directs water downwards.

3.47 Sprinkler, Roof or Ceiling — A sprinkler protecting the roof or ceiling.

3.48 Sprinkler Side-Wall Pattern — A sprinkler that gives a downward paraboloid pattern discharge.

3.49 Sprinkler System — The entire means of providing sprinkler protection in the premises comprising one or more sprinkler installation, the pipe work to the installations and the water supply/supplies except town mains and bodies of water such as lakes or canals.

3.50 Sprinkler Upright — A sprinkler in which the nozzle directs the water upwards.

3.51 Sprinkler Yoke Arms — The part of the sprinkler that retains the heat sensitive elements in load bearing contact with the sprinkler head valve.

3.52 Staggered Sprinkler Layout — An off-set lay-out with the sprinklers displaced one half pitch along the range pipe relative to the next range or ranges.

3.53 Standard Sprinkler Layout — A rectilinear layout with the sprinkler aligned perpendicular to the run of the ranges.

3.54 Suction Pump — An automatic pump supplying water to a sprinkler system from a suction tank.

3.55 Suitable for Sprinkler Use — A term applied to equipment or component accepted by the authorities as far a particular application in a sprinkler system either by a particular system or by compliance with specified general criteria.

3.56 Supply Pipe — A pipe connecting a water supply to a trunk main or the installation main control valve set(s); or a pipe supplying water to a private reservoir, suction tank or gravity tank.

3.57 Suspended Open Cell Ceiling — A ceiling of regular open cell construction through which water from sprinkler can be discharged freely.

3.58 Terminal Main Configuration — A pipe array with only one water supply route to each range pipe.

3.59 Terminal Range Configuration — A pipe array with only one water supply route from a distribution pipe.

3.60 Toggle Support — A swivel device for securing hangers to hollow sections ceiling or roofs.

3.61 Trunk Mains — A pipe connection to two or more water supply pipes to the installation main control valve set(s).

3.62 User — The person responsible for or having effective control over the fire safety provision adopted in or appropriate to the premises or the building.

4 REQUIREMENTS REGARDING LAYOUT PLANS

4.1 Layout plans should be drawn up in accordance with the following requirements.

4.1.1 Plans should be clear, contain all required details including scale and point of compass and should be dated.

4.1.2 Plans of new installation shall show the entire compound; all buildings therein, with their door and window openings, and the boundary walls. Buildings under construction and future extension envisaged, shall be indicated by the dotted lines. Plans of extensions to approved existing installations need not show the rest of the compound but sufficient details shall be given of the existing installations in correlation to the extension, to enable the Authority's Inspection staff to check the plans and offer comments. In case of storeyed buildings, drawings submitted shall include plans of each storey together with sectional elevations.

4.1.3 *Material*

Plans should be on white paper or ammonia paper or Ferro Prussiate paper.

4.1.4 Plans should generally be prepared in accordance with IS 962, shall not exceed 850 × 1 200 mm in size and should be drawn to a scale of 1:500 or 1:1 000. In the case of very large compounds with more than one risk, it is advisable to submit separate plans for each risk with a key plan showing the relative situation of the various risks, etc, in the compound.

4.2 Signs

4.2.1 Pucca walls to be shown by double lines, doors and windows being clearly marked (*see* Fig. 6).

FIG. 6 WINDOW/DOOR (PUCCA WALL)

4.2.2 Iron or other non-masonry walls to be shown by a thin line and nature of construction indicated (*see* Fig. 7).

FIG. 7 G.I. WALLS (NON-MASONRY WALLS)

4.2.3 Fire walls, *i.e.*, perfect party walls to be indicated by the sign "T" at each end of the wall, or have the letters "P.P.W." alongside or across them at regular intervals and marked in distinctive colour (*see* Fig. 8).

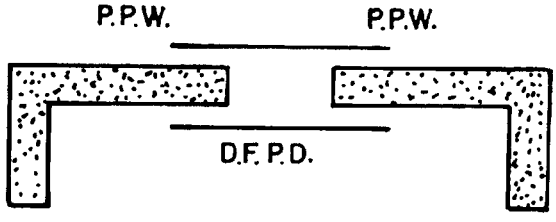


FIG. 8 FIRE WALLS

4.2.4 Fireproof doors and/or shutters to be marked as follows:

Single Fireproof Door and/or Shutter	S.F.D.
Double Fireproof Door and/or Shutter	D.F.D.

4.2.5 Sky lights to be marked "Sky Lights" or "S.L.".

4.2.6 Boiler to be shown by a rectangular figure marked "Boiler".

'BOILER'

4.2.7 Sprinkler mains to be shown by a blue line; the diameter, length and number of pipes being marked alongside and specials and reducers to be clearly indicated as below:

- mm dia, lengths of -metre each (*see* Fig. 9)

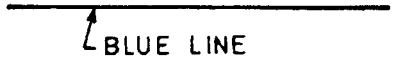


FIG. 9 SPRINKLER MAINS

4.2.8 Sprinkler pumps to be clearly marked and the capacity and head to be indicated in each case.

4.2.9 Pump(s) suction piping to be shown dotted and diameter to be indicated (*see* Fig. 10).

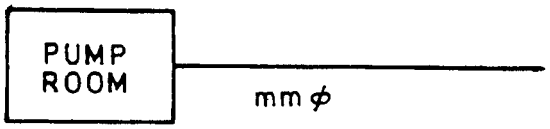


FIG. 10 PUMP SUCTION PIPE

4.2.10 Fire service water tanks and reservoirs to be shown to scale (*see* Fig. 11).

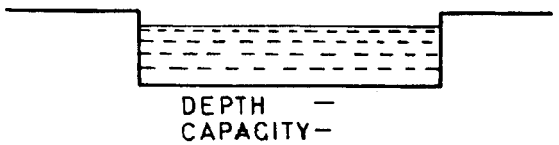


FIG. 11 FIRE SERVICE WATER TANK (RESERVOIR)

4.2.11 Sprinkler trunk mains to be shown by a blue line, the sizes being marked alongside:

mm DIA. spk. Main

4.2.12 Fire alarm bells to be shown by a blue line, the sizes being marked "F.A.B.".

4.2.13 Sprinklered blocks to be marked "S".

4.2.14 Electric cable(s) for the fire pump(s) to be shown in green line(s).

4.3 Installation Layout Drawings

4.3.1 *General*

The scale shall be not less than 1:100. Layout drawing shall include the following information:

a) North point indication;
b) The class or classes of installation according to hazard class including stock category and design storage height;
c) Constructional details of floors, ceiling, roofs and exterior walls and walls separating sprinklered and non-sprinklered areas;
d) Sectional elevations of each floor of each building showing the distance of sprinklered from ceiling, structural features, etc, which affect the sprinkler layout or the water distribution from the sprinklers;
e) The location and size of concealed roof or ceiling voids, offices and other enclosures sealed at a level lower than the roof of ceiling proper;
f) Indication of trunking, staging, platforms, machinery, fluorescent light fittings, heaters, suspended open cell ceilings, etc, which may adversely affect the sprinkler distribution;
g) The sprinkler types(S) and temperature ratings(s);
h) The location and type of main control valves and location of alarm motors and gongs;
j) The location and details of any water flow and air or water pressure, alarm switches;
k) The location and size of any tail-end air valves, subsidiary stop valves and drain valves;
m) The drainage slope of the pipework;
n) The location and specification of any orifice plate;
p) A schedule listing the numbers of sprinklers, medium and high-velocity sprayers, etc, and the area of protection; and
q) A key to the symbols used.

4.3.2 *Precalculated Pipework*

For precalculated pipework the following details shall be given on, or with, the drawings:

a) Identification of the design points of each array on the layout drawing;
b) A summary of the pressure losses between the control valve and the design points at the following design rates or flow :
   1) In a light-hazard installation : 225 l/min,
   2) In a moderate-hazard installation: 1 000 l/min, and
   3) In a high hazard installation the flow corresponding to the appropriate design density.

NOTE — For light and moderate-hazard installations with precalculated pipework the pressure needed at the design point is not stated. Instead the friction loss in the pipework between the control valve and the design points is limited to a predetermined quantity, incorporated in the value specified for pressure at the control valves. Static head is added to this pressure to give the value defining the minimum actual water supply running pressure. A typical summary of pressure losses is shown in Table 1.

4.3.3 *Hydraulically Calculated Pipework*

For hydraulically calculated pipework, the following shall be given, with detailed calculations, either on purpose designed work sheets or as a computer print-out :

a) *For each design area of operation :*
   1) the area identification;
   2) the hazard class;
   3) the specified density of discharge (in mm/min);
   4) the assumed area of maximum operation (AMAO) (in m^2);
   5) the number of sprinklers in the AMAO;
   6) the sprinkler nominal orifice size (in mm);
   7) the maximum area covered per sprinkler (in m^2);
   8) detailed and dimensioned working drawings showing the following:
      i) the node or pipe reference scheme used to identify pipes, junctions,

sprinkler heads and fittings which need hydraulic consideration;

ii) the position of the hydraulically most favourable AMAO;

iii) the position of the hydraulically most unfavourable AMAO;

iv) the four sprinklers upon which the design density is based; and

v) the height above datum of each point of identified pressure value.

b) *For each operating sprinkler :*

1) the sprinkler node or reference number;
2) the sprinkler nominal K factor;
3) the flow through the sprinkler (in l/min); and
4) the inlet pressure to the sprinkler or sprinkler assembly (in bar).

c) *For each hydraulically significant pipe :*

1) the pipe node or other reference;
2) the pipe nominal bore (in mm);
3) the hazen-williams constant (c or K factor) for the pipe;
4) the flow through pipe (in l/min);
5) the nominal fluid velocity (in m/sec);
6) the length of pipe (in m);
7) the numbers, types and equivalent lengths of fittings;
8) the static head change in pipe (in m);
9) the pressures at inlet and outlet of pipe in bar;
10) the friction loss in pipe (in bar); and
11) the indication of flow direction.

NOTE — A line diagram of the pipe layout shall be prepared showing the following:

1) the node or pipe reference numbers;
2) the distribution pipes;
3) the range pipes;
4) the sprinkler heads under consideration;
5) the four hydraulically most unfavourably placed heads; and
6) the flow through, and pressure at the end of each hydraulically significant pipe.

4.4 Water Supply Drawings

The drawings shall show water supplies and pipework therefrom up to the installation control valves. The drawings shall be on an indicated scale of not less than 1:100. A key to the symbols shall be included. The position and type of stop and check valves and any pressure reducing valve, water meter, water lock, orifice plate and any connection supplying water for other services should be indicated.

4.5 Hydraulic Calculation

4.5.1 *Pre-calculated Installations*

A hydraulic calculation (with relevant flow tests) shall show that each trunk main together with any branch main, from each water supply to a main installation control valve set water supply test and drain valve and control valve 'C' gauge (*i.e.*, including the installation control valves) is capable of providing the required pressure and flow at the installation control valve test and drain valve.

4.5.2 *Fully Hydraulically Calculated Installations*

Where the pipework is fully hydraulically calculated the following additional details shall be given:

a) a modified pressure-flow characteristic graph indicating the usable pressure at any flow up to the maximum installation demand, and

b) the demand pressure-flow characteristic graph for each installation for the hydraulically most unfavourable (and if required the most favourable) AMAO with pressure taken as at the control valve 'C' pressure gauge.

5 CLASSIFICATION OF OCCUPANCIES

5.1 As the water supply, pumping capacity and other features of the sprinkler installations depends not only on the size of the risk, but also on its fire growth and spread potentialities, the risks are to be categorized under the following classes for the purpose of design of the installation :

a) Light hazard class,
b) Moderate hazard class,
c) High hazard class, and
d) Storage hazards.

NOTE — A broad classification of various occupancies is given in National Building Code (Part IV) Fire Protection.

5.1.1 *Light Hazard Class*

Non-industrial occupancies where the areas of rooms, corridors, halls, etc, are not more than 125 m^2 and above are bounded by masonry/ or R.C.C. walls raised up to the roof and door openings therein protected by doors.

Typical occupancies are as follows:

Hospitals
Hotels
Institutions
Libraries
Laundries
Museums
Nursing homes
Office buildings
Prisons
Schools, Colleges, etc.

NOTE — If any occupancy or block within the light hazard risk is larger than 125 m^2 in area or having an area less than 125 m^2 in area but not bound on all sides as stipulated above, the risk should be classified as 'moderate' hazard.

Table 1 Statement of Distribution Pipe Losses Between the Various Design Points and the Installation Values

(*Clause* 4.3.2)

Run of Distribution Pipe from Values to	Pipe Size	Pipe Length	No. of Turns	Equivalent Pipe Length of Turns	Total Equivalent Pipe Length	Pressure Loss at Design Flow Rate		
						Pipe Losses	Static Head Gain (ph)	Difference
	(mm)	(m)		(m)	(m)	(mBars)	(mBars)	(mBars)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A-floor 3	65	3.5	—	—	35	122		
	80	7	—	—	7	111		
	100	49	2	6	55	240		
					Total	473		
							0	
								+ 473
B-floor 3	65	7	—	—	7	24.3		
	80	1.9	—	—	1.9	30		
	100	20	1	3	23	101		
					Total	374		
							0	
								+ 374
C-floor 2	65	10.5	—	—	10.5	365		
	80	16.9	—	—	16.9	268		
	100	28.3	2	6	34.3	150		
					Total	783		
							380	
								+ 403
D-floor 2	65	8.8	—	—	8.8	306		
	80	—	—	—		0		
	100	16.3	1	3	19.5	84		
					Total	390		
							380	
								+ 10
E-floor 1	65	10.5	—	—	10.5	365		
	80	38.9	2	6	44.9	712		
	100	2.5	—	—	2.5	11		
					Total	1 088		
							760	
								+ 328
F-floor 1	65	8.9	—	—	8.9	309		
	80	9.9	1	3	12.9	205		
	100	2.5	—	—	2.5	11		
					Total	525		
							760	
								− 235

NOTE — The pressure drop caused by any orifice plate in the distribution pipework should be taken into account by a corresponding reduction in the static head gain.

5.1.2 *Moderate Hazard (Manufacturing Occupancies)*

Abattoirs
Abrasive wheel and powder
Aircraft factories (excluding hangers)
Airport terminal buildings
Bakeries
Biscuit factories
Bookbinders, publishers
Breweries
Boot and shoe units
Cables
Candle
Cardboard factories
Carpentry and furniture [not involving foam/foam plastics]
Carpets
Car parking areas within building or basement
Cement
Ceramics
Chemicals
Cinematographic and T.V. production/broadcasting studios
Cloth processors
Confectioneries
Dairies
Dehydrated vegetable factories
Departmental stores/Retail shops
Electronic equipment and assembly
Engineering workshops
Fibreboard factories
Flax, jute and hemp mills
Flour mills
Food and beverages

Glass factories
Hosiery and garment
Jewellery
Laboratories
Motor garages
Paint shops
Paper mills
Photographic film factories
Plywood factories
Printing presses
Restaurants and cafes
Rope factories
Rubber and plastics (other than foam plastics)
Soap factories
Sugar mills
Synthetic fibres/yarn factories
Tanneries
Textile mills
Timber and wood-working (except saw mills)
Theatres
Tobacco factories
Woodwool
Woollen mills
Vermicelli
Wax factories

5.1.3 *High Hazard (Manufacturing Occupancies)*

Aircraft hangers
Bitumen and wax coated paper
Celluloid goods
Cellulose nitrate
Cigarette filter
Distilleries
Duplicating/stencil paper explosives
Fire works
Floor cloth and linoleum
Foam plastics and foam rubber
Hessian cloth/Tar felt match factories
Oil mills
Paint, colour and varnish factories
Resin, rosine, turpentine and lamp black
Rubber substitutes making units
Saw mills
Surgical cotton, mattress and pillow makers
Tar distillation units
Woodwool manufacturers

5.1.4 *Storage Occupancies*

Storage risks (stacked or high-piled) are categorised under four classes as per classifications below:

CATEGORY-I

Carpets, Non-synthetic/synthetic yarn and fabrics, Mechanical and electrical goods (dominantly metal parts) and hardware items, Glassware and crockery, fibreboards, groceries, metal goods, Papers other than those listed under categories 2 and 3 below, Powdered and canned foods, Plastic/glass bottles containing non-flammable liquids, etc.

CATEGORY-II

Batteries, Baled cotton/synthetic fibres, Books, Baled cork, Baled waste paper, Cartons containing alcohols (in cans/bottles), Cartons of canned lacquers which dry by solvent evaporation, Chipboard, Cardboard rolls (horizontally stored), Cereals/Grains/Foodstuff/ Flour/Sugar in sacks, Cellulose/Cellulose pulp, Electrical goods other than those stated in Category-I, Flammable liquids in non-combustible containers, Leather goods, Palletised liquor stocks, Plastics (non-foamed, other than cellulose nitrate), Rolled pulp and paper and asphalted paper (Horizontal storage), Veneer sheets, Wooden patterns, Metal/wooden furnitures with plastic seats, etc.

CATEGORY-III

Bitumen/Wax coated paper, Candles, Carbon black, Card board rolls (vertically stored), Charcoal, Coal, cellulose nitrate, Foamed plastic and foam rubber products, Flammable liquids in combustible containers, Linoleum products, Matches, Plastics other than those stated in Category-II, Rolled pulp and paper and asphalted paper (vertical storage), Rubber goods including tyres and tubes, Sawn timber, Ventilated wood stacks, Waxed and asphalt coated papers and containers in cartons, Woodwool, wooden pallets and flats (idle), All materials having wrappings or pre-formed containers of foamed plastics, etc.

CATEGORY-IV

Offcuts and random pieces of foamed plastic or foamed rubber rolls of sheets of foamed plastic or foamed rubber, Foam mattress, Expanded polystyrene packaging, Foam upholstery, etc.

6 PLANNING

6.1 Initial Considerations

6.1.1 *Outline Design*

Consideration should be given to any benefits that might be gained by changes in building design, work procedures, etc, when preparing the outline design. In planning site layout and building design, particular consideration should be given to the following :

a) the occupancy hazard class and goods category which determine the water discharge density and water supply pressure and flow ;
b) the siting of any main water supply connection(s);
c) the siting of any water supply tank(s) or reservoir;
d) the siting of any pump house;
e) the maximum quantity of water available from the supply source compared with the system requirements;
f) the location of sprinkler installation control valves, together with the access thereto,

indication of their position, and the disposal of drainage and water supply test water;

g) the source and means of supply of electric power, etc; and

h) the protection of valve sets, pipework and sprinklers against accidental damage.

6.1.2 It is important to consider building design in the context of fire protection, *e.g.*, choice of materials, support of sprinkler pipework having regard to the load imposed on structure by the weight of sprinkler pipework and the contained water, need for inbuilt drainage (which is strongly advised for computer areas) or raising of base of stacked goods above the floor where water damage may be severe, etc, when storage of goods is involved it may be appropriate to consider the height of the building and of material stacks, and the height and type of any storage rack which may have a considerable bearing on fire protection costs. The design of double entry storage racks may be influenced by the need to mount sprinklers therein. Where sprinklers are fitted in racks additional rack structural members may be needed to prevent impact damage to the sprinkler head and pipework.

6.1.3 *Interaction with Other Fire Protection Measures*

Account should be taken of possible interaction between sprinkler systems and other fire protection measures. Examples of possible adverse interactions between sprinkler protection and other fire protection measures are :

a) water damage to an inadequately shielded fire alarm control panel in a sprinkler protected area with consequent possible failure of the fire alarm system.

b) Operation or failure of smoke detectors in zones adjacent to one in which water discharge is taken place because of the water spray mist travelling to adjacent zones.

Such possible interactions need careful considerations.

6.2 Extent of Sprinkler Protection

6.2.1 *Building to be Sprinkler-Protected*

The sprinkler system should provide protection to all parts not specified as exceptions (**6.2.2**) in one of the following:

a) the building under consideration;

b) any building communicating directly or indirectly with the building under consideration.

Where there are unprotected buildings within 6 m of protected building the exposure hazard can be reduced by using cut-off sprinklers over unsealed openings and drenchers over combustible walls in the protected building.

6.2.2 *Exceptions (Buildings and Parts of Buildings Not Sprinkler-Protected)*

Obligatory exceptions, sprinkler protection shall not be provided in the following parts of a building or plant:

a) grain silos or grain bins inside buildings forming part of corn mill, distillery, maltings or oil mills;

b) ovens, hovels and kilns in pottery, earthenware, brick, tile and glass works; and

c) areas, rooms or places where the water discharged from a sprinkler may pose a hazard.

Sprinklers shall not be fitted over salt baths, metal melt pans or frying ranges, or in positions where water may discharge into them or indirectly drain into them nor shall water pipes be fitted in these positions.

6.2.3 *Optional Exceptions*

Generally sprinkler-protection shall be considered for, but need not be provided in the following parts of a building or plant:

a) *Stairs, spaces below stair headings (but not rooms above a stair) and lift wells* — Any part not provided with sprinkler protection shall be separated by walls (225 mm brick or 100 mm R.C.C.). Fire doors not less than 1 h in fire resistance, shall be provided in the openings of such walls.

b) *Washrooms, toilets and WCs (but not cloakrooms)* — Any part not provided with sprinkler protection shall be separated by walls (225 mm brick or 100 mm R.C.C.). Fire doors not less than 1 h in fire resistance, shall be provided in the openings of such walls.

c) *Rooms or compartments containing electric power distribution apparatus, such as switchgear and transformers, and used for no other purpose(s)* — Any part not provided with sprinkler protection shall be separated by walls (225 mm brick or 100 mm R.C.C.). Fire doors not less than 1 h in fire resistance, shall be provided in the openings of such walls.

d) In papermaking machines, the undersides of screens or of shields erected over the wet and (where there is no other fire hazard).

6.2.4 *Communicating Buildings*

Sprinkler protection shall be considered for, but need not be provided in the following communicating buildings or structures:

a) building or storey segregated from the sprinklered building by walls of not less than 4 h fire resistance in which each opening is protected by two (arranged in series) fire doors or fire shutters each of not less than 2 h fire resistance;

b) canopies of non-combustible construction, not extending beyond 2.3 m from the building wall. Any such canopy not provided with sprinkler protection shall be fitted with cut-off sprinklers under the canopy over each opening between it and the sprinklered building. Any opening 2.5 m or less in width shall be provided with a cut-off sprinkler, positioned centrally over the opening. Openings exceeding 2.5 m in width shall be provided with cut-off sprinklers over the opening, not more than 2.5 m apart and with a sprinkler not more than 1.25 m, from each side.

c) exterior loading docks and platforms either of the non-combustible construction or with the space beneath closed off against accumulation of debris;

d) *Building used solely as offices and/or private dwelling(s)* — Any part not provided with sprinkler protection shall be separated by walls (225 mm brick or 100 mm R.C.C. Fire doors not less than 1 h in fire resistance, shall be provided in the openings of such walls along with cut-off sprinklers.

e) *Stairs, washrooms and WCs external to the sprinkler* — protected building, in which all openings to the sprinkler-protected building are protected by doors of not less than 1 h fire resistance or cut-off sprinklers.

f) *Staircases, washrooms, toilets and WCs external or internal to the sprinkler* — protected building which forms a means of communication between the sprinklered building and non-sprinklered building. In any such part not provided with sprinkler protection all openings into the communicating area from the sprinklered and from the non-sprinklered building shall be protected by fire doors of not less than 2 h fire resistance.

6.3 Storage in Open or Open Sided Shed

The distance between combustible materials stored in the open or in an open-sided shed and the sprinklered building shall be no less than 10 m or 1.5 times the height of the stored material whichever is greater unless there is a fire wall in between or a suitable drencher system to protect the openings of the protected building facing the open storage

7 WATER SUPPLY

7.1 Water for the sprinkler system shall be stored in any easily accessible surface or underground reservoir or above ground tanks of steel, concrete or masonry. The effective capacity of the reservoir for various classes of occupancies of sprinkler installations shall be as indicated in Table 2.

Table 2 Effective Capacity of Water Reservoir
(*Clause* 7.1)

Class of Hazard (1)	Exclusive Water Storage (2)
Light hazard	Not less than 20 minutes run for the pumping capacity or 35 m^3 whichever is greater.
Moderate hazard	Not less than 1 hour run for the aggregate pumping capacity or 200 m^3 whichever is greater.
High hazard	Not less than 2 hours run for the aggregate pumping capacity.

NOTE — A higher capacity of reservoir than that required as per Table 2 may be stipulated, where considered necessary.

7.2 Water supplies for the sprinkler installations shall be free from suspended, fibrous or other matters which may accumulate in the system pipework and it is recommended to use filtered water for the system.

7.3 The use of salt or brackish water is not normally allowed. In special circumstances where there is no suitable fresh water source available, consideration may be given for the use of salt or brackish water provided the installation is normally charged with fresh water.

7.4 Combined reservoirs for other fire fighting systems such as Hydrant system, Water spray systems, etc, along with the sprinkler system are permissible provided : (a) all the suction inlets or foot valves are at same level, and (b) aggregate capacity of the reservoir is equal to the total requirement of all the systems put together.

7.5 Reservoirs of and over 225 m^3 capacity shall be in two independent but interconnected compartments with a common sump to facilitate cleaning and repairs. The construction/arrangement of the reservoir and the common sump should be in accordance with the drawings as shown in the National Building Code, Part IV.

7.6 Level indicator shall be provided for measuring the quantity of water stored at anytime. The indicator should preferably be graduated to read directly in m^3 of water.

7.7 Water reservoir shall be cleaned at least once in two years or more frequently if necessary to prevent contamination and sedimentation.

7.8 It is advisable to provide adequate inflow into the reservoir so that the protection can be re-established within a short period.

8 DESIGN DENSITY AND AMAO FOR FULLY HYDRAULICALLY CALCULATED OR PRE-CALCULATED SPRINKLER SYSTEMS

8.1 The design density and the assumed maximum area of operation for various types of risks are as given in Table 3.

Table 3 Minimum Design Density and AMAO for Light, Moderate and High Hazard (Process) Risks at Roof/Ceiling Sprinklers
(*Clause* 8.1)

Hazard	Design Density l/min/m^2	AMAO m^2
(1)	(2)	(3)
Light	2.25	84
Moderate	5.00	360
High	9.00	260

8.1.1 *Light Hazard*

The density of water discharge shall be at least 2.25 l/min/m^2 over an assumed area of operation covering 84 m^2.

Not more than six sprinklers shall be installed in a room except in either a corridor where there is a single line of sprinklers or a concealed space protected as specified in **13.3**.

8.1.2 *Moderate Hazard*

The density of water discharge shall be at least 5 l/min/m^2 over an assumed area of operation covering 360 m^2.

8.1.3 *High Hazard*

The density of water discharge for process risks shall be at least 10 l/min/m^2 over an assumed area of operation covering 260 m^2.

8.1.4 *Storage Hazards*

8.1.4.1 Storage hazards are categorised from the nature and type of storage. When the height of storage increases beyond specified limits, fire fighting is rendered more difficult. In worst cases it may not be possible to fight the fire due to difficulties in reaching the seat of fire and also accessibility to the fire fighting staff is impaired due to excessive smoke. In case of the sprinklers also the same difficulties are encountered. Storage risks can be categorised under "moderate" or "high" depending upon the type and method of storage of goods within the godown/warehouse blocks.

8.1.4.2 The storage occupancies can be regarded as "moderate hazard" risks if the height of storage is within the limits for various categories as given in Table 4.

Table 4 Storage Occupancies for Moderate Hazard
(*Clause* 8.1.4.2)

Category	Maximum Storage Height in Metres	Design Density l/min/m^2	AMAO m^2
(1)	(2)	(3)	(4)
I	4.00	5	360
II	3.00	5	360
III	2.00	5	360
IV	1.25	5	360

Goods stored not higher than what is stated in Table 4 for the appropriate category or not higher than the eaves height of the roofs or within 1 m of a flat ceiling whichever is the lowest shall be regarded as moderate hazard storage. If the above conditions are not met, the risk shall be regarded as high hazard storage.

8.1.4.3 In case of high hazard storage risks, the nature of the hazard is determined by the height of storage, storage aisle width and area of each storage block. Goods stored not higher than what is stated in Table 5 for the appropriate category or not higher than the eaves height of the roofs or within 1 m of a flat ceiling whichever is the lowest shall be regarded as high hazard storage.

8.1.5 *Requirements Common to Moderate and High Hazard Storage Risks*

8.1.5.1 Wherever possible, the deflector of the sprinkler fitted in the ceiling shall be at more than 1.5 m from the goods stored below. However, in case of jute godowns, no jute stock shall reach within 2 m of the deflectors of the sprinkler heads.

8.1.5.2 In case of storage in racks or shelves, if the height of storage is more than what is specified in Tables 4 and 5, intermediate sprinklers shall be provided for each shelf/rack in addition to the ceiling sprinklers and overall design density and AMAO shall be maintained as per Table 5.

Table 5 Storage Occupancies for High Hazard
(*Clause* 8.1.4.3)

Category	Maximum Storage Height in Metres	Design Density l/min/m^2	AMAO m^2
(1)	(2)	(3)	(4)
I	6.5	12.50	260
II	5.5	15.00	260
III	4.5	17.50	300
IV	3.5	22.50	300

8.1.5.3 If the top of the storage in the top tiers of the racks or shelves is within 3 m of the roof sprinklers, top tiers need not be protected by the intermediate

sprinklers. However, the other tiers shall need to be sprinklered.

8.1.5.4 The aisle width between the storage stacks shall not be less than 2.5 m and the maximum area of each storage stack shall not be more than 150 m^2. If these parameters are exceeded, the design density applicable shall be loaded by 2.5 l/min/m^2.

NOTE — For storage heights beyond what is stated in **8.1.4.3**, the basis for design is rendered invalidated and in such cases full details of the risk shall be submitted to the Authority in advance for consideration.

8.1.5.5 In case of mixed storage (both moderate and high hazard storage) in buildings, the parameters will be governed by the most hazardous occupancy.

8.2 Pressure and Flow Requirements

8.2.1 *Light Hazard*

For the design density and the AMAO specified the water supply running pressure at the installation valve shall not be less than 2.2 bars plus the static pressure equivalent of the height of the highest sprinkler in the installation above the "C" gauge when a water is being discharged at a flow rate of 225 l/min.

8.2.2 *Moderate Hazard*

For the design density and the AMAO specified, the water supply running pressure at the installation valve shall not be less than 2 bars plus the static pressure equivalent of the height of the highest sprinkler in the installation above the "C" gauge when water is being discharged at a flow rate of 1800 l/min or 1.5 bars plus the static pressure equivalent as stated above when the flow rate is 2 100 l/min.

8.2.3 *High Hazard*

8.2.3.1 The design density, flow rate and pressure requirements for different floor areas for this hazard class are as specified in Tables 6, 7, 8 and 9.

Table 6 Pressure and Flow Requirements for High Hazard Installations with 15 mm (K = 80) Sprinklers Precalculated and Pipe Sizes from Tables 24 and 26

(*Clause* 8.2.3.1)

Minimum Design Density (l/min/m^2)	Flow Rate Past Installation Value (l/min)	Running Pressure at the Design Point at the Level of the Highest Sprinkler in the High Hazard Area (Bars) Floor Area per Sprinkler in m^2						
		6	7	8	9	10	11[1)]	12[1)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.0	2800	1.8	2.4	3.2	3.9	4.8	5.8	6.8
12.5	4550	2.7	3.7	4.8	6.0	7.3	–	–
15.0	4550	3.8	5.2	6.8	–	–	–	–

[1)]When a moderate hazard installation requires to be upgraded to high hazard, these parameters shall be used.

Table 7 Pressure and Flow Requirements for High Hazard Installations with 15 mm (K = 80) Sprinklers Precalculated and Pipe Sizes from Tables 25 and 27

(*Clause* 8.2.3.1)

Minimum Design Density (l/min/m^2)	Flow Rate Past Installation Value (l/min)	Running Pressure at the Design Point at the Level of the Highest Sprinkler in the High Hazard Area (Bars) Floor Area per Sprinkler in m^2						
		6	7	8	9	10	11[1)]	12[1)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.0	2800	1.3	1.8	2.4	3.0	3.8	4.6	5.5
12.5	4550	2.0	2.8	3.6	4.6	5.7	7.0	8.4
15.0	4550	2.8	3.9	5.1	6.5	–	–	–

[1)]When a moderate hazard installation requires to be upgraded to high hazard, these parameters shall be used.

Table 8 Pressure and Flow Requirements for High Hazard Installations with 15 mm (K = 80) Sprinklers Precalculated and Pipe Sizes from Table 25
(*Clause* 8.2.3.1)

Minimum Design Density (l/min/m²)	Flow Rate Past Installation Value (l/min)	Running Pressure at the Design Point at the Level of the Highest Sprinkler in the High Hazard Area (Bars) Floor Area per Sprinkler in m²						
		6	7	8	9	10	11[1)]	12[1)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.0	2800	0.7	1.0	1.3	1.6	2.0	2.4	2.8
12.5	4550	1.1	1.5	2.0	2.5	3.0	3.7	4.4
15.0	4550	1.6	2.2	2.8	3.6	4.4	5.3	6.3
17.5	4550	2.2	2.9	3.8	4.8	5.9	7.2	–
20.0	5600	2.8	3.8	5.0	6.3	7.8	–	–
22.5	5600	3.5	4.8	6.3	8.0	–	–	–
25.0	6750	4.4	5.9	7.8	–	–	–	–
27.5	6750	5.3	7.2	–	–	–	–	–
30.0	9000	6.2	–	–	–	–	–	–

[1)]When a moderate hazard installation requires to be upgraded to high hazard, these parameters should be used.

Table 9 Pressure and Flow Requirements for High Hazard Installations with 20 mm (K = 115) Sprinklers Precalculated and Pipe Sizes from Table 25
(*Clause* 8.2.3.1)

Minimum Design Density (l/min/m²)	Flow Rate Past Installation Value (l/min)	Running Pressure at the Design Point at the Level of the Highest Sprinkler in the High Hazard Area (Bars) Floor Area per Sprinkler in m²						
		6	7	8	9	10	11[1)]	12[1)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.0	2800	–	–	–	1.0	1.2	1.4	1.7
12.5	4550	–	0.9	1.2	1.5	1.8	2.2	2 .6
15.0	4550	1.0	1.3	1.7	2.1	2.6	3.1	3.7
17.5	4550	1.3	1.7	2.3	2.8	3.5	4.2	5.0
20.0	5600	1.7	2.3	3.0	3.7	4.6	5.6	6.6
22.5	5600	2.0	2.9	3.7	4.7	5.8	7.0	–
25.0	6750	2.6	3.5	4.6	5.8	7.1	–	–
27.5	6750	3.0	4.2	5.5	6.9	–	–	–
30.0	9000	3.6	5.0	6.5	–	–	–	–

[1)]When a moderate hazard installation requires to be upgraded to high hazard, these parameters should be used.

8.2.3.2 The water supply running pressure at the installation valve "C" gauge shall not be less than either:

a) where the AMAO is not larger than the area protected, *i.e.*

$$P_r + P_f + P_s \text{ : or}$$

b) where the AMAO is larger than the area protected, *i.e.*

$$P_{red} + P_f + P_s$$

P_{red} = running pressure as specified in Tables 6, 7, 8 and 9 as appropriate at a flow rate equal to a value as indicated below:

$$P_{red} = \frac{\text{Area protected}}{\text{AMAO}} \times \text{specified flow rate (in bar)},$$

where

P_r = the running pressure at the design point and flow rate specified in appropriate Tables 6, 7, 8, and 9 (in bar).

P_f = the calculated pipe friction loss between the installation valve "C" gauge and the most hydraulically remote design point (in bar).

P_s = the static pressure difference between the highest sprinkler downstream of the design point and the installation valve "C" gauge (in bar).

8.2.3.3 *Where AMAO is fed by more than one distribution pipe*

The pipe friction loss shall be calculated on the basis that the flow rates in the distribution pipes are in

proportion to the fraction of the design area fed by each distribution pipe as shown in Fig. 12.

8.2.3.4 *Mixed moderate and high hazard*

Where the area of the high-hazard protection is less than the AMAO but there is an adjacent area of moderate hazard in the same room (*i.e.*, an area in which sprinklers are liable to operate simultaneously), the high-hazard area flow rate required shall be reduced by the ratio of the actual area to the AMAO and to this flow rate shall be added the flow rate for the moderate hazard area taken as 5.0 × the excess of the specified high-hazard AMAO over the actual high-hazard area (l/min) (*see* Fig. 13).

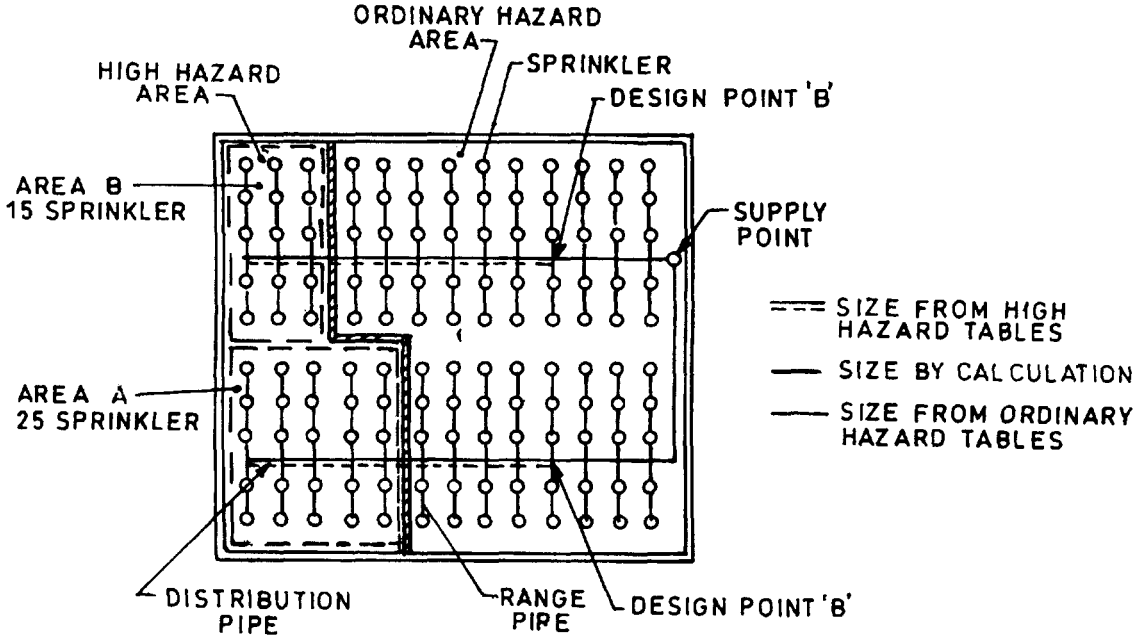


FIG. 12 PRECALCULATED HIGH RISE INSTALLATION (AMAO FED BY TWO DISTRIBUTION PIPES)

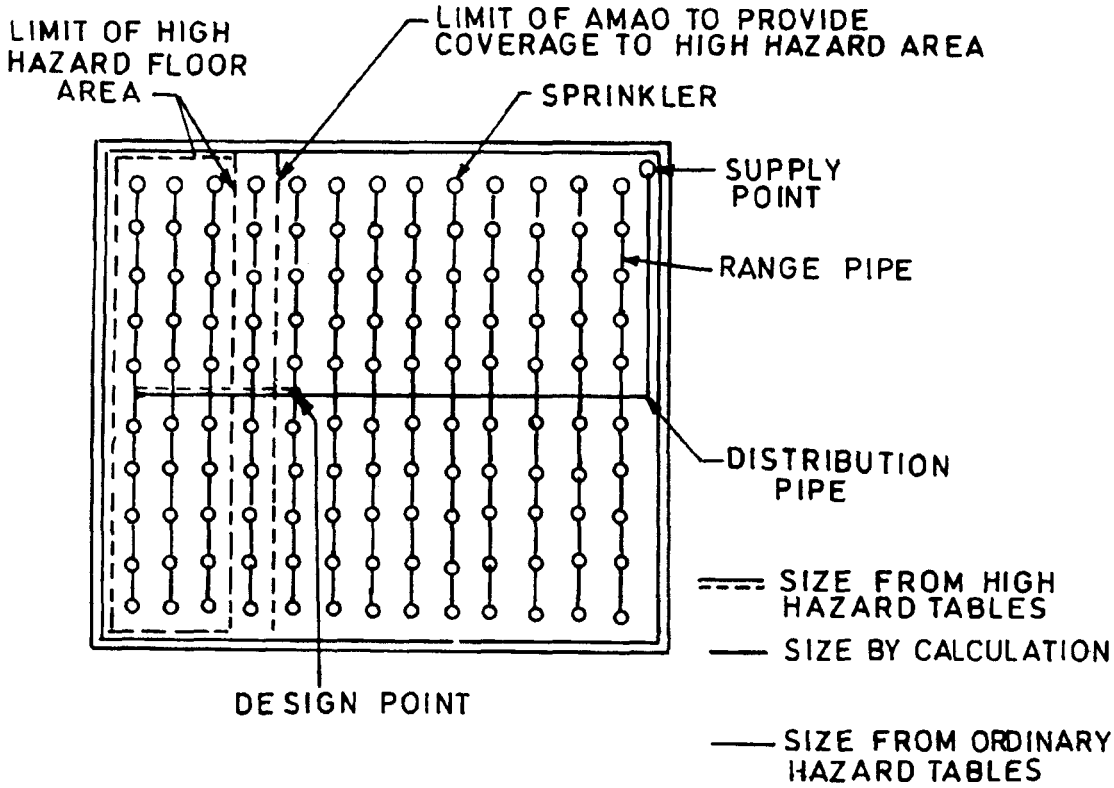


FIG. 13 PRECALCULATED HIGH RISE INSTALLATION AMAO COVERING HIGH AND ORDINARY HAZARD

8.2.3.5 When tested as described in **18.3** the water supply running pressure shall be based on the level of the highest sprinkler in the high-hazard area and shall be not less than that specified in **8.2.3.2** (*see also* **8.3**).

8.2.3.6 The moderate-hazard portion of the installation shall be supplied as specified in **8.2.2**, and the high-hazard distribution pipe feeding both high and moderate-hazard sprinklers shall be of bore not less than as specified in the moderate-hazard pipe tables.

8.3 Fully Hydraulically Calculated Pipe Size Installations

8.3.1 *Pressure Flow Requirements*

When tested as described in **18.3**, the water supply running pressure at the 'C' gauge shall be not less than the value calculated by the method as given in **13.5** (4 sprinkler method).

8.3.2 *Velocity*

The equilibrium water velocity shall not exceed 6 m/s at any valve or flow monitoring device, or 10 m/s at any other point in the system for the stabilized flow condition at the demand point involving an AMAO or, where the system includes intermediate sprinklers, the total number of sprinklers assumed to be in simultaneous operation.

9 PUMPS

9.1 General Requirements

9.1.1 Pumps shall be exclusively used for the fire fighting purposes, be of a type approved by the Authority, and shall be :

a) Electric motor driven centrifugal pumps.
   or
b) Compression ignition engine driven centrifugal pumps.
   or
c) Vertical turbine submersible pumps.

In all the above cases, pumps shall be automatic in action.

9.1.2 Pumps shall be direct-coupled, except in the case of engine-driven vertical turbine pumps wherein gear drives shall be used. Belt-driven pumps shall not be accepted.

9.1.3 Parts of pumps like impeller, shaft sleeve, wearing ring, etc, shall be of non-corrosive metal preferably of brass or bronze.

Where sea water is used or where the quality of the water necessitates the use of special metals and alloys, the use of such metals and alloys shall be insisted upon.

9.1.4 The capacity of the pump(s) would depend on the type of hazard protected and the same shall be as per the sizes shown in Table 10.

Table 10 Pump Selection

Nature of Risk	Pump Capacity l/s (m^3/h)	Delivery Pressure kg/m^2
(1)	(2)	(3)
Light	27 (96)	5.6
	30 (110)	5.6
Moderate	38 (127)	5.6/7.0
	47 (171)	7.0
	76 (273)	7.0
High	47 (171)	7.0
	76 (273)	7.0/8.8
	114 (410)	7.0/8.8

9.1.5 Pumps should be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut-off head shall not exceed 120% of rated head in case of horizontal pumps and 140% in case of vertical pumps.

9.1.6 In case of electrically driven pumps, it is recommended that a compression ignition engine driven stationery of similar capacity be installed as a standby and vice versa. However, where the sprinkler system consists of more than one pump, prime-movers of all shall not be of same type.

Notwithstanding the above, if power to motorized fire pumps is obtained from two sources, one of which is a captive generating plant located in a block either 6 m away from all surrounding building or, where this is not feasible, segregated from adjoining buildings in a manner indicated in **9.1.13**, more than one pump may be of the electrically-driven type.

9.1.7 In case of Jockey pumps in such systems to take care of minor leakages, the capacity thereof shall not be less than 3% and normally not more than 10% of the installed pumping capacity.

9.1.8 Each pump shall be provided with a pressure gauge on the delivery side between the pump and the non-return valve and a plate giving the delivery head, capacity and the number of revolutions per minute.

9.1.9 Each pump shall be provided with an independent suction pipe without any sluice or cut-off valves therein, unless the pump is situated below the level of the water supply in which case sluice or cut-off valves would be essential, where the Net Positive Suction Head (NPSH) available at site is less than 0.5 m in excess of the actual value, require at 150% of the duty point as per the manufacturers curves or where the water supply has fibrous or equally objectionable matter in suspension or mud and/or sand liable cause accumulation in the installation, suction

pipe(s) shall be installed in a jack well fed through a culvert from the main water supply. At the supply end of the culvert, a sluice or gate valve shall be provided.

9.1.10 The diameter of the suction pipe shall be such that the rate of flow of water through it does not exceed 90 m per minute when the pump is delivering at its rated discharge. If, however, the pump is situated below the level of water supply, the diameter of the suction pipe/header shall be based upon a rate of flow of 120 m per minute.

9.1.11 Centrifugal pumps should be fixed below the level of water supply. However, if the priming arrangements are such as to ensure that the suction pipe should be automatically maintained full of water notwithstanding a serious leakage therefrom (the pump being automatically brought into action to replenish the priming tank should the later be drawn upon at a greater rate than the rate at which it is fed from any other source) , positive suction may not be insisted. In such cases, the capacity of priming tank need not exceed 450 litres and the diameter of the priming pipe need not exceed 50 mm.

NOTE — For the purpose of **9.1.9**, **9.1.10** and **9.1.11**, a pump shall be considered as having positive suction only if the quantity of water in the reservoir above the level of the top of the pump casing is equivalent to the requirements in **8.1**.

9.1.12 If the pump is allowed to be installed above the level of its water supply, there shall be a foot valve and a priming arrangement, the latter consisting of a tank (having a capacity at least three times that of the suction pipe from the pump to the foot valve) connected to the delivery side of the pump by a metal pipe having a minimum internal diameter of 100 mm in the case of centrifugal pumps with a stop valve and a non-return valve therein of the same size. A dependable independent filling arrangement and a level indicator shall be provided for the priming tank. The provision of a vacuum gauge for the suction pipe is recommended.

9.1.13 Pumps shall not be installed in the open. The pump room shall be so located as to be both easily accessible and where any falling masonry and the like from other buildings occasioned by other cause, cannot damage the pump room. Normally, pump rooms shall be located 6 m away from all surrounding buildings and overhead structures. Where this is not feasible, they may be attached to a building provided a perfect party wall is constructed between the pump room and the attached building, the roof of the pump room is of R.C.C. construction at least 100 mm thick and access to the pump room is from the outside. The pump rooms shall normally have brick/concrete walls and non-combustible roof, with adequate lighting, ventilation and drainage arrangements.

NOTE — The pump room shall be located 30 m clear of the equipment/vessels handling or storing flammable liquids/solvents and/or gases.

9.2 Electrically Driven Pumps

9.2.1 The substation(s) and/or D.G. house(s) supplying power to the fire pump(s) shall be of incombustible construction and shall be located at least 6 m away from all surrounding buildings. Where this is not feasible, all door and window openings of the surrounding buildings within 6 m of the substation(s) and/or D.G. house(s) shall be protected by single fire doors and 6 mm thick wired glass in steel framework respectively. Likewise, roof eaves, if any of the surrounding buildings falling within 6 m of the substation(s) and/or D.G. house(s) shall be cut and wall raised as a parapet. The above provision shall also apply when the substation(s) and/or D.G. house(s) are within 6 m of each other.

Where the substation(s) and/or D.G. house(s) are attached to buildings, perfect party walls shall be constructed to segregate the substation(s) and/or D.G. house(s) from the attached buildings and where the attached building is storeyed, the roof of the substation(s) and/or D.G. houses shall be of RCC construction of at least 100 mm thickness.

Transformer cubicles inside these substations shall be separated from HT/LT cubicles and from each other by blank brick/stone/concrete walls of 355 mm thickness or of RCC of 200 mm with door openings, if any, therein being protected by single fireproof doors. The substation(s) and D.G. houses shall also be separated from each other as above.

Transformers installed outdoors which are supplying power to fire pump(s), shall also be located at least 6 m away from all the surrounding buildings [including substation(s) and/or D.G. house(s)]. Where this is not feasible, all door and window openings of the surrounding buildings [including substation(s) and/or D.G. house(s)] within 6 m of the transformers shall be protected by single fire doors and 6 mm thick wired glass in steel framework respectively. Likewise, roof eaves, if any of the surrounding buildings falling within 6 m of the transformers shall be cut and wall raised as a parapet. Blast walls of bricks/stone/concrete blocks of 355 mm thickness or of RCC of 200 mm thickness shall be constructed between two transformers and these walls shall be extended horizontally by 600 mm beyond the extremities of the transformers and vertically 600 mm above the highest point of the transformers.

NOTE — For high hazard (B) occupancies, substation(s) supplying power to fire pumps shall, in addition to complying with the above provisions, be located 30 m clear of all equipment where flammable fluids having a flash point below 65°C are handled and/or stored.

9.2.2 Overhead feeders to substation(s) supplying power to the fire pump(s) are not permitted within a horizontal distance of :

a) 15 m of any process building/plant or tanks containing flammable liquids, or
b) 6 m of any other building or tanks containing non-flammable liquids or of storage in open.

In case the feed to such substation(s) is by means of underground cables, the cables shall not pass under any building or permanent structure.

9.2.3 Sufficient spare power shall always be available to drive pumping set(s) at all times throughout the year.

9.2.4 The electric supply to the pumping set(s) shall be entirely independent of all other equipment in the premises, *i.e.,* even when the power throughout the entire premises is switched off, the supply to the pump shall continue to be available interrupted. This can be achieved by taking the connection for the pump(s) from the incoming side of the main LT breaker. However, in cases where two or more transformers and/or sources of supply are connected to a common busbar or where there is provision of a bus coupler between the busbar sections, the connection may be taken through the busbars (*see* Fig. 14).

9.2.5 The fire pump circuit shall be protected at the origin by an automatic circuit breaker so set as to permit the motor to be overloaded during an emergency to the maximum limit permissible by the manufacturers. Further, the under-voltage release/no volt coil of the circuit breaker shall be removed.

NOTE — Where cable lengths are long enough to warrant back-up protection, provision for such a protection shall be made.

9.2.6 It is recommended that telltale lamps which could continuously glow when power is available to the fire pump(s) circuit be provided and fixed in a prominent position, both in the substation and in the pump room.

9.2.7 A direct feeder without any tappings, shall be laid from the substation to the pump house. The feeder shall be laid underground and shall not pass under any building or permanent structure. Under extraneous circumstances, use of overhead cables may be permitted, but in no case shall such cables be permitted to contravene the distance indicated in **9.2.2.**

9.2.8 Where there is more than one source of power for the operation of pumping set(s) every electrical circuit shall preferably be so designed as to ensure that when necessary the set(s) continue to operate without the manual operation of an emergency switch.

9.2.9 The pumping set(s) shall be securely mounted on a robust bed plate, if of the horizontal type, and shall be free from vibration at all variations of load.

9.2.10 The rating and design of motors and switchgear shall conform to the relevant Indian Standard Specifications. The motor shall be of continuous rating type and its ratings shall be equivalent to the horsepower required to drive the pump at 150% of its rated discharge (*see* **9.1.4**).

9.2.11 The motor shall be of totally enclosed type or drip proof type, the latter having their air inlets and outlets protected with meshed wire panels to exclude rodents, reptiles and insects.

9.2.12 The motor(s) shall be wound for class B insulation preferably for class E — and the windings shall be vacuum impregnated with heat and moisture resisting varnish and preferably glass fibre insulated to withstand tropical conditions.

9.2.13 Motor(s) wound for high tension supplies shall have a suitable fixed warming resistance to maintain the motor windings in a dry condition at all times and particularly under monsoon conditions. The resistance shall be connected to the lighting or other equivalent circuit.

9.2.14 Heating apparatus shall also be provided, when necessary, for medium tension motor where they are located below ground level, in order to maintain the motor windings in a dry condition. Adequate drainage arrangements shall also be provided in the pump house in such cases.

9.2.15 The incoming cable to the fire pump room shall terminate in an isolating switch fuse unit incorporating the HRC fuses and where necessary provided with a distribution system.

9.2.16 The starting switch gear for the fire pumps shall be suitable for direct on line starting but other alternative arrangements as remote controlled are subject to prior approval. It shall also incorporate an ammeter with a clear indication of the motor full load current.

9.2.17 Cables for motors and switch gears shall be armoured or enclosed in heavy gauge screwed steel conduit according to conditions.

9.2.18 It is recommended that the equipment throughout be painted fire red (Shade No. 536 as per IS 5) and suitably marked for identification.

9.2.19 Necessary spare parts including a set of fuses (in a glass fronted box) shall be kept in readiness at all times in the pump house.

9.2.20 The wiring in all installations shall be done in accordance with IS 732.

9.3 Compression Ignition Engine Driven Pumps

9.3.1 *Pump Room*

The pump room shall be artificially heated, if necessary to maintain the temperature of the room

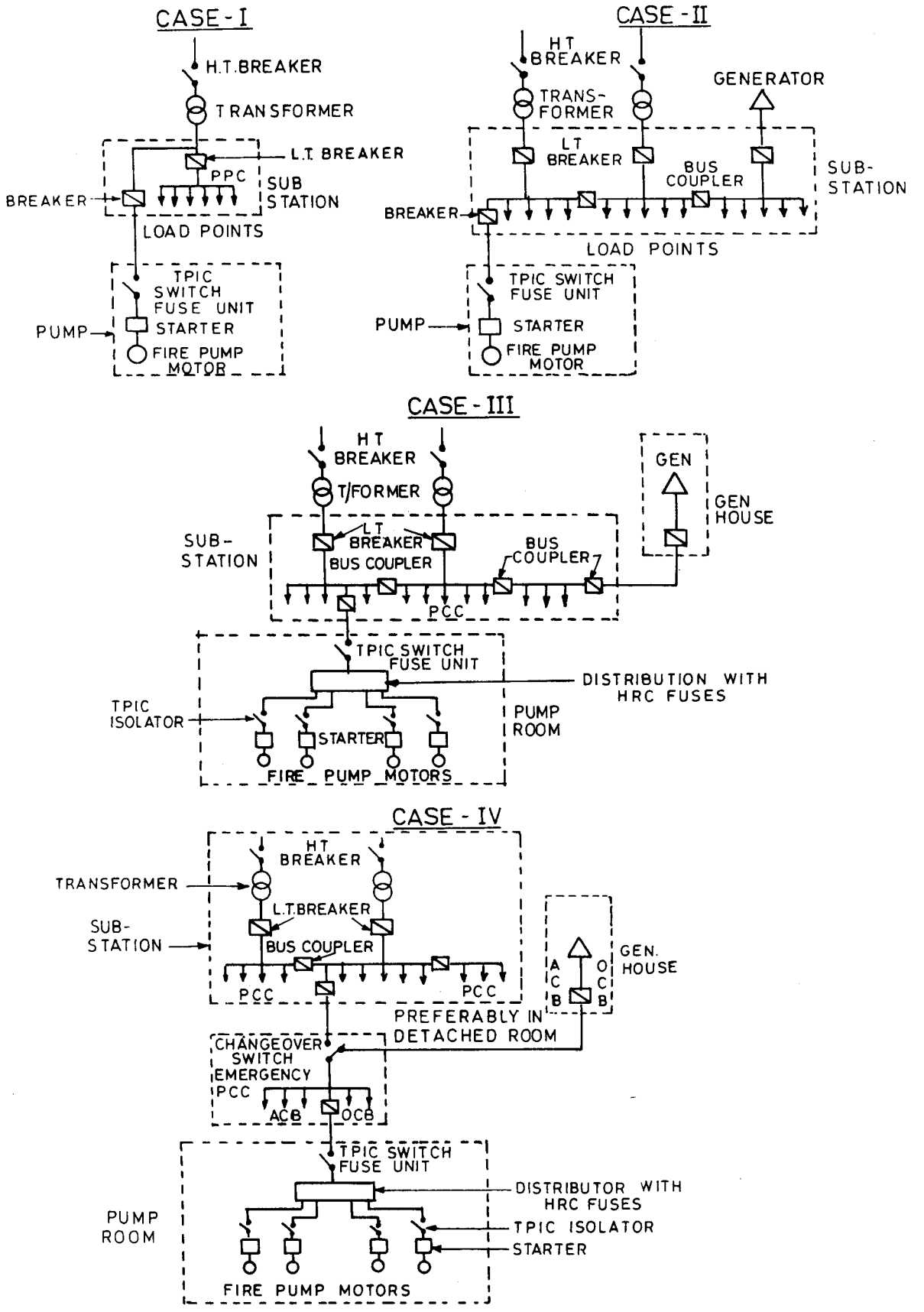


FIG. 14 FIRE PUMP CIRCUIT

above 10°C. Adequate ventilation shall be provided for the air required for aspiration and to limit the temperature rise in the room to 10°C above the ambient temperature when the engine is on full load.

9.3.2 *Engine*

9.3.2.1 The engine shall be :

a) of the compression ignition mechanical direct injection type, capable of being started without the use of wicks, cartridges, heater plugs or ether, at an engine room temperature of 7°C and shall accept full load within 15 seconds from the receipt of the signal to start.
b) naturally aspirated, supercharged or turbocharged and either air or water cooled. In the case of charged air cooling by means of a belt driven fan or of a belt driven auxiliary water pump there shall be multiple belts such that should half the belts break, the remaining belts would be capable of driving the fan or pump.
c) capable of operating continuously on full load at the site elevation for a period of six hours.
d) provided with an adjustable governor to control the engine speed within 10% of its rated speed under any conditions of load up to the full load rating. The governor should be set to maintain the rated pump speed at maximum pump load.
e) provided with an in-built tachometer to indicate the rev/m of the engine.
f) provided with a time totaliser (Hour counter).

9.3.2.2 Any manual device fitted to the engine which could prevent the engine starting shall return automatically to the normal position.

9.3.2.3 Engines, after correction for altitude and ambient temperature shall have bare engine horsepower rating equivalent to the higher of the following two valves :

a) 20% in excess of the maximum brake horsepower required to drive the pump at its duty point.
b) The brake horsepower required to drive the pump at 150% of its rated discharge.

9.3.2.4 The coupling between the engine and the pump shall allow each unit to be removed without disturbing the other.

9.3.3 *Cooling System*

The following systems are acceptable:

a) Cooling by water from the discharge of fire pump (taken off prior to the pump discharge valve) direct into the engine cylinder jackets via a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall terminate at least 150 mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.
b) A heat exchanger, the raw water being supplied from the fire pump discharge (taken off prior to the pump discharge valve) via a pressure reducing device, if necessary, to limit the applied pressure to a safe value as specified by the engine manufacturer. The raw water outlet connection shall be so designed that the discharged water can be readily observed. The water in the closed circuits shall not be less than that recommended by the engine manufacturer. If the auxiliary pump is belt driven there shall be multiple belts so that should half the belts break, the remaining belts shall be capable of driving the pump.
c) A frame or engine mounted air cooled radiator with a multiple belts driven fan from the engine. When half the belts are broken the remaining belts shall be capable of driving the fan. The water in the closed circuit should be circulated by means of the auxiliary pump driven by the engine and the capacity of the closed circuit shall be not less than that recommended by the engine manufacturer.
d) Direct air cooling of the engine by means of multiple belts driven fan. When half the belts are broken the remaining belts shall be capable of driving the fan.

NOTE — In case of systems described in b, c and d above, a failure actuated audio-visual alarm shall be incorporated.

9.3.4 *Air Filtration*

The air intake shall be fitted with the filter of adequate size to prevent foreign matter entering the engine.

9.3.5 *Exhaust System*

The exhaust shall be fitted with a suitable silencer and the total back pressure shall not exceed the engine maker's recommendation. When the exhaust system rises above the engine, means shall be provided to prevent any condensate flowing into the engine.

9.3.6 *Engine Shut-Down Mechanism*

This shall be manually operated and return automatically to the starting position after use.

9.3.7 *Fuel System*

9.3.7.1 *Fuel*

The engine fuel oil shall be of quality and grade specified by engine makers. There shall be kept on hand at all times sufficient fuel to run the engine on

full load for three hours, in addition to that in the fuel tank.

9.3.7.2 *Fuel tank*

The fuel tank shall be of welded steel construction conforming to IS 2552. The tank shall be mounted above the engine fuel pump to provide a gravity feed unless otherwise recommended by the manufacturers. The tank shall be fitted with an indicator showing the level of fuel in the tank.

The capacity of the tank shall be sufficient to allow the engine to run on full load for:

Light hazard	1 h
Moderate hazard	2 h
High hazard	3 h

NOTE — Where there is more than one compression ignition engine driven pump set there shall be separate fuel tank and fuel feed pipe for each engine.

9.3.7.3 *Fuel feed pipes*

Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. Pipe joints shall not be soldered and plastic tubing should not be used.

9.3.7.4 *Auxiliary equipment*

The following shall be provided:

a) A sludge and sediment trap,
b) A fuel level gauge,
c) An inspection and cleaning hole,
d) A filter between the fuel tank and fuel pump mounted in an accessible position for cleaning, and
e) Means to enable the entire fuel system to be bled of air. Air relief cocks are not allowed; screwed plugs are permitted.

9.3.8 *Starting Mechanism*

Provision shall be made for two separate methods of engine starting, *viz* :

a) Automatic starting by means of a battery powered electric starter motor incorporating the axial displacement type of pinion, having automatic repeat start facilities initiated by a fall in pressure in the water supply pipe to the spray installation. The battery capacity should be adequate for ten consecutive starts without recharging with a cold engine under full compression.
b) Manual starting by :
   1) Crank handle, if engine size permits, or
   2) Electric starter motor.

NOTE — The starter motor used for automatic starting may also be used for manual starting provided there are separate batteries for manual starting.

9.3.9 *Battery Charging*

The means of charging the batteries shall be by a 2-rate trickle charger with manual selection of boost charge and the batteries shall be charged in position. Where separate batteries are provided for automatic and manual starting the charging equipment shall be capable of trickle charging both the batteries simultaneously. Equipment shall be provided to enable the state of charge of the batteries to be determined.

9.3.10 *Tools*

A standard kit of tools shall be provided with the engine and kept on hand at all times.

9.3.11 *Spare Parts*

The following spare parts shall be supplied with the engine and kept on hand :

a) Two sets of fuel filters, elements and seals;
b) Two sets of lubricating oil filters, elements and seals;
c) Two sets of belts (wherever used);
d) One complete set of engine joints, gaskets and hoses;
e) Two injector nozzles;
f) One complete set of piston rings for each cylinder; and
g) One inlet valve and one exhaust valve.

9.3.12 *Engine Exercising*

The test shall be for a period of at least five minutes each day. Where closed circuits cooling systems are used the water level in the primary system shall be checked at the time of carrying out each test and, if necessary, water shall be added during the course of test procedure.

9.3.13 The following conditions will strictly be complied with:

a) To test the engine at least once a week;
b) To maintain the temperature of the engine room at not less than 4.5°C at all times;
c) To maintain the minimum quantity of fuel oil required as desired in these clauses;
d) To use a good grade of fuel oil equivalent in quality to that specified by the engine maker; and
e) To keep on hand the spare parts required as specified above.

10 PIPING AND SUPPORTS

10.1 Piping

10.1.1 The pipe used in the sprinkler system (from the pump house to the installation valves) shall be normally laid underground or in masonry culverts with

removable covers of incombustible construction and shall be of any one of the following types :

a) Cast iron double flanged class "A" pipes conforming to the following standards:
   1) Horizontally cast iron pipes — IS 7181
   2) Vertically cast iron pipes — IS 1537
   3) Centrifugally cast (spun) iron pipes — IS 1536

NOTE — In case of vertically cast iron pipes, where the nominal diameter of the pipes exceeds 300 mm or where the pump delivery pressure exceeds 7 kg/cm^2, class "B" pipes would be necessary.

b) Centrifugally cast (spun) iron class "A" pipes with Tyton joints conforming to IS 1536.

c) Wrought or mild steel pipes (galvanised or not) of heavy grade conforming to IS 1239 (Part 1) and IS 1978 (when installed underground) or electric resistance welded steel pipes conforming to IS 3589 having welded joints and coated and wrapped as per IS 10221.

NOTE — At least 10% of all the welded joints should be radiographically tested and half of the joints radiographed should be field joints.

10.1.2 Pipes may be laid overground on exclusive supports. Pipes shall be of material conforming to any of the descriptions as per **10.1.1** with welded, threaded or flanged joints and supported adequately at regular intervals. The pipes shall run at least at distances from the face of the building(s) and/or open storage area(s) as stipulated below :

Light hazard	6 m
Moderate hazard	6 m
High hazard	15 m

10.1.3 Underground pipes shall be laid not less than 1 m below ground level. Where soil conditions are unsatisfactory, masonry or equivalent supports shall be provided at regular intervals.

NOTE — In case of poor soil conditions, it may sometimes be necessary to provide continuous masonry or equivalent supports.

10.1.4 Pipes shall not be laid under buildings or plant areas or storage areas. As far as possible, pipes shall not be laid under large open storage, railroads and roads carrying heavy traffic.

10.1.5 Pipes should not traverse on ground which is not under the control of the owner of the installation. Pipes shall also not pass through public roadways.

10.1.6 The installation piping (from the pumphouse up to the installation valve and also the installation piping with sprinklers) shall be capable of withstanding for two hours a pressure equivalent to 150% of the maximum working pressure.

10.1.7 All bolt holes in the flanges shall be drilled.

10.1.8 Flanges shall be faced and have jointing of rubber insertions or asbestos compound.

10.1.9 Welded joints shall not be permitted for pipes having diameter less than 50 mm.

NOTE — Where joints with odd angles are encountered, reference shall be made.

10.1.10 It is not permissible to run the sprinkler pipes through an unsprinklered building or occupancy and where it is not practicable the supply pipe line shall be installed at ground level and enclosed in brick trenches covered with removable RCC precast slabs.

10.1.11 All installation pipework above ground shall be installed at a slope not less than 1 : 500 for horizontal run of pipes. Normally the pipework shall slope through the installation valve. If the pipework is trapped (below the level of the installation valve for example in the basements), arrangements shall be made to provide drain cocks at the bottom of such pipes to drain the trapped water.

10.1.12 Sprinkler pipes shall not be embedded in concrete floors or ceilings of any building.

10.2 Fittings

10.2.1 Fittings installed underground shall be of cast iron heavy grade conforming to IS 1538 whereas those installed overground shall be of medium grade wrought or mild steel conforming to IS 1239 (Part 2) or malleable iron fittings conforming to IS 1879.

10.2.2 All fittings shall be able to withstand at least a pressure of 150% of the maximum working pressure.

10.2.3 Welded fittings according to the laid down welding procedure are permitted. Welded parts shall be galvanised or suitably coated after welding as per the requirement of the areas to be protected by the system, *i.e.*, chemical and electrolytic corrosion.

10.2.4 Welded joints should not be permitted for fittings of less than 50 mm diameter.

10.3 Supports (Pipes and Fittings Above Installation Valve)

10.3.1 Sprinkler pipes should be supported from the building structure which itself should be capable of supporting the water filled pipework and should not impair the performance of sprinklers under fire conditions.

10.3.2 Pipework should not be used to support any other loads except where primary support is designed for the suspension of the piped service.

10.3.3 Distribution/Range pipes should not be supported from ceiling sheathing or cladding or from any other associated suspension systems.

10.3.4 Pipes below obstructions such as duct work should be either supported from the building structure or from the steel members supporting such obstructions. Such members should be capable of supporting the weight of water filled pipes too.

10.3.5 Hangers should not be welded or fastened directly to the pipework.

10.3.6 The supports on which the pipework rests should be secured firmly in position.

10.3.7 The thickness of all parts of pipe supports should not be less than 3 mm.

10.3.8 Wherever possible, pipes should be supported from non-combustible building elements.

10.3.9 Pipework in corrosive areas should be of either stainless steel or suitably protected against corrosion.

10.3.10 The distance between the pipe supports measured along the line of connected pipes (whether the pipes run horizontally, vertically or at angles) shall not be less than that given in Table 11.

Table 11 Distance Between Pipe Supports
(*Clause* 10.3.10)

Pipe Diameter	Spacing
(1)	(2)
Up to 65 mm	4.0 m
65 mm to 100 mm	6.0 m
100 mm to 250 mm	6.5 m

10.3.11 *Distribution Pipes*

a) The first support on a nominally horizontal distribution pipe shall not be more than 2 m from the main distribution pipe.
b) The last support on a nominally horizontal distribution pipe shall not be more than 450 mm from the end.
c) Drop or rise pipes shall be secured to the building structure either directly or indirectly at the adjacent nominally horizontal part of the pipe within 300 mm of the drop or rise.

10.3.12 *Range Pipes*

a) At least one support shall be provided for:
   1) each pipe run connecting adjacent sprinkler, and
   2) the pipe run connecting the distribution pipe and the first sprinkler on the range pipe.
b) Pipe supports shall not be closer than 150 mm to any sprinkler axial central line.
c) The first support on a range pipe shall not be more than 2 m from the distribution pipe.
d) The last support on a range pipe shall not be more than 1.5 m from:
   1) The range pipe end; or
   2) Where there is a horizontal arm pipe of 450 mm or longer, the arm pipe end ; or
   3) Where there is a drop or rise exceeding 600 mm, the drop or rise pipe end.

10.3.13 Outgoing mains from the Installation valve to the system should be supported at every 3.5 m of its run.

10.3.14 The thickness of all components used in pipe supports should not be less than 3 mm anywhere.

10.3.15 Some of the typical supporting arrangements are shown in Fig. 15.

11 SPRINKLER SPACING, ARRANGEMENT AND LOCATION

11.1 General Requirements

11.1.1 All the measurements between sprinklers or of areas covered by groups of individual sprinklers shall be taken in the horizontal plane.

Notwithstanding the above provisions, the hydraulic calculations shall show the dimensions of the true lengths measured along the slope of the pipe.

11.1.2 Sprinklers shall be installed upright or pendent as required under the circumstances, with the deflector parallel to the slope of the roof, ceiling or pitch line of stairs.

11.1.3 Where the slope of the roof is greater than 1 in 3, a line of sprinklers shall be fitted at the apex unless there is a row of sprinklers at not more than 750 mm distant radially therefrom.

11.2 Coverage and Spacing of Sprinklers

11.2.1 *Light Hazard Class*

11.2.1.1 *Maximum area coverage per sprinkler*

a) Sidewall sprinklers 17 m^2
b) Other types of sprinklers 21 m^2

11.2.1.2 Maximum distance between sprinklers on range pipes and between adjacent rows of sprinklers:

a) Sidewall sprinklers 4.5 m[1)]
b) Other types of sprinklers 4.5 m

11.2.1.3 *Minimum spacing between sprinklers*

Sprinklers shall not be spaced at less than 2 m except in locations where the heat sensitive elements of the sprinklers can be protected from wetting of the operation of the adjoining sprinkler by suitable baffles with the prior approval (*see* Fig. 17).

[1)] For rooms exceeding 3.7 m but within 7.4 m in width, one row of sprinklers shall be provided on each wall at the above spacing and if the length of the room exceeds 9.2 m, the sprinklers in the opposite walls shall be staggered (*see* Fig. 16A).

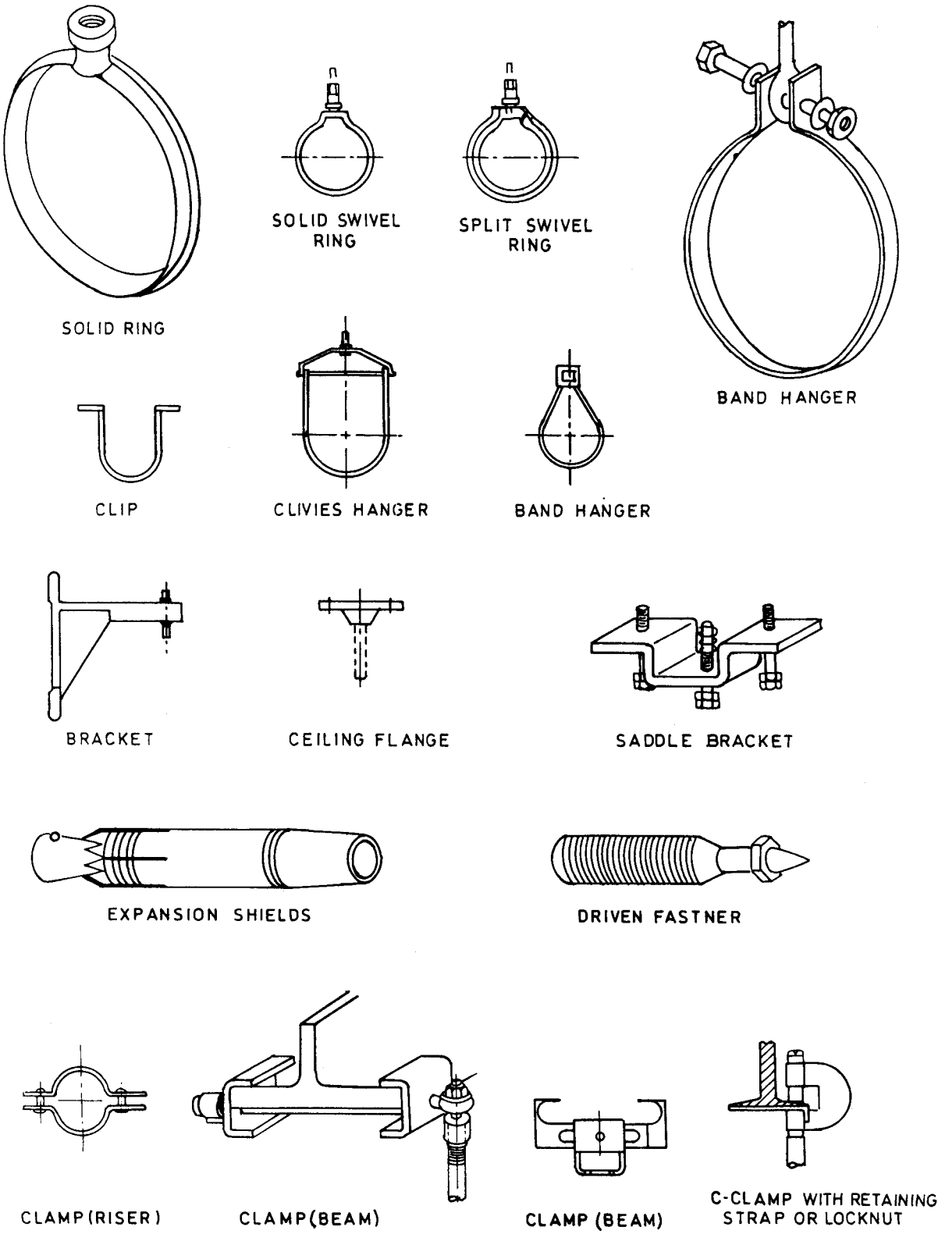
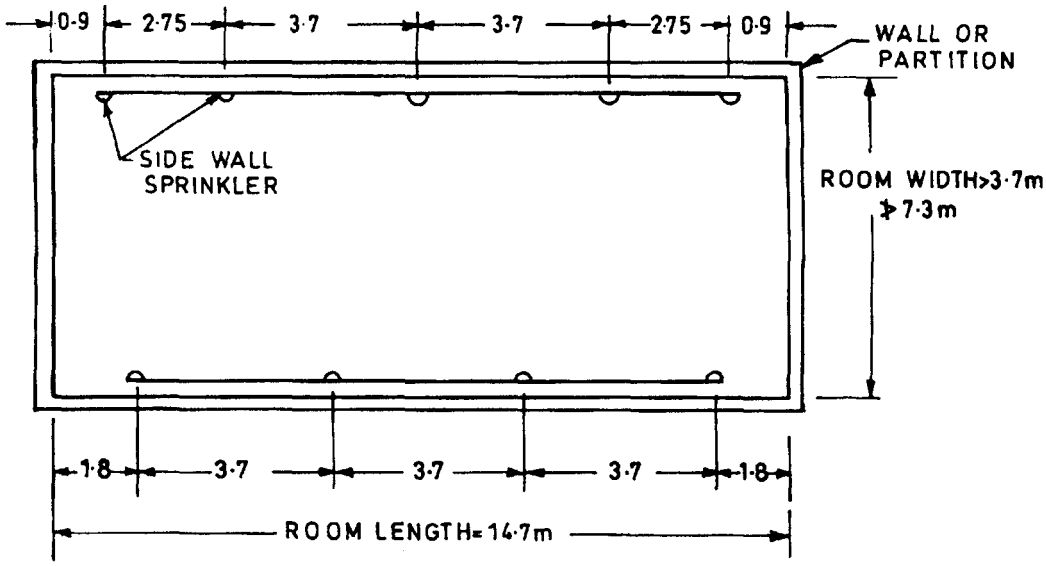
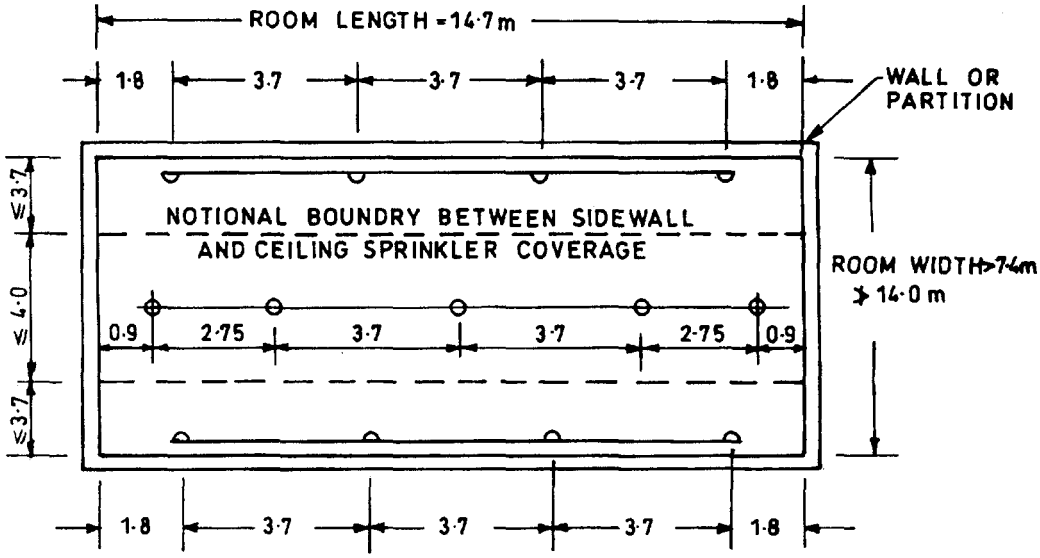


FIG. 15 COMMON TYPES OF PIPE HANGER EQUIPMENT



16A ROOMS OVER 3.7 m BUT NOT MORE THAN 7.4 m WIDE



16B ROOMS MORE THAN 7.4 m BUT NOT MORE THAN 14.1 m WIDE

All dimensions in millimetres.

FIG. 16 SIDEWALL SPRINKLER SPACING

11.2.1.4 *Distance between sprinklers and the boundary* (*see* Fig. 17):

a) The distance between the boundary and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and when measured perpendicular to the range pipe shall not be more than 0.5 times the spacing between the range pipes.

b) However, where the external walls are combustible or built with asbestos and metal or open sided and also in case of open joisted ceilings or where the roof has the rafters exposed, the distance between the boundary and the sprinklers shall not exceed 1.5 m.

c) Side wall sprinklers shall be located with the deflector vertical centre line not less than 50 mm and not more than 150 mm from the wall face against which they are mounted.

11.2.2 *Moderate Hazard Class*

11.2.2.1 *Maximum area coverage per sprinkler*

a)	Sidewall sprinklers	9 m^2
b)	Other types of sprinklers	12 m^2

11.2.2.2 *Maximum distance between sprinklers on range pipes and between adjacent rows of sprinklers*

a)	Sidewall sprinklers	3.4 m [1)]
b)	Other types of sprinklers :	
	With standard spacing	4.0 m
	With staggered spacing :	
	Sprinklers on ranges	4.6 m
	Adjacent rows	4.0 m

11.2.2.3 *Minimum spacing between sprinklers*

Sprinklers shall not be spaced at less than 2 m except in locations where the heat sensitive elements of the sprinklers can be protected from wetting of the operation of the adjoining sprinkler by suitable baffles with the prior approval (*see* Fig. 17).

11.2.2.4 *Distance between sprinklers and the boundary* (*see* Fig. 17)

a) The distance between the boundary and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and when measured perpendicular to the range pipe shall not be more than 0.5 times the spacing between the range pipes.

b) However when the layout is staggered, the distance between the boundary and the sprinklers when measured on range perpendicular to the boundary shall not be more than 0.5 times and 0.25 times the spacing between the sprinklers on alternate range lines.

c) However, where the external walls are combustible or built with asbestos and metal or open sided and also in case of open joisted ceilings or where the roof has the rafters exposed, the distance between the boundary and the sprinklers shall not exceed 1.5 m.

d) Side wall sprinklers shall be located with the deflector vertical centre line not less than 50 mm and not more than 150 mm from the wall face against they are mounted.

11.2.3 *High Hazard Class*

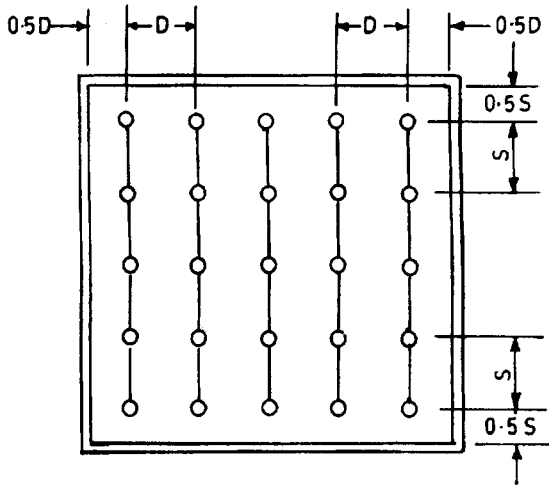
11.2.3.1 *Maximum area coverage per sprinkler*

a)	In general	9 m^2
b)	In storage racks (intermediate) :	
	With a single row of sprinklers	10 m^2
	With a double row of sprinklers	7.5 m^2

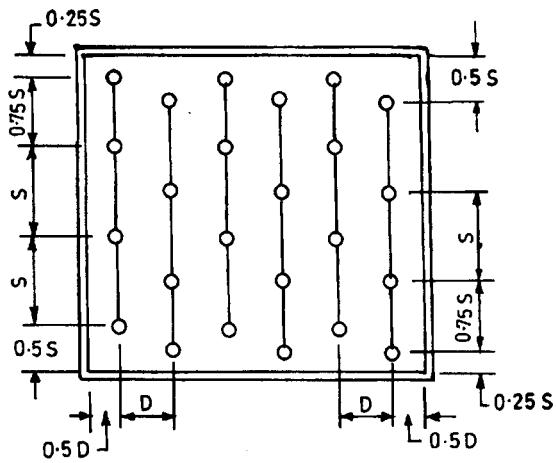
11.2.3.2 Maximum distance between sprinklers on range pipes and between adjacent rows of sprinklers:

a)	In general	3.7 m
b)	Within storage racks (intermediate)	2.5 m

[1)]For rooms exceeding 3.7 m but within 7.4 m in width, one row of sprinklers shall be provided on each wall at the above spacing and the sprinklers in the opposite walls shall be staggered as shown in the Fig. 16A. If the width of the room exceeds 7.4 m, it is necessary to sprinkler the central portion by conventional ceiling sprinklers and the distance between the above and the sidewall sprinklers shall not be less than 3.7 m (*see* Fig. 16B).



17A STANDARD LAYOUT FOR RECTANGULAR MATRIX, 4 m WIDE



S — Spacing between sprinkler on range pipes.
D — Spacing between range pipes.

17B STAGGERED LAYOUT FOR ORDINARY HAZARD SYSTEMS WHERE *S* IS TO EXCEED 4 m

All dimensions in millimetres.

FIG. 17 CEILING SPRINKLER SPACING

11.2.3.3 *Minimum spacing between sprinklers*

Sprinklers shall not be spaced at less than 2 m except in locations where the heat sensitive elements of the sprinklers can be protected from wetting of the operation of the adjoining sprinkler by suitable baffles with the prior approval (*see* Fig. 17).

11.2.3.4 *Distance between sprinklers and the boundary* (*see* Fig. 17)

a) The distance between the boundary and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing

between the sprinklers and when measured perpendicular to the range pipe shall not be more than 0.5 times the spacing between the range pipes.

b) However, where the external walls are combustible or built with asbestos and metal or open sided and also in case of open joisted ceilings or where the roof has the rafters exposed, the distance between the boundary and the sprinklers shall not exceed 1.5 m.

11.2.3.5 Side wall sprinklers and staggered layout for the installation are not permitted in high hazard risks.

11.3 Spacing Below Sprinkler Heads

A clear space of 0.5 m shall be maintained below the deflector of the sprinkler heads in all cases except high piled combustible storage areas/jute storage and above open suspended ceilings where the clear space required as above shall be 1 m.

11.4 Location of Sprinklers in Relation to Building Structure and Plant

11.4.1 *Roofs and Ceilings*

11.4.1.1 *Roofs and ceilings, without beams or bays*

a) For conventional and spray type of sprinklers, the sprinklers shall be installed in such a way that the deflectors are at distances as shown in Table 12.

b) For side wall sprinklers, the deflector of the sprinklers shall be not less than 100 mm and not more than 150 mm below the ceiling.

Table 12 Distance of Deflectors from Ceiling

Type of Ceiling	Distance in Millimetres		
	Minimum	Maximum	Preferred
(1)	(2)	(3)	(4)
Combustible, asbestos cement sheets, wired glass and other types of frangible elements	75	300	150
Combustible with exposed rafters and/or open joists	75	150	–
Non-combustible — either plane or arched or sloping	75	150	150

11.4.1.2 *Roofs and ceilings, with beams but without bays*

a) In case of conventional and spray type of sprinklers where a beam or joist is so deep that a sprinkler cannot be located below the beam or joist as specified in Table 12, they should be located above the base of the beam or joist at a distance below the ceiling and at a distance horizontal from the beam/joist as specified in Table 13 (depth of beam/joist less than 300/450 mm) (Fig. 18).

b) In case of side wall sprinklers any beam or other obstruction below the ceiling within the rectangle centred on the sprinkler, of dimension $A \times 2B$ shall not exceed the depth as given in Table 14.

Table 13 Sprinkler Location in Relation to Beams and Joists
(*Clause* 11.4.1.2)

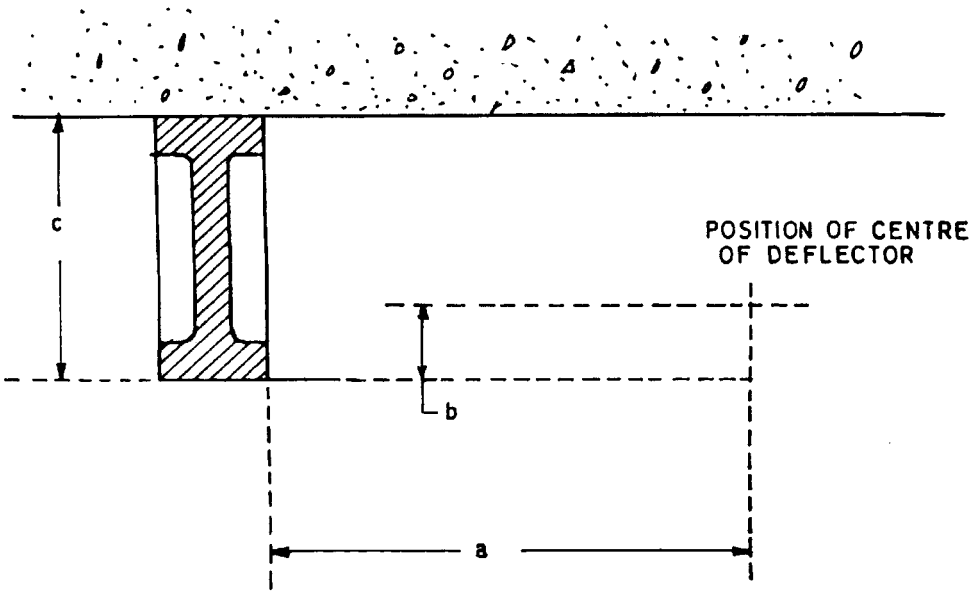
Minimum Horizontal Distance from Sprinkler Vertical Axis to the Side of Beam or Joist (in mm) (*a*) (*see also* Fig. 18)	Maximum Height of Sprinkler Deflector Above(+) or Below(–) Bottom of Beam (*b*) or Joist (in mm) (*see also* Fig. 18)			
	Conventional Sprinkler		Spray Sprinkler	
	Installed Upright	Installed Pendent	Installed Upright	Installed Pendent
(1)	(2)	(3)	(4)	(5)
200	– 20	[1]	[1]	[1]
400	0	[1]	0	0
600	+ 30	[1]	+ 20	+ 60
800	+ 60	[1]	+ 30	+ 120
1 000	+100	–200	+ 50	+ 200
1 200	+140	–170	+100	+ 280
1 400	+190	–120	+130	+ 360
1 600	+260	– 30	+160	+ 470
1 800	+390	+170	+180	+ 670

[1] These types are not used at these horizontal distances.

Table 14 Sidewall Sprinkler Location in Relation to Beams
(*Clause* 11.4.1.2)

Depth of Beam (mm)		Minimum Horizontal Distance Between Sprinkler/ Wall to Beam (in m)	
More Than	Less Than	Perpendicular to Wall Dimension "*A*"	Parallel to Wall Either Side of Sprinkler Dimension "*B*"
(1)	(2)	(3)	(4)
0	100	1.8	1.0
100	125	2.1	1.2
125	150	2.4	1.4
150	175	2.7	1.6
175	200	3.0	1.8

NOTE — Any obstruction below the plane of the ceiling within a rectangle either side of the sprinkler by 1.8 m should be regarded as a boundary.



KEY:
a — Minimum horizontal distance.
b — Distance of deflector above (+) or below (–) bottom of beam or joist.
c — Depth of beam or joist.

FIG. 18 SPRINKLER LOCATION RELATING TO BEAMS

11.4.1.3 *Roofs and ceilings, with bays and/or deep beams*

a) Where the depth of a beam or joist exceeds 300 mm or 450 mm for combustible and non-combustible ceilings respectively or other similar obstructions form ceiling bays so that requirements under **11.4.1.1** cannot be met, then the beam or joist or any other such obstructions shall be regarded as a boundary.
b) Where the distance between centre to centre of beams or joists is 1.8 m or less, the above parameters do not hold good and reference shall be made with full particulars.

11.5 Columns

As far as possible, the sprinklers shall be located away from the columns. Where a roof or ceiling sprinkler is less than 0.6 m from the face of a column, another sprinkler shall be located not more than 2 m from the opposite side of the column.

11.6 Girders

a) Where the top flange of a girder is not more than 200 mm in width, sprinklers shall be positioned either not less than 1.2 m from the side of the girder or directly above the girder with the deflector not less than 150 mm from the top face of the girder.
b) Where the top flange of the girder is more than 200 mm in width, sprinklers shall be positioned not less than 1.2 m from the side of the girder.

11.7 Roof Trusses

a) Where the roof truss members are not more than 100 mm wide, sprinkler shall be positioned either not less than 0.3 m from the side of the truss or equidistant from each side of the truss with the deflector not less than 150 mm above any truss member.
b) Where the roof truss members are more than 100 mm but less than 200 mm wide, sprinkler shall be positioned either not less than 0.6 m from the side of the truss or equidistant from each side of the truss with the deflector not less than 150 mm above any truss member.
c) Where the roof truss members are more than 200 mm wide, sprinklers shall be positioned not less than 0.6 m from the sides of the truss.

11.8 Concealed Spaces

11.8.1 *Roof Spaces*

Spaces between roofs and ceilings (including those at the apexes and sides of buildings) more than 0.8 m deep measured between the highest point under the roof and the top of the ceiling shall be sprinkler-protected.

11.8.2 *Intermediate Floor Space*

Concealed spaces between floors and ceilings shall be sprinklered where they are as follows:

a) More than 0.8 m deep; or

b) Not wholly of non-combustible construction; or
c) Containing combustible materials.

11.8.3 *Space Under Lowest Floor*

Sprinklers shall be installed in all spaces below the lowest floors in a building where the floor is combustible and :

a) the space is accessible for storage purpose and/or entrance of unauthorized persons and/or accumulation of waste and debris and/or is not sealed against liquid spillage;
b) the space contains utility piping and installation such as air, steam, wiring, shafting, conveyors, etc; and
c) flammable liquids are stored in the floor above.

11.8.4 *Bins and Silos*

Where the area of the bins and silos exceed 9 m^2 and where the same are detached, sprinklers should be provided inside the bins and silos containing sawdust, wood flour, pulverized coal and similar ignitable materials. Care shall be exercised to ensure that for materials which tend to swell under water and burst, reference shall be made with full particulars.

11.8.5 *Corn, Rice, Provender and Oil Mills*

a) A sprinkler should be fitted at the head of each dust trunk. Sprinklers shall be installed at not more than 3 m apart in all dust trunks which are constructed of combustible materials and which are installed at more than 30° from the vertical.
b) Tiers of cyclones (centrifuges), or similar plant, separated by less than 1 m shall be protected by sprinklers in the interspace as shown in Fig. 19.

11.8.6 *Elevators, Rope or Strap Races, Gearing Boxes and Dust Receivers*

a) Elevators, other than pneumatic elevators or slow moving endless chain, ring, loop or fork elevators capable of operating only when the elevator is full, shall be fitted with a sprinkler. The sprinkler shall be in the box at the top, located to discharge over the head and both legs or shafts of the elevator.
b) Rope or strap races, gearing boxes and enclosed shaft machine drives of combustible construction or communicating between floors, shall be fitted with internal sprinklers.
c) Dust cyclones and dust collection chambers and boxes either inside the protected building or outside and directly above any protected building with a combustible roof, shall be fitted with internal sprinklers.
d) The trunkings connecting the dust collection chambers to the protected building within 10 m shall be protected with sprinklers.

11.8.7 *Escalators*

Sprinklers shall be installed in the following areas:

a) In the passenger carrying space;
b) Below the ceiling;
c) Between the ceiling below the escalator and the passenger carrying space;
d) In the escalator boot; and
e) In the motor areas.

11.8.8 *Hoists, Lift Wells and Enclosed Chutes Through the Floors*

The above areas, if not segregated from the main buildings in which they are located, shall be sprinklered.

11.8.9 *Machinery Pits and Production Lines*

Machinery pits in which combustible wastes may accumulate and the undersides of the production lines shall be sprinklered.

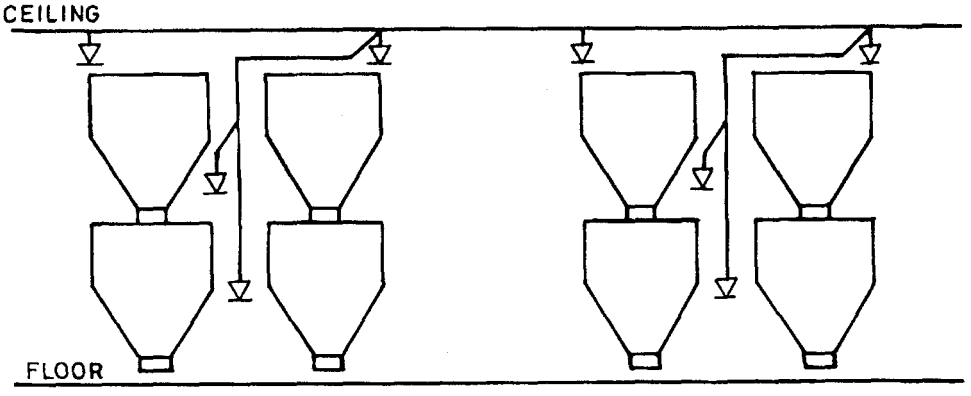


FIG. 19 PROTECTION OF TIERED CONICAL PLANT, *e.g.*, CYCLONE DUST COLLECTOR

11.8.10 *Enclosed Paint Lines, Drying Ovens and Drying Enclosures*

The areas shall be sprinklered on the inside and side wall sprinklers may be considered for these areas.

11.9 Obstruction Below Sprinklers

11.9.1 Sprinklers shall be fitted under the following types of obstructions which are either: (a) more than 0.8 m wide and less than 150 mm from the adjacent walls or partitions, or (b) more than 1 m wide.

Internal overhead platforms, heating panels, galleries, walkways, stagings other than in film or television studios and stairs and stairways unless specifically excepted.

11.9.2 *Ducts*

Sprinklers shall be fitted below the ducts under the following circumstances:

a) Rectangular and more than 0.8 m wide and less than 150 mm from the adjacent walls or partitions;
b) Circular and more than 1 m in diameter and less than 150 mm from the adjacent walls or partitions;
c) Rectangular and more than 1 m in width; and
d) Circular and more than 1 m in diameter.

11.9.3 *Hoods Over Paper Making Machines*

Sprinklers shall be fitted under the hoods or shields over the dry ends of above machines. If there is an enclosures, side wall sprinklers are recommended.

11.9.4 *Storage Racks*

Sprinklers should be fitted to protect the storage in racks.

11.9.5 *Worktables*

Sprinklers shall be fitted under the worktables where there is a power source or where combustible process waste may accumulate.

11.9.6 *Suspended Ceilings*

For protecting the suspended imperforate or open ceilings with sprinklers, the protection needs special considerations due to several factors like combustibility of the roof material, behaviour under fire conditions, structural integrity, etc.

11.10 Canopies

Canopies that are non-combustible and less than 2 m from the wall of the building need not be protected with sprinklers provided cut-off sprinklers are fitted at the door openings leading to the canopies. However, under other circumstances, the underside of the canopies shall be fitted with sprinklers.

11.11 Exterior Docks and Platforms

Sprinklers shall be fitted under the exterior docks and platforms of combustible construction unless such spaces are sealed against accumulation of debris and waste.

11.12 Sprinkler Protection for Specific Hazards

11.12.1 *Film and Television Production Studios*

Sprinklers shall be fitted under solid or slated platforms (except those used for temporary platforms, etc, for sets but including those for lighting and other equipment) if these are more than 0.8 m wide and also for walkways, connecting stairs including those used for lighting and other equipment. Sprinklers shall also be fitted in concealed spaces or cavities more than 100 mm deep between combustible linings and walls/roofs.

11.12.2 *Theatres and Similar Premises*

In addition to the sprinklers in the roof or ceiling, sprinklers shall be fitted under the grid, the flies, the stage and any other obstruction to the discharge from the roof or ceiling sprinklers. Care shall be exercised in siting the sprinklers and associated pipework in case where moving sets are involved and also where personnel have to work in the close proximity of the sprinklers.

11.12.3 *Computer and Similar EDP Areas*

Pre-action sprinkler installation is recommended for above type of risks keeping in mind the effect of water discharge on such risks

11.12.4 *Plastic Roof Lights*

Sprinklers shall not be installed directly below roof lights of PVC or plastics of similar thermal behaviour and shall only be installed where (a) the area of rooflight does not exceed 5 m^2, (b) the distance between the individual rooflights is not less than 1.8 m, and (c) the total area of rooflights in any building or in those communicating therewith does not exceed 15% of the plan area of such building(s).

11.13 Intermediate Level Sprinklers

For high hazard storage in racks, shelves, etc, protection by rows of intermediate sprinklers is mandatory, if storage heights are beyond the limits specified in **9.1.5.2** and **9.1.5.3** (Tables 4 and 5). The requirements for the above provisions are as given in **11.3.1** to **11.3.4**.

11.13.1 The location of sprinklers shall be such that they are not obstructed by racks or structural steel work and as far as possible, they are in the path of longitudinal flue space. The discharge of water shall be able to penetrate the goods stored in the racks. The clearance between the sprinkler deflectors and the stored goods shall not be less than 150 mm anywhere.

The number of rows are determined by the height of the racks and/or shelves.

11.13.2 The horizontal spacing (longitudinal) between sprinklers shall not exceed 3.5 m for Category I/II goods and 1.8 m for Category III/IV goods. Laterally for every 3 m width of the racks (including two racks when stored back to back), there shall be one sprinkler.

11.13.3 The vertical spacing between sprinklers shall not exceed 3 m. If the top tier of the racks is within 3 m of the roof sprinklers, top tier need not be protected with intermediate sprinklers.

11.13.4 The location of intermediate sprinklers shall be such that the product of the horizontal and vertical spacing between sprinklers is not more than 9 m^2 for Category I/II storage goods and 5 m^2 for Category III/IV storage goods.

12 PIPE SIZING AND SPRINKLERS ARRAY DESIGN

12.1 General Requirements

12.1.1 *Supply Mains*

The nominal size of supply trunk mains and branch mains shall be not less than the size of any installation main distribution pipe, at its main installation control valve, supplied by the trunk main.

12.1.2 *Installation Pipework*

Individual sprinklers shall not be connected directly to distribution and main distribution pipes, except in the case of light-hazard installations where sprinkler may be connected directly to pipes not exceeding 50 mm nominal bore.

12.1.3 In moderate or high-hazard installations arm pipes or drop pipes not exceeding 32 mm nominal bore shall be used to connect individual sprinklers where these are fed from pipes larger than 65 mm nominal bore.

12.1.4 Where upright or pendent conventional or spray sprinklers are fitted within 400 mm of the pipe axis alongside a pipe of nominal size greater than 65 mm, the deflector shall be not more than the appropriate distance given in Table 15 above the lower edge of the pipe.

12.2 Orifice Plates

12.2.1 An orifice plate used to hydraulically balance an installation, or to accommodate pump characteristic, shall:

a) have an orifice diameter not less than one-half of the internal diameter of the pipe into which it is fitted;

b) be fitted only in pipes of 50 mm nominal bore or greater;

c) be of brass or stainless steel with a plain central hole without burrs, and of a thickness complying with Table 16;

d) have an identification tag, projecting beyond any flanges between which it is clamped, on which is clearly stamped the nominal pipe diameter and the orifice "K" factor.

12.2.2 The orifice plate shall be fitted not less than two pipe internal diameters downstream of the outlet from any elbow or bend.

12.2.3 The relationship between orifice size, flow rate and the pressure loss shall be calculated using the data given in Tables 32 and 33.

Table 15 Location of Sprinklers Alongside Feed Pipes Larger Than 65 mm Nominal Size
(*Clause* 12.1.4)

Minimum Horizontal Distance from Pipe Centre Line to the Sprinkler Centre Line (mm)	Maximum Height of Sprinkler Deflector Above Lower Edge of Pipe (mm)	
	Conventional Sprinkler Installed Upright	Spray Sprinkler Upright/ Pendent and Conventional Sprinkler Pendent
(1)	(2)	(3)
100	00	17
200	17	40
400	34	100

NOTE — Dimensions may be interpolated.

Table 16 Orifice Plate Thickness According to Pipe Nominal Bore Pipe Nominal Bore
(*Clause* 12.2.1)

Pipe Nominal Bore (mm)		Orifice Plate Thickness (mm)
Over	Not Greater than	
—	80	3
80	150	6
150	200	9

12.3 Concealed Spaces

12.3.1 *Protection in Concealed Spaces*

Where there are concealed spaces above ceilings or below floors, and where the space below the ceiling or above the floor is classified as moderate or high-hazard for which protection is specified in **11.8**, the concealed spaces shall be protected as follows:

a) if the concealed space contains only water pipes, electric wiring or air-conditioning trunking of non-combustible material by

10 mm sprinklers with a maximum area of coverage 21 m^2 per sprinkler and a design density discharged of 5 mm / min; or

b) otherwise as specified for moderate hazard.

The maximum area of sprinkler coverage and pipework design shall be as given in Table 17.

12.3.2 The feed pipe to the sprinklers in the concealed space shall be arranged and sized as follows.

12.3.2.1 *Light hazard*

The concealed space above or below shall be protected by a separate pipe from the installation valve.

12.3.2.2 *Moderate hazard*

If the concealed space above a precalculated installation are fed individually from the pipework below, the range and distribution pipes in the installation shall be sized by taking the room and concealed space sprinklers cumulatively. Alternatively if two feed pipes are used, one for the concealed space and one for the room sprinklers, the common feed pipe shall have a nominal bore of not less than 65 mm.

The concealed space below a precalculated installation shall be fed by two feed pipes, one for the concealed space and one for the room sprinklers, the common feed pipe should have a nominal bore of not less than 65 mm.

12.3.2.3 *High hazard*

If the concealed space above or below a precalculated installation shall be fed by a separate feed pipe from that feeding the sprinklers in the room. The concealed sprinkler feed pipe shall be connected outside the room between the installation valve set and any 48 sprinkler design point for a high hazard sprinkler array outside the room concerned.

12.3.2.4 *Fully hydraulically calculated installation*

The pressure and flow characteristics of the installation shall be satisfactory under each of the following operating conditions:

a) When the appropriate density and AMAO are needed wholly in the room.

b) When the appropriate density and the AMAO given in Table 17 are needed wholly in the concealed space.

12.4 Precalculated Sprinkler Arrays

12.4.1 *General*

12.4.1.1 The size of distribution feed pipes, including in light-hazard installations any which are partly range pipes because of the three sprinkler limitation, shall be as specified in the tables from the terminal point(s) up to the design point(s).

12.4.1.2 The feed pipe between the installation main control valves and the design point shall be hydraulically calculated on the basis of a maximum flow loss, corrected for static head gain for design points not at the highest level, at a particular flow rate.

12.4.1.3 Where the number of sprinklers in an array in a room, or in an area protected by a distinct group of sprinklers having its own distribution pipe spur, is less than or equal to the number of sprinklers for which the distribution pipes are hydraulically designed, the design point shall be positioned at the point of connection to the distribution pipe of the range of the

Table 17 Sprinkler Protection of Concealed Spaces
(*Clause* 12.3.1)

Class of Protection in Room		Concealed Space Pipework Design		Concealed Space Maximum Area per Sprinkler, or Treat as Hazard Class Listed (in m^2)
Pipework Design Method	Hazard Class	Nominal Size as for Hazard Class Listed	AMAO as for Hazard Class Listed	
(1)	(2)	(3)	(4)	(5)
Pre-calculated	Light	Light	–	Light
	Moderate	Moderate Moderate	–	21 Moderate
	High	Moderate Moderate	–	21 Moderate
Fully calculated	Light	–	Light	Light
	Moderate	–	Moderate Moderate	21 Moderate
	High	–	Moderate Moderate	21 Moderate

array which is hydraulically nearest to the installation control valves.

12.4.1.4 Where the number of sprinklers in an array in a room on a distribution pipe terminal spur exceeds the number for which the distribution pipes are hydraulically designed, the design point shall be positioned at the point of connection to the range or ranges immediately upstream of the group of ranges containing not more than the maximum specified number of sprinklers beyond the design point.

12.4.1.5 Risers or drops, connecting ranges to distribution pipes and pipes longer than 300 mm connecting single sprinklers to distribution pipes, shall be considered to be distribution pipes and sized accordingly. The design point shall be positioned at the point of connection of the riser, drop or single sprinkler pipe to the horizontal distribution pipe run when designing the hydraulically determined length of feed pipe.

12.4.1.6 Pipe diameters shall not increase in the direction of flow of water to any sprinkler.

12.4.2 *Light Hazard*

12.4.2.1 *Range and terminal spur distribution pipes*

The nominal size of range pipe and terminal distribution pipes, *i.e.*, distribution pipes downstream of the design point, shall be as given in Table 18.

NOTE — It is possible only under light hazard risks that sprinklers can be fed directly from the distribution pipes.

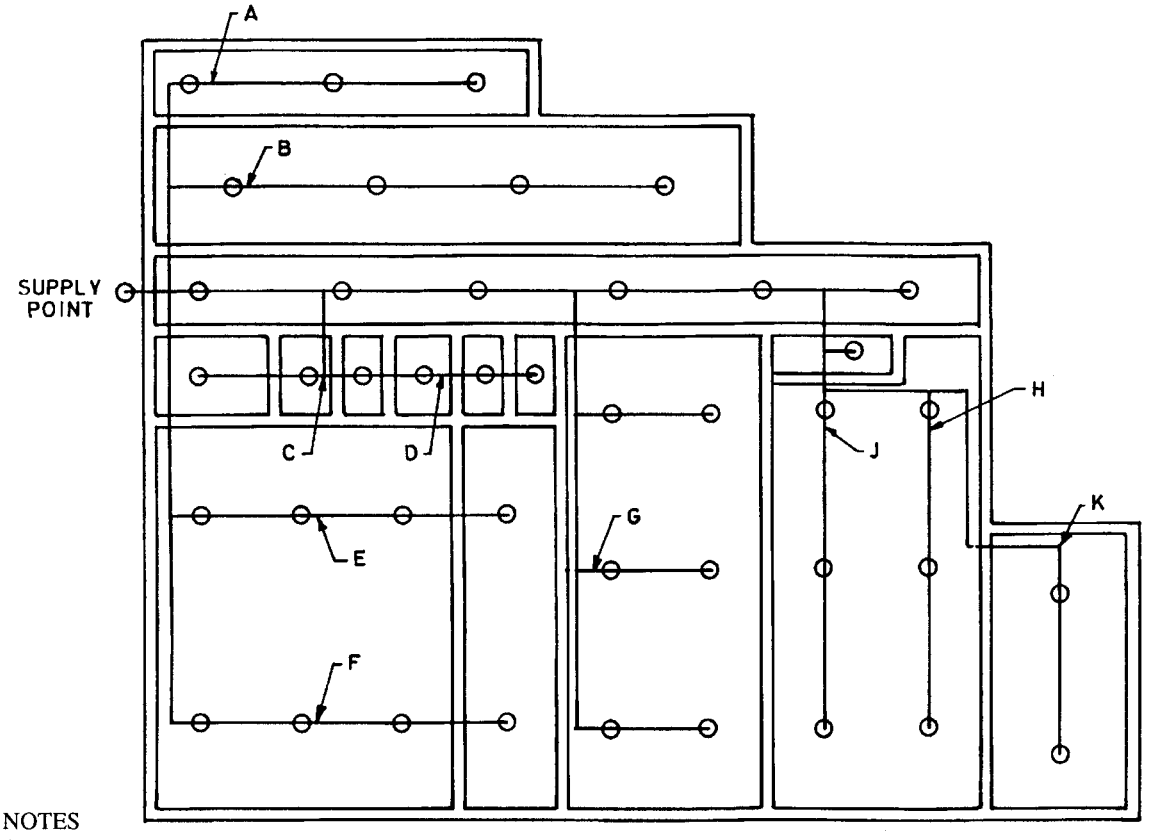
12.4.2.2 *Distribution pipes (other than terminal spurs)*

All pipework between the installation main control valves and the design point at each extremity of an installation array at the highest level shall be sized by hydraulic calculation using the values of Tables 19 and 20.

12.4.2.3 *Design point*

Normally it shall be two sprinkler point. However, under the following circumstances, it shall be three sprinkler point (*see* Fig. 20):

a) If the range pipe caters to 4 or more sprinklers; and
b) When the range pipe runs along the apex of the ridge roof; or



NOTES

1 Pressure loss between supply point and:
A (2 sprinkler point) = 0.7 bar
B (3 sprinkler point) = 0.7 bar
C, D, E, F, G, H, J & K (2 sprinkler point) = 0.9 bar

2 Dimensions shown as < 25 mm> or < 32 mm > indicates probable pipe sizes resulting from calculation.

FIG. 20 DESIGN POINTS IN A L.H. INSTALLATION

c) When the range pipe is the only line along a narrow room or corridor.

12.4.2.4 Maximum number of sprinklers that can be fed from a range pipe shall not be more than six.

12.4.2.5 The pressure loss between the design point and the entry point from the distribution pipe to the range (where more than two sprinklers are provided in the range) shall be calculated as per Table 20 (column A).

12.4.2.6 The pressure loss from the entry point as said above at the extremity of the installation and the installation valve shall be calculated as per Table 20 (column B).

12.4.2.7 In case of sprinklers in different levels in the same risk, allowance can be given to the static pressure gain in the successive levels below the top-most level. The nominal size of the distribution pipe shall however not be less than the minimum size specified in Table 18 for the range pipe fed from the design point.

12.4.2.8 The layout of the sprinkler installation should, by and large, conform to the method shown in Fig. 20.

Table 18 Light Hazard Range and Terminal Distribution Pipe Sizes
(*Clause* 12.4.2.1)

Pipe	Size (mm)	Maximum Length (in m)	Maximum Number of Sprinklers[1] Allowed on the Pipe Size Stated
(1)	(2)	(3)	(4)
Steel	20	8	1
	25	N.A.	3

[1]The limit of 3 sprinklers does not preclude the use of 25 mm pipe between the 2/3 sprinkler design point and the installation valve if hydraulic calculation shows it is possible nor does it follow that 25 mm pipe may be used between the 3rd and 4th sprinklers where the two sprinkler point is the design point.

Table 19 Maximum Pipe Flow Loss Between Each Design Point and the Installation Control Valve in Light Hazard Installation
(*Clause* 12.4.2.2)

Design Point	Maximum Friction Loss Including Changes of Direction (Bars)	Distribution and Range Pipe Loss
(1)	(2)	(3)
Two sprinkler point	0.9	*See* Columns A and B of Table 20
Three sprinkler point	0.7	*See* Column B of Table 20
Two sprinkler point in a narrow room or range at roof apex each with a single line of three sprinklers	0.7	*See* Column B of Table 20

Table 20 Pressure Loss Per Unit Length for Design Flow Rates in Light Hazard Installation
(*Clause* 12.4.2.2)

Pipe Material	Nominal Size (mm)	Pressure Loss Per Unit Length (in mBar/m)	
		Column "A"	Column "B"
(1)	(2)	(3)	(4)
Steel [IS1239 (Part 1)]	25	44.0	200.0
	32	12.0	51.0
	40	5.5	25.0
	50	1.7	7.8
	63	0.5	2.2

NOTES

1 The equivalent length of an elbow, bend or tee where the water is turned through an angle shall be taken as 2 m in using the data or in using Table 30 or Table 31.

2 Where heavy grade steel as per IS 1239 (Part 1) is used, flow rate shall be taken as 100 l/min for column B.

12.4.3 *Moderate Hazard*

12.4.3.1 *Range pipe and terminal distribution pipe sizes*

The size of the nominal bores shall be as shown in Table 21.

Table 21 Range Pipe Nominal Sizes for Various Pipe Layouts in Moderate Hazard Installations

Range Pipe Layout	Pipe Nominal Bore (mm)	Maximum Number of Sprinklers to be Fed by Pipe of Size Listed
(1)	(2)	(3)
a) Ranges at remote end of each distribution pipe spur:		
1) Last two ranges in two end-side layout	25	1
	32	2
2) Last three ranges in three end-side layout	25	2
	32	3
3) Last range in all other layouts	25	2
	32	3
	40	4
	50	9
b) All other ranges	25	3
	32	4
	40	6
	50	9

12.4.3.2 A single sprinkler shall be fed by pipe of not less than 25 mm nominal bore.

12.4.3.3 There shall be not more than six sprinklers on any range, including apex range where the ranges run under a roof longitudinally, sloping at an angle that is greater than 6°.

12.4.3.4 *Distribution pipe (except terminal pipe)*

The main distribution and distribution pipes (including all risers and drops) between the highest

design point and the installation valve shall be sized by hydraulic calculation based on Table 22. The maximum friction loss shall not exceed 0.5 bars at a flow rate of 1000 l/min. The distribution pipes downstream the design point shall comply with sizes stated in Table 23. The layout of the installation shall, by and large, be in the same fashion as shown in Fig. 21 (particularly for large installations) to enable hydraulic balance.

Table 22 Pressure Loss Per Unit Length for Design Flow Rates in Moderate Hazard Installation

Pipe Nominal Bore [IS 1239 (Part 1), Medium] (mm)	Pressure Loss Per Unit Length (mbar/m)
(1)	(2)
65	35
80	16
100	4.4
150	0.65
200	0.16

NOTES

1 The equivalent length of an elbow, bend or tee where the water is turned through an angle shall be taken as 3 m when using the data or in using Table 30 or Table 31.

2 Where heavy grade steel as per IS 1239 (Part 1) is used, flow rate shall be taken as 1000 l/min.

Pre-calculated distribution pipe nominal bores downstream of the design point shall comply with Table 23.

Table 23 Distribution Pipe Nominal Sizes in Moderate Hazard Installations and Maximum Number of Sprinklers Downstream of Design Point

(*Clause* 12.4.3.4)

Pipe Layout	Distribution Pipe Nominal Size (mm)	Maximum Number of Sprinklers to be Fed by Pipe Listed Below
(1)	(2)	(3)
a) Two end -side	32	2
	40	4
	50	8
	65	16
b) All other types	32	3
	40	6
	50	9
	65	18[1)]

[1)] This does not preclude the use of 65 mm nominal bore pipe between the 16/18 sprinkler point and the installation valves if hydraulically found in order.

12.4.3.5 The feed pipe for all the other design points (except the highest design point) shall be similarly sized by hydraulic calculation. In case of friction loss in any part of the feed pipe not common with that feeding the highest design point, allowance can be given to the static pressure gain in the successive levels below the top most level. The nominal size of the distribution pipe shall however not be less than the minimum size specified in Table 23 for the range pipe fed from the design point.

12.4.3.6 *Design point*

The design point shall be 16 sprinkler point for two end-side sprinkler range pipe and the 18 sprinkler point for all other layouts (*see* Fig. 21).

12.4.4 *High Hazard*

12.4.4.1 *Range pipe and terminal distribution pipe sizes*

Range pipes and nominal bores shall be as given in Table 24 or Table 25 depending on the sprinkler nominal size and the table in which the water supply-pressure flow characteristic is specified (i.e. Tables 6, 7, 8 or 9).

Table 24 Range Pipe Nominal Sizes for Various Pipe Layouts for High Hazard Installations with Sprinklers of 15 mm Nominal Bore and Pressure Flow Characteristics as Given in Tables 6 or 7

Range Pipe Layout	Pipe Nominal Size (mm)	Maximum Number of Sprinklers to be Fed by Pipe Listed
(1)	(2)	(3)
a) Ranges at remote end of each distribution pipe spur:		
1) Last two ranges in two end-side layout	25	1
	32	2
i) Last three ranges in two end-side layout	25	2
	32	3
ii) Last range in all other layouts	25	2
	32	3
	40	4
b) All other ranges	25	3
	32	4

12.4.4.2 No range pipe shall connect to a distribution pipe exceeding 150 mm nominal bore.

12.4.4.3 Pre-calculated distribution pipe nominal bores downstream of the design point shall be as given in Table 26 or Table 27 depending upon the sprinkler head nominal size and the table in which the water supply pressure flow characteristic is specified (*i.e.*, Tables 6, 7, 8 or 9).

12.4.4.4 *Distribution pipe upstream of the design point*

The main distribution and distribution pipes between each sprinkler design point and the installation valve shall be sized by hydraulic calculation using the pipe friction loss per unit length given in Table 28 for the flow specified in **9.2.3.2**.

Table 25 Range Pipe Nominal Sizes for Various Pipes Layouts for High Hazard Installations with Sprinklers of 15 mm Nominal Bore and Pressure Flow Characteristics as Given in Table 8 or of 20 mm Nominal Size and Pressure Flow Characteristics as Given in Table 9
(*Clause* 12.4.4.1)

Range Pipe Layout	Pipe Nominal Size (mm)	Maximum Number of Sprinklers to be Fed by Pipe Listed
(1)	(2)	(3)
a) End-side arrangements		
1) Last three ranges	40	1
	50	3
	65	6
2) Other ranges	32	1
	40	2
	50	4
	65	6
b) End-centre arrangements		
1) Two end centre layout		
i) Last three ranges	32	1
	40	2
ii) Other ranges	32	2[1)]
2) Three and four end centre layouts, all ranges	32	1
	40	2
	50	4

[1)] 32 mm feed to each.

Table 26 Distribution Pipe Nominal Sizes for Various Numbers of Sprinklers Downstream of the Design Point in High Hazard Installations with Sprinklers of 15 mm Nominal Bore and Pressure Flow Characteristics as Given in Table 6
(*Clause* 12.4.4.3)

Distribution Pipe Nominal Size Listed (mm)	Maximum Number of Sprinklers to be Fed by the Pipe of Size
(1)	(2)
32	2
40	4
50	8
65	12
80	18
100	48[1)]

[1)] This does not preclude the use of 100 mm nominal size pipe between the design point and the installation valve if it is possible by hydraulic calculation requirements (**12.4.4.4**).

Table 27 Distribution Pipe Nominal Sizes for Feeding Various Numbers of Sprinklers Downstream of the Design Point in the High Hazard Installations with Sprinklers of 15 mm Nominal Size and Pressure Flow Characteristics as Given in Tables 7 or 8 or Sprinklers of 20 mm Nominal Size and Pressure Flow Characteristics as Given in Table 9
(*Clause* 12.4.4.3)

Range Pipe Layout	Distribution Pipe Nominal Size (mm)	Maximum Number of Sprinklers to be Fed by Pipe Listed
(1)	(2)	(3)
Four end side layout	65	8
All other layouts	50	4
	65	8
	80	12
	100	16
	150	48[1)]

[1)] This does not preclude the use of 100 mm nominal size pipe between the design point and the installation valve if it is possible by hydraulic calculation requirements.

Table 28 Pressure Loss Per Unit Length of Pipe for Design Flow Rates in High Hazard Installations
(*Clause* 12.4.4.4)

Flow Rate l/min	Pressure Loss Per Unit Length (in mBar/m)			
	100 mm Nominal Size Medium Grade Pipe [IS1239 (Part 1)]	150 mm Nominal Size Medium Grade Pipe [IS1239 (Part 1)]	200 mm Nominal Size Medium Grade Pipe [IS1239 (Part 1)]	250 mm Nominal Size Medium Grade Pipe [IS1239 (Part 1)]
(1)	(2)	(3)	(4)	(5)
2800	34	5.1	1.3	0.43
4550	72	11.0	2.7	0.90
5600	115	16.0	4.1	1.40
6750	160	23.0	5.8	1.85
9000	250	36.0	9.1	3.00

NOTES
1 Where other grades of pipes are used, pressure loss data should accordingly be changed.
2 The equivalent length of an elbow, bend or tee where the water is turned through an angle should be taken as 3 m when using the data or in using Tables 30 or 31.

12.4.4.5 *Design point*

The design point shall be the 48 sprinkler point or if appropriate as specified in **9.2.3.2**, **9.2.3.3** or **12.4.1.3** (*see* Fig. 23, 24, 25)

12.4.4.6 The highest sprinkler shall be either downstream of a sprinkler design point or in an array with its own terminating distribution spur.

12.4.4.7 The layout of the sprinkler installation shall, by and large, conform to the methods shown in Fig. 22, 23, 24.

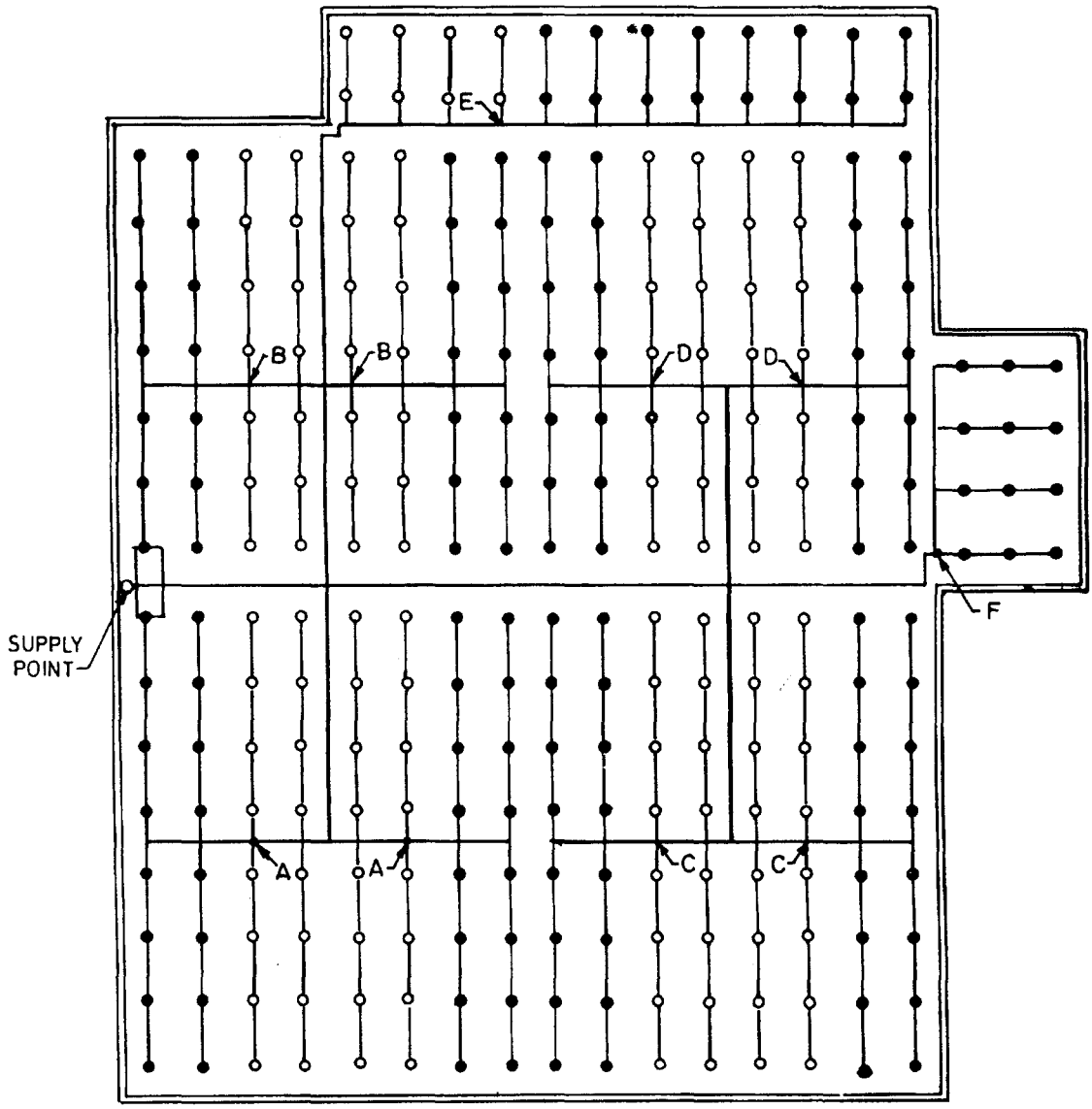


FIG. 21 DESIGN POINTS IN AN OH INSTALLATION

12.4.4.8 The pressure loss in the distribution pipe to any particular section of the installation valve, shall be adjusted to that needed to match the water supply characteristic by either·

a) suitably sizing the distribution pipe spur feeding the particular section when the distribution pipe nominal size shall not be less than that of the first length, sized by the pipe tables, of distribution pipe downstream of the design point to which it is connected, or

b) fitting an orifice plate complying with **12.2** in the particular distribution pipe (*see* Fig. 23, 24, 25).

12.5 Intermediate Level In-Rack Sprinklers

12.5.1 Where more than 50 intermediate level sprinklers are installed in the racks, roof and/or ceiling sprinklers in the concerned area along with the intermediate level sprinklers shall be installed with a separate installation control valve set.

12.5.2 For hydraulic calculation purpose, it shall be assumed that minimum of three sprinklers are operating simultaneously on each level up to a maximum of three levels at the hydraulically remote position. The minimum operating pressure in any sprinkler shall not be less than 2 bars.

12.5.3 In-rack sprinklers in association with the ceiling sprinklers shall always be fully calculated for the purpose of hydraulics.

12.5.4 Areas covered by individual sprinklers in large arrays for standard layout and staggered layout are shown in Fig. 26.

12.5.5 Sprinklers not constituting a full range or range pair shall be grouped as close as possible to the distribution pipe on the next upstream range row to the rectangular area (*see* Fig. 27).

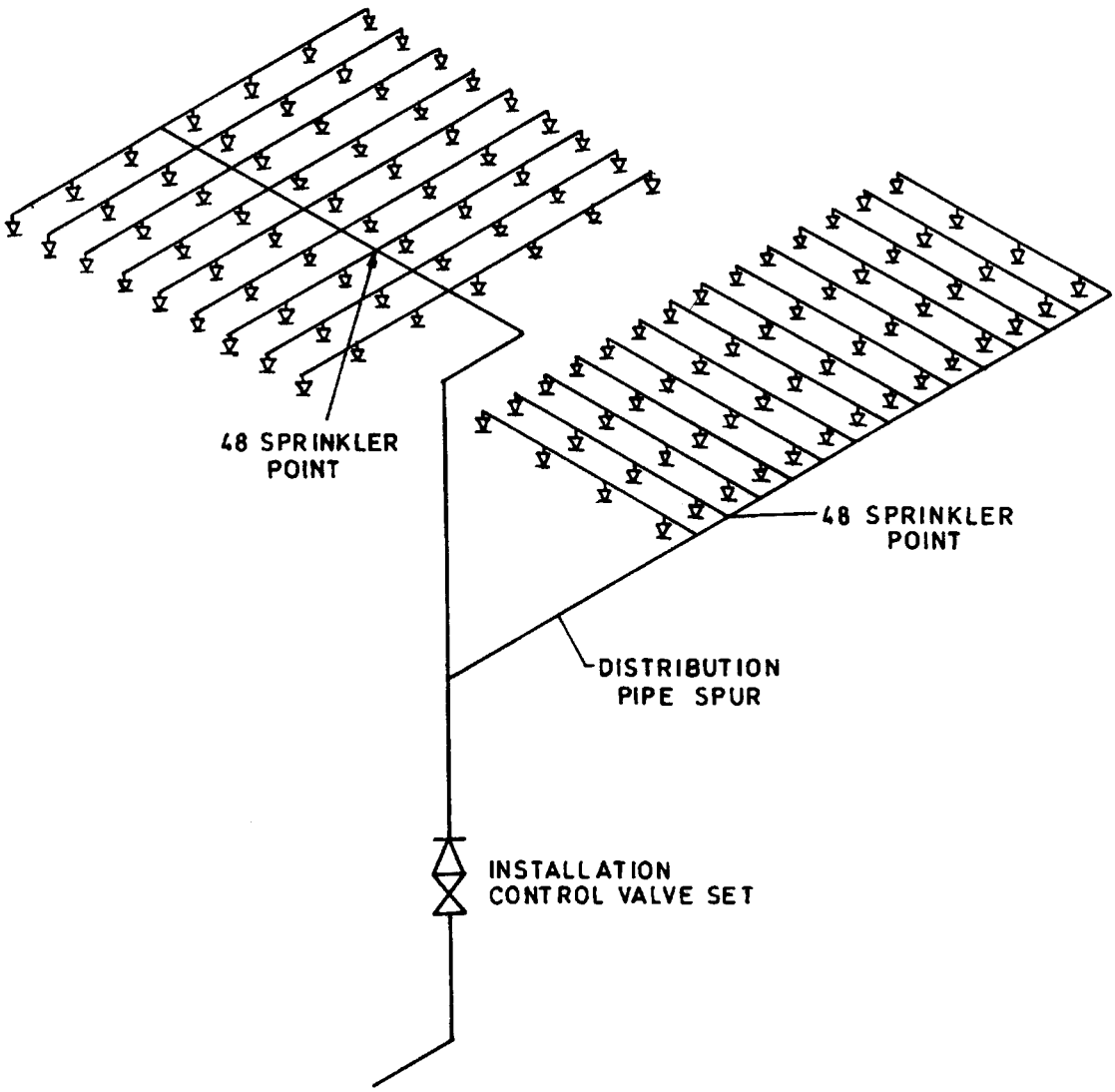


FIG. 22 DESIGN POINTS IN HIGH HAZARD INSTALLATION WITH PIPEWORK SIZED FROM TABLES 32 AND 33

13 MISCELLANEOUS DESIGN PARAMETERS

13.1 Hydraulic Calculation and Pipe Sizing

13.1.1 Pipe size and layout shall be based on either :

a) *full hydraulic calculation* in which case the basic hydraulic performance shall be as specified in **8**, *i.e.*, under "Design density and AMAO".
Notwithstanding the density requirements as stated in this section, no roof or ceiling sprinklers in a fully hydraulically designed system shall discharge at a pressure less than the required as shown in Table 29.

b) *pre-calculated installation* (not including intermediate sprinklers), the pipe sizing tables with hydraulic calculation of portions of the feed pipework as specified in **12.4.2** or **12.4.3** or **12.4.4** according to the class of hazard.

c) Any extension to a precalculated installation shall not be fully hydraulically calculated.

Table 29 Minimum Sprinkler Discharge Pressure at Any Sprinkler in Fully Hydraulically Calculated Installations
(*Clause* 13.1.1)

Hazard Class	Minimum Pressure at Any Discharging Sprinkler (bar)
(1)	(2)
Light	0.70
Moderate	0.35
High	0.50
In rack sprinklers	2.00

13.2 Calculation of Pipework Losses

13.2.1 The static pressure difference between two interconnecting points in a system shall be calculated from :

Static pressure difference (β) = $0.1h$ (bar),

where h = vertical distance between the points in metres.

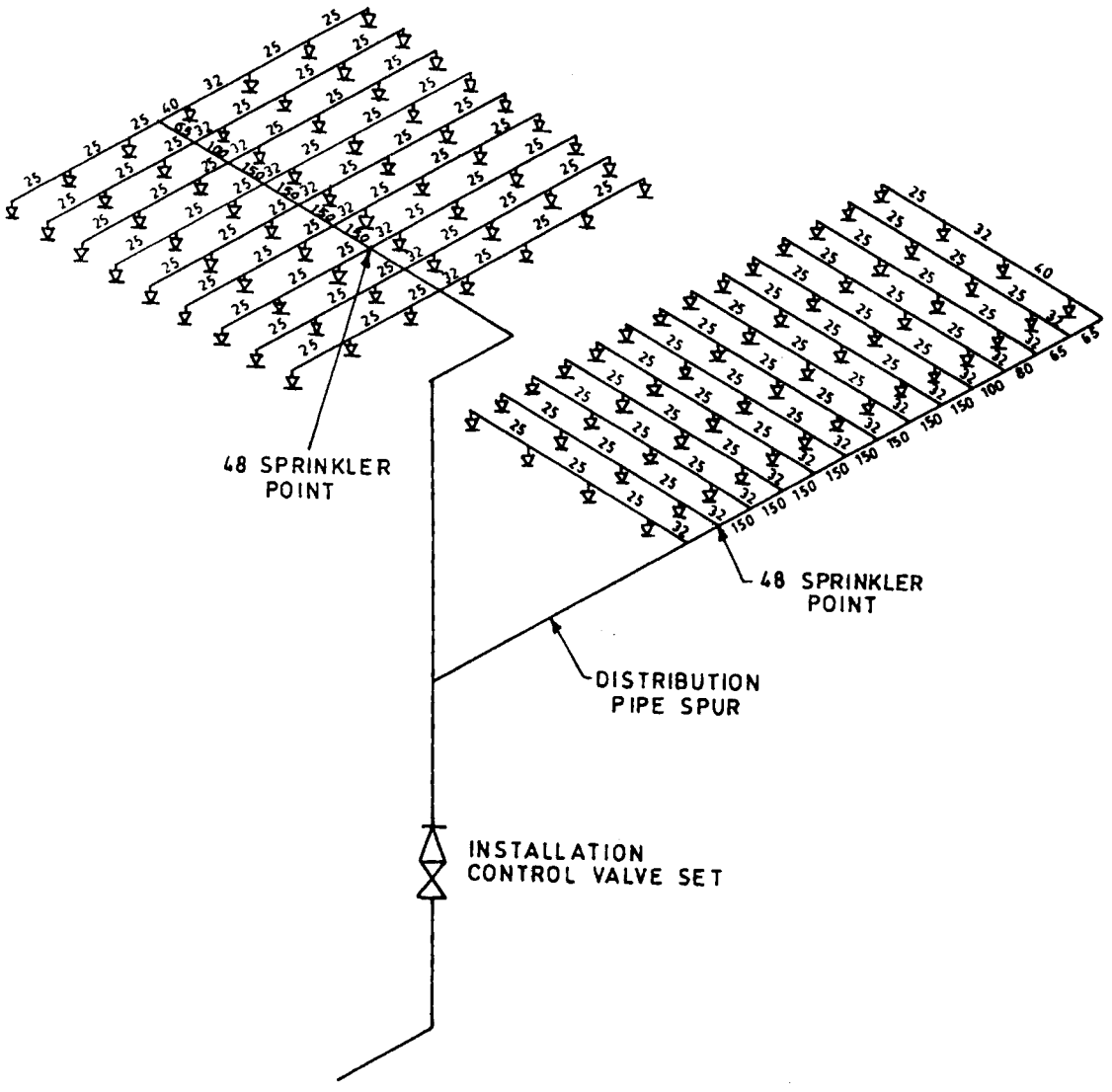


FIG. 23 DESIGN POINTS IN HIGH HAZARD INSTALLATION WITH PIPEWORK SIZED FROM TABLES 32 AND 34

13.2.2 *Pipe Friction Loss*

Frictional pressure loss in pipes shall be calculated from the Hazen-Williams formula as under:

$$p = \frac{6.05 \times 10^5}{C^{1.85} \times d^{4.87}} \times L \times Q^{1.85}$$

where

p = loss of pressure per metre length of pipe (bar)
Q = flow rate through the pipe (in l/min)
d = mean bore of the pipe (in m)
C = a constant for the type and condition of pipe
L = equivalent length of pipe and fittings (in m)

The following values shall be used for "C" in sprinkler installations for calculation purpose:

Cast iron	=	100
Mild steel	=	120
Galvanized steel	=	120

13.2.3 *Fittings and Valve Frictional Losses*

Frictional losses in valves and fittings where the direction of water flow is changed through 45° or more should be calculated by the formula stated in **13.2.2** above using the appropriate equivalent length given in Table 30.

13.2.4 The effect of velocity head can be ignored for the purpose of hydraulic calculation.

13.2.5 The size of range pipe shall not be less than 25 mm and also the minimum pressure shall not be lower than those specified in **13.1.1**.

13.3 Maximum Flow Demand Calculation for a Fully Hydraulically Calculated Installation

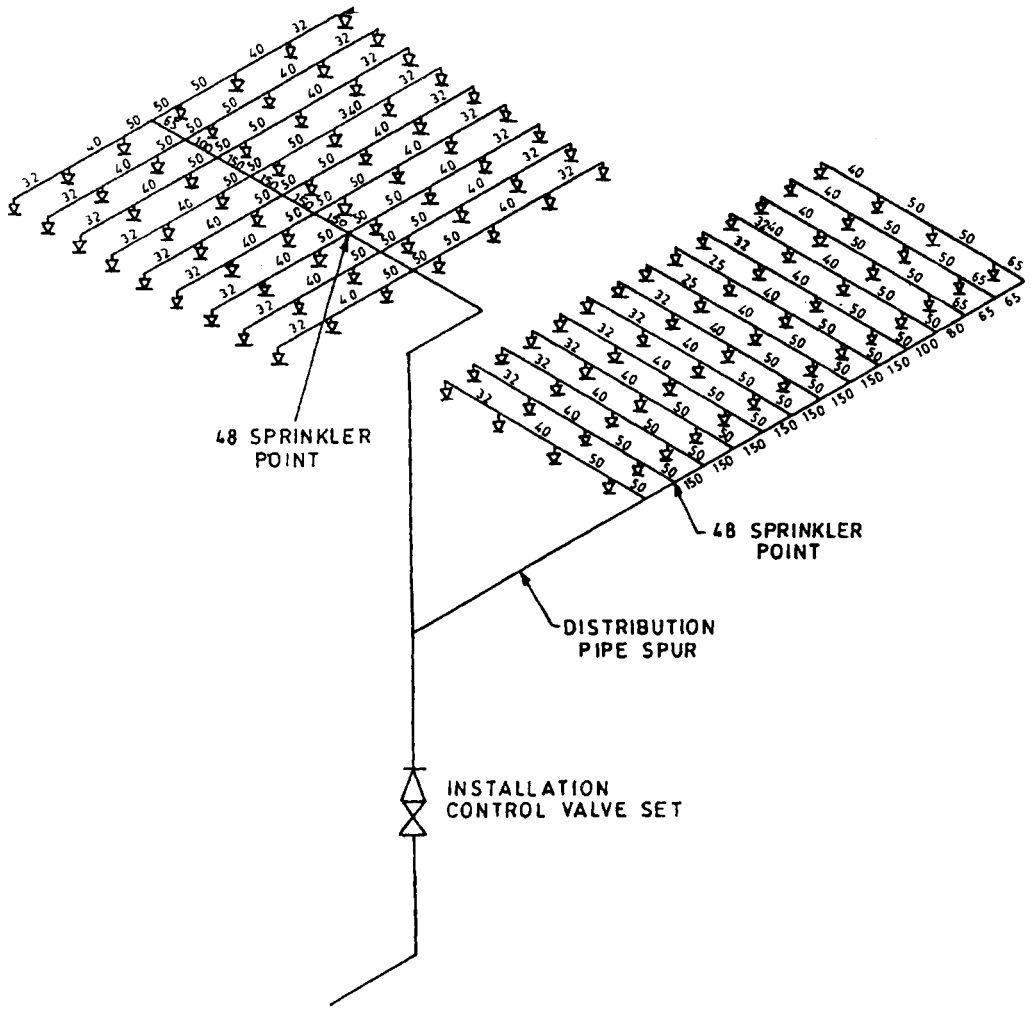


FIG. 24 DESIGN POINTS IN A HIGH HAZARD INSTALLATION WITH PIPEWORK SIZED FROM TABLES 34 AND 35

13.3.1 The datum point for pressures and heights shall not be downstream from the control valve "C" gauge.

13.3.2 At any pressure (P) , the flow demand (Q) of the installation shall be regarded as the sum of :

a) the flow to the ceiling or roof sprinklers with the AMAO in the hydraulically most favourable location; plus
b) the flow to any non-rack intermediate sprinklers associated with (a); plus
c) the simultaneous hydraulically balanced flow to any rack or shelf sprinklers in their specified number and hydraulically most favourable location.

13.3.3 The pressure-flow demand characteristics of the installation shall be determined either:

a) by calculation (as stated in **13.3.2**) of sufficient values of Q to determine the intercept of the installation characteristics of the curve with the water supply characteristic curve; or
b) by calculation (as stated in **13.3.2**) of a single value of Q from the equation:

$$P = P_o + 0.1(h)\ (Q/Q_o)^2 - 0.1(h),$$

where

P = pressure at flow Q measured at the datum point in bar.
P_o = pressure corresponding to the calculated installation flow demand measured at the datum point in bar.
Q = flow demand at pressure P in l/min.
Q_o = calculated installation flow demand in l/min for pressure P_o.
h = height of the highest sprinkler in the AMAO under consideration above the datum point in m.

By extrapolating the pressure flow demand graph to intersect the water supply pressure flow characteristic, Q_{Max} can be determined.

13.3.4 The maximum flow demand (Q_{Max}) shall be regarded as the point of intersection of the pressure

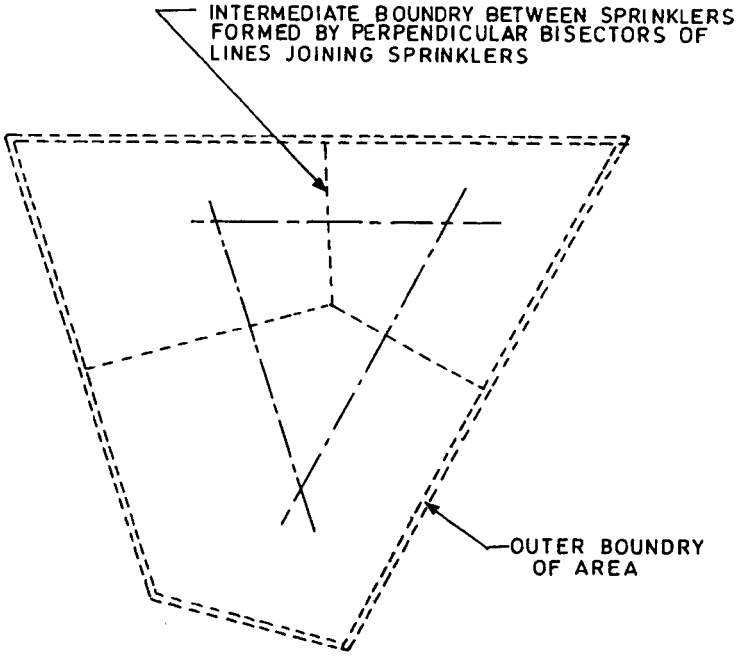


FIG. 25 AREA COVERED BY INDIVIDUAL SPRINKLERS WHERE LESS THAN FOUR SPRINKLERS ARE IN OPEN COMMUNICATION

flow demand characteristic of the installation and the characteristic of the pump either at low water level or when the reservoir is full whichever is higher (*see* Fig. 28).

Table 30 Equivalent Length of Fittings and Valves
(*Clause* 13.2.3)

Fittings & Valves	Equivalent Length of Medium Grade Steel Pipe (in m) According to IS 1239 (Part 1) (C = 120) for Diameter in mm Equal to						
	50	65	80	100	150	200	250
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Screwed elbow 90°	1.46	1.89	2.37	3.04	4.30	5.67	7.42
Welded elbow 90°	0.69	0.88	1.10	1.43	2.00	2.64	3.35
Screwed elbow 45°	0.76	1.02	1.27	1.61	2.30	3.05	3.89
All other fittings	2.91	3.81	4.75	6.10	8.61	11.34	13.85
Gate valve	0.38	0.51	0.63	0.81	1.13	1.50	1.97
Alarm valve N.R. valve	—	—	3.94	5.07	7.17	9.40	12.30
Alarm valve N.R. valve (mushroom)	—	—	119.71	5.36	35.88	47.27	61.85
Butterfly valve	2.19	2.86	3.55	4.56	6.38	8.62	9.90
Globe valve	6.43	21.64	126.80	34.48	48.79	64.29	84.11

NOTES
1 The equivalent lengths can be converted as necessary for pipes of cast iron by multiplying the above values by 0.714.
2 The equivalent length for sizes smaller than 50 mm are provided in Table 31.

Table 31 Equivalent Length of Fittings and Valves
(*Clause* 13.3.2)

Fittings	Equivalent Length (in m) of Medium Grade Steel Pipe (in m) According to IS 1239 (Part 1) (C = 120) for Diameter in mm Equal to:		
(1)	(2)	(3)	(4)
	25	32	40
Screwed elbow 90°	0.77[1)]	1.04	1.22
Welded elbow 90°	0.36[1)]	0.49	0.56
Screwed elbow 45°	0.40[1)]	0.55	0.66
All other fittings	1.54	2.13	2.44

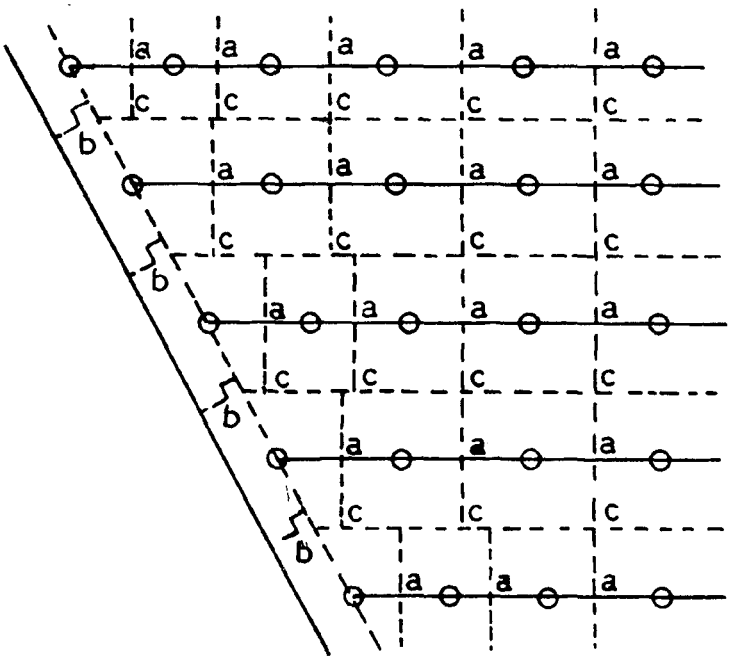
[1)]It is recommended to avoid, as far as possible, 25 mm sized elbows in the installation.

13.3.5 At the maximum flow demand, the pressure at the datum point shall not be less than P_o, *i.e.*, pressure corresponding to the calculated installation flow demand measured at the datum point in bar.

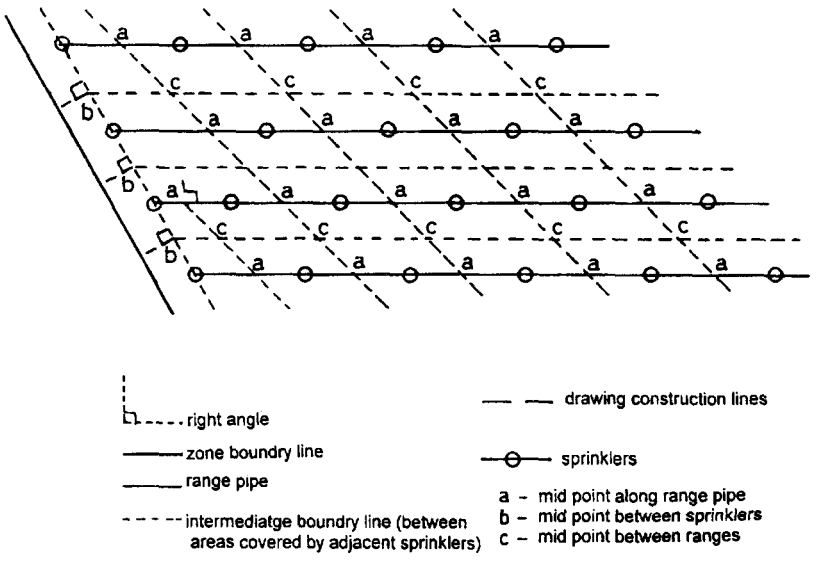
13.4 Maximum Pressure Demand Calculation for a Fully Hydraulically Calculated Installation

The calculation shall be as follows :

Pressure flow calculation shall be made for the minimum allowable density from the most remote group of four sprinklers in the AMAO hydraulically most remote from the installation valves (*see* **9.1, 9.2, 9.3** and **13.5.4**). Where there are both roof or ceiling sprinklers and intermediate sprinklers, the true hydraulically most unfavourable locations of each installation should be taken together, irrespective of their actual locations in the building. The result can be



26A STANDARD LAYOUT



26B STAGGERED LAYOUT

FIG. 26 AREA COVERED BY INDIVIDUAL SPRINKLERS (LARGE ARRAYS)

extrapolated on to the water supply pressure flow characteristics curve of the pump as stated in **13.3.4**. The water supply pressure at the point of intersection of the curves shall not be less than that given by the minimum density calculation.

13.5 Hydraulic Balance Calculations

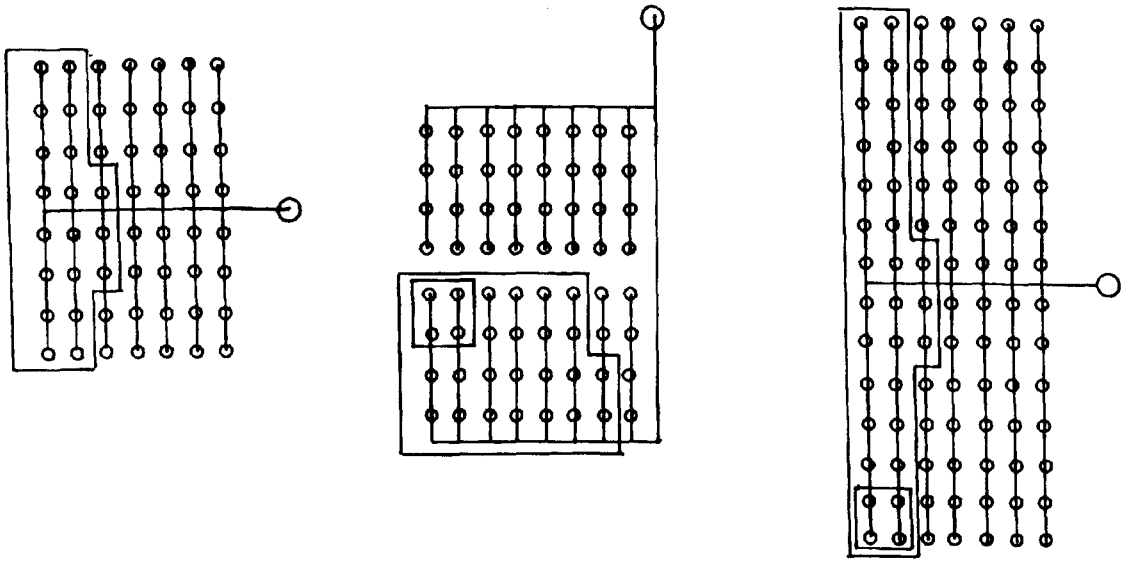
13.5.1 *Balancing Across Junctions*

Hydraulic calculations for each pipe junction where flows join or separate for each position of the AMAO or for each group of intermediate sprinklers assumed to be in operation shall be sufficiently accurate that :

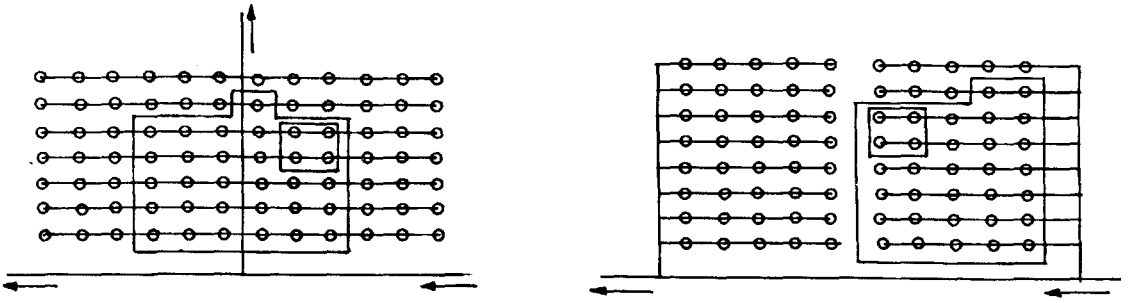
a) the calculated flow rate(s) into the junction are within ±2 litres per minute of the calculated flow rate(s) out of the junction;
b) all values of the pressure calculated for the junction are within ±0.005 bar of the mean value.

13.5.2 *Overall Balancing of the Installation*

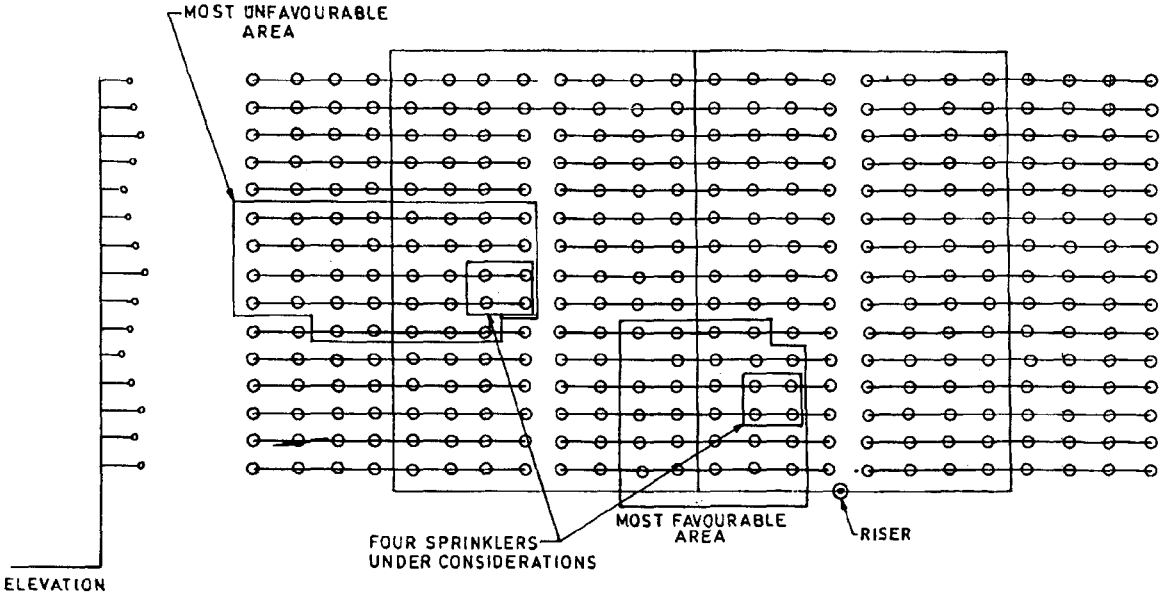
For each position of the AMAO the sum of the calculated sprinkler discharge values of all sprinklers discharging simultaneously (using the calculated nozzle pressure in each case to establish the outlet



27A MOST UNFAVOURABLE AREAS OF OPERATION IN ONE SIDED AND TWO SIDED PIPE LAYOUTS



27B MOST FAVOURABLE AREAS OF OPERATION IN ONE SIDED AND TWO SIDED PIPE LAYOUTS



27C MOST FAVOURABLE AND UNFAVOURABLE AREAS OF OPERATION IN LOOPED PIPE LAYOUT

FIG. 27 AREAS OF OPERATION IN DIFFERENT LAYOUTS

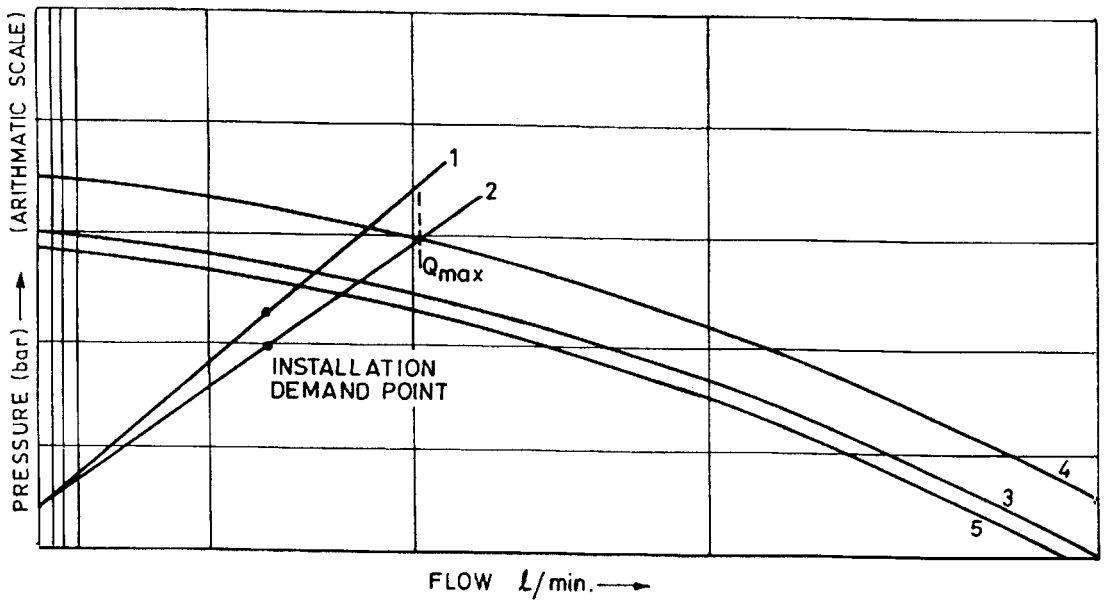


FIG. 28 TYPICAL PUMP DATA SHEET

flow) shall be within ±1% of the hydraulically calculated total flow into the installation.

13.6 Design of Orifice Plates

13.6.1 Tables 32 and 33 may be used to design the size of the orifice plate according to the system requirements for achieving hydraulic balance.

Table 32 Orifice Plates for Medium Grade Pipes as per IS 1239 for Sizes 50 mm and 65 mm
(*Clauses* 13.6.1 and 13.6.3)

Pressure Loss Pr_o (Bar)	Diameter of Orifice Pipe Sizes		Orifice K Factor
	50 mm	65 mm	
(1)	(2)	(3)	(4)
2.50	25.90	–	316
2.25	26.50	–	333
2.00	27.10	–	354
1.75	27.90	–	378
1.50	28.80	–	408
1.25	29.60	–	447
1.00	30.90	–	500
0.90	31.50	–	527
0.80	32.20	34.50	559
0.70	32.80	35.30	598
0.60	33.70	36.30	645
0.50	34.70	37.60	707
0.40	35.90	39.30	791
0.30	37.50	41.20	913
0.20	39.70	44.20	1118
0.10	42.70	49.10	1581
0.05	–	53.60	2236

13.6.2 The orifice diameter for medium grade pipes conforming to IS 1239 (Part 1) of sizes 50 mm to 200 mm for discrete values of net pressure loss Pr_o for a standard flow rate of 500 l/min are provided in Table 34 and 5 000 l/min in Table 35.

13.6.3 To select an orifice plate which will produce a net pressure loss of Pr_x bar with a rate of Q_x in l/min, the value of Pr_o can be calculated from the formula as below:

$Pr_o = P_x (500/Q_x)^2$ when using Table 32
$Pr_o = P_x (5000/Q_x)^2$ when using Table 33

as appropriate, and refer to the appropriate column for the correct orifice diameter, interpolating as necessary.

14 COMPONENTS OF SPRINKLER SYSTEM

14.1 General

14.1.1 The various types of valves used in the installation are as under :

a) Stop valves
b) Test valves
c) Drain valves
d) Flushing valves
e) Check valves
f) Installation valves
g) Pre-action valves
h) Subsidiary valves

14.1.2 All valves in the sprinkler installation shall be right-handed (*i.e.*, the handwheel or key should be rotated clockwise to close the valve); the direction of opening and closing shall be marked and an open/shut indicator fitted.

Table 33 Orifice Plates for Medium Grade Pipes as per IS 1239 for Pipe Sizes 80 mm, 100 mm, 150 mm and 200 mm
(*Clause* 13.6.3)

Pressure Loss Pr_0 (Bar)	Diameter of Orifice Pipe Sizes				Orifice K Factor
	80 mm	100 mm	150 mm	200 mm	
(1)	(2)	(3)	(4)	(5)	(6)
35.00	41.90	–	–	–	845
30.00	43.00	–	–	–	913
25.00	44.80	–	–	–	1000
20.00	46.40	–	–	–	1118
15.00	48.90	56.20	–	–	1291
10.00	52.30	57.60	–	–	1581
9.00	53.20	59.00	–	–	1667
8.00	54.10	60.40	–	–	1768
7.00	55.30	62.00	–	–	1890
6.00	56.60	63.90	–	–	2041
5.00	58.20	66.50	–	–	2236
4.00	59.80	69.70	–	–	2500
3.00	62.00	74.20	82.30	–	2887
2.00	65.00	81.10	95.80	–	3536
1.00	–	82.20	97.10	105.70	5000
0.90	–	83.30	99.30	108.10	5270
0.80	–	84.40	101.70	111.10	5590
0.70	–	85.70	104.00	113.90	5976
0.60	–	87.00	106.80	117.70	6455
0.50	–	–	110.10	122.20	7071
0.40	–	–	115.10	129.10	7906
0.30	–	–	120.60	137.70	9129
0.20	–	–	–	152.60	11180
0.10	–	–	–	165.80	15810

NOTE — The pressure loss produced by the orifice plate is the net loss across the orifice, not the pressure difference of the flange. The K factor should be marked on the plate.

14.1.3 Butterfly valves, if used, shall be of the gear-operated type for sizes more than 150 mm.

14.1.4 Valves which interlock when closed shall be positioned in a conspicuous place where the key is obtrusive when the valve is closed.

14.2 Main Stop Valves

14.2.1 One, and only one, main stop valve shall be fitted immediately downstream of the main alarm valve of a standard sprinkler installation.

14.2.2 The main stop valve(s) should be at a fire brigade access level and readily accessible when responding to a fire alarm.

14.2.3 Where the working pressure of the installation is more than 7 kg/cm^2, Cast iron valves with PN 1.6 rating shall be provided. However, Cast steel valves of class 150 shall suffice for installation under all pressure conditions.

14.3 Test Valves and Cocks

14.3.1 *Alarm and Pump Start Test Valves*

Test valves (15 mm nominal size) shall be provided, as appropriate, to test:

a) the hydraulic alarm or any electric alarm pressure switch if provided, by drawing water from the downstream side of a wet alarm valve, and any downstream main stop valve(s);
b) any water flow alarm switch installed downstream of the main installation valve set. The test valve shall be connected downstream of the water flow alarm;
c) an automatic starting device on a pump; and
d) any pump house sprinkler alarm flow switch installed upstream of the installation control valve.

The test valve should be installed close to the alarm valve, flow switch or pump starter as appropriate.

14.3.2 *Test Cocks*

A test cock should be fitted as follows:

a) on suction pump supplies, upstream of the pump outlet stop valve and the check valve;
b) Immediately upstream of the check valve on a water supply feed pipe or trunk subject to any requirements of the inflow water authority.

14.4 Drain Valves

Drain valves sized as below shall be fitted to allow drainage from:

a) Immediately downstream of the installation alarm valve or, if fitted, its downstream stop valve; and

b) Immediately downstream of any subsidiary stop valve; and
c) Any pipe other than drop pipes to single sprinklers in a wet installation which cannot be drained through another drain valve.

The valves shall be fitted at the lower end of permanent pipework. The outlet shall be not more than 3 m above the floor and shall be fitted with a brass plug.

Light hazard	:	40 mm
Moderate hazard	:	50 mm
High hazard	:	50 mm

14.5 Flushing Valves

Where a sprinkler pump draws water from a non-potable source such as a canal, river, lake, etc, flushing valves shall be fitted at the spur ends of the installation distribution pipes.

The valves and any associated drain pipework shall be of the same nominal size as the distribution pipe to which they are attached. Each valve outlet shall be fitted with a brass plug cap.

14.5.1 *Check Valves*

Check valves shall be provided where more than one water supply is available and the same fitted on each water supply pipe to trunk main.

A test cock shall be fitted upstream of the check valve and downstream of the water supply main stop valve, except in the case of a pump supply where it shall be upstream of the pump delivery check valve and of the outlet stop valve.

14.6 Subsidiary Stop Valves

Subsidiary stop valves, which shall be of the same nominal size as the pipe in which they are fitted, shall be provided only to control the water supply to the following:

a) Any sprinklers supplied from upstream of an installation main control valve set.
b) Sprinklers under hoods over the dry ends of paper making machines where it is necessary to turn off the sprinklers to enable machine cylinders to be changed. The valve shall be secured open.
c) Sprinklers protecting a computer area. The stop valve shall be electrically monitored or of the type which interlocks when closed, and in alternate installations shall be a screw-down diaphragm valve.

14.7 Installation and Alarm Valves

14.7.1 A sprinkler installation shall be fitted with a suitable main installation valve to control the water supply to the installation. The valve set comprise of :

a) a main stop valve,
b) an alarm valve, and
c) a water motor alarm and gong (*see* Fig. 29).

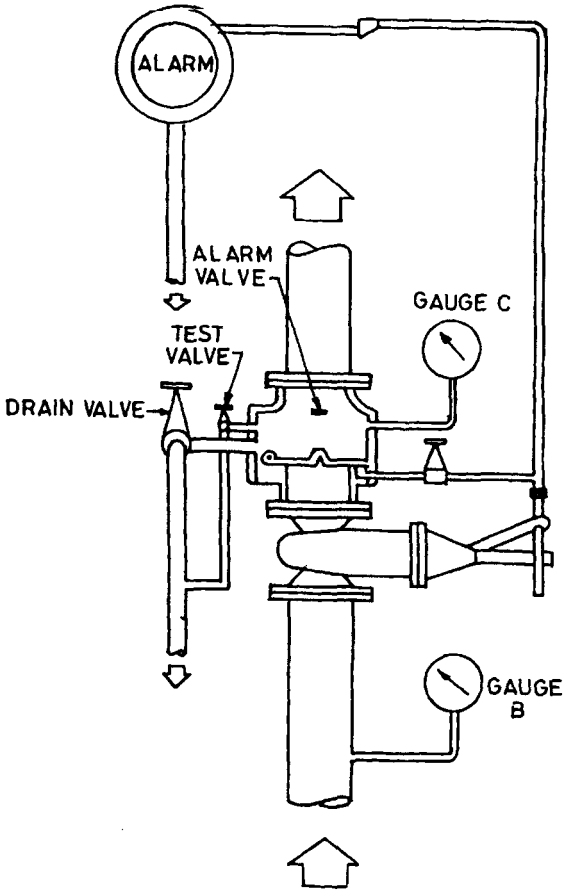


FIG. 29 SPRINKLER INSTALLATION VALVE ASSEMBLY

14.7.2 The main installation alarm valve(s) shall be fitted immediately downstream of the main stop valve.

14.7.3 An alarm valve controlling the water supply to either a high-temperature area or to an area where freezing temperatures may occur either shall be of a type without a water seal or positioned at such a distance from the protected area that the water seal is not affected by the high temperature or freezing.

14.7.4 The main stop valve shall be placed in the vicinity of the main entrance of the risk protected at an easily accessible place. The valve shall be secured open by a pad-locked or rivetted strap and protected against impact damage.

14.7.5 A plan of the risk with the position of main stop valves shall be placed in a conspicuous location. A location plate shall be fixed near the valves bearing the following words in raised letters :

SPRINKLER

STOP VALVE

14.7.6 *Alarm Valve*

14.7.6.1 Alarm valves shall be fitted on the main supply pipe immediately above the main control valve and before any connection is taken off to supply any part of the installation.

14.7.6.2 In buildings containing more than one installation, each alarm valve must have a number indicated thereon and the relevant alarm gong shall bear the same number in bold figures.

14.7.6.3 As far as possible, one risk shall be protected by one alarm valve only. Where the risk is quite large and has to be fed by more than one valve, the areas fed by the alarm valves should be planned and suitably demarcated. Details of the division of the sprinkler load with the demarcated areas shall be exhibited near the alarm valves.

14.7.6.4 The provision of one alarm valve for different blocks in one compound is not normally permissible.

14.8 Multiple Controls

Multiple controls installed to control open sprinklers or open drenchers or to operate a pressure switch shall be acceptable in specific cases.

14.9 Alarms and Alarm Devices

14.9.1 Each installation main control valve set shall be provided with a water motor alarm suitable for sprinkler service located as close as possible to the alarm valve.

14.9.2 The water motor shall be installed with its gong on the outside of an exterior wall and with its centre line not higher than 6 m above the point of connection to the alarm valve. A strainer, readily accessible for cleaning, shall be fitted between the motor nozzle and the alarm valve connection. The water outlet shall be positioned so that any flow of water can be seen.

14.9.3 The pipework to the water motor should be galvanized, medium grade complying with IS 1239 (Part 1). The equivalent length of pipe between the alarm valve and the water motor shall be not more than 25 m assuming an equivalent length of 3 m for each change of direction. The nominal size shall be not less than:

a) 14 mm for equivalent lengths less than or equal to 6 m; and
b) 20 mm for equivalent lengths greater than 6 m.

14.9.4 The pipe shall be fitted with a stop valve located within the premises and should be provided with a permanent drain through an orifice not larger than 3 mm diameter. The orifice place may be integral with the pipe fitting, and shall be of either stainless steel or a non-ferrous material.

14.9.5 Any device to reduce the frequency of false or intermittent alarms fitted to the installation shall be suitable for sprinkler service.

14.10 Pressure Gauges

14.10.1 *General Specification*

a) Pressure gauges fitted in the installations shall comply with IS 3624.
b) The scale subdivision shall not exceed:
   1) 0.2 bar for a maximum scale value up to and including 10 bar;
   2) 0.5 bar for a maximum scale value of more than 10 bar, up to and including 16 bar;
   3) 1.0 bar for a maximum scale value more than 16 bar.

14.10.2 *Application of Pressure Gauges*

14.10.2.1 *Installation control valves*

Main control valve sets — A pressure gauge shall be fitted at each of the following points:

a) Immediately downstream of the alarm valve (designated the 'C' gauge); and
b) Immediately upstream of the main control stop valve (designated the 'B' gauge).

14.10.2.2 *Water supply connections*

Pump supply — Each pump supply shall be fitted with a damped pressure gauge on the supply pipe immediately downstream of the outlet check valve and upstream of any outlet stop valve.

14.10.2.3 *Removal*

Means shall be provided to enable each pressure gauge to be removed readily without interruption of the water or air supply to the installation.

14.11 Any other provisions like fire brigade signalling from the alarm valves, Advance warning, etc, proposed to be incorporated in the installation.

15 SPRINKLERS — GENERAL REQUIREMENTS

15.1 General

15.1.1 Sprinklers and multiple controls installed in the sprinkler systems shall be suitable for the fire protection service.

15.1.2 Sprinklers shall not be reconditioned or repaired. Used and/or defective sprinklers shall be replaced by new ones. However, the multiple control systems may be repaired or reconditioned but pressure testing shall be carried out before commissioning such installations.

15.1.3 Sprinklers and multiple controls shall not be painted except for the identification purposes. They shall not be altered in any respect nor have any type of ornamentation or coating.

15.2 Sprinkler Types and Applications

15.2.1 Sprinklers shall be of the following types :

a) Conventional pattern;
b) Spray pattern;
c) Ceiling or flush pattern;
d) Concealed pattern; and
e) Side wall pattern.

The selection of sprinklers shall conform to Table 34.

Table 34 Sprinkler Types and Sizes for Various Hazard Classes
(*Clause* 15.2.1)

Hazard Class	Pattern of Sprinkler	Sprinkler Size Nominal Orifice Less Than
(1)	(2)	(3)
Light hazard	Spray, ceiling or flush and/or side wall types	10 mm
Moderate hazard	Any type from the above	15 mm
High hazard	Conventional or spray pattern only	15 or 20 mm as the case may be

15.2.2 *Conventional type of sprinklers* are designed to produce a spherical type of discharge with a proportion of water being thrown upwards the ceiling. These are usually built with a universal type deflector enabling the sprinklers to be installed either upright or pendent. It is also possible to designate them for upright or pendent for certain applications. These sprinklers can almost be used for any type of application (*see* Fig. 30).

15.2.3 *Spray pattern type sprinklers* are designed to produce a hemispherical discharge and no water is directed towards the ceiling. These are built both ways, *i.e.*, upright or pendent. These shall not be used in high hazard, high piled storage risks and also in case of moderate/high hazard class risks where there is exposed structural steel work or where the roof or ceiling or its supporting structure is of combustible material (*see* Fig. 30).

15.2.4 *Ceiling or flush and concealed type of sprinklers* are designed for use with the concealed pipework and are installed pendent with plate or base flush to the ceiling with the heat sensitive element below the ceiling line. These shall be installed only in light or moderate hazard risks and not for the high hazard class. Common applications are hotels, board rooms, offices retail stores, etc, where the aesthetic appearance is of value. The deflectors are normally fixed however, retracted type of deflectors may also be used.

15.2.5 *Side wall type sprinklers* are designed to produce a downward paraboloidal discharge and the special deflector fitted to the sprinkler causes most of the water to be discharged on the opposing wall and floor with a little of water discharging on the wall behind the sprinkler. These shall not be installed in high hazard applications or above suspended ceilings. These are not substitutes for standard sprinklers but may be used only in offices, hotels, halls, lobbies, corridors, conveyor housings, etc (*see* Fig. 30).

15.2.6 *Multiple controls system* consists of heat sensitive sealed valve controlled outlets using sprinklers or any other heat detecting device as sensing elements. Multiple control is used when a group of open sprinklers or sprayers have to operate simultaneously on a single detection according to the desired circumstances.

15.3 Sprinkler Size and "*K*" Factor

Sprinklers shall have a nominal orifice sizes of 10 mm, 15 mm or 20 mm as shown in Table 35. "*K*" factor of the sprinkler shall be as per the following equation:

$$K = \frac{Q}{(P)^{0.5}}$$

where

K = K Factor,
Q = flow through the sprinkler orifice in l/min, and
P = pressure at the entry point of the sprinkler (bar).

Table 35 Sprinklers Nominal Threads, Orifice Sizes and *K* Factors
(*Clause* 15.3)

Nominal Orifice Size (mm)	Nominal Thread Size (mm)	Mean Value of *K* Factor	Limiting Values of *K* Factors			
			Dry Sprinklers		Others	
			Min	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
10	10	57	52	62	54	60
15	15	80	74	86	76	84
20	20	115	106	124	109	121

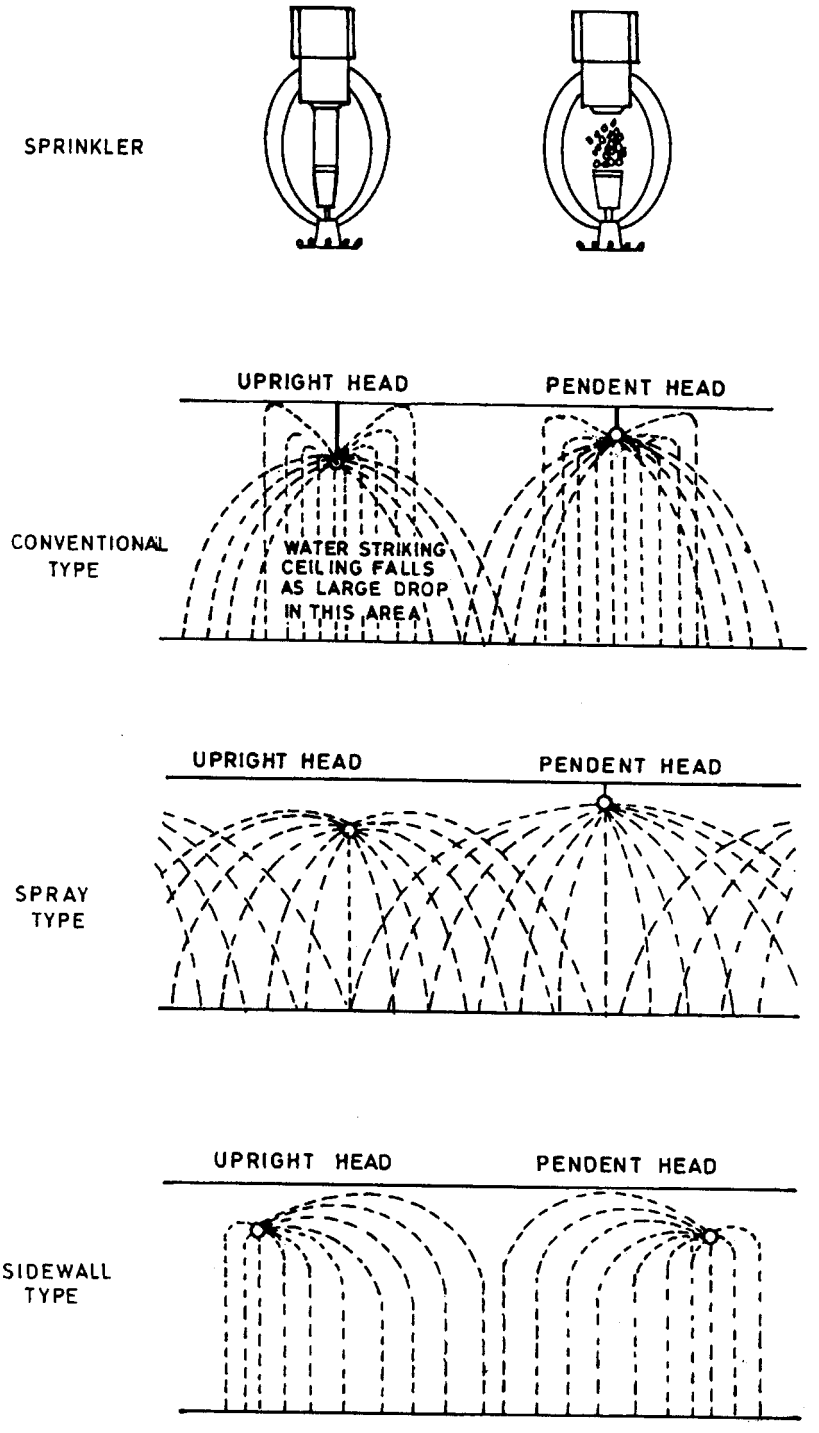


FIG. 30 TYPE OF SPRINKLERS

The desired "*K*" factors for the sprinklers are shown in Table 35.

15.4 Temperature Rating and Colour Coding

Sprinklers shall have one of the temperature ratings given in Table 36 or Table 37 and shall be correspondingly colour coded.

Table 36 Fusible Link Type
(*Clause* 15.4)

Temperature Rating °C	Colour of Yoke Arms
(1)	(2)
68/74	Natural
93/100	White
141	Blue
182	Yellow
227	Red

Table 37 Glass Bulb Type
(*Clause* 15.4)

Temperature Rating °C	Colour of Bulb Liquid
(1)	(2)
57	Orange
68	Red
79	Yellow
93	Green
141	Blue
182	Mauve
204/260	Black

15.5 Selection of Temperature Rating

15.5.1 *General*

15.5.1.1 The temperature rating of a sprinkler should not be less than 30°C greater than the highest anticipated temperature of the location of the installation. If the process conditions in a risk calls for continuous air conditioning round the clock throughout the year.

15.5.1.2 In high hazard installations protecting high piled storage with intermediate sprinklers, the roof or ceiling sprinklers should have a temperature rating of 141°C.

NOTE — The sprinklers at the top of the racks should be governed as per **15.5.1.1**.

15.5.1.3 Under glazed roof or where there are roof sheets of PVC or similar plastic material, the sprinkler rating shall be either 79°C to 100°C, or 141°C for high piled storage.

15.5.1.4 The temperature rating of the roof or ceiling sprinklers within 3 m of the plan area of the boundary of either an oven or a hot process ventilating hood, fitted with sprinklers shall be the same as the oven or hood sprinklers, or 141°C, whichever is lower.

15.6 Protection to the Sprinklers

15.6.1 Any sprinkler, other than ceiling or flush sprinkler, installed in a position at risk of accidental damage shall be fitted with a metal guard suitable for sprinkler service. It is particularly important for intermediate sprinklers in storage racks.

15.6.2 Sprinklers installed in a rack or under a perforated shelf, platform and the like, where water from higher sprinklers including roof/ceiling sprinklers may cause wetting in close proximity to the bulb or fusible element shall be fitted with metal water shields of nominal diameter 80 mm. The shield shall not be directly attached to an upright sprinkler deflector or yoke assembly. Such shield shall form little or no obstructions the sprinkler spray pattern.

15.6.3 Sprinkler rosettes shall be provided for the concealed sprinklers which should be of metal or thermoplastic plastics and shall be suitable for the sprinkler service. No part of the rosette shall be used to support ceilings or other structures and shall project from the ceiling below the top of the visible portion of the heat sensitive element.

15.6.4 Sprinklers and multiple controls installed in areas where corrosive vapours are prevalent shall have corrosion resistant coatings suitable to sprinkler service. Frequent coating with good quality petroleum jelly is recommended. The coating shall however not be applied on the fusible links or the body of the glass bulb.

15.7 Spare Sprinklers to be Kept in Stock

15.7.1 A stock of spare sprinklers shall be maintained in the premises so that prompt replacement is possible after the operation/damage of sprinkler heads. The spares shall be kept in an easily accessible location under conditions where the temperature does not exceed 38°C.

15.7.2 The following guidelines shall be followed in respect of stocking spare sprinkler heads:

Hazard Class	*In all State Capitals and within 100 km thereof*	*Other Places*
Light hazard	6 sprinklers of each type	25
Moderate hazard	24 sprinklers of each type	50
High hazard	36 sprinklers of each type	100

When there are more than one installation within a risk, the above quantity shall also be increased in proportion. Each type of sprinkler used in the installation such as conventional or spray or ceiling/flush or side wall sprinklers and appropriate temperatures shall be stocked as per the above requirements.

15.7.3 Spanners for the sprinklers shall also be kept along with the spare sprinklers in readiness.

15.7.4 *Drainage Arrangement*

It shall be possible to drain the water from the entire installation through the installation control valve by opening the drain cock. Normally, it is not permissible to provide separate arrangements for draining the water from different areas or pockets. However, in case of sprinklers below the false ceilings, below the obstructions like ducts and also for intermediate sprinklers, it should be possible to drain the water from time to time through separate arrangements. In case of areas, where sprinklers are installed below the level of the installation control valve, it is necessary to provide drain cocks for all such sprinklers as deemed necessary.

16 SELECTION OF INSTALLATION, TYPE AND THEIR SIZE

16.1 A sprinkler installation should be based on anyone of the following types:

a) Wet pipe installation,
b) Pre-action type installation,
c) Recycling installation, and
d) Deluge installation.

NOTE — Other types of installations like alternate wet and dry pipe or dry pipe may also be used.

16.2 Wet Pipe Installation

16.2.1 A wet pipe system is a standard type sprinkler system permanently charged with water under pressure both above and below the installation alarm valve. The above system shall be only installed where there is no danger at any time of the water in the pipes freezing.

16.2.2 *Size of the Installation*

The number of sprinklers in an installation but not including the sprinklers in the concealed spaces and inside machines, etc, shall not exceed the following:

a)	Light hazard	:	500 per installation
b)	Moderate hazard	:	1 000 per installation
c)	High hazard	:	1 000 per installation

16.3 Pre-action Installation

16.3.1 A pre-action system is a sprinkler system installed only to prevent a premature discharge of water from pipework or sprinklers that have suffered mechanical damage. The pipework should normally be charged with air under pressure and monitored to give a warning indication on reduction of the air pressure. Complete loss of air results in the opening of pre-action valve and thus allowing water into the pipework. The system at this stage becomes a wet pipe installation valve. The system provides a pre-action time for the users to save their valuable equipment like EDP and computer installation, antiques, museums, etc, where water damage due to the sprinkler operation is colossal. These systems need additional detection installations for triggering the pre-action valves.

16.4 Recycling Installation

16.4.1 Recycling installations shall be used only where these are necessary for the following reasons:

a) To restrict water damage after extinguishment;
b) To avoid closure of the main installation valve if modifications are made to the pipework or if sprinkler heads are to be replaced;
c) To prevent accidental water damage due to breakage of pipework/sprinklers

These are similar to the pre-action type installations except for the additional built-in features for automatic control of the water by timers.

16.5 Size of the Installation

The number of sprinklers in an installation (pre-action and recycling) but not including the sprinklers in the concealed spaces and inside machines, etc, shall not exceed the following:

a)	Light hazard	:	500 per installation
b)	Moderate hazard	:	1 000 per installation
c)	High hazard	:	1 000 per installation

16.6 Deluge Installations

Deluge installations shall be installed where it is necessary to apply water over an entire area in which a fire may originate.

16.7 Multi-jet Sprinkler System

Under extraneous circumstances, the above type of systems can be considered. For example, the above system may be considered for installation within ducts which pass through the perfect party walls if provision of dampers on both sides of the perfect party wall is impracticable. The above system shall consist of main sprinkler that should operate a group of open sprinklers inside the duct on both sides of the wall. The main sprinkler shall be installed preferably in the centre of the wall within the duct. The open sprinklers are expected to provide water curtains within the ducts on both sides to prevent propagation of the fire through the ducts in the absence of dampers.

16.8 Detector Sprinklers

In locations where electrical installations are to be protected, sprinklers in such locations may act only as detectors and sound the installation alarm without discharge of water. The water from the sprinkler pipes may be suitably arranged to be by-passed outside the risk upon operation of sprinklers.

16.9 Other Type of Sprinklers

Where other types of sprinklers are used for special applications such as Fast response sprinklers, Early response quick suppression sprinklers, large orifice sprinklers, Recycling sprinklers, etc, are proposed to be used in the system.

17 MAINTENANCE OF THE SPRINKLER INSTALLATION

17.1 General Arrangements

The user shall carry out a programme of inspection and checks, arrange a test, service and maintenance schedule and keep appropriate records including a logbook which shall be produced on demand.

17.2 Precautions and Procedures When System is not Operational

17.2.1 Maintenance, alterations and repair of systems not fully operational shall be carried out in a way that will minimize the time and extent of non-operability.

17.2.2 When an installation is rendered inoperative, the user shall implement compensatory measures. These measures include—shutting of fire doors and shutters, alertness of the security and safety staff, reinforcement of first-aid appliances, etc.

17.2.3 As much as possible of the installation shall be retained in an operative condition by blanking off pipework feeding the inoperative part or parts where work is taking place.

17.2.4 In case of manufacturing risks, where the repairs and alterations are extensive, or it is necessary to disconnect a pipe exceeding 40 mm nominal diameter, or to overhaul or to remove a main stop valve, alarm valve or check valve, every effort shall be made to carry out the work when the machinery is stopped.

17.2.5 Any pump out of commission shall be isolated by means of the valves provided.

17.3 Planned Shut Down

17.3.1 Authorities shall be kept informed before shutting of the installation for any reason whatsoever.

17.3.2 A round through the risk shall be undertaken before a part or total shut down to ensure that there is no indication of fire.

17.3.3 The heads of all the departments or blocks shall be notified in writing that the installation shall remain inoperative and they shall exercise abundant caution during the period.

17.4 Unplanned Shut Down

When the installation is rendered inoperative as a matter of urgency or by accident, the measures stated above for planned shut down shall be implemented with least possible delay.

17.5 Action Following Sprinkler Operation

17.5.1 Following the operation of sprinkler(s), the operated heads shall be removed and replaced with appropriate sprinkler heads and water supply shall be restored.

17.5.2 The sprinklers in the vicinity of the operated sprinklers shall be checked for damage by heat or any other cause and replaced if necessary.

17.5.3 The sprinkler pump shall not be shut off until the extinguishment of the fire. The starting of the pump shall be automatic and the stopping of the pump after an extinguishment shall be manual.

17.6 Periodical Testing and Maintenance

17.6.1 *General*

17.6.1.1 Sprinkler systems require competent and effective care and maintenance to assure that they will perform their purpose effectively at the time of fire. Systems shall be serviced and tested periodically by personnel trained in this work. An inspection contract with a qualified agency for service, test, and operation at regular intervals is recommended.

17.6.1.2 Operating and maintenance instructions and layout shall be available or can be posted at control room and/or at the fire station of the plant. Selected plant personnel shall be trained and assigned the task of operating and maintaining the equipment.

17.6.1.3 At weekly, or other frequent, regular scheduled plant inspection, equipment shall be checked visually for obvious defects such as broken or missing parts, external loading or other evidence of impaired protection.

17.6.1.4 At least once a week the system shall be visually checked and the reading of various pressure gauges of each Installation valve shall be recorded.

17.6.1.5 A trained pump man shall be available on all shifts and at all hours to operate the pump or whenever required.

17.6.2 *Fire Water Reservoirs/Tank*

17.6.2.1 It shall be ensured that fire water tank reservoirs are always full and free from any foreign materials. The water level shall be recorded weekly.

17.6.2.2 Depending upon quality of water, reservoirs shall be cleaned once in a year or two years and sludge formation shall be prevented.

17.6.3 *Fire Pumps*

17.6.3.1 All the fire pumps shall be run at least 5 minutes everyday. During testing water level of priming tank, delivery pressures of pumps, speed and also other parameters are to be checked and recorded.

17.6.3.2 All pump glands shall be maintained in good working conditions and checked weekly.

17.6.3.3 The bearing grease caps shall be checked once every week and refilled with fresh grease. if necessary.

17.6.3.4 Starter contacts shall be cleaned every week.

17.6.3.5 Insulation resistance of pump motors shall be examined once in every six months and record shall be maintained.

17.6.3.6 Starting mechanism of diesel engine must be checked, the battery charger and also the batteries

must be maintained in effective conditions and the engine shall be run at least for 5 minutes every day.

17.6.4 *Sprinkler System Installation*

17.6.4.1 All piping shall be examined at intervals to determine its conditions. Frequency of inspections will be dependent upon local conditions and shall be examined once in a year.

17.6.4.2 All the Installation valves and sprinkler installation and associated equipment shall be serviced and tested annually by qualified personnel.

17.6.4.3 Discharge test of sprinklers shall be carried out at least once in six months. After each operation, sprinklers shall be removed and cleaned, unless observations under flow conditions indicate this is not necessary.

17.6.4.4 Manual checking devices shall be operated at least twice annually.

17.6.4.5 When normally opened valves are closed following the system operation or test, suitable procedures shall be instituted to ensure that they are reopened and that the system is promptly restored to full normal operating condition.

17.6.4.6 All sprinklers shall be inspected for proper positioning or test, external loading and corrosion and cleaned if necessary, based on experience but at least once in six months.

17.6.4.7 The entire system shall be flushed at least once a year.

17.6.4.8 It is important to ensure that the sprinkler bulbs are kept free from paint or dust (otherwise it may not function correctly) and that the bulbs are accessible and clearly identified for maintenance purposes.

17.6.4.9 All the equipment pertaining to the sprinkler system shall be painted at least once in two years.

17.6.5 *Installation Valve and Alarm Gong Assembly*

17.6.5.1 The pressure gauge readings above and below the valves shall be monitored everyday at commencement of the first shift.

17.6.5.2 The time taken for the operation of alarm gong after opening the drain valves shall be monitored every week and corrective actions taken in case of malfunction of alarm gong.

17.6.5.3 The alarm gong assembly shall be checked thoroughly once in three months.

Periodic maintenance chart and summary sheets for the hydraulic calculation are shown in Table 38:

Table 38 Periodical Testing and Maintenance Chart
(*Clause* 17.6.5.3)

Sl No.	Subject	Activities	Duration
i)	Reservoir	Level checking	Weekly
		Cleaning	Once in two years
ii)	Pump	Running test	Daily 5 minutes
		Test flow	Annually
		Lubrication	Quarterly
		Gland packing	Weekly
		Overhaul	Once in two years
iii)	Engine	Running	5 min all days
		Lubrication	Quarterly
		Battery	Status weekly
		Load test	Annually
		Overhaul	Once in 2 years
		Fuel tank check	Daily
iv)	Motor	Lubrication	Weekly
		Starter contact checking	Weekly
		Insulation resistance	Half yearly
v)	Main piping	Flushing	Once in 2 years
		Gauge pressure	Check daily
vi)	Sluice valves	Operation	Monthly
		Gland packing	Monthly
		Lubrication	Quarterly
vii)	Installation valves	Operation	Weekly
		Alarm check	Weekly
		Overhaul	Annually
		Cleaning	Quarterly
viii)	Sprinklers	Cleaning	Quarterly
		Flow test	Quarterly
ix)	Detector element	Performance	Six monthly
x)	Sprinkler installation	Performance	Quarterly
		Physical check up of piping for seeing dislocation of support, wrong orientation, overloading, etc	Monthly
xi)	Pressure gauges	Calibration	Annually
xii)	Painting of installation	—	Every two years

18 PIPING SYSTEM

18.1 Installation Pipework

18.1.1 All installation pipework shall be pressure tested in accordance with **10.1.6**.

NOTE — In water sensitive areas, it is advisable to test the pipes pneumatically before carrying out any hydraulic testing.

18.1.2 The coating and wrapping of the underground wrought or mild steel pipes shall be carried out and also subjected to 'Halliday' tests as per IS 10221.

18.2 Initial Testing to Regular Testing Procedures

The system shall be tested as specified in **17.6.2, 17.6.3** and **17.6.4**, *i.e.*, making the initial tests which shall become routine tests later as a part of upkeep of the system.

18.3 Water Supplies

18.3.1 The entire piping system shall be thoroughly flushed before commissioning in order to remove foreign materials which might have entered or be present in the system piping during the course of installation or which may have been present in existing piping at maximum flow rate available to the system consideration shall be given to the disposal of water discharged during the flushing.

18.3.2 In case of large installations (where the number of sprinklers in a single building and those in the buildings communicating therewith exceed 500), it is necessary to ascertain the hydraulic balance to check the performance of the pump when working at most favourable and unfavourable locations. Pressure at the outlets of the orifice plates shall be measured at all locations to check the correctness of the size of orifice plates selected.

18.3.3 Each installation valve shall be tested separately. The pump shall start automatically and the supply pressure at the appropriate flow rate shall not be less than the appropriate value specified in **9.2** and **9.3** for all types of hazards.

18.3.4 The drain valves fitted above the installation valve shall be opened and the time taken for the alarm gong to operate be noted. There shall not be a significant variation in the timing between the 15 mm and 50 mm drain valves fitted above the installation valve to drain the water from the installation.

18.4 Pump Output

A running pressure test shall be carried out at the delivery of the pump at full load conditions (Q_{Max}). The pressure obtained in the test can be used to correct the pressure available at the 'C' gauge of the installation valve.

18.5 Auto Start of Diesel Pumps

When commissioning the installation the automatic starting system of the diesel engine driven pumpset shall be activated with the fuel supply isolated for six cycles each of not less than 15 seconds cranking and at not more than 15 seconds rest. After completion of six starting cycles "the fail to start alarm" shall operate. The fuel supply shall then be restored and the pumpset shall start when the manual start button is operated.

18.6 Installation Valves

18.6.1 All the valves shall be physically checked for proper installation and leakage if any. The reading of the pressure gauges shall be checked to see whether they match after a few drain tests.

18.6.2 The proper functions of the alarm gong associated with the installation valve and its level of audibility shall be checked. An audibility level of 85 dB above the background noise level is required.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
5 : 1994	Colours for ready mixed paints and enamels (*fourth revision*)	1978 : 1982	Line pipe (*second revision*)
732 : 1989	Code of practice for electrical wiring installations (*third revision*)	2552 : 1989	Steel drums (galvanized and ungalvanized) (*third revision*)
962 : 1989	Code of practice for architectural and building drawings (*second revision*)	3589 : 1991	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 to 2032 mm outside diameter) (*second revision*)
1239 (Part 1) : 1990	Mild steel tubes, tubulars and other wrought steel fittings : Part 1 Mild steel tubes (*fifth revision*)	3614 (Part 1) : 1966	Fire check doors: Part 1 Plate metal covered and rolling type
1239 (Part 2) : 1992	Mild steel tubes, tubulars and other wrought steel fittings : Part 2 Mild steel tubulars and other wrought steel pipe fittings (*fourth revision*)	3614 (Part 2) : 1992	Metallic and non-metallic fire check doors: Part 2 Resistance test and performance criteria
1536 : 1989	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage (*third revision*)	3624 : 1987	Pressure and vacuum gauges (*second revision*)
1537 : 1976	Vertically cast iron pressure pipes for water, gas and sewage (*first revision*)	3809 : 1979	Fire resistance test for structures (*first revision*)
1538 : 1993	Cast iron fittings for pressure pipes for water, gas and sewage (*third revision*)	7181 : 1986	Horizontally cast iron double flanged pipes for water, gas and sewage (*first revision*)
1879 : 1987	Malleable cast iron pipe fittings (*second revision*)	10221 : 1982	Code of practice for coating and wrapping of underground mild steel pipelines

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Fire Fighting Sectional Committee, CED 22

Organization	*Representative*
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
	DY 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 & Development Organization, Delhi	DIRECTOR
	DY DIRECTOR (*Alternate*)
Delhi Fire Service, Delhi	SHRI S. K. DHERI
	SHRI SURINDER KUMAR (*Alternate*)
Directorate General of Supplies & 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 & Safety Appliances Co, Kolkata	SHRI S. N. KUNDU
Home Department (Fire Service), Chennai	DIRECTOR
	DEPUTY DIRECTOR (*Alternate*)
Home (Police Department), Govt of Andhra Pradesh, Hyderabad	SHRI SWARANJIT SEN
	DEPUTY DIRECTOR (*Alternate*)
Indian Rayon, Delhi	SHRI S. K. SUREKA
Institution of Fire (India), Delhi	PRESIDENT
	GENERAL SECRETARY (*Alternate*)
Kooverji Devshi & 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
	DY 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 & Natural Gas	SHRI SANJEEVI GANESAN K.
	SHRI D. K. VARSHNEY (*Alternate*)
Railway Board, Delhi	ASSTT SECURITY COMMISSIONER (FIRE)
Real Value Appliances, Mumbai	SHRI ASHUTOSH MANGAL
Safex Fire Services, Mumbai	SHRI JITENDRA SHAH
Steelage Industries Ltd, Chennai/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 Production & Sales Pvt Ltd, Kolkata	SHRI TARIT SUR
	SHRI D. NEOGI (*Alternate*)

Organization	*Representative*
Tariff Advisory Committee, Ahmadabad/Delhi	SHRI J. N. VAKIL
	SHRI T. R. A. KRISHNAN (*Alternate*)
Vijay Fire Protection System Pvt Ltd, Mumbai	SHRI HARISH SALOT
West Bengal Fire Service, Kolkata	SHRI B. PATHAK
In Personal Capacity	SHRI G. B. MENON
(*House No. 33/2965A, Vennala High School Road, Cochin*)	
In Personal Capacity	SHRI P.N. PANCHAL
(*B-1/64, Sector-16, Rohini, Delhi*)	
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	[Representing Director General, (*Ex-officio*)]

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

(*Continued from second cover*)

be overlooked or given insufficient attention by supervisors. It is, however, neglected at peril to the lives of the occupants of the premises and also at the risk of crippling financial status of the owners. The importance of proper maintenance cannot be too highly emphasized. When sprinkler systems are disabled, extra attention sould be paid to fire precautions and the appropriate authorities informed. This has been discussed in detail in this code.

This code has been divided into several sections and each section deals elaborately with various aspects of the sprinkler protection system. The requirements have been supported by figures for illustration and clarity. Main elements of the sprinkler installation are shown in Fig. 1. The code is very clear about where the system is not required and where the systems can be excluded.

In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries and considerable assistance has been derived from LPC and TAC regulations with some radical departures on areas suitable to environment in India.

The composition of the Committee responsible for the 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.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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