MALAYSIAN STANDARD

MS 1910:2017

Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance
(First revision)

ICS: 13.220.20

Descriptors: fixed firefighting systems, automatic sprinkler, design, installation, maintenance

DEPARTMENT OF STANDARDS MALAYSIA

DEVELOPMENT OF MALAYSIAN STANDARDS

The **Department of Standards Malaysia (STANDARDS MALAYSIA)** is the national standards and accreditation body of Malaysia.

The main function of STANDARDS MALAYSIA is to foster and promote standards, standardisation and accreditation as a means of advancing the national economy, promoting industrial efficiency and development, benefiting the health and safety of the public, protecting the consumers, facilitating domestic and international trade and furthering international cooperation in relation to standards and standardisation.

Malaysian Standards (MS) are developed through consensus by committees which comprise balanced representation of producers, users, consumers and others with relevant interests, as may be appropriate to the subject at hand. To the greatest extent possible, Malaysian Standards are aligned to or are adoption of international standards. Approval of a standard as a Malaysian Standard is governed by the Standards of Malaysia Act 1996 [Act 549]. Malaysian Standards are reviewed periodically. The use of Malaysian Standards is voluntary except in so far as they are made mandatory by regulatory authorities by means of regulations, local by-laws or any other similar ways.

For the purposes of Malaysian Standards, the following definitions apply:

Revision: A process where existing Malaysian Standard is reviewed and updated which resulted in the publication of a new edition of the Malaysian Standard.

Confirmed MS: A Malaysian Standard that has been reviewed by the responsible committee and confirmed that its contents are current.

Amendment: A process where a provision(s) of existing Malaysian Standard is altered. The changes are indicated in an amendment page which is incorporated into the existing Malaysian Standard. Amendments can be of technical and/or editorial nature.

Technical corrigendum: A corrected reprint of the current edition which is issued to correct either a technical error or ambiguity in a Malaysian Standard inadvertently introduced either in drafting or in printing and which could lead to incorrect or unsafe application of the publication.

NOTE: Technical corrigenda are not to correct errors which can be assumed to have no consequences in the application of the MS, for example minor printing errors.

STANDARDS MALAYSIA has appointed **SIRIM Berhad** as the agent to develop, distribute and sell Malaysian Standards.

For further information on Malaysian Standards, please contact:

Department of Standards Malaysia
Ministry of Science, Technology and Innovation
Level 1 & 2, Block 2300, Century Square
Jalan Usahawan
63000 Cyberjaya
Selangor Darul Ehsan
MALAYSIA

Tel: 60 3 8318 0002
Fax: 60 3 8319 3131
http://www.jsm.gov.my
E-mail: central@jsm.gov.my

OR

SIRIM Berhad
(Company No. 367474 - V)
1, Persiaran Dato' Menteri
Section 2, P. O. Box 7035
40700 Shah Alam
Selangor Darul Ehsan
MALAYSIA

Tel: 60 3 5544 6000
Fax: 60 3 5510 8095
http://www.sirim.my
E-mail: msonline@sirim.my

Contents

Contents (*continued*)

Page

Committee representation

The Industry Standards Committee on Fire Safety (ISC M) under whose authority this Malaysian Standard was developed, comprises representatives from the following organisations:

Association of Consulting Engineers Malaysia
Construction Industry Development Board Malaysia
Department of Chemistry, Malaysia
Department of Standards Malaysia
Forest Research Institute Malaysia
Jabatan Bomba dan Penyelamat Malaysia
Jabatan Kerja Raya Malaysia
Malaysian Association of Standards Users
Malaysian Fire Protection Association
Master Builders Association Malaysia
Ministry of Domestic Trade, Co-operatives and Consumerism
Persatuan Insuran Am Malaysia
Pertubuhan Akitek Malaysia
Real Estate and Housing Developers' Association Malaysia
SIRIM Berhad (Secretariat)
SIRIM QAS International Sdn Bhd
Tenaga Nasional Berhad (Distribution Division)
The Institution of Engineers, Malaysia
The Institution of Fire Engineers (UK) Malaysia Branch
Universiti Kebangsaan Malaysia
Universiti Putra Malaysia

The Technical Committee on Wet Fire Protection System which developed this Malaysian Standard consists of representatives from the following organisations:

Association of Consulting Engineers Malaysia

Jabatan Bomba dan Penyelamat Malaysia

Jabatan Kerja Raya Malaysia

Kolling Engineering Sdn Bhd

Malaysian Fire Protection Association

Pertubuhan Akitek Malaysia

SIRIM Berhad (Secretariat)

SIRIM QAS International Sdn Bhd (Product Certification and Inspection Department)

SIRIM QAS International Sdn Bhd (Testing Services Department)

Tenaga Nasional Berhad (Generation Division)

The Institution of Engineers, Malaysia

The Institution of Fire Engineers (UK) Malaysia Branch

Universiti Putra Malaysia

Foreword

This Malaysian Standard was developed by the Technical Committee on Wet Fire Protection System under the authority of the Industry Standards Committee on Fire Safety.

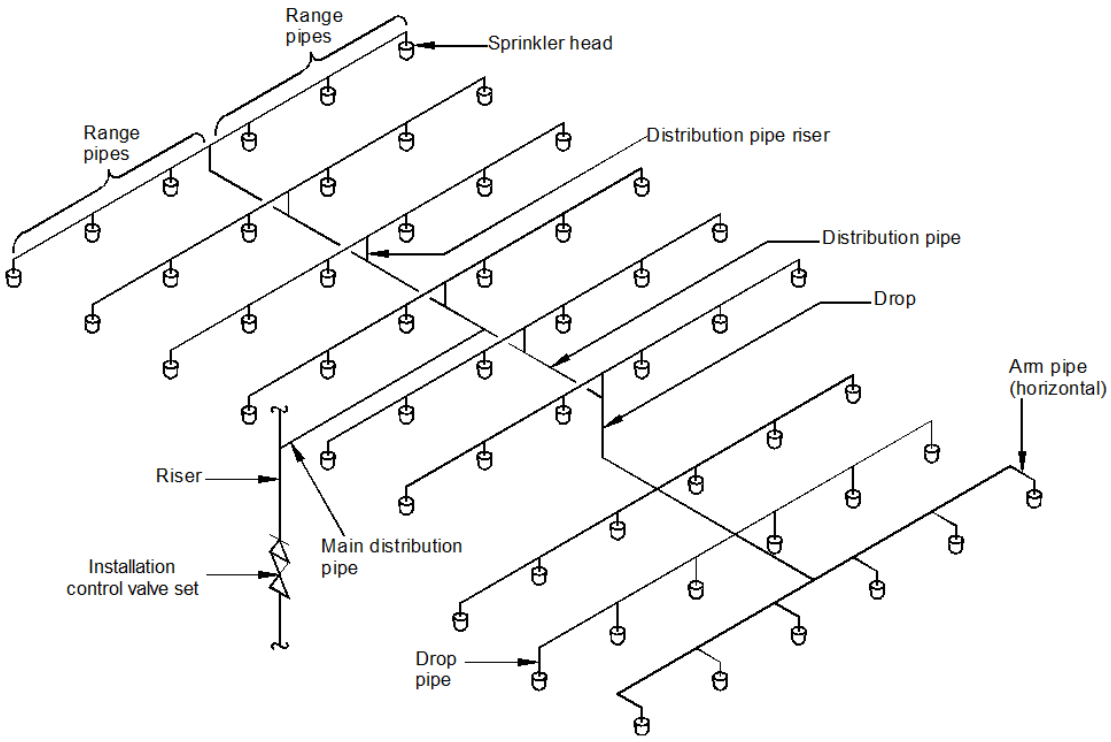
This Malaysian Standard cancels and replaces MS 1910:2006, *Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance*.

Compliance with a Malaysian Standard does not of itself confer immunity from legal obligations.

Introduction

An automatic sprinkler system is designed to detect a fire and extinguish it with water in its early stages or hold the fire in check so that extinguishment can be completed by other means.

A sprinkler system consists of a water supply (or supplies) and one or more sprinkler installations. Each installation consists of a set of installation main 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, and in ovens or stoves. The main elements of a typical installation are shown in Figure 1.



NOTE. Installation control valve set consist of control alarm set and main stop valve

Figure 1. Main elements of a sprinkler installation

The sprinklers operate at predetermined temperatures to discharge water over the affected part of the area below. The flow of water through the alarm valve initiates 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. The sprinkler system is intended to extend throughout the premises with only limited exceptions. In some life safety applications an authority might specify sprinkler protection only in certain designated areas and solely to maintain safe conditions for the evacuation of people from the sprinkler protected areas.

It should not be assumed that the provision of a 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 goods handling methods, management supervision and good housekeeping, all need consideration.

It is essential that sprinkler systems be properly maintained to ensure operation when required. This routine is liable to be overlooked or given insufficient attention by supervisors. It is, however, neglected at peril to the lives of occupants of the premises and at the risk of crippling financial loss. The importance of proper maintenance should be highly emphasised.

When sprinkler systems are out of service extra attention should be paid to fire precautions and the appropriate authorities informed.

This standard is intended for use by those concerned with purchasing, designing, installing, testing, inspecting, approving, operating and maintaining automatic sprinkler systems, in order that such equipment will function as intended throughout its life.

This standard is intended only for fixed fire sprinkler systems in buildings and other premises on land. Although the general principles may as well apply to other uses (e.g. maritime use), for these other uses, additional considerations will almost certainly have to be taken into account. It is a basic assumption that this standard is for the use of companies employing personnel competent in the field of application with which it deals. Only trained and experienced personnel should undertake the design, installation and maintenance of sprinkler systems. Similarly, competent technicians should be used in the installation and testing of the equipment.

Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance

1 Scope

This Malaysian Standard specifies requirements and gives recommendations for the design, installation and maintenance of fixed fire sprinkler systems in buildings and industrial plant, and particular requirements for sprinkler systems, which are integral to measures for the protection of life.

This standard covers only the types of sprinkler with the following conditions:

a) the sprinkler 'K' factors shall be as prescribed in this standard; and

b) the sprinkler head and its 'K' factor shall be verified/tested/certified and/or listed by an organisation recognised by the fire authority.

The requirements and recommendations of this standard are also applicable to any addition, extension, repair or other modifications to a sprinkler system. They are not applicable to water spray or deluge systems. It covers the classification of hazards, provision of water supplies, components to be used, installation and testing of the system, maintenance and the extension of existing systems, and identifies construction details of buildings which are the minimum necessary for satisfactory performance of sprinkler systems complying with this standard.

This standard does not cover water supplies to the systems other than sprinklers. Its requirements may be used as guidance for other fixed firefighting extinguishing systems, however, provided that any specific requirements for others firefighting extinguishing supplies are taken into account.

This standard also covers sprinkler kits where a kit comprises all the components necessary to complete the installed sprinkler system.

The requirements are not valid for automatic sprinkler systems on ships, in aircraft, on vehicles and mobile fire appliances or for below ground systems in the mining industry.

2 Normative references

The following normative references are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the normative reference (including amendments) applies.

MS 68, *Specification for containers for lead - Acid batteries*

MS 775, *LPG fuel system in internal combustion engines - Specification*

MS 862, *Specification for welded and seamless carbon steel pipes for general pressure purposes*

MS 863, *Non-alloy steel tubes suitable for welding and threading - Technical delivery conditions*

MS 1206: Part 1, *Specification for qualification for welders - Fusion welding: Part 1: Steels*

MS 1745 (all series), *Fire detection and fire alarm systems*

MS 2616, *Fixed fire fighting systems - Fire pumps*

MS ISO 6182-1, *Fire protection - Automatic sprinkler systems - Part 1: Requirements and test methods for sprinklers*

MS ISO 6182-2, *Fire protection - Automatic sprinkler systems - Part 2: Requirements and test methods for wet alarm valves, retard chambers and water motor alarms*

MS ISO 6182-3, *Fire protection - Automatic sprinkler systems - Part 3: Requirements and test methods for dry pipe valves*

MS ISO 6182-4, *Fire protection - Automatic sprinkler systems - Part 4: Requirements and test methods for quick opening devices*

MS ISO 6182-5, *Fire protection - Automatic sprinkler systems - Part 5: Requirements and test methods for deluge valves*

MS ISO 9001, *Quality management systems - Requirements*

MS IEC 60529, *Degree of protection provided by enclosures (IP code)*

MS IEC 60947-1, *Low-voltage switchgear and controlgear - Part 1: General rules*

MS IEC 60947-4-1, *Low - voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters*

ISO 3046-1, *Reciprocating internal combustion engines - Performance - Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use*

ISO 3677, *Filler metal for soft soldering, brazing and braze welding - Designation*

IEC 60095-1, *Lead-acid starter batteries - Part 1: General requirements and methods of test*

IEC 60204-1, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

IEC 60623, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel-cadmium prismatic rechargeable single cells*

EN 1057:1996, *Copper and copper alloy - Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1254, *Copper and copper alloys plumbing fittings*

EN 12259-5, *Fixed firefighting systems - Components for sprinkler and waterspray systems - Part 5: Water flow detectors*

EN 12723, *Liquid pumps - General terms for pumps and installation symbols and units - Definitions, quantities, letter*

EN 29453, *Soft solder alloy chemical composition and forms*

BS 476-6, *Fire tests on building materials and structures - Part 6: Method of test for fire propagation for products*

prEN 12259-6, *Fixed firefighting systems - Components for sprinkler and waterspray systems - Part 6: Pipe couplings*

prEN 12259-7, *Fixed firefighting systems - Components for sprinkler and waterspray systems - Part 7: Pipe hangers*

prEN 12259-8, *Fixed firefighting systems - Components for sprinkler and waterspray systems - Part 8: Pressure switches*

prEN 12259-12, *Fixed firefighting systems - Components for sprinkler and waterspray systems - Part 12: Sprinkler pump sets*

3 Terms and definitions

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

3.1 'A' gauge

A pressure gauge connected at the pump discharge, between the pump discharge stop valve and the non-return valve.

3.2 accelerator

A device that reduces the delay in operation of a dry alarm valve, or composite alarm valve in dry mode, by early detection of the drop in air or inert gas pressure on sprinkler operation.

3.3 alarm test valve

A valve through which water may be drawn to test the operation of the water motor fire alarm and/or of any associated electric fire alarm.

3.4 alarm valve

A non-return valve, of the wet, dry or composite type that also initiates the water motor fire alarm when the sprinkler installation operates.

3.4.1 dry alarm valve

An alarm valve suitable for a dry installation.

3.4.2 pre-action alarm valve

An alarm valve suitable for a pre-action installation.

3.4.3 wet alarm valve

An alarm valve suitable for a wet installation.

3.5 area of operation

The maximum area, over which it is assumed, for design purposes that sprinklers will operate in a fire.

3.5.1 hydraulically most favourable

The location in a sprinkler array of an area of operation of specified shape at which the water flow is the maximum for a specific pressure measured at the control valve set.

3.5.2 hydraulically most unfavourable

The location in a sprinkler array of an area of operation of specified shape at which the water supply pressure measured at the control valve set is the maximum needed to give the specified design density.

3.6 arm pipe

A pipe less than 0.3 m long, other than the last section of a range pipe, feeding a single sprinkler.

3.7 authorities

An organisation responsible for approving sprinkler systems, equipment and procedures, e.g. the fire and building control authorities.

3.8 'B' gauge

A pressure gauge connected to and on the same level as an alarm valve, indicating the pressure on the upstream side of the valve.

3.9 booster pump

An automatic pump supplying water to a sprinkler system from a gravity tank.

3.10 'C' gauge

A pressure gauge connected to and on the same level as an alarm valve, indicating the pressure on the downstream side of the valve.

3.11 ceiling or flush sprinkler

A pendent sprinkler for fitting partly above, but with the temperature sensitive element below, the lower plane of the ceiling.

3.12 class 'O'

Materials as defined in BS 476-6 under class 'O' rating.

3.13 concealed sprinkler

Recessed sprinkler with a cover plate that disengages when heat is applied.

3.14 conventional pattern sprinkler

Sprinkler that gives a spherical pattern of water discharge.

3.15 control valve

Assembly comprising an alarm valve, a stop valve and all the associated valves and accessories for the control of one sprinkler installation.

3.16 cut-off sprinkler

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

3.17 design density

The minimum density of discharge, in millimetres per minute of water, for which a sprinkler installation is designed, determined from the discharge of a specified group of sprinklers, in litres per minute, divided by the area covered, in square metres.

3.18 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.

3.19 distribution pipe

A pipe feeding a range pipe directly.

3.20 distribution pipe spur

A distribution pipe from a main distribution pipe, to a terminal branched pipe array.

3.21 drencher

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

3.22 drop

A vertical distribution pipe feeding a distribution or range pipe below.

3.23 dry pendent pattern sprinkler

Unit comprising a sprinkler and a dry drop pipe unit with a valve, at the head of the pipe, held closed by a device maintained in position by the sprinkler head valve.

3.24 dry upright pattern sprinkler

Unit comprising a sprinkler and dry rise pipe unit with a valve, at the base of the pipe, held closed by a device maintained in position by the sprinkler head valve.

3.25 dry (pipe) installation

An installation in which the pipework is charged with air or inert gas under pressure.

3.26 end-centre array

A pipe array with range pipes on both sides of a distribution pipe.

3.27 end-side array

A pipe array with range pipes on one side only of a distribution pipe.

3.28 exhauster

A device to exhaust the air or inert gas from a dry installation to atmosphere on sprinkler operation to give more rapid operation of the alarm valve.

3.29 fire resistant compartment

An enclosed volume capable of maintaining its fire integrity for a minimum specified time.

3.30 fully calculated

Term applied to an installation in which all the pipework is sized by hydraulic calculation.

3.31 fusible link sprinkler

Sprinkler which opens when a component provided for the purpose melts.

3.32 glass bulb sprinkler

Sprinkler which opens when a liquid-filled glass bulb bursts.

3.33 gridded configuration

A pipe array in which water flows to each sprinkler by more than one route.

3.34 hanger

An assembly for suspending pipework from elements of building structure.

3.35 high rise system

Sprinkler system in which the highest sprinkler is more than 45 m above the lowest sprinkler or above the sprinkler pumps, whichever is the lower.

3.36 horizontal sprinkler

Sprinkler in which the nozzle directs water horizontally.

3.37 inexhaustible sources

A natural and artificial water sources such as rivers, canals and lakes which are virtually inexhaustible for reasons of capacity and climate, etc.

3.38 life safety system

A term applied to sprinkler systems forming an integral part of measures required for the protection of life especially where evacuating the building depends on the performance of the sprinkler system and sprinklers are required expressly for life safety purposes.

3.39 looped configuration

A pipe array in which there is more than one distribution pipe route along which water may flow to a range pipe.

3.40 main distribution pipe

A pipe feeding a distribution pipe.

3.41 maximum flow demand (Q_{max})

The flow at the point of intersection of the pressure-flow demand characteristic of the most favourable area of operation and the water supply pressure-flow characteristic with the suction source at its lowest level.

3.42 mechanical pipe joint

A pipe fitting other than threaded tubulars, screwed fittings, spigots and socket and flanged joint, used to connect pipes and components.

3.43 multi-storey building

Building comprising two or more storeys, above or below ground.

3.44 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.

3.45 non-combustible

Materials as defined in BS 476-6 as being non-combustible.

3.46 normal water level

The water level at the water supply needed to give the required effective capacity in relation to the low water level.

3.47 open sprinkler

Sprinkler not sealed by a temperature sensitive element.

3.48 pendent sprinkler

Sprinkler in which the nozzle directs water downwards and the deflector is below the nozzle.

3.49 pipe array

The pipes feeding a group of sprinklers. Pipe arrays may be looped, gridded or branched.

3.50 pressure maintenance pump (jockey pump)

A small automatic pumpset used to replenish minor water loss and maintain system pressure.

3.51 pre-action installation

One of two types of dry installation in which the alarm valve can be opened by an independent fire detection system in the protected area.

3.52 pre-calculated

A term applied to an installation in which the pipes downstream of the design point(s) are selected by the use of pre-determined/pre-calculated tables of pipe sizes which does not require any hydraulic calculations to be performed.

3.53 recessed sprinkler

Sprinkler in which all or part of the heat sensing element is above the lower plane of the ceiling.

3.54 riser

A vertical distribution pipe feeding a distribution or range pipe above.

3.55 sidewall pattern sprinkler

Sprinkler that gives an outward half-paraboloid pattern discharge.

3.56 sprayer

Water spray nozzle that gives a downward conical pattern discharge.

3.57 spray flat sprinkler

Sprinkler that gives a pattern of water discharge with a proportion of the discharge directed above the level of the deflector.

3.58 spray pattern sprinkler

Sprinkler that gives a downward paraboloid pattern discharge.

3.59 sprinkler alarm valve installation

A part of sprinkler system comprising a control valve set, the associated downstream pipes, sprinklers and devices.

3.60 sprinkler rosette

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

3.61 sprinkler system installation

An entire sprinkler system comprising of water supplies, automatic pumps (if any), control valve sets, all associated pipes, sprinklers and devices.

3.62 sprinkler kit

A complete set of components needed for the correct working of the sprinkler system for its intended purpose, ready for site installation.

3.63 sprinkler system

The entire means of providing sprinkler protection in the premises comprising one or more sprinkler installations, the pipework to the installations and the water supply/supplies.

3.64 sprinkler yoke (arms)

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

3.65 sprinkler (automatic)

A nozzle with a thermally sensitive sealing device which opens to discharge water for fire fighting.

3.66 staggered (sprinkler) layout

An off-set layout with the sprinklers displaced one-half pitch along the range pipe relative to the next range or ranges.

3.67 standard (sprinkler) layout

Rectilinear layout with the sprinklers aligned perpendicular to the run of the ranges.

3.68 subsidiary dry extension

Part of a wet installation that is charged permanently with air or inert gas under pressure.

3.69 suitable for sprinkler use

Term applied to equipment or components accepted by the authorities as suitable for a particular application in a sprinkler system, either by conforming to Malaysian Standard or EN product standard where available or if not by compliance with specified criteria.

3.70 supply pipe

Pipe connecting a water supply to a trunk main or the installation control valve set(s); or a pipe supplying water to a private reservoir or storage tank.

3.71 suspended open cell ceiling

A ceiling of regular open cell construction through which water from sprinklers can be discharged freely.

3.72 terminal main configuration

Pipe array with only one water supply route to each range pipe.

3.73 terminal range configuration

Pipe array with only one water supply route from a distribution pipe.

3.74 trunk main

A pipe connecting two or more water supply pipes to the installation control valve set(s).

3.75 upright sprinkler

Sprinkler in which the nozzle directs water upwards and the deflector is above the nozzle.

3.76 water supply datum point

Point on the installation pipework at which the water supply pressure and flow characteristics are specified and measured.

3.77 wet (pipe) installation

An installation in which the pipework is always charged with water.

3.78 zone

Sub-division of an installation with a specific flow alarm and fitted with a monitored subsidiary stop valve.

4 Extent of sprinkler protection

4.1 Buildings and areas to be protected

Where a building is to be sprinkler protected, all areas of that building or of a communicating building or canopies of non-combustible construction extending beyond 2.3 m from the building wall, including exterior loading docks and platforms shall be sprinkler protected, except in the cases indicated in 4.1.1 and 4.1.2 and 4.3. Consideration should be given to the protection of load bearing steel.

NOTE. It is recommended that the inside of walk-in cold rooms, walk-in chillers and walk-in freezers should be protected internally by special ‘dry’ sprinkler heads. There is a possibility of a fire starting when it is shut down for maintenance works.

4.1.1 Permitted exceptions within a building

Sprinkler protection shall be considered in the following cases, but may be omitted after due consideration of the fire load in each case:

a) washrooms and toilets (but not cloakrooms) of non-combustible materials and which are not used to store combustible materials;

b) enclosed staircases and enclosed vertical shafts (e.g. lifts or service shafts) containing no combustible material and constructed as a fire resistant separation (see 4.3);

c) rooms protected by other automatic extinguishing systems (e.g. gas, powder and water spray); and

d) wet processes such as the wet end of paper making machines.

4.1.2 Necessary exceptions

Sprinkler protection shall not be provided in the following areas of a building or plant:

a) silos or bins containing substances which expand on contact with water;

b) in the vicinity of industrial furnaces or kilns, salt baths, smelting ladles or similar equipment if the hazard would be increased by the use of water in extinguishing a fire; and

c) areas, rooms or places where water discharge might present a hazard.

NOTE. In these cases, other automatic extinguishing systems should be considered (e.g. gas or powder).

4.2 Storage in the open air

The distance between combustible materials stored in the open air and the sprinklered building shall be no less than 10 m or 1.5 times the height of the stored material.

NOTE. Such a fire resistant separation may be achieved by a firewall or by a suitable exposure protection system.

4.3 Fire resistant separation

The separation between a sprinkler protected area and a non-protected area shall have a fire resistance specified by the authority but in no case less than 60 min. Doors shall be self-closing or be closed automatically in the event of fire.

NOTE. No part of an unsprinklered building or section should be located vertically below a sprinklered building or section except as indicated in 4.1.1 and 4.1.2.

4.4 Protection of concealed spaces

If the height of the concealed space at roof and floor exceeds 0.8 m, measured between the underside of the roof and the top of the suspended ceiling or between the floor and the underside of the raised floor, these spaces shall be sprinkler protected.

If the height of the concealed space at roof and floor is no greater than 0.8 m, the spaces shall be sprinkler protected only if they contain combustible materials or are constructed with combustible materials.

Electrical cables enclosed in metal conduit or trunking are allowed. Unenclosed fire rated electrical cables clipped on non-combustible supports are also permitted.

The protection in the concealed space shall be to Light Hazard (LH) when the main hazard class is LH and Ordinary Hazard 1 (OH1) in all other cases. See 16.3 for the pipework arrangement.

4.5 Height difference between the highest and lowest sprinklers

Where the height difference between the highest and lowest sprinklers in a system or building exceeds 45 m the requirements of Annex A shall be applied.

The height difference between the highest and lowest sprinkler on an installation (i.e. connected to a single control valve set) shall not exceed 45 m.

5 Classification of occupancies and fire hazards

5.1 General

The hazard class to which the sprinkler system is to be designed shall be determined before the design work is begun.

The buildings and areas to be protected by the automatic sprinkler system shall be classified as Light Hazard, Ordinary Hazard or High Hazard.

This classification depends on the occupancy and the fire load, as defined in Annex B.

Where there are areas in open communication having different hazard classification, the higher design criteria shall be extended at least two rows of sprinklers into the area with the lower classification.

5.2 Hazard classes

Buildings or areas to be protected which contain one or more of the following occupancies and fire hazards shall be classified as belonging to the appropriate hazard class, as follows:

5.2.1 Light Hazard (LH)

Occupancies with low fire loads and combustibility and with no single compartment greater than 126 m² with a fire resistance of at least 30 min. See Annex B for examples.

5.2.2 Ordinary Hazard (OH)

Occupancies where combustible materials with a medium fire load and medium combustibility are processed or manufactured. See Annex B for examples.

Ordinary Hazard (OH) is sub-divided into four groups, as follows:

a) OH1, Ordinary Hazard Group 1;

b) OH2, Ordinary Hazard Group 2;

c) OH3, Ordinary Hazard Group 3; and

d) OH4, Ordinary Hazard Group 4.

Materials may be stored in occupancies classified as OH1, OH2 and OH3 provided the following conditions are met:

a) the protection throughout the room shall be designed to at least OH3;

b) the maximum storage heights shown in Table 1 shall not be exceeded; and

c) the maximum storage areas shall be 50 m^2 for any single block, with no less than 2.4 m clearance around the block.

When the process occupancy is classified as OH4, storage areas shall be treated as HHS.

Table 1. Maximum storage heights for OH1, OH2 and OH3

Storage category	Maximum storage height for OH3 (m)	
	Free standing or block storage (ST1 - see 5.3.2)	All other cases (ST2 - ST6 - see 5.3.2)
Category I	4.0	3.5
Category II	3.0	2.6
Category III	2.1	1.7
Category IV	1.2	1.2
NOTE. For storage heights exceeding these values, see 5.2.3.1 and 6.2.		

5.2.3 High Hazard (HH)

5.2.3.1 High Hazard, Process (HHP)

High Hazard Process, covers occupancies where the materials concerned have a high fire load and high combustibility and are capable of developing a quickly spreading or intense fire. HHP is sub-divided into four groups:

a) HHP1, High Hazard Process Group 1;

b) HHP2, High Hazard Process Group 2;

c) HHP3, High Hazard Process Group 3; and

d) HHP4, High Hazard Process Group 4.

NOTE. HHP4 hazards are usually protected by deluge systems, which are not within the scope of this standard.

5.2.3.2 High Hazard, Storage (HHS)

High Hazard, Storage, covers the storage of goods where the height of storage exceeds the limits given in 5.2.2.

High Hazard, Storage (HHS), is sub-divided into four categories:

a) HHS1, High Hazard Storage Category I;

b) HHS2, High Hazard Storage Category II;

c) HHS3, High Hazard Storage Category III; and

d) HHS4, High Hazard Storage Category IV.

Methodology for categories of stored goods are described in Annex C and stored products are listed in Annex D.

5.3 Storage

5.3.1 General

The overall fire hazard of stored goods is a function of the combustibility of the materials being stored, including their packaging, and of the storage configuration.

Annex E shall be consulted. If Annex E is not applicable and the goods or packaging contain plastic or rubber, the categorisation methodology specified in Annex C shall be used.

If neither is applicable, the alphabetical listing in Annex D shall be used, extrapolating where necessary.

To determine the required design criteria when stored goods are involved, the procedure shown in Figure 2 shall be followed.

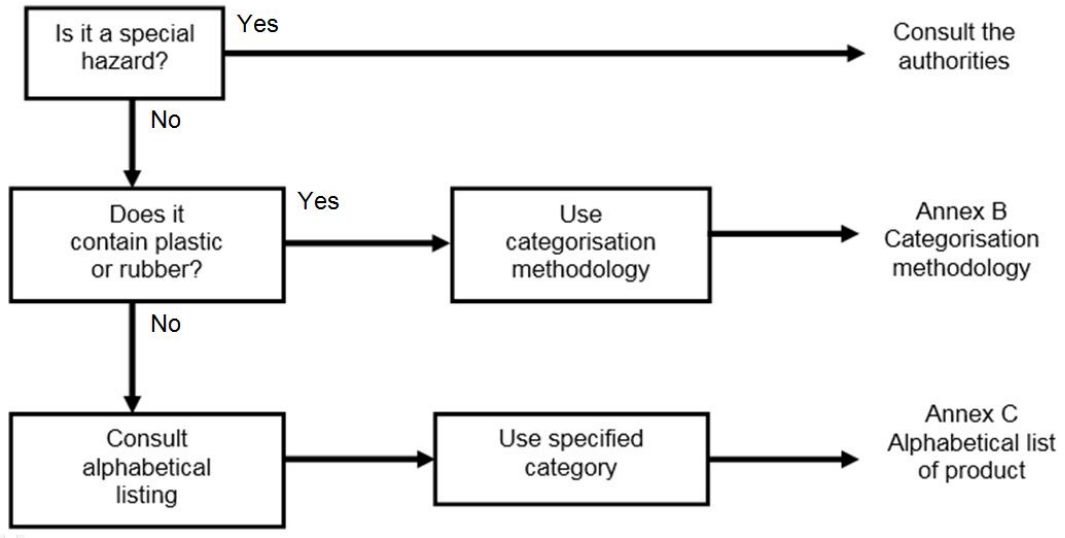


Figure 2. Flow chart for determining the class required for storage

NOTE. Where none of these annexes is fully applicable, and large scale fire test data are available, it may be appropriate to use such data to establish design criteria.

5.3.2 Storage configuration

The storage configuration shall be classified as follows:

a) ST1: free standing or block stacking;

b) ST2: post pallets in single rows, with aisles not less than 2.4 m wide;

c) ST3: post pallets in multiple (including double) rows;

d) ST4: palletized rack (beam pallet racking);

e) ST5: solid or slatted shelves 1 m or less wide; and

f) ST6: solid or slatted shelves over 1 m and no more than 6 m wide;

Typical examples of storage configurations are given in Figure 3.

NOTE. For each storage method, there are specific limitations to storage heights depending on the type and design of sprinkler systems (see 6.2).

In order for sprinkler protection to be effective, the limitations and protection requirements of Table 2 shall be met.

Table 2. Limitations and protection requirements for different storage configurations

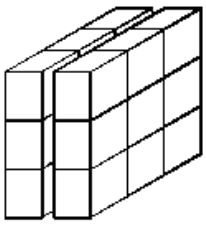
Storage configuration	Layout limitations	Protection in addition to sprinklers at ceiling or roof	Applicable table notes
ST1	Storage shall be confined to blocks not exceeding 150 m² in plan area for Categories III and IV	None	2.3
ST2	Aisles between rows shall be not less than 2.4 m wide	None	2
ST3	Storage shall be confined to blocks not exceeding 150 m² in plan area	None	2
ST4	Aisles separating rows are equal or greater than 1.2 m wide	Intermediate sprinklers are recommended	1.2
	Aisles separating rows are less than 1.2 m wide.	Intermediate sprinklers are recommended.	1
ST5	Either the aisles separating rows shall be no less than 1.2 m wide, or storage blocks shall be no more 150 m2 in plan area.	Intermediate sprinklers are recommended.	1.2

Table 2. Limitations and protection requirements for different storage configurations *(continued)*

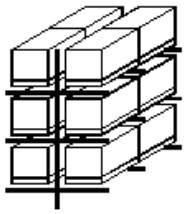
Storage configuration	Layout limitations	Protection in addition to sprinklers at ceiling or roof	Applicable table notes
ST6	Either the aisles separating rows shall be no less than 1.2 m wide, or storage blocks shall be no more 150 m^2 in plan area.	Intermediate sprinklers are required or, if this is impossible, continuous full height vertical bulkheads of non-combustible or limited combustibility, shall be fitted longitudinally and transversely within each shelf.	1.2

NOTES:

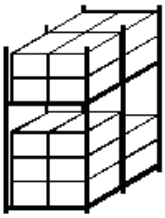
1. When the ceiling is more than 4 m above the highest level of stored goods, intermediate levels of in-rack sprinklers should be used.
2. Storage blocks should be separated by aisles no less than 2.4 m wide.
3. Storage blocks should be confined to blocks not exceeding 150 m² in plan are for Categories I and II.

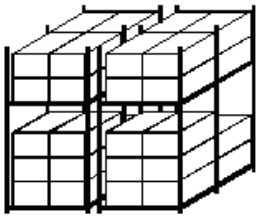


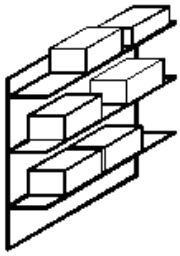
a) Free-standing storage (ST1)



b) Palletised rack (ST4)







c) Post-pallet storage (ST2) d) Post-pallet storage (ST3) e) Solid slattered shelves (ST5/6)

Figure 3. Storage configuration

6 Hydraulic design criteria

6.1 LH, OH and HHP

The design density shall be no less than the appropriate value given in this clause when all the ceiling or roof sprinklers in the room concerned, or in the area of operation, whichever is the fewer, plus any in-rack sprinklers and supplementary sprinklers, are in operation. The minimum requirements for design density and area of operation for LH, OH and HHP classes are given in Table 3. For HHS systems, 6.2 shall be applied.

NOTE. For pre-calculated systems, the design criteria are achieved by the application of water supply and piping requirements stated elsewhere in this standard (see 6.3, 8.2.2.2 and 9.7).

Table 3. Design criteria for LH, OH and HHP

Hazard class	Design density (mm/min)	Area of operation (m^2)	
		Wet or pre-action	Dry
LH	2.25	84	Not allowed. Use OH1.
OH1	5.0	72	90
OH2	5.0	144	180
OH3	5.0	216	270
OH4	5.0	360	Not allowed. Use HHP1.
HHP1	7.5	260	325
HHP2	10.0	260	325
HHP3	12.5	260	325
HHP4	deluge (see Note)		
NOTE. It needs special consideration. Deluge systems are not covered by this standard.			

6.2 High Hazard Storage (HHS)

6.2.1 General

The type of protection and determination of the design density and area of operation are dependent on the combustibility of the product (or mix of products) and its packaging (including the pallet) and the method and height of storage. Specific limitations apply to the various types of storage methods as detailed in Clause 5.

6.2.2 Ceiling or roof protection only

Table 4 specifies the appropriate design density and area of operation according to the category and maximum permitted storage height for the various types of storage with roof or ceiling protection only. More specifically, the storage heights indicated in the table are considered the maximum for efficient sprinkler protection where sprinklers are only provided at the roof or ceiling.

NOTE. The distance between the maximum permitted storage height and the roof or ceiling sprinklers should not exceed 4.0 m.

Where storage heights exceed these limits or where the distance between the top of the storage and the roof or ceiling exceeds 4.0 m, intermediate levels of in-rack sprinklers shall be provided as per 6.2.3.

NOTE. Storage height, building height and ceiling clearance (the vertical distance between the roof or ceiling sprinklers and the top of the storage) are all significant variables contributing to the effectiveness and required design density of sprinkler protection.

Table 4. Design criteria for HHS with roof or ceiling protection only (without in-rack intermediate sprinkler protection)

Storage configuration	Maximum permitted storage height (see Note 1) (m)				Design density (mm/min)	Area of operation (wet or pre-action system (see Note 2)) (m^2)
	Category I	Category II	Category III	Category IV		
ST1 Free standing or block stacking	5.3 6.5 7.6	4.1 5.0 5.9 6.7 7.5	2.9 3.5 4.1 4.7 5.2	1.6 2.0 2.3 2.7 3.0	7.5 10.0 12.5 15.0 17.5	260
			5.7 6.3 6.7 7.2	3.3 3.6 3.8 4.1 4.4	20.0 22.5 25.0 27.5 30.0	300
ST2 Post pallets in single rows ST4 Palletised racks	4.7 5.7 6.8	3.4 4.2 5.0 5.6 6.0	2.2 2.6 3.2 3.7 4.1	1.6 2.0 2.3 2.7 3.0	7.5 10.0 12.5 15.0 17.5	260
			4.4 4.8 5.3 5.6 6.0	3.3 3.6 3.8 4.1 4.4	20.0 22.5 25.0 27.5 30.0	300

Table 4. Design criteria for HHS with roof or ceiling protection only (without in-rack intermediate sprinkler protection) *(continued)*

Storage configuration	Maximum permitted storage height (see Note 1) (m)				Design density (mm/min)	Area of operation {wet or pre-action system (see Note 2)} (m^2)
	Category I	Category II	Category III	Category IV		
ST3 Post pallets in multiple rows ST5 and ST6 Solid or slatted shelves	4.7 5.7	3.4 4.2 5.0	2.2 2.6 3.2	1.6 2.0 2.3 2.7 3.0	7.5 10.0 12.5 15.0 17.5	260

NOTES:

1. The maximum storage height is the vertical distance from the floor to the sprinkler deflectors, minus 1.0 m, or the highest value shown in the table, whichever is the lower.

2. Dry systems should be avoided on High Hazard storage especially with the more combustible products (the higher categories) and the higher storage. Should it nonetheless be necessary to install a dry system, the area of operation should be increased by 25 %.

6.2.3 Intermediate level in-rack sprinklers

6.2.3.1 Where more than 50 intermediate level sprinklers are installed in the racks, they shall not be fed from the same control valve set as the roof or ceiling sprinklers. The control valve set shall be not less than 100 mm diameter.

6.2.3.2 The design density for the roof or ceiling sprinklers shall be a minimum of 7.5 mm/min over an area of operation of 260 m^2. If goods are stored above the highest level of intermediate sprinkler protection, the design criteria for the roof or ceiling sprinklers shall be taken from Table 5.

6.2.3.3 For the purposes of hydraulic calculation it shall be assumed that 3 sprinklers are operating simultaneously at the most hydraulically remote position on each level of in-rack sprinklers, up to a maximum of three levels. Where rack aisles are 2.4 m or more in width only one rack need be assumed to be involved. Where rack aisles are less than 2.4 m but greater than or equal to 1.2 m in width, two racks shall be assumed to be involved. Where rack aisles are less than 1.2 m in width, three racks shall be assumed to be involved.

NOTE. It is not necessary to assume simultaneous operation of more than three rows of sprinklers in the vertical plane nor more than three rows of sprinklers in the horizontal plane.

6.2.3.4 In-rack sprinklers and the associated ceiling sprinklers shall always be fully calculated (see 12.1.1).

NOTE. For minimum pressure at any operating sprinkler, see 12.4.4.

Table 5. Design criteria for roof or ceiling sprinklers with in-rack (intermediate) sprinkler protection

Storage configuration	Maximum permitted storage height above the top level of in-rack protection (see Note 1)				Design density (mm/min)	Area of operation (wet or pre-action system (see Note 2)) (m^2)
	Category I	Category II	Category III	Category IV		
ST4 Palletised racks	3.5	3.4	2.2 2.6 3.2 3.5	1.6 2.0 2.3 2.7	7.5 10.0 12.5 15.0	260
ST5 and ST6 Solid or slatted shelves	3.5	3.4	2.2 2.6 3.2	1.6 2.0 2.3 2.7	7.5 10.0 12.5 15.0	260

NOTES:

1. The maximum permitted storage height above the top level of in-rack protection is the vertical distance from the highest level in-rack sprinklers to the storage.

2. Dry systems should be avoided on High Hazard storage especially with the more combustible products (the higher categories) and the higher storage. Should it nonetheless be necessary to install a dry system, the area of operation should be increased by 25 %.

6.3 Pressure and flow requirements for pre-calculated systems

6.3.1 LH and OH systems

The water supply shall be capable of providing not less than the appropriate flows and pressures specified in Table 6 at each control valve set. The pressure loss due to friction and static head between the water supply and each control valve set shall be calculated separately.

Table 6. Pressure and flow requirements for pre-calculated LH and OH systems

Hazard class	Flow (L/min)	Pressure at the control valve set (bar)	Maximum demand flow (L/min)	Pressure at the control valve set (bar)
LH (Wet and pre-action)	225	2.2 + p_s	-	-
OH1 (Wet and pre-action)	375	1.0 + p_s	540	0.7 + p_s
OH1 (Dry) OH2 (Wet and pre-action)	725	1.4 + p_s	1 000	1.0 + p_s
OH2 (Dry) OH3 (Wet and pre-action)	1 100	1.7 + p_s	1 350	1.4 + p_s
OH3 (Dry) OH4 (Wet and pre-action)	1 800	2.0 + p_s	2 100	1.5 + p_s
NOTE. p_s is the static head loss due to the height of the highest sprinkler in the array concerned above the control valve set 'C' gauge, in bar.				

6.3.2 HHP and HHS systems without in-rack sprinklers

6.3.2.1 The water supply shall be capable of delivering at the highest design point not less than the appropriate flow and pressure specified in Table 7, or as modified in 6.3.2.2 to 6.3.2.5. The total requirement for the running pressure at the control valve set shall be the sum of the pressure at the design point, the pressure equivalent of the difference in height between the control valve set and the highest sprinkler downstream of the design point and the pressure loss for the flow in the piping from the control valve set to the design point.

6.3.2.2 Where the area of the HHP or HHS portion of an occupancy is less than the area of operation, the flow rate in Table 7 may be proportionately reduced, (see 6.3.2.6), but the pressure at the highest design point for the area shall be equal to that shown in the table, or be determined by hydraulic calculation.

6.3.2.3 When the HHP or HHS portion of an occupancy involves less than 48 sprinklers, the flow rate and appropriate pressure shown in Table 7 shall be available at the level of the highest sprinklers at the point of entry of the distribution pipe to the HHP or HHS area of sprinklers.

6.3.2.4 Where the area of operation is greater than the area of HHP or HHS protection and this area is adjacent to the OH protection, the total flow rate shall be calculated as the sum of the HHP or HHS portion when reduced proportionately as in 6.3.2.2 plus the flow rate for the OH section calculated on the basis of a design density of 5 mm/min. The pressure at the design point of the highest sprinklers in the HHP or HHS portion of the risk shall be either that shown in Table 7, or be determined by hydraulic calculation.

NOTE. If the OH portion is upstream of the HH area, the hydraulic gradient will mean that the greater flow to the OH portion will be taken as for purely OH systems. Therefore, in a fire involving the complete design area the HH portion will have a reduced flow rate.

6.3.2.5 When the area of operation is fed by more than one distribution pipe, the pressure at the level of the highest sprinklers of the design points shall either be as shown in Table 7 for the appropriate design density, or be determined by hydraulic calculation. The flow rate for each distribution pipe shall be determined proportionately (see 6.3.2.6).

Table 7. Pressure and flow requirements for HHP and HHS pre-calculated installations designed using Tables 33 to 36

Design density (mm/min)	Maximum demand flow (L/min)		Pressure at the highest design point (see Note) (p_d) (bar) Area of operation per sprinkler (m^2)			
	Wet or pre-action	Dry	6	7	8	9
(1) With pipe diameters in accordance with Tables 33 and 34 and sprinklers having a K factor of 80						
7.5	2 300	2 900	-	-	1.80	2.25
10.0	3 050	3 800	1.80	2.40	3.15	3.90
(2) With pipe diameters in accordance with Tables 33 and 35 and sprinklers having a K factor of 80						
7.5	2 300	2 900	-	-	1.35	1.75
10.0	3 050	3 800	1.30	1.80	2.35	3.00
(3) With pipe diameters in accordance with Tables 35 and 34 and sprinklers having a K factor of 80						
7.5	2 300	2 900	-	-	0.70	0.90
10.0	3 050	3 800	0.70	0.95	1.25	1.60
(4) With pipe diameters in accordance with Tables 35 and 36 and sprinklers having a K factor of 115						
10.0	3 050	3 800	-	-	-	0.95
12.5	3 800	4 800	-	0.90	1.15	1.45
15.0	4 550	5700	0.95	1.25	1.65	2.10
17.5	4 850	6 000	1.25	1.70	2.25	2.80
20.0	6 400	8 000	1.65	2.25	2.95	3.70
22.5	7 200	9 000	2.05	2.85	3.7	4.70
25.0	8 000	10 000	2.55	3.50	4.55	5.75
27.5	8 800	11 000	3.05	4.20	5.5	6.90
30.0	9 650	12 000	3.60	4.95	6.5	-
NOTE. If there are sprinklers in the array which are higher than the design point, the static head from the design point to the highest sprinklers should be added to p_d.						

6.3.2.6 Where the basic area of operation for a given design density is increased or decreased as described in 6.3.2.2 to 6.3.2.5, the flow rate shall be proportionately increased or decreased, (see 6.3.2.7), but the pressure at the design point shall remain unchanged.

6.3.2.7 The increased or decreased flow rates shall be determined proportionately as follows:

$$Q_2 = Q_1 \times \frac{a_2}{A}$$

where,

Q_2 is the flow rate required or in the case of the circumstances described in 6.3.2.2 to 6.3.2.5 the flow rate in each distribution pipe, in litres per minute;

Q_1 is the flow rate required as given in Table 7, in litres per minute (L/m);

A is the area of operation for design density, in square metres (see Table 4); and

a_2 is the area of operation required, or in the case of the circumstances described in 6.3.2.2 to 6.3.2.5, the area served by each distribution pipe, in square metres (m^2).

7 Water supplies

7.1 General

7.1.1 Duration

Water supplies shall be capable of automatically furnishing at least the required pressure or flow conditions of the system. If the water supply is used for other firefighting systems, see 8.4.3. Each water supply shall have sufficient capacity for the following minimum durations:

a) LH 30 min;

b) OH 60 min;

c) HHP 90 min; and

d) HHS 90 min.

NOTE. In the case of inexhaustible sources and all pre-calculated systems, the duration is implicit in the requirements given in this standard.

7.1.2 Continuity

A water supply shall not be liable to be affected by possible frost conditions or drought or flooding or any other conditions that could reduce the flow or effective capacity or render the supply inoperative.

All practical steps shall be taken to ensure the continuity and reliability of water supplies.

NOTE. Water supplies should preferably be under the control of the user, or else the reliability and right of use should be guaranteed by the organisation having control.

The water shall be free from fibrous or other matter in suspension liable to cause accumulations in the system piping. Salt or brackish water shall not be retained in sprinkler installation pipework.

Where there is no suitable fresh water source available, a salt or brackish water supply may be used provided the installation is normally charged with fresh water.

7.2 Maximum water pressure

7.2.1 Except during testing, water pressure shall not exceed 12 bar at equipment connections or locations identified in 7.2.1.1 and 7.2.1.2. The pressure in pumped systems shall take into account any increase in driver speed and pressure due to closed valve conditions.

7.2.1.1 All types of sprinklers system shall have the following:

a) sprinklers;

b) multiple jet controls;

c) water flow detectors;

d) dry pipe and pre-action alarm valves;

e) accelerators and exhausters;

f) water motor alarms; and

g) zone control valves.

7.2.1.2 For sprinkler systems, where the height difference between the highest and lowest sprinkler heads does not exceed 45 m shall have the following:

a) pump outlets, taking into account any increases in driver speed under closed valve conditions;

b) wet alarm valves;

c) stop valves; and

d) mechanical pipe joints.

7.2.2 In sprinkler systems, where the height difference between the highest and lowest sprinkler exceeds 45 m, water pressures may exceed 12 bar at the following locations (provided all equipment subject to pressures greater than 12 bar is fit for the purpose):

a) pump outlets; and

b) riser and distribution pipes.

7.3 Housing of equipment for water supplies

Water supply equipment, such as pumps, suction tanks and gravity tanks, shall not be housed in buildings or sections of premises in which there are hazardous processes or explosion hazards. The water supplies, stop valves and control valve sets shall be installed in locations not prone to flooding such that they are safely accessible even in a fire situation through a protected access route. All components of the water supplies and control valve sets shall be installed such that they are secured against tampering.

7.4 Connections for other services

Water for other services may be taken from a sprinkler only when the following conditions are met:

a) the connections shall be as specified in Table 8;

b) the connections shall be made through a stop valve fitted upstream of the control valve set(s), as close as is practical to the point of connection to the sprinkler system supply pipe;

c) the sprinkler system shall not be a high rise system; and

d) the sprinkler system shall not be protecting a multi-storey building.

The sprinkler system pumps shall be separated from any hydrant system pumps unless a combined water supply in accordance with 8.4.3 is used.

NOTE. An additional feed arrangement with check valve may be provided for the fire brigade.

Table 8. Connections for water for other services in low rise systems

Water supply type	Acceptable number, size and purpose of connection(s)
Elevated private reservoir, gravity tank or automatic suction pumps	One, no more than 50 mm diameter, for fire hose reels.

7.5 Test facility devices

Sprinkler installations shall be permanently provided with devices for measuring pressure and flow for checking compliance with 6.3 and Clause 9.

7.5.1 At control valve sets

A flow measuring device shall be installed at each control valve set except in the following cases:

a) where two or more control valve sets are installed together, the device need be installed only at the hydraulically most remote set, or, when the installations belong to different hazard classes, at the control valve set which requires the highest water flow; and

b) where the water supply is by automatic suction pumps, the flow measuring device may be installed at the pump house.

In all cases, the appropriate allowance shall be made for the pressure losses between the water source and the control valve set(s) using the calculation methods specified in 12.2. Facilities shall be provided for the disposal of test water.

Dry control valve sets (main or subsidiary) may have an additional flow test valve arrangement of unspecified flow loss characteristic fitted below the control valve set, downstream of the main stop valve, to facilitate informal supply pressure testing. Such flow test valves and pipework shall have a nominal diameter of 40 mm for LH installations and of 50 mm for other installations.

7.5.2 At water supplies and automatic suction pumps

At least one suitable flow and pressure measuring arrangement shall be permanently installed and shall be capable of checking each water supply or each automatic suction pump.

The testing apparatus shall be of adequate capacity and shall be installed in accordance with the supplier's instructions.

7.6 Water supply test

7.6.1 General

The test facility specified in 7.5.2 shall be used. Each supply to the installation shall be tested independently with all other supplies isolated.

For both pre-calculated and fully calculated installations, the water supply shall be tested at least at the installation maximum demand flow.

7.6.2 Storage tank supplies

The stop valves controlling the flow from the water supply to the installation shall be fully opened. Automatic pump starting shall be checked by fully opening the installation drain and test valve. The flow shall be verified in accordance with Clause 6 and with the value recorded during the commissioning test. The supply pressure measured on the 'C' gauge shall be verified as being at least the appropriate value specified in Clause 6.

7.6.3 Booster pump, elevated private reservoir and gravity tank supplies

The stop valves controlling the flow from the supply to the installation shall be fully opened. Automatic pump starting shall be checked by fully opening the installation drain and test valve. The drain and test valve shall be adjusted to give the flow specified in Clause 6. When the flow is steady the supply pressure measured on the 'C' gauge shall be verified as being at least the appropriate value specified in Clause 6.

8 Type of water supply

8.1 General

Water supplies shall be one or more of the following:

a) storage tanks in accordance with 8.2; and

b) inexhaustible sources in accordance with 8.3.

8.2 Storage tanks

8.2.1 General

Storage tanks shall be one or more of the following:

a) pump suction tank;

b) gravity tank; and

c) reservoir.

8.2.2 Water volume

8.2.2.1 General

For each system a minimum water volume is specified. This shall be supplied from one of the following:

a) a full capacity tank, with an effective capacity at least equal to the specified water capacity; or

b) a reduced capacity tank (see 8.2.4), where the required water volume is supplied jointly by the effective capacity of the tank plus the automatic infill.

The effective capacity of a tank shall be calculated by taking the difference between the normal water level and the lowest effective water level. In the case of enclosed tanks, easy access shall be provided.

Except for open reservoirs, tanks shall be provided with an externally readable water level indicator.

8.2.2.2 Pre-calculated systems

Table 9 shall be used to determine the minimum effective volume of water required for LH and OH pre-calculated systems. The volumes of water indicated shall be reserved solely for the use of the sprinkler system.

Table 9. Minimum water volume for pre-calculated LH and OH systems

Group	Height *h* of the highest sprinkler above the lowest sprinkler (see Note) (m)	Minimum water volume (m^3)
LH (Wet or pre-action)	h ≤ 15	9
	15 ≤ h ≤ 30	10
	30 ≤ h ≤ 45	11
OH1 (Wet or pre-action)	h ≤ 15	55
	15 ≤ h ≤ 30	70
	30 ≤ h ≤ 45	80
OH1 (Dry) OH2 (Wet or pre-action)	h ≤ 15	105
	15 ≤ h ≤ 30	125
	30 ≤ h ≤ 45	140
OH2 (Dry) OH3 (Wet or pre-action)	h ≤ 15	135
	15 ≤ h ≤ 30	160
	30 ≤ h ≤ 45	185
OH3 (Dry) OH4 (Wet or pre-action)	h ≤ 15	160
	15 ≤ h ≤ 30	185
	30 ≤ h ≤ 45	200
OH4 (Dry)	Use HH protection	
NOTE. Sprinklers in the sprinkler valve room should not be considered in calculating the height of the highest sprinkler above the lowest sprinkler.		

Table 10 specifies the minimum volume of water required for pre-calculated HHP or HHS systems. The water volume indicated shall be reserved solely for the use of the sprinkler system.

Table 10. Minimum water volume for pre-calculated HHP and HHS systems

Design density not exceeding (mm/min)	Minimum water volume (m^3)	
	Wet systems	Dry systems
7.5	225	280
10.0	275	345
12.5	350	440
15.0	425	530
17.5	450	560
20.0	575	720
22.5	650	815

Table 10. Minimum water volume for pre-calculated HHP and HHS systems *(continued)*

Design density not exceeding (mm/min)	Minimum water volume (m^3)	
	Wet systems	Dry systems
25.0	725	905
27.5	800	1 000
30.0	875	1 090

8.2.2.3 Calculated systems

The minimum effective water volume shall be calculated by multiplying the maximum demand flow by the duration specified in 7.1.1.

8.2.3 Refill rates for full capacity tanks

The water source shall be capable of refilling the tank in no more than 36 h. The outlet of any feed pipe shall be not less than 2.0 m horizontally from the suction pipe inlet.

8.2.4 Reduced capacity tanks

The following conditions shall be met for reduced capacity tanks and break tanks:

a) the inflow shall be from a town main and shall be automatic, via at least two mechanical float valves. The inflow shall not adversely influence the pump suction;

b) the capacity shall be not less than that stated in Table 11;

c) the tank capacity plus the inflow shall be sufficient to supply the system at full capacity as specified in 8.2.2;

d) it shall be possible to check the capacity of the inflow; and

e) the inflow arrangement shall be accessible for inspection.

Table 11. Minimum capacity of reduced capacity tanks

Hazard class	Minimum capacity (m^3)
LH - Wet or pre-action	5
OH1 - Wet or pre-action	10
OH1 - Dry or alternate OH2 - Wet or pre-action	20
OH2 - Dry or alternate OH3 - Wet or pre-action	30
OH3 - Dry or alternate OH4 - Wet or pre-action	50
HHP and HHS	70 But in no case less than 10 % of the full capacity

8.2.5 Effective capacity of tanks and dimensions of suction chambers

Table 12 specifies minimum dimensions for the following:

a) A from the suction pipe to the low water level (see Figure 4); and

b) B from the suction pipe to the bottom of the sump (see Figure 4).

If a vortex inhibitor is installed with the minimum dimensions specified in Table 12, dimension *A* may be reduced to 0.10 m measured from the top of the vortex inhibitor.

A tank may be provided with a sump in order to maximise the effective capacity (see Figure 4).

8.2.6 Strainers

In the case of pumps under suction lift conditions, a strainer shall be fitted upstream of the foot valve on the pump suction pipe. It shall be fitted so that it can be cleaned without the tank having to be emptied.

NOTE. See 9.6.1.

In the case of open tanks feeding pumps under positive head conditions, a strainer shall be fitted to the suction pipe outside the tank. A stop valve shall be installed between the tank and the strainer.

The surface area of the strainer bucket or mesh shall be at least 1.5 times the nominal area of the pipe and shall not allow objects greater than 5 mm diameter to pass.

Table 12. Suction pipe inlet clearances

Nominal diameter of suction pipe d (mm)	A, min. (m)	B, min. (m)	Minimum width or diameter of vortex inhibitor (m)
65	0.25	0.08	0.20
80	0.31	0.08	0.20
100	0.37	0.10	0.40
150	0.50	0.10	0.60
200	0.62	0.15	0.80
250	0.75	0.20	1.00
300	0.90	0.20	1.20
400	1.05	0.30	1.20
500	1.20	0.35	1.20

8.3 Inexhaustible sources

8.3.1 Settling and suction chambers

8.3.1.1 Where a suction or other pipe draws from a settling or suction chamber fed from an inexhaustible source, the design and dimensions in Figure 5 shall apply, where D is the diameter of the suction pipe, d is the diameter of the inlet pipe and d^1 is the water depth at the weir. Pipes, conduits and the bed of open-topped channels shall have a continuous slope towards the settling or suction chamber of at least 1:125. The diameter of feed pipes or conduit shall not be less than as given in Table 13. For dimensions not included in the table, the following equation shall be used:

$$d^1 \geq 21.68Q^{0.357}$$

The suction chamber dimensions shall be as specified in 8.2.5.

In the case of flowing water the angle between the flow direction and the intake axis (seen in the direction of flow) shall be less than 60°.

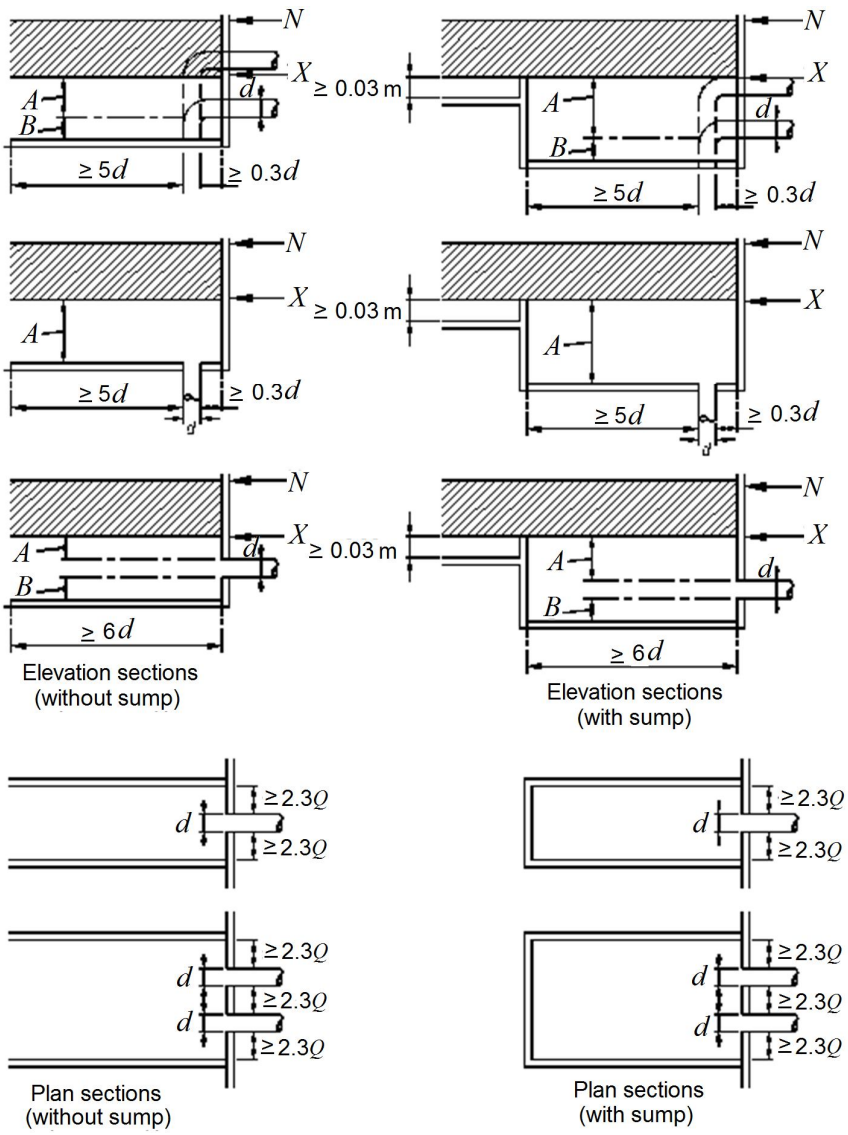
8.3.1.2 The inlet to pipes or conduit shall be submerged at least one nominal pipe diameter below the lowest known water level. The total depth of open channels and weirs shall accommodate the highest known water level of the water source.

The dimension of the suction chamber and the location of suction pipes from the walls of the chamber, the submergence below the lowest known water level and clearance from the bottom shall conform to 8.2.5 and Figures 4 and 5.

The settling chamber shall have the same width and depth as the suction chamber and a length of at least 10*d* where *d* is the minimum bore of the pipe or conduit, and no less than 1.5 m.

The system shall be designed such that the mean water velocity does not exceed 0.2 m/s at any point between the inlet to the settling chamber and the pump suction pipe inlet.

8.3.1.3 The settling chamber, including any screening arrangement, shall be arranged to prevent ingress of wind borne debris and of sunlight.



Key

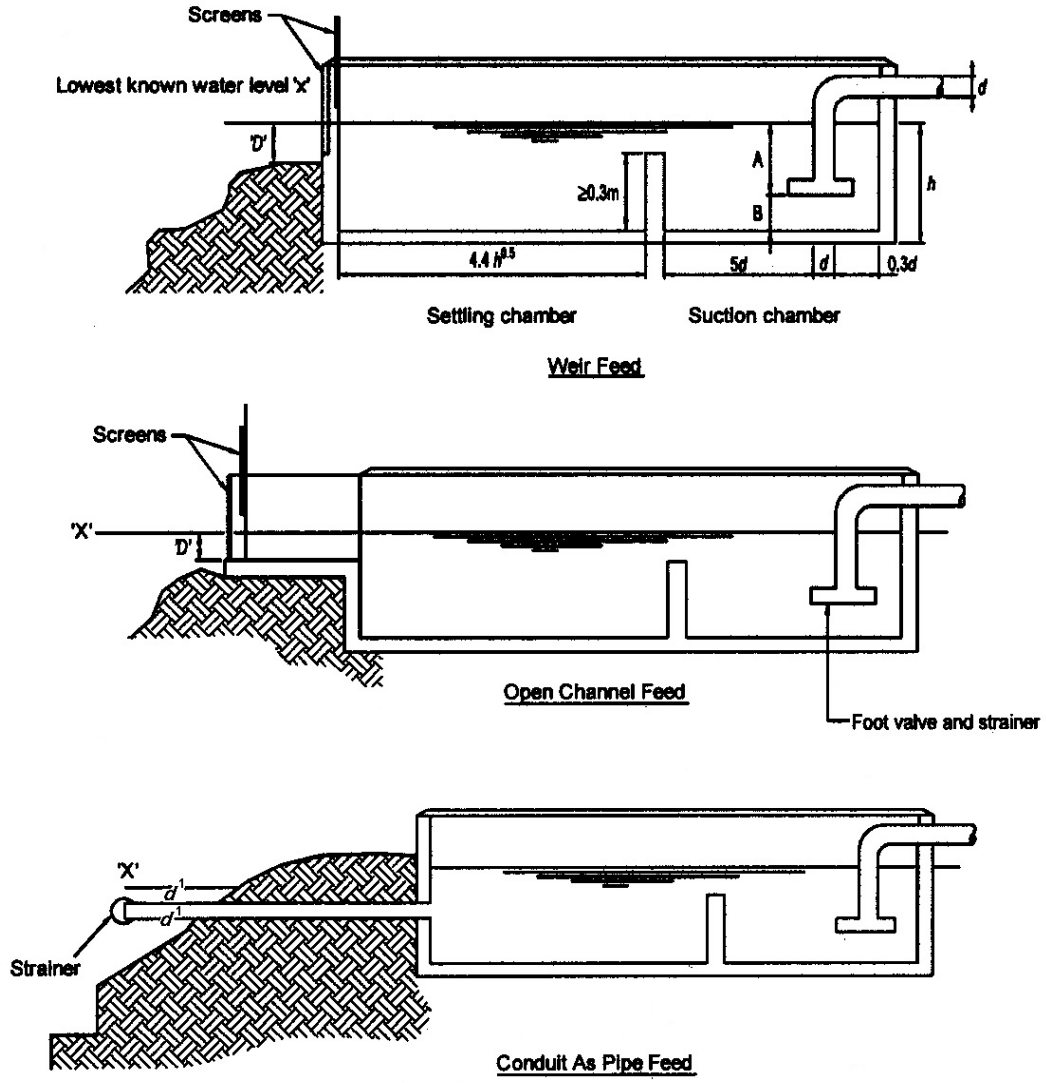
A minimum dimension from the suction pipe to the low minimum dimensions water level

B minimum dimension from the suction pipe to the bottom of the sump

N the normal water level

X the low water level

Figure 4. Effective capacity of suction tanks and dimensions of suction chambers



Key

d suction pipe size

d^1 inlet pipe size

D water depth at weir

Figure 5. Settling and suction chambers

Table 13. Nominal diameter of feed pipes or conduits for settling and suction chambers

Nominal diameter of feed pipes, or minimum dimension of conduits, d[1] (mm)	Maximum flow of pump, Q (L/min)
200	500
250	940
300	1 570
350	2 410
400	3 510
500	6 550
600	10 000

8.3.1.4 Before entering the settling chamber the water shall first pass through a removable screen of wire mesh or perforated metal plate having an aggregate clear area below the water level of 150 mm^2 for each L/min of pump nominal flow in the case of LH or OH or maximum design flow for HHP or HHS.

The screen shall be strong enough to withstand the weight of water should it become obstructed and shall have a mesh not greater than 12.5 mm. Two screens shall be provided, with one in use and the other in a raised position ready for interchange when cleaning is necessary.

8.3.1.5 The inlet to the pipe or conduit feeding the settling chamber or suction pit shall be provided with a strainer having an aggregate clear area of at least five times the cross sectional area of the pipe or conduit. The individual openings shall be of such a size as to prevent the passage of a 25 mm diameter sphere.

8.3.1.6 Where the suction inlet draws from a walled off area of the bed of a river, canal, lake, etc., the wall itself shall be extended above the water surface with an aperture screening arrangement.

Alternatively, the space between the top of the wall and the water surface shall be enclosed with a screen. Screens shall be as specified in 8.3.1.4.

8.3.1.7 Excavation of the bed of the lake etc., to create the necessary depth for a pump suction inlet is not recommended, but if unavoidable the area shall be enclosed with the largest screen practicable, but in any case having sufficient clear area as specified in 8.3.1.4.

8.3.1.8 Duplicate supplies shall be provided with separate suction and settling chambers.

8.4 Choice of water supply

8.4.1 Single water supplies

The following constitute acceptable single water supplies:

a) a gravity tank with no booster pump, or storage tank with two or more automatic pumps, where the tank fulfils the following conditions:

   i) the tank shall be full capacity;

   ii) the tank shall be compartmented in two equal parts or as near equal as permitted by the storage tank configuration;

   iii) there shall be no entry for light or foreign matter;

   iv) potable water shall be used;

   v) the tank shall be painted or given other corrosion protection which reduces the need for emptying the tank for maintenance to periods of no less than 10 years. Generally hot dipped galvanised steel tanks, HDPE lined steel tanks, FRP/GRP tanks or R.C. tanks;

   vi) means shall be provided for balancing the water level between compartments; and

   vii) the tank should be dedicated for fire protection usage only; and

b) an inexhaustible source with two or more automatic pumps.

8.4.2 Duplicate water supplies

Duplicate water supplies shall consist of two single water supplies where each supply is independent of the other. Each of the supplies forming part of a duplicate supply shall conform to the pressure and flow characteristics given in Clause 6. Any combination of single supplies may be used.

8.4.3 Combined water supplies

Combined water supplies shall be single or duplicate water supplies designed to supply more than one fixed firefighting system, as for example in the case of combined hydrant, hose reel and sprinkler installations.

Sprinkler systems may be fed from a combined supply provided the following conditions are fulfilled:

a) the systems shall be fully calculated;

b) the supply shall be capable of supplying the sum of the simultaneous maximum calculated flows from each system. The flows shall be corrected up to the pressure required by the most demanding system;

c) the duration of the supply shall be no less than that required for the most demanding system at the simultaneous maximum calculated flows from each system;

d) other than the above requirements, the pumps and starters, water supplies, installations and fire alarm monitoring requirements shall comply with the requirements of this standard; and

e) all non-sprinkler system connections shall be connected upstream of sprinkler alarm valves.

8.5 Isolation of water supply

The connections between the water sources and sprinkler control valve sets shall be arranged so as to ensure the following:

a) that servicing of main components such as strainers, pumpsets, non-return valves and water meters is facilitated;

b) that any problem occurring to one supply or tank compartment shall not impair the operation of any other source or supply or other tank compartment; and

c) that maintenance can be carried out on one supply or tank compartment without impairing the operation of any other source or supply or tank compartment.

9 Pumps

9.1 General

Pump sets shall be in accordance with MS 2616. The pump shall have a stable pressure/flow curve, i.e. one in which the maximum head and shut-off head are coincidental, and the total head declines continuously with increasing rate of flow.

Pumps shall be driven either by electric motors or diesel engines, capable of providing at least the power required to comply with the following:

a) for pumps with non-overloading power characteristic curves, the maximum power required at the peak of the power curve; and

b) for pumps with rising power characteristic curves, the maximum power for any conditions of pump load, from zero flow to a flow corresponding to a pump net positive suction head (NPSH) required equal to 16 m or maximum suction static head plus 11 m, whichever is greater.

The coupling between the driver and the pump of horizontal pump sets shall be of a type which ensures that either can be removed independently and in such a way that pump internals can be inspected or replaced without affecting suction or discharge piping. End suction pumps shall be of the "back pull-out" type. Pipes shall be supported independently of the pump.

Each sprinkler system installation using pumps, shall be provided with a jockey pump to replenish minor water loss and maintain the static pressure at any check or alarm valve at not less than 1.25 times the static head difference between the valve and the highest sprinkler in the installation. The jockey pump should be provided with a motor sized for the maximum power required at the peak of the entire pump power curve.

9.2 Multiple pump arrangements

Pumps shall have compatible characteristic curves and be capable of operating in parallel at all possible flow rates.

Where two pumps are installed, each one shall be capable independently of providing the specified flows and pressures. Where three pumps are installed, each pump shall be capable of providing at least 50 % of the specified flow at the specified pressure.

Where more than one pump is installed in a single or duplicate water supply, no more than one shall be driven by an electric motor, unless there is a duplicate independent source of power supply available such as a generating set.

9.3 Compartments for pump sets

9.3.1 General

Pump sets shall be housed in a compartment having a fire resistance of no less than 120 min, used for no other purpose than fire protection. In no case shall pump sets be located in areas were flooding may occur. It shall be one of the following (in order of preference):

a) a separate building;

b) a building adjacent to a sprinkler protected building with direct access from outside;

c) a compartment within a sprinkler protected building with direct access from outside; and

d) a compartment within a sprinkler protected building with access from outside via a protected access route.

NOTE. See 7.3.

9.3.2 Sprinkler protection

Compartments for pump sets shall be sprinkler protected. Where the pump compartment is separate, it may be impractical to provide sprinkler protection from the control valve sets in the premises. Sprinkler protection may be provided from the nearest accessible point on the downstream side of the outlet non-return valve of the pump via a subsidiary stop valve secured in the open position, together with a water flow detector in accordance with EN 12259-5, to provide visible and audible indication of the operation of the sprinklers. The alarm equipment shall be installed either at the control valves or at a responsibly manned location such as a guardhouse (see Annex F).

A 15 mm nominal diameter drain and test valve shall be fitted downstream of the flow alarm to permit a practical test of the alarm system.

9.3.3 Temperature

The pump compartment shall be maintained at or above the following temperature:

a) 4 °C for electric motor driven pumps; and

b) 10 °C for diesel engine driven pumps.

9.3.4 Ventilation

Pump compartments for diesel engine driven pumps shall be provided with adequate ventilation in accordance with the supplier's recommendations.

9.4 Maximum temperature of water supply

The water supply temperature shall not exceed 40 °C. Where submersible pumps are utilised, the water temperature shall not exceed 25 °C, unless the suitability of the motor has been proven for temperatures up to 40 °C.

9.5 Valves and accessories

A stop valve shall be fitted in the pump suction pipe unless the maximum water level is lower than the pump. A non-return valve and a stop valve shall be fitted in the delivery pipe of each pump.

Any taper pipe fitted to the pump outlet shall expand in the direction of flow at an angle not exceeding 20°. Valves on the delivery side shall be fitted after any taper pipe.

Means for venting all cavities of the pump casing shall be provided unless the pump is made self-venting by arrangement of its branches.

Arrangements shall be made to ensure a continuous flow of water through the pump sufficient to prevent overheating when it is operating against a closed valve. This flow shall be taken into account in the system hydraulic calculation and pump selection. The outlet shall be clearly visible and where there is more than one pump the outlets shall be separate.

Diesel engine cooling circuits usually use the same water. However, if additional water is used, it shall also be taken into account.

Tappings on the pumps for inlet and outlet pressure gauges shall be easily accessible.

9.6 Suction conditions

9.6.1 General

Wherever possible, horizontal centrifugal pumps shall be used, installed with a positive suction head, i.e. in accordance with the following:

a) at least two thirds of the effective capacity of the suction tank shall be above the level of the pump centre line; and

b) the pump centre line shall be no more than 2.0 m above the low water level of the suction tank (level X in 8.2.5).

If this is not feasible, the pump may be installed under suction lift conditions or vertical turbine pumps may be used.

NOTE. Suction lift and submersible pump arrangements should be avoided and only used when it is not practicable to arrange positive suction head.

9.6.2 Suction pipe

9.6.2.1 General

The pump suction shall be connected to a straight or taper pipe at least two diameters long. The taper pipe shall have a horizontal top side and a maximum included angle not exceeding 20°. Valves shall not be fitted directly to the pump inlet. Where a reducer exceeding 15° taper is installed, the pump suction shall be connected to a straight pipe at least four diameters long downstream of the reducer.

The suction piping, including all valves and fittings, shall be designed in such a way as to ensure that the available net positive suction head (NPSH) at the pump inlet exceeds the required net positive suction head (NPSH) by at least 1.0 m at the maximum pump flow as shown in Table 14.

Table 14. Pump pressure and flow rating

Pipework	Hazard class	Rated pump flow	Pump inlet condition
Pre-calculated	LH/OH	Pressure and flow requirements from Table 6	For tanks, with water supply at low level (see X in Figure 4).
	HH	Pressure and 1.4 x Flow required from Table 7	
Fully calculated	All	Maximum demand flow required for the most favourable area	

Suction piping shall be laid either horizontal or with a continuous slight rise towards the pump to avoid the possibility of air locks forming in the pipe.

A foot valve shall be fitted where the centre line of the pump is above the low water level (see 8.2.5).

9.6.2.2 Positive head

In positive head conditions, the diameter of the suction pipe shall be no less than 65 mm. Furthermore, the diameter shall be such that a velocity of 1.8 m/s is not exceeded when the pump is operating at maximum demand flow.

Where more than one pump is provided, the suction pipes may only be inter-connected if they are fitted with stop valves to allow each pump to continue operating when the other is removed for maintenance. The connections shall be dimensioned as appropriate for the flow rate required.

9.6.2.3 Suction lift

In suction lift conditions, the diameter of the suction pipe shall be no less than 80 mm. Furthermore, the diameter shall be such that a velocity of 1.5 m/s is not exceeded when the pump is operating at maximum demand flow.

Where there is more than one pump set installed, the suction pipes shall not be interconnected.

The height from the low water level to the centre line of the pump shall not exceed 3.2 m (see 8.2.5).

The suction pipe shall be positioned in the tank or reservoir in accordance with Figure 4 and Table 12 or Figure 5 and Table 13, as appropriate. A foot valve shall be fitted at the lowest point on the suction pipe.

Each pump shall have automatic priming arrangements in accordance with 9.6.2.4.

9.6.2.4 Pump priming

Each pump shall be fitted with a separate automatic priming arrangement. The arrangement shall consist of a tank situated at a higher level than the pump and with a pipe connection sloping from the tank to the delivery side of the pump. A non-return valve shall be fitted to this connection. Figure 6 shows two examples.

The tank, the pump and the suction pipework shall be kept constantly full of water even where there is leakage from the foot valve referred to in 9.6.2.3. Should the water level in the tank fall to two-third of the normal level, the pump shall start. The size of the priming tank and the pipe shall be in accordance with Table 15.

9.6.2.5 Pressure maintenance pump

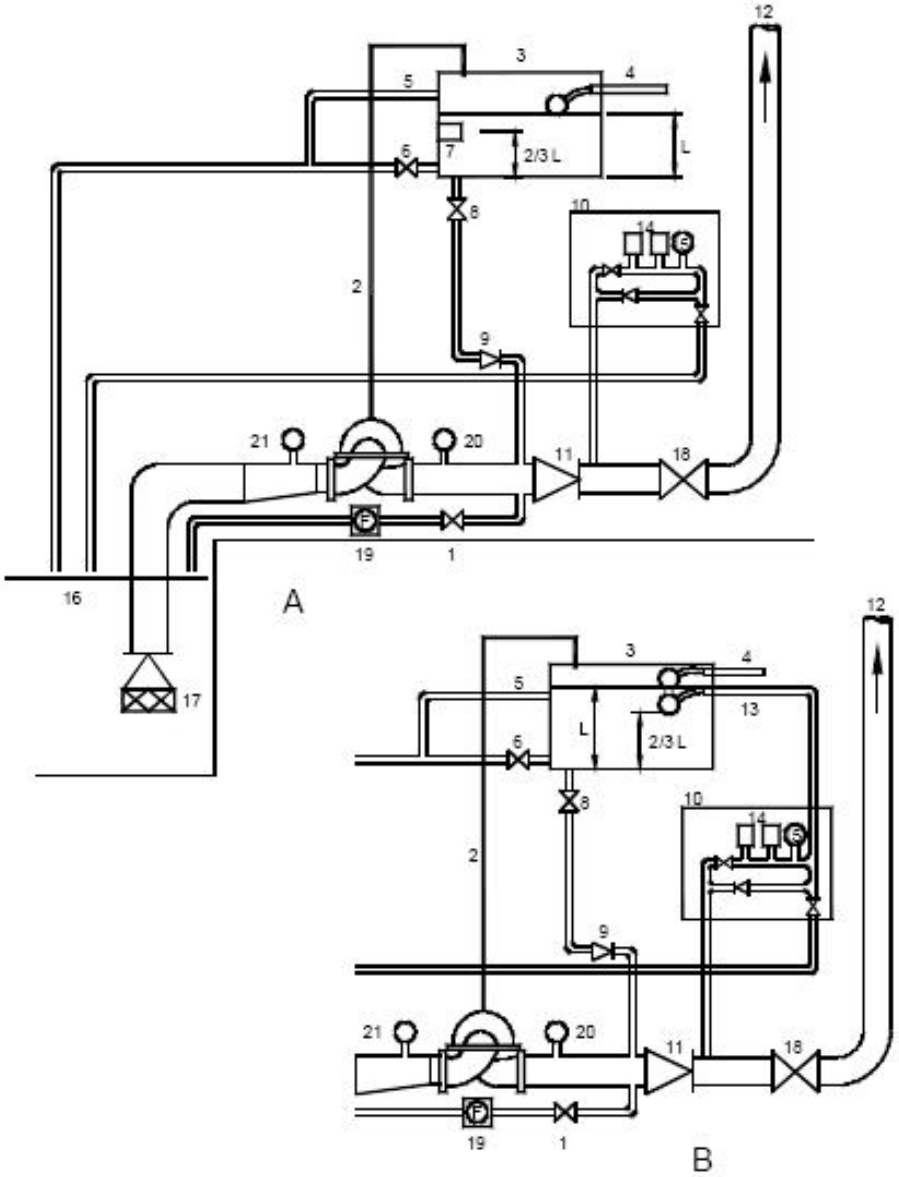
A pressure maintenance pump may be installed to avoid starting one of the main pumps unnecessarily or to maintain the system pressure above control valve sets.

The pressure maintenance pump shall be sized and arranged in such a way that it is not capable of providing enough flow and pressure for a single open sprinkler and thus prevent the main pump(s) from starting.

In the case of pressure maintenance pumps installed with negative suction, the suction piping and fittings shall be independent of those of the main pump(s).

Table 15. Pump priming tank capacity and pipe size

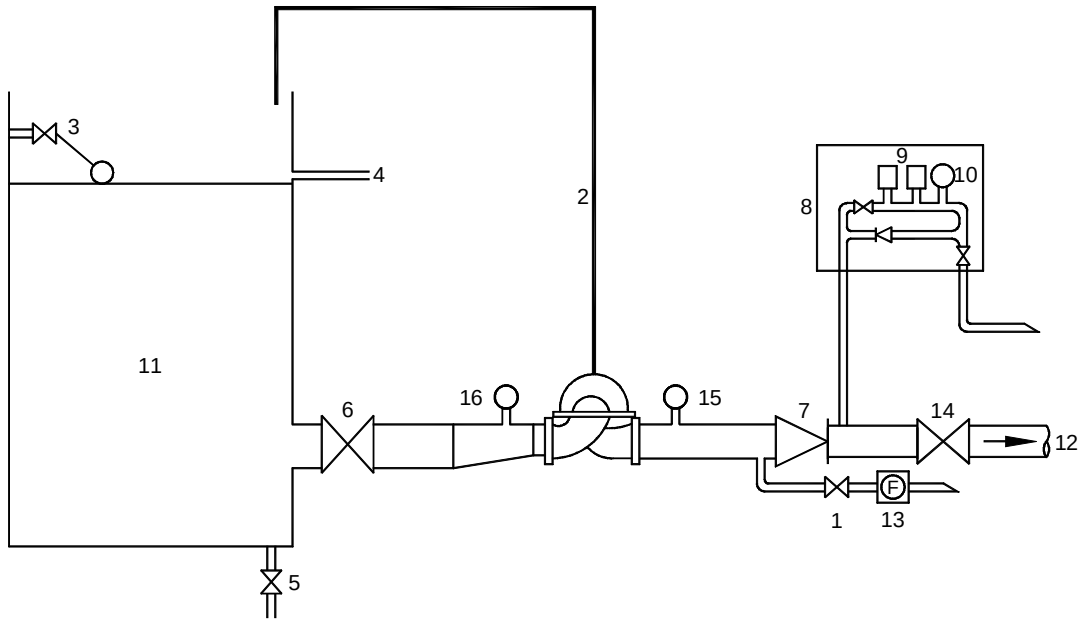
Hazard class	Minimum tank capacity (L)	Minimum diameter of priming pipe (mm)
LH	100	25
OH, HHP, HHS	500	50



Key

1	test drain and valve	12	installation trunk main
2	pump air bleed and min. flowline	13	low level valve for pump starting
3	pump priming tank	14	duplicate pressure switches for pump starting
4	inflow	15	pressure gauge
5	over flow	16	suction tank
6	drain valve	17	foot valve
7	low level switch for pump starting	18	main discharge stop valve
8	priming supply stop valve	19	flowmeter
9	priming non-return valve	20	pump discharge pressure 'A' gauge
10	pump start arrangement	21	pump suction compound pressure gauge
11	discharge non-return valve		

Figure 6. Pump priming arrangement for suction lift



Key

1	test drain and valve	9	duplicate pressure switches for pump starting
2	pump air bleed and min. flow line	10	pressure gauge
3	iInflow	11	suction tank
4	over flow	12	installation trunk main
5	drain valve	13	flow meter
6	suction stop valve	14	main discharge stop valve
7	discharge non-return valve	15	pump discharge pressure ‘A’ gauge
8	pump start arrangement	16	pump suction compound pressure gauge

Figure 7. Pump arrangement for positive suction

9.7 Performance characteristics

9.7.1 Pre-calculated systems - LH and OH

Where the pumps take water from a storage tank, the characteristic of pre-calculated LH and OH systems shall conform to Table 16.

The pressures shown for the pump nominal data in Table 15 shall be measured downstream of the orifice plate at the pump discharge.

In the case of buildings which exceed the heights shown, it shall be proved that the pump characteristics are adequate for supplying the flows and pressures specified in 6.3.1.

Table 16. Minimum pump characteristics for LH and OH (pre-calculated systems)

Hazard class	Sprinkler height *h* above the control valve set(s) (m)	Pump nominal data		Flow characteristic (see Note)			
				Max. demand flow		Design flow	
		Pressure at pump outlet 'A' gauge (bar)	Flow (L/min)	Pressure at 'C' Gauge (bar)	Flow (L/min)	Pressure at 'C' gauge (bar)	Flow (L/min)
LH (Wet or pre-action)	$h \leq 15$	1.5	300	3.7	225	-	-
	$15 < h \leq 30$	1.8	340	5.2	225	-	-
	$30 < h \leq 45$	2.3	375	6.7	225	-	-
OH1 (Wet or pre-action)	$h \leq 15$	1.2	900	2.2	540	2.5	375
	$15 < h \leq 30$	1.9	1 150	3.7	540	4.0	375
	$30 < h \leq 45$	2.7	1 360	5.2	540	5.5	375
OH1 (Dry) OH2 (Wet or pre-action)	$h \leq 15$	1.4	1 750	2.5	1 000	2.9	725
	$15 < h \leq 30$	2.0	2 050	4.0	1 000	4.4	725
	$30 < h \leq 45$	2.6	2 350	5.5	1 000	5.9	725
OH2 (Dry) OH3 (Wet or pre-action)	$h \leq 15$	1.4	2 250	2.9	1 350	3.2	1 100
	$15 < h \leq 30$	2.0	2 700	4.4	1 350	4.7	1 100
	$30 < h \leq 45$	2.5	3 100	5.9	1 350	6.2	1 100
OH3 (Dry) OH4 (Wet or pre-action)	$h \leq 15$	1.9	2 650	3.0	2 100	3.5	1 800
	$15 < h \leq 30$	2.4	3 050	4.5	2 100	5.0	1 800
	$30 < h \leq 45$	3.0	3 350	6.0	2 100	6.5	1 800
NOTE. The flow characteristic pressures shown are as measured at the 'C' gauge of the control valve set(s).							

9.7.2 Pre-calculated systems - HHP and HHS with no in-rack sprinklers

The nominal pump flow and pressure for HHP and HHS pre-calculated systems shall conform to 6.3.2. In addition the pump shall be capable of supplying 140 % of this flow at a pressure of no less than 70 % of the pressure at the design pump flow (see Figure 6).

9.7.3 Calculated systems

The rated duty of the pump shall be a function of the most unfavourable area curve. When measured by the supplier's test facility, the pump shall provide a pressure at least 0.5 bar higher than that required for the most unfavourable area. The pump shall also be capable of providing the flow and pressure of the most favourable area at all water supply water levels (see Figure 8).

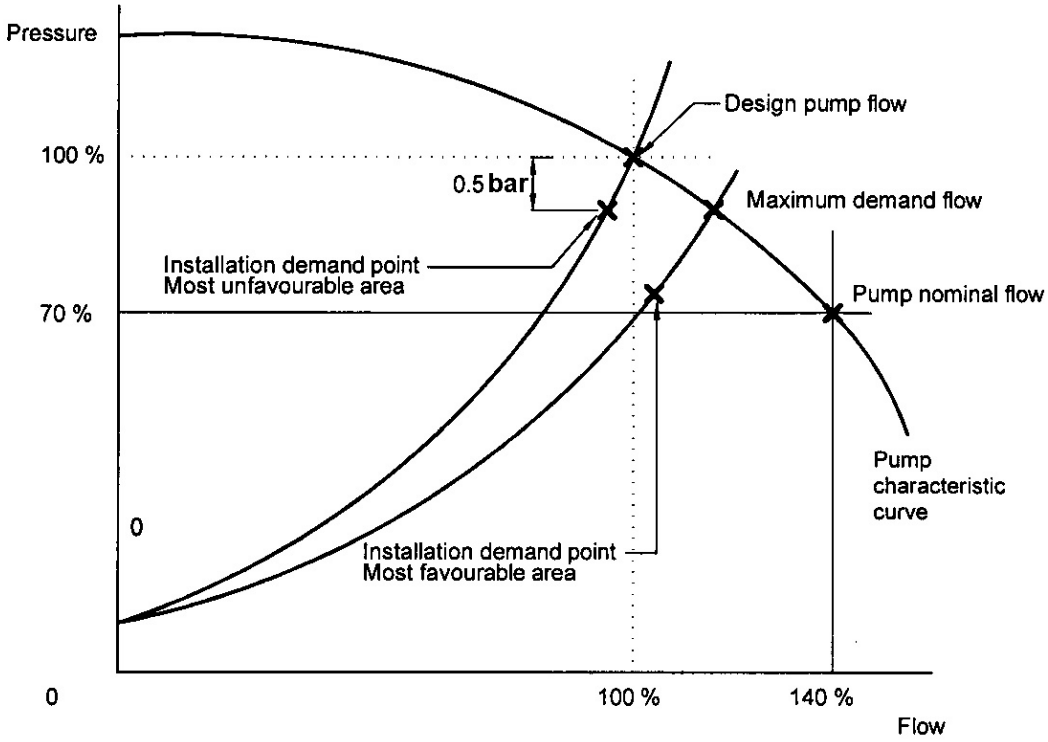


Figure 8. Typical pump curve

9.7.4 Pressure switches

9.7.4.1 Number of pressure switches

Two pressure switches shall be provided to start each pump set. The pipe to the pressure switches shall be at least 15 mm diameter. They shall be connected in such a way that either switch will start the pump.

9.7.4.2 Pump start

The first pump set shall start automatically when the pressure in the trunk main falls to a value of no less than 0.8P, where P is the pressure at the closed valve condition. Where two pump sets are installed, the second pump shall start before the pressure falls to a value of no less than 0.6P. Once the pump has started, it shall continue to run until stopped manually.

9.7.4.3 Testing the pressure switches

Means shall be provided for testing pump starting with each pressure switch. If any isolating valve is installed on the connection between the trunk main and any pump starting pressure switch, a non-return valve shall be installed in parallel with the isolating valve so that a fall in pressure on the trunk main will be transmitted to the pressure switch even when the isolating valve is closed.

9.8 Electrically driven pump sets

9.8.1 General

9.8.1.1 The electric supply system shall be available at all times.

9.8.1.2 Up to date documentation, such as installation drawings, main supply and transformer diagrams and connections for supplying the pump controller panel as well as motor, control alarm circuits and signals shall be kept available in the sprinkler valve or pump compartment.

9.8.2 Electricity supply

The electrical supply schematics for pumps are indicated in Figure 9.

9.8.2.1 The supply to the pump controller shall be solely for use of the sprinkler pump set and separate from all other connections including other fire fighting systems. The fuses or circuit breakers in the pump controller shall be of high rupturing capacity, capable of carrying the start current for a period of no less than 20 s.

9.8.2.2 All cables shall be protected against fire and mechanical damage. To protect cables from direct exposure to fire they shall be run outside the building or through those parts of the building where the fire risk is negligible and which are separated from any significant fire risk by walls, partitions or floors with a fire resistance of no less than 60 min, or they shall be given additional direct protection or be buried. Where this is not possible, cables shall be of fire rated type or mineral insulated fire resistant type with full metal enclosure or armour protection.

9.8.3 Main switchboard

9.8.3.1 The main switchboard for the premises shall be situated in a fire compartment used for no other purpose than for electrical power supplies. The electrical connections in the main switchboard shall be such that the supply to the pump controller is dedicated for the pump controller only. The supply to the pump controller shall not be isolated when isolating other services.

9.8.3.2 Each switch on the dedicated power feed to the sprinkler pump shall be labelled:

SPRINKLER PUMP MOTOR SUPPLY -
NOT TO BE SWITCHED OFF IN THE EVENT OF FIRE

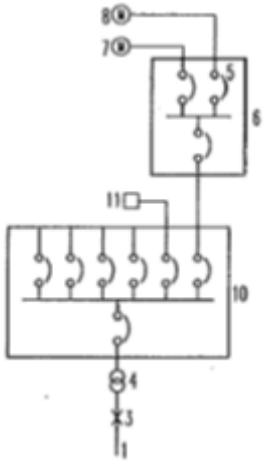
The letters on the notice shall be at least 10 mm high and shall be white on a red background. The switch shall be locked to protect it against tampering.

NOTE. Where there is a standby generator set of sufficient capacity provided, the power supply for the duty and jockey pumps may also be taken from the main generator set supply switchboard, provided that the main generator set supply switchboard is also connected to the incoming mains supply.

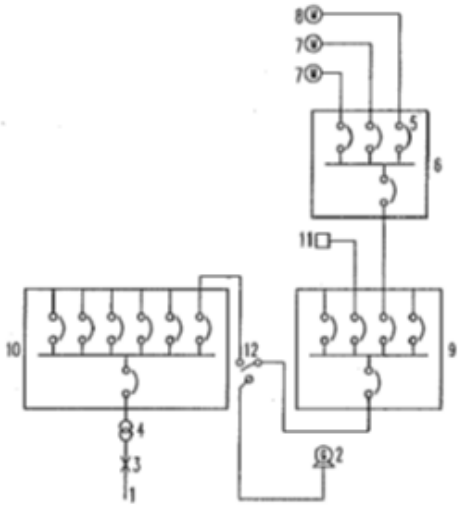
9.8.4 Installation between the main switchboard and the pump controller

The current for calculating the correct dimension for the cable shall be determined by taking 150 % of the largest possible full load current.

Cables between the main switchboard and the pump controller shall be in single lengths, with no joints.



a) Duty sprinkler pump with standby pump (diesel, not shown)



b) Duty and standby pump with mains power and generator set power supply backup

Key

1 mains supply

2 stand by generator

3 transformer isolation means and protection

4 transformer

5 sprinkler pump isolating protective device

6 sprinkler pump controller

7 main sprinkler pump motor

8 sprinkler jockey pump motor

9 essential main switch board-for building services

10 main switch board-for building services

11 sprinkler pump house ancillary equipment (e.g. lighting, fans, battery chargers etc.)

12 change-over switch

Figure 9. Electrical supply schematic for pumps

9.8.5 Pump controller

9.8.5.1 Each pump shall have its own separate and self-contained pump controller with its own power supply cable from the main switchboard.

9.8.5.2 The pump controller shall be able:

a) to start the motor automatically on receiving a signal from the pressure switches;

b) to start the motor on manual actuation; and

c) to stop the motor by manual actuation only.

The controller shall be equipped with an ammeter. In the case of submersible pumps a plate with its characteristics shall be affixed to the pump controller.

Jockey pumps shall be started automatically and stopped automatically by a pressure switch after a 30 s run-on period.

9.8.5.3 Except in the case of submersible pumps, the pump controller shall be situated in the same compartment as the electric motor and pump.

9.8.5.4 Contacts shall comply with utilisation category AC-3 of MS IEC 60947-1 and MS IEC 60947-4-1.

9.8.5.5 Overload relays shall not be provided for the duty or standby pumps.

9.8.6 Monitoring of pump operation

9.8.6.1 The following conditions shall be monitored (see Annex F):

a) power available to the motor and, where AC, on all three phases;

b) pump on demand (automatic mode on);

c) pump running; and

d) start failure.

9.8.6.2 All monitored conditions shall be visually indicated individually in the pump room. They shall also be visually indicated at the main fire alarm panel. Pump running and fault alarms shall also be audibly and visually indicated at location permanently attended by responsible person.

9.8.6.3 The visual fault indication shall be yellow. The audible signals shall have a signal strength of at least 75 dB and shall be able to be silenced.

9.8.6.4 A lamp test for checking the signal lamps shall be provided.

9.9 Diesel engine driven pump sets

9.9.1 General

The diesel engine shall be capable of operating continuously for 6 h at full load at site elevation with a rated continuous power output in accordance with ISO 3046-1. The pump shall be fully operational within 15 s of the beginning of any starting sequence.

Horizontal pumps shall have a direct drive.

The automatic start and operation of the pump set shall not depend on any energy sources other than the engine and its batteries.

9.9.2 Engines

The engine shall be capable of starting at an engine room temperature of 5 °C. It shall be provided with a governor to control the engine speed to ± 5 % of its rated speed under normal load conditions i.e. from stall condition to pump nominal flow rating, and be constructed so that any mechanical device fitted to the engine which could prevent the engine starting automatically, will return to the starting position.

9.9.3 Cooling system

The cooling systems shall be one of the following types:

a) Cooling by water from the sprinkler pump directly into the engine-cylinder jackets, via a pressure reducing device if necessary, in accordance with the supplier's specification. The outlet pipe shall be open so that the discharge water is visible.

b) A heat exchanger, where the water is taken from the sprinkler pump, via a pressure reducing device if necessary, in accordance with the supplier's specification. The outlet pipe shall be open so that the discharge water is visible. An auxiliary pump driven by the engine shall circulate the water in the closed circuit. If the auxiliary pump is belt driven, there shall be multiple belts such that even if up to half the belts are broken, the remaining belt(s) are able to drive the pump. The capacity of the closed circuit shall conform to the value specified by the engine supplier.

c) An air cooled radiator with a fan multiple belt driven from the engine. If one of the belts should break, the remaining belts shall be capable of driving the fan. An auxiliary pump driven by the engine shall circulate the water in the closed circuit. If the auxiliary pump is belt driven, there shall be multiple belts such that even if one of the belts is broken, the remaining belts are able to drive the pump. The capacity of the closed circuit shall conform to the value specified by the engine supplier.

d) Direct air cooling of the engine by means of a multiple belt driven fan. When one of the belts is broken, the remaining belts shall be capable of driving the fan.

9.9.4 Air filtration

The engine air intake shall be fitted with a suitable filter.

9.9.5 Exhaust system

The exhaust pipe shall be fitted with a suitable silencer and the total back pressure shall not exceed the supplier's recommendation.

Where the exhaust pipe is higher than the engine, means shall be provided to prevent any condensate flowing back to the engine. The exhaust pipe shall be positioned in such a way as to prevent exhaust gases from re-entering the pump room. It shall be insulated and installed so that it does not cause a fire ignition risk.

9.9.6 Fuel, fuel tank and fuel feed pipes

The quality of the diesel fuel used shall conform to the supplier's recommendations. The fuel tank shall contain sufficient fuel to enable the engine to run on full load for:

a) 3 h for LH;

b) 4 h for OH; and

c) 6 h for HHP and HHS.

The fuel tank shall be of welded steel. Where there is more than one engine, there shall be a separate fuel tank and fuel feed pipe for each one.

The fuel tank shall be fixed at a higher level than the motor’s fuel pump to ensure a positive head, but not directly above the engine. The fuel tank shall have a sturdy fuel level gauge.

Any valves in the fuel feed pipe between the fuel tank and the engines shall be placed adjacent to the tank, have an indicator and be locked in the open position. Pipe joints shall not be soldered. Metallic pipes shall be used for fuel lines.

The feed pipe shall be situated at least 20 mm above the bottom of the fuel tank. A drain valve of at least 20 mm diameter shall be fitted to the base of the tank.

Galvanised material shall not be used for the fuel tank or for the fuel lines.

NOTE. The fuel tank vent should be terminated outside the building.

9.9.7 Starting mechanism

9.9.7.1 General

Automatic and manual starting systems shall be provided and shall be independent except that the starter motor and batteries may be common to the two systems.

It shall be possible to start the diesel engine both automatically, upon receipt of a signal from the pressure switches, and manually by means of a push button on the pump controller. It shall be possible to shut down the diesel engine only manually; engine monitoring devices shall not cause the engine to stop. The rated voltage of the batteries and starter motor shall be no less than 12 V.

Each set of batteries shall be designed to allow for 10 attempts of not less than 10 s cranking and not more than 10 s pause. This is to allow for the deterioration in battery condition over the useful life of the battery.

9.9.7.2 Automatic starting system

The automatic starting sequence shall make six attempts to start the engine, each one of not less than 10 s duration, with a maximum pause of 10 s between each attempt. The starting device shall reset itself automatically. It shall function independently of the line power supply. The system shall switch over automatically to the other battery after each starting attempt. The control voltage shall be drawn from both batteries simultaneously. Facilities shall be provided to prevent one battery having an adverse effect on the other.

In the event that one battery becomes inoperative or is missing, the system shall lock-in onto the remaining battery for the remainder of the automatic starting sequence. If the engine has not started upon the completion of the automatic starting sequence, the starting system shall cease all further cranking and operate a visible indicator to indicate failure to start.

9.9.7.3 Emergency manual starting system

Emergency manual start facilities, with starting power available from both batteries, shall be provided. Facilities shall be provided to prevent one battery having an adverse effect on the other e.g. independent manual crank pushbuttons, each having control over one bank.

There shall be a manually operated switch on the starting system that, when manually activated, will prevent the starting system from being operated via automatic means. Failure of any automatic starting circuits shall not affect manual operation.

9.9.7.4 Starter motor

The electric starter motor shall incorporate a moveable pinion, which engages automatically with the flywheel gear rim. To avoid shock loading, the system shall not apply full power to the starting motor until the pinion is fully engaged. The pinion shall not be ejected from engagement by spasmodic engine firing. There shall be a means to prevent attempted engagement when the engine is rotating.

The starter motor shall cease to operate and shall return to the rest position if the pinion fails to engage with the flywheel gear ring. After the first failure to engage, the starter motor shall automatically make up to five further attempts to achieve engagement.

When the engine starts the starter motor pinion shall withdraw from the flywheel gear ring automatically by means of a speed sensor. Flexible drives shall not be used for speed sensors. Pressure switches, for example on the engine lubrication system or water pump outlet, shall not be used as a means of de-energising the starter motor.

9.9.8 Electric starter motor batteries

Two separate battery power supplies shall be provided and shall be used for no other purpose. Batteries shall be either open nickel-cadmium prismatic rechargeable cells complying with EN 60623 or lead-acid positive batteries complying with the EN 60095-1. The electrolyte for lead acid batteries shall comply with the EN 60095-1.

Batteries shall be selected, used, charged and maintained in accordance with the requirements of this standard and with the supplier's instructions (see 9.9.7.1). A hydrometer, suitable for checking the density of the electrolyte, shall be provided.

9.9.9 Battery chargers

Each starter battery shall be provided with an independent, continuously connected, fully automatic, constant potential charger, as specified by the supplier. It shall be possible to remove either charger while leaving the other operational.

NOTES:

1. Chargers for lead acid batteries should provide a float voltage of (2.25 ± 0.05) V per cell. The nominal charging voltage should be suitable for local conditions (climate, regular maintenance, etc.). A boost charge facility should be provided for charging to a higher voltage not exceeding 27 V per cell. The charger output should be between 3.5 % and 7.5 % of the 10 h capacity of the battery.

2. Chargers for open nickel-cadmium prismatic batteries should provide a float voltage of (1.445 ± 0.025) V per cell. The nominal charging voltage should be suitable for local conditions (climate, regular maintenance, etc.). A boost charge facility should be provided for charging to a higher voltage not exceeding 1.75 V per cell. The charger output should be between 25 % and 167 % of the 5 h capacity of the battery.

9.9.10 Siting of batteries and chargers

Batteries shall be mounted on stands.

The chargers may be mounted with the batteries. Batteries and chargers shall be located in readily accessible positions where the likelihood of contamination by oil fuel, damp, pumpset cooling water, or of damage by vibration is minimal. The battery shall be as close as possible to the engine starter motor, subject to the above constraints, in order to minimise voltage drop between the battery and starter motor terminal.

9.9.11 Starter alarm indication

The following conditions shall each be indicated both locally and at the main fire alarm panel (see Annex F):

a) the use of any switch which prevents the engine starting automatically;

b) the failure of the engine to start after the six attempts;

c) pump running; and

d) diesel controller fault.

The warning lights shall be appropriately marked.

9.9.12 Tools and spare parts

A standard kit of tools as recommended by the engine and pump suppliers shall be provided together with the following spare parts:

a) two sets of fuel filter elements and seals;

b) two sets of lubrication oil filter elements and seals;

c) two sets of belts (where used);

d) one complete set of engine joints, gaskets and hoses; and

e) two injector nozzles.

9.9.13 Engine tests and exercising

9.9.13.1 Supplier's test and certification of results

Each complete engine and pump set shall be tested by the supplier for no less than 1.5 h at the rated flow. The following shall be recorded on the test certificate:

a) the engine speed with the pump churning;

b) the engine speed with the pump delivering water at the rated flow;

c) the pump churning pressure;

d) the suction head at the pump inlet;

e) the pump outlet pressure at the rated flow downstream of any outlet orifice plate;

f) the ambient temperature;

g) the cooling water temperature rise at the end of the 1.5 h run;

h) the cooling water flow rate;

i) the lubrication oil temperature rise at the end of the test run; and

j) where the engine is fitted with a heat exchanger the initial temperature and the temperature rise of the engine closed circuit cooling water.

9.9.13.2 Site commissioning test

When commissioning an installation the automatic starting system of the diesel engine shall be activated with the fuel supply isolated for the six cycles each of no less than 15 s cranking and no more than 15 s or less than 10 s rest. After completion of the six starting cycles the fail to start alarm shall operate. The fuel supply shall than be restored and the engine shall start when the manual start test button is operated.

NOTE. Start duration is different from auto-start sequence of 6 sets of 10 s crank and 10 s pauses.

10 Installation type and size

10.1 Wet pipe installations

10.1.1 General

Except where covered by 10.1.2, wet pipe installations are permanently charged with water under pressure. Wet pipe installations shall be installed only in premises where there is no possibility of frost damage to the installation, and where the ambient temperature will not exceed 95 °C. Only wet pipe installations shall be used for grid and loop systems.

10.1.2 Protection against freezing

Parts of the installation subject to freezing may be protected by anti-freeze liquid or electrical trace heating or subsidiary dry pipe extensions (see 10.4).

10.1.2.1 Protection by anti-freeze liquid

The number of sprinklers in any one section of piping protected by anti-freeze liquid shall not exceed 20. Where more than two anti-freeze sections are controlled by one control valve set, the total number of sprinklers in the anti-freeze sections shall not exceed 100. The anti-freeze solution shall have a freezing point below the expected minimum temperature for the locality. The specific gravity of the prepared solution shall be checked using a suitable hydrometer. Systems which rely on anti-freeze liquid shall be fitted with backflow prevention devices to prevent contamination of the water.

10.1.2.2 Protection by electrical trace heating

The trace heating system shall be monitored for power supply failure and failure of the heating element(s) or sensor(s) (see Annex F). The piping shall be provided with insulation.

Duplicate heating elements shall be provided over the unheated pipework. Each of the two elements shall be capable of maintaining the pipework at the minimum temperature of not less than 4 °C. Each trace heating circuit shall be electrically monitored and switched by separate circuits. Trace heating tape shall not crossover other lengths of trace heating tape. Trace heating tape shall be affixed on the other side of the pipe to the sprinkler heads. Trace heating tape shall terminate within 25 mm from the pipe ends. All trace heated pipework shall be lagged insulating material of not less than 25 mm thick with a water resistant covering. All ends shall be sealed to prevent ingress of water. Trace heating tape shall have a maximum rating of 10 W/m.

10.1.3 Size of installations

The maximum area controlled by a single wet alarm valve, including any sprinklers in a subsidiary extension, shall not exceed that shown in Table 17.

Table 17. Maximum number of sprinklers in wet pipe and pre-action installations

Hazard class	Maximum protected area per valve set (m^2) (see Note)
LH	10 000
OH, including any LH sprinklers	12 000 except as allowed in Annexes G and H.
HH, including any OH and LH sprinklers	9 000
NOTE. Not including sprinklers in concealed spaces or machines.	

10.2 Dry pipe installations

10.2.1 General

Dry pipe installations are normally charged with air or inert gas under pressure downstream of the dry alarm valve and water under pressure upstream of the dry alarm valve.

A permanent air/inert gas supply to maintain the pressure in the pipework shall be installed. The installation shall be pressurised to fall within the pressure range recommended by the alarm valve supplier.

Dry pipe installations shall be installed only where there is a possibility of frost damage or the temperature exceeds 70 °C, e.g. in drying ovens.

10.2.2 Size of installations

The net volume of the pipework downstream of the control valve set shall not exceed that shown in Table 18, unless a calculation and test shows that the maximum time between a sprinkler opening and water discharging is less than 60 s. The test shall be carried out using the remote test valve specified in 14.5.2.

NOTE. It is strongly recommended that dry installations should not be used for HHS applications, since the delay in water reaching the first operating sprinklers could seriously impair the effectiveness of the system.

Table 18. Maximum size per installation - dry and alternate installations

Installation type	Maximum volume of pipework (m^3)	
	LH and OH	HH
Without accelerator or exhauster	1.5	-
With accelerator or exhauster	4.0	3.0

10.3 Pre-action installations

10.3.1 General

Pre-action installations shall be one of the following types.

10.3.1.1 Type A pre-action installation

This is an otherwise normal dry pipe installation in which the control valve set is activated by an automatic fire detection system but not by the operation of the sprinklers. The air/inert gas pressure in the installation shall be monitored at all times (see Annex F). At least one quick opening manually operated valve shall be installed in an appropriate position to enable the pre-action valve to be activated in an emergency.

NOTE. Type A pre-action installations should only be installed in areas where considerable damage could occur if there was an accidental discharge of water.

10.3.1.2 Type B pre-action installation

This is an otherwise normal dry pipe installation in which the control valve set is activated either by an automatic fire detection system or by the operation of the sprinklers. Independently of the response of the detectors a pressure drop in the pipework causes the opening of the alarm valve.

Type B pre-action installations may be installed wherever a dry pipe system is called for and the spread of fire is expected to be rapid. They may also be used instead of ordinary dry pipe systems with or without an accelerator or exhauster.

10.3.1.3 Sprinkler systems with more than one pre-action installation

Where a sprinkler system includes more than one pre-action sprinkler installation, a risk assessment shall be undertaken to establish whether simultaneous operation of more than one pre-action installation could occur. Where simultaneous charging of pre-action sprinkler installations may occur the following shall be implemented:

a) the volume of stored water supplies shall be increased by the volume of the total pre-action installations; and

b) the time between multiple pre-action installations tripping and water discharging from any remote test valve on the installations under consideration shall not exceed 60 s.

10.3.2 Automatic detection system

The detection system shall be installed in all rooms and compartments protected by the pre-action sprinkler system and shall comply with the relevant parts of MS 1745 or, in their absence, with appropriate specifications valid in the place of use of the sprinkler system.

10.3.3 Size of installations

The number of sprinklers controlled by a pre-action alarm valve shall not exceed that shown in Table 17.

10.4 Subsidiary dry pipe extension

10.4.1 General

Subsidiary dry pipe extensions shall conform to 10.2 except that they will be of limited extent and form extensions to normal wet installations.

They shall be installed only as follows:

a) as a dry pipe extension to a wet pipe installation in small areas where there is a water leak will result in unacceptable damages to sensitive areas of a building such as computer rooms, archives, etc.; and

b) as a dry pipe extension to a wet pipe installation in cold stores and high temperature ovens or stoves.

10.4.2 Size of subsidiary extensions

The number of sprinklers in any subsidiary extension shall not exceed 100. Where more than two subsidiary extensions are controlled by one control valve set, the total number of sprinklers in the subsidiary extensions shall not exceed 250.

10.5 Subsidiary water spray extension

These extensions utilise open sprinklers or sprayers connected to a sprinkler installation via their own actuation valve (deluge valve or multiple control).

Water spray extensions may be connected to a sprinkler installation, provided that the connection is no greater than 80 mm and that the additional water demand is taken into consideration when designing the water supplies (see Clause 7).

These installations are installed where there are expected to be intensive fires with a very fast rate of fire spread and where it is desirable to apply water over a complete area in which a fire may originate and spread.

11 Spacing and location of sprinklers

11.1 General

11.1.1 All measurements of sprinkler spacing shall be taken in the horizontal plane except where otherwise specified.

11.1.2 A clear space shall be maintained below the deflector of roof and ceiling sprinklers of at least:

a) for LH and OH:

   i) 0.3 m for flat spray sprinklers; and

   ii) 0.5 m in all other cases; and

b) for HHP and HHS:

   i) 1.0 m.

11.1.3 Sprinklers shall be installed as specified by the supplier.

Except when dry pendent pattern sprinklers are used, sprinklers on dry pipe and pre-action installations shall be upright. Upright sprinklers shall be fitted with yoke arms parallel to the pipe.

NOTES:

1. Upright sprinklers may be less prone to mechanical damage and collection of foreign matter in the sprinkler fittings. Sprinklers in the upright orientation also facilitate complete drainage of water from the sprinkler waterways.

2. Pendent sprinklers have the potential to deliver greater densities of water at a higher velocity, immediately below and adjacent to the sprinkler axis, consequently pendent sprinklers may have better fire control abilities for some applications such as in-rack protection and protection of storage areas.

11.2 Maximum area of coverage per sprinkler

The maximum area of coverage per sprinkler shall be determined in accordance with Table 19 for sprinklers other than sidewall sprinklers and in Table 20 for sidewall sprinklers.

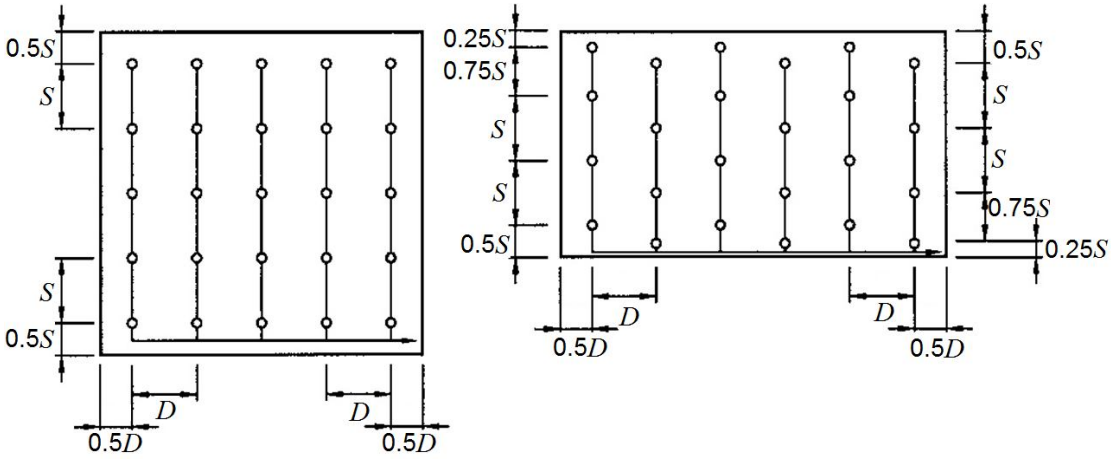
The sprinkler deflectors shall be located between 0.1 m and 0.15 m below the ceiling and between 0.05 m and 0.15 m horizontally from the wall.

There shall be no obstruction at the ceiling within a square extending along the wall 1.0 m on each side of the sprinkler and 1.8 m perpendicular to the wall.

NOTE. Examples are given in Figure 10 where dimensions S and D are the distance between sprinklers in opposing planes.

Table 19. Maximum coverage and spacing for sprinklers other than sidewall

Hazard class	Maximum area per sprinkler (m²)	Maximum distances as shown in Figure 10 (m)		
		Standard layout *S* and *D*	Staggered layout	
			S	*D*
LH	21.0	4.6	4.6	4.6
OH	12.0	4.0	4.6	4.0
HHP and HHS	9.0	3.7	3.7	3.7



Key

S spacing between sprinklers along range pipes

D spacing between range pipes

Figure 10. Ceiling sprinkler spacing

Table 20. Maximum coverage and spacing for sidewall sprinklers

Hazard class	Maximum area per sprinkler (m^2)	Spacing along walls		Room width, w (m)	Room length, l (m)	Rows of sidewall sprinklers	Spacing pattern (horizontal plane)
		Between sprinklers (m)	Sprinklers to end of wall (m)				
LH	17.0	4.6	2.3	$w \leq 3.7$	any	1	single line
				$3.7 < w \leq 7.4$	≤ 9.2	2	standard
					> 9.2	2	staggered
				$w > 7.4$	any	2 (see Note 1)	standard
OH	9.0	3.4 (see Note 2)	1.8	$w \leq 3.7$	any	1	single line
				$3.7 < w \leq 7.4$	< 6.8	2	standard
					> 6.8	2	staggered
				$w > 7.4$	any	2	standard (see Note 1)

NOTES:

1. An additional row or rows of roof or ceiling sprinklers is required.
2. This may be increased to 3.7 m provided the ceiling has a fire resistance of no less than 120 min.
3. The sprinkler deflectors should be located between 0.1 m and 0.15 m below the ceiling and between 0.05 m and 0.15 m horizontally from the wall.
4. There should be no obstruction at the ceiling within a square extending along the wall 1.0 m on each side of the sprinkler and 1.8m perpendicular to the wall.

11.3 Minimum distance between sprinklers

Sprinklers shall not be installed at intervals of less than 2.0 m except in the following cases:

a) where arrangements are made to prevent adjacent sprinklers from wetting each other. This may be achieved by using baffles of approximately 200 mm x 150 mm, or by using intervening constructional features;

b) intermediate sprinklers in racks; and

c) escalators and stairwells (see 11.4.11).

11.4 Location of sprinklers in relation to building construction

11.4.1 The maximum distance from walls and partitions to the sprinklers shall be the smallest appropriate value of the following:

a) 2.0 m for standard spacing;

b) 2.3 m for staggered spacing;

c) 1.5 m where the ceiling or roof is open-joisted or the rafters are exposed;

d) 1.5 m from the open face of open-faced buildings;

e) 1.5 m where the walls are of combustible material or with combustible linings or insulating materials;

f) 1.5 m where the external walls are of metal, with or without combustible linings or insulating materials; and

g) half the maximum distance given in Tables 19 and 20.

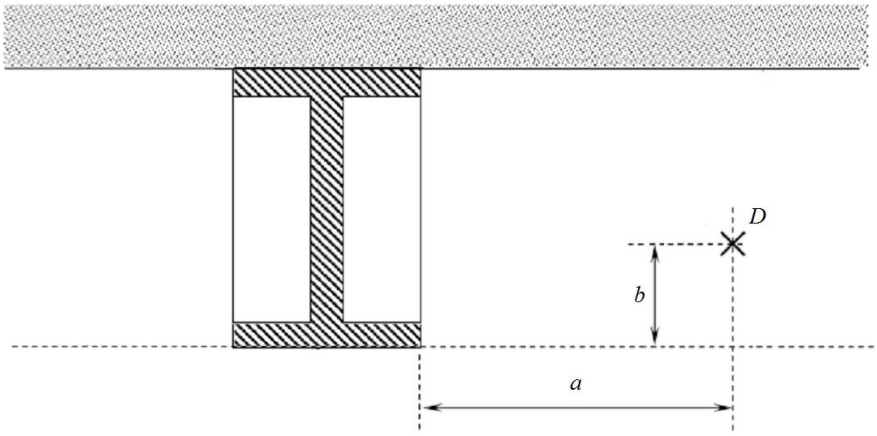
11.4.2 Sprinklers shall be installed not lower than 0.3 m below the underside of combustible ceilings or 0.45 m below non-combustible roofs or ceilings. Where possible, sprinklers shall be situated with the deflector between 0.075 m and 0.15 m below the ceiling or roof except when ceiling, flush or recessed sprinklers are used. Where circumstances make it unavoidable to use the maximum distances of 0.3 m and 0.45 m, the area involved shall be as small as possible.

11.4.3 Sprinklers shall be installed with their deflectors parallel to the slope of the roof or ceiling. Where the slope is greater than 30° to the horizontal plane, a row of sprinklers shall be fixed at the apex or not more than 0.75 m radially from it.

11.4.4 The distance from the edge of a canopy to the nearest sprinklers shall not exceed 1.5 m.

11.4.5 Skylights with a volume greater than 1.0 m³ measured above the normal ceiling level shall be sprinkler protected unless the distance from the normal ceiling level to the top of the skylight does not exceed 0.3 m, or there is a tightly fitting frame and glass fitted level with the roof or ceiling.

11.4.6 Beams and similar obstructions



Key

D deflector

a distance from beam

b distance from beam

Figure 11. Sprinkler location relative to beams

When the deflector (at D in Figure 11) is positioned above the level of the underside of beams or joists or similar structural members, one of the following solutions shall be adopted in order to ensure that effective discharge of the sprinklers is not impaired:

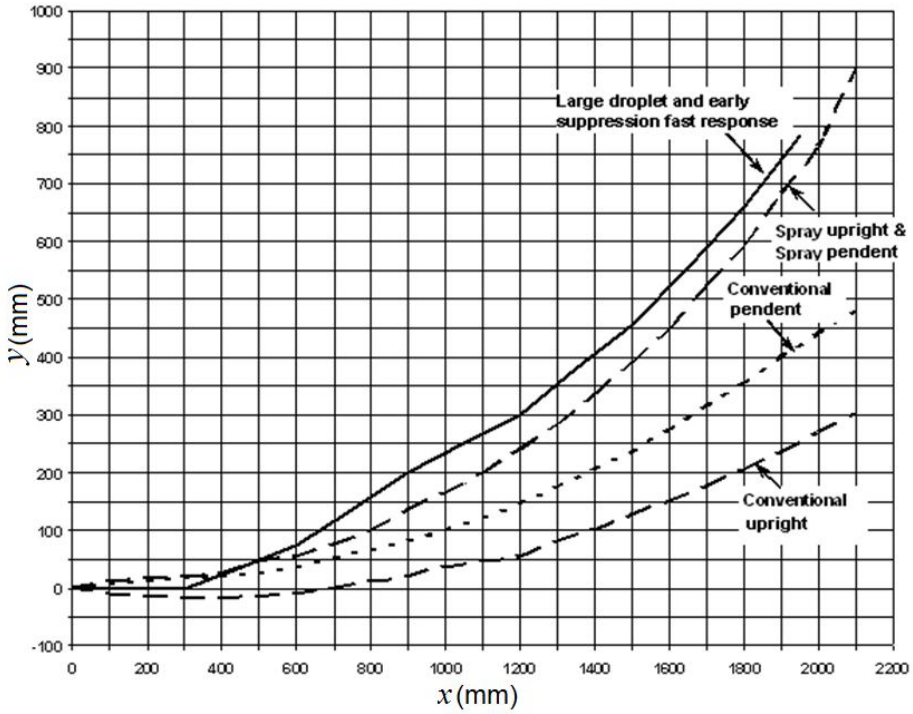
a) the dimensions shown in Figure 11 shall conform to the values specified in Figure 12;

b) the spacing requirements of 11.4.7 shall be applied; and

c) the sprinklers shall be installed on either side as though it were a wall.

Sprinklers shall be positioned directly above girders or beams no wider than 0.2 m at a vertical distance of not less than 0.15 m.

In all cases, the ceiling clearances specified in 11.4.2 are applicable. If none of the above solutions is feasible, e.g. because it results in a large number of sprinklers, the beams may be under drawn and sprinklers installed underneath the flat ceiling thus formed.



Key

x minimum horizontal distance (a) from beam to sprinkler, in mm

y height of deflector (b) above (+) or below (-) beam, in mm

Figure 12. Distance of sprinkler deflector from beams

11.4.7 Beams and bays

Where narrow bays are formed between beams spaced at not more than 1.5 m between centres, the following spacing shall be used:

a) one row of sprinklers shall be installed in the centre of each third bay, with another row underneath the centre line of the beam separating the two unprotected bays (see Figures 13 and 14);

b) the maximum distance between sprinklers in the other direction, i.e. along the bay, (*S* in Figures 13 and 14), shall be in accordance with the rules for the hazard class involved (see 11.2);

c) sprinklers shall be installed at a distance no greater than 1.0 m from walls parallel to the beams and no greater than 1.5 m from walls perpendicular to the beams; and

d) sprinklers installed inside bays shall be placed such that the deflectors are between 0.075 m and 0.15 m below the underside of the ceiling.

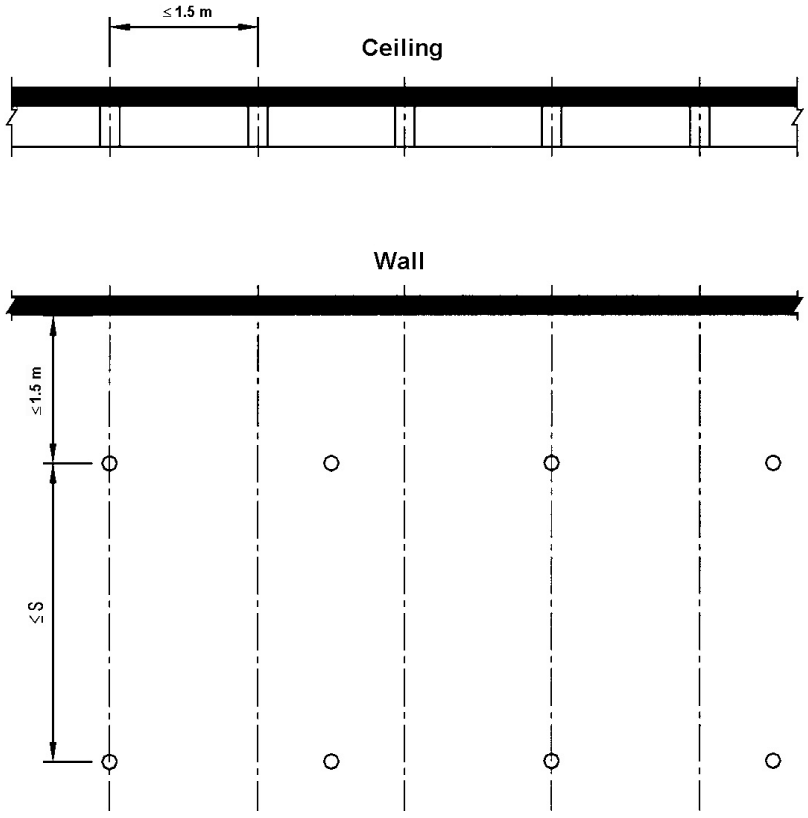


Figure 13. Beam and bay spacing (beams in one direction only)

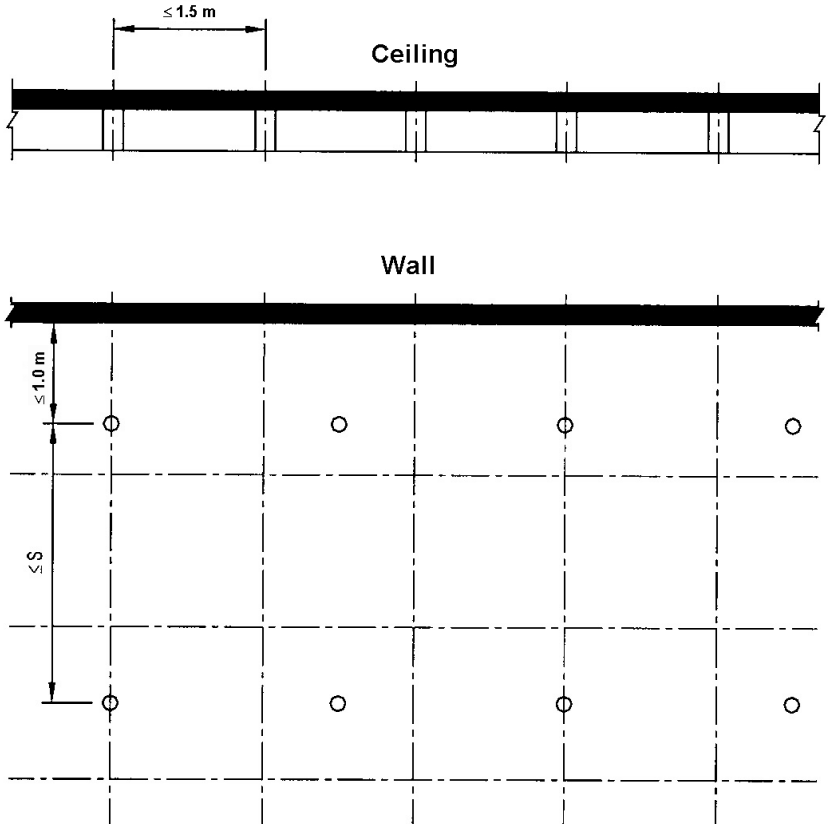


Figure 14. Beam and bay spacing (beams in both directions)

11.4.8 Roof trusses

Sprinklers shall be installed in accordance with one of the following:

a) directly above or below the truss where the flange of the truss is no more than 0.2 m wide;

b) not less than 0.3 m laterally from truss members where the flange of the truss is not more than 0.1 m wide; and

c) not less than 0.6 m laterally from truss members where the flange of the truss is greater than 0.1 m wide.

11.4.9 Columns

If roof or ceiling sprinklers are installed closer than 0.6 m to one side of a column, another sprinkler shall be installed on the opposite side of the column within 2.0 m of the column.

11.4.10 Platforms, ducts, etc.

Sprinklers shall be installed under platforms, ducts, heating panels, galleries, walkways, etc., which are:

a) rectangular, more than 0.8 m wide and less than 0.15 m from adjacent walls or partitions;

b) rectangular and more than 1.0 m wide;

c) circular, more than 1.0 m in diameter and less than 0.15 m from adjacent walls or partitions; and

d) circular and more than 1.2 m in diameter.

11.4.11 Escalators and stair wells

The number of sprinklers shall be increased around the ceiling opening formed by escalators, stairs etc. Sprinklers shall be neither more than 2.0 m nor less than 1.5 m away from each other. If, owing to the design of the structure, e.g. girders, the minimum distance of 1.5 m cannot be maintained, smaller spacing may be used provided adjacent sprinklers are not able to wet each other.

The horizontal distance between the sprinklers and the opening in the ceiling shall not exceed 0.5 m. These sprinklers shall be capable of providing the minimum flow rate per sprinkler in the rest of the ceiling protection.

For the purposes of hydraulic calculation, only the sprinklers on the longer side of the opening need be considered.

11.4.12 Vertical shafts and chutes

In shafts with combustible surfaces, sprinklers shall be installed at each alternate floor level and at the top of any trapped section.

At least one sprinkler shall be installed at the top of all shafts except where the shaft is incombustible and inaccessible and contains incombustible materials or electrical cabling only.

11.4.13 Suspended ceilings

The use of suspended ceiling material below the sprinklers is not allowed unless the material has been shown not to impair sprinkler protection.

Where sprinklers are fitted below suspended ceilings, the ceiling material shall be of a type, which has been shown to be stable under fire conditions.

11.4.14 Suspended open cell ceilings

Suspended open cell ceilings, i.e. ceilings with a regular open cell construction, may be used beneath LH and OH sprinkler installations where all of the following conditions are met:

a) the total plan open area of the ceiling, including light fittings, is not less than 70 % of the ceiling plan area;

b) the minimum dimension of the ceiling openings is not less than 0.025 m or not less than the depth of the suspended ceilings, whichever is the greater;

c) the structural integrity of the ceiling and any other equipment, such as light fittings within the volume above the suspended ceiling, will not be affected by operation of the sprinkler system; and

d) there are no storage areas below the ceiling.

In such cases, sprinklers shall be installed as follows:

a) the sprinkler spacing above the ceiling shall not exceed 3.0 m;

b) the vertical distance between any conventional or spray sprinkler deflector and the top of the suspended ceiling shall be not less than 0.8 m for sprinklers other than flat spray sprinklers and not less than 0.3 m if flat spray sprinklers are used; and

c) supplementary sprinklers shall be installed to discharge below obstructions (e.g. light fittings) exceeding 0.8 m in width.

Where obstructions above the ceiling are likely to cause significant interference of the water discharge they shall be treated as walls for the purpose of sprinkler spacing.

11.5 Intermediate sprinklers in HH occupancies

11.5.1 General

Sprinklers protecting double row racks shall be installed in the longitudinal flue spaces, preferably in the intersection with the transverse flue (see Figures 15 and 16).

Whenever any rack or structural steelwork is likely to interfere significantly with the water discharge from the sprinklers, additional sprinklers shall be provided and taken into account in the flow calculation.

It shall be ensured that water from sprinklers operating at intermediate levels can penetrate the goods stored. The distance between goods stored in racking and placed back to back shall be at least 0.15 m, and if necessary pallet stops fitted. The clearance between the sprinkler deflectors and the top of the storage shall be not less than 0.10 m for flat spray sprinklers and 0.15 m for other sprinklers.

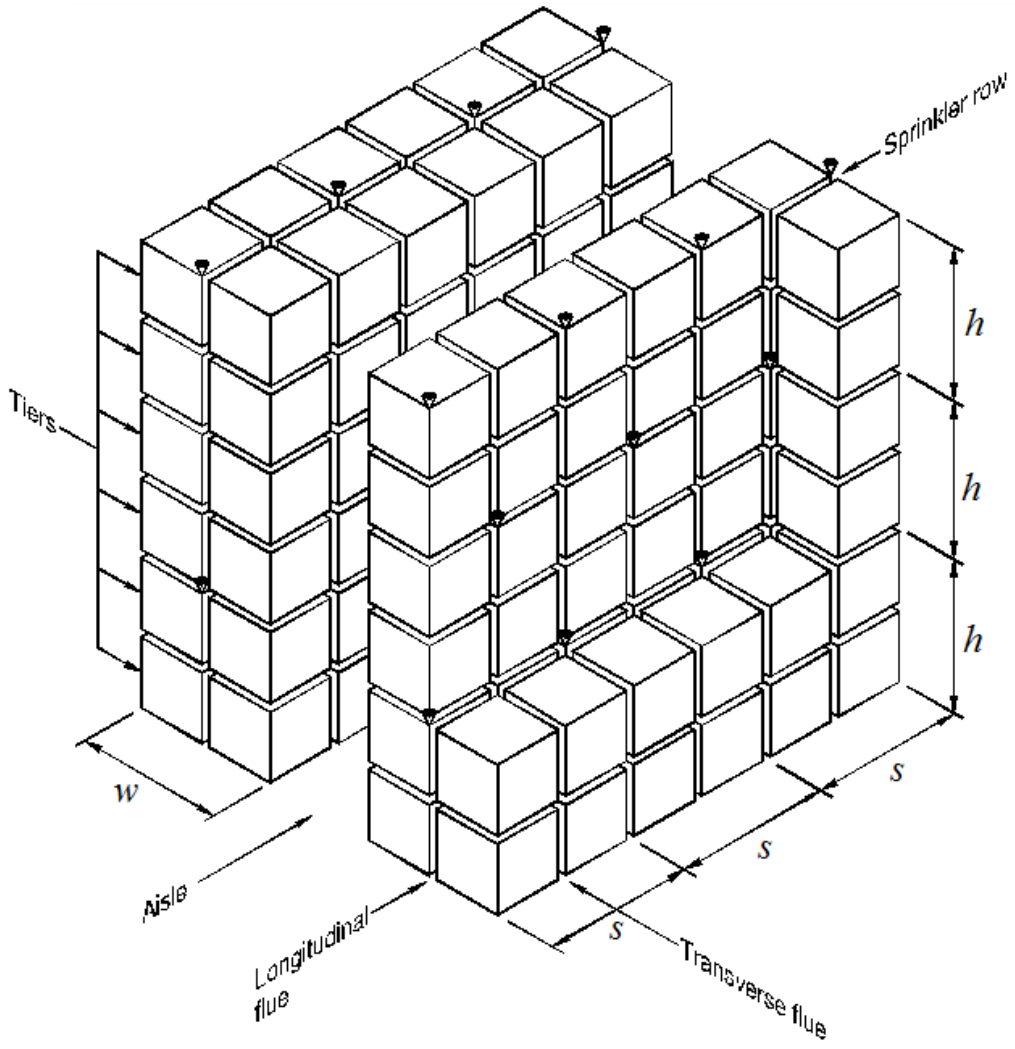
11.5.2 Maximum vertical distance between sprinklers at intermediate levels

The vertical distance from the floor to the lowest intermediate level and between levels shall not exceed 3.5 m or two tiers, whichever is the lesser, as shown in Figures 15 and 16. An intermediate level shall be installed above the top level of storage except where all the roof or ceiling sprinklers are situated at less than 4.0 m above the top of the storage.

In no case shall the highest level of intermediate sprinklers be installed lower than one tier below the top of the storage.

11.5.3 Horizontal position of sprinklers at intermediate levels

In the case of Category I or II goods, sprinklers shall where possible be installed in the longitudinal flue at the intersection with every second transverse flue, with the sprinklers staggered with respect to the next highest row (see Figure 15). The horizontal distance between sprinklers shall not exceed 3.75 m. The product of the horizontal and vertical distances between sprinklers shall not exceed 9.8 m².



Key

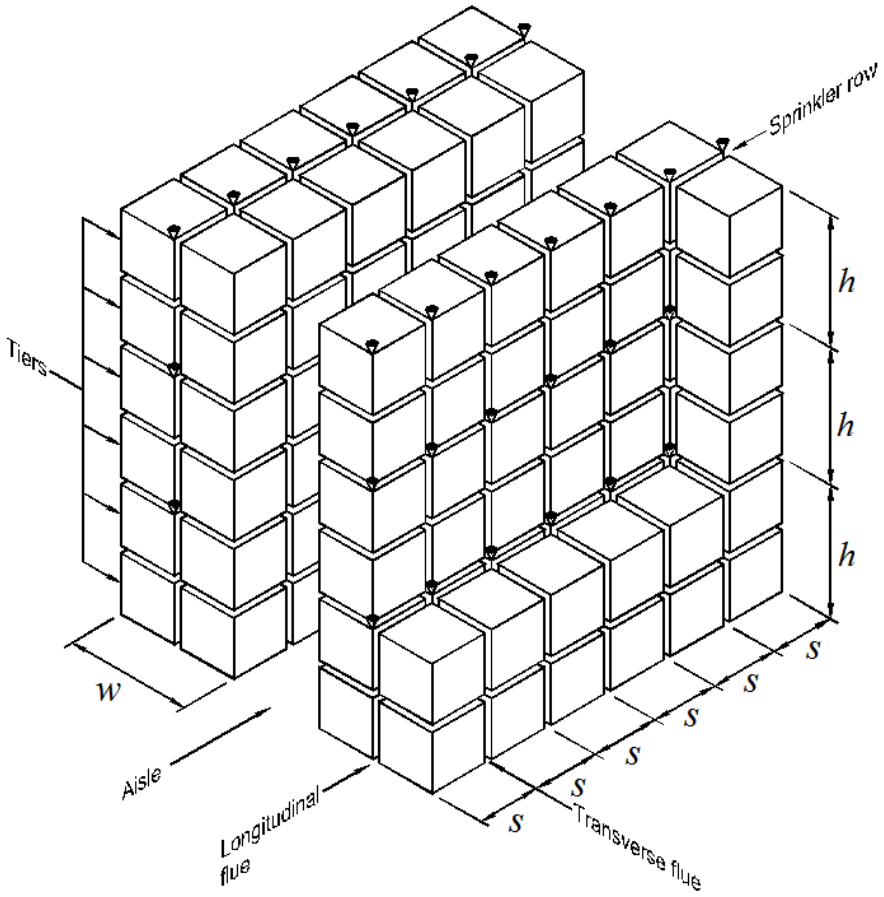
W ≤ 3.2 m per row of sprinkler

S ≤ 3.75 m

h ≤ 3.5 m or two tiers

NOTE. $S \times h \leq$ 9.8 m².

Figure 15. Location of rack intermediate level sprinklers - Category I or II



Key

W ≤ 3.2 m per row of sprinkler

S ≤ 1.9 m

h ≤ 3.5 m or two tiers

NOTE. S x h ≤ 4.9 m².

Figure 16. Location of rack intermediate level sprinklers - Category III or IV

In the case of Category III or IV goods, sprinklers shall be installed in the longitudinal flue at the intersection with each transverse flue (see Figure 16). The horizontal distance between sprinklers shall not exceed 1.9 m and the product of the horizontal distance and the vertical distance between sprinklers shall not exceed 4.9 m².

11.5.4 Numbers of rows of sprinklers at each level

The number of sprinkler rows per level shall be determined by the total rack width. When racking is placed back to back the total width shall be calculated by adding together the width of each rack and the distance between them.

One row of sprinklers per level shall be installed for every 3.2 m of rack width. They shall be installed in the flue spaces wherever possible.

11.5.5 HHS intermediate sprinklers in non-shelved racks

Intermediate sprinklers shall be installed for palletized rack storage and multiple row drive-through storage (see type ST4 in Figure 3 and Table 4) as follows:

a) single row racks no more than 3.2 m wide shall be protected by single rows of sprinklers fitted at the tier levels shown in Figures 15 and 16;

b) double row racks no more than 3.2 m wide shall be protected by sprinklers centrally in the longitudinal flue space, at the stack ends, and at the tier levels shown in Figures 15 and 16; and

c) double or multiple row racks more than 3.2 m wide, but no more than 6.4 m wide shall be protected by two rows of sprinklers installed no more than 3.2 m apart. Each row shall be the same distance from the nearest shelf edge. The sprinklers at a particular level in each line shall be located in the same set of transverse flues.

Where any rack or structural steelwork could significantly interfere with the water distribution from a sprinkler, an additional sprinkler shall be provided to ensure water distribution on the area where the water would have been impeded.

11.5.6 HHS intermediate sprinklers below solid or slatted shelves in racks (ST5 and ST6)

Where intermediate sprinklers are required, they shall be installed above each shelf (including the top shelf if the roof or ceiling sprinklers are more than 4.0 m above the goods or water access to the goods is restricted), and located as shown in Table 21 and Figure 17. The vertical distance between rows shall not exceed 3.5 m.

Single rows of sprinklers shall be central above shelves. Double rows shall be positioned so that each row is the same distance from the nearest shelf edge.

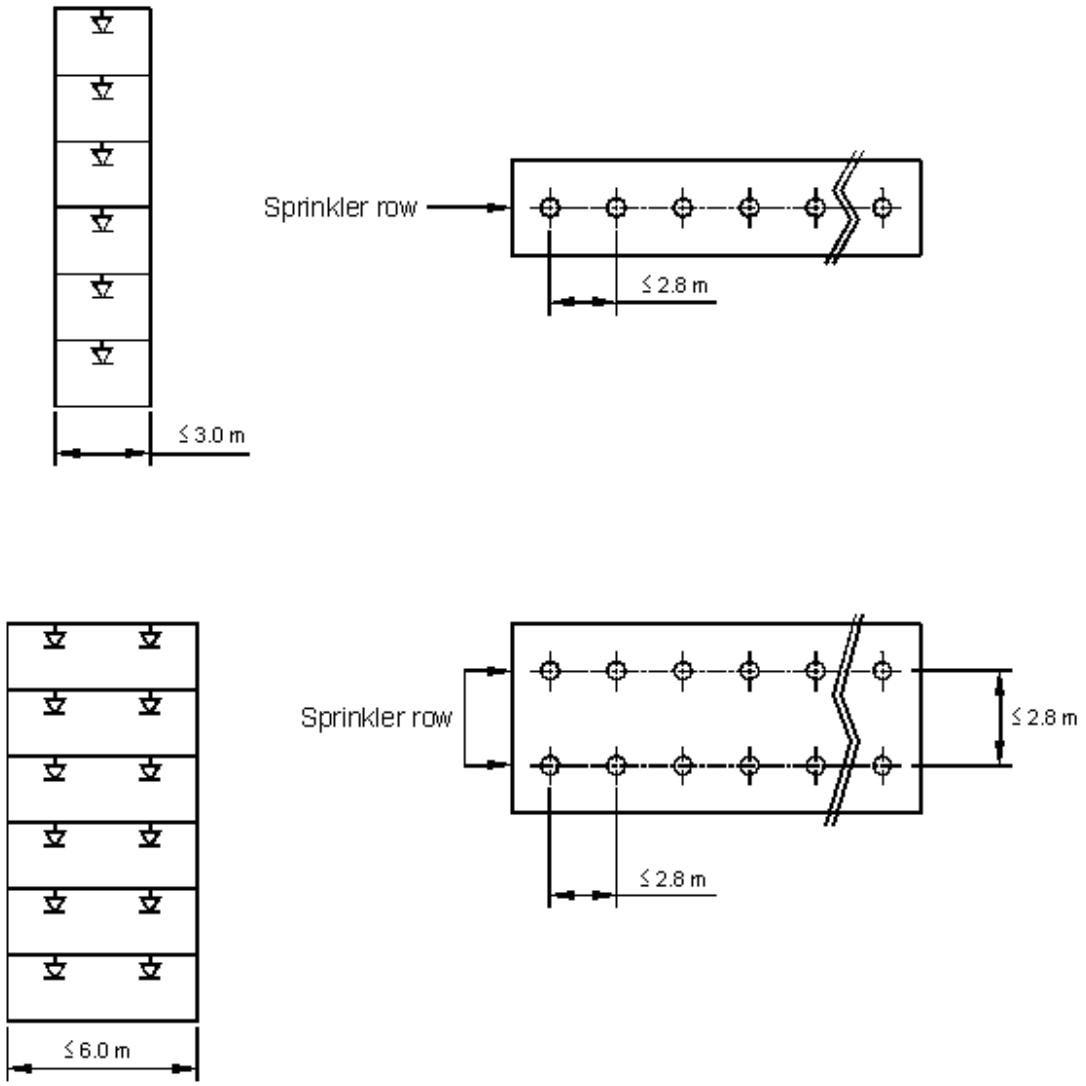


Figure 17. Location of intermediate sprinklers in type ST5 and ST6 storage

The distance from the end of the shelf parallel to the range pipe lines to the nearest sprinkler shall be half the sprinkler spacing along the range lines or 1.4 m, whichever is the less.

Table 21. Location of intermediate sprinklers in type ST5 and ST6 storage

Shelf width, s (m)	Rows of sprinklers	Maximum distance between sprinklers along rows (m)	Maximum distance between rows of sprinklers (m)
ST5: $s \leq 1.0$	1	2.8	-
ST6: $1.0 < s \leq 3.0$	1	2.8	-
ST6: $3.0 < s \leq 6.0$	2	2.8	2.8

12 Pipe sizing and layout

12.1 General

12.1.1 Pipe sizing

Pipe sizes shall be determined using one of the following methods:

a) pre-calculated systems, where the diameters are partly taken from tables and partly calculated (see 12.3); and

b) fully calculated systems, where all diameters are determined by hydraulic calculation (see 12.4).

The designer may choose between the two systems, except in the following cases, where full calculations shall always be used:

a) layouts with intermediate level HHS sprinklers; and

b) gridded or looped layouts.

12.2 Calculation of pressure losses in pipework

12.2.1 Pipe friction loss

Calculations of pipe friction loss shall be not less than those derived from the Hazen-Williams formula:

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

where

p is the pressure loss in the pipe, in bar;

Q is the flow through the pipe, in litres per minute;

d is the mean internal diameter of the pipe, in millimetres;

C is a constant for the type and condition of the pipe (see Table 22); and

L is the equivalent length of pipe and fittings, in metres.

The values of C indicated in Table 22 shall be used.

12.2.2 Static pressure difference

The static pressure difference between two inter-connecting points in a system shall be calculated from:

$$p = 0.098h$$

where

p is the static pressure difference, in bar; and

h is the vertical distance between the points, in metres.

The pressure loss due to velocity may be ignored.

Table 22. C values for various types of pipe

Type of pipe	Value of C
Cast iron	100
Ductile iron	110
Mild steel	120
Galvanized steel	120
Spun cement	130
Cement lined cast iron or ductile iron	130
Cement lined mild steel	130
Stainless steel	140
Copper	140
Reinforced glass fibre	140
NOTE. The list is not exhaustive.	

12.2.3 Velocity

The water velocity shall not exceed:

a) 6 m/s through any valve or flow monitoring device; and

b) 10 m/s at any other point in the system.

For the stabilised flow condition at the demand point with the total number of sprinklers assumed to be in simultaneous operation.

12.2.4 Pressure loss through fittings and valves

The pressure loss due to friction in valves, and in fittings where the direction of water flow is changed through 45° or more, shall be calculated using the formula specified in 12.2.1. The appropriate equivalent length shall be one of the following:

a) as specified by the equipment supplier; and

b) as taken from Table 23, if a) is not available.

If there is a bend, tee or cross where there is a change in direction of flow and there is also a change in diameter at the same point, the equivalent pipe length and pressure loss shall be determined by using the smaller diameter.

Table 23. Equivalent length of fittings and valves

Fittings and valves	Equivalent length of steel straight pipe for a *C* value of 120[a] (m)										
	Nominal diameter (mm)										
	20	25	32	40	50	65	80	100	150	200	250
90° Screwed elbow (standard)	0.76	0.77	1.0	1.2	1.5	1.9	2.4	3.0	4.3	5.7	7.4
90° Welded elbow (r/d = 1.5)	0.30	0.36	0.49	0.56	0.69	0.88	1.1	1.4	2.0	2.6	3.4
45° Screwed elbow (standard)	0.34	0.40	0.55	0.66	0.76	1.0	1.3	1.6	2.3	3.1	3.9
Standard screwed Tee or cross (flow through branch)	1.3	1.5	2.1	2.4	2.9	3.8	4.8	6.1	8.6	11.0	14.0
Gate valve - straight way	-	-	-	-	0.38	0.51	0.63	0.81	1.1	1.5	2.0
Alarm or non-return valve (swinging type)	-	-	-	-	2.4	3.2	3.9	5.1	7.2	9.4	12.0
Alarm or non-return valve (mushroom type)	-	-	-	-	12.0	19.0	19.7	25.0	35.0	47.0	62.0
Butterfly valve	-	-	-	-	2.2	2.9	3.6	4.6	6.4	8.6	9.9
Globe valve	-	-	-	-	16.0	21.0	26.0	34.0	48.0	64.0	84.0

[a] These equivalent lengths may be converted as necessary for pipes with other C values by multiplying by the following factors:

C value	100	110	120	130	140
Factor	0.714	0.85	1.00	1.16	1.33

12.2.5 Accuracy of calculations

12.2.5.1 Calculations shall be carried out in the units and with the accuracy given in Table 24.

Table 24. Accuracy of hydraulic calculations

Quantity	Unit	Accurate to
Length	m	0.01
Height	m	0.01
Equivalent length	m	0.01
Flow	L/min	1
Pressure loss	mbar/m	1
Pressure	mbar	1
Velocity	m/s	0.1
Area	m^2	0.01
Density of water application	mm/min	0.1

12.2.5.2 The calculations shall balance as follows:

a) the algebraic sum of pressure loss in a loop shall equal (0 ± 1.0) mbar;

b) where water flows join at a junction, the calculation shall balance to ± 1.0 mbar; and

c) the algebraic sum of water flow at a junction shall equal (0 ± 0.1) L/min.

12.3 Pre-calculated systems

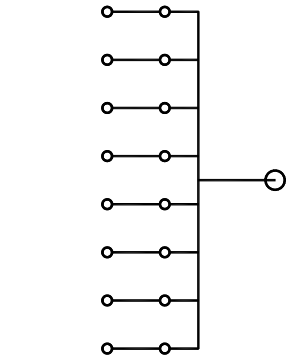
12.3.1 General

12.3.1.1 Pipe sizes shall be determined partly from the following tables and partly by hydraulic calculation. Pipe diameters shall not increase in the direction of flow of water to any sprinkler.

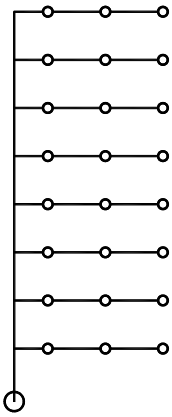
12.3.1.2 Range pipe sizes and the maximum number of sprinklers fed by each size of pipe in the range shall be as specified in Table 31, except in the case of Light Hazard, where Table 28 specifies only the pipes feeding the last three or four sprinklers on each range.

12.3.1.3 The size of all pipes upstream of each design point shall be calculated as specified in 12.3.3.2 for Light Hazard and 12.3.4.2 for Ordinary Hazard.

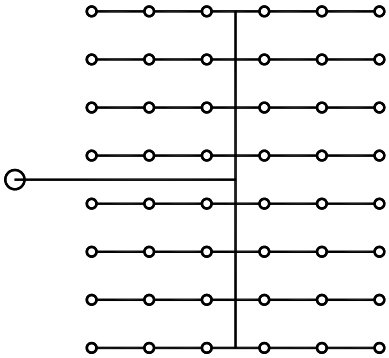
12.3.1.4 Risers and drops connecting distribution pipes to ranges, and pipes connecting single sprinklers, other than arm pipes, shall be considered as distribution pipes and sized accordingly.



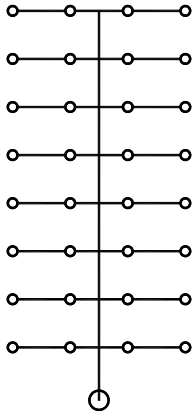
a) 2-end with central feed



b) 3-end with end feed

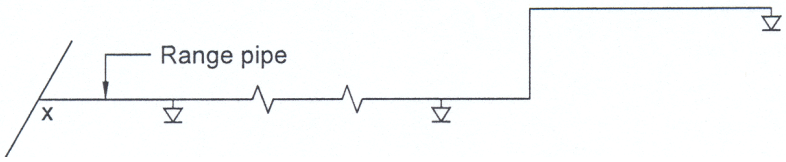


c) 3-end-centre with central feed

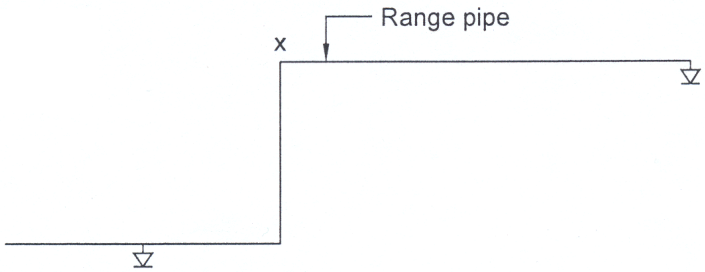


d) 2-end centre with end feed

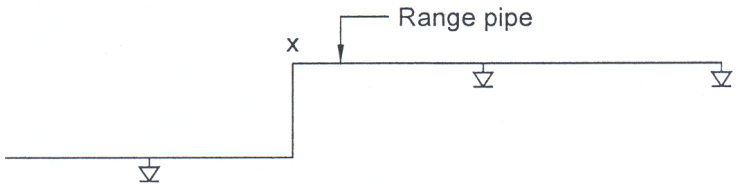
Figure 18. Examples of range pipe arrays



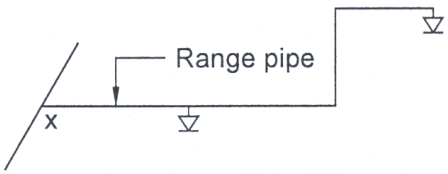
a) Riser (or drop) not greater than 300 mm



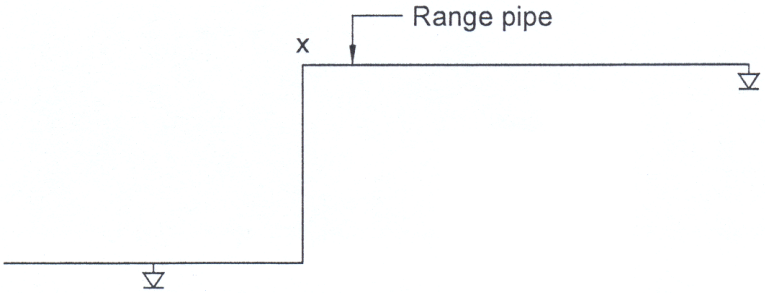
b) Riser (or drop) greater than 300 mm



c) Riser (or drop) of any length

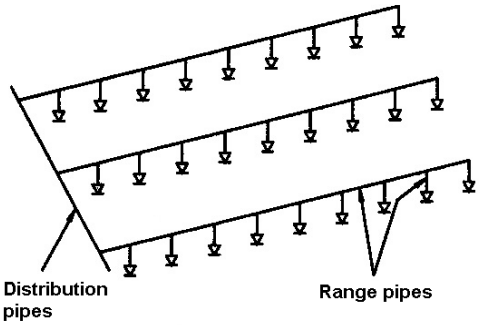


d) Armpiece not greater than 300 mm

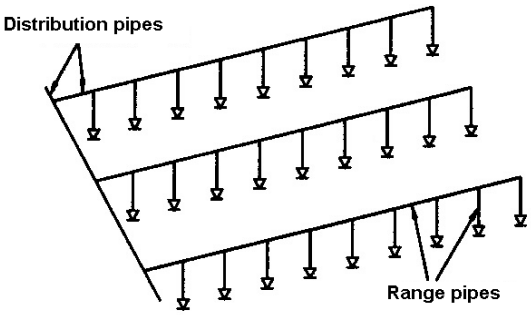


Pipework upstream of point '*x*' is considered as distribution pipe, and downstream of point '*x*' is considered as range pipe.

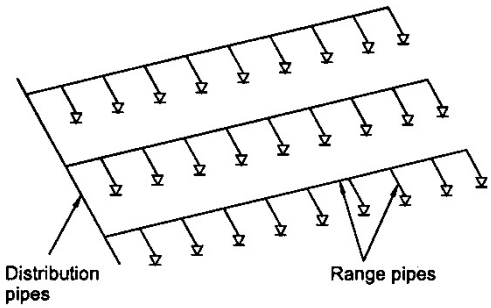
Figure 19. OH and HH pre-calculated installations - arm pipes and risers (or drops)



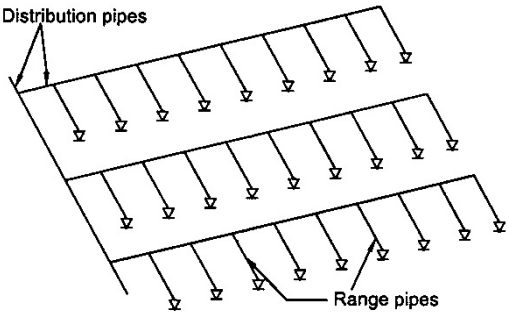
a) Drops not greater than 300 mm



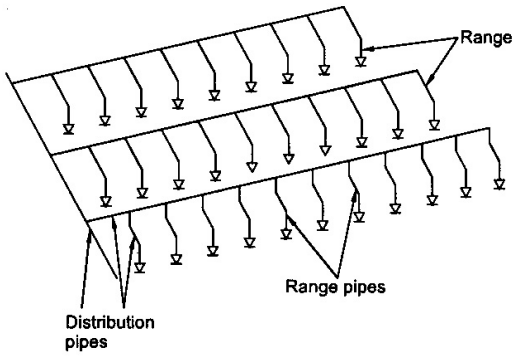
b) Drops greater than 300 mm



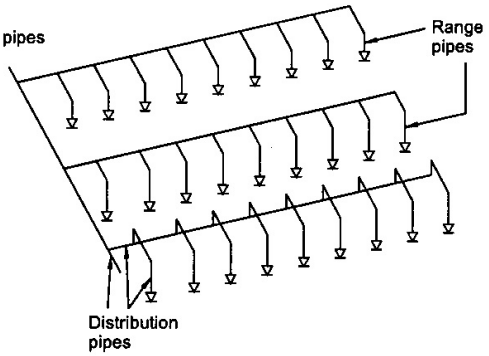
c) Armpieces not greater than 300 mm



d) Armpieces greater than 300 mm



e) Armpieces greater than 300 mm feeding



f) Armpieces feeding drops greater drops less than 300 mm than 300 mm

NOTES:

1. For ordinary hazard:
   Distribution pipe sizes from Table 32
   Maximum length of 25 mm pipe is 15 m

2. For high hazard:
   Maximum numbers of sprinklers on these arrangements:
   Tables 34 and 35 is 4 nos.
   Table 36 is 6 nos.

Figure 19. OH and HH pre-calculated installations - arm pipes and risers (or drops) (*continued*)

12.3.2 Location of design points

12.3.2.1 The design point shall be at the point of connection of a horizontal distribution pipe to one of the following:

a) a range pipe;

b) a riser, drop or offset connecting ranges to distribution pipes; and

c) a pipe feeding a single sprinkler.

The maximum number of sprinklers downstream of each design point shall be as specified in Tables 26 and 27.

12.3.2.2 In Light Hazard installations the design point shall be downstream of the sprinkler identified in Table 25 column 3.

Table 25. Location of design points - LH

Hazard class	Number of sprinklers on a range, in a room	Location of design point downstream of *n*th sprinkler where *n* is
LH	≤ 3	3
	≥ 4	4

12.3.2.3 In Ordinary and High Hazard installations the design point shall be downstream of the junction of distribution pipes and range pipes in accordance with Table 26 column 3.

Where the number of sprinklers on one array, in a room or on a single distribution pipe, is less than or equal to the number of sprinklers for which the distribution pipes are designed, (see Table 26 column 2), the design point shall be downstream of the point of connection to the distribution pipe of the range or the array hydraulically nearest to the control valve set.

NOTES:

1. Figure 18 illustrates typical range pipe arrays.

2. Examples of pipe layouts with the appropriate design points are given in Figure 20 for LH, Figures 20, 21, 22 and 23 for OH and Figures 20, 21, 22, 25 and 26 for HHP and HHS.

Table 26. Location of design points - OH, HHP and HHS

Hazard class	Number of sprinklers on a distribution pipe, in a room	Location of design point on a distribution pipe junction to a range holding *n*th sprinkler where *n* is	Range layout
OH	> 16	17	two end-side
	> 18	19	all others
HHP and HHS	> 48	49	all

12.3.3 Light Hazard - LH

12.3.3.1 The size of range pipes, and terminal distribution pipes downstream of the design point shall be as specified in Table 27.

It is permitted to install a 25 mm diameter pipe between the design point and the control valve set if a hydraulic calculation shows this to be possible. However, if the 2 sprinkler point is the decisive one, a 25 mm pipe shall not be installed between the 3rd and 4th sprinkler.

Table 27. Range pipe diameters for LH installations

Pipes	Diameter (mm)	Maximum number of sprinklers on range pipes
All range pipes and terminal distribution pipes.	20	1
	25	3

12.3.3.2 All pipework between the control valve set and the design point at each extremity of an array shall be sized by hydraulic calculation using the values in Tables 28 and 29.

Table 28. Maximum friction loss between control valve set and any design point - LH

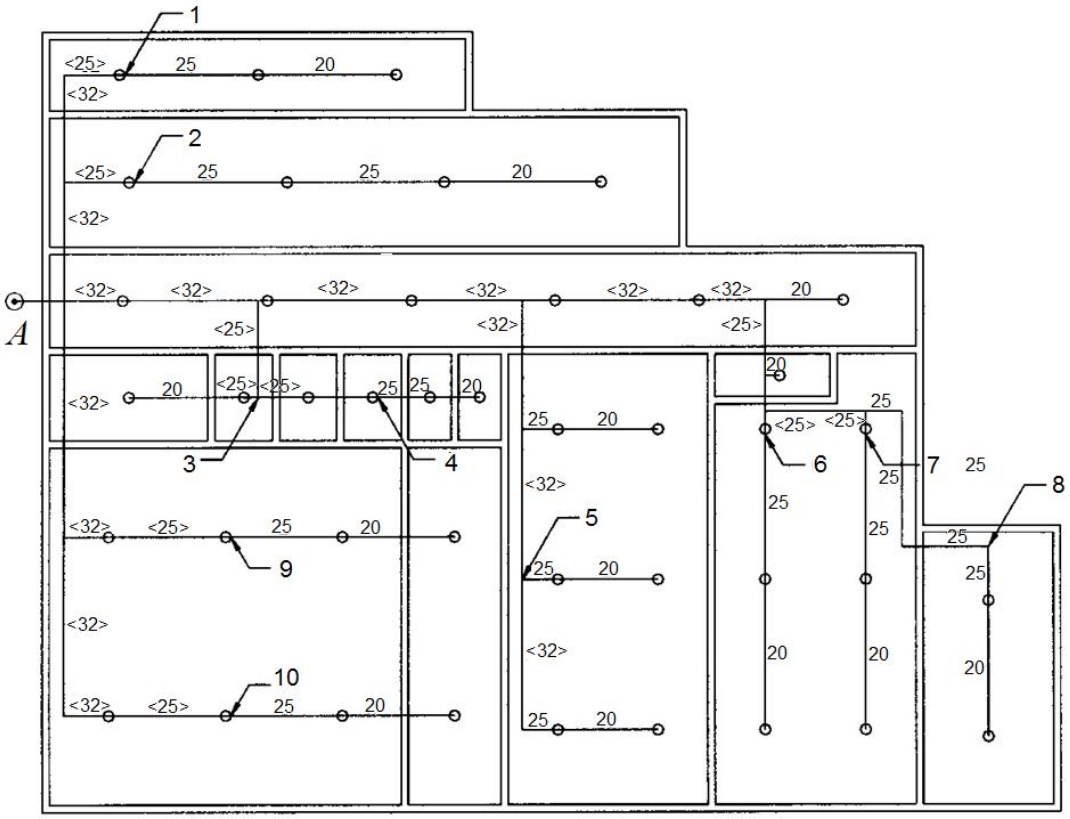
Number of sprinklers on a range or in a room	Maximum friction loss including changes in direction (see Note) (bar)	For range and distribution pipe loss
≤ 3	0.9	Table 29 columns 2 and 3
≥ 4	0.7	Table 29 column 3
≥ 3 in a single line, in a narrow room or range at a roof apex	0.7	Table 29 column 3
NOTE. In buildings with more than one floor, the pressure loss may be increased by an amount equivalent to the static pressure between the level of the sprinklers concerned and the level of the sprinklers on the highest floor.		

12.3.3.3 If there are more than two sprinklers on a range pipe, the pressure loss between the two sprinkler points and the distribution pipe shall be determined by using the pressure loss given in column 2 of Table 29. The pressure loss in the distribution pipe between this connection and the control valve set shall be determined by the pressure loss per metre given in column 3 of Table 29.

NOTE. Figure 20 shows an example of a pipe layout in a LH installation with design points from which the piping is to be fully calculated.

Table 29. Pressure loss for design flow rates in LH installations

Diameter Column 1 (mm)	Loss of pressure in pipe (mbar/m)	
	Column 2 (100 L/min)	Column 3 (225 L/min)
25	44	198
32	12	52
40	5.5	25
50	1.7	7.8
65	0.44	2.0



Key

A Control valve set
Pressure loss between control valve set and: 1 (2 sprinkler point) = 0.7 bar
2 (3 sprinkler point) = 0.7 bar
3, 4, 5, 6, 7, 8, 9 and 10 (2s sprinkler point) = 0.9 bar
Dimension shown as <25> or <32> indicate probable pipe sizes resulting from calculation.
Pipes sizes are in millimetres

Figure 20. Example of application of design points in an LH installation

12.3.4 Ordinary Hazard - OH

12.3.4.1 Range pipe diameters shall conform to Table 30, and distribution pipe diameters shall conform to Table 31.

The pressure loss per unit length of pipe for the design flow rate in ordinary hazard installation shall conform to Table 32 and the equivalent of an elbow, bend or tee where water is turned through an angle shall be taken as 3 m.

Table 30. Range pipe diameters in OH installations

Range pipes	Layout	Diameter (mm)	Maximum number of sprinklers fed
Range at remote end of all distribution pipes:			
- last 2 ranges	2-end side layouts	25	1
		32	2
- last 3 ranges	3-end side layouts	25	2
		32	3
Last range	All other layouts	25	2
		32	3
		40	4
		50	9
All other range pipes	All	25	3
		32	4
		40	6
		50	9

Table 31. Distribution pipe diameters in OH installations

Distribution pipes	Layout	Diameter (mm)	Maximum number of sprinklers fed
At extremities of installation	2-end side	32	2
		40	4
		50	8
		65	16
	All others	32	3
		40	6
		50	9
		65	18
Between design points and the control valve set	All	To be calculated in accordance with 12.3.4.2	

Table 32. Pressure loss per unit length of pipe for design flow rates in ordinary-hazard installations

Pipe nominal bore (mm)	Pressure loss per metre (MS 863)			
	Medium grade		Heavy grade	Heavy grade
	Black (mbar/m)	Galvanised (mbar/m)	Black (mbar/m)	Galvanised (mbar/m)
65	35	35	39	39
80	16	16	17	18
100	4.4	4.4	4.7	4.8
150	0.65	0.66	0.67	0.68
Pipe nominal bore (mm)	**Pressure loss per metre (MS 862)**		**Pressure loss per metre (MS 863)**	
	Black (mbar/m)	**Galvanised (mbar/m)**	**Black (mbar/m)**	**Galvanised (mbar/m)**
200	0.16	0.16	0.18	0.18
NOTE. Where steel pipework other than MS 863 (medium or heavy grade), MS 862 is used, calculate the pressure loss from the data in Clause 12 using a flow rate of 1 000 L/min.				

When the range pipes run longitudinally under roofs sloping at an angle of more than 6°, the number of sprinklers on a range pipe shall not exceed six.

NOTE. Figures 22 gives an example of a pipe layout in OH with the design points from which the piping is to be fully calculated.

12.3.4.2 The pipe diameters between the design point in the most remote area of the installation and the control valve set shall be calculated to ensure that the total pressure loss due to friction with a flow of 1 000 L/min does not exceed 0.5 bar, except as modified in 12.3.4.3 and 12.3.4.4.

12.3.4.3 In buildings with more than one floor, or where there are a number of different levels, e.g. platforms or lean-to's, the 0.5 bar loss in pressure from the design point may be increased by an amount equivalent to the static pressure due to the height difference between the highest sprinkler point in the building and the remote area design point on the floor concerned.

In these cases, the height difference between the highest sprinkler level and the installation pressure gauge shall be indicated on the completion certificate, together with the pressure required at the installation pressure gauge.

12.3.4.4 Where sprinkler protection is required in concealed spaces such as false ceilings and floors, the sprinklers above the ceiling may be fed from the same range pipes as the sprinklers below the ceiling. In pre-calculated systems, the sprinklers shall be taken cumulatively for the purposes of determining pipe diameters.

12.3.4.5 Where the same system includes both OH3 or OH4 and HHP or HHS areas, all connected to a common water supply, the maximum friction loss of 0.5 bar may be increased by 50 % of the available extra pressure, as indicated in the following example for OH3.

Example for an OH3 installation:

Pressure required at the control valve set excluding static pressure (Table 6 for OH3)	1.40 bar
Pressure difference due to the difference in height between the highest sprinkler and the control valve set	1.20 bar
Required pressure at the control valve set	2.60 bar
Pressure available at the control valve set for the flow appropriate in HH e.g.	6.00 bar

Extra pressure which may be used:

50 % of (6.00 - 2.60) = 1.70 bar

The pipework shall be sized to allow for a maximum pressure loss of:

$0.5 + 1.70\ (1\ 000/1\ 350)^2 =$ 1.43 bar

12.3.5 High hazard - HHP and HHS (except intermediate level sprinklers)

12.3.5.1 The pipe shall be sized according to:

a) the design density;

b) the spacing of the sprinklers;

c) the K-factor of sprinkler used; and

d) the pressure/flow characteristic of water supply.

No pipe shall have a nominal diameter of less than 25 mm.

12.3.5.2 For installations with water supplies which conform to Table 7 (1) and with sprinklers having a K factor of 80, the pipe sizes for range pipes and distribution pipes shown in Tables 33 and 34 shall apply.

No more than four sprinklers shall be installed on any range pipe. Range pipes shall not be connected to distribution pipes of more than 150 mm in diameter.

NOTE. Figure 23 gives an example of a pipe layout in accordance with Tables 33 and 34 and design points from which the pipe diameters are to be fully calculated.

Table 33. Range pipe diameters for HH installations with pressure and flow characteristics as given in Table 7 (1 or 2) and sprinklers having a K factor of 80

Range pipe	Layout	Diameter (mm)	Maximum number of sprinklers fed by pipe
Range at remote end of all distribution pipes:	2-end side layouts, last two ranges	25	1
		32	2
	3-end side layouts last three ranges	25	2
		32	3
	All other layouts, last range only	25	2
		32	3
		40	4
All other ranges	Any	25	3
		32	4

Table 34. Distribution pipe diameters downstream of the design point, in HH installations with pressure and flow characteristics as given in Table 7 (1) and sprinklers having a K factor of 80

Distribution pipes	Diameter (mm)	Maximum number of sprinklers fed by distribution pipe
Pipes at extremities of installation	32	2
	40	4
	50	8
	65	12
	80	18
	100	48
Pipes between the design points and the control valve set	To be calculated in accordance with 12.3.5	

12.3.5.3 For installations with water supplies, which conform to Table 7 (2) or as modified by 6.3.2.6 and with sprinklers having a K factor of 80, the sizes for range pipes and distribution pipes shall be determined from Tables 33 and 35.

No more than four sprinklers shall be installed on any range pipe. No range pipe shall be connected to a distribution pipe exceeding 150 mm in diameter. Distribution pipes less than 65 mm diameter shall not be used in 4-end-side systems.

NOTE. Figure 23 gives an example of a pipe layout in accordance with Tables 33 and 35 and design points from which the pipe diameters are to be fully calculated.

Table 35. Distribution pipe diameters downstream of the design point in HH installations with pressure and flow characteristics as given in Table 7 (2, 3 or 4) and sprinklers having a K factor of 80 or 115

Distribution pipes	Diameter (mm)	Maximum number of sprinklers fed by distribution pipes
Pipes at extremities of system	50	4
	65	8
	80	12
	100	16
	150	48
Pipes between the design points and the control valve set	To be calculated in accordance with 12.3.5	

12.3.5.4 For installations with water supplies which conform to the requirements shown in Table 7 (3) and with sprinklers having a K factor of 80, and as shown in Table 7 (4) with sprinklers having a K factor of 115, the sizes for range pipes and distribution pipes shall be determined from Tables 35 and 36.

In an end-side arrangement, no more than six sprinklers shall be fitted to any range pipe. In a 2-end-centre layout, no more than four sprinklers shall be fitted to any range pipe. Range pipes shall not be connected to a distribution pipe more than 150 mm in diameter. Distribution pipes less than 65 mm diameter shall not be used in 4-end-side systems.

NOTE. Figure 25 gives an example of a pipe layout in accordance with Tables 35 and 36 and design points from which the pipe diameters are to be fully calculated.

Table 36. Range pipe diameters for HH installations with pressure and flow characteristics as given in Table 7 (3 or 4) and sprinklers having a K factor of 115

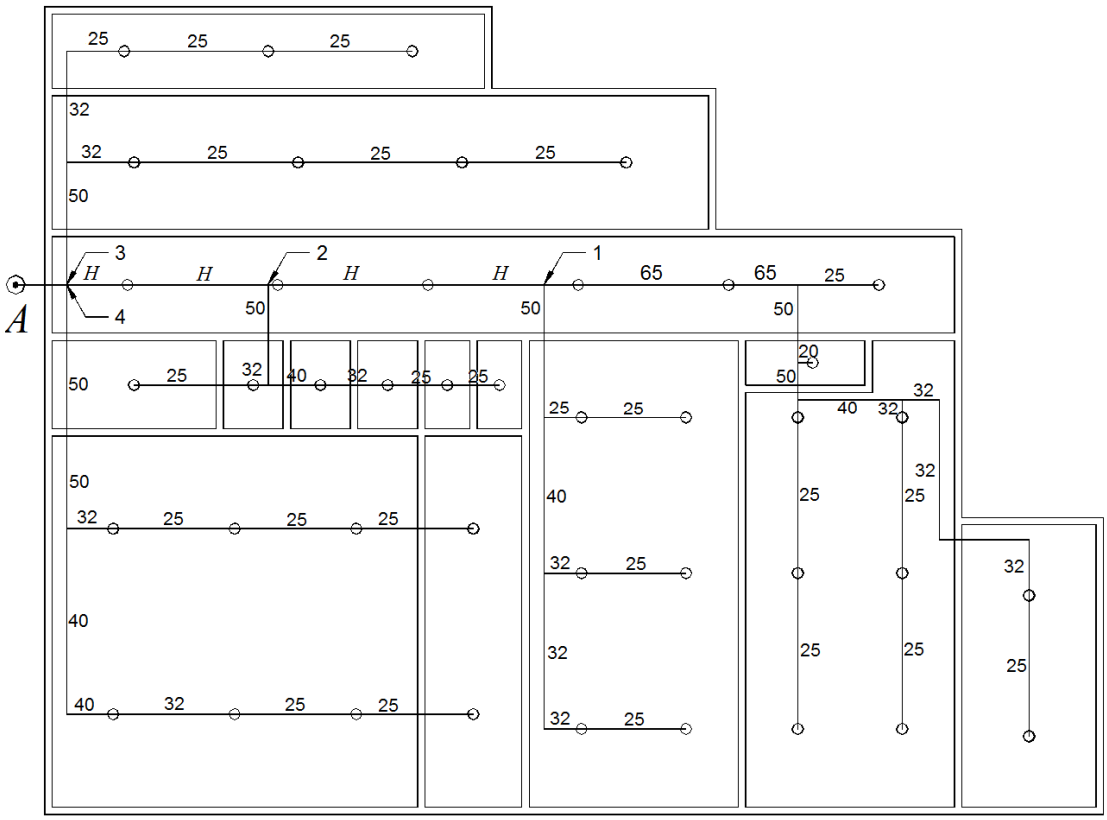
Range pipe	Layout	Diameter (mm)	Maximum number of sprinklers fed by pipe
Range at remote end of all distribution pipes Other ranges	End side, last three ranges	40	1
		50	3
		65	6
		32	1
		40	2
		50	4
		65	6
Ranges at remote end of all distribution pipes Other ranges	2-end-centre, last three ranges	32	1
		40	2
		32	2
All ranges	3 and 4-end centre	32	1
		40	2
		50	4

12.3.5.5 Where sprinkler protection is required in concealed spaces such as false ceilings and floors, the sprinklers in the concealed space shall be fed from separate range pipes. In the case of pre-calculated systems, the diameter of distribution pipes feeding sprinklers both inside and outside the concealed space shall be not less than 65 mm.

12.3.5.6 The pressure loss between the design points and the control valve set shall be determined by calculation. The pressure loss with the flows shown in Table 7, plus the necessary pressure at the design point, plus the static pressure equal to the height difference between the highest sprinkler and the control valve set shall not exceed the available pressure.

Where the highest sprinkler is upstream of the design point, the portion requiring the higher static head shall have its own distribution pipe.

The pressure loss in the distribution pipes feeding each section of the risk may be balanced by suitably sizing the distribution pipe.



Key

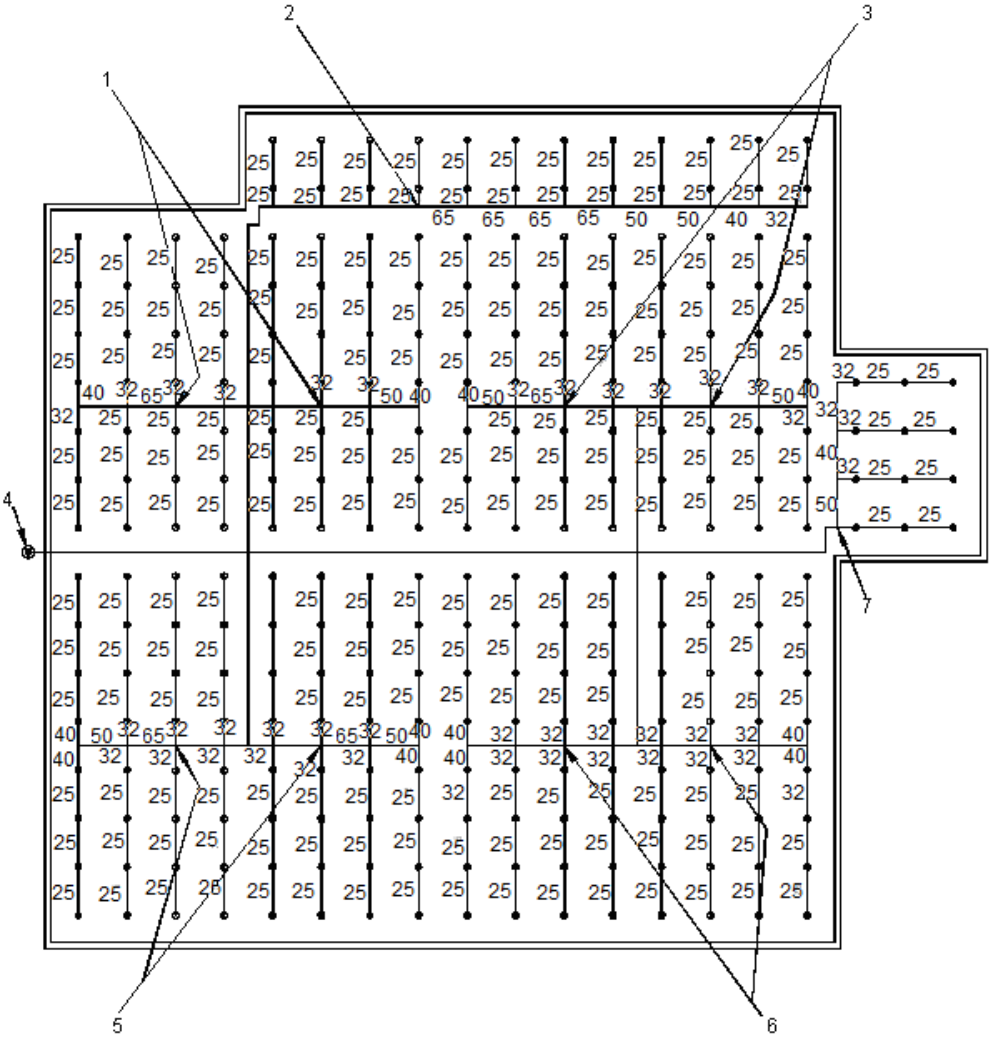
A Control valve set

Pressure loss between control valve set and:	1	18 sprinkler design point	= 0.5 bar
	2, 3, 4	default design point	= 0.5 bar

Dimensions shown as H indicate pipe sizes to be obtained by calculation.

Pipe sizes are in millimetres.

Figure 21. Example A of application of design points in an OH installation



Key

1 design point

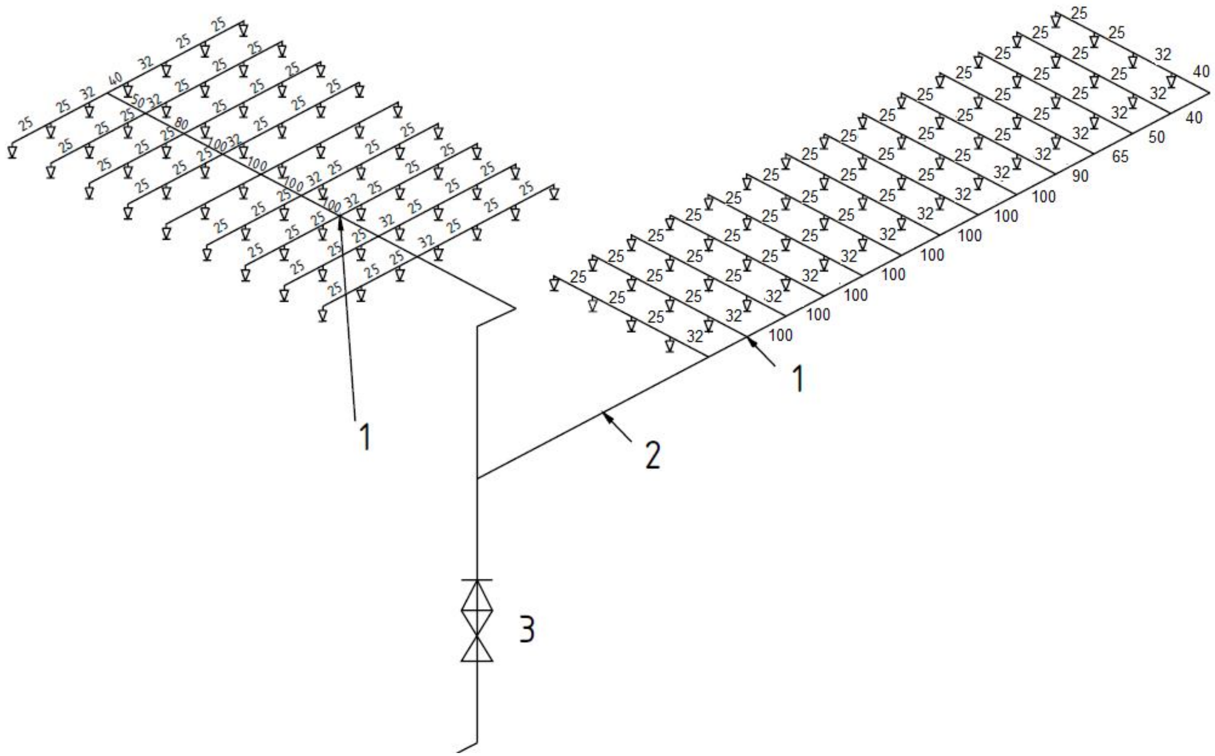
2 16 sprinkler point

3, 5, 6 18 sprinkler point

4 riser

7 default design point

Figure 22. Example B of application of design points in an OH installation



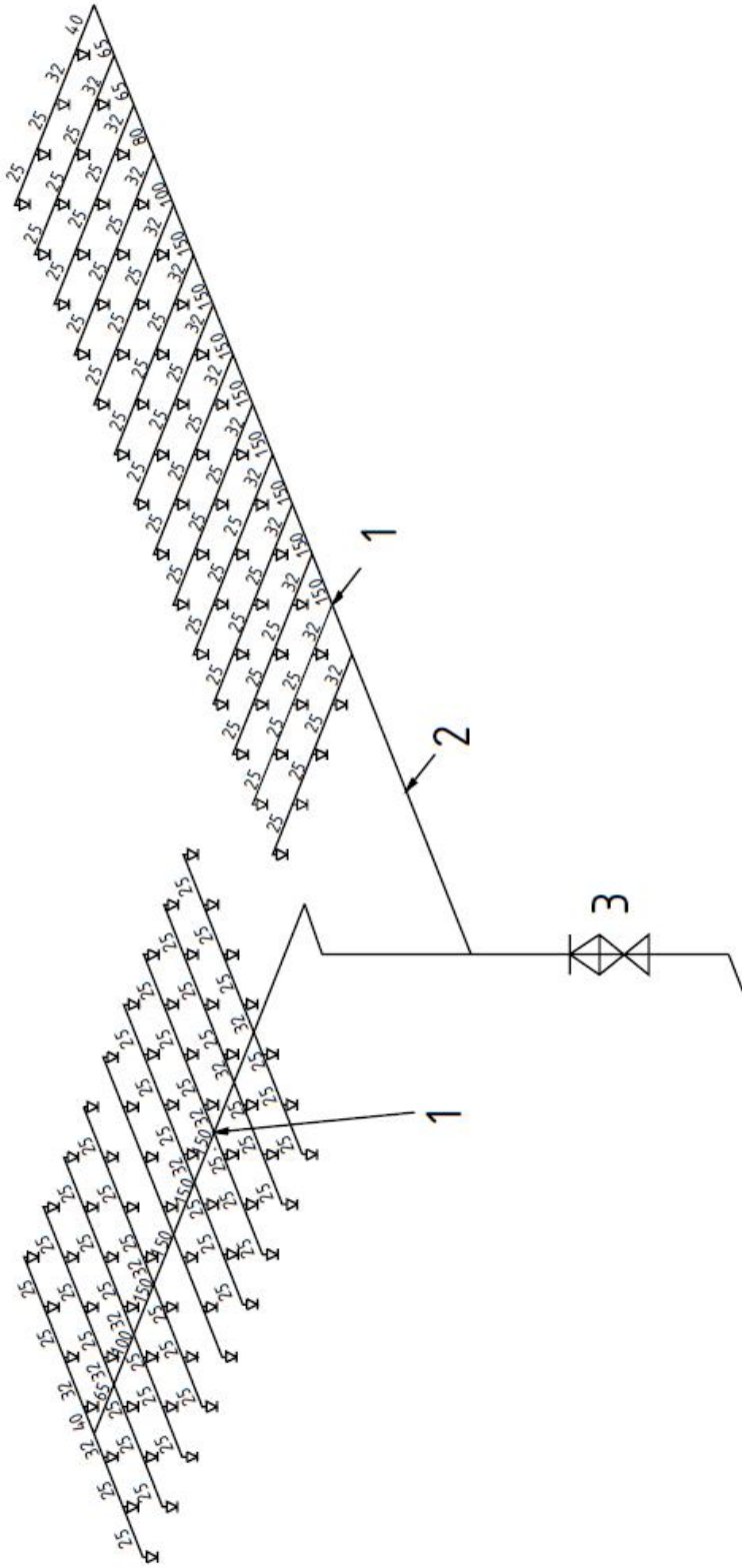
Key

1 48 sprinkler point

2 distribution pipe spur

3 control valve set

Figure 23. Example of application of design points in a high hazard installation with pipe sizes from Tables 33 and 34



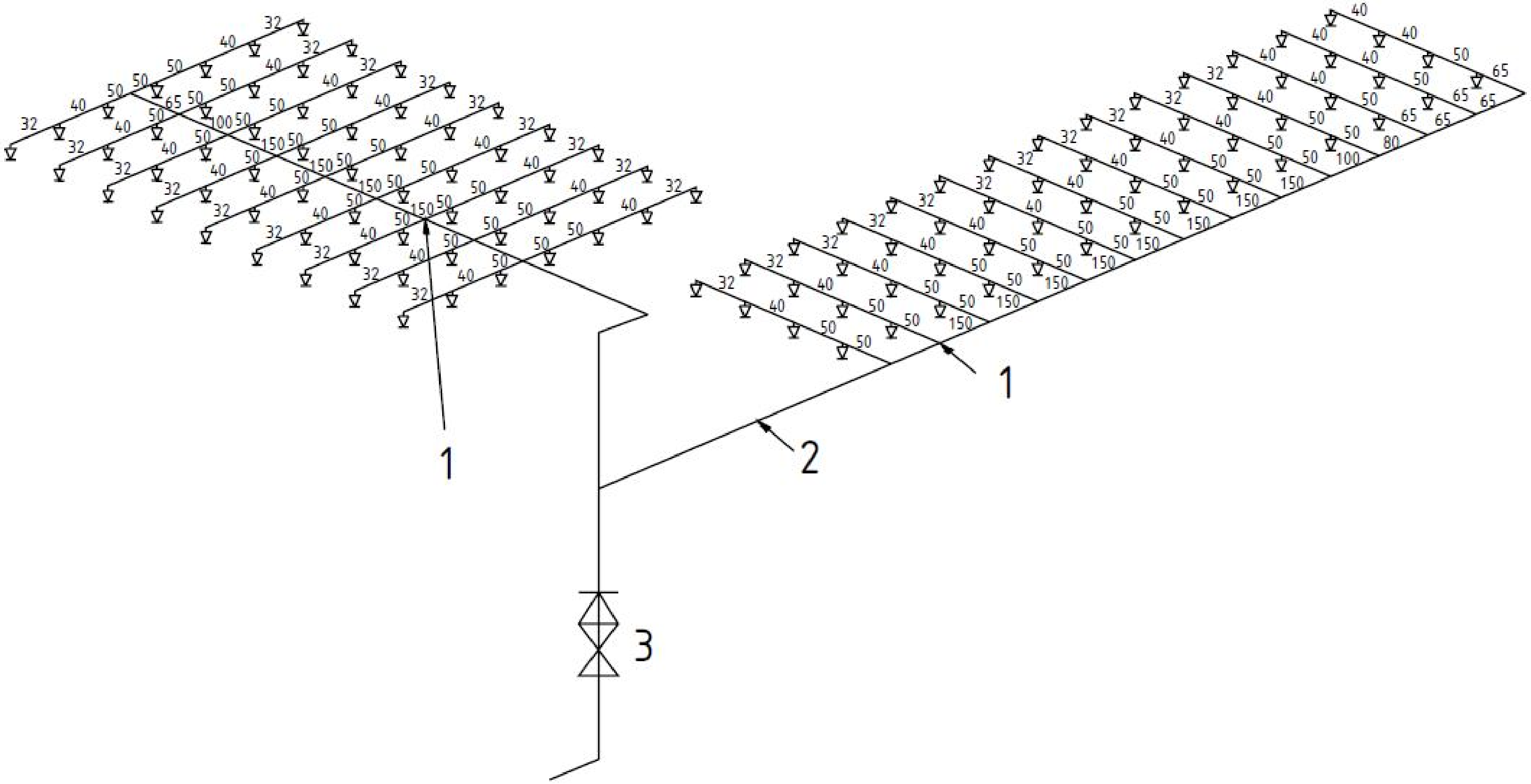
Key

1 48 sprinkler point

2 distribution pipe spur

3 control valve set

Figure 24. Example of application of design points in a high hazard installation with pipe sizes from Tables 33 and 35



Key

1 48 sprinkler point

2 distribution pipe spur

3 control valve set

Figure 25. Example of application of design points in a high hazard installation with pipe sizes from Tables 35 and 36

12.4 Fully calculated systems

12.4.1 Design density

The density of discharge shall be taken as the total flow in litres per minute from a group of four sprinklers which are most closely adjacent, divided by the area in square metres covered by the four sprinklers, or, where fewer than four sprinklers are in open communication, the density of discharge shall be taken as the lowest value of the flow from any sprinkler divided by the area covered by the sprinkler.

The density of discharge from each area of operation, or the entire protected area, whichever is the smaller, containing the relevant group of four sprinklers, with each water supply or supply combination available, shall be not less than the design density specified in Clause 6.

The area covered by each sprinkler shall be defined by the centre-lines drawn midway between adjacent sprinklers at right angles to the line joining the sprinklers and by the boundary of the area covered or half the distance to the closest sprinkler, whichever is the greater (see Figure 26). Where in-rack sprinklers are installed, the calculation shall be carried out taking into account the simultaneous flow and pressure requirement for roof or ceiling sprinklers and the intermediate level sprinklers.

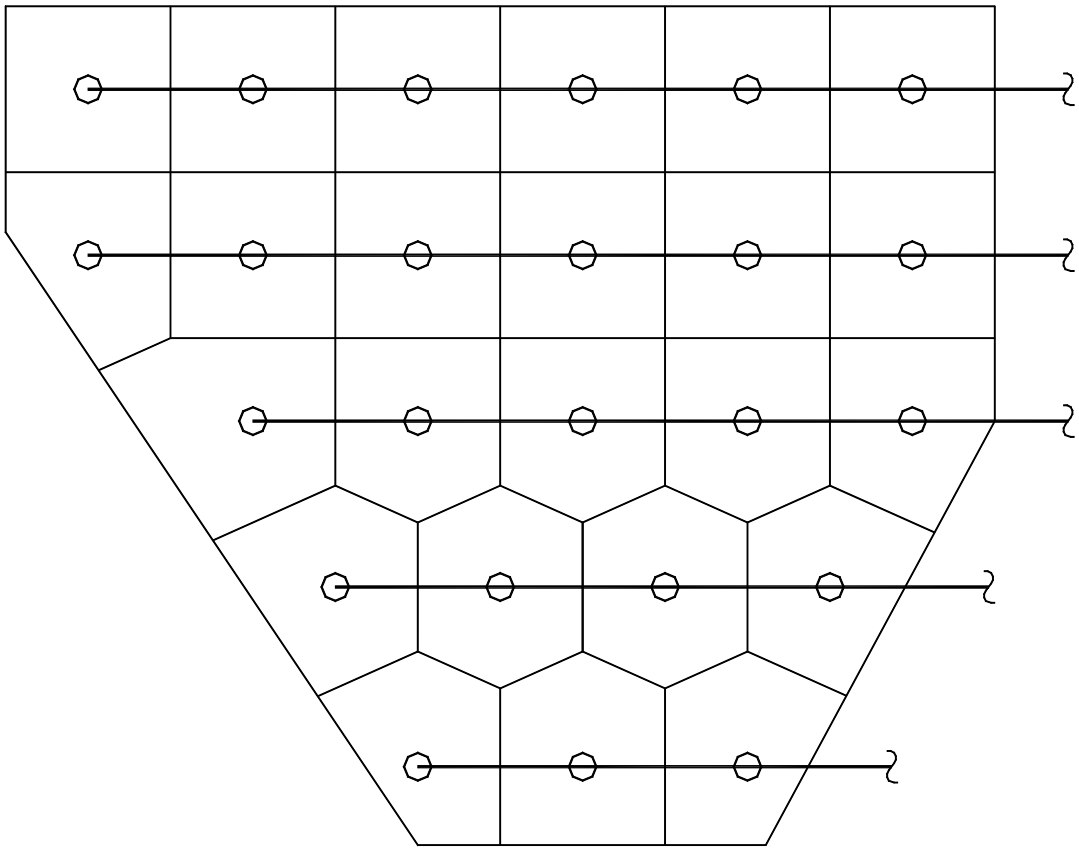


Figure 26. Determination of area covered per sprinkler

12.4.2 Locations of the area of operation

12.4.2.1 Hydraulically most unfavourable location

Variations in sprinkler spacing, layout, elevation, range centres, sprinkler orifice size and pipe sizes, as well as all possible locations, whether on the distribution pipes or between distribution pipes where these are connected by range pipes, shall be considered when determining the hydraulically most unfavourable location of the area of operation (see Figures 27, 29 and 30).

The correct position of the hydraulically most unfavourable area of operation in gridded installations shall be proved by displacing the area of operation by one sprinkler pitch in each direction along the range pipes until the area with the highest pressure requirement is identified.

The correct position of the hydraulically most unfavourable area of operation in looped installations shall be proved by displacing the area of operation by one sprinkler pitch in each direction along the distribution pipe until the area with the highest pressure requirement is identified.

12.4.2.2 Hydraulically most favourable location

All possible locations, whether on the distribution pipes, or between distribution pipes where these are connected by range pipes, shall be considered when determining the hydraulically most favourable location of the area of operation (see Figures 27 to 29).

12.4.3 Shape of the area of operation

12.4.3.1 Hydraulically most unfavourable location

The area of operation shall be as near as possible rectangular, symmetrical with respect to the sprinkler layout (see Figure 27) and as follows:

a) In the case of terminal and looped configurations, the far side of the area shall be defined by the range, or pair of ranges where there is an end-centre layout. Sprinklers not constituting a full range or pair of ranges shall be grouped as close as possible to the distribution pipe on the next upstream range row to the rectangular area (see Figures 27 and 29).

b) In the case of gridded configurations where ranges run parallel to the ridge of a roof having a slope greater than 6°, or along bays formed by beams greater than 1.0 m deep, the far side of the area shall have a length L parallel to the ranges, such that L is greater than or equal to two times the square root of the area of operation.

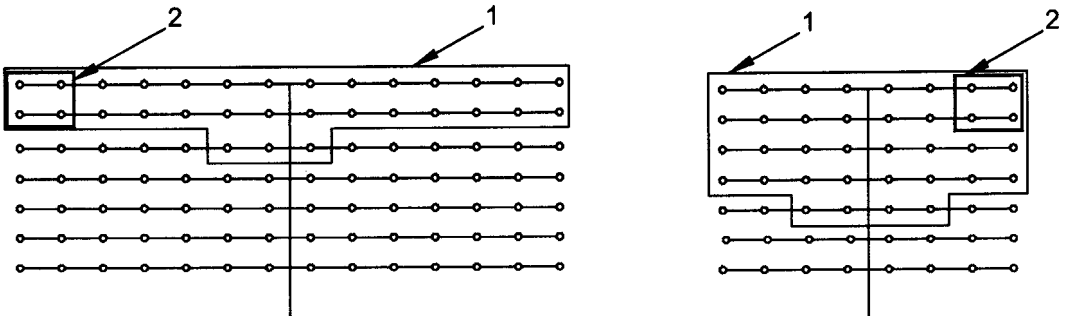
c) In the case of all other gridded configurations the far side of the area shall have a length L parallel to the ranges, such that L is greater than or equal to 1.2 times the square root of the area of operation.

12.4.3.2 Hydraulically most favourable location

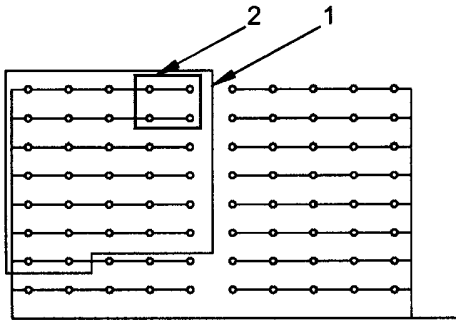
The area of operation shall be as near as possible square and as follows:

a) In the case of terminal and looped configurations, the area shall, where possible, include sprinklers on one distribution pipe only. The number of sprinklers calculated to be operating on ranges, or pairs of ranges in end-centre installations, shall be located on each range or pair of ranges at the hydraulically most favourable location. Sprinklers not forming a full range or pair of ranges shall be located on the next range row at the hydraulically closest locations (see Figures 28 and 30).

b) In the case of gridded configurations, the area shall be located on ranges at the hydraulically most favourable location. Sprinklers not forming a full range length shall be located on the next range row at the hydraulically closest locations (see Figure 29).



a) Most unfavourable areas of operation in two-sided pipe layouts



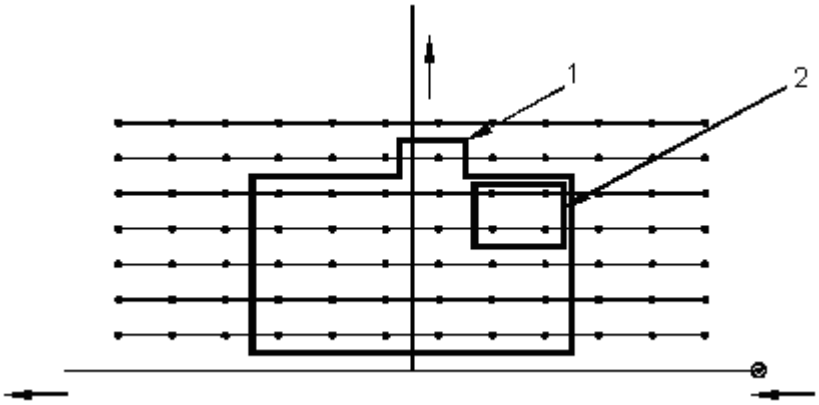
b) Most unfavourable areas of operation in one-sided pipe layouts

Key

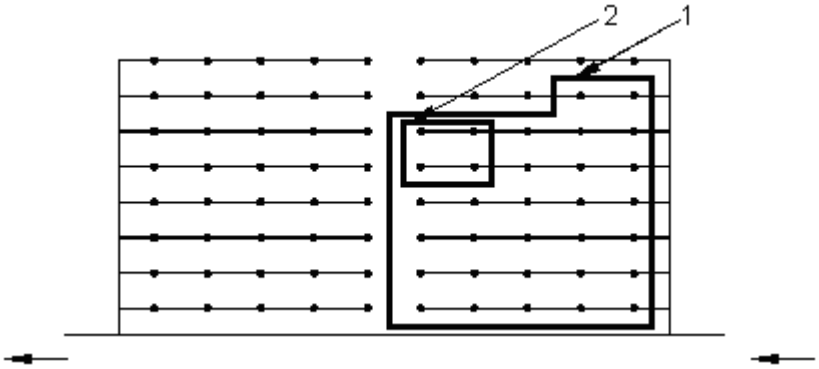
1 most unfavourable area

2 four sprinkler under construction

Figure 27. Most unfavourable areas of operation in one-sided and two-sided pipe layouts



a) Most favourable areas of operation in two-sided pipe layouts



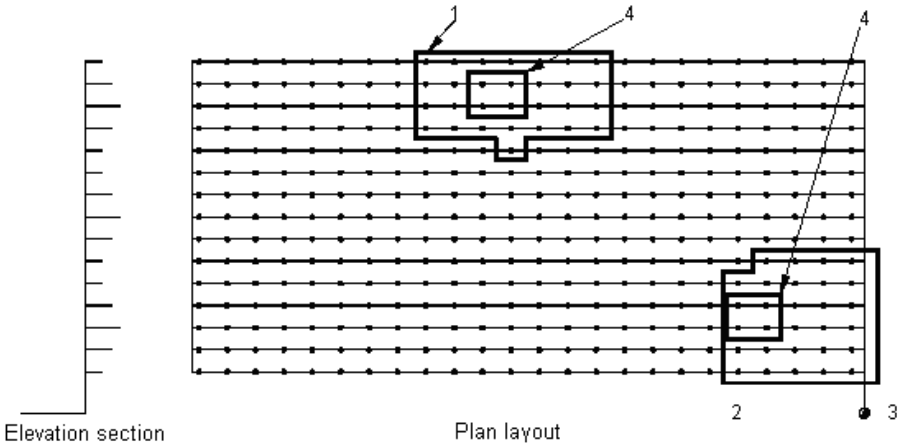
b) Most favourable areas of operation in one-sided pipe layouts

Key

1 most favourable area

2 four sprinkler under construction

Figure 28. Most favourable areas of operation in one-sided and two-sided pipe layouts



Key

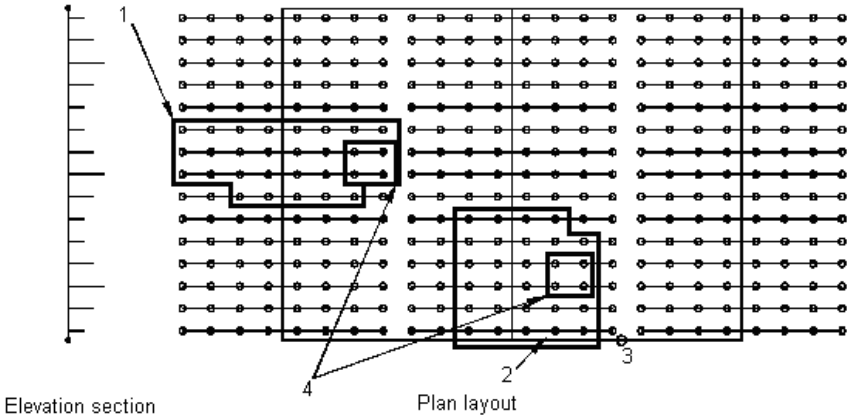
1 most unfavourable area

2 most favourable area

3 riser

4 sprinklers under consideration

Figure 29. Most favourable and unfavourable areas of operation in gridded pipe layout



Key

1 most unfavourable area

2 most favourable area

3 riser

4 sprinklers under consideration

Figure 30. Most favourable and unfavourable areas of operation in a looped pipe layout

12.4.4 Minimum sprinkler discharge pressure

The pressure at the hydraulically most unfavourably situated sprinkler, when all the sprinklers in the area of operation are in operation, shall be not less than that required to achieve the density specified in 12.4.1 or the following, whichever is the higher:

a) 0.70 bar in LH;

b) 0.35 bar in OH;

c) 0.50 bar in HHP and HHS except for in-rack sprinklers;

d) 1.00 bar for K 115 in-rack sprinkler; and

e) 2.00 bar for in-rack sprinklers.

In any case, discharge sprinkler pressures shall meet manufacturer's listed minimum operating pressures.

12.4.5 Minimum pipe diameters

The pipe diameter shall not be less than as shown in Table 37.

Table 37. Minimum pipe diameters

Risk	Diameter (mm)
LH	20
OH and HH horizontal and upright pipe connecting one sprinkler having a K factor not greater than 80	25
All others	25

Pipe diameters on the installation side of the control valve set may decrease only in the direction of water flow, except in the case of grid and loop configurations.

Upright sprinklers shall not be connected to any pipe with a diameter greater than 65 mm, or 50 mm if lagged. Pendent sprinklers shall not be directly connected to any pipe with a diameter greater than 80 mm.

For larger diameters an arm pipe shall be fitted so that the distance from the sprinkler deflector to the edge of the main pipe is not less than 1.5 times the diameter of this pipe.

13 Sprinkler design characteristics and uses

13.1 General

NOTE. This standard covers only the use of the types of sprinkler specified in MS ISO 6182-1.

Only new (i.e. unused) sprinklers shall be used. They shall not be painted except as allowed by MS ISO 6182-1. They shall not be altered in any respect or have any type of ornamentation or coating applied after dispatch from the production factory, except as specified in 13.9.

13.2 Sprinkler types and application

13.2.1 General

Sprinklers shall be used for the various hazard classes in accordance with Table 38, and as specified in 13.2.2 to 13.2.4.

Table 38. Sprinkler types and *K* factors for various hazard classes

Hazard class	Design density mm/min	Sprinkler type	Nominal *K* Factor
LH	2.25	conventional, spray, recessed, concealed, ceiling, flush, flat spray and sidewall	57
OH	5.0	conventional, spray, ceiling, flush, flat spray, recessed, concealed and sidewall	80
HHP and HHS ceiling or roof sprinklers	less than or equal to 10	conventional, spray	80 or 115
	more than 10	conventional, spray	115
HHS intermediate sprinklers in high piled storage		conventional, spray and flat spray	80 or 115

13.2.2 Ceiling, flush, recessed and concealed pattern

Ceiling, flush, recessed and concealed sprinklers shall not be installed in OH4, HHP or HHS areas.

Sprinklers without fixed deflectors, e.g. with retracted deflectors which drop to the operating position on actuation, and shall not be fitted in the following situations:

a) where the ceiling is more than 45° from the horizontal;

b) in situations where the atmosphere is corrosive or likely to have a high dust content; and

c) in racks or under shelves.

13.2.3 Sidewall pattern

Sidewall sprinklers shall not be installed in HH installations or OH storage areas or above suspended ceilings. They may only be installed under flat ceilings.

Sidewall sprinklers shall be used only in the following cases:

a) in LH, OH1, and OH3 without storage;

b) OH4 non-storage risks; and

c) For the protection of corridors, cable ducts and columns in HH.

13.2.4 Flat spray pattern

Flat spray sprinklers shall be used only in concealed spaces, above suspended open ceilings and in racks.

13.3 Flow from sprinklers

The water flow from a sprinkler shall be calculated from the following equation:

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

where,

Q is the flow in litres per minute;

K is the constant given in Table 38;

P is the pressure in bar.

13.4 Sprinkler temperature ratings

Sprinklers shall be chosen with a temperature rating close to but no lower than 30 °C above the highest anticipated ambient temperature.

In unventilated concealed spaces, under skylights or glass roofs, etc., it may be necessary to install sprinklers with a higher operating temperature, up to 93 °C or 100 °C. Special consideration shall be given to the rating of sprinklers in the vicinity of drying ovens, heaters and other equipment, which gives off radiant heat.

NOTE. Under normal conditions in temperate climates, a rating of 68 °C or 74 °C is suitable.

Sprinklers are colour coded in accordance with MS ISO 6182: Part 1 to indicate their temperature rating as tabulated in Table 39.

Table 39. Sprinkler temperature rating and colour coding

Bulb	Temperature rating (°C)	Fusible link	Temperature rating (°C)
Orange	57	-	-
Red	68	Uncoloured	68/74
Yellow	79	-	-
Green	93	White	93/100
Blue	141	Blue	141
Mauve	182	Yellow	182
Black	204/260	Red	227

13.5 Sprinkler thermal sensitivity

13.5.1 General

Sprinklers of different sensitivities shall be used in accordance with Table 40. Where sprinklers are situated in racks, the sprinklers at the ceiling shall have a sensitivity equal to or of slower response than the sprinklers situated in the racks.

Table 40. Sprinkler sensitivity ratings

Sensitivity rating	In-rack	Ceiling above in-rack sprinklers	Dry systems pre-action Type A	All others
Standard 'A'	No	Yes	Yes	Yes
Special	No	Yes	Yes	Yes
Quick	Yes	Yes	No	Yes
NOTE. When new sprinklers are added to an existing sprinkler installation, it may be necessary to take into account the effect of different sensitivities in order to avoid excessive activation's.				

NOTE. Most types of sprinkler are rated, in descending order of sensitivity, as one of the following types (see MS ISO 6182: Part 1):

a) quick response;

b) special response; and

c) standard response 'A'.

13.5.2 Interaction with other measures

Account shall be taken of possible interaction between sprinkler systems and other measures. Consequently the responsiveness of sprinkler systems shall not be inhibited.

The effective functioning of other fire safety measures may depend on the most effective operation of sprinkler equipment, and in such instances the total fire safety measures shall not be impaired. Particular attention shall be given to this aspect when High Hazard systems are involved.

The effective functioning of sprinkler systems depends on the early suppression or control of fire in the early stages. Except when located in racks, sprinklers are normally operated by the flow of hot combustion gases from the fire horizontally across the sprinklers. Consequently, nothing shall interfere with this horizontal flow of combustion gases.

13.6 Sprinkler guards

When sprinklers, other than ceiling or flush sprinklers, are installed in a position at risk of accidental mechanical damage, they shall be fitted with a suitable metal guard.

13.7 Sprinkler water shields

Sprinklers installed in racks, or under perforated shelves, platforms, floors or similar locations, where water from a higher sprinkler or sprinklers may cause wetting close to the bulb or fusible element, shall be fitted with a metal water shield with a diameter of between 0.075 m and 0.15 m.

Water shields on upright sprinklers shall not be attached directly to the deflector or yoke, and any bracket supports shall be designed so as to minimise obstruction to the sprinkler water distribution.

13.8 Sprinkler rosettes

Rosettes shall be made of metal and shall not be used to support ceilings or other structures. No part of a rosette shall project from the ceiling below the top of the visible portion of the heat sensitive element of the sprinkler.

13.9 Corrosion protection of sprinklers

Sprinklers installed in premises where corrosive vapours are prevalent shall be protected with a suitable corrosion resistant coating applied by the supplier in conformity with EN 12259-1 unless the sprinklers are manufacture from suitably corrosion resistant material

14 Valves

14.1 Control valve set

14.1.1 General

A sprinkler installation shall be fitted with a control valve set suitable for sprinkler service to control the water supply to the installation in accordance with MS ISO 6182: Part 2 or MS ISO 6182: Part 3.

The main installation alarm valve(s) shall be fitted immediately downstream of the main stop valve (see 14.2).

NOTE. In high rise building the alarm valves should be suitable for the installation working pressure. Wet and mechanical dry valves are usually designed to control the flow of water to the hydraulic alarm by the clack seat ring normally covering a port in the valve seat which communicates with the hydraulic alarm connection point. When the valve opens the movement of the clack uncovers the seat ring port. Alternatively the clack may carry an auxiliary valve covering a seating at the opening to a port leading to the alarm connection point. Differential dry pipe valves have a permanently drained intermediate chamber, between the water and air seatings, from which the alarm connection is taken.

14.1.2 Life safety installation

Life safety installations shall be of the wet pipe type (see Figure F.1.).

14.1.3 Tail end extensions

Tail end extensions shall be of the dry pipe type to retain the air pressure.

14.1.4 Valve clack seal

An alarm valve controlling the water supply to either a high temperature area or to an area where freezing temperature may occur shall be of the following:

a) type without a water seal; or

b) positioned at such a distance from the protected area that the water seal is not affected by the high temperature or freezing.

NOTE. A valve serving an area exposed to freezing conditions should be installed in a heated position (4 °C minimum temperature) so that any water seal required will be prevented from freezing. This approach is not always practicable for cold store protection as the moist air in the distribution pipe may lead to water condensation and ice formation at the point where the pipework enters the cold store. Any special sealing arrangement adopted for either the seal liquid or seat washer should be suitable for sprinkler service.

14.2 Stop valves

All stop valves which may cut off the water supply to the sprinklers shall:

a) close in the clockwise direction;

b) be fitted with an indicator that clearly shows whether it is in the open or closed position; and

c) be secured in the right position by a strap and padlock or secured in an equivalent manner such as a locked room with access to authorised trained personnel only.

Butterfly valves shall be of the gear operated type. Stop valves may not be installed downstream of the control valve set except as specified in this standard.

NOTE. The spindle seal on a pump suction valve should be suitable for operation under suction conditions so that air cannot be drawn into the pump. Stop, test, drain and flushing valves used in high rise systems should be suitable for the installation working pressure.

14.2.1 Main stop valves

14.2.1.1 Installations except life safety installations

A main stop valve shall be fitted immediately upstream of the main alarm valve of an installation.

Main stop valves shall be at a fire brigade access level and readily accessible when responding to a fire alarm.

NOTE. Control valve sets for an installation protecting explosion hazards should be in a building directly accessible from the open air and separate from the containment areas.

14.2.1.2 Life safety installations

See Annex H.

14.2.1.3 Water supply stop valves

For elevated private reservoirs and gravity tanks, a stop valve shall be fitted upstream of and close to the non-return valve.

14.2.1.4 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 control valve set;

b) immediately downstream of a tail end or installation alarm valve where it is not practicable to allow water to enter the pipework for routine alarm valve test purposes. The valve shall be a screw down diaphragm valve of the type which interlocks when closed;

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;

d) each section and/or zone of an installation in a life safety, high rise or multi-storey installation. The stop valve shall be electrically monitored and secured open; and

e) each zone of an installation.

NOTE. Subsidiary water supply stop valves are valves which control water supply to sprinklers fitted downstream of main installation control valves or which control sprinklers in remote pump or pressure tank houses.

It is recommended that an installation be divided into zones where this is appropriate, for example, in a shopping complex where the installation covers more than one shop unit

14.3 Ring main valves

Where sprinkler systems are fed by a ring main supply pipe arrangement on the premises, stop valves shall be installed to isolate the ring into sections, in such a way that no section shall include more than four control valve sets.

14.4 Drain valves

Drain valves shall be fitted as specified in Table 41 to allow drainage from pipework as follows:

a) immediately downstream of the control valve set or of its downstream stop valve if fitted;

b) immediately downstream of any subsidiary alarm valve;

c) immediately downstream of any subsidiary stop valve for pre-action systems;

d) between a dry pipe or subsidiary control valve set and any subsidiary stop valve installed for testing; and

e) any pipe, with the exception of drop pipes to single sprinklers in a wet installation, which cannot be drained through another drain valve.

Table 41. Minimum size of drain valves

Valve principally draining:	Minimum diameter of valve and pipe (mm)
LH installation	40
OH or HHP or HHS installation	50
Subsidiary installation	50
A zone	50
Trapped distribution pipes, diameter $>$ 80 mm nominal bore	40
Trapped distribution pipes, diameter $\leq$ 80 mm nominal bore	25
Trapped range pipes	25
Trapped pipework between dry or subsidiary alarm valve and a subsidiary stop valve installed for testing purposes	15

The valves shall be fitted at the lower end of permanent pipework sized as specified in Table 41. The outlet shall be not more than 3.0 m above the floor and shall be fitted with a cap, plug or blank flange.

14.5 Test valves

14.5.1 Alarm and pump start test valves

15 mm test valves shall be fitted, as appropriate, to test the following:

a) the hydraulic alarm and any electric alarm pressure switch by drawing water from the immediate downstream side of a wet alarm valve, and any downstream main stop valves;

b) the hydraulic alarm and any electric alarm pressure switch by drawing water downstream of the main water supply stop valve and from the upstream side of:

   i) a dry pipe alarm valve; or

   ii) a pre-action alarm valve.

c) any water flow alarm switch installed downstream of the control valve set by drawing water downstream of the water flow alarm;

d) an automatic pump starting device; and

e) any pump or pressure tank house sprinkler alarm flow switch installed upstream of the control valve set.

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

14.5.2 Remote test valves

A test facility shall be provided, incorporating a test valve with any associated fittings and pipework, delivering a flow equivalent to the discharge from a single sprinkler, connected at the hydraulically most remote location on a distribution pipe of each zone.

NOTE. The test facility is provided to ensure that the pipe network is not blocked and to ensure that the zone sprinkler flow switch will function correctly.

14.5.3 Test cocks

A test cock shall be fitted as follows:

a) on suction pump supplies, upstream of the pump outlet stop valve and the check valve; and

b) on town main, gravity tank or elevated private reservoir supplies, upstream of the check valve and downstream of the water supply stop valve.

14.6 Flushing connections

Flushing connections, with or without permanently installed valves, shall be fitted on the spur ends of the installation distribution pipes.

Flushing connections shall be of the same size as the distribution pipe. For pipes bigger than DN 40 flushing connections of DN 40 may be used, if connected to the lower side of the distribution pipe. Flushing connections shall be fitted with a suitable plug.

It may be desirable in certain cases to fit flushing connections on ranges, e.g. in the form of a blank tee. In addition to their use for periodic flushing of the pipework, flushing connections may be used to check that water is available and for carrying out pressure and flow tests.

14.6.1 Life safety

Each zone shall be fitted with a valve not less than 20 mm nominal size, either on the end of the distribution pipe hydraulically most remote from the water supply, or on the end of each distribution pipe spur as appropriate. The valve outlet shall be fitted with a plug, cap or blank flange.

NOTE. A flushing valve of the same nominal size as the range pipe to which it is connected may be fitted at the level of the highest sprinkler to conduct periodic flushing and/or a comparative running pressure test. The valves may be used to check that water is available as well as for occasional flushing use. In addition flushing connections may be fitted to the ends of distribution and range pipes. These should be capped, threaded nipples 50 mm or the same size as the pipe whichever is the smaller.

14.7 Pressure relief valves

Pipework, which is completely full of water, may be damaged by the increase in pressure due to temperature rises. If complete venting of air in an installation is likely to occur, e.g. in the case of a gridded layout with flushing connections at the extremities, consideration shall be given to the fitting of pressure relief valves.

14.8 Pressure gauges

14.8.1 General

Pressure gauge scale divisions shall not exceed:

a) 0.2 bar for a maximum scale value less than or equal to 10.0 bar; and

b) 0.5 bar for a maximum scale value greater than 10.0 bar.

The maximum scale value shall be of the order of 150 % of the maximum pressure.

14.8.2 Water supply connections

Each pump supply shall be fitted with a damped pressure gauge ('A' gauge) on the supply pipe immediately downstream of the outlet non-return valve and upstream of any outlet stop valve.

Each pump suction shall be fitted with a compound pressure gauge on or immediately upstream of the pump suction flange (see Figures 6 and 7).

14.8.3 Control valve set

A pressure gauge shall be fitted at each of the following locations:

a) immediately upstream of each control valve set, ('B' gauge);

b) immediately downstream of each control valve set, ('C' gauge); and

c) immediately downstream of each dry subsidiary control valve set, but upstream of any stop valve.

The ‘B’ gauge on dry alarm valves shall have an indicator showing the maximum pressure attained.

14.8.4 Removal

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

15 Alarms and alarm devices

15.1 Water motor alarm and gong

15.1.1 General

Each control valve set shall be provided with a water motor alarm in accordance with MS ISO 6182: Part 2 and an electrical device for remote alarm indication, both located as close as possible to the alarm valve. A single alarm motor and gong may be installed common to a group of wet alarm valves provided that these are situated in the same valve room and an indicator is fitted to each alarm valve to show when it is operating.

Each water motor alarm gong shall be prominently marked with the number of the installation.

15.1.2 Water motor and gong

The water motor shall be installed in such a way that the gong is on the outside of an exterior wall and with its centre line not higher than 6.0 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 arranged so that any flow of water can be seen.

15.1.3 Piping to water motor

The piping shall be 20 mm diameter galvanised steel or non-ferrous metallic material. The equivalent length of pipe between the alarm valve and the water motor shall be no more than 25 m assuming an equivalent length of 2.0 m for each change of direction.

The pipe shall be fitted with a stop valve located within the premises and shall be provided with a permanent drain through an orifice of no more than 3 mm in diameter. The orifice plate may be integral with the pipe fitting, and shall be made either of stainless steel or of a non-ferrous material.

15.2 Electrical water flow and pressure switches

15.2.1 General

Electrical devices to detect the operation of sprinkler systems shall be either water flow switches conforming to EN 12259-5 or pressure switches conforming to prEN 12259-8.

15.2.2 Water flow alarm switches

Water flow alarm switches shall only be used in wet installations. A test connection shall be fitted downstream of each switch to simulate the operation of a single sprinkler. It shall be fitted with a drain.

The draw-off pipe shall be galvanized steel or copper. The pressure/flow characteristic of the fully opened test valve and draw-off pipe shall be equal to that of the smallest nominal bore sprinkler supplied through the flow switch. Any orifice plate shall be at the pipe outlet and shall be either stainless steel or non-ferrous material.

The test pipe outlet shall be positioned relative to the drainage system in such a way that the flow of water can be seen during tests.

15.2.3 Dry and pre-action systems

Each installation shall be provided with a low air/gas pressure alarm, to provide a visual and audible warning in accordance with Annex F.

15.3 Fire brigade and remote central station alarm connection

The equipment for automatic transmission of alarm signals from a sprinkler installation to a fire brigade or remote manned centre shall be capable of being checked for:

a) continuity of the connection; and

b) continuity of the connection between the alarm switch and the control unit.

NOTE. If a direct connection to the fire brigade exists, the testing procedure should be agreed with the authorities in order to avoid false calls.

16 Pipework

16.1 General

The nominal pressure rating of pipe and fittings shall be greater than the expected test pressure of the system.

16.1.1 Underground piping

Pipes shall be laid in accordance with the supplier's recommendations and shall have sufficient corrosion resistance.

NOTES:

1. The following types of pipe are recommended: heavy duty cast iron, ductile iron, stainless steel, reinforced glass fibre, polyethylene high density, mild steel cement lined and galvanised steel pipe complete with additional anti-corrosion system.

2. All nuts, bolts and washers installed underground shall be of:

a) stainless steel; or

b) hot dipped galvanised mild steel, protected with an anti-corrosion system.

Adequate precautions shall be taken to prevent damage to piping, for example by passing vehicles.

16.1.2 Above ground piping

Piping downstream of control valves shall be steel or copper (see 16.1.10) or other material in accordance with appropriate specifications valid in the place of use of the system. When steel pipes of diameter equal to or less than 150 mm are threaded, cut-grooved or otherwise machined whereby material is cut or removed, they shall have a minimum wall thickness in accordance with Medium Class of MS 863. For larger diameters the minimum wall thickness shall be in accordance with MS 862.

Copper pipes shall be in accordance with EN 1057.

NOTE. For dry or pre-action installations, galvanized steel should preferably be used.

16.1.3 Welding of steel pipe

Pipes and fittings less than 50 mm in diameter shall not be welded on site except if the installer uses an automatic welding machine. In no case shall welding, flame cutting, soldering or any other hot work be carried out in situ without the necessary safety precautions.

Welding of sprinkler pipework shall be carried out in such a way that:

a) all joints are welded continuously;

b) the inside of the weld does not interfere with the flow of water; and

c) the piping is deburred and the slag removed.

Pipe fittings used shall be standard items as manufactured by approved manufacturers. The use of fabricated tees, tap-offs, bends or any fittings are not permitted.

For odd angles, cutting of welding bends to achieve odd angles are permitted. Site or self fabricated mitred bends and mitred elbows are not permitted.

Welders shall be approved and certified by the relevant authorities.

16.1.4 Mechanical pipe joints for steel piping

Mechanical pipe joints shall be in accordance with prEN 12259-6.

16.1.5 Flexible pipes and joints

If relative movement is likely to occur between different sections of pipework within the sprinkler system, e.g. owing to expansion joints or in the case of certain types of racking, a flexible section or joint shall be fitted at the point of connection to the distribution main. It shall meet the following requirements:

a) before installation, it shall be capable of withstanding a test pressure of four times the maximum working pressure or 40 bar, whichever is the greater, and shall not include parts which, when subject to fire, might impair either the integrity or the performance of the sprinkler system; and

b) flexible pipes shall contain a continuous pressure-retaining stainless steel or non-ferrous metal inner tube;

   i) flexible pipes shall not be fitted in the fully extended position; and

   ii) flexible pipes and joints shall not be used to take up misalignment between a distribution main and the feed pipes to intermediate sprinklers.

16.1.6 Concealment

Pipes shall be installed in such a way that they are easily accessible for repairs and alterations. They shall not be embedded in concrete floors or ceilings.

NOTE. Wherever possible, piping should not be installed in concealed spaces, which make inspection, repairs and modifications difficult.

16.1.7 Protection against fire and mechanical damage

Piping shall be installed in such a way that the pipes are not exposed to mechanical damage. Where pipes are installed above gangways with low headroom, or at intermediate levels, or in other similar situations, precautions shall be taken against mechanical damage. Where it is unavoidable for water supply pipework to pass through an unsprinklered building, it shall be installed at ground level and shall be enclosed to protect against mechanical damage, with appropriate fire resistance.

16.1.8 Painting

Non-galvanised ferrous pipework shall be painted. Galvanised piping shall be painted wherever the coating has been damaged, e.g. by threading.

NOTE.Extra protection may be needed for unusually corrosive conditions.

16.1.9 Drainage

Means shall be provided to enable all the pipework to be drained. Where this cannot be done through the drain valve at the control valve set, extra valves shall be fitted in accordance with 14.4.

In the case of dry and pre-action installations, range pipes shall have a slope towards the distribution pipe of at least 0.4 % and distribution pipes shall have a slope towards the appropriate drain valve of at least 0.2 %. Range pipes shall only be connected to the side or top of distribution pipes.

16.1.10 Copper pipe

Copper pipes may be used only in wet pipe systems for LH, OH1, OH2 and OH3 downstream of any steel piping. Copper pipes shall be joined either by mechanical joints or by hard soldering, using fittings according to EN 1254.

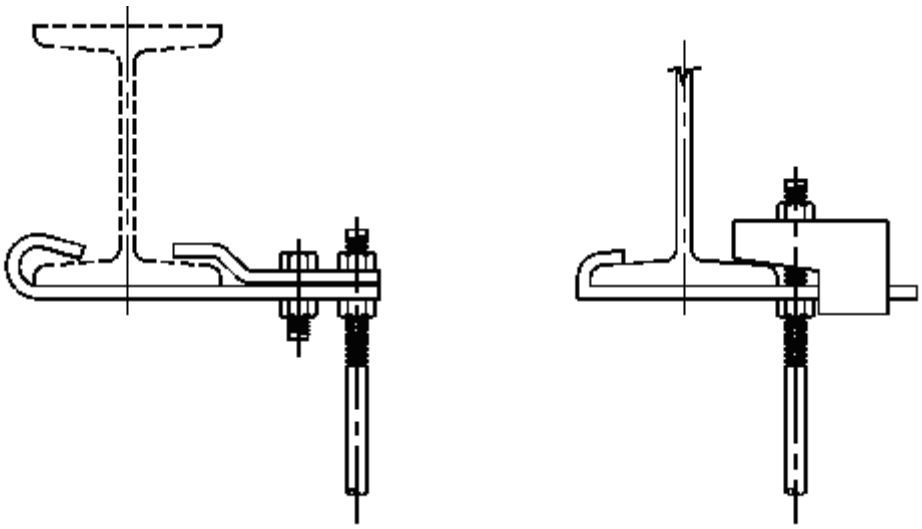
For hard soldering, copper to copper joints and joints involving alloys of copper and zinc (brass) or copper, tin and zinc (gunmetal) shall be made according to ISO 3677. Hard solder connections shall only be carried out by properly trained personnel.

Copper to steel joints shall be flanged, using stainless steel bolts. Piping shall not be bent on site. Precautions shall be taken to avoid galvanic corrosion.

16.2 Pipe supports

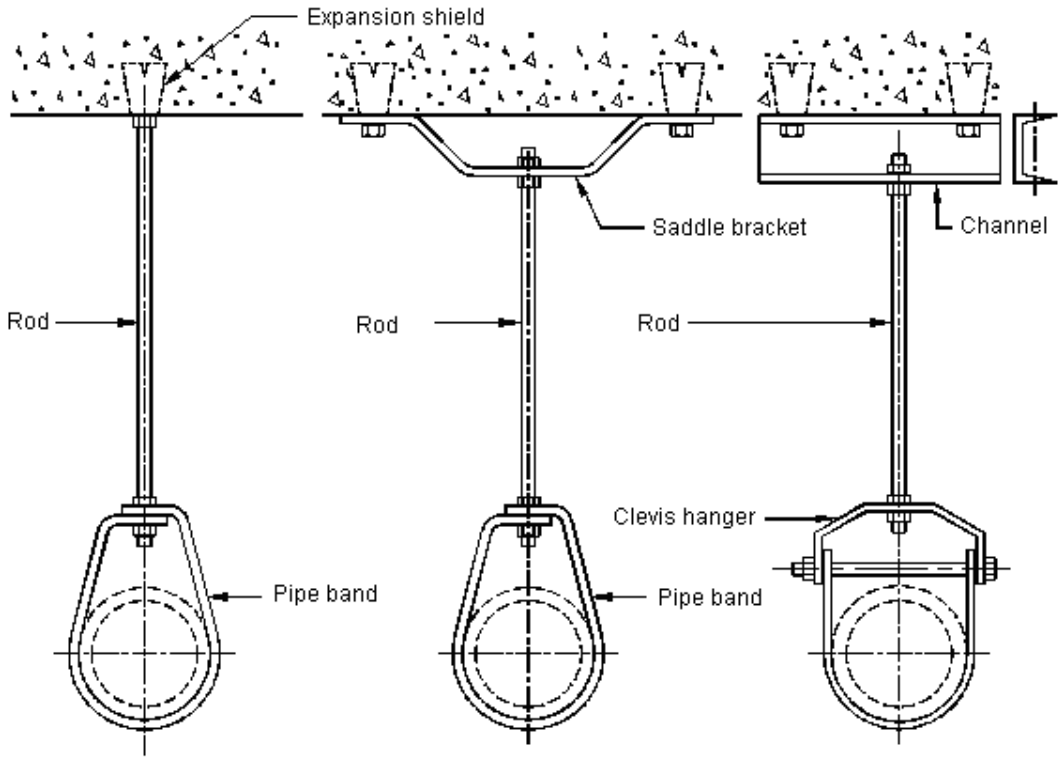
16.2.1 General

Pipe supports shall be fixed directly to the building or, if necessary, to machines, storage racks or other structures. Preferably, they shall not be used to support any other installations. Where a common support is unavoidable, they shall be manufactured in a manner rigid enough to avoid movement of the pipe and pipe support under the worst possible conditions of operation inclusive of fire. They shall be of the adjustable type in order to secure an even load-bearing capability. Supports shall completely surround the pipe and shall not be welded to the pipe or fittings.



a) Girder or beam clamp

b) Girder or beam clamp

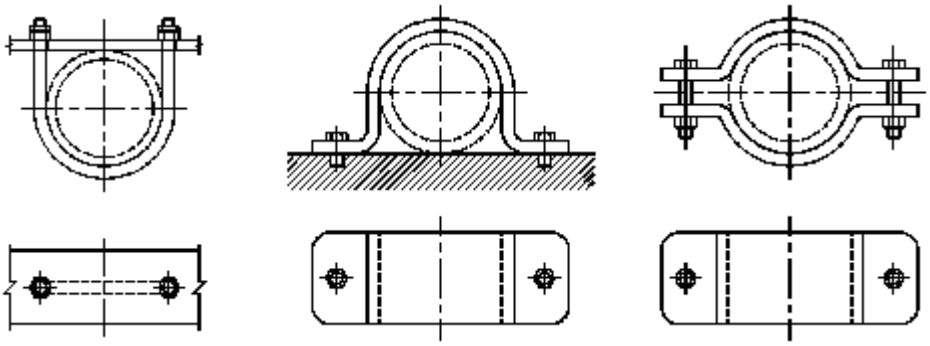


a) Expansion shield, rod and Pipe band

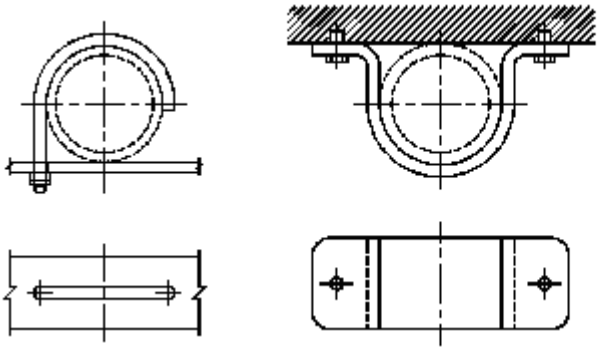
d) Saddle bracket, rod and pipe band

e) Channel bracket, rod and clevis hanger

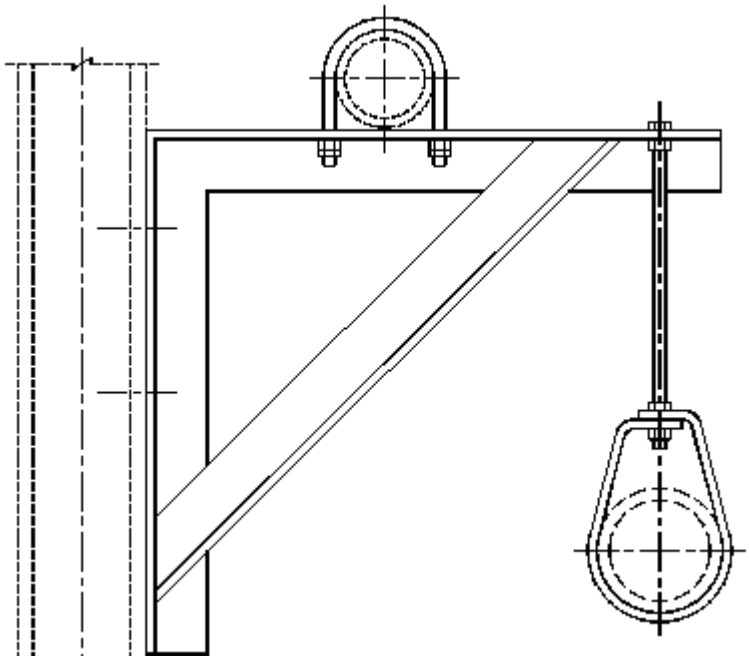
Figure 31. Typical pipe support components



f) U-bolt g) U-clip h) Riser clamp

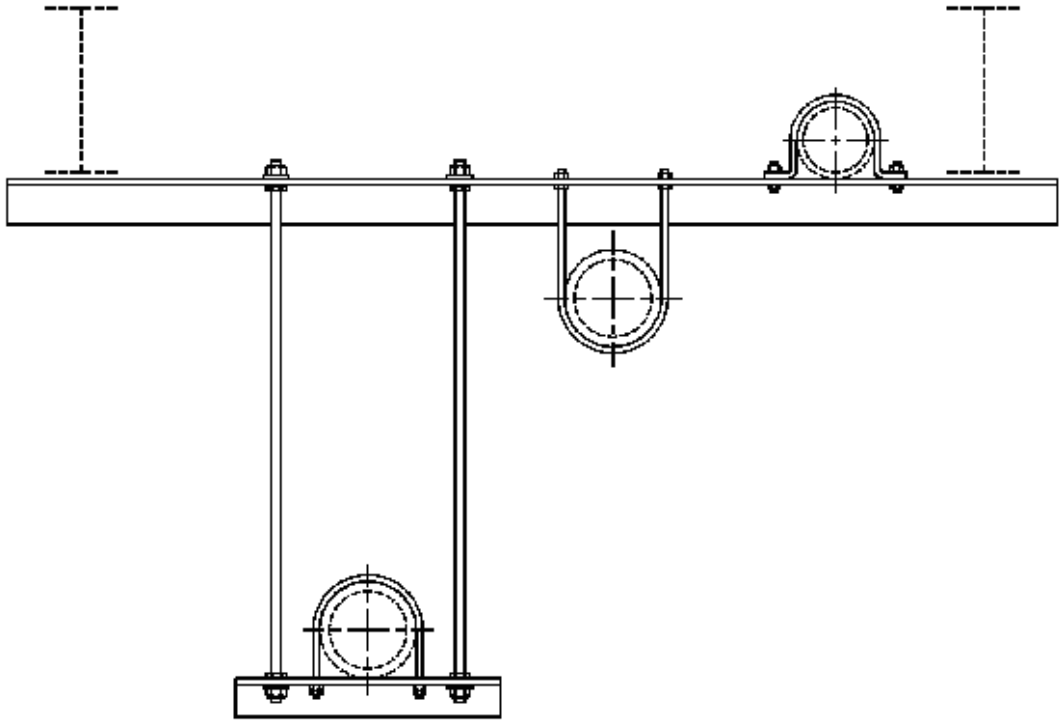


i) Hook bolt j) U-hanger



k) Cantilever type illustrating two type applications

Figure 31. Typical pipe support components (*continued*)



i) Pipe support beam illustrating three typical applications

Figure 31. Typical pipe support components (*continued*)

The part of the structure to which the supports are secured shall be capable of supporting the pipework (see Table 43). Pipes greater than 50 mm diameter shall not be supported from corrugated steel sheet or aerated concrete slabs.

Distribution pipes and risers shall have a suitable number of fixed points to take account of axial forces.

No part of any support shall be made of combustible material. Nails shall not be used. Supports for copper pipes shall be provided with a suitable lining with sufficient electrical resistance, in order to prevent galvanic corrosion.

16.2.2 Spacing and location

Supports shall be spaced in accordance with Table 43.

Table 42. Maximum distance between pipe supports

Nominal pipe diameter (mm)	Maximum support spacing	
	Steel pipes (m)	Copper pipes (m)
$d \leq 65$	4.0	2.4
$65 < d \leq 100$	6.1	3.6
$100 < d \leq 250$	6.5	4.5

Where the spacing of pipe supports is unable to comply with Table 42 for any of the following reasons, the method shown in Figure 32 shall be used:

a) absence of structural or architectural elements for fixing pipe supports;

b) inappropriate spacing or location of structural or architectural elements for fixing pipe supports resulting in spacing exceeding Table 42; and

c) structural or architectural elements are unable to support the resulting load from the proposed pipe support.

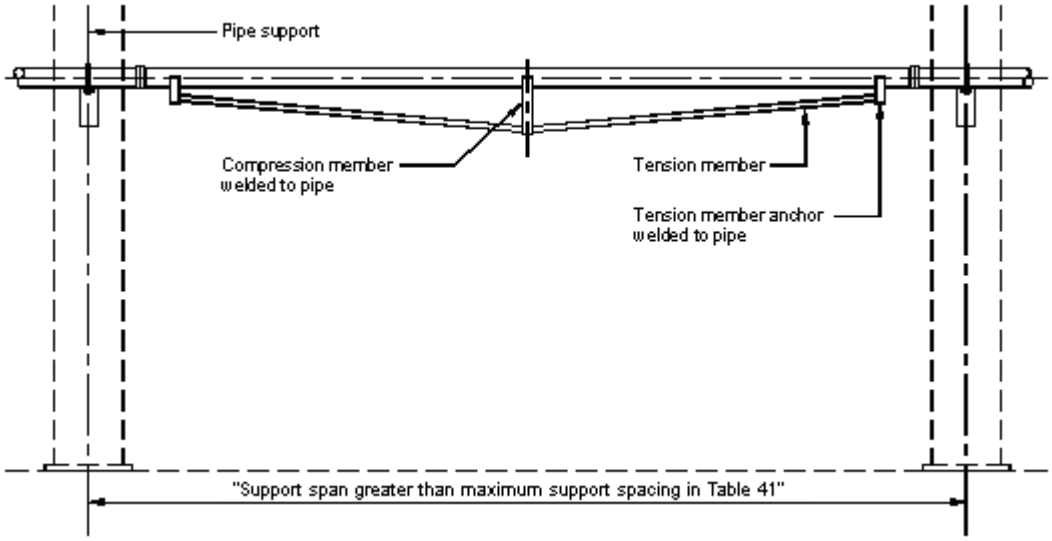


Figure 32. Typical method of support for extended spans exceeding the requirements of Table 42

When mechanical pipe joints are used:

a) there shall be at least one support within 1.0 m of each joint; and

b) there shall be at least one support on each pipe section, exceeding a span of 2.0 m.

The horizontal distance from any terminal sprinkler to a support shall not exceed:

a) 0.9 m for 25 mm diameter piping; and

b) 1.2 m for piping greater than 25 mm diameter.

The distance from any upright sprinkler to a support shall not be less than 0.15 m.

NOTE. This is to prevent the support from affecting the sprinkler head discharge pattern, and therefore the coverage of the sprinkler head.

Vertical pipes more than 2.0 m long shall have additional supports.

Pipes that are at a low level or otherwise vulnerable to mechanical impact shall be separately supported except for the following cases:

a) horizontal arm pipes less than 0.45 m long feeding individual sprinklers; and

b) drop or rise pipes less than 0.6 m long feeding individual sprinklers.

16.2.3 Design

Pipe supports shall either be designed and tested in accordance with prEN 12259-7 or designed in accordance with the requirements of Tables 42, 43 and 44.

Table 43. Design parameters for pipe supports

Nominal pipe Diameter, d (mm)	Minimum load capacity at 20 °C (see Note 1) (kg)	Minimum cross section (see Note 2) (mm^2)	Minimum length of anchor bolt(see Note 3) (mm)	Minimum number of anchor bolts per support assembly (see Note 4)
$d \leq 50$	200	30 (M8)	30	One
$50 < d \leq 80$	350	50 (M10)	40	One
$80 < d \leq 150$	500	70 (M12)	40	Two
		125 (M16)	50	One
$150 < d \leq 200$	850	125 (M16)	50	Two
		225 (M20)	50	One
$200 < d \leq 250$	1000	125 (M16)	50	Two
		225 (M20)	50	One

NOTES:

1. When the material is heated to 200 °C the load bearing capacity should not deteriorate more than 25 %.
2. The nominal cross section of threaded rods should be increased so that the minimum cross section is still achieved.
3. The length of anchor bolts depends on the type used and the quality and type of material into which they are fixed. The values given are for concrete.
4. Single anchor bolt support for pipes are only permitted for anchoring to concrete slabs, concrete beams and concrete walls. Twin anchor supports are required for all other building materials.

16.3 Pipework in concealed spaces

Where sprinkler protection is required in concealed spaces such as false ceilings and floors, the pipework shall be designed as follows:

16.3.1 False ceilings above OH occupancies

Sprinklers above the ceiling may be fed from the same range pipes as the sprinklers below the ceiling. In pre-calculated systems, the sprinklers shall be taken cumulatively for the purposes of determining pipe diameters.

16.3.2 All other cases

The sprinklers in the concealed space shall be fed from separate range pipes. In the case of pre-calculated systems, the diameter of distribution pipes feeding sprinklers both inside and outside the concealed space shall be not less than 65 mm.

Table 44. Minimum dimension of flat iron rods and clips

Nominal pipe diameter (mm)	Minimum material cross section		Maximum hole size in clip (mm)
	Ungalvanised (mm)	stainless steel or galvanised (mm)	
$d \leq 65$	20 x 3.0	20 x 1.2	11
$65 < d \leq 100$	25 x 3.0	25 x 1.2	11
$100 < d \leq 150$	32 x 3.0	32 x 1.6	13
$150 < d \leq 200$	40 x 3.0	40 x 2.0	18
$200 < d \leq 250$	50 x 3.0	50 x 2.0	22

Table 45. Minimum dimension of sling rods and 'U' bolts

Nominal pipe diameter (mm)	Minimum diameter of single sling rod or 'U' bolt (mm)
$d \leq 50$	8
$50 < d \leq 100$	10
$100 < d \leq 150$	12
$150 < d \leq 200$	16
$200 < d \leq 250$	20

17 Signs, notices and information

17.1 Block plan

17.1.1 General

A block plan of the premises shall be placed in the main fire control room or elsewhere, where it can readily be seen by the fire brigade or others responding to an alarm. The plan shall show:

a) the installation number and the location of the corresponding control valve set and water motor alarm;

b) each separate area of hazard classification, the relevant hazard class and, where appropriate, the maximum storage height;

c) by means of colour shading or hatching the area covered by each installation and, if required by the fire brigade, indication of routes through the premises to those areas; and

d) the location of any subsidiary stop valves.

17.2 Signs and notices

17.2.1 Location plate

A location plate of weather-resistant material and lettering shall be fixed on the outside of the external wall as close as practical to the entrance nearest the control valve set(s). The plate shall bear the wording as

'SPRINKLER STOP VALVE'

in letters no less than 35 mm high, and

'INSIDE'

in letters no less than 25 mm high. The wording shall be in white letters on a red background.

17.2.2 Signs for stop valves

A sign shall be fitted close to the main and any subsidiary stop valves bearing the words as

'SPRINKLER CONTROL VALVE'

The sign shall be rectangular with white letters no less than 20 mm high on a red background. Where the stop valve is enclosed in a room with a door the sign shall be fixed on the outside of the door, and a second sign, bearing the words 'Keep locked shut', shall be fixed on the inside of the door. The second sign shall be circular with white letters no less than 5 mm high, on a blue background.

17.2.3 Control valve set

17.2.3.1 General

Where the sprinkler system comprises more than one installation each control valve set shall be prominently marked with the number identifying the installation it controls.

17.2.3.2 Fully calculated installations

In fully calculated installations a durable notice shall be fixed to the rise pipe next to each control valve set.

The notice shall include the following information:

a) the installation number;

b) the hazard classification or classifications of the installation; and

c) for each hazard class area within an installation:

   i) the design requirements (area of operation and density of discharge);

   ii) the pressure-flow requirement at the 'C' gauge or flow test facilities for the most unfavourable and most favourable areas of operation;

   iii) the pressure-flow requirement at the pump delivery pressure gauge for the most unfavourable and most favourable areas of operation;

   iv) the height of the highest sprinkler above the level of the 'C' gauge; and

   v) the height difference between the 'C' gauge and the pump delivery pressure gauge.

17.2.4 Water supply connections to other services

A label shall be fixed to stop valves controlling water supplies from sprinkler system supply pipes or trunk mains to other services; it shall be appropriately marked; e.g. 'Fire fighting hose reels', 'Hydrant water supply' in raised or embossed lettering.

17.2.5 Suction and booster pumps

17.2.5.1 General

A nameplate shall be fixed to each suction or booster pump, carrying the following information:

a) the output pressure in bar, and the corresponding rated speed and flow in litres per minute, at the inlet condition and flow rating specified in Table 16; and

b) the maximum power absorbed at the relevant speed at any value of flow.

17.2.5.2 Fully calculated installations

The following details of each automatic pump set shall be provided in the operation and maintenance manual:

a) a pump characteristic curve for low water level 'X' (see Figures 4 and 5), showing the estimated performance of the pump or pumps under installed conditions at the control valve 'C' gauge;

b) the pump supplier's data sheet showing the following:

   i) the generated head graph;

   ii) the power absorption graph;

   iii) the net positive suction head (NPSH) graph; and

   iv) a statement of the power output of each prime mover;

c) the installer's data sheet showing the pump set installed performance pressure/flow characteristics, at the control valve 'C' gauge for normal water level and for low water level 'X' (see Figures 4 and 5), and at the pump outlet pressure gauge for normal water level;

d) the height difference between the control valve 'C' gauge and the pump delivery pressure gauge;

e) the installation number and the hazard classification(s);

f) the available and the specified NPSH at maximum required flow; and

g) the minimum depth of water cover of submersible pumps. Where the pipework is fully calculated, the demand pressure/flow characteristic for the hydraulically most unfavourable and most favourable area of operation calculated at the control valve 'C' gauge shall be provided.

17.2.6 Electric switches and control panels

17.2.6.1 Diesel pump set

The alarms specified in 9.8.6.1 and 9.9.11 at both the pump controller and the main fire alarm panel shall be marked as appropriate:

a) diesel fire pump starter switched off;

b) diesel fire pump failure to start;

c) pump running; and

d) diesel controller fault.

The manually operated shut-down mechanism (see 9.9.7.1) shall be labelled as follows:

'SPRINKLER PUMP SHUT-OFF'

17.2.6.2 Electric motor driven fire pump

Each switch on the dedicated power feed to an electric sprinkler fire pump motor shall be labelled as follows:

'SPRINKLER PUMP MOTOR SUPPLY -
NOT TO BE SWITCHED OFF IN THE EVENT OF FIRE'

17.2.7 Testing and operating devices

All valves and instruments used for testing and operation of the system shall be appropriately labelled. Corresponding identification shall appear in the documentation.

18 Commissioning and acceptance tests and periodic inspection

18.1 Commissioning tests

18.1.1 Pipework

18.1.1.1 Dry pipework

Dry pipework shall be tested pneumatically to a pressure of not less than 2.5 bar for not less than 24 h. Any leakage that results in a loss of pressure greater than 0.15 bar for the 24 h shall be corrected.

NOTE. If climatic conditions do not allow the hydrostatic test specified in 18.1.1.2 to be carried out immediately after the pneumatic test, it should be carried out as soon as conditions permit.

18.1.1.2 All pipework

All installation pipework shall be hydrostatically tested for no less than 2 h, to a pressure of no less than 15 bar, or 1.5 times the maximum pressure to which the system will be subjected, (both measured at the installation control valves), whichever is the greater.

Any faults disclosed, such as permanent distortion, rupture or leakage, shall be corrected and the test repeated.

Care shall be taken not to subject any system components to pressure higher than those recommended by the supplier.

18.1.2 Equipment

The system shall be tested once as specified in 19.2.2 and 19.3.2 (i.e. making the tests, which will be made on a routine weekly and quarterly basis) and any faults shall be corrected.

18.1.3 Water supplies

Water supplies shall be tested once as specified in 7.5, and diesel engine driven pumps shall be tested as specified in 19.2.2.5.

18.2 Completion certificate and documents

The installer of the system shall provide the user with the following:

a) a completion certificate stating that the system complies with all appropriate requirements of this standard, or giving details of any deviation from the requirements; and

b) a complete set of operating instructions and "as-built" drawings including identification of all valves and instruments used for testing and operation and a users programme for inspection and checking (see 19.2).

19 Maintenance

19.1 General

19.1.1 Programmed work

The user shall carry out a programme of inspection and checks (see 19.2), arrange a test, service and maintenance schedule (see 19.3) and keep records including a logbook which shall be held on the premises.

The user shall arrange for the test, service and maintenance schedule to be carried out under contract by the system installer or a similarly qualified company.

After an inspection, check, test, service or maintenance procedure the system, and any automatic pumps, pressure tanks and gravity tanks shall be returned to the proper operational condition.

NOTE. If appropriate, the user should notify interested parties of the intent to carry out tests and/or of the results.

19.1.2 Precautions while carrying out work

See Annex J for precautions to be taken while the system is not operational or after a sprinkler operation.

19.1.3 Replacement sprinklers

A stock of spare sprinklers shall be kept on the premises as replacements for operated or damaged sprinklers. Spare sprinklers, together with sprinkler spanners as supplied by the supplier, shall be housed in a cabinet or cabinets located in a prominent and easily accessible position where the ambient temperature does not exceed 27 °C.

The minimum number of spare sprinklers per system shall be no less than:

a) 6 for LH installations;

b) 24 for OH installations; and

c) 36 for HHP and HHS installations.

The quantities mentioned above is applicable to the main type of sprinkler used.

Where installations other types of head e.g. high-temperature sprinklers, sidewall or other variations of sprinkler pattern or contain multiple controls, an adequate number of these spares, in addition to the above quantities, shall also be maintained. There should not be less than 6 numbers of spares for each additional type of sprinkler installed in the system.

The stocks shall be replenished promptly after spares are used.

19.2 User's programme of inspection and checking

19.2.1 General

The installer shall provide the user with a documented inspection and checking procedure for the system. The programme shall include instruction on the action to be taken in respect of faults, operation of the system, with particular mention of the procedure for emergency manual starting of pumps, and details of the weekly routine of 19.2.2.

19.2.2 Weekly routine

19.2.2.1 General

Each part of the weekly routine shall be carried out at intervals of no more than 7 days.

19.2.2.2 Checks

The following shall be checked and recorded:

a) all water and air pressure gauge readings on installations;

NOTE. The pressure in the pipework in dry and pre-action installations should not fall at a rate of more than 1.0 bar per week.

b) all water levels in elevated private reservoirs, rivers, canals, lakes, water storage tanks (including pump priming water tanks); and

c) the correct position of all main stop valves.

19.2.2.3 Water motor alarm test

Each water motor alarm shall be sounded for no less than 30 s.

19.2.2.4 Automatic pump starting test

Tests on automatic pumps shall include the following;

a) fuel and engine lubricating oil levels in diesel engines shall be checked;

b) water pressure on the starting device shall be reduced, thus simulating the condition of automatic starting;

c) when the pump starts, the starting pressure shall be checked and recorded; and

d) the oil pressure on diesel pumps shall be checked, as well as the flow of cooling water through open circuit cooling systems.

19.2.2.5 Diesel engine restarting test

Immediately after the pump start test of 19.2.2.4, diesel engines shall be tested as follows:

a) the engine shall be run for 20 min, or for the time recommended by the supplier. The engine shall then be stopped and immediately restarted using the manual start test button; and

b) the water level in the primary circuit of closed circuit cooling systems shall be checked.

Oil pressure (where gauges are fitted), engine temperatures and coolant flow shall be monitored throughout the test. Oil hoses shall be checked and a general inspection made for leakage of fuel, coolant or exhaust fumes.

19.2.2.6 Trace heating and localised heating systems

Heating systems to prevent freezing in the sprinkler system shall be checked for correct function.

19.2.3 Monthly routine

The electrolyte level and density of all lead acid cells (including diesel engine starter batteries and those for control panel power supplies) shall be checked. If the density is low the battery charger shall be checked, and if this is working normally, the battery or batteries affected shall be replaced.

19.3 Service and maintenance schedule

19.3.1 General

19.3.1.1 Procedures

In addition to the schedule given in this clause any procedures recommended by component suppliers shall be carried out.

19.3.1.2 Records

A signed, dated report of the inspection shall be provided to the user and shall include advice of any rectification carried out or needed, and details of any external factors, e.g. weather conditions, which may have affected the results.

19.3.2 Quarterly routine

19.3.2.1 General

The following checks and inspections shall be made at intervals of no more than 13 weeks.

19.3.2.2 Review of hazard

The effect of any changes of structure, occupancy, storage configuration, heating, lighting or equipment, etc. of a building on hazard classification or installation design shall be identified in order that the appropriate modifications may be carried out.

19.3.2.3 Sprinklers, multiple controls and sprayers

Sprinklers, multiple controls and sprayers affected by deposits (other than paint) shall be carefully cleaned.

Painted or distorted sprinkler heads, multiple controls or sprayers shall be replaced.

Any petroleum jelly coatings shall be checked. Where necessary the existing coatings shall be removed and the sprinklers, multiple controls or sprayers shall be coated twice with petroleum jelly (in the case of glass bulb sprinklers to the sprinkler body and yoke only).

Particular attention shall be paid to sprinklers in spray booths, where more frequent cleaning and/or protective measures may be necessary.

19.3.2.4 Pipework and pipe supports

Pipework and hangers shall be checked for corrosion and painted as necessary. Bitumen-based paint on pipework, including the threaded ends of galvanised pipework and hangers, shall be renewed as necessary.

NOTE. Bitumen-based paint may need renewal at intervals varying from 1 year to 5 years according to the severity of the conditions.

Tape wrapping on pipes shall be repaired as necessary.

The pipework shall be checked for electrical earthing connections. Sprinkler pipework shall not be used for earthing electrical equipment and any earthing connections from electrical equipment shall be removed and alternative arrangements made.

19.3.2.5 Water supplies and their alarms

Each water supply shall be tested with each control valve set in the system. The pump(s), if fitted, in the supply shall start automatically and the supply pressure at the appropriate flow rate shall be no less than the appropriate value in accordance with Clause 9, recognising any changes required by 19.3.2.2.

19.3.2.6 Electrical supplies

Any secondary electrical supplies from diesel generators shall be checked for satisfactory operation.

19.3.2.7 Stop valves

All stop valves controlling the flow of water to sprinklers shall be operated to ensure that they are in working order, and securely refastened in the correct mode. This shall include the stop valves on all water supplies, at the alarm valve(s) and all zone or other subsidiary stop valves.

19.3.2.8 Flow switches

Flow switches shall be checked for correct function.

19.3.2.9 Replacement

The number and condition of replacement parts held as spare shall be checked.

19.3.3 Half-yearly routine

19.3.3.1 General

The following checks and inspections shall be made at intervals of no more than 6 months.

19.3.3.2 Dry alarm valves

The moving parts of dry alarm valves, and any accelerators and exhausters, in dry pipe installations and subsidiary extensions shall be exercised in accordance with the supplier's instructions.

19.3.3.3 Fire brigade and remote central station alarm

The electrical installation shall be checked.

19.3.4 Yearly routine

19.3.4.1 General

The following checks and inspection shall be made at intervals of no more than 12 months.

19.3.4.2 Automatic pump flow test

Each water supply pump in the installation shall be tested at the full load condition (by means of the test line connection coupled to the pump delivery branch downstream of the pump outlet non-return valve) and shall give the pressure/flow values stated on the nameplate.

Appropriate allowances shall be made for pressure losses in the supply pipe and valves between the source and each control valve set.

19.3.4.3 Diesel engine failed-to-start test

The failed-to-start alarm shall be tested to be in accordance with 9.9.7.2.

Immediately after this test the engine shall be started using the manual starting system.

19.3.4.4 Float valves on water storage tanks

Float valves on water storage tanks shall be checked to ensure they function correctly.

19.3.4.5 Pump suction chambers and strainers

Pump suction strainers and settling chamber and their screens shall be inspected at least annually and cleaned as necessary.

19.3.5 Three-yearly routine

19.3.5.1 General

The following checks and inspections shall be made at intervals of no more than 3 years.

19.3.5.2 Storage tanks

All tanks shall be examined externally for corrosion. They shall be drained, cleaned as necessary and examined internally for corrosion.

All tanks shall be repainted and/or have the corrosion protection refurbished, as necessary.

19.3.5.3 Water supply stop valves, alarm and non-return valves

All water supply stop valves, alarm and non-return valves shall be examined and replaced or overhauled as necessary.

20 Evaluation of conformity

20.1 Sprinkler kit

20.1.1 General

The compliance of a sprinkler kit shall be demonstrated by:

a) initial type evaluation; and

b) factory production control by the kit supplier.

20.1.1.1 Initial type evaluation

The design of the kit shall be verified in accordance with the provisions of this standard. The performance of the components used in the kit shall be verified to be in accordance with the requirements of the design.

Where the kit supplier uses components in conformity with Malaysian Standards, or in their absence, European or ISO Standards, the performance stated by the component manufacturer may be used to satisfy this requirement. However, this does not remove the responsibility on the kit supplier to correctly select the components.

20.1.1.2 Factory production control by the kit supplier

The kit supplier shall establish, document and maintain a factory production control system to ensure that the kits placed on the market conform with the stated performance characteristics. The factory production control system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the kit. It shall be sufficiently detailed to ensure that the conformity of the kit is apparent, ensuring detection of irregularities at the earliest possible stage.

A quality control system conforming to the requirements of MS ISO 9001, and made specific to the requirements of this standard shall be considered to satisfy the above requirements.

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

The production control procedure shall be recorded in a manual. The kit supplier shall carry out and record the results of production tests as part of the production control.

20.2 Sprinkler system

20.2.1 General

The compliance of a sprinkler system with the requirements of this standard shall be demonstrated by:

a) the evaluation carried out in 20.1.1; and

b) commissioning tests (see Clause 18).

Annex A
(normative)

Special requirements for high rise systems

A.1 General

The requirements of this annex shall be applied to the sprinkler protection of multi-storey buildings with a height difference between the highest and lowest sprinkler exceeding 45 m.

The requirements are applicable to buildings intended for use with occupancies where the hazard is classified as no greater than OH3. Special fire engineering solutions are needed for high rise systems with hazards greater than OH3, and specialist advice should be sought.

A.2 Design criteria

A.2.1 Hazard group

High rise sprinkler systems shall comply with the requirements for Ordinary Hazard Group III protection, except for residential occupancies which shall be Ordinary Hazard Group I minimum.

A.2.2 Subdivision of high rise sprinkler systems

High rise sprinkler systems shall be sub-divided into sprinkler installations such that the height difference between the highest and lowest sprinkler on any one installation does not exceed 45 m (see Figures A.1 and A.2).

A.2.3 Standing water pressures at non-return and alarm valves

The minimum standing pressure at any non-return or alarm valve inlet shall be no less than 1.25 times the static head difference between the valve and the highest sprinkler on the installation.

Non-return and alarm valves controlling installation flow shall operate correctly with a ratio of service pressure to installation pressure not exceeding 1.16:1, as measured by valve lift and pressure equalisation upstream of the non-return valve. Alarm valves shall also comply with MS ISO 6182-2.

A.2.4 Calculation of distribution pipework for pre-calculated high rise systems

The main distribution pipes, including risers and drops, between the highest design point in an installation and the zone subsidiary stop valve at the same floor shall be sized by hydraulic calculations. The maximum friction loss shall not exceed 0.5 bar at a flow of 1 000 L/min.

Where sprinkler protection is at various floor in an installation the allowable pressure loss between the design points and zone subsidiary stop valves on lower floors, may be increased by an amount equal to the difference in static head gain between the sprinklers at the level concerned and the highest sprinkler in the installation.

A.2.5 Water pressures

Pipework, fittings, valves and other equipment shall be capable of withstanding the maximum pressure likely to be encountered.

To overcome the problem of pressures in excess of 12 bar, hydraulic alarm gongs may be driven via a pressure reducing valve or from a secondary water supply such as a town main, controlled by a diaphragm valve connected to the main installation control valve alarm port.

A.3 Water supplies

A.3.1 Types of water supplies

The system water supply shall be dedicated for sprinklers only.

A.3.2 Pressure and flow requirements for pre-calculated high rise installations

The water supply shall be designed to achieve a minimum pressure and flow condition at the zone subsidiary stop valve outlet as specified in Table 6, taking P_s to be the pressure difference equivalent to the height of the highest sprinkler above the installation zone subsidiary stop valve.

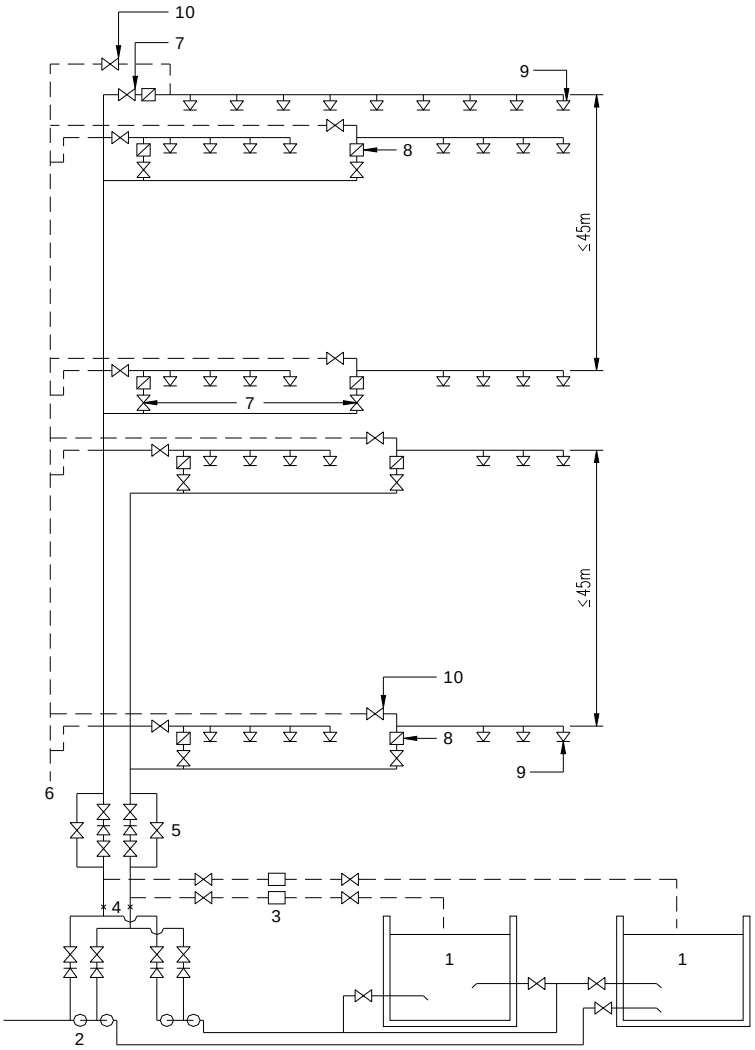
A.3.3 Water supply characteristics for pre-calculated high rise installations

The water supply characteristics shall be determined by a hydraulic calculation of the pipework upstream of the zone subsidiary stop valve outlet, at the higher and lower flow rates specified in Table 6, and shall include calculations at the water supply datum point.

A.3.4 Pump performance for pre-calculated high rise installations

Automatic pumps shall have characteristics in accordance with Table 16.

NOTE. Pressures are taken at the pump outlet or the relevant stage of multi-stage pumps, on the delivery side of any orifice plate.



Key

1 storage tank

2 multistage pump

3 flow meter

4 water supply datum point at pump discharge header

5 alarm valve station (with bypass arrangement)

6 flow test and zone drainage

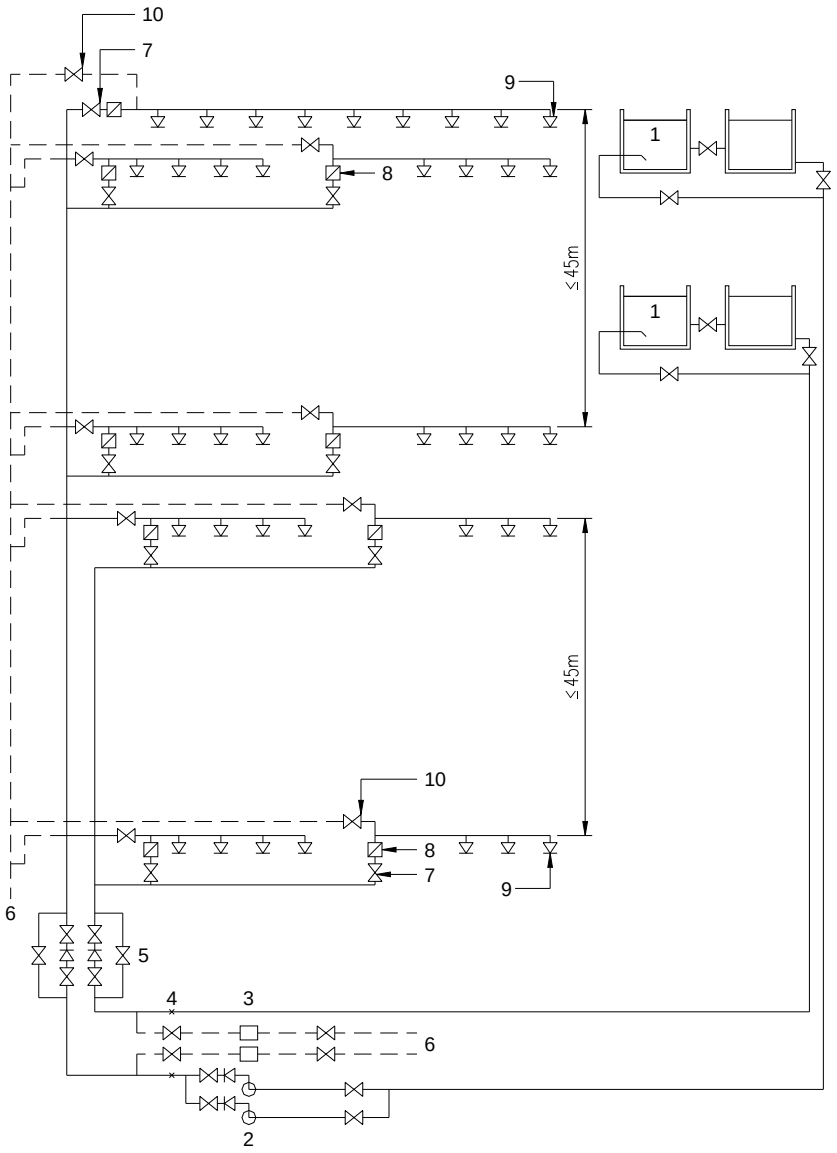
7 zone subsidiary stop valve

8 water flow alarm switch

9 sprinkler head

10 water flow alarm switch rest valve and zone drain valve

Figure A.1. Typical layout of high rise system with pump supply



Key

1	storage tank	6	flow test and zone drainage
2	multistage pump	7	zone subsidiary stop valve
3	flow meter	8	water flow alarm switch
4	water supply datum point	9	sprinkler head
5	alarm valve station (with bypass arrangement)	10	water flow alarm switch rest valve and zone drain valve

Figure A.2. Typical layout of high rise system with gravity tanks and booster pumps

Annex B
(normative)

Classification of hazards

Tables B.1 and B.2 contain lists of minimum hazard classification. They shall also be used as guidance for occupancies not specifically mentioned. They shall be read in conjunction with 5.2.

Light Hazard occupancies consists of:

a) schools and other educational institutions (certain areas);

b) offices (certain areas); and

c) prisons.

Table B.1. Ordinary Hazard occupancies

Occupancy	Ordinary Hazard group			
	OH1	OH2	OH3	OH4
Ceramics and glass	-	-	- glass factories	-
Chemicals	- cement works	- photographic film factories	- dyers works - soap factories - photographic laboratories - paint application shops with water based paint	-
Engineering	- sheet metal product factories	- metal working	- electronic factories - radio equipment factories - washing machine factories - car workshops	-
Food and beverages	-	- abattoirs, meat factories - bakeries - biscuit factories - breweries - chocolate factories - confectionery - dairies - factories	- animal fodder factories - corn mills - dehydrated vegetable and soup factories - sugar factories	- alcohol distilleries

Table B.1. Ordinary Hazard occupancies (*continued*)

Occupancy	Ordinary Hazard group			
	OH1	**OH2**	**OH3**	**OH4**
Miscellaneous	- apartments and condominiums - hospitals - hotels - libraries (excluding book stores) - restaurants - schools see 6.2.1 - offices see 6.2.1	- laboratories (physical) - laundries - museums	- broadcasting studios (small) - plant rooms - railway stations - farm building - car parks	- cinemas and theatres - concert halls - tobacco factories - film and TV production studio
Paper	-	-	- book binding factories - cardboard factories - paper factories	- waste paper processing
Shops and offices	- data processing (computer room, excluding tape storage) - offices see 6.2.1	-	- departmental stores - shopping centres	- exhibition halls
Textiles and clothing	-	- leather goods factories	- carpet factories (excluding rubber and foam plastics) - cloth and clothing factories - fibre board factories - footwear factories (excluding plastics and rubber) - knitting factories - linen factories - mattress factories (excluding foam plastics) - sewing factories - weaving mills - woollen and worsted mills	- cotton mills - flax preparation plants - hemp preparation plants
Timber and wood	-	-	- woodworking factories - furniture factories (without foam plastics) - furniture showrooms - upholstery plastics) factories (without foam)	- saw mills - plywood factories
Where there is painting or other similar high fire load areas in a OH1 or OH2 occupancy, they shall be treated as OH3.				

Table B.2. High Hazard Process occupancies

HHP1	HHP2	HHP3	HHP4
- floor cloth and linoleum varnish manufacture - resin, lamp black and turpentine manufacture - rubber substitute manufacture - wood wool manufacture -match manufacturers - paint application shops with solvent - refrigerator factories - printing works - cable factories for PP/PE/PS or similar burning characteristics other than OH3 - injection moulding (plastics) for PP/PE/PS or similar burning characteristics other than OH3 - plastic factories and plastic goods (excluding foam plastics) for PP/PE/PS or similar burning characteristics other than OH3 - rubber goods factories - synthetic fibre factories (excluding acrylic) - rope factories - carpet factories including unexpanded plastics - footwear factories including plastics and rubber	- fire lighter manufacture - tar distilling - depots for buses, unladen lorries and railway carriages - candle wax and paraffin manufacturers - paper machine halls - carpet factories including rubber and foam plastics - saw mill - chipboard manufacturing - paint, colour and varnish manufacture	- cellulose nitrate manufacture - rubber tires for cars and lorries - manufacture of material factor M3 (see table B.1) foam plastics, foam rubber and foam rubber goods manufacture (excluding M4 see Table B.1)	- firework manufacture

Annex C
(normative)

Methodology for categorising stored goods

C.1 General

NOTE. The overall fire hazard of stored goods (defined as a product and its packaging) is a function of its heat release rate (kW) which in turn is a function of its heat of combustion (kJ/kg) and its burning rate (kg/sec).

The heat of combustion is determined by the material or mix of materials in the goods. The burning rate is determined by both the materials involved and the configuration of the material.

The material shall be analysed to determine a material factor. Where necessary the material factor shall be modified according to the configuration of the goods to determine the category. If no modification is required, the material factor shall be the sole determinant of the category.

C.2 Material factor (M)

C.2.1 General

Figure C.1 shall be used to determine the material factor when goods consist of mixtures of materials. When using Figure C.1, the stored goods shall be considered to include all packaging and pallet material. For the purpose of this evaluation, rubber shall be treated in the same way as plastic.

The following four material factors shall be used in determining the category.

C.2.2 Material Factor 1

Non-combustible products in combustible packaging and low or medium combustibility products in combustible/non-combustible packaging. Products having little plastic content as defined below:

a) unexpanded plastics content less than 5 % by mass (including the pallet); and

b) expanded plastics content less than 5 % by volume.

The examples are as follows:

a) metal parts with/without cardboard packaging on wood pallets;

b) powdered foods in sacks;

c) canned foods;

d) non-synthetic cloth;

e) leather goods;

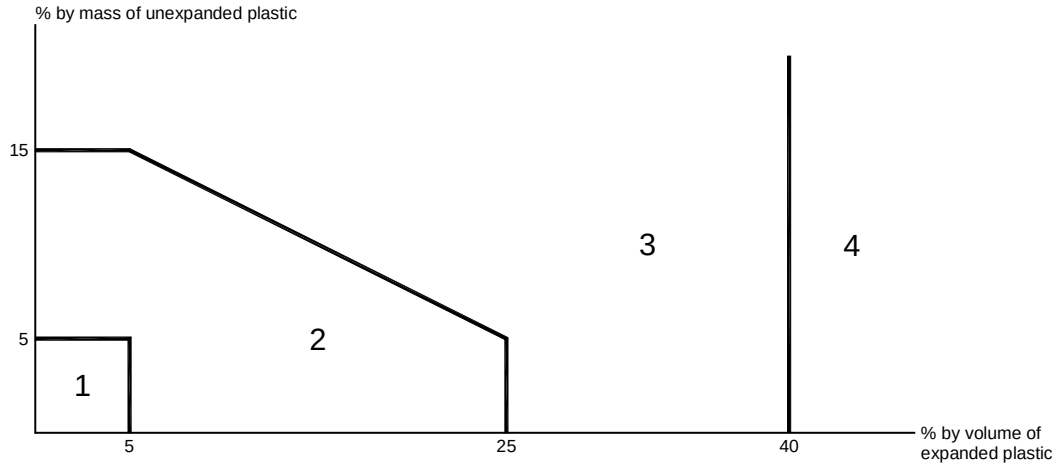
f) wood products;

g) ceramics in cardboard/wood cases;

h) metal tools in cardboard/wood packaging;

i) cartonned plastic or glass bottles of non-flammable liquids; and

j) large electrical appliances (with little packaging).



Key

1 material factor 1

2 material factor 2

3 material factor 3

4 material factor 4

Figure C.1. Material factor

C.2.3 Material factor 2

Goods having a higher energy content than material factor 1 goods, for instance those containing plastics in greater quantities as defined in Figure C.1.

The examples are as follows:

a) wood or metal furniture with plastic seats;

b) electrical equipment with plastic parts or packaging;

c) electric cables on reels or in cartons; and

d) synthetic fabrics.

C.2.4 Material factor 3

Materials which are predominantly unexpanded plastic (see Figure C.1) or materials of a similar energy content.

The examples are as follows:

a) car batteries with no electrolyte;

b) plastic brief cases;

c) personal computers; and

d) unexpanded plastic cups and cutlery.

C.2.5 Material Factor 4

Materials which are predominantly expanded plastic (more than 40 % by volume) or materials of a similar energy content (see Figure C.1).

The examples are as follows:

a) foam mattresses;

b) expanded polystyrene packaging; and

c) foam upholstery.

C.3 Storage configuration

C.3.1 Effect of Storage configuration

After determining the material factor, the storage configuration shown in Column 1 of Table C.1 shall be referred to determine the most appropriate categorisation. If an appropriate category is also given in Table D.1 the higher of the two values shall be used.

Table C.1. Categories as a function of storage configuration

Storage configuration	Material Factor			
	1	2	3	4
Exposed plastic container with	Cat. I, II, III	Cat. I, II, III	Cat. I, II, III	Cat. IV
Exposed plastic surface - unexpanded	Cat. III	Cat. III	Cat. III	Cat. IV
Exposed plastic surface - expanded	Cat. IV	Cat. IV	Cat. IV	Cat. IV
Open structure	Cat. II	Cat. II	Cat. III	Cat. IV
Solid block materials	Cat. I	Cat. I	Cat. II	Cat. IV
Granular or powdered material	Cat. I	Cat. II	Cat. II	Cat. IV
No special configuration	Cat. I	Cat. II	Cat. III	Cat. IV

The storage configurations in the table are as follows:

C.3.2 Exposed plastic container with non-combustible content

This applies only to plastic containers containing non-combustible liquids or solids in direct contact with the container.

NOTE. This configuration does not apply to metal parts in plastic storage boxes.

The categories are as follow:

Category I : Containers with non-combustible liquids;

Category II : Small (≤ 50 L) containers with non-combustible solids; and

Category III : Large (> 50 L) containers with non-combustible solids.

The examples as follows:

a) plastic bottles of soft drinks or liquids with less than 20 % alcohol; and

b) plastic tubs or drums of inert powder such as talcum.

NOTE. The non-combustible contents act as a heat sink and reduce the rate of burning of the containers. Liquids are more effective than solids since they conduct heat more efficiently.

C.3.3 Exposed plastic surface - Unexpanded

The category shall be increased to III or IV when the commodity has exposed plastic surfaces comprising one or more sides or more than 25 % of the surface area.

The examples as follows:

a) metal parts in PVC storage bins;

b) shrink wrapped tinned foods; and

c) or polypropylene and polyethylene storage bins, see Clause E.8.

C.3.4 Exposed plastic surface - Expanded

Exposed expanded plastics are more severe than unexposed plastics. They shall be treated as Category IV.

C.3.5 Open structure

Materials having very open structures generally present a higher hazard than materials with a closed structure. The high surface area together with high air access encourages rapid burning.

The increase in hazard can be very substantial particularly with ordinary combustibles.

The examples as follows:

a) cardboard has a material factor of 1;

b) in card flats it is Category I;

c) in empty boxes assembled it is Category II (due to ready air access); and

d) in rolls stored vertically it is either Category III or greater (Special Risk) depending on the storage method (closely stacked, banded or unbanded etc.).

C.3.6 Solid block materials

Materials in solid block form have a low surface area to volume/mass ratio. This reduces the burning rate and permits a reduction in category.

The example are blocks of solid rubber, vinyl floor tiles in block storage.

NOTE. This configuration does not apply to blocks of expanded plastics (Category IV).

C.3.7 Granular or powdered materials

The example are plastic granules used for injection moulding stored in cardboard boxes.

NOTES:

1. Granular materials excluding expanded plastics that will spill out during a fire tend to smother the fire and are thus less hazardous than their basic material counterparts.

2. This configuration does not apply to rack storage.

C.3.8 No special configuration

Goods that have none of the above characteristics, e.g. cartonned goods.

Annex D
(normative)

Alphabetic listing of stored products and categories

Table D.1 shall be used to determine the category of stored products where any packaging, with or without pallets, is no more hazardous than a cardboard box or a single layer of corrugated cardboard wrapping.

Table D.1. Stored products and categories

Product	Category	Comments
Adhesives	I	With flammable solvents special protection required
Asphalt paper	II	In horizontal rolls
Asphalt paper	III	In vertical rolls
Batteries, dry cell	II	-
Batteries, wet cell	II	Empty plastic accumulators require special protection
Beer	I	
Beer	II	Containers in wooden crates
Books	II	-
Candles	III	-
Canvas, tar impregnated	III	-
Carbon black	II	-
Cardboard (all types)	II	Stored flat
Cardboard (except corrugated)	II	Rolls stored horizontally
Cardboard (except corrugated)	III	Rolls stored vertically
Cardboard (corrugated)	III	Rolls stored horizontally
Cardboard (corrugated)	IV	Rolls stored vertically
Cardboard cartons	III	Empty, heavyweight, made up boxes
Cardboard cartons	II	Empty, lightweight, made up boxes
Carpet tiles	III	-
Carpets, without foam backing	II	Storing in racks requires in-rack sprinklers
Cartons, waxed, flats	II	-
Cartons, waxed, made-up	III	-
Cellulose	II	Baled, without nitrite and acetate
Cellulose pulp	II	-
Ceramics	I	-
Cereals	II	Boxed
Charcoal	II	Excluding impregnated charcoal

Table D.1. Stored products and categories (*continued*)

Product	Category	Comments
Cloth, synthetic	III	Stored flat
Cloth, wool or cotton	II	-
Clothes	II	-
Coconut matting	II	-
Confectionary	II	-
Cork	II	-
Cotton, baled	II	Special measures, such as an increased area of operation, may be necessary
Crockery	I	-
Electrical appliances	I	Predominantly metal construction
Electrical cable or wire	II	Storage in racks requires in-rack sprinklers
Esparto	III	Loose or baled
Fertiliser, solid	II	May require special measures
Fibreboard	II	-
Firelighters (barbecue)	III	-
Flax	II	Special measures, such as an increased area of operation, may be necessary
Flour	II	In sacks or paper bags
Foods, tinned	I	In cardboard boxes and trays
Foodstuffs	II	In sacks
Furniture, upholstered	II	With natural fibres and materials but excluding plastics
Furniture, wooden	II	-
Furs	II	Flat in boxes
Glass fibre	I	Unfabricated
Glassware	I	Empty
Grain	I	In sacks
Hemp	II	Special measures, such as an increased area of operation, may be necessary
Hides	II	-
Jute	II	-
Knitwear	II	See clothes
Laminated board	II	-
Leather goods	II	-
Linen	II	-
Linoleum	III	-
Matches	III	-
Mattresses	II	-
Meat	I	Chilled or frozen
Metal Goods	I	-

Table D.1. Stored products and categories (*continued*)

Product	Category	Comments
Milk powder	II	In bags or sacks
Office material	II	-
Paints	I	Water based
Paper	II	Sheets stored horizontally
Paper	III	Mass < 5 kg/100 m², (e.g. tissue paper), rolls stored horizontally
Paper	IV	Mass < 5 kg/100 m², (e.g. tissue paper), rolls stored vertically
Paper	III	Mass ≥ 5 kg/100 m², (e.g. newspaper), rolls stored vertically
Paper	II	Mass ≥ 5 kg/100 m², (e.g. newspaper), rolls stored horizontally
Paper, bitumen coated	III	-
Paper, pulp	II	Rolled or baled
Paper, waste	III	Special measures, such as an increased area of operation, may be necessary
Pillows	II	Feather or down
Rags	II	Loose or baled
Resins	II	Excluding flammable liquids
Roof felt in rolls	II	Horizontal storage
Roof felt in rolls	III	Vertical storage
Rope, natural fibres	I	-
Shoes	I	-
Soap, water soluble	II	-
Spirituous liquors	I	Cased glass bottles
String, natural fibres	I	-
Sugar	II	In bags or sacks
Textiles		See cloth
Timber, sawn	III	In ventilated stacks
Timber, sawn	II	Not in ventilated stacks
Timber, unsawn	II	-
Tobacco	II	Leaf and finished goods
Tyres stored horizontally	IV	Tyres stored vertically, in racks, are not covered by this standard
Vegetable fibres	II	Special measures, such as an increased area of operation, may be necessary
Wax (paraffin)	IV	-
Wicker work	III	-
Wood		See timber
Wood, chipboard, plywood	II	Stored flat, excluding ventilated stacks
Wood pulp	II	Baled

Table D.1. Stored products and categories (*concluded*)

Product	Category	Comments
Wood veneer sheets	IV	-
Vegetable fibres	II	Special measures, such as an increased area of operation, may be necessary
Wood wool	IV	Baled

Annex E
(normative)

Protection of special hazards

E.1 General

The additional requirements of this annex shall be used for the protection of the products specified.

E.2 Aerosols

The following design of protection (see Table E.1) shall be used when aerosol products are segregated from other types of product and are contained in cages.

NOTE. Sprinkler protection may not be effective where such products are not contained in cages.

Table E.1. Protection criteria for aerosol storage

Aerosol storage method	Maximum storage or tier height (m)		Ceiling sprinkler temperature (°C)	Density (mm/min)	Area of Operation (m^2)
	alcohol based	hydrocarbon based			
ST1 Free standing and block storage	1.5	-	141	12.5	260
	-	1.5	141	25.0	300
ST4 Palletised rack	tiers ≤ 1.8	-	141	12.5 plus in-rack sprinklers	260
	-	tiers ≤ 1.8	141	25.0 plus in-rack sprinklers	300

In rack sprinklers shall be quick response type with a temperature in accordance with 13.4.

E.3 Clothes in multiple garment hanging storage

E.3.1 General

NOTE. This Annex contains special requirements for the protection of intensive hanging garment stores having multiple rows or garment racks at two or more levels. They may have automatic or semi-automatic garment delivery, picking or transportation systems. Access to elevated garment storage levels within the warehouse is usually by walkways and ramps. A common feature of hanging garment storage is that there is no fire separation between the decks. Walkways, aisles, ramps and garment racks create a significant obstruction to ceiling level sprinkler protection. Protection of hanging garments stored in carousels or vertical blocks without aisles is beyond the scope of this Annex.

E.3.2 Categorisation

The requirements of this annex shall be applied to all types of garments, irrespective of their storage category.

E.3.3 Sprinkler protection other than at ceiling

Sprinkler protection shall be in accordance with the requirements for in-rack sprinklers.

Each garment rack shall be limited to two rows of hanging garments (side by side) and a storage height of 3.5 m between intermediate levels of sprinklers. Each rack shall be separated by an aisle of at least 0.8 m width. The garment racks shall be protected by a single row of sprinklers. The spacing between the sprinkler rows shall not exceed 3.0 m.

The sprinklers installed directly above the garment racks shall be stagger spaced in the vertical plane, at horizontal intervals of not more than 2.8 m along the length of the rack. There shall be a sprinkler not more than 1.4 m from the rack end. The clearance between the top of the garments and the sprinkler deflector shall be at least 0.15 m (see Figure E.1).

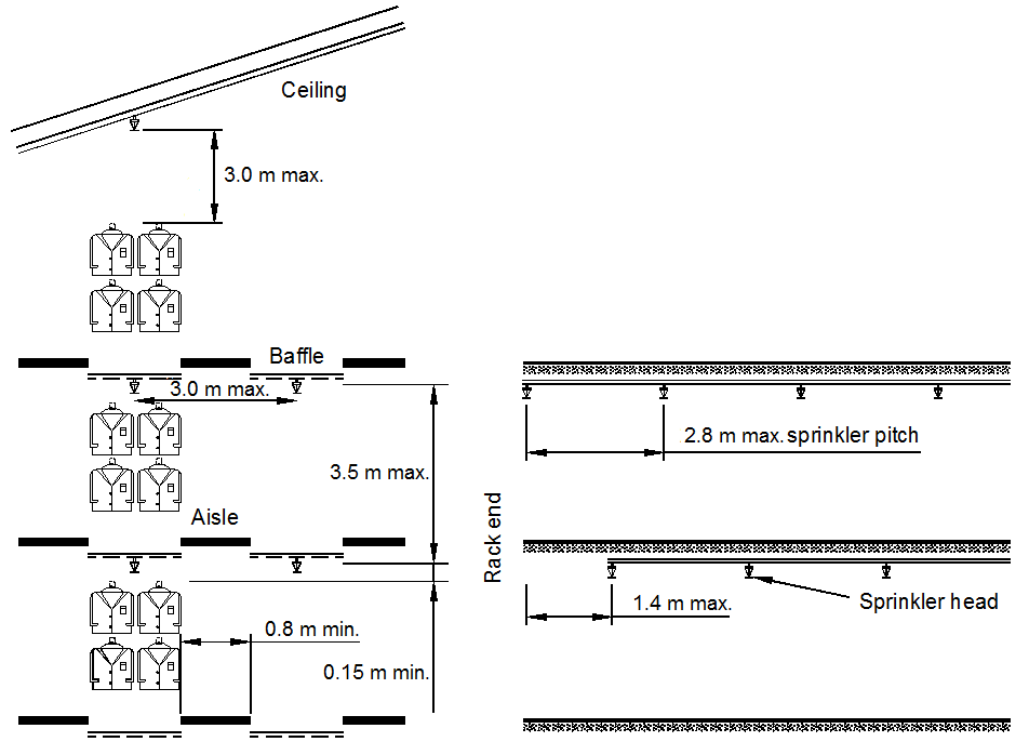


Figure E.1 Typical sprinkler protection of garment racks

Except as modified below, each sprinkler row protecting garment storage racks shall be capped by a continuous solid horizontal baffle of at least the length and width of the garment row. The baffle shall be of non-combustible or limited combustibility material.

The upper level of sprinkler rack protection and baffle may be omitted provided the clearance between the top of the garments and the deflectors of the ceiling sprinklers does not exceed 3 m height.

Sprinklers shall be installed below all access ramps, main aisles, walkways and transportation routes, with the exception of aisles, not exceeding 1.2 m wide, between sprinkler protected garment storage rows.

E.3.4 Sprinklers in operation

The number of rack sprinklers assumed to be in operation shall be as follows:

a) rows: 3;

b) levels: ≤ 3; and

c) sprinklers per row: 3.

Where there are more than 3 levels of sprinkler protection, 3 rows of 3 sprinklers on 3 protected levels shall be assumed to operate. Where there are 3 levels or less, 3 rows of 3 sprinklers shall be assumed to operate on all protected levels.

E.3.5 Ceiling sprinklers

Ceiling sprinklers shall be designed to provide a density of 7.5 mm/min over an area of operation of 260 m², providing the uppermost level of racks is capped and protected by rack sprinklers.

If the uppermost level or the capping is omitted, the ceiling sprinklers shall be designed on the basis of at least Category III goods. The stack height shall be measured from above the uppermost intermediate level sprinklers to the top of the hanging garments.

E.3.6 Automatic shutdown

Operation of the sprinkler system shall automatically stop all automated distribution systems within the warehouse.

E.3.7 Control valve set

All installations shall be of the wet pipe type.

E.4 Flammable liquid storage

Flammable liquids shall be classified into four classes according to their flash point (FP) and boiling point (BP), as shown in Tables E.2, E.3 and E.4.

Table E.2. Flammable liquids in metal drums (ST1) with a capacity > 20 L and < 208 L

Class	Properties (°C)	Drum orientation	Permitted storage	Ceiling sprinklers	
				Density (mm/min)	Area of operation (m²)
1	FP ≥ 100	on side	≤ 12 drums high	10	450
		on end	≤ 6 drums high		
2	FP < 100	on side	≤ 6 drums high	25	450
		on end	≤ 2 drums high		
3	FP < 35	on side	≤ 3 drums high	25	450
		on end	≤ 1 drums high		
4	FP < 21 and BP < 35	on side or on end	1 drum high	25	450

Table E.3. Flammable liquids in metal drums (ST4) with a capacity > 20 L and < 208 L

Class	Properties (°C)	Drum orientation	Intermediate sprinkler levels	Ceiling sprinklers	
				Density (mm/min)	Area of operation (m²)
1	FP ≥ 100	on side on end	each 12th tier each 6th tier	10 10	450
2	FP < 100	on side on end	each 6th tier each tier	25 10	450
3	FP < 35	on side on end	each 3rd tier each tier	25 10	450
4	FP < 21 and BP < 35	on side or on end	each tier	25	450
NOTE. This table applies to drums stored at a height of one drum per tier.					

Table E.4. Flammable liquids in metal drums (ST1, ST5, ST6) with a capacity < 20 L

Class	Properties (°C)	Type of storage	Maximum permitted storage height (m)	Ceiling sprinklers	
				Density (mm/min)	Area of operation (m^2)
1	FP ≥ 100	ST1 ST5/6	5.5 4.6	10 7.5	450
2	FP < 100	ST1 ST5/6	4.0 4.6	12.5	450
3	FP < 35	ST1 ST5/6	1.5 2.1	12.5	450
4	FP < 21 and BP < 35				

E.5 Idle pallets

Idle pallets stored in solid piles or on pallets shall be protected with ceiling sprinklers in accordance with Table E.5. Pallets stored in racks shall be protected with ceiling and in-rack sprinklers in accordance with Table E.6.

Table E.5. Protection of idle pallets (ST1)

Type of pallet	Maximum permitted storage height (m)	Ceiling sprinklers (see Table 4)	Special requirements
Wood and cellulose material pallets	3.8	As for Category IV	
Non-expanded high density polyethylene pallets with solid deck	3.8	As for Category IV, with sprinkler rated at 93 °C or 100 °C	Storage in 60 min fire resistant compartment
All other plastic pallets	3.3	25 mm/min over 300 m^2	Storage in 60 min fire resistant compartment

Table E.6. Protection of rack storage of pallets (ST4, ST5, ST6)

Type of pallet	In-rack sprinklers	Ceiling sprinklers (see Table 4)	Special requirements
Wood and cellulose material pallets. Non-expanded high density polyethylene pallets with solid deck	Category IV	As per Category IV. Sprinklers rated at 93 °C or 100 °C	60 min fire resistant compartment when storage height > 3.8 m
All other plastic pallets.	Category IV, including one level of sprinklers above top level of storage, sprinklers with K=115 and minimum operating pressure of 3.0 bar	25 mm/min over 300 m²	Storage in 60 min fire resistant compartment.

E.6 Spirit based liquors in wooden barrels

Barrels may be stored to a height not exceeding 4.6 m with ceiling sprinklers only. For greater storage heights intermediate sprinklers shall be installed in accordance with Category III/IV requirements. In both cases the ceiling sprinklers shall be installed with a density of 15.0 mm/min over an area of operation of 360 m².

NOTES:

1. Drainage or bunding should be provided to limit the spread of liquid spills.

2. For the purposes of this standard, spirituous liquor is defined as that containing more than 20 % alcohol.

E.7 Non-woven synthetic fabric

E.7.1 Free standing storage

Ceiling sprinklers shall be installed using the criteria shown in Table E.7.

NOTE. For storage heights above 4.1 m consideration may be given to the use of special technology sprinklers such as the so-called "large drop" or "ESFR" sprinklers (see Annex K).

Table E.7. Non-woven synthetic fabric: Design criteria with roof or ceiling protection only

Storage configuration	Maximum permitted storage height (see Note 1) (m)	Minimum design density (mm/min)	Area of operation (wet or pre-action system) (see Note 2) (m^2)
ST1 Free standing or block stacking	1.6	10.0	260
	2.0	12.5	
	2.3	15.0	
	2.7	17.5	
	3.0	20.0	300
	3.3	22.5	
	3.6	25.0	
	3.8	27.5	
	4.1	30.0	

NOTES:

1. The vertical distance from the floor to the sprinkler deflectors, minus 1.0 m, or the highest value shown in the table, whichever is the lower.

2. Dry and alternate installations should be avoided.

E.7.2 Rack storage

In-rack sprinklers shall be used in accordance with Category IV requirements. Ceiling sprinklers shall have a minimum design density of 12.5 mm/min over 260 m^2.

E.8 Polypropylene or polyethylene storage bins

E.8.1 General

The following requirements shall be met unless other types of sprinkler protection are shown to be valid by appropriate fire testing.

E.8.2 Classification

Polypropylene and polyethylene storage containers shall be classified as HHS Category IV.

E.8.3 Palletized rack storage (ST4)

In-rack sprinklers shall have a horizontal spacing not exceeding 1.5 m. The vertical distance between in-rack sprinklers shall not exceed 2.0 m. The ceiling sprinklers shall have a sensitivity rating of “Special” and in-rack sprinklers shall have a sensitivity of “Special” or “Quick”.

E.8.4 All other storage

Maximum storage height shall not exceed 3.0 m. Only non-inflammable pallets, for example steel pallets, shall be used. The stack height per pallet shall not exceed 1.0 m and the uppermost storage container on each pallet shall be closed with a lid. The sprinklers shall have a sensitivity rating of “Special” or “Quick”.

E.8.5 Foam additive

A suitable film forming foam, used in accordance with the supplier's recommendation, shall be added to the sprinkler water.

NOTE. In full scale fire tests, AFFF (aqueous film forming foam) has been shown to be effective.

Annex F
(normative)

Transmission of alarms

F.1 Functions to be monitored

Alarms, as specified in this standard, shall be connected to an alarm panel in the sprinkler control room or pump room and be transmitted onwards depending on the importance of the alarm. Alarms shall be transmitted to the main fire alarm panel.

F.2 Alarm levels

Signals such as water flow indication, which could be indicative of a fire, shall be shown as fire alarms (Alarm level A in Table F.1). Technical faults such as a power failure, which could prevent the system operating correctly in case of fire, shall be shown as trouble alarms (Alarm level B in Table F.1).

Table F.1. Type of alarm for transmission

Alarm	Clause	Alarm type
Water flow detector in pump room	9.3.2	A
Electric pump set	9.8.6.1	
- on demand (pump pressure switch activated)		B
- start failure		B
- running		A
- power not available		B
Diesel pump set	9.9.11	
- automatic mode off		B
- start failure		B
- running		A
- power not available		B
Trace heating circuits	10.1.2.2	B
Low pressure		
- pre-action Type A system	10.3.1.1	B
- dry pipe and pre-action systems	15.2.3	B

Table F.1. Type of alarm for transmission *(continued)*

Alarm	Clause	Alarm type
Zoned systems	D.3.7	
- open control valve		B
- partially closed control valve		B
- partially open control valve		B
- water flow in installation		A
- water flow in zone		A
Monitored sprinkler systems	H.3	
- partially closed stop valves		B
- liquid levels		B
- low pressure		B
- power failure		B

Annex G
(normative)

Zoning of sprinkler installations

G.1 General

This annex specifies requirements particular to the sprinkler protection of buildings when zoning is adopted. It applies only to OH sprinkler installations of the wet pipe type.

NOTES:

1. Zoning is optional except where required elsewhere in this standard (see Annexes A and H).

2. Quantities of sprinklers mentioned in this section is inclusive of all exposed and concealed sprinklers.

G.2 Zoning of installations

Wet pipe Ordinary Hazard sprinkler installations may be zoned or unzoned.

The protected floor area to be controlled by any one wet control valve set in Ordinary Hazard may exceed that shown in Table 18, with the following restrictions.

a) The protected floor area to be controlled by any one wet control valve set on any one floor shall not exceed 12 000 m^2.

b) The installation shall be zoned in accordance with G.3.

c) Zoned installations shall not include any hazard greater than OH3.

d) Car parks and areas involving the unloading and storage of goods shall be on a separate unzoned installation.

e) The building shall be sprinkler protected throughout on all floors.

f) The total number of sprinklers controlled by any one control valve set shall not exceed 120 000 m^2.

G.3 Requirements for zoned installations

G.3.1 Extent of zones

The protected floor area per zone shall be no greater than 6 000 m^2.

G.3.2 Zone subsidiary stop valves

Each zone shall be independently controlled by a single zone subsidiary stop valve, installed in a readily accessible position on the same floor as the zone it controls. Each valve shall be secured open and be labelled to identify the area of protection it controls.

G.3.3 Flushing valves

Each zone shall be fitted with a valve no less than 20 mm nominal diameter, either on the end of the distribution pipe hydraulically most remote from the water supply, or on the end of each distribution pipe spur, as appropriate. The valve outlet shall be fitted with a brass plug cap.

G.3.4 Monitoring

Zoned sprinkler installations shall be provided with tamper-proof devices to monitor the status of:

a) each stop valve (i.e. either fully open or not fully open), including subsidiary stop valves, capable of interrupting the flow of water to sprinklers;

b) water flow into each zone immediately downstream of each zone subsidiary stop valve, to indicate the operation of each zone, by means of a water flow alarm switch capable of detecting a flow equal to or greater than that from any single sprinkler; and

c) for unzoned installations, water flow through each main installation control valve set.

G.3.5 Zone test and drainage facilities

Permanent test and drainage facilities shall be provided immediately downstream of the water flow alarm switch on each zone. The test facility shall simulate operation of any single sprinkler head. Adequate provision shall be made for the disposal of waste water.

G.3.6 Installation control valve set

The control valve set of a zoned sprinkler installation shall have two stop valves, one on each side of a single alarm valve with a bypass connection of the same nominal bore around all three valves, fitted with a normally closed stop valve (see Figure G.1.). Each of the three stop valves shall be fitted with tamper proof devices to monitor their status.

G.3.7 Installation monitoring and alarms

The monitoring devices required by G.3.4 and G.3.6 shall be electrically connected to a control and indicating panel, installed at an accessible location on the premises, where the following indications and warnings shall be given:

a) green visual indicators to indicate that each monitored stop valve is in its correct operational position;

b) audible devices and amber visual indicators to indicate that one or more control valve sets are not fully open;

c) audible devices and amber visual indicators to indicate that one or more zone subsidiary stop valves are not fully open;

d) audible devices and amber visual indicators to indicate that the static pressure in any trunk main supplying the system has fallen to a value 0.5 bar or more below the normal static pressure or jockey pump cut in pressure setting;

e) audible devices and red visual indicators to indicate that water is flowing into an unzoned installation; and

f) audible devices and red visual indicators to indicate that water is flowing into one or more zones.

Facilities shall be provided at the indicator panel for silencing the audible alarms but the visual indicators shall continue to operate until the installation is restored to the normal standby condition.

Fire and fault signals shall be indicated at the main fire alarm panel (see Annex H).

Any change in the panel alarm or fault indication after the audible alarm has been silenced shall cause it to resume sounding until it is again silenced or the panel reset to the normal standby condition.

G.4 Block plan

Where installations are arranged in zones, the site block plan shall additionally indicate the positions of the zone subsidiary stop valves.

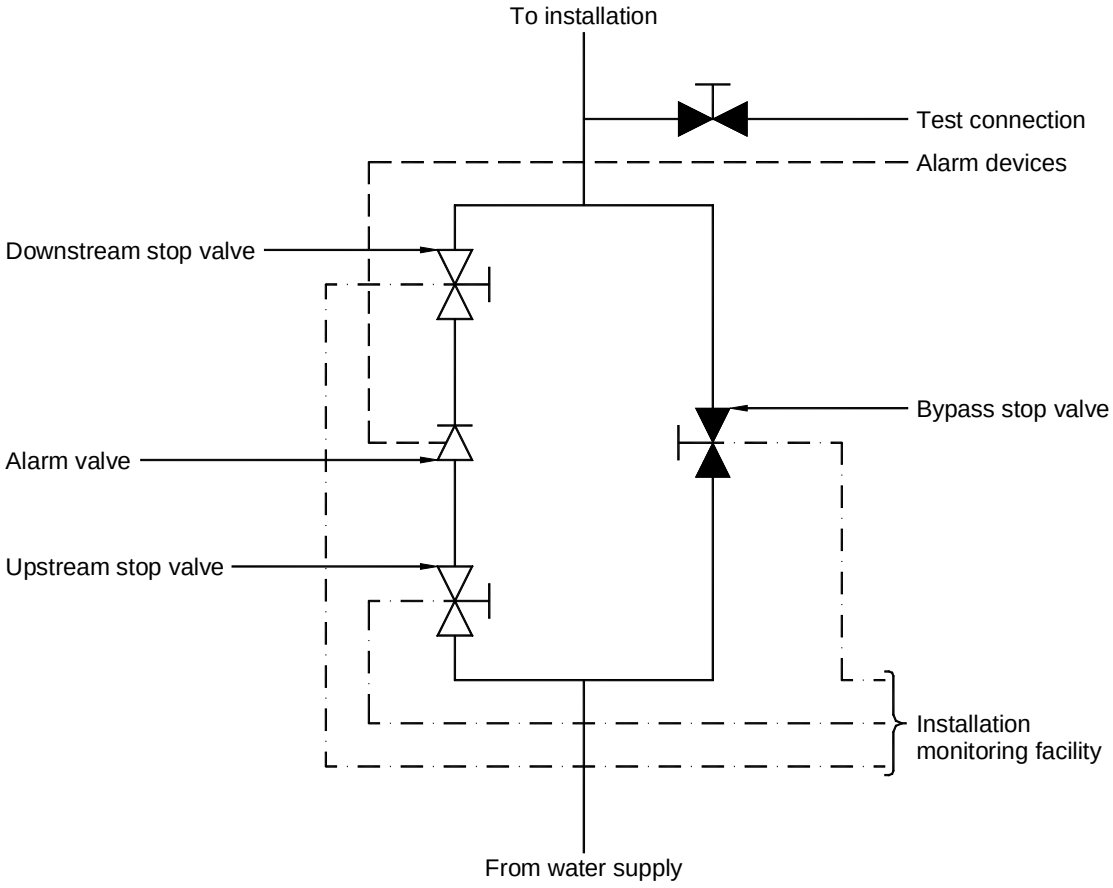


Figure G.1. Control valve bypass arrangement for zoned building installation

Annex H
(normative)

Special requirements for life safety systems

H.1 Subdivision into zones

Installations shall be subdivided into zones, in accordance with Annex G, with a maximum of 2 400m^2 protected floor area.

H.2 Wet pipe installations

Sprinkler installations for life safety shall be of the wet pipe type and any subsidiary dry pipe or alternate extension shall comply with 10.4.

H.3 Sprinkler type and sensitivity

Quick response sprinklers shall be used. Where rooms area are greater than 500 m^2 or room height is greater than 5.0 m, Standard 'A' and special response may be used (see 13.5).

H.4 Control valve set

Duplicate installation control valve sets are required.

The installation main control valve set shall have a stop valve on each side (i.e. upstream and downstream) of each of a pair of wet alarm valves, each set of three valves being connected in parallel into the feed main as shown in Figure H.1. The alarm valves in each leg shall have interconnected feeds to a common fire alarm arrangement.

NOTE. Where duplicate alarm valves are used the stop valves to one alarm valve (designated the main alarm valve) should be normally open and the stop valves to the other (designated the bypass valve) should be normally shut.

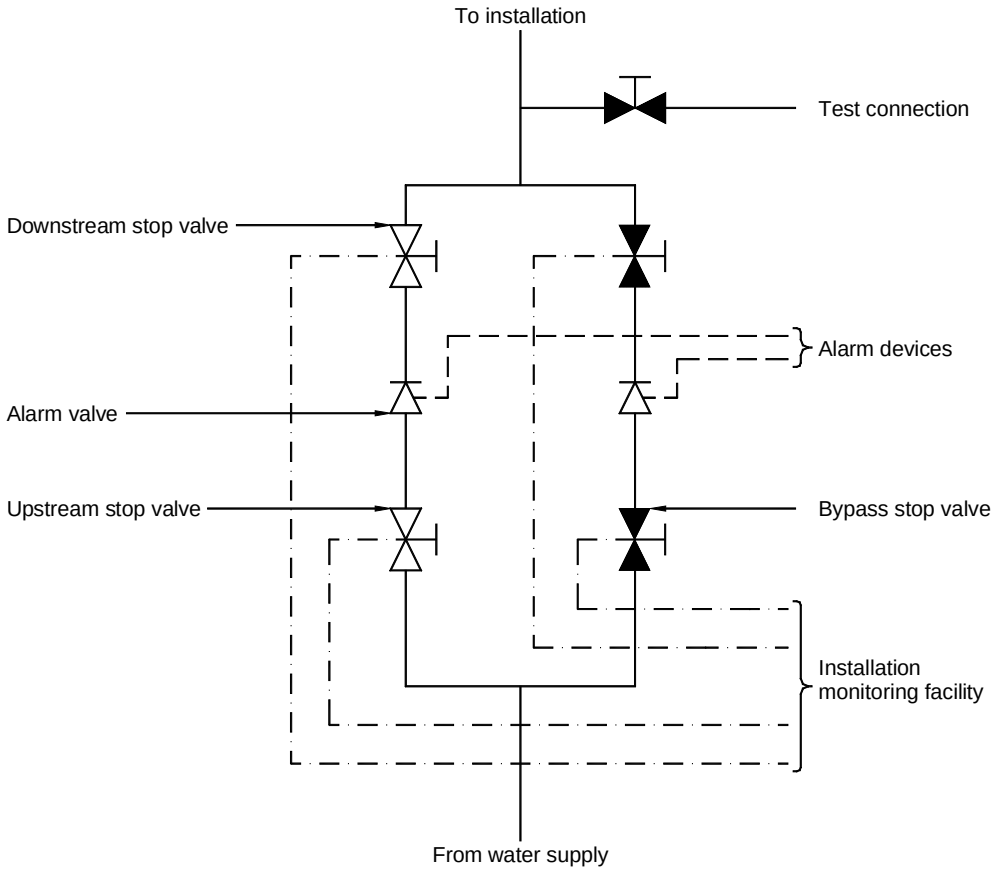


Figure H.1. Duplicate alarm valve arrangement for life safety installation

During servicing and maintenance of the installation alarm valves, the sprinkler installation shall be fully operational in all aspects.

H.5 Water supplies

The system shall water supply shall be dedicated for sprinklers only.

For water tanks, the tanks must be compartmented in such a way that water is still available when one compartment is shut down for maintenance. Under no circumstances shall both compartments of the tank be rendered inoperative simultaneously.

H.6 Theatres

In theatres with separated stages (i.e. where there is a safety curtain between the stage and auditorium) the safety curtain shall be provided with a line of drenchers controlled by a full bore, quick opening valve (e.g. a plug valve or ball valve) fitted in an accessible position. The water supply for the drenchers shall be taken upstream of any control valve set. The stage shall be protected by a water spray installation with automatic and manual activation.

Alternatively, stages with a total height no greater than 12 m may be protected by sprinklers. All workshops, dressing rooms, scenery, storerooms and spaces below the stage shall be sprinklered.

H.7 Additional precautions for maintenance

Only one zone of a multi-zone installation shall be shut down at a time. An installation or zone shall be shut down for the minimum time necessary for maintenance.

The partial or complete shut-down of a life safety sprinkler installation shall be avoided wherever possible. Only the smallest part of the installation necessary shall be isolated.

When a zone (or zones) is charged or recharged with water after draining, the flushing valve(s) (see D.3.3) shall be used to check that water is available in the zone (or zones).

Individual alarm valves in a duplicate control valve set, where required, shall be separately serviced, provided the water supply to the installation is maintained.

The following procedures shall be followed before servicing duplicate control valve sets.

a) The stop valves to the duplicate alarm valve shall be opened. The stop valves to the alarm valve to be serviced shall be closed and an alarm test (see 19.2.2.3) carried out immediately on the other alarm valve.

b) If water is not available, the stop valve shall be opened immediately, and the fault rectified before proceeding.

Annex J
(normative)

Orifice plate design and installation

J.1 General

An orifice plate used to hydraulically balance an installation or to accommodate pump characteristics shall:

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

b) be fitted to zones, pipe spurs and branches of pre-calculated installations, when the difference in pressure loss (inclusive of static gain), between the zone, pipe spur or branch under consideration and the most unfavourable design point, is greater than 1.5 bar;

c) have an orifice diameter not less than one-half or the nominal bore of the pipe into which it is fitted;

d) be fitted not less than two pipe internal diameters downstream of the outlet from any elbow or bend; and

e) with a plain central hole without burrs and of a thickness complying with Table J.1 and constructed of brass or stainless steel.

NOTES:

1. In pre-calculated systems, the failure to install an orifice plate will result in a much higher flow for the most favourable sprinkler area of discharge. This may cause a problem for the water supply, pump flow rate and also insufficient storage for storage and suction tanks.

2. In fully hydraulically calculated systems, the use of an orifice plate will result in a lower design flow for the most favourable sprinkler area of discharge and hence a smaller water supply flow rate and storage requirements.

Table J.1. Orifice plate thickness according to pipe nominal bore

Pipe nominal bore (mm)	Orifice plate thickness	
	Brass (mm)	Stainless Steel (mm)
$d \leq 80$	3.0	1.5
$80 < d \leq 150$	6.0	3.0
$150 < d \leq 200$	9.0	4.5

Tables K.2 and K.3 may be used to size orifices used to achieve hydraulic balance.

The relationship between orifice size, the flow rate and the pressure loss shall be calculated using the date given in Tables K.2 and K.3.

The tables give the orifice diameter for medium grade pipe complying with MS 863 of sizes from 50 mm to 200 mm for discrete values of net pressure loss P_o for a standard rate of flow (500 L/min in Table J.2 and 5 000 L/min for Table J.3).

NOTE. Orifice plates in horizontal pipe runs may form trapped pipework, which will require a drain valve (see 14.4 for pre-action systems).

J.2 Use of Tables J.2 and J.3

To select an orifice plate which will produce a net pressure loss of P_x bar with a rate of Q_x (in L/min) calculate the value of P_o from the formula:

$$P_o = P_x \times \left(\frac{500}{Q_x} \right)^2$$

when using Table J.2 and

$$P_o = P_x \times \left(\frac{5\,000}{Q_x} \right)^2$$

when using Table J.3,

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

Table J.2. Orifice plates for 50 and 65 mm medium grade pipes complying with MS 863

Pressure loss P_o (bar)	Pipe nominal bore (mm)		Orifice K factor
	50	65	
	Orifice diameter		
	(mm)	(mm)	
2.50	25.9	-	316
2.25	26.5	-	333
2.00	27.1	-	354
1.75	27.9	-	378
1.50	28.8	-	408
1.25	29.6	-	447
1.00	30.9	-	500
0.90	31.5	-	527
0.80	32.2	34.5	559
0.70	32.8	35.3	598
0.60	33.7	36.3	645
0.50	34.7	37.6	707
0.40	35.9	39.3	791
0.30	37.5	41.2	913
0.20	39.7	44.2	1 118
0.10	42.7	49.1	1 581
0.05	-	53.6	2 236

NOTES:

1. The pressure loss produced by the orifice plate is the net loss across the orifice, not the pressure difference measured at flange, corner or D and D/2 tappings.

2. The K factor for the orifice is marked on the plate.

Table J.3. Orifice plates for 80 mm, 100 mm, 150 mm and 200 mm medium grade pipes complying with MS 863

Pressure loss P_o (bar)	Pipe nominal bore (mm)				Orifice K factor
	80	100	150	200	
	Orifice diameter (mm)				
35	41.9	-	-	-	845
30	43.0	-	-	-	913
25	44.8	-	-	-	1000
20	46.4	-	-	-	1 118
15	48.9	-	-	-	1 291
10	52.3	56.2	-	-	1 581
9	54.1	57.6	-	-	1 667
8	55.3	59.0	-	-	1 768
7	56.6	60.4	-	-	1 890
6	58.2	62.0	-	-	2 041
5	59.8	63.9	-	-	2 236
4	62.0	66.5	-	-	2 500
3	65.0	69.7	-	-	2 887
2	-	74.2	82.3	-	3 536
1	-	81.1	95.8	-	5 000
0.9	-	82.2	97.1	105.7	5 270
0.8	-	83.3	99.3	108.1	5 590
0.7	-	84.4	101.7	111.1	5 976
0.6	-	85.7	104.0	113.9	6 455
0.5	-	87.0	106.8	117.7	7 071
0.4	-	-	110.1	122.2	7 906
0.3	-	-	115.1	129.1	9 129
0.2	-	-	120.6	137.7	11 180
0.1	-	-	-	152.6	15 810
0.05	-	-	-	165.8	22 360

NOTES:

1. The pressure loss produced by the orifice plate is the net loss across the orifice, not the pressure difference measured at flange, corner or D and D/2 tappings.

2. The K factor for the orifice is marked on the plate.

Annex K
(informative)

Special technology

This standard covers only the types of sprinkler specified in MS ISO 6182-1. During the years preceding the preparation of this standard special technologies were being developed for special applications, including in particular the following:

a) early suppression fast response sprinklers (ESFR);

b) large drop sprinklers;

c) residential sprinklers;

d) extended coverage sprinklers; and

e) special in rack sprinklers.

The engineering of such applications is currently very specialised. It is intended that they will be included in future editions of this standard.

Annex L
(normative)

Sprinkler systems monitoring

L.1 General

The aim of monitoring sprinkler systems is the continuous supervision of the main functions of the system, i.e. those whose failure might impair the correct automatic operation of the system in case of fire, and the raising of a supervisory alarm to allow corrective measures to be taken. This annex specifies requirements, which are additional to those elsewhere in the standard. They shall be complied with whenever monitoring is specified.

All devices used for monitoring shall have at least IP54 protection as specified in MS IEC 60529. No more than 15 non-addressable supervisory alarm devices shall be connected to a common indication.

All signaling and alarm circuits shall be fully supervised and a fault alarm shall be given in the event of short or open circuit where this corresponds to a fault.

Control and indicating equipment shall be in accordance with MS 1404.

L.2 Functions to be monitored

L.2.1 General

The following shall be monitored in addition to all monitoring requirements specified elsewhere in this standard (see Annex F).

L.2.2 Stop valves controlling water flow to sprinklers

The position of all normally open stop valves the closing of which could prevent water flowing to the sprinklers, including incoming water supply valves where tanks are dependent on inflow, control valve sets, subsidiary valves and sectional valves. An indication shall be given whenever the valve is less than fully open.

L.2.3 Other stop valves

The position of all normally open stop valves the closing of which could prevent the correct operation of an alarm or indicating device, e.g. pressure switch, hydraulic alarm, flow switch. An indication shall be given whenever the valve is less than fully open.

L.2.4 Liquid levels

All critical liquid levels, including water storage tanks and engine fuel tanks. An indication shall be given before a water storage level drops more than 10 % below its nominal fill level, or before a fuel level drops more than 25 % below its nominal fill level.

L.2.5 Pressures

Pressures downstream of all dry control valve sets. In all other cases an indication shall be given when the static pressure drops by more than 20 % below the tested level.

L.2.6 Electrical power

The power supply to electrical pump sets or other critical electrical equipment. An indication shall be given if one or more phases fail at any point in the main supply, or in the control circuit or an electric or diesel pump controller or any other critical control equipment.

Annex M
(normative)

Precautions and procedures when a system is not fully operational

M.1 Minimising the effects

Maintenance, alterations and repair of systems which are not fully operational should be carried out such as to minimise the time and extent of non-operation.

When an installation is rendered inoperative the user should implement the following measures:

a) The authorities and any central monitoring station should be informed.

b) Alterations and repairs to an installation or its water supply (except possibly a life safety installation (see Annex H) should be carried out during normal working hours.

c) Supervisory staff in the areas affected should be notified and the area should be patrolled continuously.

d) Any hot work should be subject to a permit system. Smoking and naked lights should be prohibited in affected areas during the progress of the work.

e) When an installation remains inoperative outside working hours all fire doors and fire shutters should remain closed.

f) Fire extinguishing appliances should be kept in readiness, with trained personnel available to handle them.

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

h) In the case of manufacturing premises, when the alterations or repairs are extensive, or it is necessary to disconnect a pipe exceeding 40 mm nominal diameter, or to overhaul or remove a main stop valve, alarm valve or non-return valve, every effort should be made to carry out the work while the machinery is stopped.

i) Any pump which is out of commission should be isolated by means of the valves provided.

j) Where possible parts of installations should be reinstated to provide some protection overnight by using blinders and blanks within the pipework; the blinders and blanks should be fitted with visible indicator tags numbered and logged to aid timely removal.

M.2 Planned shut-down

Only the user should give permission for a sprinkler installation or zone to be shut down for any reason other than an emergency.

Before a system is wholly or partly shut down every part of the premises should be checked to ensure that there is no indication of fire.

Where premises are subdivided into separate occupancies constituting buildings in communication or at risk, protected by common sprinkler systems or installations, all occupiers should also be advised that the water is to be turned off.

Particular attention should be given to situations where installation pipework passes through walls or ceilings where these may feed sprinklers in areas needing special consideration.

M.3 Unplanned shut-down

When an installation is rendered inoperative as a matter of urgency or by accident, the precautions in M.1 should be observed as far as they are applicable with the least possible delay. The authorities concerned should also be notified as soon as is possible.

M.4 Action following sprinkler operation

M.4.1 General

Following shut-down after operation of an installation, the operated sprinkler heads should be replaced by heads of the correct type and temperature rating, and the water supply restored. Unopened sprinklers around the area in which operation took place should be checked for damage by heat or other cause and replaced as necessary.

The water to an installation or zone of an installation that has operated should not be shut off until all fire has been extinguished.

The decision to shut down an installation or zone which has operated because of a fire should be taken only by the fire service.

Components removed from the system should be retained by the user for possible examination by an authority.

M.4.2 Installations protecting cold storage warehouses (air circulation refrigeration)

The installation should be dismantled for drying out after each operation.

Annex N
(normative)

Twenty five year inspection

After 25 years the pipes and the sprinklers should be inspected, the pipework should be thoroughly flushed out and hydrostatically tested to a pressure equal to 1.5 times the maximum static pressure or 12 bar, whichever is the higher.

The pipework should be internally and externally inspected. At least one metre length of range pipe should be inspected per 100 sprinklers. Two pipe sections of at least one metre length of each pipe diameter should be inspected.

All defects which might adversely affect the performance of the system should be eliminated. In the case of wet pipe systems at least one sprinkler installation per building should be checked. If several wet control valve sets are installed in one building, only 10 % need be inspected. In the case of dry pipe systems, such a reduction of the number of installations to be checked is not allowed.

A number of sprinklers shall be removed and inspected. Table N.1 specifies the scope of sampling as a function of the total number of sprinklers installed.

Table N.1. Table of number of sprinklers to be inspected

Total number of sprinklers installed	Number of sprinklers to be inspected
≤ 5 000	20
≤ 10 000	40
≤ 20 000	60
≤ 30 000	80
≤ 40 000	100

The sprinklers should be evaluated for the following:

a) operation;

b) operation temperature;

c) variation of K factor;

d) spray obstacles;

e) lodgement; and

f) thermal sensitivity.

Acknowledgements

Members of Technical Committee on Wet Fire Protection System

Ir Wong See Foong (Chairman)	The Institution of Engineers, Malaysia
Mr Muhaimin Mat Salleh (Secretary)	SIRIM Berhad
Ir Chong Pen Kwong	Association of Consulting Engineers Malaysia
Mr Jasni Ali/ Mr Zamhuri Zainnordin/ Mr Mohd Rizuan Razali/ Mr Arjunaidi Ismail	Jabatan Bomba dan Penyelamat Malaysia
Ir Mustaffa Tek	Jabatan Kerja Raya Malaysia
Mr William Kong Mei Fatt	Kolling Engineering Sdn Bhd
Mr Micheal Toh	Malaysian Fire Protection Association
Mr Chee Soo Teng	Pertubuhan Akitek Malaysia
Mr Mohd. Shaharin Ahmad Latif	SIRIM QAS International Sdn Bhd (Product Certification and Inspection Department)
Ms Rohaya Ibrahim	SIRIM QAS International Sdn Bhd (Testing Services Department)
Mr Sufian Kamarudin	Tenaga Nasional Berhad (Generation Division)
Mr Thin Choon Chai	The Institution of Engineers, Malaysia
Ir Lee Kong Fan	The Institution of Fire Engineers (UK) Malaysia Branch
Assoc Prof Ir Dr Nor Mariah Adam	Universiti Putra Malaysia