British Standard

BRITISH STANDARD

BS 5306-2: 1990

Incorporating Amendment No. 1 and implementing Corrigendum No. 1

Fire extinguishing installations and equipment on premises —

Part 2: Specification for sprinkler systems

ICS 13.220.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Fire Standards Policy Committee (FSM/-) to Technical Committee FSM/13, upon which the following bodies were represented:

Association of Metropolitan Authorities
British Automatic Sprinkler Association
British Fire Protection Systems Association Ltd.
British Fire Services' Association
British Nuclear Fuels Ltd.
Chief and Assistant Chief Fire Officers' Association
Convention of Scottish Local Authorities
Department of Health
Department of the Environment (Property Services Agency)
Department of the Environment (Building Research Establishment)
Department of Transport (Marine Directorate)
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Fire Brigades Union
Fire Extinguishing Trades' Association
Health and Safety Executive
Hevac Association
Home Office
Incorporated Association of Architects and Surveyors
Institution of Fire Engineers
Lloyds Syndicates Survey Department
London Fire and Civil Defence Authority
Loss Prevention Council
Ministry of Defence
Royal Institute of British Architects
Society of Fire Protection Engineers
Society of Motor Manufacturers and Traders Ltd.
United Kingdom Atomic Energy Authority
Warrington Fire Research Centre
Water Research Centre

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Copper Development Association
London District Surveyors Association

This British Standard, having been prepared under the direction of the Fire Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 July 1990

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The following BSI references relate to the work on this standard:
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Amendments issued since publication

Amd. No.	Date of issue	Comments
9809	January 1998	
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Contents

Foreword

This Part of BS 5306 is published under the direction of the Fire Standards Policy Committee. It is a revision of BS 5306-2:1979 which is superseded and withdrawn.

The other Parts of BS 5306 in preparation or published are as follows:

— *Part 0: Guide for the selection of installed systems and other fire equipment;*

— *Part 1: Hydrant systems, hose reels and foam inlets;*

— *Part 3: Code of practice for selection, installation and maintenance of portable fire extinguishers;*

— *Part 4: Specification for carbon dioxide systems;*

— *Part 5: Halon systems;*

— *Section 5.1: Halon 1301 total flooding systems*[1)]*;*

— *Section 5.2: Halon 1211 total flooding systems;*

— *Part 6: Foam systems — Section 6.1: Specification for low expansion foam systems;*

— *Section 6.2: Specification for medium and high expansion foam systems;*

— *Part 7: Specification for powder systems.*

The foreword of the previous edition of this Part of this standard pointed out that it should be read in conjunction with the "Rules for automatic sprinkler installations" (29th edition), issued by the Fire Offices Committee (FOC) now incorporated in the Loss Prevention Council (LPC), and used by the majority of insurers in the UK.

With the agreement and active cooperation of the LPC, this revision, initially prepared by a consultant funded by the Department of Trade and Industry under the BSI/DTI consultancy scheme for Initial Draft Standards, includes all matters previously dealt with by reference to the FOC Rules.

Full acknowledgment is given to the LPC for its agreement to incorporate material from the FOC rules, and also texts of amendments to the FOC Rules as yet unpublished, in this new edition of this Part of this British Standard.

It is the intention of the LPC to replace the 29th edition of the FOC Rules by new document "LPC Rules for Automatic Sprinkler Installations".

That new document will incorporate the full text of this British Standard specification and include additional material not suitable for inclusion in a British Standard, related to the use of sprinkler systems installed primarily to reduce loss of property by fire. It will be available from:

Loss Prevention Council
140 Aldersgate Street
London
EC1A 4HX

Arrangements have been made for the continual review of this specification and the "LPC Rules for Automatic Sprinkler Installations" to ensure that, as far as possible, amendments to the two documents are made simultaneously so that they remain compatible. In consequence this standard will be reviewed on an annual basis, more frequently than is usual for most other standards. In particular it is intended as part of the first review to consider some proposals, made as part of the public comment, related to applications of sprinkler systems in multi-storey buildings which merit issue for public comment. However, some new requirements and recommendations are included covering the installation of sprinkler systems in high-rise buildings.

[1)] Under revision.

There is increasing use of sprinkler systems which, in addition to protecting property, may serve for the protection of life, usually as an integral part of measures approved by a fire authority. An example is in covered and enclosed shopping centres, where automatic sprinkler systems can serve to prevent the spread of fire and its products to adjacent exit routes. This revision includes new recommendations together with those previously given in BS 5306-1:1979 in an appendix, to ensure that the reliability of such a sprinkler system is consistent with its function as an essential life safety measure, in such particular circumstances or where sprinkler systems may be called for in BS 5588-10[2)]. Although sprinkler systems are likely to provide some life safety protection to occupants of the areas of buildings in which sprinklers are installed, additional requirements may be necessary for systems specifically intended for life safety protection, e.g. where smoke could accumulate so rapidly that the lives of some of the occupants might be endangered before they could escape. It is intended to cover this subject, which may include additional recommendations for sprinkler sensitivity for life safety purposes, in a future revision of this specification.

Emphasis is given to the importance of ensuring that components of sprinkler systems are of established reliability and durability and suitable for the particular application and circumstances.

The requirements and recommendations are made in the light of the best technical data known to the committee at the time of writing, but since a wide field is covered it has been impracticable to consider every possible factor or circumstance that might affect implementation of the recommendations.

The previous edition of this standard was written in the form of a code of practice, but this revision is written as a specification to make it more suitable for reference in designs and specifications for actual projects. To comply with this specification, the user has to comply with all its requirements. He may depart from recommendations, but this would be on his own responsibility and he would be expected to have good reasons for doing so. It is a requirement of this specification to have consulted the various authorities concerned with the system, a procedure which allows for discussion and agreement of which recommendations may be appropriate in any particular case.

It has been assumed in the preparation of this standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations. In particular, attention is drawn to:

Health & Safety at Work etc. Act 1974

Water Acts 1989

Water (Scotland) Acts 1946/67

Water Supplies and Sewerage Act (Northern Ireland) 1945

Public Health Acts (Northern Ireland) 1878–1955

[2)] Under revision.

Product Certification. Users of this British Standard are advised to consider the desirability of independent certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS 5750.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to x, pages 1 to 156, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Section 1. General

0 Introduction

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.

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 initiating a fire alarm. The operating temperature is generally selected to suit ambient temperature conditions.

Only sprinklers in the vicinity of the fire, i.e. those which become sufficiently heated, operate.

In some life safety applications an authority may require sprinkler protection only in certain designated areas and solely to maintain safe conditions for the evacuation of persons from the sprinklers protected areas. Such a system may not provide protection against a fire which starts in a non-sprinklered part of the premises and develops to some size before spreading to the sprinkled parts, and for more complete protection the sprinkler system is extended throughout the premises with only limited exceptions.

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.

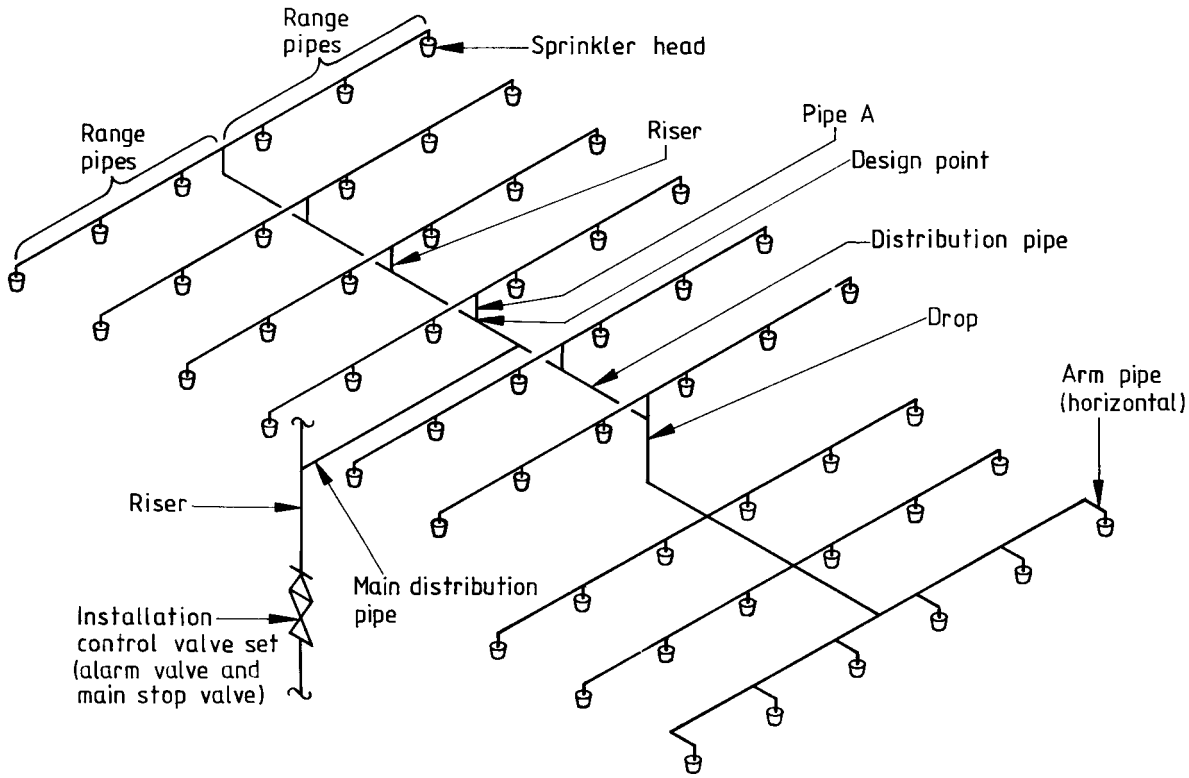


Figure 1 — Main elements of a sprinkler installation

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. Advice on these matters may be obtained from the fire authority, the Health and Safety Executive or other enforcing authority under the Health and Safety at Work etc. Act 1974, and the fire insurers. In addition, reference should be made to BS 5306-0 and as necessary to other Parts of this standard.

It is essential that sprinkler systems should 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 cannot be too highly emphasized.

When sprinkler systems are disabled, extra attention should be paid to fire precautions and the appropriate authorities informed. Advice on fire precautions is given in Appendix C, and is particularly appropriate when hot work is being carried out on a sprinkler system which in consequence is not operational.

1 Scope

This Part of BS 5306 specifies requirements and gives recommendations for the design, installation and maintenance of fire sprinkler systems in buildings and industrial plant. It includes particular requirements for sprinkler systems which are integral to measures for the protection of life.

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 necessary for satisfactory performance of sprinkler systems complying with this specification.

NOTE 1 This standard does not deal with water spray deluge systems in detail.

NOTE 2 Unless otherwise stated in this standard all pressures are gauge pressures and are expressed in bars.

1 bar = 10^5 N/m^2 = 10^2 kPa.

NOTE 3 The titles of publications referred to in this standard are listed on page 155.

2 Definitions

For the purposes of this Part of BS 5306 the following definitions apply.

2.1
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 pressure when a sprinkler operates

2.2
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

2.3
alarm valve

a check valve, of the wet, dry or composite type, that also initiates the water motor fire alarm when the sprinkler installation operates

2.4
alarm valve, composite

an alarm valve suitable for a wet, dry or alternate installation

2.5
alarm valve, dry

an alarm valve suitable for a dry installation; and/or in association with a wet alarm valve for an alternate installation

2.6
alarm valve, pre-action

an alarm valve suitable for a pre-action installation

2.7
alarm valve, recycling

an alarm valve suitable for a recycling installation

2.8
alarm valve, wet

an alarm valve suitable for a wet installation

2.9
arm pipe

a pipe, other than the last section of a range pipe, feeding a single sprinkler

2.10
assumed maximum area of operation (AMAO)

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

2.11
assumed maximum area of operation, hydraulically most favourable location

the location in a sprinkler array of an AMAO of specified shape at which the water flow is the maximum for a specific pressure

2.12
assumed maximum area of operation, hydraulically most unfavourable location

the location in a sprinkler array of an AMAO of specified shape at which the water supply pressure is the maximum needed to give the specified design density

2.13
authority

an organization, officer or individual responsible for approving sprinkler systems, equipment and procedures (see **3.1**)

2.14
booster pump

an automatic pump supplying water to a sprinkler system from an elevated private reservoir or a town main

2.15
competent person

a person with the necessary training and experience, and with access to the requisite tools, equipment and information, accepted by the authorities as capable of carrying out installation, inspection and maintenance procedures

2.16
cut-off sprinkler

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

2.17
deluge installation

an installation or tail-end extension fitted with open sprayers and either a deluge valve or a multiple control arrangement so that an entire area is sprayed with water on operation of the installation

2.18
deluge valve

a valve suitable for use in a deluge installation

NOTE The valve is operated manually and usually also automatically by a fire detection system.

2.19 design density

the minimum density of discharge, in mm/min of water, for which a sprinkler installation is designed, determined from the discharge of a specified group of sprinklers, in L/min, divided by the area covered, in m^2

2.20
design point

a point on a distribution pipe of a precalculated installation, downstream of which pipework is sized from tables and upstream of which pipework is sized by hydraulic calculation

2.21
detector sprinkler

a sealed sprinkler mounted on a pressurized pipeline used to control a deluge valve. Operation of the detector sprinkler causes loss of air pressure to open the valve

2.22
distribution pipe

a pipe feeding either a range pipe directly or a single sprinkler on a non-terminal range pipe more than 300 mm long

2.23
distribution pipe spur

a distribution pipe from a main distribution pipe, to a terminal branched pipe array (see Figure 30)

2.24
drencher

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

2.25
drop

a vertical pipe feeding a distribution or range pipe

2.26
end-centre array

a pipe array with range pipes on both sides of a distribution pipe (see Figure 2)

2.27
end-side array

a pipe array with range pipes on one side only of a distribution pipe (see Figure 2)

2.28
exhauster

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

2.29
fastener

a device for attaching pipe hanger components to a building structure or racking

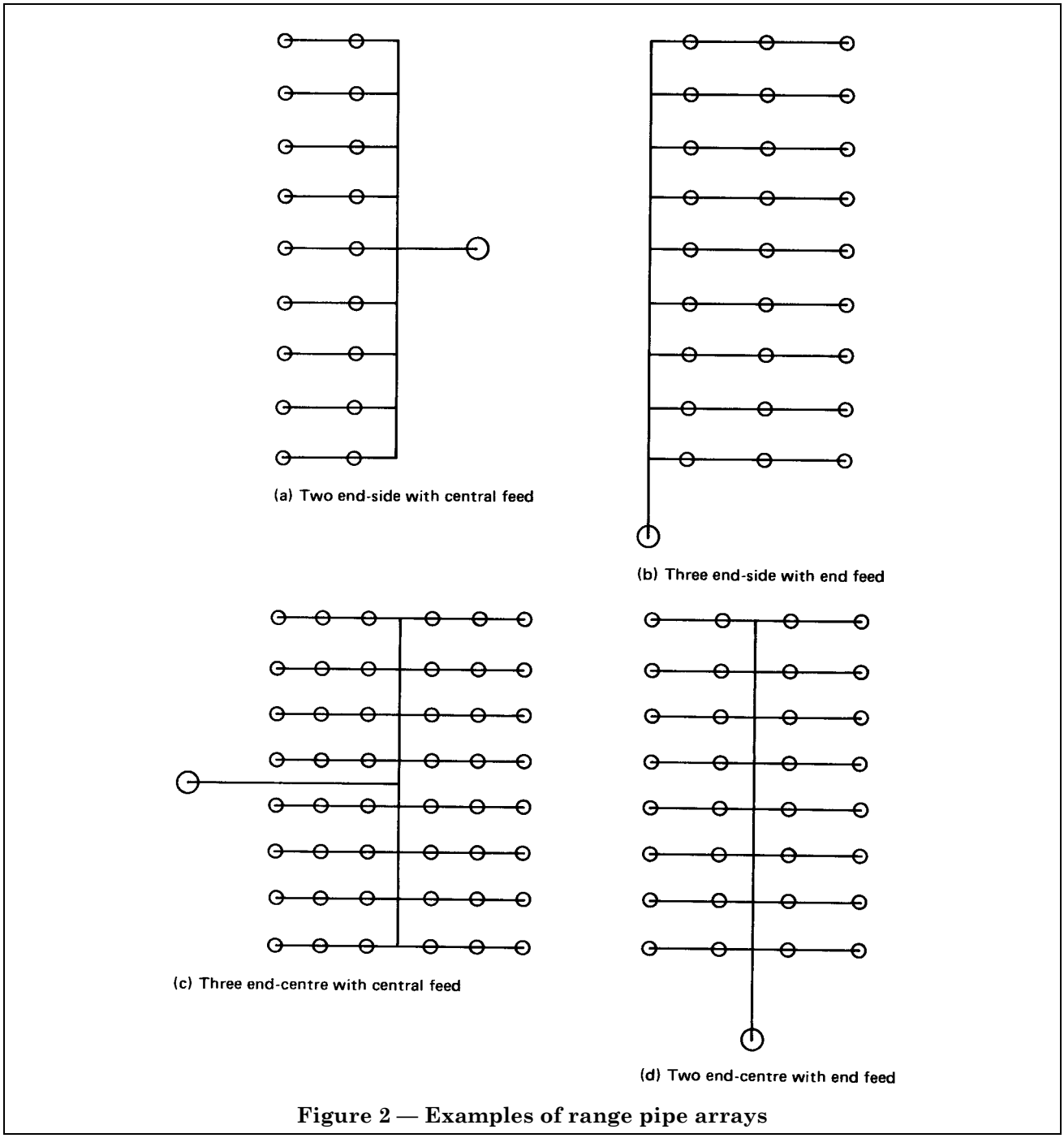


Figure 2 — Examples of range pipe arrays

2.30
fire door

a door and frame of specified fire resistance complying with either:

a) BS 476-8:1972; or

b) BS 476-22:1987

with respect to integrity

2.31
fire resistance

the ability of a component or the construction of a building to satisfy for a stated period of time the appropriate criteria specified in the relevant part of BS 476

2.32
fire shutter

a shutter and frame of specified fire resistance complying with either:

a) BS 476-8:1972; or

b) BS 476-22:1987;

with respect to integrity

2.33
(fully) hydraulically calculated

a term applied to pipework sized as specified in **18.1** a) or an installation in which all the pipework downstream of the main installation control valve set is sized as specified in **18.1** a)

2.34
gridded configuration pipe array

a pipe array in which water flows to each sprinkler by more than one route (see Figure 37)

2.35
hanger

an assembly for suspending pipework from elements of building structure

2.36
high-rise system

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

2.37
hydraulic alarm, intermittent

sounding of an hydraulic water motor alarm gong for intervals totalling less than the alarm period

2.38
installation (sprinkler installation)

part of a sprinkler system comprising a set of installation main control valves, the associated downstream pipes and sprinklers

2.39
installation, alternate

an installation in which the pipework is selectively charged with either water or air according to ambient temperature conditions

2.40
installation, dry (pipe)

an installation in which the pipework is charged with air under pressure

2.41
installation, pre-action

dry or alternate in dry mode, installation in which the alarm valve can be opened by an independent fire detection system in the protected area

2.42
installation, recycling

a pre-action installation in which the alarm valve can be opened and closed repeatedly by a heat detection system

2.43
installation, wet (pipe)

an installation in which the pipework is always charged with water

2.44
jockey pump

a small pump used to replenish minor water loss, to avoid starting an automatic suction or booster pump unnecessarily

2.45
life safety

a term applied to sprinkler systems forming an integral part of measures required for the protection of life

2.46
looped configuration

a pipe array in which there is more than one distribution pipe route along which water may flow to a range pipe (see Figure 36)

2.47
low-rise system

sprinkler system in which the highest sprinkler is not more than 45 m above the lowest sprinkler or the sprinkler pumps whichever is the lower

2.48
main distribution pipe

a pipe feeding a distribution pipe (see Figure 1)

2.49
mechanical pipe joint

a component part of pipework other than threaded tubulars, screwed fittings, lead or compound sealed spigots and socket and flanged joint, used to connect pipes and to produce a seal both against pressure and vacuum

2.50
multiple control

a valve, normally held closed by a temperature-sensitive element, suitable for use in a deluge system or for the operation of a pressure switch

2.51
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

2.52
pipe array

the pipes feeding a group of sprinklers

NOTE Pipe arrays may be looped (see **2.46**), gridded (see **2.34**) or branched (see Figure 35).

2.53
precalculated

a term applied to pipework sized as specified in **18.1** b) or an installation in which pipes downstream of the design point are sized as specified in **18.1** b)

2.54
range pipe

a pipe feeding sprinklers directly or via arm pipes of restricted length

2.55
riser

a vertical pipe feeding a distribution or range pipe above

2.56
rosette (sprinkler rosette)

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

2.57
section

that part (which may be one or more zones) of an installation on a particular floor fed by a particular riser

2.58
sling rod

a rod with a sling eye or screwed ends for supporting pipe clips, rings, band hanger etc.

2.59
sprayer

a sprinkler that gives a downward conical pattern discharge

2.60
sprayer, high velocity

an open nozzle used to extinguish fires of high flashpoint liquids

2.61
sprayer, medium velocity

a sprayer of sealed or open type used to control fires of lower flashpoint liquids and gases or to cool surfaces

2.62
sprinkler, (automatic)

a temperature-sensitive sealing device which opens to discharge water for fire extinguishing

NOTE The term "automatic sprinkler" is now rarely used. The term "sprinkler" does not include "open sprinkler" (see **2.72**).

2.63
sprinkler, ceiling or flush pattern

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

2.64
sprinkler, concealed

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

2.65
sprinkler, conventional pattern

a sprinkler that gives a spherical pattern of water discharge

See also:

cut-off sprinkler (**2.16**);

detector sprinkler (**2.21**).

2.66
sprinkler, dry pendent pattern

a 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

2.67
sprinkler, dry upright pattern

a 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

2.68
sprinkler, fusible link

a sprinkler which opens when a component provided for the purpose melts

2.69
sprinkler, glass bulb

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

2.70
sprinkler, horizontal

a sprinkler in which the nozzle directs water horizontally

2.71
sprinkler, intermediate

a sprinkler installed below, and additional to the roof or ceiling sprinklers

2.72
sprinkler, open

a device, otherwise like a sprinkler (automatic sprinkler), not sealed by a temperature-sensitive element

2.73
sprinkler, pendent

a sprinkler in which the nozzle directs water downwards

2.74
sprinkler, recessed

a sprinkler in which all or part of the heat-sensing element is above the plane of the ceiling

2.75
sprinkler, roof or ceiling

a sprinkler protecting the roof or ceiling

2.76
sprinkler, sidewall pattern

a sprinkler that gives an outward half-paraboloid discharge

2.77
sprinkler, spray pattern

a sprinkler that gives a downward paraboloid pattern discharge

2.78
sprinkler, upright

a sprinkler in which the nozzle directs water upwards

2.79
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 except town mains and bodies of water such as lakes or canals

2.80
sprinkler yoke (arms)

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

2.81
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 [see Figure 38(b)]

2.82
standard (sprinkler) layout

a rectilinear layout with the sprinklers aligned perpendicular to the run of the ranges (see Figure 38(a)]

2.83
suction pump

an automatic pump supplying water to a sprinkler system from a suction tank, river, lake, or canal

2.84
suitable for sprinkler use

a term applied to equipment or components accepted by the authorities as suitable for a particular application in a sprinkler system, either by particular test or by compliance with specified general criteria

NOTE The LPC publishes a list of components suitable for use in sprinkler systems.

2.85
supply pipe

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

2.86
suspended open cell ceiling

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

2.87
tail-end alternate (wet and dry pipe) extension

a part of a wet installation that is selectively charged with water or air according to ambient temperature conditions

2.88
tail-end dry extension

a part of a wet or alternate installation that is charged permanently with air under pressure

2.89
terminal main configuration

a pipe array with only one water supply route to each range pipe

2.90
terminal range configuration

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

2.91
toggle support

a swivel device for securing hangers to hollow section ceilings or roofs

2.92
trunk main

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

2.93
user

the person responsible for or having effective control over the fire safety provision adopted in or appropriate to the premises or the building

2.94
zone

a subdivision of an installation fitted with a subsidiary stop valve or multiple control

Section 2. Planning

3 Initial considerations

3.1 Consultation

Where a sprinkler system or an extension or alteration to a sprinkler system is being considered for new or existing buildings the following shall be consulted at an early stage:

a) the fire authority;

b) the local water authority or local water undertaker;

c) other appropriate public authorities;

d) the fire insurers.

COMMENTARY AND RECOMMENDATIONS ON **3.1**.
There may be statutory or local bye-laws requirements, life safety requirements and other requirements of these authorities which should be coordinated in the planning stages of the contract.

Local water authorities and local water undertakers in England and Wales operate under the provisions of the Water Acts 1989, in Scotland under the Water (Scotland) Acts 1946/67 and in Northern Ireland under the Water Supplies and Sewerage Act (Northern Ireland) 1945, the Public Health Acts (Northern Ireland) 1878–1955 or under Private Acts and under Water Byelaws which may differ slightly between undertakings.

Although there is a duty to supply water for domestic purposes (subject to conditions), water supplies for sprinkler installations are given only upon request and on terms and conditions which are subject to agreement. The usual conditions in Great Britain and Northern Ireland include compliance with Byelaw to prevent contamination and waste of water. Attention is drawn to BS 6920-1 which may be relevant to systems using water drawn from town mains.

Connections to a town main within the highway remain the property of the water undertaking which usually requires a valve under its own control on each connection between the town main and the highway boundary. Any valve on the town main will be under the control of the water undertaking. Branches for hose reels and for non-industrial purposes may or may not be allowed in certain circumstances.

Water authorities and undertakers will not normally allow the use of booster pumps.

Water authorities and undertakers will not normally allow any connection between their mains and another source of water, whether by permanent pipework or, for example, by means of a fire brigade inlet even where a check valve is fitted.

The supply to any tank under atmospheric pressure should be controlled by a float valve discharging above the top level of the tank. There should not be any connection between town mains and a discharge pipe from such a tank.

3.2 Outline design

Consideration should be given to any benefits that might be gained by changes in building design, work procedures etc., when preparing the outline design.

COMMENTARY AND RECOMMENDATIONS ON **3.2**.
In planning site layout and building design, particular consideration should be given to the following:

a) *the occupancy hazard class and goods category which determine the water discharge density and water supply pressure and flow;*

b) *the siting of any town main water supply connection(s);*

c) *the siting of any water supply tank(s) or reservoir;*

d) *the siting of any pump house;*

e) *the maximum quantity of water available and maximum rate of supply (based on site tests at periods of maximum demand) from the supply source compared with the system requirements;*

f) *the location of sprinkler installation control valves, together with the access thereto, indication of their position (see section 5), and the disposal of drainage and water supply test water;*

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

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

It is important to consider building design in the context of fire protection, e.g. choice of materials, support of sprinkler pipework having regard to the load imposed on structure by the weight of sprinkler pipework and the contained water, building heating, need for inbuilt drainage (which is strongly advised for computer areas) or raising of base of stacked goods above the floor where water damage may be severe, etc. When storage of goods is involved it may be appropriate to consider the height of the building and of material stacks, and the height and type of any storage racks, which may have a considerable bearing on fire protection costs.

The design of double entry storage racks may be influenced by the need to mount sprinklers therein. Where sprinklers are fitted in racks additional rack structural members may be needed to prevent impact damage to the sprinkler head and pipework.

3.3 Interaction with other fire protection measures

Account shall be taken of possible interaction between sprinkler systems and other fire protection measures.

COMMENTARY AND RECOMMENDATIONS ON **3.3**.

Examples of possible adverse interaction between sprinkler protection and other fire protection measures are:

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

b) *operation or failure of smoke detectors in zones adjacent to one in which water discharge is taking place because of the water spray mist travelling into adjacent zones.*

Such possible interactions need particularly careful consideration in the case of systems which are part of life safety measures.

4 Extent of sprinkler protection

4.1 Buildings to be sprinkler-protected

The sprinkler system shall provide protection to all parts not specified as exceptions in **4.2** of the following:

a) the building under consideration;

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

COMMENTARY AND RECOMMENDATIONS ON **4.1**.

Sprinkler protection should also be provided in any neighbouring building which is of more than 150 m^3 capacity, and which is within 10 m of, and may present an exposure hazard to, any building protected by the system. Where there are unprotected buildings the exposure hazard can be reduced by using cut-off sprinklers over unsealed openings and drenchers over combustible walls in the protected building.

*Other means of fire protection may be appropriate in some instances. For protection of rooms and areas containing oil-filled transformers etc. see **5.4.5**.*

*BS 5655-1 specifies that lift wells shall not be provided with sprinklers and to comply with both that standard and this specification lift wells complying with **4.2.2.1** a) are essential.*

4.2 Exceptions (buildings and parts of buildings not sprinkler-protected)

4.2.1 *Obligatory exceptions.* Sprinkler protection shall not be provided in the following parts of a building or plant:

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

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

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

COMMENTARY AND RECOMMENDATIONS ON **4.2.1**.

*Sprinklers should not be fitted over salt baths, metal melt pans or frying ranges, or in positions where water may discharge into them or indirectly drain into them nor should waterpipes be fitted in these positions (see **7.1**).*

4.2.2 *Optional exceptions*

4.2.2.1 *General.* Sprinkler-protection shall be considered for, but need not be provided in, the following parts of a building or plant:

a) stairs, spaces below stair headings (but not rooms above a stair) and lift wells. Any part not provided with sprinkler protection shall be enclosed by walls, ceilings and floors with a fire resistance of not less than 2 h, in which all doors are of not less than 1 h fire resistance, and in which all glazed areas either are of not less than 1 h fire resistance or in the case of stairs are protected by cut-off sprinklers. The area of glazing in any part not provided with sprinkler-protection shall not exceed 1.5 m^2 in each storey;

b) washrooms, toilets and WCs (but not cloakrooms). Any part not provided with sprinkler-protection shall be enclosed by walls, ceilings and floors with a fire resistance of not less than 2 h, in which all doors are of not less than 1 h fire resistance, and in which all glazed areas are of not less than 1 h fire resistance or are protected by cut-off sprinklers;

c) rooms or compartments containing electric power distribution apparatus, such as switchgear and transformers, and used for no other purpose(s). Any part not provided with sprinkler protection shall be enclosed by walls, ceilings and floors of not less than 2 h fire resistance in which all doors are of not less than 1 h fire resistance;

d) in papermaking machines, the undersides of screens or of shields erected over the wet end (where there is no other fire hazard);

e) areas containing oil or similar flammable liquids.

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

a) a building or storey separated from the sprinklered building by walls of not less than 6 h fire resistance in which each opening is protected by two (arranged in series) fire doors or fire shutters each of not less than 2 h fire resistance;

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

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

d) buildings used solely as offices and/or private dwelling(s). Any part not provided with sprinkler protection shall be separated from the sprinkler-protected building by a wall of not less than 6 h fire resistance in which any glazed areas are of not less than 1 h fire resistance and are provided with cut-off sprinklers, and in which all door openings are protected by either:

1) single fire doors or single fire shutters of not less than 2 h fire resistance; or

2) fire doors of not less than 1 h fire resistance and cut-off sprinklers;

e) buildings, storeys or rooms of non-combustible construction used mainly for wet processes;

f) stairs, washrooms and WCs external to the sprinkler-protected building, in which all openings to the sprinkler-protected building are protected by doors of not less than 1 h fire resistance;

g) staircases, washrooms, toilets and WCs external or internal to the sprinkler-protected building which form a means of communication between the sprinklered building and a non-sprinklered building. In any such part not provided with sprinkler protection all openings into the communicating area from the sprinklered and from the non-sprinklered building shall be protected by fire doors of not less than 1 h fire resistance.

4.2.2.3 *Life safety systems.* Sprinkler protection shall be considered for, but need not be provided in, the following.

a) In general, rooms adjacent to areas where a life safety sprinkler system is required by an authority solely to maintain safe conditions for the evacuation of persons from the sprinkler-protected areas. Any part not provided with sprinkler protection shall be enclosed by walls, ceilings and floors with a fire resistance of not less than 1 h in which any openings are fitted with cut-off sprinklers on the non-sprinklered side and either with a fire door or fire shutter with a fire resistance of not less than 30 min.

b) Auditoria in theatres with separated stages (i.e. where there is a safety curtain between the stage and auditorium) where a life safety sprinkler system is required as a licensing condition by an authority solely to maintain safe conditions for the evacuation of persons from the theatre. Where sprinkler protection is not provided in the auditorium the safety curtain shall be provided with a line of drenchers controlled by a quick opening valve (e.g. a plug valve) fitted in an accessible position. The water supply for the drenchers shall not be taken downstream of any sprinkler installation valve set.

COMMENTARY AND RECOMMENDATIONS ON **4.2.2.3**.

In theatres with a separated stage it may be necessary, in order to satisfy the requirements of some licensing authorities, to provide sprinklers throughout the stage and associated areas including workshops, dressing rooms, scenery and other storerooms but not in the auditorium, etc. The licensing authorities will normally require drenchers to be fitted as specified here.

*Subject to the requirements of the authorities it is recommended that life safety sprinkler systems be extended to all areas except those specified in **4.2.1**, **4.2.2.1** and **4.2.2.2**.*

5 Classification of occupancies and fire hazards

5.1 General

Occupancies or parts thereof shall be classified as:

light hazard; or

ordinary hazard; or

high hazard.

Ordinary- and high-hazard occupancies shall in addition be assessed for any special variation to normal requirements specified in **5.5**.

In storage areas the goods including any packaging shall be categorized as category I, II, III or IV (see Table 1 and Table 2).

COMMENTARY AND RECOMMENDATIONS ON **5.1**.
*Hazard classification provides the basis for the design of sprinkler systems and is a skilled operation which is best carried out by the authorities (see **2.13**). The range of occupancies and hazards encountered is extremely large, and it may be necessary to classify a particular case by analogy. The classification affects the choice of installation, operational method, water supply arrangements, components, pipework design etc.*

Although this specification deals mainly with sprinkler systems which are installed primarily to reduce loss of property in fire, some sprinkler systems are installed which additionally may serve for the protection of life. In particular circumstances these may form an integral part of measures approved by the fire authority for the protection of life, for example in covered and enclosed shopping complexes, where automatic sprinkler systems serve to prevent the spread of fire and its products to adjacent exit routes (see BS 5588-10[3]*).*

Where a system is a high-rise system or a life safety system, additional safeguards are considered necessary to ensure reliability although the hazard is classified in the normal manner. These are detailed under the heading "Life safety" in the appropriate sections.

Figure 3 shows the relationship between classes and may be used in the process of classification.

5.2 Light hazard

In non-industrial occupancies where the quantity and combustibility of the contents are low, rooms and corridors not more than 126 m^2 in area and bounded by elements of construction with a fire resistance of not less than 30 min shall be classified as light hazard.

COMMENTARY AND RECOMMENDATIONS ON **5.2**.
*Typical light-hazard occupancies are given in Figure 3. No room may have more than six sprinklers (see **14.2**).*

Rooms larger than 126 m^2 or with walls of lower fire resistance are classified as ordinary hazard, group I.

5.3 Ordinary hazard

5.3.1 In non-industrial occupancies, rooms which exceed the limits specified in **5.2** for light-hazard classification shall be classified as ordinary hazard, group I.

5.3.2 Commercial and industrial occupancies involving the handling, processing and storage of mainly ordinary combustible materials, which are unlikely to develop intensely burning fires in the initial stages, shall be classified as:

ordinary hazard, group I; or

ordinary hazard, group II; or

ordinary hazard, group III; or

ordinary hazard, group IIIS (group III special).

COMMENTARY AND RECOMMENDATIONS ON **5.3**.
Table 2 gives examples of goods categories.

Examples of the four ordinary-hazard occupancy groups are given in Table 3.

Goods stored not higher than the eaves height of roofs, or within 1 m *of a flat ceiling, and not higher than as specified in column 3 of Table 1 for the appropriate method of storage and goods category, whichever is the lowest, and within the appropriate limits of column 5 of Table 1 in ordinary-hazard areas, should be classified as ordinary hazard group III.*

To allow flexibility in change of use, warehouses and high-rise buildings should be classified as group III.

*See **5.5** for occupancies for which special variation may be needed.*

5.4 High hazard

5.4.1 *General.* Commercial and industrial occupancies having abnormal fire loads shall be classified as high hazard, and subclassified as:

process high hazards; or

high-piled storage hazards; or

potable spirit storage hazards; or

oil and flammable liquid hazards.

COMMENTARY AND RECOMMENDATIONS ON **5.4.1**.
*See **5.5** for occupancies for which special variation may be needed.*

5.4.2 *Process high hazards.* Processes using materials mainly of a hazardous nature likely to develop into rapidly and intensely burning fires shall be subclassified as type 1, 2, 3 or 4.

COMMENTARY AND RECOMMENDATIONS ON **5.4.2**.
Typical examples of the four types of process high hazard are given in Table 4.

[3] In preparation.

Table 1 — Classification of stacked goods and limitations on storage methods

Type (and storage method)	Goods category reference (see 5.1 and Table 2)	Maximum storage height for protection by roof or ceiling sprinklers only		Limitations (ordinary and high hazard)	Design density and stack height given in
		Ordinary hazard Group III	High hazard		
		m	m		
S1 free standing or block stacking	I	4.0	7.6	None	Table 8 for high hazard, or Table 7 for ordinary hazard
	II	3.0	7.5		
	III	2.1	7.2		
	IV	1.2	4.4		
S2 post or box pallets in single rows	I	3.5	6.8	Aisles shall be not less than 2.5 m wide	Table 9 for high hazard, or Table 7 for ordinary hazard
	II	2.6	6.0		
	III (except rubber tyres)	1.7	6.0		
	IV	1.2	4.4		
S3 post or box pallets in multiple rows	I	3.5	5.7	No storage block shall exceed 150 m^2 in plan area. Each storage block shall have aisles all round not less than 2.5 m wide	Table 10 for high hazard, or Table 7 for ordinary hazard
	II	2.6	5.0		
	III (except rubber tyres)	1.7	3.2		
	IV	1.2	3.0		
S4 open-bottom post pallets	III (rubber tyres only)	1.7	7.2	None	Table 8 for high hazard, or Table 7 for ordinary hazard
S5 palletized rack (beam pallet racking)	I	3.5 } see note 1	6.8 } see note 1	Intermediate sprinklers shall be fitted where the aisles are less than 1.2 m wide (see **26.1.4**)	Table 9 for high hazard, or Table 7 for ordinary hazard
	II	2.6	6.0		
	III	1.7	6.0		
	IV	1.2	4.4		
S6 solid or slatted shelves 1 m or less wide	I	3.5 } see note 1	5.7 } see note 1	Gangways shall be not less than 1.2 m wide, or storage blocks shall be not more than 150 m^2 with aisles all round not less than 2.5 m wide	Table 10 for high hazard, or Table 7 for ordinary hazard
	II	2.6	5.0		
	III	1.7	3.2		
	IV	1.2	3.0		
S7 solid or slatted shelves over 1 m and not more than 6 m wide	I	Note applicable	Not applicable	As S6 above. Intermediate sprinklers should be fitted under each shelf and shall be installed where storage blocks exceed 150 m^2 in plan area or do not have aisles all round not less than 2.5 m wide	Table 10
	II				
	III				
	IV				
S8 solid or slatted shelves over 1 m wide where intermediate sprinklers cannot be installed	I	Not applicable	5.7 } see note 1	Continuous non-combustible full height vertical bulkheads shall be fitted longitudinally and transversely within each shelf (see **26.1.4**) No storage block shall exceed 150 m^2 in plan area. Each storage block shall have aisles all round not less than 2.5 m wide	Table 10
	II		5.0		
	III		3.2		
	IV		3.0		

NOTE 1 Intermediate sprinklers shall be fitted under shelves where the maximum heights specified are exceeded.
NOTE 2 See clause **14** for design density and AMAO according to storage heights and goods category.

Table 2 — High-piled storage hazards showing typical examples in goods categories

Category I	Category II	Category III	Category IV
carpets clothing electrical appliances fibreboard glassware and crockery, in cartons groceries metal goods, in cartons textiles all forms of paper storage not listed under categories II or III ordinary combustible materials, and non-combustible materials in combustible wrappings	baled cork baled waste paper cartons containing alcohols in cans or bottles cartons of canned lacquers which dry by solvent evaporation chipboard flammable liquids in non-combustible containers[a] linoleum products palletized whisky stocks plastics (non-foamed) other than cellulose nitrate rolled pulp and paper, horizontal storage rolled asphalt paper, horizontal storage veneer sheets wood patterns wooden furniture	bitumen-coated or wax-coated paper cellulose nitrate esparto (loose) foam plastics and foam rubber products, with or without cartons, other than those specified in category IV flammable liquids in combustible containers[a] rolled asphalt paper (vertical storage) rolled pulp and paper (vertical storage) rubber goods ventilated wood stacks waxed or asphalt-coated paper and containers in cartons wood wool wooden pallets and wooden flats (idle) all materials having wrappings or preformed containers or foamed plastics	offcuts and random pieces of foamed plastics or foamed rubber rolls of sheet foamed plastics or foamed rubber

NOTE The lists are not exhaustive. Category I does not automatically include goods or materials not listed here as categories II, III or IV.

[a] Excluding aerosol dispensers which are a special case.

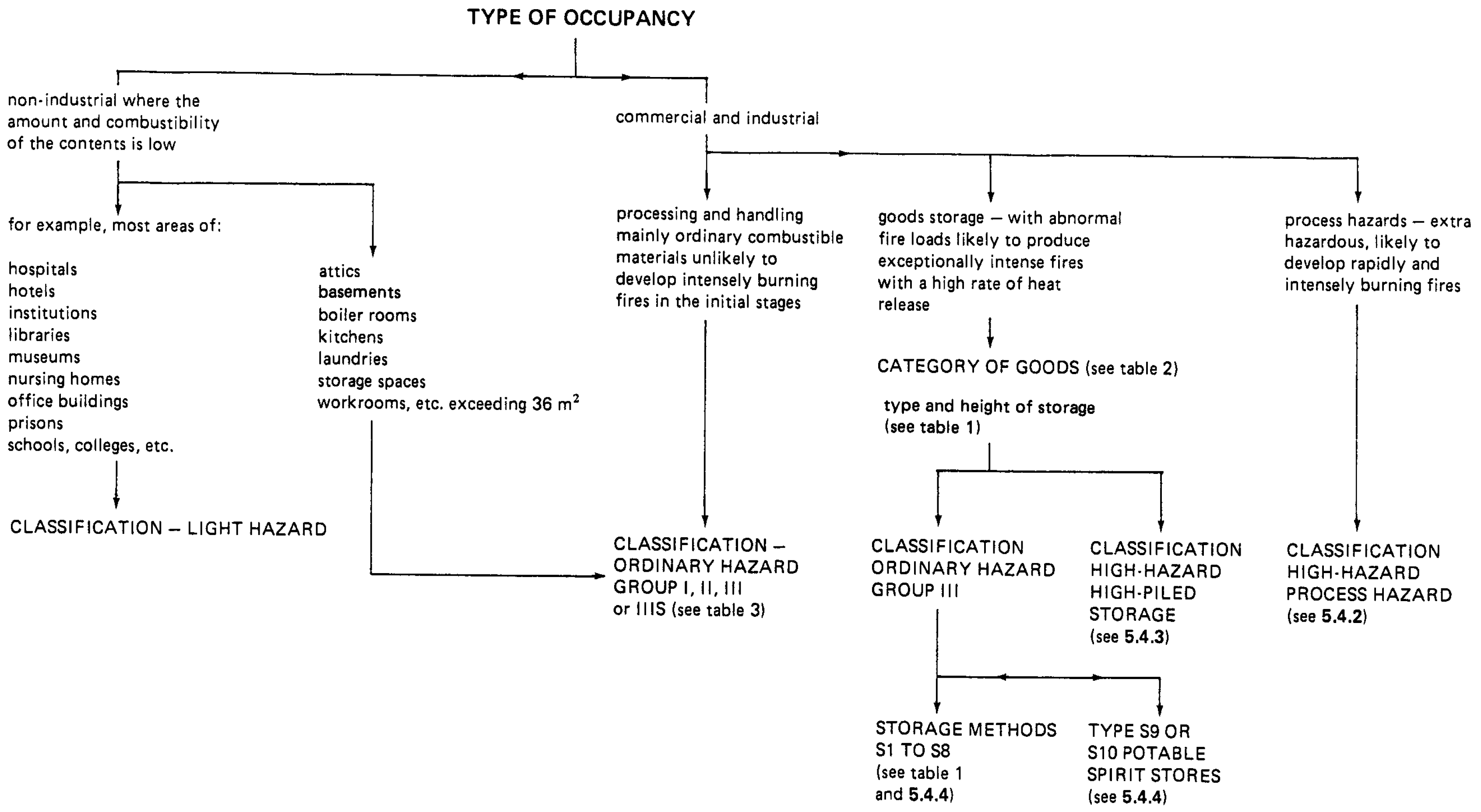


Figure 3 — Hazard classification flow chart

Table 3 — Typical examples of ordinary-hazard occupancies

Type of business	Ordinary hazard group			
	I	II[a]	III[b]	IIIS
Ceramics	abrasive wheel and powder factories	potteries	glass factories	
Chemicals	cement works	chemical works (ordinary)	soap and candle factories	match factories
Engineering	jewellery factories	engineering works including light metal works	aircraft factories excluding hangars, radio and television and electronic equipment factories, motor vehicle manufacturing and assembly plants	
Food and beverages	abattoirs, breweries (excluding bottling sections, maltings and cooperages) creameries and wholesale dairies	bakeries and biscuit factories, brewery bottling sections, brewery maltings and cooperages of non-combustible construction, confectionery factories, sauce, pickle and preserved foods factories	corn, flour and provender mills, sugar refineries	distilleries (still houses), oil mills (except areas where flammable solvents are stored)
Miscellaneous	restaurants and cafes		laundries, motor garages broadcasting studios and transmitting stations, brush factories, tanneries car parks (above or below ground)	theatres, film and television and studios
Paper			paper mills and paper goods factories, printing (and allied trades) works, wallcovering factories	
Rubber and plastics			plastics and plastics goods (excluding foamed plastics) factories, rubber and rubber goods factories (excluding foamed rubber), wallcovering factories	
Shops and offices	Offices (not high-rise) not meeting the requirements of **5.2** for light hazard		departmental stores and retail shops	
Textiles and clothing			bleach, dye and print works, boot and shoe manufacturers, carpet factories, clothing factories, cotton mills (excluding preparatory processes), flax, jute and hemp mills (excluding preparatory processes), hosiery and lace factories, shirt factories, woollen and worsted mills	cotton mills, (processes preparatory to spinning) flax, jut and hemp mills, processes preparatory to spinning), flax and hemp scutch mills
Timber and wood			Saw mills, woodworking and furniture (without foam upholstery) factories	

[a] Where there is painting or such other areas of high fire load treat as group III.
[b] Warehouses generally, multi-storey and high-rise buildings to ensure flexibility.

Table 4 — Process high-hazards showing typical examples of types

Type 1	Type 2	Type 3	Type 4
floor cloth and linoleum manufacture paint, colour and varnish manufacture resin, lamp black and turpentine manufacture rubber substitute manufacture wood wool manufacture	fire lighter manufacture manufacture of category III (see Table 2) foam plastics, foam rubber, foam plastics goods manufacture and foam rubber goods manufacture excluding category IV (see Table 2) tar distilling	cellulose nitrate manufacture	firework manufacture

5.4.3 *High-piled storage hazards.* Goods including packaging, and stored so as to be likely to produce exceptionally intense fires with a high rate of heat release shall be classified as high hazard.

COMMENTARY AND RECOMMENDATIONS ON **5.4.3**.
The reference height of goods used as the basis for design of the sprinkler system should be taken as:

a) *for flat ceilings and roofs: the appropriate maximum given in Table 1, or the height* 1 m *below the ceiling or roof, whichever is the less; or*

b) *for pitched roofs: either*

1) *where the goods are not stacked above eaves height, the appropriate maximum given in Table 1, or the height* 1 m *below the ceiling or roof, whichever is the less; or*

2) *where goods are stacked above eaves height, the appropriate maximum given in Table 1, or the height* 1 m *below the ceiling or roof, whichever is less.*

If goods are stored above this height the basis for design is invalidated.

5.4.4 *Potable spirit storage hazard.* Potable spirits not in racked barrels, stored to heights exceeding those given in column 3 of Table 1, shall be classified as high-piled goods storage categories II or III.

Potable spirit in racked barrels exceeding the ordinary-hazard class storage height specified in column 3 of Table 1 (reference S5) shall be classified as either:

type S9, for double rack storage with aisles between, having walkways at various levels; or

type S10, for continuous racking without aisles or walkways.

COMMENTARY AND RECOMMENDATIONS ON **5.4.4**.
Additional sprinkler protection at intermediate levels is specified for type S9 exceeding 9.7 m *storage height, and for type S10 exceeding* 5.0 m *storage height (see **14.5** and clause **26**).*

5.4.5 *Oil and flammable liquid hazards.* Occupancies where oil and flammable liquids are stored or used in such quantities, and in such a manner, that standard sprinkler protection may not be effective shall be classified as oil and flammable liquid hazards.

COMMENTARY AND RECOMMENDATIONS ON **5.4.5**.
*A deluge installation with medium-and/or high-velocity sprayers may be effective against these hazards. Only some aspects of the design of such systems are considered in this specification (see **6.9**).*

5.5 Sprinkler installation variations

Special consideration shall be given to ordinary-and high-hazard occupancies where variations of the generally applicable requirements are specified.

COMMENTARY AND RECOMMENDATIONS ON **5.5**.
Variations are specified for the following:

a) *hazardous processes and explosion hazards (see **6.1.2**, **12.5**, **20.1.2.1** and **21.2.2.4**);*

b) *bleach, dye and textile print works, paper mills (see also Item (h) below), tanneries, premises or parts of premises where corrosive conditions exist (see **21.2.1.3**, **22.1.2**, **25.11** and **35.2.3**);*

c) *alkali plants, electroplating and galvanizing works, foundries, organic fertilizer plants, pickle and vinegar works (see **25.11** and **35.2.3**);*

d) *cold-storage warehouses (see **6.5.1.2**, **6.5.3.3**, **20.3.4**, clause **23**, **25.8**, **26.6.4**, Table 70 and **27.2**);*

e) *computer areas (see **6.1.2**, **10.1.2**, **20.1.4**, **26.9.3** and **27.4.6**);*

f) *corn, rice, provender and oil mills (see Table 70 and **26.7.2**);*

g) *film and television production studios (see Table 70 and **26.9.1**);*

h) *papermaking machines (see **20.1.4** and **26.8.4**);*

i) *theatres and auditoria (see **4.2.2.3**, **26.9.2** and Table 70);*

j) *drying ovens and enclosed paint lines (see **25.7.4** and **26.7.7**);*

k) *high-rise buildings (see **6.3.2**, **6.3.4**, **12.3**, **13.2**, **15.2.2.2**, **17.3.2**, **17.4.6.1**, **17.4.6.3**, **20.1.4**, **20.3.1**, **24.2.3.2**, **27.1.1**, **27.2.3**, Table 3 and Table 28).*

6 Selection of installation type, size and design

6.1 General

6.1.1 *Suitability.* The type, size and design of each sprinkler installation used in the system shall be appropriate to the hazards covered by the installation.

6.1.2 *Size of an installation.* In addition to the size limits appropriate to types given in this clause an installation shall not cover more than the following:

a) if protecting an explosion hazard, the containment area of the hazard; or

b) if protecting a computer area, the computer area except where the installation includes a zone covering only the computer area.

6.2 Types

A sprinkler installation shall be based on one of the following main types:

a) wet pipe;

b) alternate (wet and dry pipe);

c) dry pipe;

d) pre-action;

e) recycling.

COMMENTARY AND RECOMMENDATIONS ON **6.2**.

*Installations based on a) and/or b) of **6.2** may also include extensions of the following additional types:*

a) *tail-end alternate;*

b) *tail-end dry pipe;*

c) *deluge.*

Wet pipe installations are preferred. However if the temperature of the premises cannot be guaranteed to remain above freezing at all times an alternate installation should be fitted. Where only part of the premises may fall below 5 °C *during the winter, a tail-end alternate extension should be installed in that part as an extension to the wet installation.*

*Where freezing or elevated temperatures are experienced either frequently or continuously a dry pipe installation should be installed, or only in small areas tail-end dry pipe extensions should be installed as extensions to the main installation. See **6.3** to **6.9** for the limits on size of the various types of installation.*

Sprinkler installations may incorporate deluge systems to cover small areas of flammable liquid hazards such as oil-fired boiler rooms etc.

6.3 Wet pipe installations

6.3.1 *General.* Wet pipe installations shall only be installed where there is no danger at any time of the water in the pipes freezing, and where the temperature will not exceed 70 °C. Anti-freeze shall not be employed as a means of preventing the water freezing in the pipes.

COMMENTARY AND RECOMMENDATIONS ON **6.3.1**.

*Where non-freezing conditions cannot be ensured throughout the premises, unheated areas may be protected by a tail-end alternate wet and dry pipe system subject to the limits on number of sprinklers concerned given in **6.6**, or by the use of dry upright or dry pendent sprinklers projecting into the low-temperature area or less preferably by the use of trace heating and lagging of the pipework.*

BS 6351-3 gives recommendations for trace heating. BS 5422 and BS 5970 give recommendations for lagging.

6.3.2 *Size of installations, sections and zones.* The number of sprinklers in an installation, section or zone (including tail-end extensions (see **6.6**) but not including sprinklers in concealed spaces or in machines etc.) shall not exceed the following.

a) Light hazard:	500 per installation.
b) Ordinary hazard:	
1) In single-storey buildings, or unheated service areas and car parks near or below ground level in multi-storey buildings, ordinary and/or high hazard inclusive of any light-hazard sprinklers on the same installation main control valve set:	1 000 per installation.
2) In multi-storey buildings, and for high-rise systems, excluding unheated service areas and car parks near or below ground level:	500 per zone, or if an installation is not divided into zones, 1 000 per installation.
c) High hazard:	1 000 per installation.
d) Installations with intermediate level sprinklers	
1) Installations with only intermediate level sprinklers (i.e. fed from a set of installation control valves separate from the roof or ceiling sprinkler distribution pipework):	1 000 per installation

2) Installations with ceiling and intermediate level sprinklers:	1 000 per installation of which not more than 50 shall be intermediate level protection.
e) In a life safety system:	200 per zone or, for an installation not divided into zones, 200 per installation.

6.3.3 ***Life safety***

6.3.3.1 Sprinkler installations for life safety shall be of the wet pipe type and any tail-end extension shall comply with **6.6**.

6.3.3.2 Sprinkler installations shall, if necessary, be arranged in zones; no unzoned installation or zone shall:

a) cover an area under more than one ownership;

b) cover more than one floor level, but this level may include additionally a mezzanine floor not exceeding 100 m^2 in area.

COMMENTARY AND RECOMMENDATIONS ON **6.3.3.2**.

6.3.2 *e) restricts the size of zones to 200 sprinklers.*

6.3.4 *High-rise buildings*. The height difference between the lowest and highest sprinklers in an installation shall be not more than 45 m. The distribution pipes shall be independently connected to the main rise pipe at the floor they serve. No section shall extend to more than one floor and each section shall be served by a separate main rise pipe.

6.4 Alternate (wet and dry pipe) installations

6.4.1 *General.* Alternate installations shall only be installed where there is an intermittent danger of the water in the pipes freezing, for example, during the winter months, and where the ambient temperature does not exceed 70 °C.

COMMENTARY AND RECOMMENDATIONS ON **6.4.1**.

Alternate installations are not recommended for the protection of high-hazard storage.

Areas where freezing conditions may be experienced at times when the installation is in the wet mode may be protected by a tail-end dry or alternate system, or with dry upright or dry pendent sprinklers projecting into the low-temperature area.

6.4.2 *Mode of operation.* Alternate installations shall be operated in the wet mode only when there is no danger of water in the pipes freezing. In the dry mode the installation shall be pressurized with air to within the pressure range recommended by the alarm valve manufacturer.

6.4.3 ***Size of installation***

6.4.3.1 The number of sprinklers, including any in tail-end extensions, shall not exceed the following.

a) In a light-hazard installation with accelerator or exhauster:	250 per installation.
b) In a light-hazard installation without accelerator or exhauster:	125 per installation.
c) In an ordinary-and/or high-hazard installation with accelerator or exhauster:	500 per installation.
d) In an ordinary-and/or high-hazard installation without accelerator or exhauster:	250 per installation.

6.4.3.2 The notional number of sprinklers, including any in tail-end extensions, shall not exceed the following.

a) In a combined light-and ordinary-hazard installation:	500 per installation.
b) In a combined light-and high-hazard installation:	250 per installation.

The notional number shall be calculated as the actual number of ordinary-and/or high-hazard sprinklers plus twice the actual number of light-hazard sprinklers in the installation.

6.4.4 *Sprinkler types.* The installation shall be fitted with upright sprinklers, or dry pendent sprinklers.

6.5 Dry pipe installations

6.5.1 ***General***

6.5.1.1 Dry pipe installations shall only be installed where the conditions are such that a wet pipe system or alternate installation cannot be used.

COMMENTARY AND RECOMMENDATIONS ON **6.5.1**.

For example, wet pipe and alternate installations cannot be used in buildings where the temperature is artificially maintained close to or below 0 °C, *such as in cold stores, fur vaults, etc., or where the temperature is maintained or may be raised above* 70 °C *such as in drying ovens, etc., and where the pipework cannot be run outside the cold or hot areas.*

6.5.1.2 In cold-storage warehouses refrigerated by air circulation, automatic means shall be provided to automatically shut down the air circulation fans when the sprinkler system operates.

6.5.2 *Charging pressure.* The installation shall be pressurized with air to within the pressure range recommended by the alarm valve manufacturer.

COMMENTARY AND RECOMMENDATIONS ON **6.5.2**.
A higher pressure may cause undesirable delay in water discharge.

6.5.3 ***Size of installation***

6.5.3.1 The number of sprinklers shall not exceed the following.

a) In a light-hazard installation with accelerator or exhauster:	250 per installation.
b) in a light-hazard installation without accelerator or exhauster:	125 per installation.
c) In an ordinary-and/or high-hazard installation with accelerator or exhauster:	500 per installation.
d) In an ordinary-and/or high-hazard installation without accelerator or exhauster:	250 per installation.

6.5.3.2 The notional number of sprinklers (including any in tail-end extensions) shall not exceed the following.

a) In a combined light-and ordinary-hazard installation:	500 per installation.
b) In a combined light-and high-hazard installation:	250 per installation.

The notional number shall be calculated as the actual number of ordinary-and/or high-hazard sprinklers plus twice the actual number of light-hazard sprinklers in the installation.

6.5.3.3 In cold-storage warehouses with air circulation refrigeration where:

a) the pipework is within the cold chamber; and

b) the number of sprinklers excluding any sprinklers above a false ceiling exceeds 50;

each installation shall comprise two, three, four or five tail-end extensions each containing not more than 50 sprinklers plus any sprinklers in the plenum fed directly from the pipework below.

6.5.4 *Sprinkler types.* The installation shall be fitted with:

a) upright sprinklers; or

b) dry pendent sprinklers; or

c) in cold-storage warehouses where the pipework is in the cold chamber, pendent sprinklers.

6.6 Tail-end alternate pipe and tail-end dry pipe extensions

6.6.1 ***General***

6.6.1.1 Tail-end alternate extensions shall be installed only in comparatively small areas where there is a possible frost danger in an otherwise adequately heated building as extensions to wet pipe installations. They shall comply with the appropriate requirements of **6.4**.

6.6.1.2 Tail-end dry extensions shall be installed only as the following:

a) extensions to wet or alternate installations in high-temperature ovens or stoves; or

b) extensions to wet, dry or alternate installations in buildings where freezing conditions may occur and with an air/gas pressure not less than the air/gas pressure between the main installation control valve and the tail-end valve.

They shall comply with the appropriate requirements of **6.5**.

6.6.2 *Size of tail-end extensions.* The number of sprinklers on any tail-end extension shall not exceed 100. Where more than two tail-end extensions are controlled by one installation control valve set, the total number of sprinklers in the tail-end extensions shall not exceed 250.

6.7 Pre-action installations

6.7.1 *General.* There are two types of pre-action installation as follows:

a) *Type 1,* which shall be installed only to prevent a premature discharge of water from pipework or sprinklers that have suffered mechanical damage; and

b) *Type 2,* which shall be installed only to facilitate an early discharge of water from a dry pipe or alternate installation by opening the installation main control valve, thus filling the installation pipework with water, upon operation of a fire detection system.

COMMENTARY AND RECOMMENDATIONS ON **6.7.1**.
Type 1 installations are appropriate to hazards where the cost or inconvenience of water damage may be exceptionally high. Because the sprinkler installation control valve opens only as a result of operation of the fire detection system much reservation should be exercized when considering the use of Type 1 installations. Where a pre-action installation is to be used for high hazard Type 2 should preferably be used. The fire detectors may be expected to signal the presence of fire at a early stage (before operation of any sprinkler) so that hand or manually operated appliances may well be successfully used to prevent sprinkler water discharge.

Type 2 installations are appropriate to large alternate dry pipe sprinkler installations where rapidly developing intense fires may occur. The possible early detection of a fire by fire detectors will prime the sprinkler installation with water, so that discharge will not be delayed when a sprinkler or sprinklers operate. Failure of the fire detector system does not prevent normal operation of the sprinkler installation.

For high-hazard occupancies Type 2 is preferable to Type 1.

Because they are more complicated, pre-action installations should be used only where a wet, dry or alternate system would be unsuitable. The detection system should be installed as recommended in BS 5839-1.

6.7.2 ***Mode of operation***

6.7.2.1 The sprinkler installation pipework shall be normally charged with air under pressure, and monitored to give a warning indication on reduction of the air pressure. Complete loss of air pressure shall initiate the visual and audible indications for a fire alarm (see clause **27**).

6.7.2.2 The fire detection system shall automatically give an alarm on operation and shall operate a continuously energized valve or other trip mechanism, suitable for sprinkler service, to release (Type 1) or prime (Type 2) the pre-action alarm valve when the valve or trip mechanism becomes de-energized.

6.7.3 *Sprinkler head orientation.* In type 1 installations, sprinklers shall be installed in the upright position or only in a building free from the danger of freezing, in the upright or pendent position. In type 2 installations, sprinklers shall be installed in the upright position.

6.7.4 *Size of pre-action installations.* The number of sprinklers shall not exceed the following.

a) In a light-hazard installation:	500 per installation.
b) In an ordinary-hazard installation:	1 000 per installation.
c) In a high-hazard installation:	1 000 per installation.

6.8 Recycling installations

6.8.1 *General.* Recycling installations shall only be installed where it is necessary for the following reasons:

a) to restrict water damage after a fire is extinguished;

b) to avoid closure of the main installation stop valve if modifications are made to the installation pipework or if sprinkler heads are to be replaced;

c) to prevent water damage caused by accidental mechanical damage of the installation pipework or sprinklers.

The heat detectors and control equipment shall be suitable for use in recycling pre-action sprinkler installations.

COMMENTARY AND RECOMMENDATIONS ON **6.8.1**.
Heat detectors used in this application may be exposed to flame during the course of the on/off cycling process, and it is therefore essential that the operating temperature characteristics do not change during the course of a fire incident.

The requirements detailed in b) above may only be met if a safe working practice can be devised to meet the contingency that the installation may operate while work progress (see ***7.4****). Full details of the practice should be provided at the planning stage.*

6.8.2 ***Mode of operation***

6.8.2.1 Water discharge cycling shall be controlled by heat detectors installed at the roof or ceiling which operate as an electrical interlock causing a water flow control valve to open and close. A timer shall be provided to delay closure of the flow control valve for a predetermined period in each cycle after lowering of the temperature of the heat detectors.

COMMENTARY AND RECOMMENDATIONS ON **6.8.2.1**.
A 5-min *delay is recommended.*

6.8.2.2 The flow control valve, monitoring devices, and the electrical interlock system shall be suitable for sprinkler use.

COMMENTARY AND RECOMMENDATIONS ON **6.8.2.2**.
Closure of the flow control valve during the automatic cycling sequence should not cause excessive water hammer.

6.8.2.3 Heat detectors to operate the installation flow control valve cycling sequence shall be provided at the roof or ceiling as specified in BS 5839-1.

6.8.3 *Sprinkler head orientation.* Where there is a danger of freezing, sprinklers shall be installed in the upright direction.

COMMENTARY AND RECOMMENDATIONS ON **6.8.3**.
Where there is no danger of freezing, sprinklers may be installed in the upright or pendent position.

6.8.4 *Size of recycling installations.* The number of sprinklers shall not exceed 1 000 per installation.

6.9 Deluge installations

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

6.9.2 *Mode of operation.* The installation shall be provided with the following:

a) a manual release; and/or

b) an automatic release, which shall be either:

1) a multiple control or controls; or

2) a deluge valve;

to initiate discharge.

COMMENTARY AND RECOMMENDATIONS ON **6.9.2**.
A manual release should only be provided where a process is continuously supervised by personnel, and where the disruption caused by unwanted discharge may be excessive. Installations without an automatic release should be used for small area protection only.

A multiple control should only be used for small areas of hazard. The area is limited because fire detection is possible only at the multiple control, and also by the water-carrying capacity of the multiple control. The number of detection points may be increased by the use of two or more controls delivering water into a ring pipework arrangement feeding all of the open sprayers in the installation.

6.9.3 *Pipework.* Pipework shall be fully hydraulically calculated (see clause **18** and **24.3**).

The installation pipework shall drain automatically after operation, by means not involving excessive loss of water during normal operation.

COMMENTARY AND RECOMMENDATIONS ON **6.9.3**.
*Design densities and AMAOs for process hazards are specified in **14.4.1**. Design densities and AMAOs for oil and flammable liquid hazards are not given in this specification.*

7 Hazard to personnel

7.1 High-temperature liquids

Sprinklers shall not be installed in locations where water discharge from sprinkler heads or sprayers, or water leakage from installation pipework, may come into contact with high-temperature liquid baths such as salt baths, metal melt pans, frying ranges, hot dip bitumen baths etc.

COMMENTARY AND RECOMMENDATIONS ON **7.1**.
Water falling into the bath would produce steam and might cause dangerous splashing or overflow of the bath contents. It may be possible to fit sprinkler heads or sprayers and pipework above such locations if adequate shielding of water discharge, drainage and leakage is provided. In either event consideration should be given to the need for alternative forms of fire protection in these areas.

7.2 Water reactive chemicals

The consequences of sprinkler water discharge onto water reactive chemicals below shall be considered and safe storage and usage practices adopted.

COMMENTARY AND RECOMMENDATIONS ON **7.2**. *Water discharge may ignite certain chemicals, or cause a violent reaction and/or emission of poisonous or noxious fumes.*

Where water run-off from sprinkler discharge may be dangerous owing to contact with water-soluble chemicals or by waterborne dispersion of hazardous materials, construction of suitable drains, sumps, bunds etc. should be considered at the planning stage.

BS 5908 gives advice on these matters.

7.3 Electrical earthing

7.3.1 All exposed metalwork in systems shall be efficiently earthed to prevent the metalwork becoming electrically charged.

7.3.2 Sprinkler pipework shall not be used as a means of earthing electrical equipment.

COMMENTARY AND RECOMMENDATIONS ON **7.3**.
Electrical equipment below sprinkler installations should have normal earthing and overload protection.

Where the electrical installation is covered by the Regulations for Electrical Installations (Wiring Regulations 15th edition[4]) the sprinkler system metalwork should be efficiently connected to the main earthing terminal of the electrical installation, as required by the Wiring Regulations (15th edition).

[4] Available from Institution of Electrical Engineers, Publications Sales Department, Station House, Nightingale Road, Hitchin, Herts. SG5 1RJ.

7.4 During maintenance

Where sprinkler or deluge installation pipework is normally unpressurized, work shall not be undertaken involving removal or fitting of sprinkler heads or water sprayers when operation of the installation is possible unless measures are taken to ensure the safety of the erection personnel concerned.

Section 3. Contract arrangements

8 Contract drawings/information documents

8.1 General

The information specified in **8.2** and **8.3** shall be provided to the user, together with details of the authorities consulted (see **3.1**) and any response to the consultation.

All drawings and information documents shall carry the following information:

a) the name of the user and the owner;

b) the address and location of premises;

c) the occupancy of each building;

d) the name of the designer;

e) the name of the checker, who shall not be the designer.

COMMENTARY AND RECOMMENDATIONS ON **8.1**.
Drawings should follow the recommendations of BS 1192 and use the symbols of BS 1635. The authorities may wish to be provided with some, or all of this, or other information.

8.2 Preliminary or estimating stage

The information provided shall include the following:

a) a general specification of the system; and

b) a block plan of the premises showing:

1) the type(s) of installation(s) and the hazard class(es) and stock categories in the various buildings;

2) the extent of the system with details of any unprotected areas;

3) the construction and occupancy of the main building and any communicating and/or neighbouring buildings;

4) a cross section of the full height of the building(s) showing the height of the highest sprinkler above a stated datum level; and

c) particulars of the water supplies, which if a town main shall include pressure flow data with the date and time of test, and a plan of the test site; and

d) a statement that the installation will comply with this specification including details of any deviation(s) from its recommendations with reasons for the deviation(s).

8.3 Design stage

8.3.1 *General.* The information provided shall include a summary schedule (see **8.3.2**), complete working drawings of the sprinkler installation(s) (see **8.3.3**) and details of the water supplies (see **8.3.4**).

8.3.2 *Summary schedule.* The summary schedule shall give the following information:

a) the name of the project;

b) all drawing or document reference numbers;

c) all drawing or document issue numbers;

d) all dates of issue of drawings or documents;

e) all drawing or document titles;

f) the number of sprinklers on each installation control valve set;

g) the height of the highest sprinkler on each installation control valve set;

h) the type(s) of installation(s) and the nominal diameter(s) of the main control valves;

i) the number or reference of each installation main control valve set in the system;

j) a statement that the system will comply with this specification including details of any deviation(s) from its recommendations with reasons for the deviation(s).

k) a list of the components suitable for sprinkler use, included in the system each identified by manufacturer's name and model/reference number.

8.3.3 ***Installation layout drawings***

8.3.3.1 *General.* The scale shall be not less than 1 : 100. Layout drawings shall include the following information:

a) north point indication;

b) the class or classes of installation according to hazard class including stock category and design storage height;

c) constructional details of floors, ceilings, roofs, exterior walls and walls separating sprinklered and non-sprinklered areas;

d) sectional elevations of each floor of each building showing the distance of sprinklers from ceilings, structural features, etc. which affect the sprinkler layout or the water distribution from the sprinklers;

e) the location and size of concealed roof or ceiling voids, offices and other enclosures sealed at a level lower than the roof or ceiling proper;

f) indication of trunking, stagings, platforms, machinery, fluorescent light fittings, heaters, suspended open cell ceilings etc. which may adversely affect the sprinkler distribution;

g) the sprinkler type(s) and temperature rating(s);

h) the location and type of main control valves and location of alarm motors and gongs;

i) the location and details of any water flow, and air or water pressure, alarm switches;

j) the location and size of any tail-end air valves, subsidiary stop valves and drain valves;

k) the drainage slope of the pipework;

l) the location and specification of any orifice plate;

m) a schedule listing the numbers of sprinklers, medium- and high-velocity sprayers etc., and the area of protection;

n) a key to the symbols used.

8.3.3.2 *Precalculated pipework.* For precalculated pipework the following details shall be given on, or with, the drawings:

a) identification of the design point of each array on the layout drawing (for example, as in Figure 29);

b) a summary of the pressure losses between the control valve and the design points at the following design rates of flow.

1) In a light-hazard installation: 225 L/min.

2) In an ordinary-hazard installation: 1 000 L/min.

3) In a high-hazard installation: the flow corresponding to the appropriate design density given in Table 16, Table 17, Table 18 or Table 19.

The calculation as specified in **24.2**, showing that:

i) in light- and ordinary-hazard installations, for each run of distribution pipework

$$P_f - P_h$$

is not more than the appropriate value specified in **24.2**; and/or

ii) In high-hazard installations designed using Table 60 or Table 61

$$P_f + P_d + P_s$$

is not more than the residual pressure available at the control valves from the water supply when it is tested at the appropriate flow rate

where

P_d is the pressure at the design point specified in Table 16, Table 17, Table 18 or Table 19 as appropriate;

P_f is the frictional pressure loss in the distribution pipework between the design point and the control valve "C" gauge;

P_h is the static pressure between the level of the highest design point on the floor concerned and the level of the highest design point in the top storey; and

P_s is the static head loss owing to the height of the highest sprinkler in the array concerned above the control valve "C" gauge.

COMMENTARY AND RECOMMENDATIONS ON **8.3.3.2**.

A typical summary is shown in Figure 4. The relevant layout drawing should also be supplied.

For light- and ordinary-hazard installations with precalculated pipework the pressure needed at the design point is not stated. Instead the friction loss in the pipework between the control valve and the design points is limited to a predetermined quantity, incorporated in the value specified for pressure at the control valves in section 4. Static head is added to this pressure to give the value defining the minimum actual water supply running pressure.

8.3.3.3 *Hydraulically calculated pipework.* For hydraulically calculated pipework (see **24.3**), the following shall be given, with detailed calculations, either on purpose-designed work sheets or as a computer print-out:

a) *for each design area of operation:*

1) the area identification;

2) the hazard class;

3) the specified density of discharge (in mm/min);

4) the assumed area of maximum operation (AMAO) (in m^2);

5) the number of sprinklers in the AMAO;

6) the sprinkler nominal orifice size (in mm);

7) the maximum area covered per sprinkler (in m^2);

8) detailed and dimensioned working drawings showing the following:

i) the node or pipe reference scheme used to identify pipes, junctions, sprinkler heads and fittings which need hydraulic consideration;

ii) the position of the hydraulically most unfavourable AMAO;

iii) the position of the hydraulically most favourable AMAO;

iv) the four sprinklers upon which the design density is based (see **24.3.4**);

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

b) *for each operating sprinkler:*

1) the sprinkler node or reference number;

2) the sprinkler nominal *k* factor;

3) the flow through the sprinkler (in L/min);

4) the inlet pressure to the sprinkler or sprinkler assembly (in bar);

c) *for each hydraulically significant pipe:*

1) the pipe node or other reference;

2) the pipe nominal bore (in mm);

3) the Hazen-Williams constant, C, or the k factor, for the pipe (see Table 36);

4) the flow through pipe (in L/min);

5) the nominal fluid velocity (in m/s);

6) the length of pipe (in m);

7) the numbers, types and equivalent lengths of fittings;

8) the static head change in pipe (in m);

9) the pressures at inlet and outlet of pipe (in bar);

10) the friction loss in pipe (in bar);

11) the indication of flow direction.

COMMENTARY AND RECOMMENDATIONS ON **8.3.3.3**.
A line diagram of the pipe layout should be prepared showing the following:

i) *the node or pipe reference numbers;*

ii) *the distribution pipes;*

iii) *the range pipes;*

iv) *the sprinkler heads under consideration;*

v) *the four hydraulically most unfavourably placed heads (see **24.3**);*

vi) *the flow through, and pressure at the end of, each hydraulically significant pipe.*

8.3.4 ***Water supply***

8.3.4.1 *Water supply drawings.* The drawings shall show water supplies and pipework therefrom up to the installation control valves. The drawings shall be on an indicated scale of not less than 1 : 100. A key to the symbols shall be included. The position and type of stop and check valves and any pressure reducing valve, water meter, water lock, orifice plate and any connection supplying water for other services (see **12.3**), shall be indicated.

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

8.3.4.3 *Town main.* Where a town main forms one or both of the supplies or provides infill to a suction tank type C (see **17.1.4**) the following details shall be given:

a) the nominal diameter of the main;

b) whether the main is double-end fed or dead-end; if dead-end, the location of the nearest double-end fed main connected to it;

c) the pressure-flow characteristic graph of the town main determined by test at a period of peak demand. The graph shall be corrected for friction losses and static head difference between the test location and either the control valve "C" gauge or the suction tank infill valve, as appropriate,

d) the date and time of the town main test;

e) the location of the town main test point relative to the installation control valve.

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

f) a modified pressure-flow characteristic graph [see **8.3.4.3** c)] indicating the usable pressure at any flow up to the maximum installation demand;

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

8.3.4.4 *Automatic pump set.* Where automatic pump sets form one or more of the water supplies a pump characteristic curve for low water level "X" (see Figure 23) shall be provided. The curve shall show the estimated performance of the pump or pumps under installed conditions at the control valve "C" gauge.

In addition where the pipework is fully hydraulically calculated the following details of the automatic pump set shall be provided:

a) the pump manufacturer's data sheet showing the following:

1) the generated head graph;

2) the power absorption graph;

3) the net positive suction head (NPSH) graph;

4) a statement of the power output of each prime mover.

b) the installers' 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 Figure 23), and at the pump outlet pressure gauge for normal water level;

c) the height difference between the control valve "C" gauge and the pump delivery pressure gauge;

d) the installation number and the hazard classification(s);

Statement of distribution pipe losses between the various design points and the installation valves

HAZARD GROUP: ORDINARY HAZARD DESIGN FLOW RATE: 1000 L/min.

NAME & ADDRESS: A.B. CEE COMPANY, DEE LANE, ENDING

1	2	3	4	5	6	7		
Run of distribution pipe from valves to (letter)	*Pipe size*	*Pipe length*	*No. of turns*	*Equiv. pipe length of turns*	*Total equiv. length of pipe*	*Pressure loss at design flow rate*		
						Pipe losses	*Static head gain (Ph)*	*Difference*
	mm	m		m	m	mbar	mbar	mbar
A-FLOOR 3	65	3.5	–	–	3.5	122		
	80	7	–	–	7	111		
	100	49	2	6	55	240		
						473		
							0	
								473
B-FLOOR 3	65	7	–	–	7	243		
	80	1.9	–	–	1.9	30		
	100	20	1	3	23	101		
						374		
							0	
								374
C-FLOOR 2	65	10.5	–	–	10.5	365		
	80	16.9	–	–	16.9	268		
	100	28.3	2	6	34.3	150		
						783		
							380	
								403
D-FLOOR 2	65	8.8	–	–	8.8	306		
	80	–	–	–	–	0		
	100	16.3	1	3	19.3	84		
						390		
							380	
								10
E-FLOOR 1	65	10.5	–	–	10.5	365		
	80	38.9	2	6	44.9	712		
	100	2.5	–	–	2.5	11		
						1088		
							760	
								328
F-FLOOR 1	65	8.9	–	–	8.9	309		
	80	9.9	1	3	12.9	205		
	100	2.5	–	–	2.5	11		
						525		
							760	
IN ALL SECTIONS THE PRESSURE LOSS IN THE DISTRIBUTION PIPE IS LESS THAN 500 mbar								-235

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

Figure 4 — Typical statement of pressure loss calculations

e) the demand pressure-flow characteristic for the hydraulically most unfavourable and most favourable AMAO, calculated at the control valve "C" gauge as specified in clause **24**;

f) the available and the specified NPSH at maximum predicted flow ($Q_{max.}$; see Figure 20).

COMMENTARY AND RECOMMENDATIONS ON **8.3.4.4**.
Typical examples of pump manufacturer's data sheets are shown in Figure 5. Figure 20 is an illustration of an installer's data sheet.

9 Work on site

9.1 Care of materials on site

Components shall be properly stored on site until required for installation.

COMMENTARY AND RECOMMENDATIONS ON **9.1**.
Unloading, stacking and storage should be carried out with care to prevent damage to pipes and pipe threads, valves and sprinklers, gauges and any pumps and power units used in the system.

Components should be stored so that they are not damaged by building operations. Site locations should be prepared in advance of delivery so that heavy items such as fire pumps, strainers and pressure tanks can be transported directly to their final locations.

Pipes should be protected (for example by caps) against entry of foreign matter such as rubble, cordage, etc. into the bore, and they should be examined for such matter immediately prior to erection. Open ends of pipes should be capped as building construction proceeds.

Sprinklers, controls and sprayers should preferably be fitted to pipes in situ. Where fabricated ranges are used the sprinklers may be fitted immediately before erection using pipe racks to hold the ranges off the ground.

9.2 Fire protection of buildings under construction or modification

9.2.1 *General.* Work on the system shall proceed with the progress of the building. Installations and zones shall be made operational as soon as is practical.

COMMENTARY AND RECOMMENDATIONS ON **9.2**.
It is particularly important that there should be no storage of combustible materials within any area of the building below, or more than 7.5 m above, ground level until the installation in that area is operational.

Huts erected within the building should be as follows:

a) *made of non-combustible materials and, if the contents are combustible, protected by portable fire extinguishers (see BS 5306-3);*

b) *sited not less than 6 m from each other or from any combustible material store;*

c) *not sited on floors below, or more than 7.5 m above, ground level*

9.2.2 *Hot work.* Suitable precautions shall be taken when carrying out hot work.

COMMENTARY AND RECOMMENDATIONS ON **9.2.2**.
The precautions outlined in Appendix C should be taken.

*The user should notify the insurers of the premises and contents before work commences. Occupiers of communicating and/or neighbouring buildings (see **4.1**) should be advised that hot work is to be carried out.*

*See **21.3** for welding procedures.*

10 Commissioning and acceptance tests

10.1 Commissioning tests

10.1.1 *Installation pipework.* All installation pipework shall be pressure tested hydraulically to not less than:

a) 15 bar; or

b) 1.5 times the working pressure;

whichever is the greater, for not less than 1 h. Any faults disclosed, such as permanent distortion, rupture or leakage shall be corrected and the test repeated.

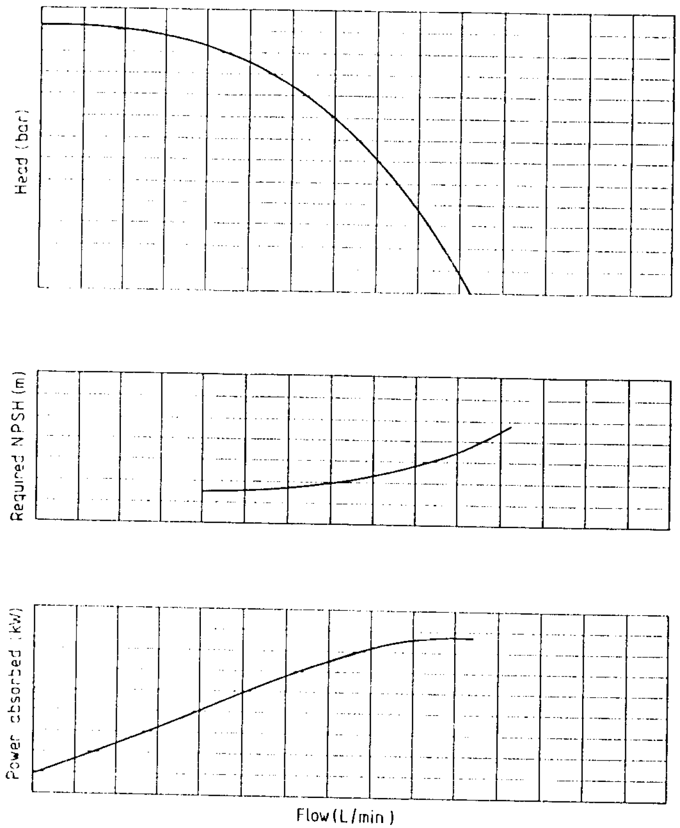
COMMENTARY AND RECOMMENDATIONS ON **10.1.1**.
An initial pneumatic test is advisable where special conditions apply, for example in water-sensitive areas such as computer suites, or cold stores or other places where the hydraulic test will require that the protected area be non-functional.

10.1.2 *Initial testing to regular routine procedures.* The system shall be tested as specified in **34.2**, **34.3** and **35.2**, i.e. making the tests which will be made on a routine daily, weekly and quarterly basis, and any faults shall be corrected.

10.2 Acceptance tests

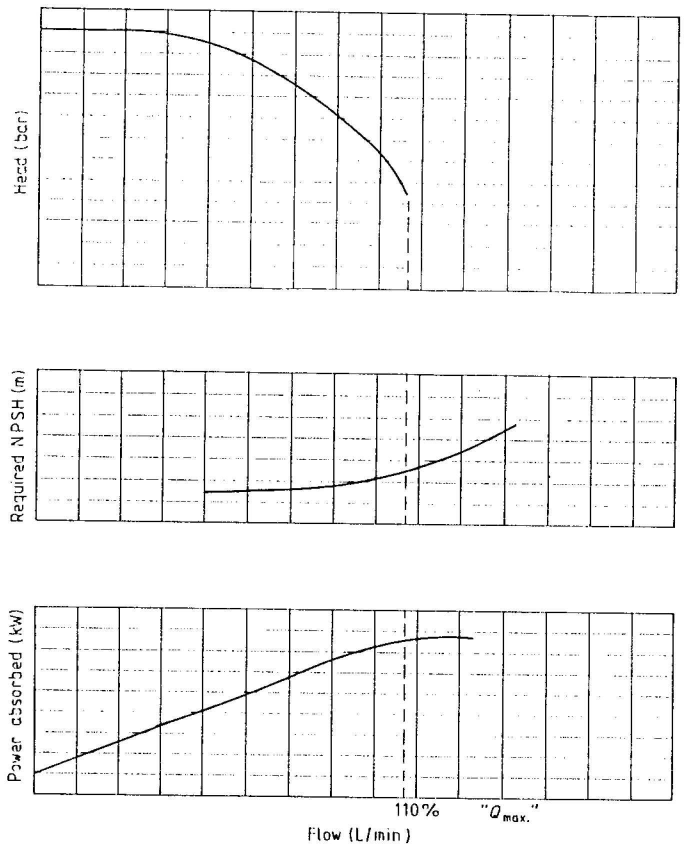
10.2.1 The authorities shall be invited to witness the tests specified in **10.2.2** and to inspect the system.

10.2.2 Water supplies shall be tested as specified in clause **19**, and diesel engine driven pumps shall be tested as specified in **17.4.13.11** b) and **35.4.3**.



Pump details		Driver details		
Model		Manufacturer and model		
Nominal rating L/min	bar			
Maximum flow (NPSH = 5.38 m)	L/min	Rated power output		kW
Maximum power absorbed	kW	Speed	RPM	Insulation class

a) electrically driven



Pump details		Driver details	
Model		Manufacturer and model	
Nominal rating L/min	bar		
Maximum flow (NPSH = 5.38 m)	L/min	Rated power output	kW
Maximum power absorbed	kW	Speed	RPM

b) diesel driven

Figure 5 — Typical pump data sheet

10.3 Completion certificate and documents

10.3.1 *General.* The installer of the system or his supervising supplier shall provide to the user the following:

a) a completion certificate (see Figure 6) stating that the system complies with all appropriate requirements of this standard, and giving details of any departure from appropriate recommendations; and

b) a copy of the independent laboratory test report where pipe assemblies do not comply with the recommendations of **22.1.3**;

c) a complete set of operating instructions and as-installed drawings including identification of all valves and instruments used for testing and operation and a user's programme for inspection and checking (see clause **34**); and

d) if requested by the user a certificate giving the results of in-situ testing of pipe fasteners (see **22.7.1**).

10.3.2 *Components suitable for sprinkler service.* If requested by the user appropriate certificates stating that components used in the system are suitable for sprinkler service shall be provided.

COMMENTARY AND RECOMMENDATIONS ON **10.3.2**.

For the purposes of inspection the purchaser or his representative may request access to the component manufacturer's works.

For some components it may be possible to consider the desirability of independent certification of product conformity with a British Standard coupled with assessment of a supplier's quality system against the appropriate Part of BS 5750.

11 Extension and alteration of sprinkler systems

Any addition, extension, alteration or repair to a sprinkler system complying with this specification shall be carried out following the requirements and recommendations of this specification.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **11**. *After completion of the work the restored system should comply with this specification.*

*The consultation procedures of **3.1** apply. Any addition, extension, alteration or repair to a sprinkler installation should be carried out by the installer or his agent.*

COMPLETION CERTIFICATE

We (name of sprinkler engineers) _____

_____

of _____

hereby certify that we have completed on (date) _____

an automatic sprinkler installation/s designed and erected in accordance with all the appropriate requirements and, except as detailed here, recommendations of BS 5306 : Part 2

Details of alternatives provided in lieu of recommendations

Name of client _____

Address of protected premises _____

Buildings protected	Hazard class*	Installation No.	No. of sprinklers

Extra high hazard areas

High piled storage (if any), (type, height and location) _____

Water supplies

The following water supplies have been provided:

*Town main (Primary) Diameter _____ mm

*Town main (Secondary) Diameter _____ mm

*Elevated private reservoir Capacity _____ m^2

*Gravity tank _____ Capacity _____ m^2

(If sole supply)

Rate of replenishment by town main _____ L/hr

Delete where not applicable

†Pump

Motive power _____

Nominal rating _____

L/min _____ bar _____

Drawing water from _____

†Pressure tank

Total capacity _____ m^2

Ratio air to water

Required air pressure (taking into account any losses referred to below) _____

Delete whichever not applicable

*These supplies were tested on (date) and met/did not meet the relevant requirements of BS 5306 : Part 2 for pressure and flow for each hazard class. Particulars are set out in the attached test data sheet.

†The pressure losses under the flow conditions for the respective hazard class in the pipework and fittings check valves and alarm valves between the pump or pressure tank and the various installation pressure gauges (gauge 'C') are calculated to be as follows:

Installation No.	Pressure losses in bar*
No.	
No.	
No.	

*Including pipework, fittings, check valves and alarm valves.

Date _____ Signature _____

WATER SUPPLIES TEST DATA SHEET

accompanying Completion certificate in respect of sprinkler systems

completed on _____ for

Name of client _____

Premises protected _____

Installation No.	Water supply	Hazard class	Test requirements		Installation C gauge reading			
			Flow	Pressure	(a) under test conditions	(b) with drain valve fully open	(c) after tests completed (standing pressure)	Static pressure loss between installation gauge and highest sprinkler in hazard class area (pre-calculated systems only)
			L/min	bar	bar	bar	bar	bar

Note. Where an installation protects more than one hazard class the static pressure loss is that between the installation gauge and the highest sprinkler in the particular hazard class.

Static pressure loss values are not given for hydraulically calculated systems; the required pressure at the C gauge includes the static loss component.

TEST APPARATUS. The test apparatus used in the above tests complied with the appropriate requirements of BS 5306 : Part 2.

INSTALLED TEST ORIFICES. Test orifices, complying with the appropriate requirements of BS 5306 : Part 2, have been fitted to the following ordinary-hazard installations, and have the following k factors:

Installation No.	k factor

Figure 6 — Typical completion certificate and test data sheet

Section 4. Water supplies

12 General

12.1 Reliability

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

COMMENTARY AND RECOMMENDATIONS ON **12.1.1**.
The flow from town mains to the sprinkler system may be reduced by fire brigade operations.

Water supplies should preferably be under the control of the user, or guaranteed by the organization having control. The pressure and flow capacity of town mains are not guaranteed by water authorities.

WARNING. Where an installation has a town main supply a reduction in pressure may have adverse consequences. Stored water supplies provide more security in this respect.

12.1.2 *Frost protection.* The installation main control valve set and the feed pipe shall be maintained at a minimum temperature of 4 °C.

12.2 Quality

Water supplies for sprinkler installations shall be free from suspended fibrous or other matter which may accumulate in the system pipework.

Salt or brackish water shall not be retained in sprinkler installation pipework.

COMMENTARY AND RECOMMENDATIONS ON **12.2**.
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.

12.3 Connections supplying water for other services

Water for other services shall be taken from a sprinkler system only in accordance with the following:

a) through a stop valve, fitted upstream of the installation control valve set(s), as close as is practical to the point of connection to the sprinkler system supply pipe; and

b) if the system is not a high-rise system; and

c) if the system is not protecting a multi-storey building;

d) as specified in Table 5.

The sprinkler system pumps and water source shall be separate from any hydrant system pumps and water source.

COMMENTARY AND RECOMMENDATIONS ON **12.3**.
*The water authority will not normally allow water for non-sprinkler use to be taken from sprinkler installation supply pipes, and where allowed will require such use to be metered (see Commentary and recommendations on **3.1**).*

*See **31.3** for marking of connections for other services.*

Preferably the water supply to fire hose reels should be such that the hose reels and the sprinkler system are simultaneously not out of service during maintenance.

12.4 Ring mains

Where sprinkler systems are fed by a ring main supply pipe arrangement on the premises, any isolating valves on the ring main shall be of the interlocking key type.

COMMENTARY AND RECOMMENDATIONS ON **12.4**.
Isolating valves positioned at various suitable points on a ring main enable the supply to be maintained to the maximum possible extent in the event of fracture or other need to close down part of the ring main.

12.5 Housing of equipment for water supplies

Equipment, such as pumps, pressure tanks and gravity tanks, shall not be housed in buildings or sections of premises in which there are hazardous processes or explosion hazards.

13 Types of water supply

13.1 Low-rise systems

13.1.1 *Selection of suitable supplies*

13.1.1.1 *Light- and ordinary-hazard occupancies.* Systems for light- and ordinary-hazard occupancies shall be provided with the following:

a) a single supply complying with **13.1.2**; or

b) a superior supply complying with **13.1.3**; or

c) duplicate supplies complying with **13.1.4**.

COMMENTARY AND RECOMMENDATIONS ON **13.1.1**.
Wherever practical a superior supply or duplicate supplies should be provided.

13.1.1.2 *High-hazard occupancies.* Systems for high-hazard occupancies shall be provided with the following:

a) a superior supply complying with **13.1.3**; or

b) duplicate supplies complying with **13.1.4**.

13.1.1.3 *Provision of fire brigade inlet.* Systems supplied only from a pressure tank and/or a gravity tank and/or a pump suction tank shall, if possible, be fitted with a fire brigade inlet.

COMMENTARY AND RECOMMENDATIONS ON **13.1.1.3**.
It is strongly recommended that a fire brigade inlet be fitted to all systems to allow the brigade to pump water into the system using their own equipment.

The water authority will not normally allow a fire brigade inlet on systems with town main supplies, because water from the inlet could enter the town main.

Table 5 — Connections for water for other services in low-rise systems

Water supply type	Acceptable number, size and purpose of connection(s)
Single or superior supplies	
Town main. Main and supply pipe not less than 100 mm	one, not more than 40 mm, for non-industrial use or one, not more than 50 mm, for fire hose reels, to which may be made a further connection (close to the first connection, and fitted with a stop valve close to the feed end), not more than 40 mm, for non-industrial use
Elevated private reservoir, gravity tank or automatic pump	one, not more than 50 mm, for fire hose reels
Duplicate supplies	
Elevated private reservoirs gravity tanks, or automatic pumps in any combination	any number, each not more than 50 mm, for fire hose reels
Duplicate town mains	any number, each not more than 50 mm, for fire hose reels to one of which may be made a further connection (close to the first connection fitted with a stop valve, feed end), not more than 40 mm, for non-industrial use
Duplicate supplies, where one is a pressure tank with automatic maintenance of pressure and water level	one, not more than 50 mm, for fire hose reels
NOTE Connections to high-rise and multi-storey systems for other services do not comply (see **12.3**).	

13.1.2 *Single supplies.* A single supply shall be one of the following:

a) a town main complying with **17.1.1**; or

b) a single automatic suction pump, drawing water from a source complying with **17.4.3.1**; or

c) a single automatic booster pump, drawing water from a town main complying with **17.1.1**.

13.1.3 *Superior supplies. A superior supply shall be one of the following:*

a) a town main; or

b) two automatic suction pumps drawing water from a suction tank complying with **17.4.3.2**; or

c) two automatic booster pumps; or

d) an elevated private reservoir; or

e) a gravity tank; or

f) for light- and/or ordinary-hazard group I occupancies only, a pressure tank.

COMMENTARY AND RECOMMENDATIONS ON **13.1.3**.
Typical superior supply arrangements are shown in Figure 7 to Figure 11.

13.1.4 *Duplicate supplies.* Duplicate supplies shall include at least one of the suitable combinations given in Table 6. The supply pipes from each source shall be joined into a common trunk main at a point as close as possible to the protected premises. The common trunk main shall neither: traverse ground not under the control of the user; nor be under a public roadway.

COMMENTARY AND RECOMMENDATIONS ON **13.1.4**.
The common trunk main may serve more than one installation in a system. Typical duplicate supplies are shown in Figure 12 to Figure 18. In general water authorities will not permit a town main to form a duplicate supply with another source except another town main or pressure tank. In the latter case special conditions may be applied by the water authority.

13.2 High-rise systems

The water supply for a high-rise system shall be either:

a) a gravity tank; or

b) an automatic suction pump arrangement in which each installation is served by either a separate pump or a separate stage of a multistage pump.

13.3 Life safety systems

Life safety systems shall be provided with duplicate water supplies conforming to **13.1.4**.

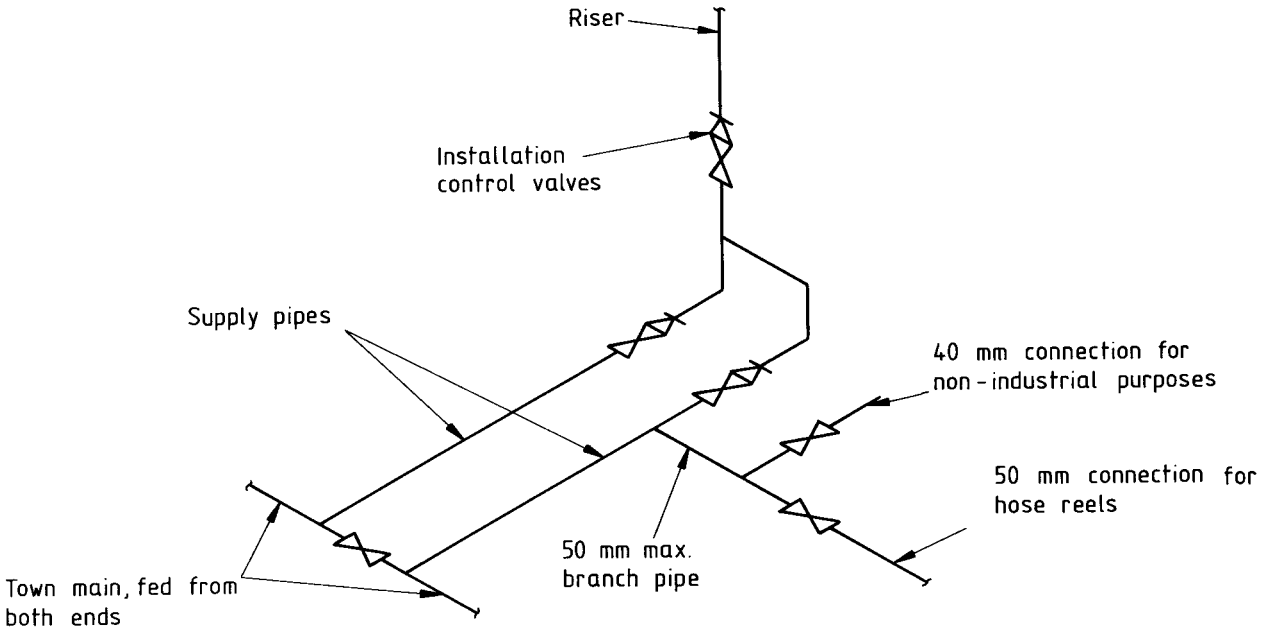


Figure 7 — Superior supply using town main

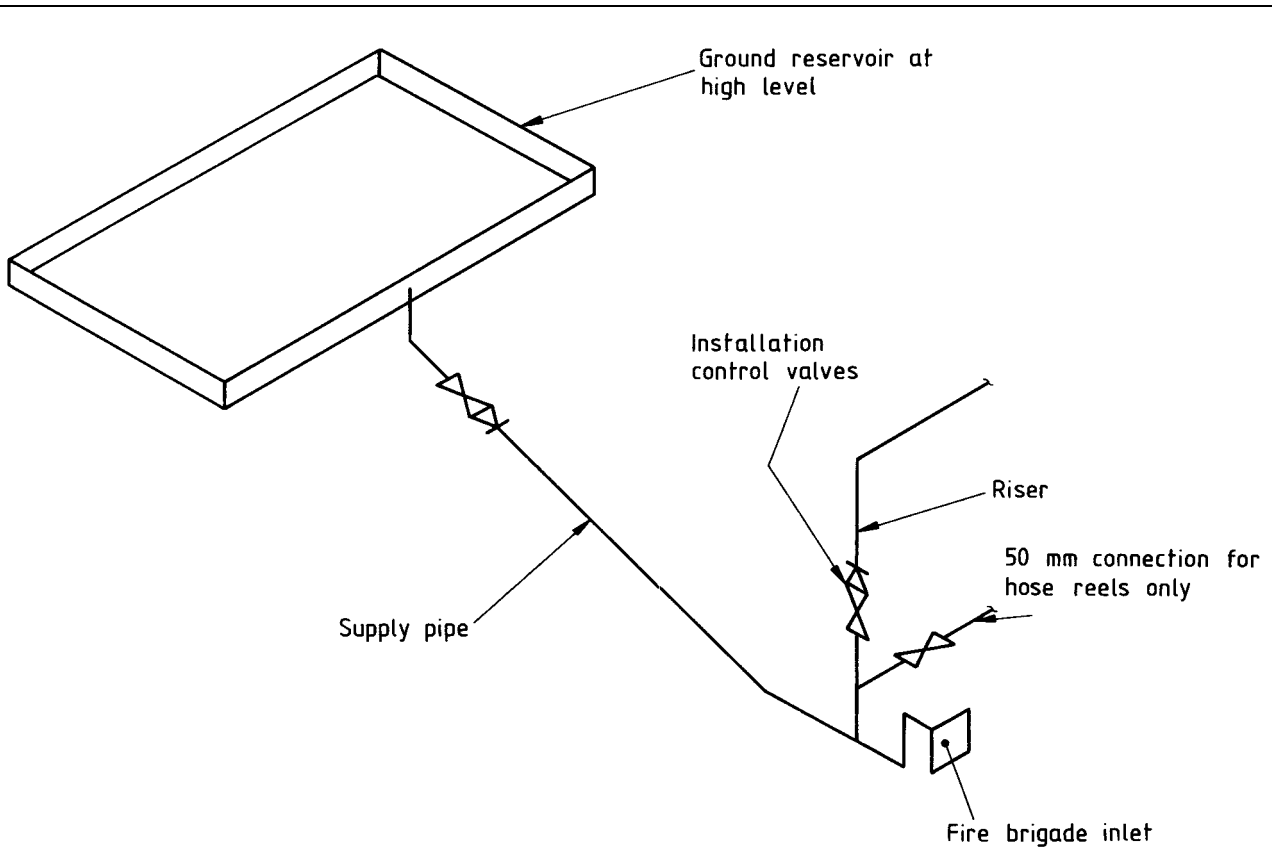


Figure 8 — Superior supply using elevated private reservoir

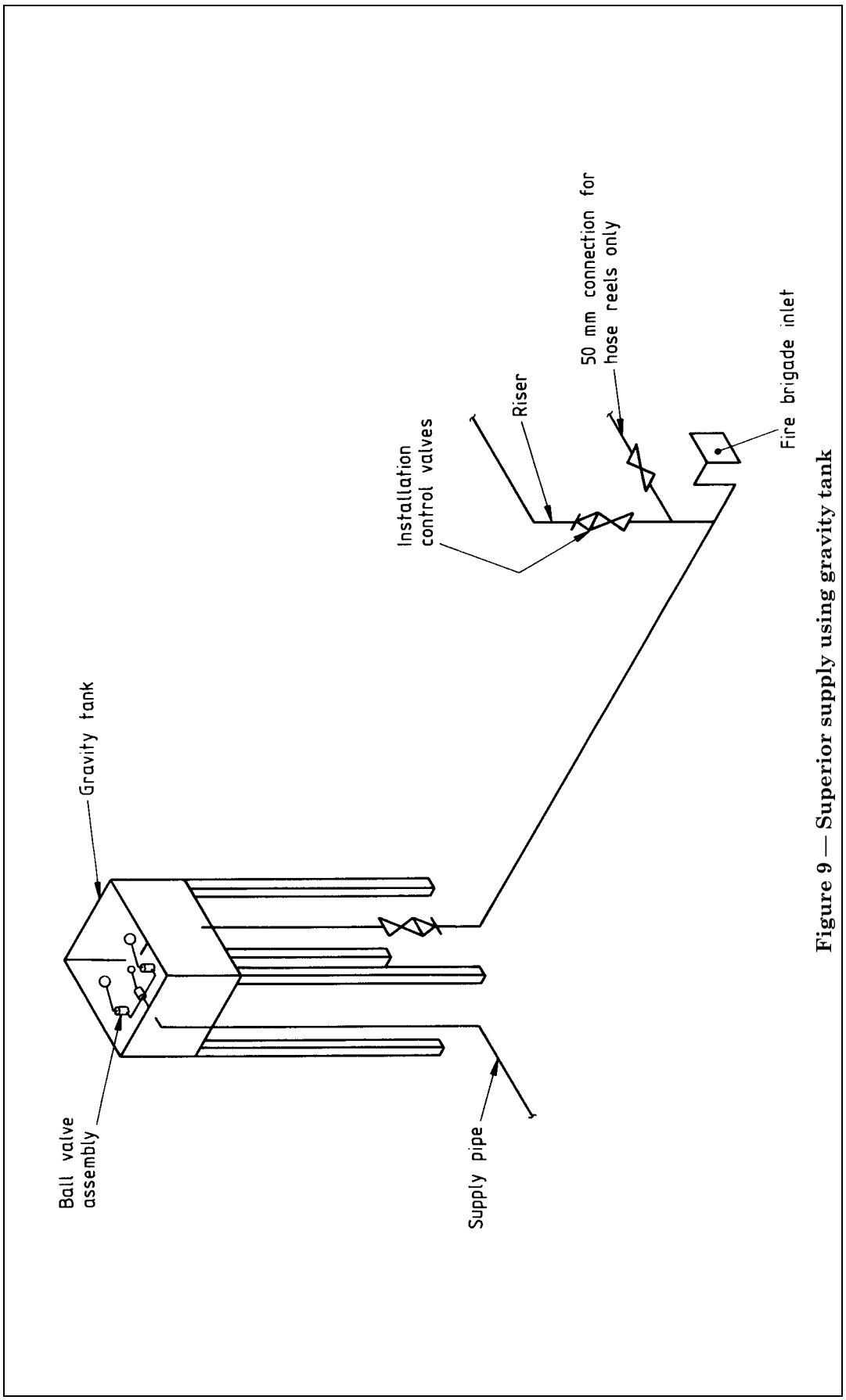


Figure 9 — Superior supply using gravity tank

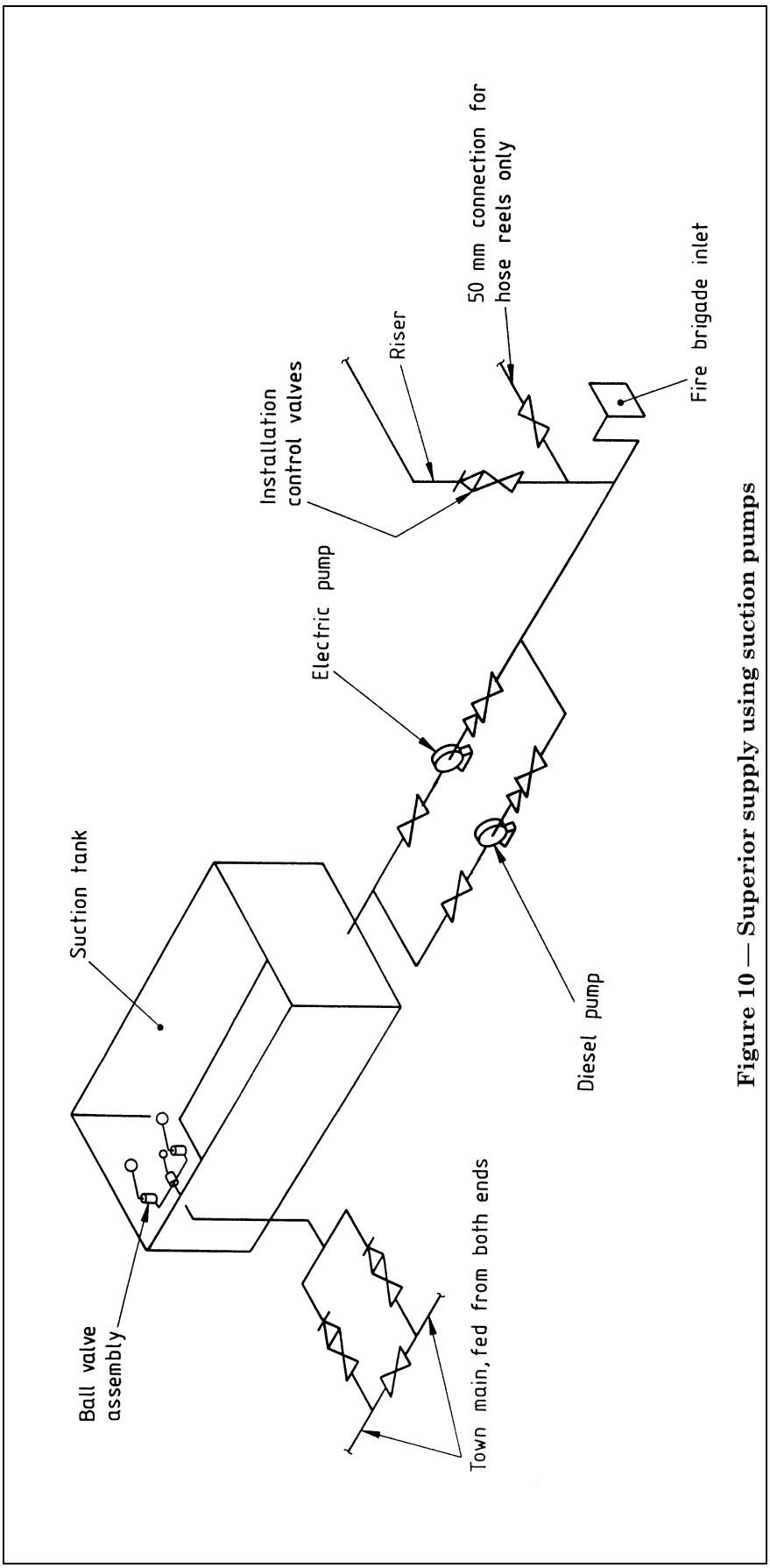


Figure 10 — Superior supply using suction pumps

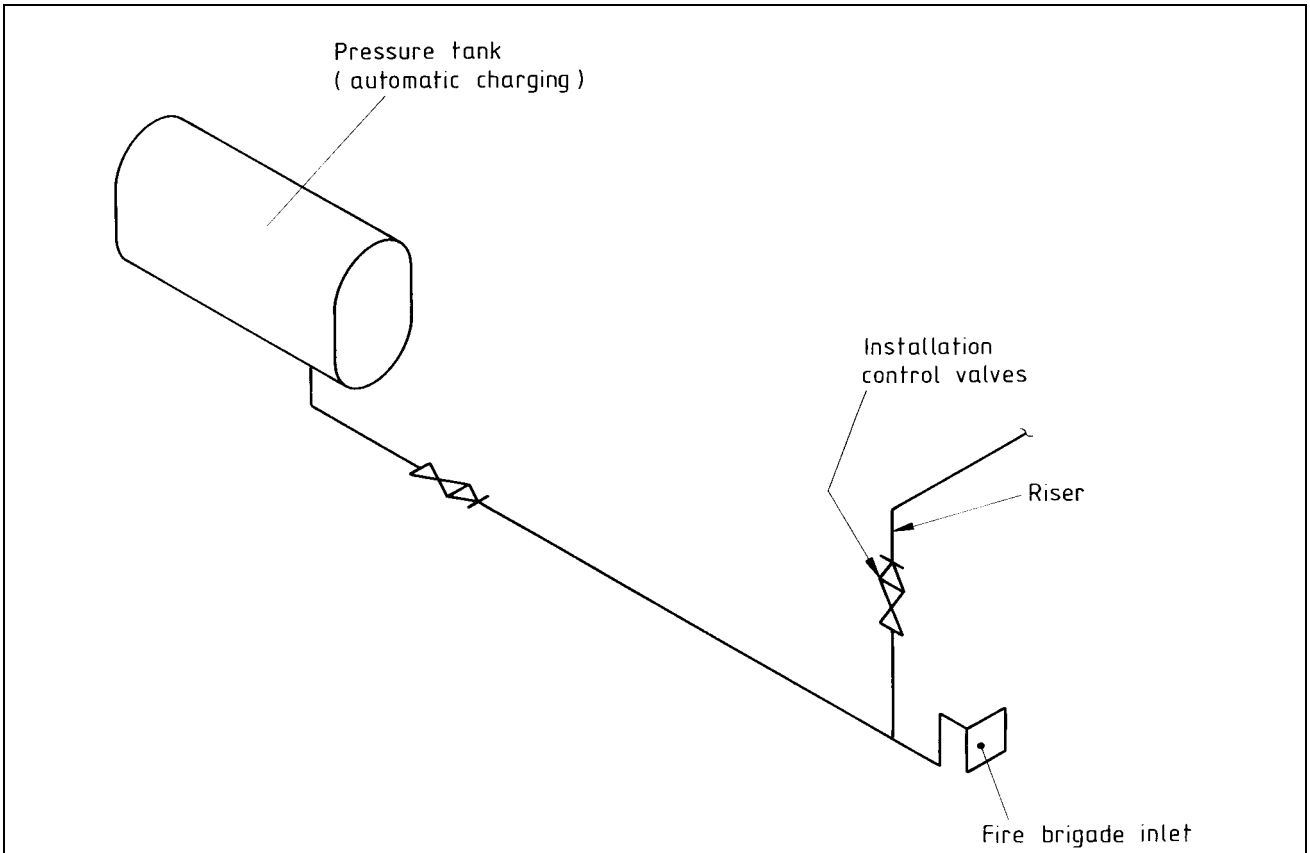


Figure 11 — Superior supply using pressure tank

Table 6 — Combinations suitable for duplicate water supplies

Supply	Supply					
	Town main with or without booster pump	Booster pump from elevated private reservoir	Suction pump	Gravity tank	Elevated private reservoir	Pressure tank
Pressure tank	Light Ordinary	Light Ordinary	Light Ordinary	Suitable only with a third supply given as suitable	Light Ordinary	Suitable only with a third supply given as suitable
Elavated private reservoir	Not suitable	Light Ordinary High	Light Ordinary High	Light Ordinary High	Light Ordinary High	
Gravity tank	Not suitable	Light Ordinary High	Light Ordinary High	Light Ordinary High[a]		
Suction pump	Not usually permitted	Light Ordinary High	Light Ordinary High			
Booster pump from elevated private reservoir	Not usually permitted	Light Ordinary High				
Town main with or without booster pump	Light Ordinary High					

[a] A divided tank or two separate tanks may be used.

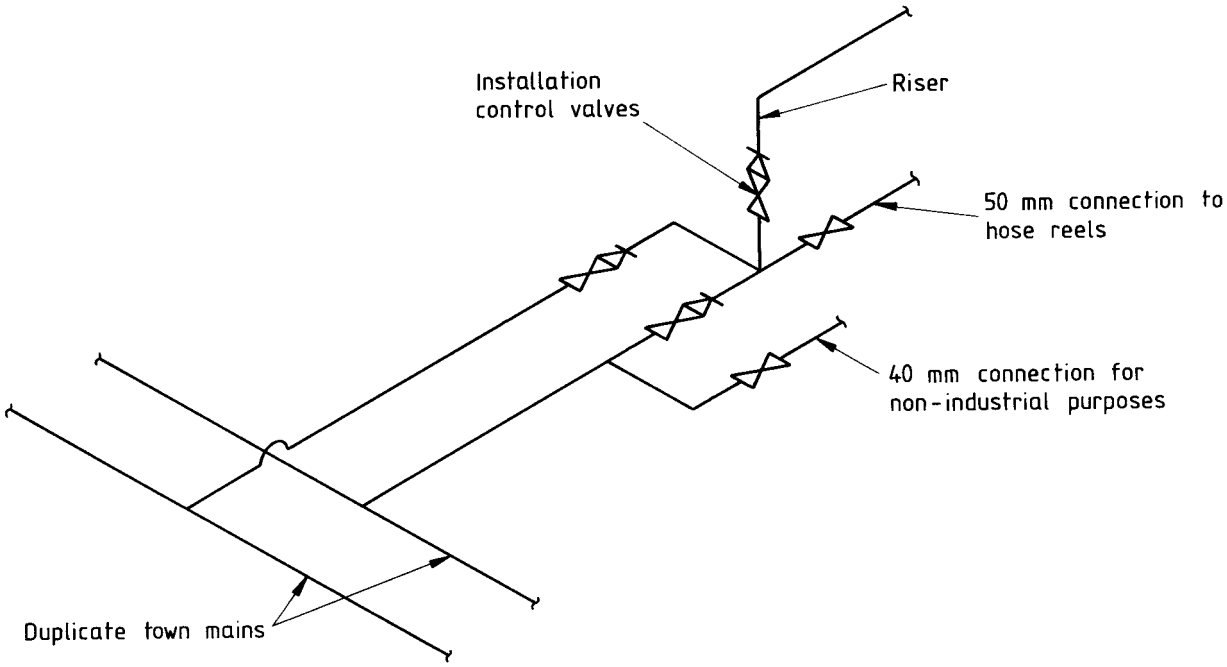


Figure 12 — Duplicate supplies using two town mains

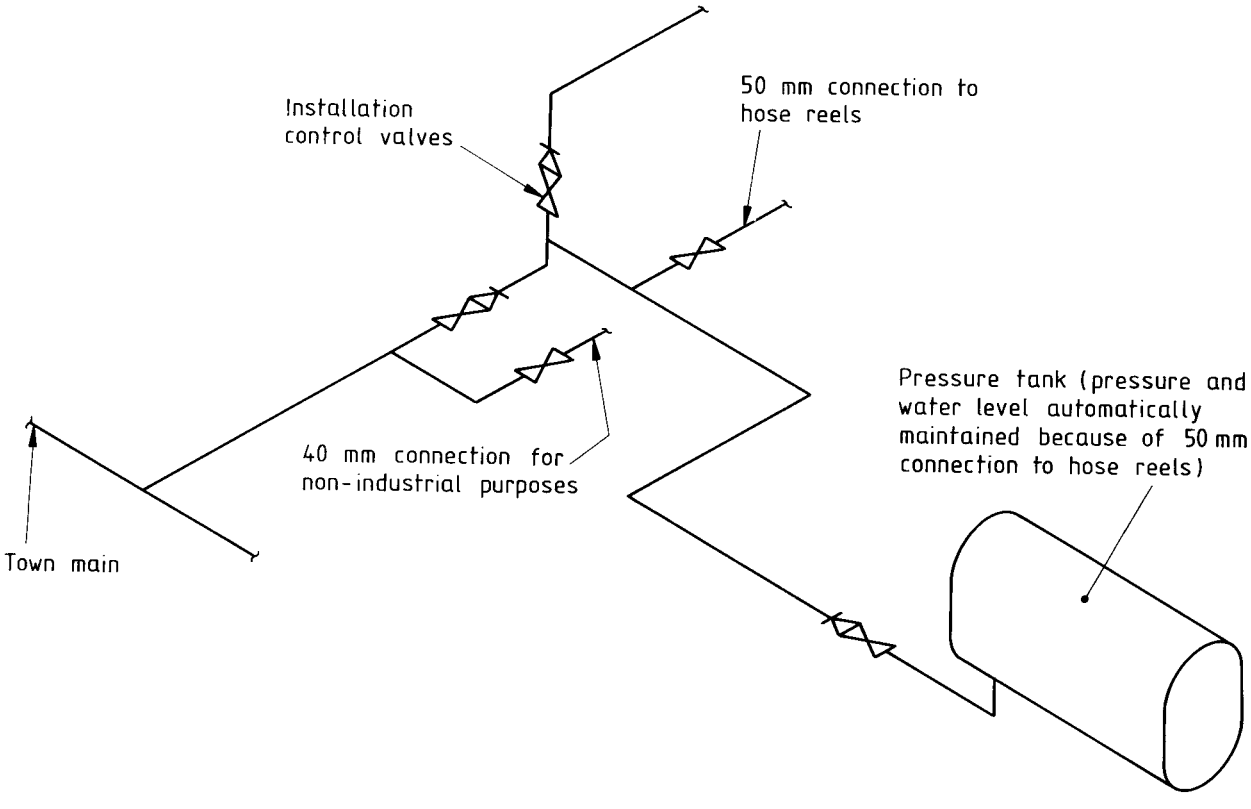


Figure 13 — Duplicate supplies using town main and pressure tank

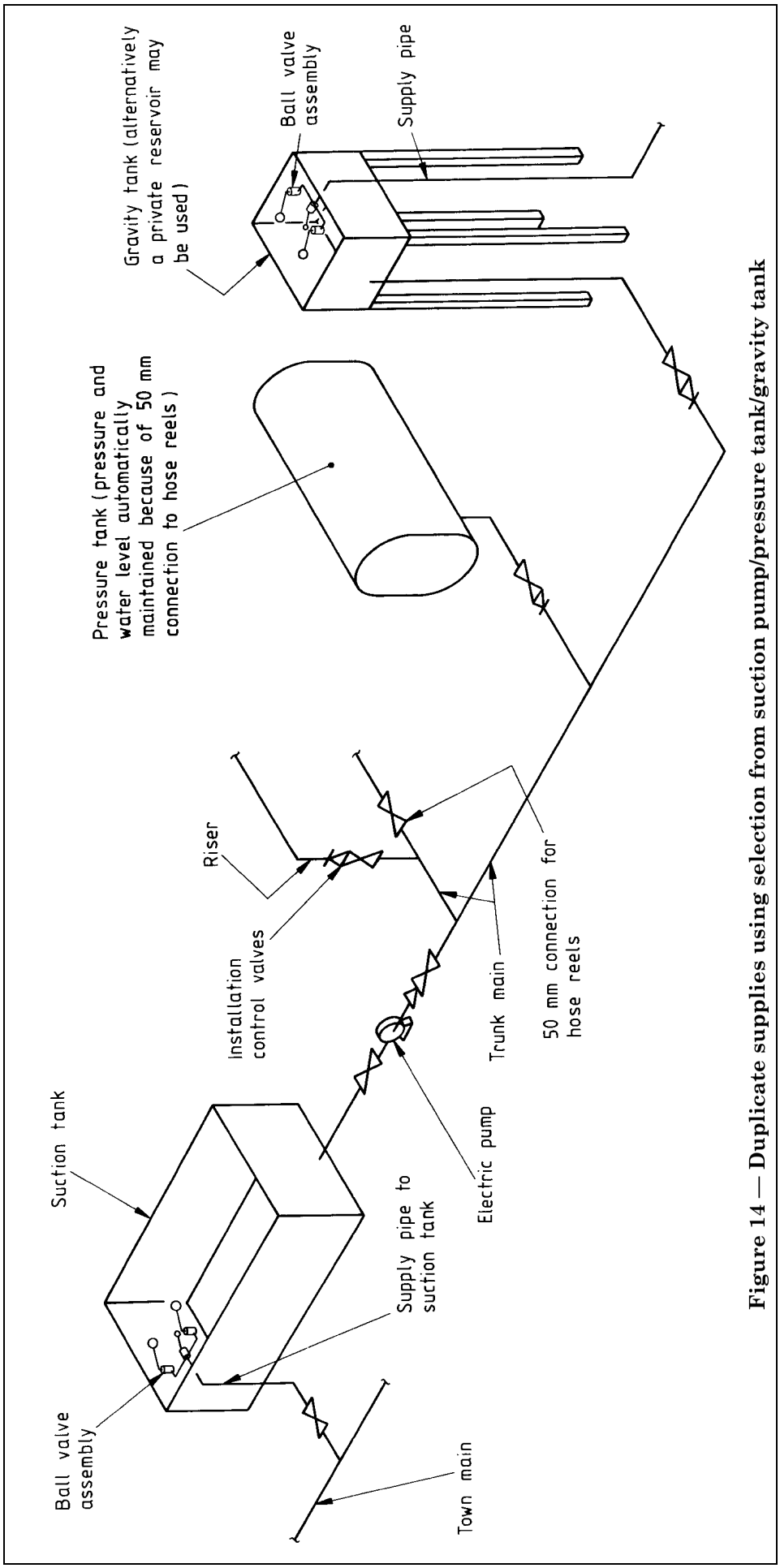


Figure 14 — Duplicate supplies using selection from suction pump/pressure tank/gravity tank

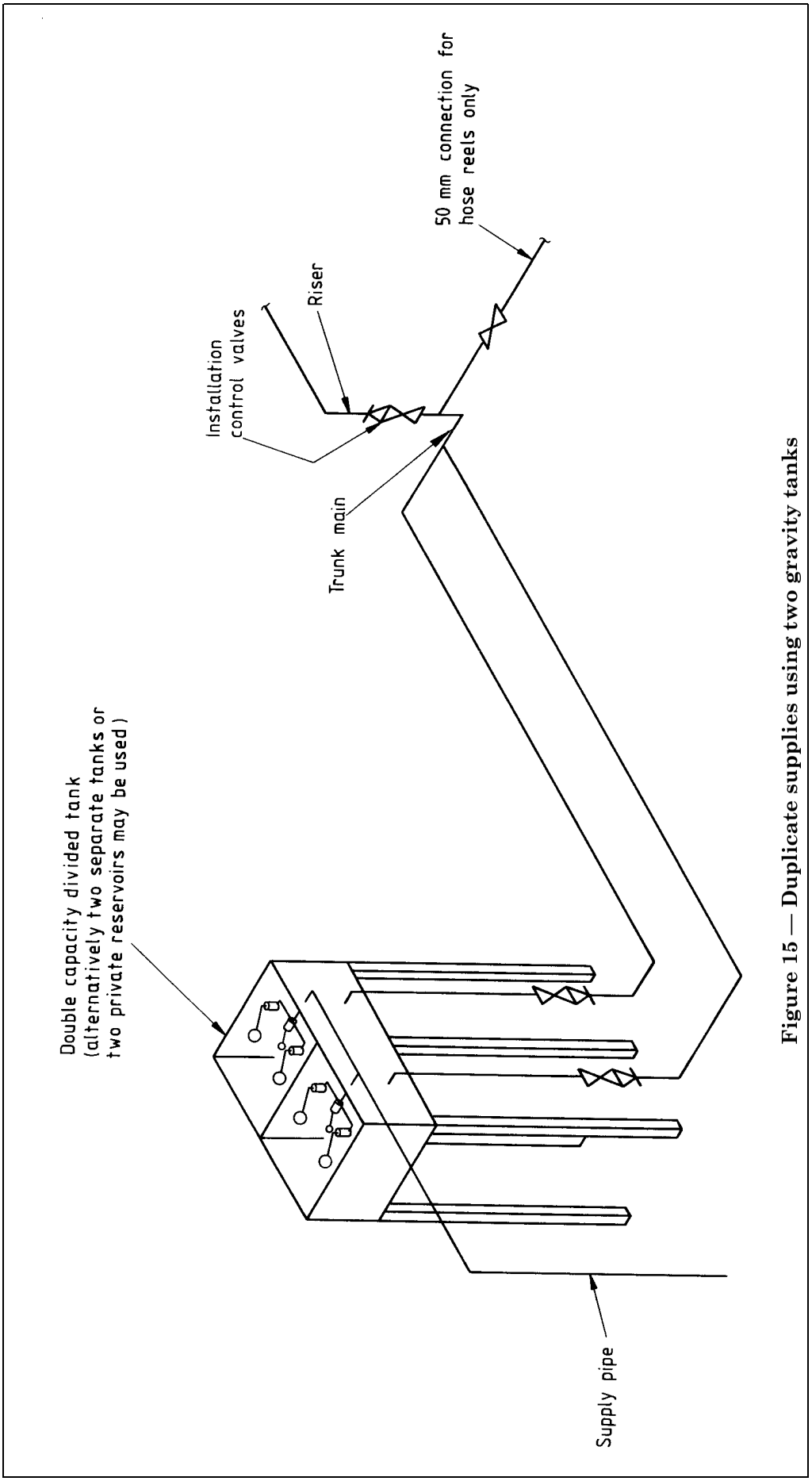


Figure 15 — Duplicate supplies using two gravity tanks

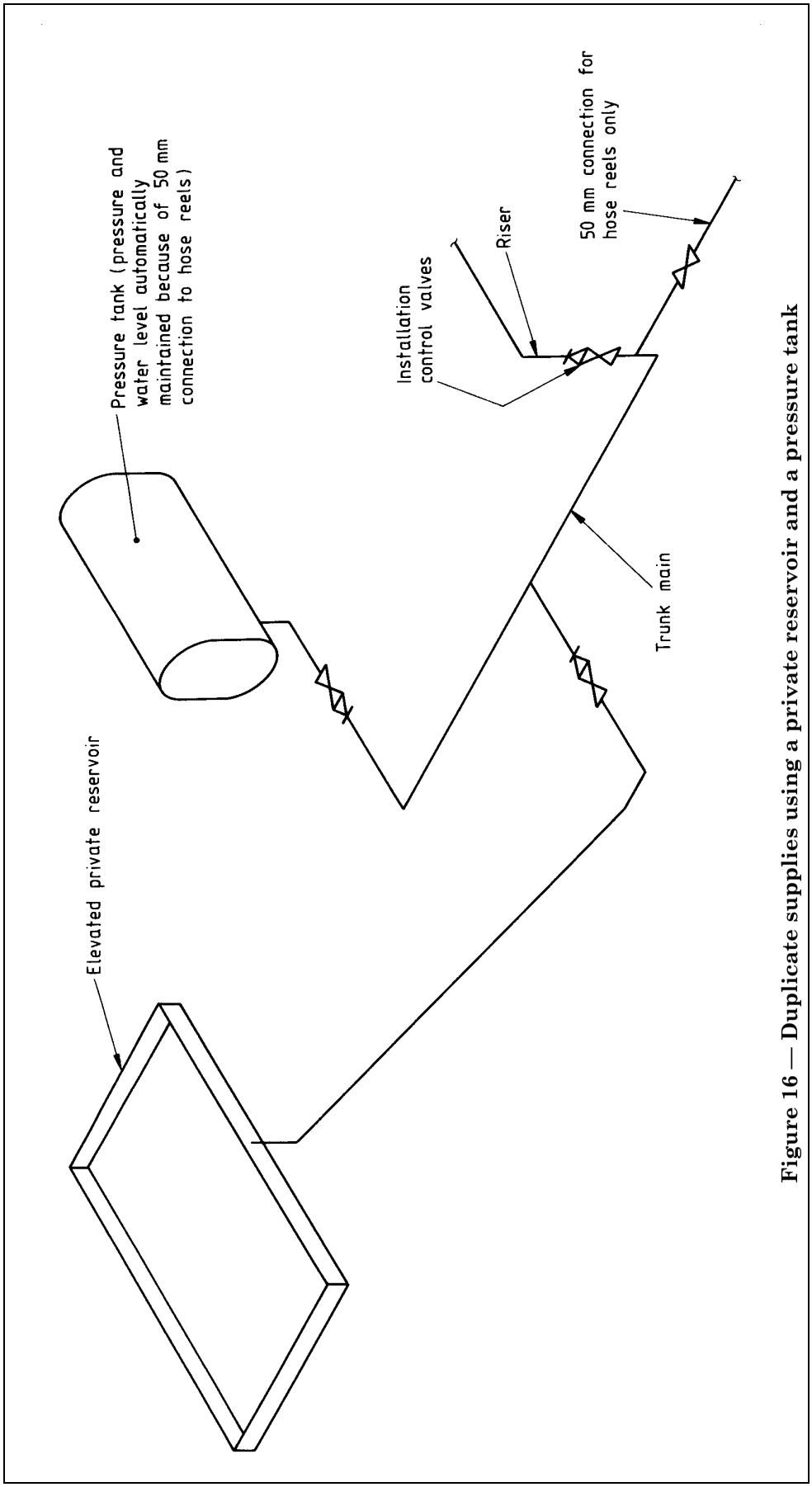


Figure 16 — Duplicate supplies using a private reservoir and a pressure tank

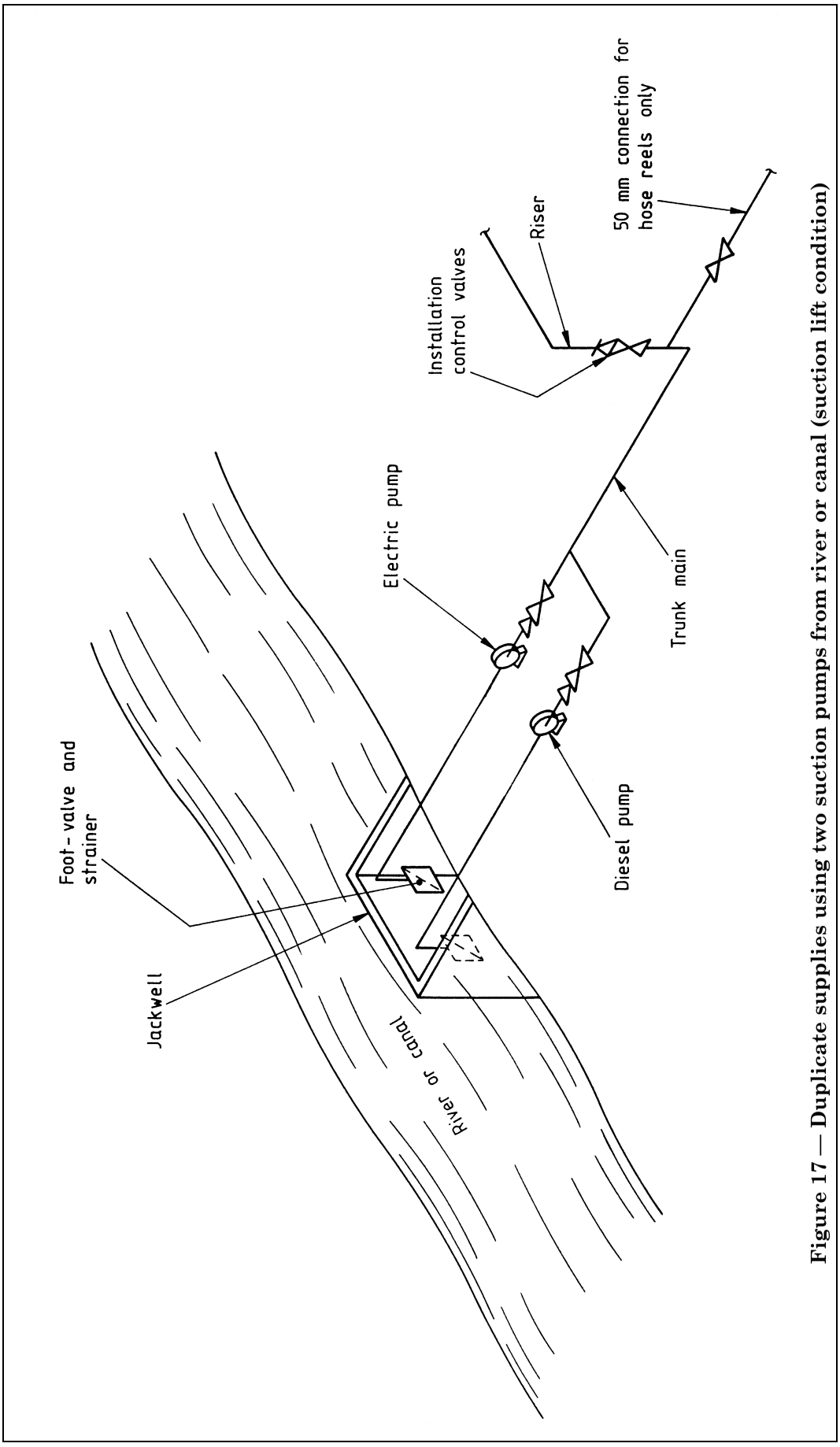


Figure 17 — Duplicate supplies using two suction pumps from river or canal (suction lift condition)

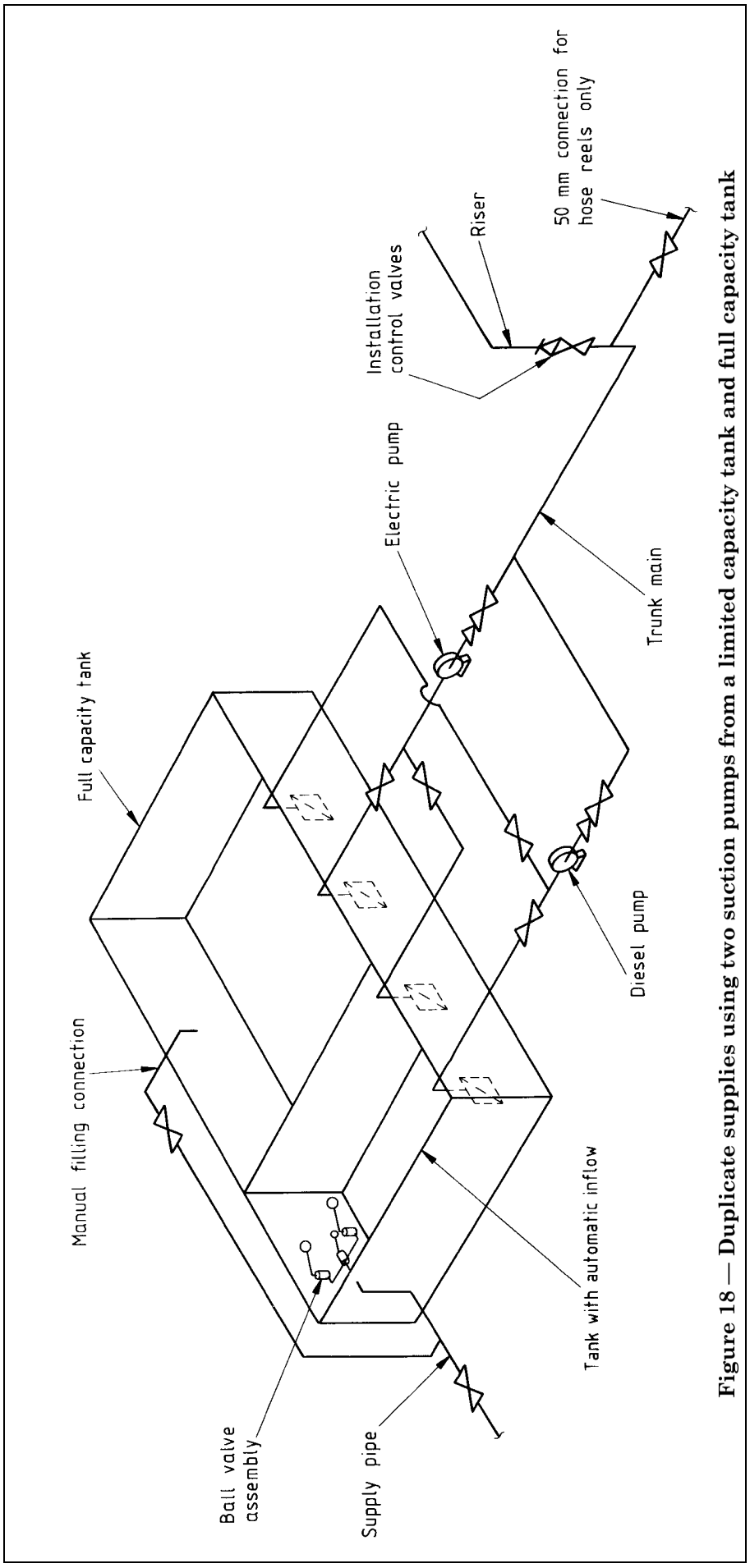


Figure 18 — Duplicate supplies using two suction pumps from a limited capacity tank and full capacity tank

14 Design density and AMAO for fully hydraulically calculated installations

14.1 General

For fully hydraulically calculated installations the density of discharge, calculated as specified in clause **18**, shall be not less than the appropriate value given in this clause when all the ceiling or roof sprinklers in the room concerned, or in the AMAO, whichever is the fewer, plus any supplementary sprinklers, and/or sprayers, and/or medium-velocity sprayers, and/or high-velocity sprayers, installed below the roof or ceiling sprinklers considered to be in operation, are in operation.

COMMENTARY AND RECOMMENDATIONS ON **14.1**.
*The basis for full hydraulic calculation for all fire hazard classes is the specification of a minimum design density from a group of sprinklers (four in number if the number in open communication is four or more) in a specified geometric pattern (see **24.3**). This group is the most hydraulically remote from the water supply, and is part of a larger group of sprinklers assumed to be discharging simultaneously. The larger group is the AMAO and is specified for each hazard class. The hydraulically most unfavourable AMAO is used to calculate design density. The shape of the AMAO is specified in **24.3.8**.*

14.2 Light hazard

The design density and the AMAO of roof or ceiling sprinklers shall be not less than as given in Table 7.

Not more than six sprinklers shall be installed in a room, except in either a corridor where there is a single line of sprinklers or a concealed space protected as specified in **24.1.4** a).

14.3 Ordinary hazard

The design density and AMAO of roof or ceiling sprinklers for each of the various groups shall be not less than as given in Table 7.

14.4 High hazard

14.4.1 *Process hazard.* The minimum design density and AMAO shall be not less than as given in Table 7.

14.4.2 *High-piled storage hazards (goods), storage classes S1 and S4.* Where the storage height exceeds that for ordinary hazard given in Table 1, the design density and AMAO of roof or ceiling sprinklers shall be not less than the appropriate value given in Table 8.

14.4.3 *High-piled storage hazards (goods), storage classes S2 and S5.* Where the storage height exceeds that for ordinary hazard given in Table 1, the design density and AMAO shall be not less than the appropriate value given in Table 9.

COMMENTARY AND RECOMMENDATIONS ON **14.4.3**.
*For storage heights greater than those given in Table 9, for class S5, intermediate sprinklers are specified (see **14.6**). Intermediate sprinklers are strongly recommended for class S5 storage regardless of height.*

Table 7 — Minimum design density and AMAO for light-, ordinary- and high-hazard (processes) roof or ceiling sprinklers

Hazard	Minimum design density	AMAO
	mm/min	m^2
Light	2.25	84
Ordinary		
Group I	5	72
Group II	5	144
Group III	5	216
Group III special	5	360
High (process)		
Type 1	7.5	260
Type 2 (see Table 4)	10.0	260
Type 3	12.5	260
Type 4	10.0	Complete deluge protection for each building

14.4.4 *High-piled storage hazards (goods), storage classes S3, S6, S7 and S8.* For goods of classes S3 and S6, stored to heights above those specified in Table 1, column 3 and for goods of classes S7 and S8 the design density and AMAO shall be not less than as given in Table 10.

COMMENTARY AND RECOMMENDATIONS ON **14.4.4**.
*For storage heights greater than those given in Table 10, for classes S7 and S8, intermediate sprinklers are specified (see **14.6**). Intermediate sprinklers are strongly recommended for class S7 storage regardless of height.*

14.4.5 *High-piled storage hazards (goods), roof or ceiling protection where intermediate sprinklers are fitted in racks or under shelves*

14.4.5.1 Where intermediate sprinklers are provided as specified in **26.1.4** and the roof or ceiling sprinklers are more than 3 m above the top of the goods the roof or ceiling sprinklers shall have a design density of not less than 7.5 mm/min and an AMAO of not less than 260 m^2 and intermediate sprinklers shall be provided at each tier, including the top tier, of storage.

14.4.5.2 Where intermediate sprinklers are provided as specified in **26.1.4** and the roof or ceiling sprinklers are not more than 3 m above the top of the goods the roof or ceiling sprinklers shall have a design density and an AMAO not less than as given in Table 11, and intermediate sprinklers shall be provided at each tier, except the top tier, of storage.

COMMENTARY AND RECOMMENDATIONS ON **14.4.5**.

*See **14.6** for discharge density from intermediate sprinklers. Maximum storage heights between levels of rack or shelf protection are specified in **26.1.4.1** and **26.1.4.2**.*

Table 8 — Minimum design density and AMAO for high-piled storage hazards (goods), storage types S1 and S4 roof or ceiling sprinklers

Category I S1 only		Category II S1 only		Category III S1 and S4		Category IV S1 only		Minimum design density	AMAO	
Stack height		Stack height		Stack height		Stack height				
more than	not more than	more than	not more than	more than	not more than	more than	not more than		Wet pipe, pre-action and recycling systems	Dry pipe and alternate systems
m	m	m	m	m	m	m	m	mm/min	m^2	m^2
0	5.3	0	4.1	0	2.9	0	1.6	7.5	260	325
5.3	6.5	4.1	5.0	2.9	3.5	1.6	2.0	10.0	260	325
6.5	7.6	5.0	5.9	3.5	4.1	2.0	2.3	12.5	260	325
—	—	5.9	6.7	4.1	4.7	2.3	2.7	15.0	260	325
—	—	6.7	7.5	4.7	5.2	2.7	3.0	17.5	260	325
—	—	—	—	5.2	5.7	3.0	3.3	20.0	300	375
—	—	—	—	5.7	6.3	3.3	3.6	22.5	300	375
—	—	—	—	6.3	6.7	3.6	3.8	25.0	300	375
—	—	—	—	6.7	7.2	3.8	4.1	27.5	300	375
—	—	—	—	—	—	4.1	4.4	30.0	300	375

NOTE Class S4 includes only category III goods (see Table 1).

Table 9 — Minimum design density and AMAO for high-piled storage hazards (goods), storage types S2 and S5 (see Table 1), roof or ceiling sprinklers

Category I		Category II		Category III		Category IV		Minimum design density	AMAO	
Stack height		Stack height		Stack height		Stack height				
more than	not more than	more than	not more than	more than	not more than	more than	not more than		Wet pipe, pre-action and recycling systems	Dry pipe and alternate systems
m	m	m	m	m	m	m	m	mm/min	m^2	m^2
0	4.7	0	3.4	0	2.2	—	—	7.5	260	325
4.7	5.7	3.4	4.2	2.2	2.6	1.6	2.0	10.0	260	325
5.7	6.8	4.2	5.0	2.6	3.2	2.0	2.3	12.5	260	325
—	—	5.0	5.6	3.2	3.7	2.3	2.7	15.0	260	325
—	—	5.6	6.0	3.7	4.1	2.7	3.0	17.5	260	325
—	—	—	—	4.1	4.4	3.0	3.3	20.0	300	375
—	—	—	—	4.4	5.3	3.3	3.8	25.0	300	375
—	—	—	—	5.3	6.0	3.8	4.4	30.0	300	375

Table 10 — Minimum design density and AMAO for high-piled storage hazards (goods), storage types S3 and S6, S7 and S8(see Table 1), roof or ceiling sprinklers

Category I		Category II		Category III		Category IV		Minimum design density	AMAO	
Stack height		Stack height		Stack height		Stack height			Wet pipe, pre-action and recycling systems S3, S6, S7, S8	Dry pipe and alternate systems S3 and S8, only
more than	not more than	more than	not more than	more than	not more than	more than	not more than			
m	m	m	m	m	m	m	m	mm/min	m^2	m^2
0	4.7	0	3.4	0	2.2	0	1.6	7.5	260	325
4.7	5.7	3.4	4.2	2.2	2.6	1.6	2.0	10.0	260	325
—	—	4.2	5.0	2.6	3.2	2.0	2.3	12.5	260	325
—	—	—	—	—	—	2.3	2.7	15.0	260	325
—	—	—	—	—	—	2.7	3.0	17.5	260	325

Table 11 — Minimum design density and AMAO for high-piled storage hazards (goods), top tier protection by roof or ceiling sprinklers only

Category I	Category II	Category III		Category IV		Minimum design density	AMAO Wet pipe pre-action and recycling systems
Stack height above the highest intermediate sprinkler not more than	Stack height above the highest intermediate sprinkler not more than	Stack height above the highest intermediate sprinkler		Stack height above the highest intermediate sprinkler			
		more than	Not more than	more than	Not more than		
m	m	m	m	m	m	mm/min	m^2
3.5	3.5	—	2.2	—	1.6	7.5	260
—	—	2.2	2.6	1.6	2.0	10.0	260
—	—	2.6	3.2	2.0	2.3	12.5	260
—	—	3.2	3.5	—	—	15.0	260

14.4.6 *High-hazard with intermediate sprinklers.* Where a high-hazard installation includes intermediate and roof or ceiling sprinklers it shall be assumed that the AMAO of the intermediate sprinklers and the AMAO of the roof or ceiling sprinklers are in simultaneous operation even where there is no overlap.

14.5 Potable spirit barrel stores, with barrels stored on racks

14.5.1 *High hazard, type S9.* The design density and AMAO of the roof or ceiling sprinklers shall be not less than the appropriate value given in Table 12.

Where stack heights exceed 9.7 m intermediate sprinklers shall be fitted under walkways (see **14.6** and **26.1.4.3**).

14.5.2 *High hazard, type S10.* For rack storage heights above 3.5 m up to and including 5.0 m the minimum design density shall be 7.5 mm/min, and the AMAO shall be 260 m^2 for wet pipe systems and 325 m^2 for alternate systems.

For rack storage heights more than 5.0 m, intermediate sprinklers shall be installed at vertical intervals not exceeding 5.0 m (see **14.6** and **26.1.4.3**). The roof sprinkler minimum design density shall be 7.5 mm/min, and the AMAO shall be 260 m^2.

COMMENTARY AND RECOMMENDATIONS ON **14.5**.

It is strongly recommended that wet pipe installations be used even in cases where there is sprinkler protection at the roof or ceiling only.

Stack heights up to 3.5 m high (to top of barrel stack) are regarded as an ordinary hazard (see Table 1, S5).

Table 12 — Minimum design density and AMAO for bonded spirit stores, type S8, roof or ceiling sprinklers

Rack storage height		Minimum design density	AMAO	
more than	not more than		Wet pipe pre-action and recycling systems	Dry pipe and alternate systems
m	m	mm/min	m^2	m^2
—	5.3	7.5	260	325
5.3	6.5	10.0	260	325
6.5	7.6	12.5	260	325
7.6	8.7	15.0	260	325
8.7	9.7	17.5	260	325

14.6 Rack intermediate level sprinklers

14.6.1 *General.* Only wet pipe, pre-action and recycling installations (see clause **6**) shall be installed where there are both roof or ceiling sprinklers and intermediate sprinklers in racks.

COMMENTARY AND RECOMMENDATIONS ON **14.6.1**.
Speed of response is particularly important in rack storage; dry and alternate systems may cause an unacceptable delay in the discharge of water.

14.6.2 *Minimum flow pressure.* The flow pressure at the hydraulically most unfavourably situated rack sprinkler when the number of rack sprinklers as specified in **14.6.3** and the specified AMAO of roof or ceiling sprinklers are operating simultaneously shall be not less than the following.

a) For general rack or shelf storage (see Table 1): 2 bar.

b) For spirit stores, type S9 (see **5.4.4**): 2 bar.

c) For spirit stores, type S10 (see **5.4.4**): 1 bar.

COMMENTARY AND RECOMMENDATIONS ON **14.6.2**.
The minimum design density for rack intermediate sprinklers is specified indirectly by the minimum sprinkler operating pressure and maximum spacing requirements of this standard.

14.6.3 ***Numbers of sprinklers in simultaneous operation***

14.6.3.1 *Number of sprinklers per row and number of tiers per rack.* The number of sprinklers assumed to be in simultaneous operation in each row of each tier, and the number of tiers assumed to be operating in a rack, in each case in the hydraulically most unfavourable location, shall be not less than as given in Table 13.

14.6.3.2 *Numbers of racks or ranges in simultaneous operation.* The number of adjacent racks, or in the case of spirit stores types S9 and S10 walkways or sprinkler ranges, assumed to have sprinklers in simultaneous operation in the hydraulically most unfavourable location, shall be as specified in Table 14.

Where there is more than one row of sprinklers at a tier level in the rack under consideration all the rows shall be considered to be in operation and the excess number of rows referred to in column 6 of Table 14 shall be assumed to be in the adjacent rack producing the hydraulically most unfavourable condition.

Where there is one row per tier in a rack and three rows per tier are to be taken as in operation then the two extra rows shall be assumed to be one in each of the adjacent racks.

Table 13 — Number of sprinklers per row, and number of levels per rack, assumed to be in simultaneous operation

Goods	Type and storage method	Number of sprinklers in operation		Number of levels in rack in operation
Category I, II or III	S5, pallets	3 per row		All
Category IV	S5, pallets	2 per row	plus any additional sprinklers in the design area which provide compensation [see **26.1.4.1** d)]	All
Category I, II, III or IV	S7, solid or slatted shelves more than 1 m, but not more than 6 m, wide	4 per row		2
Spirits	S9, double racks	7 per walkway		All
Spirits	S10, continuous racks	3 along range		All

Table 14 — Number of racks, walkways or ranges and of total rows at a level assumed to be in simultaneous operation

Goods	Types and storage method	Aisle width		Number of racks (or walkway or ranges)	Maximum total number of rows per tier in operation in all racks involved
		over	not greater than		
		m	m		
Category I, II, III or IV	S5, pallets	—	1.2	3	3
		1.2	2.4	2	3
		2.4	—	1	3
Category I, II, III or IV	S7, solid or slatted shelves not wider than 3.2 m	—	2.4	3	3
		2.4	—	1	All
	solid or slatted shelves not wider than 3.2 m but not wider than 6 m	—	2.4	3	4
		2.4	—	1	All
Spirits	S9, double racks	—	—	1 (walkway)	—
Spirits	S10, continuous racks	—	—	3 (ranges	—

15 Water supply pressure-flow characteristics and velocity

15.1 General

15.1.1 *Application.* For the purposes of this clause requirements applicable to wet pipe installations also apply to pre-action and recycling installations and requirements applicable to alternate installations apply also to dry pipe, tail-end dry pipe and tail-end alternate installations.

15.1.2 *High hazards, extra sprinklers.* Where additional sprinklers are installed because of obstructions within racks [see **26.1.4.1** e)] or to protect columns within storage areas (see **26.5.2.2**), the water supply for the extra sprinklers within the AMAO shall be added to that for the normal installation.

15.2 Precalculated pipe size installations

15.2.1 *Light hazard.* When tested as described in Appendix A the water supply running pressure at the "C" gauge shall be not less than 2.2 bar plus the static pressure equivalent of the height of the highest sprinkler in the installation above the "C" gauge when a water flow rate of 225 L/min is established through the drain and test valve.

15.2.2 ***Ordinary hazard***

15.2.2.1 *General.* When tested as described in Appendix A the water supply running pressure at each section control in a high-rise installation, or at the "C" gauge in a low-rise installation, shall be not less than that specified in Table 15 when the higher and lower water flow rates are established through the drain and test valve.

15.2.2.2 *High-rise installations.* Each installation rise pipe shall be provided with a jockey pump to 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 shall not be so large as to prevent the operation of suction or booster pumps when a single sprinkler operates.

Table 15 — Pressure and flow requirements for ordinary-hazard installations

Hazard group	Lower flow rate		Higher flow rate	
	Pressure at "C" gauge or section stop valve	Flow rate through installation test valve	Pressure at "C" gauge or section stop valve	Flow rate through installation test valve
	bar	L/min	bar	L/min
I	1.0 + S[a]	375	0.7 + S[a]	540
II	1.4 + S[a]	725	1.0 + S[a]	1 000
III	1.7 + S[a]	1 100	1.4 + S[a]	1 350
IIIS	2.0 + S[a]	1 800	1.5 + S[a]	2 100

[a] S is the static pressure difference between the "C" gauge and the highest sprinkler in the installation.

15.2.3 ***High hazard***

15.2.3.1 When tested as described in Appendix A the water supply running pressure at the control valve "C" gauge shall be not less than either:

a) where the AMAO is not larger than the area protected

$P_r + P_f + P_s$; or

b) where the AMAO is larger than the area protected

$P_{red} + P_f + P_s$.

where

P_{red} is the running pressure specified in Table 16, Table 17, Table 18 or Table 19 as appropriate at a flow rate equal to $\frac{\text{area protected}}{\text{AMAO}}$ times the flow rate specified in the table (in bar);

P_r is the running pressure at the design point and flow rate specified in Table 16, Table 17, Table 18 or Table 19 as appropriate (in bar);

P_f is the calculated pipe friction loss between the control valve "C" gauge and the most hydraulically remote design point (in bar);

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

COMMENTARY AND RECOMMENDATIONS ON **15.2.3.1**.
Note that the requirements apply where the area of the high-hazard protection in the same room (or area in which sprinklers are liable to operate simultaneously) contains fewer than 48 sprinklers but is not less than the AMAO.

*In some circumstances the hydraulically most remote design point may not feed the highest sprinkler in the installation, in which case it will be necessary to verify that the water supply can also provide the pressure needed with a second design area containing the highest sprinkler (see **24.2.4.2**).*

15.2.3.2 Where AMAO is fed by more than one distribution pipe the pipe friction loss (see **15.2.3.1**) shall be calculated on the basis that the flow rates in the distribution pipes are in proportion to the fraction of the design area fed by each distribution pipe.

COMMENTARY AND RECOMMENDATIONS ON **15.2.3.2**.
See Figure 19 a) for an example of this.

15.2.4 *Mixed high/ordinary hazard.* Where the area of the high-hazard protection is less than the AMAO but there is an adjacent area of ordinary hazard in the same room (i.e. an area in which sprinklers are liable to operate simultaneously), the high-hazard area flow rate required shall be reduced by the ratio of the actual area to the AMAO (see clause **14**) and to this flow rate shall be added the flow rate for the ordinary-hazard area taken as 5.0 × the excess of the specified high-hazard AMAO over the actual high-hazard area (L/min).

When tested as described in Appendix A the water supply running pressure shall be based on the level of the highest sprinkler in the high-hazard area and shall be not less than that specified in **15.2.3.1** (see also **15.3**).

The ordinary-hazard portion of the installation shall be supplied as specified in **15.2.2**, and the high-hazard distribution pipe feeding both high-and ordinary-hazard sprinklers shall be of bore not less than as specified in the ordinary-hazard pipe tables.

COMMENTARY AND RECOMMENDATIONS ON **15.2.4**.
See Figure 19 b) for an example of this.

15.3 Fully hydraulically calculated pipe size installations

15.3.1 *Pressure-flow requirement.* When tested as described in Appendix A the water supply running pressure at the "C" gauge shall be not less than the value calculated by the method of **24.3**.

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

Table 16 — Pressure and flow requirements, for high-hazard installations, with 15 mm sprinklers (precalculated), and pipe sizes from Table 60 and Table 62

Minimum design density	Flow rate through installation test valve		Running pressure at the design point at the level of the highest sprinkler in the high-hazard area						
	Wet pipe, pre-action, and recycling installations	Alternate and dry (including tail-end) installations	Floor area per sprinkler (m^2)						
			6	7	8	9	10[a]	11[a]	12[a]
mm/min	L/min	L/min	bar	bar	bar	bar	bar	bar	bar
7.5	2 300	2 875	—	—	1.80	2.25	2.80	3.35	3.95
10.0	3 050	3 825	1.80	2.40	3.15	3.90	4.80	5.75	6.80
12.5	3 800	4 750	2.70	3.65	4.75	6.00	7.30	—	—
15.0	4 550	5 700	3.80	5.20	6.75	—	—	—	—

[a] See **26.1.3** for restrictions on use of these spacings.

Table 17 — Pressure and flow requirements, for high-hazard installations, with 15 mm sprinklers (precalculated), and pipe sizes from Table 60 and Table 63

Minimum design density	Flow rate through installation test valve		Running pressure at the design point at the level of the highest sprinkler in the high-hazard area						
	Wet pipe, pre-action, and recycling installations	Alternate and dry (including tail-end) installations	Floor area per sprinkler (m^2)						
			6	7	8	9	10[a]	11[a]	12[a]
mm/min	L/min	L/min	bar	bar	bar	bar	bar	bar	bar
7.5	2 300	2 875	—	—	1.35	1.75	2.15	2.65	3.15
10.0	3 050	3 825	1.30	1.80	2.35	3.00	3.75	4.55	5.45
12.5	3 800	4 750	2.00	2.75	3.60	4.60	5.70	7.00	8.35
15.0	4 550	5 700	2.80	3.85	5.10	6.50	—	—	—

[a] See **26.1.3** for restrictions on use of these spacings.

Table 18 — Pressure and flow requirements, for high-hazard installations, with 15 mm sprinklers (precalculated), and pipe sizes from Table 61 and Table 63

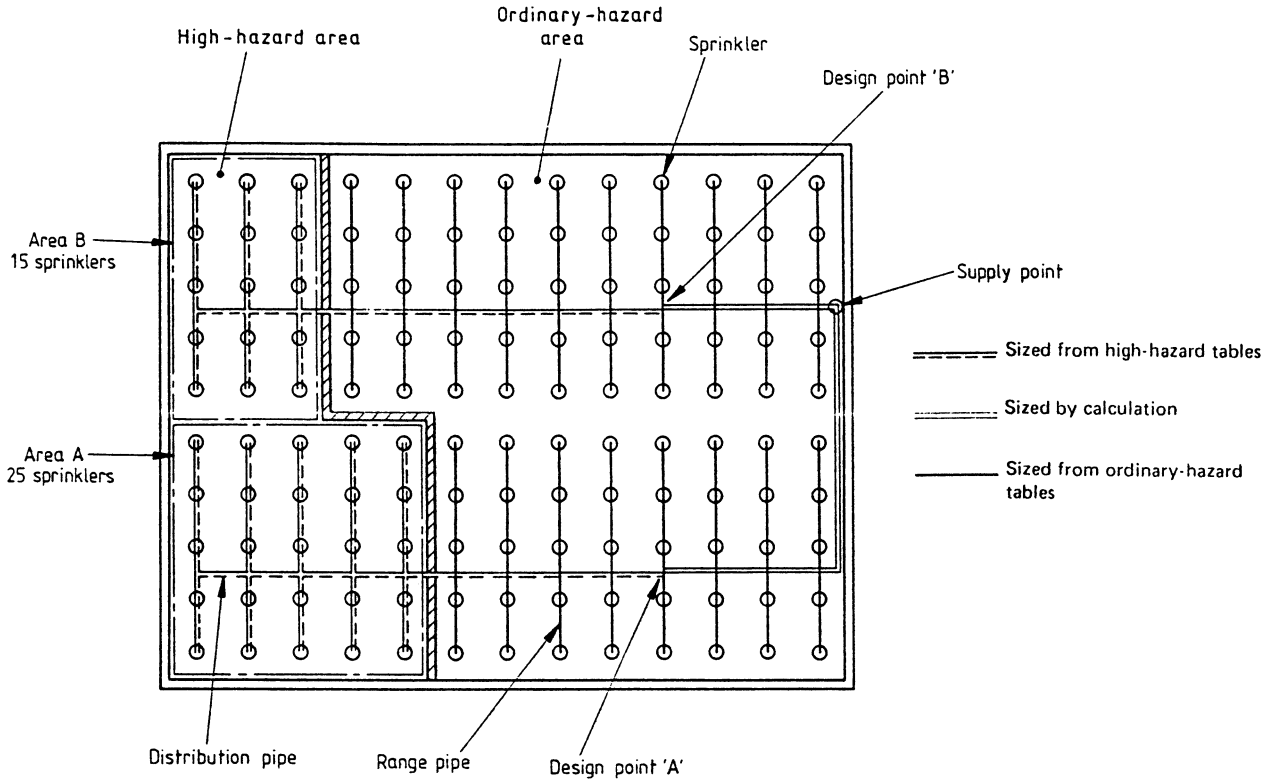
Minimum design density	Flow rate through installation test valve		Running pressure at the design point at the level of the highest sprinkler in the high-hazard area						
	Wet pipe, pre-action and recycling installations	Alternate and dry (including tail-end) installations	Floor area per sprinkler (m^2)						
			6	7	8	9	10[a]	11[a]	12[a]
mm/min	L/min	L/min	bar	bar	bar	bar	bar	bar	bar
7.5	2 300	2 875	—	—	0.70	0.90	1.10	1.35	1.60
10.0	3 050	3 825	0.70	0.95	1.25	1.60	1.95	2.35	2.80
12.5	3 800	4 750	1.10	1.50	1.95	2.45	3.05	3.70	4.35
15.0	4 550	5 700	1.60	2.15	2.80	3.55	4.35	5.25	6.25
17.5	4 850	6 075	2.15	2.90	3.80	4.80	5.90	7.15	—
20.0	6 400	8 000	2.80	3.80	5.00	6.30	7.75	—	—
22.5	7 200	9 000	3.50	4.80	6.30	7.95	—	—	—
25.0	8 000	10 000	4.35	5.90	7.75	—	—	—	—
27.5	8 800	11 000	5.25	7.15	—	—	—	—	—
30.0	9 650	12 100	6.20	—	—	—	—	—	—

[a] See **26.1.3** for restrictions on use of these spacings.

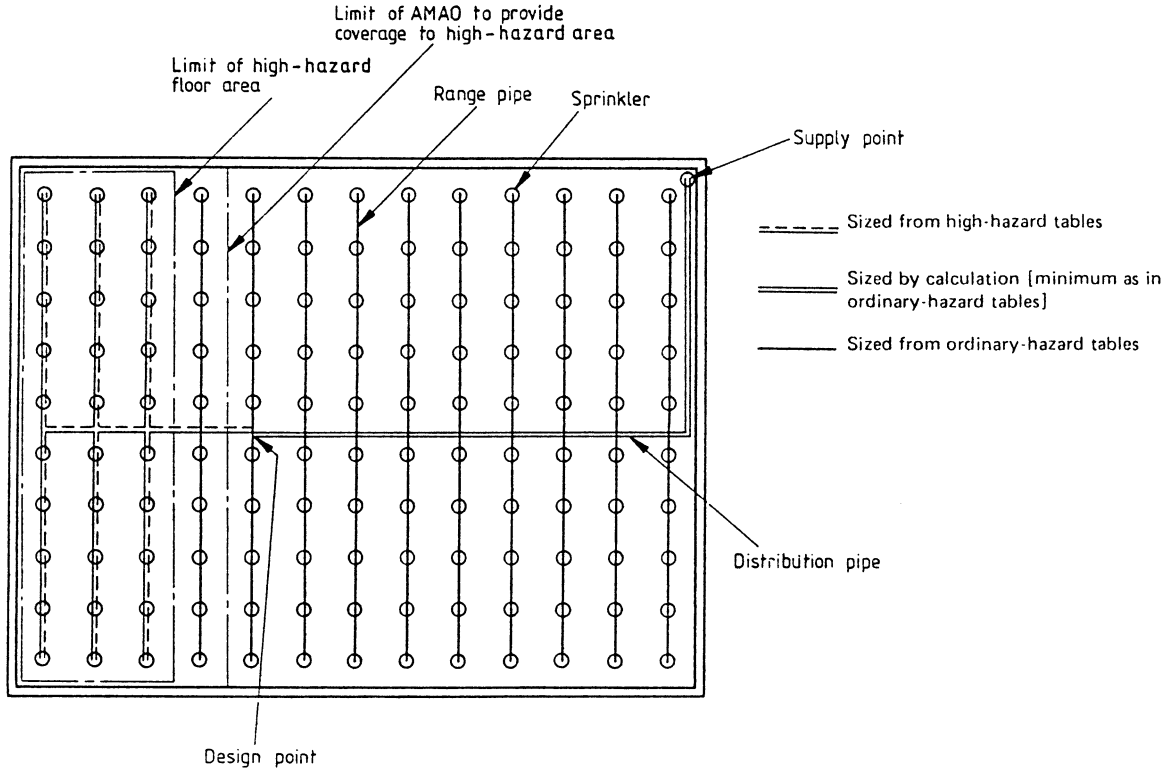
Table 19 — Pressure and flow requirements, for high-hazard installations, with 20 mm sprinklers (precalculated), and pipe sizes from Table 61 and Table 63

Minimum design density	Flow rate through installation test valve		Running pressure at the design point at the level of the highest sprinkler in the high-hazard area						
	Wet pipe, pre-action and recycling installations	Alternate and dry (including tail-end) installations	Floor area per sprinkler (m^2)						
			6	7	8	9	10[a]	11[a]	12[a]
mm/min	L/min	L/min	bar	bar	bar	bar	bar	bar	bar
7.5	2 300	2 875	—	—	—	—	—	0.80	0.95
10.0	3 050	3 825	—	—	—	0.95	1.15	1.40	1.65
12.5	3 800	4 750	—	0.90	1.15	1.45	1.80	2.15	2.55
15.0	4 550	5 700	0.95	1.25	1.65	2.10	2.55	3.10	3.65
17.5	4 850	6 075	1.25	1.70	2.25	2.80	3.45	4.20	4.95
20.0	6 400	8 000	1.65	2.25	2.95	3.70	4.60	5.55	6.55
22.5	7 200	9 000	2.05	2.85	3.70	4.70	5.75	6.95	—
25.0	8 000	10 000	2.55	3.50	4.55	5.75	7.10	—	—
27.5	8 800	11 000	3.05	4.20	5.50	6.90	—	—	—
30.0	9 650	12 100	3.60	4.95	6.50	—	—	—	—

[a] See **26.1.3** for restrictions on use of these spacings.



(a) AMAO fed by two distribution pipes (see **15.2.3.2**)



(b) AMAO covering high and ordinary hazard (see **15.2.4**)

Figure 19 — Examples of precalculated mixed ordinary and high-hazard installations

16 Water storage capacity

16.1 Application

For the purposes of this clause requirements applicable to wet pipe installations apply also to pre-action and recycling installations, and requirements applicable to alternate installations apply also to dry pipe, tail-end dry pipe and tail-end alternate installations.

COMMENTARY AND RECOMMENDATIONS ON **16.1**.
Note that water storage capacities are given in m^3 *and refilling rates in*L/min, *and that the factors used for calculation take account of this.*

16.2 Source of water

16.2.1 *General.* An appropriate source of water shall be provided as specified in Table 20.

16.2.2 *Refilling rate for suction tanks not dependent on inflow.* The water source shall provide a refilling rate, *f,* of not less than 75 L/min for single tank or a duplicate tank.

16.3 Minimum capacity

16.3.1 *Town main reservoirs.* The capacity shall be not less than the appropriate design capacity, *V*, specified in Table 20.

16.3.2 *Private elevated reservoirs and virtually unrestricted supplies.* The capacity shall be not less than the appropriate design capacity, *V,* specified in Table 20.

16.3.3 *Pump suction tanks dependent on inflow.* The effective capacity shall be not less than the appropriate design capacity, *V,* specified in Table 20.

16.3.4 ***Pump suction tanks not dependent on inflow***

16.3.4.1 *Single tanks.* The effective capacity shall be not less than the following:

a) if V/f is less than 1, the appropriate design capacity, *V,* specified in Table 20; or

b) if V/f is not less than 1, 1.33 V or $(2\ V - f)$ whichever is the less.

16.3.4.2 *Duplicate tanks.* The effective capacity of each tank shall be not less than the following:

a) if V/f is less than 0.7, the appropriate design capacity, *V,* specified in Table 20; or

b) if V/f is not less than 0.7, 1.33 V or $(2\ V - f/0.7)$ whichever is the less.

16.3.5 *Gravity tanks.* The capacity shall be not less than the following:

a) for high-rise systems, 2 V; or

b) for low-rise systems, either:

1) if V/f is less than 0.36, the appropriate design capacity, *V,* specified in Table 20; or

2) if V/f is not less than 0.36, $(2\ V - 0.36f)$.

COMMENTARY AND RECOMMENDATIONS ON **16.3.5**.
Where the capacity exceeds the specified minimum a separate outlet pipe above the level corresponding to the specified minimum capacity may be used to supply water for other uses.

17 Town mains, elevated private reservoirs, gravity tanks, suction and booster pumps, and pressure tanks

17.1 Town mains

17.1.1 *General*

17.1.1.1 *Pressure-flow requirement.* A town main shall normally provide at the time of anticipated maximum demand for all other purposes the appropriate minimum pressure-flow specified in clause **15**.

COMMENTARY AND RECOMMENDATIONS ON **17.1.1.1**.
Town main standing pressure should not exceed 10 bar. *Pressure-reducing valves are not recommended and they should be used only after consultation as specified in* ***3.1***.

17.1.1.2 *Terminal mains.* The nominal bore of any terminal main, or branch dead-end main, feeding an ordinary hazard (group III or IIIS) or a high-hazard installation shall be not less than 150 mm.

COMMENTARY AND RECOMMENDATIONS ON **17.1.1.2**.
It is preferable not to feed sprinkler installations from town main dead-end branches.

17.1.1.3 *Stop valves.* Stop valves on the branch connection from the town main, other than those under the control of the water undertaking, shall be padlocked open and be under the control of the user.

17.1.1.4 *Fully hydraulically calculated installations.* Where the installation pipework sizes are hydraulically calculated the pressure of the main or mains used for hydraulic calculations shall be as follows:

a) if the pressure, measured during a flow test at a period of maximum demand and adjusted to take account of static head and friction losses between the test point and the position of the "C" gauge is greater than 3.3 bar, 85 % of the measured pressure; or

b) if the measured pressure is not greater than 3.3 bar, 0.5 bar less than the lowest test pressure.

COMMENTARY AND RECOMMENDATIONS ON **17.1.1.4**.
The roof or ceiling sprinkler minimum pressure specified in ***24.3.5*** *is to be satisfied at a pressure-flow point on or below the intercept of the installation characteristic for any AMAO position with the adjusted town supply pressure-flow graph as required.*

Table 20 — Water source and design capacity

Source of water	Pipework design method	Hazard class	Supply type	Design capacity (V) m^3
Town main reservoir	Either[a]	Light	Any	1 000
Private elevated reservoir	Either[a]	Light	Any	500
Town main reservoir or private elevated reservoir[b] or virtually unrestricted supply (such as river lake or canal)	Either[a]	Ordinary, all groups	Any	1 000
	Precalculated	High	Superior or duplicate	1 000 plus capacity specified in Table 23[c]
	Fully calculated	High	Superior or duplicate	1 000 plus capacity specified in Table 24
Pump suction tank not dependent on inflow (Types A or B) or gravity tank	Precalculated	Light	Any	As specified in Table 21
		Ordinary, all groups	Any	As specified in Table 22
		High	Superior of duplicate	As specified in Table 23[bc]
	Fully calculated	Ordinary, all groups	Any	As specified in Table 24
		High	Superior or duplicate	
Pump suction tanks dependent on inflow (Types C and D)	Either[a]	Ordinary, all groups	Any	As specified in Table 25
		High	Superior or duplicate	
Pressure tank	Precalculated	Light	Superior or duplicate	7
		Ordinary, group, 1	Superior	23
		Ordinary, all group,	Superior or duplicate	15
	Fully calculated	Ordinary, group 1	Superior or duplicate	As specified in Table 24
		Ordinary, groups II, III and IIIS	Duplicate	

[a] i.e. precalculated or fully calculated.
[b] The capacities stated apply to private elevated reservoirs supplying the sprinkler system and other services.
[c] In high-hazard, precalculated installations where the area of high-hazard is less than the AMAO the design capacity shall not be less than

$$\text{Capacity given in column 5} \times \frac{\text{actual area of high hazard}}{\text{AMAO}}$$

plus, if there is any area of ordinary hazard in the same room 0.45[AMAO (m^2) – actual area of high hazard (m^2)] m^3, or the design capacity appropriate to the ordinary hazard in the tables whichever is the greater.

Table 21 — Design capacity, where tank is not dependent on inflow, for light-hazard precalculated installations

Height of highest sprinkler above lowest sprinkler not exceeding	Design capacity
m	m^3
15	9
30	10
45	11

Table 22 — Design capacity, where tank is not dependent on inflow, for ordinary-hazard precalculated installations

Group	Height of highest sprinkler above lowest sprinkler not exceeding	Design capacity
	m	m^3
I	15	55
	30	70
	45	80
II	15	105
	30	125
	45	140
III	15	135
	30	160
	45	185
IIIS	15	160
	30	185

Table 23 — Design capacity, where tank is not dependent on inflow, for high-hazard precalculated installations

Design density	Design capacity	
	All systems except alternate and dry systems for high-hazard risks	Alternate and dry systems for high-hazard risks
mm/min	m^3	m^3
7.5	225	285
10.0	275	345
12.5	350	440
15.0	425	535
17.5	450	565
20.0	575	720
22.5	650	815
25.0	725	910
27.5	800	1 000
30.0	875	1 095

Table 24 — Design capacity, where tank is not dependent on inflow, for fully hydraulically calculated installations

Hazard class	Design capacity
	m^3
Light	0.03 $Q_{max.}$
Ordinary	0.06 $Q_{max.}$
High	0.09 $Q_{max.}$
$Q_{max.}$ expressed in L/min	

NOTE $Q_{max.}$ is the maximum flow demand specified in **18.3.4**.

Table 25 — Design capacity, where tank is dependent on inflow at refilling rate *f*, L/min

Hazard class	Design capacity
	m^3
Light	2.5 or, as given in Table 21 or Table 24 less 0.03*f*, whichever is the greater
Ordinary, Group I	25 or, as given in Table 22 or Table 24 less 0.06*f*, whichever is the greater
Ordinary, Group II	50 or, as given in Table 22 or Table 24 less 0.06*f*, whichever is the greater
Ordinary, Group III	75 or, as given in Table 22 or Table 24 less 0.06*f*, whichever is the greater
Ordinary, Group IIIS	100 or, as given in Table 22 or Table 24 less 0.06*f*, whichever is the greater
High	2/3 of the value given in Table 23 or Table 24 or, the value given in Table 23 or Table 24 less 0.09*f*, whichever is the greater

NOTE Requirements for the town main supplying the inflow are given in **17.1.4**.

17.1.2 *Town main as superior supply*

17.1.2.1 A town main used as a superior supply shall be:

a) fed from each end by mains, each of which shall be capable of furnishing the pressure and flow specified in clause **15**; and

b) not directly dependent on a common trunk main anywhere in the town main complex; and

c) fed from more than one source.

17.1.2.2 *Either*

a) duplicate connections, carried separately up to the premises containing the sprinkler system, with a stop valve (open or closed as required by the water undertaking) on the main between the two connection points, shall be made to the main; or

b) where duplicate connections cannot be provided a single connection with a stop valve (secured open) fitted immediately on each side of the branch connection shall be used.

COMMENTARY AND RECOMMENDATIONS ON **17.1.2.2**.
Where duplicate connections are used the stop valve is used as necessary to isolate part of the supply main whilst supply is maintained to the system.

17.1.3 *Two town mains as a duplicate supply*. Where two mains form a duplicate supply the mains shall be either completely independent or fed from an interconnected network having two or more reservoirs and with stop valves so positioned that in the event of a breakdown anywhere in the network one of the mains can remain operative.

17.1.4 *Town main as supply to pump suction tank dependent upon inflow*. Where town main forms the supply to a tank (type C) dependent upon inflow the connection shall be reserved solely for the tank inflow and shall be provided with a bypass line with a dedicated direct reading flow meter suitable for sprinkler service.

The flow meter and pipework shall be protected from freezing.

COMMENTARY AND RECOMMENDATIONS ON **17.1.4**.
The flowmeter can be used to indicate during tank filling that the specified inflow is available.

17.2 Elevated private reservoirs

The elevated private reservoir and its feed main shall be under the control of the user.

17.3 Gravity tanks

17.3.1 *General*

17.3.1.1 The tank shall not supply more than one sprinkler system.

17.3.1.2 The specified water capacity shall be maintained by automatic means.

17.3.1.3 The tank, inlet float valves, and inflow, outlet and overflow pipes shall be protected against freezing.

The tank shall be covered to exclude daylight and solid matter.

COMMENTARY AND RECOMMENDATIONS ON **17.3.1.3**.
The water authority will have requirements for the float valves.

BS 6700 covers precautions against freezing. If a heating system is used it should be provided with a device to give an audible and visible warning of malfunction.

17.3.1.4 The tank shall be provided with a side-outlet overflow pipe.

COMMENTARY AND RECOMMENDATIONS ON **17.3.1.4**.
The water authority will have requirements for the minimum size, and will advise on location.

Where the tank is a superior supply the size should not be less than that of the water inflow pipe; or where the tank is part of a duplicate supply the size should be not less than 100 mm.

17.3.1.5 The tank shall be fitted with a water depth indicator.

17.3.1.6 The tank shall be fitted with a permanent ladder or stair extending above the top of the tank to permit access.

COMMENTARY AND RECOMMENDATIONS ON **17.3.1.6**.
Safety precautions to control access should be implemented.

17.3.2 *High-rise buildings*. The tank shall be refilled by an automatic pump controlled by duplicated on/off float switches in the tank.

COMMENTARY AND RECOMMENDATIONS ON **17.3.2**.
The refilling pump need not be dedicated for this purpose only.

17.4 Suction and booster pumps

17.4.1 *Drive and power arrangements*

17.4.1.1 The pressure-flow characteristics of pumps shall be as given in Table 26. Pumps shall be driven directly, by either:

a) an electric motor with a maximum power output not less than 1.1 times the power needed to drive the pump at any flow within its characteristics; or

b) a diesel engine with a 6 h rating (determined as specified in BS 5514), not less than 1.1 times the power needed to drive the pump at a flow of 1.1 times the maximum predicted flow.

17.4.1.2 Power to drive the pumps shall be available at all times.

The electric supply to electrically driven pumps shall be obtained from a public electricity supply or other reliable source.

COMMENTARY AND RECOMMENDATIONS ON **17.4.1.2**.
*Some of the authorities listed in **3.1** may have requirements relating to the approval of installers of automatic pumps.*

Where the electricity supply is not taken from a public source full particulars of the generating plant should be submitted to the authorities concerned at the planning stage.

Generating plant engine fuel tanks should be kept fully filled when in the stand-by condition.

17.4.1.3 Pumps shall be driven either:

a) directly from the driver; or

b) in the case of submersible pumps only through a 1 : 1 ratio angle gear.

Table 26 — Pump pressure, flow and speed rating

Hazard class	Pump installation type	Installation pipework design	Flow condition for nameplate pressure[a], flow and speed rating	
			Flow	Pump inlet condition
			L/min	
Light and ordinary	Suction	Precalculated	Nominal as Table 28	Zero suction lift
Light and ordinary	Booster	Precalculated	Nominal as Table 28	Zero town main pressure
High	Suction	Precalculated	1.35 × Table 16 or 1.2 × Table 17 or Table 18 Table 19 (see also **15.2.3**)	Zero suction lift
High	Booster	Precalculated	1.35 × Table 16 or 1.2 × Table 17 or Table 18 Table 19 (see also **15.2.3**)	Zero town main pressure
All	Suction	Fully calculated	$Q_{max.}$ (see **18.3**)	Water supply at normal level (see Figure 23)
All	Suction	Fully calculated	$Q_{max.}$ (see **18.3**)	Zero town main pressure

[a] Outlet pressure at delivery side of any outlet orifice plate fitted.

The coupling between the driver and the pump shall be such that either unit can be removed without disturbing the other.

17.4.1.4 Where two booster pumps provide a superior supply, or totally provide a duplicate supply, each pump when operating alone shall provide not less than the flow and pressure specified in clause **15** and shall have compatible pressure flow characteristics so that when operating in parallel it is not overloaded at any point.

Where both pumps are electrically driven either:

a) they shall be separately driven by independent supplies; or

b) they shall both be driven from the same supply with an automatic changeover to a completely independent supply in the event of failure of the first supply.

17.4.1.5 Where automatic suction pumps provide a superior supply or totally provide a duplicate supply they shall be arranged as either:

a) two pump arrangements. Each pump when operating alone shall provide not less than the flow and pressure specified in clause **15**, and shall have compatible pressure-flow characteristics so that when operating in parallel it is not overloaded at any point within the specified range of output flows.

Where both pumps are electrically driven either they shall be separately driven by completely independent power supplies or from the same power supply with an automatic changeover to a completely independent supply in the event of failure of the first supply; or

b) three pump arrangements. Each pump shall have compatible flow characteristics so that when operating in parallel it is not overloaded at any point within the specified range of output flows.

The flow and pressure specified in clause **15** shall be provided by any combination of two pumps operating in parallel, and where all three pumps are electrically driven, by one nominated pump operating alone.

Where two or three pumps are electrically driven either one pump, which shall be the nominated pump in the case of three pumps, shall be separately driven by a power supply completely independent of the supply to the other pump or pumps, or all shall be driven by the same power supply with an automatic changeover to a completely independent supply in the event of failure of the first supply.

17.4.2 *Starting and test facilities*

17.4.2.1 *Starting.* A single stage pump set shall be fitted with a starting device suitable for sprinkler service immediately downstream of the outlet check valve. A multistage high-rise pump shall be fitted with a starting device suitable for sprinkler service immediately downstream of each stage outlet check valve.

The starting device shall open a normally closed electrical circuit and cause the pumps to operate when the pressure in the water supply trunk main has fallen to a value not less than 80 % of the pressure attained in the trunk main when the pump or pumps are churning. The pumps shall be fully operational in not more than 30 s.

A push button manual start device, protected by a quick access front, shall be provided at the control panel.

Means shall be provided for emergency manual starting and for testing starting by reduction of the water pressure applied to each starting device.

Where a drain valve is fitted to test the starting device and to facilitate servicing, an isolating valve with a bypass shall be fitted on the hydraulic connection. The bypass shall incorporate a 3 mm diameter orifice and a check valve allowing flow towards the trunk main. A pressure gauge to indicate the pressure at which the pump starts shall be placed between the isolating and drain valves in such a position that it can be read during the pump starting test.

COMMENTARY AND RECOMMENDATIONS ON **17.4.2.1**.
The quick access front protecting the manual start push button, if of the frangible glass type, should not produce jagged or sharp edges which might cause injury.

The drain valve should be fitted with an orifice plug to control the rate of pressure drop and should have permanent drainage facilities.

17.4.2.2 *Starting devices.* The starting devices shall be housed in an enclosure with a degree of protection not less than IP65 as specified in BS 5490.

17.4.2.3 *Stopping.* The pump shall not have any automatic stopping device.

17.4.2.4 *Alarms.* Means shall be provided to initiate visual and audible warnings in an area with responsible manning as follows:

a) (when the pump is not running) when the sprinkler trunk main pressure falls to a value at which the pump, or the first pump when more than one forms the supply, should start; and

b) when the water level in the priming tank is not being maintained by its normal source.

These warnings shall latch in until cancelled manually.

17.4.2.5 *Pump output test facility.* A test facility, including a direct reading flow meter suitable for sprinkler service, shall be provided at the pump delivery branch downstream of each outlet check valve to permit a running pressure test of the pump at the full load condition ($Q_{max.}$) or nominal rating as appropriate.

Where the installation main control valves are remote from the pump(s) an additional test facility shall be provided upstream of each group of control valve sets.

COMMENTARY AND RECOMMENDATIONS ON **17.4.2.5**.
This facility should be such that the full load condition of the pump is not exceeded when the test valve is fully open.

The test pipework should have means for automatic or manual drainage.

*Adequate provision should be made for the disposal of the waste water, and if water is returned to the pump suction tank the arrangement should be such that aerated water is not drawn into the pump suction. Water should not be returned directly into a jackwell or to a point close to the pump suction connection as the recirculation of the water may cause overheating and possible cavitation in the pump casing. See clause **19** for pressure flow/testing.*

17.4.2.6 *Bypass on booster pumps.* Booster pumps shall be fitted with a bypass with a stop valve and a check valve. The bypass size shall be not less than the size of the water supply pipe to the pump.

17.4.2.7 *Cooling.* Means shall be provided to allow a continuous flow of water through a pump at a sufficient rate to prevent overheating of the pump when churning, with adequate provision for disposal of any cooling water run to waste.

17.4.2.8 *Location of pumps.* Water supply pumps shall be sited at or near ground level.

COMMENTARY AND RECOMMENDATIONS ON **17.4.2.8**.
*To maintain water pressure wet and alternate installations may be provided with a jockey pump which shall not be so large as to prevent the operation of suction or booster pumps when a single sprinkler operates. A jockey pump is specified for high-rise systems (see **15.2.2.2**).*

Pumps at ground level are more accessible to the fire brigade.

17.4.3 *Water sources for suction pumps*

17.4.3.1 *Single supply.* A suction pump providing a single supply shall draw water from either:

a) a suction tank type A not dependent on inflow suitable for sprinkler service, and complying with **17.4.11**; or

b) a suction tank type B not dependent on inflow, and complying with **17.4.11**; or

c) a suction tank type C dependent upon inflow, and complying with **17.4.11**; the inflow shall be from a town main complying with **17.1.1.2**, **17.1.1.3** and **17.1.4**; or

d) a virtually inexhaustible source such as a river, canal, lake, etc.

17.4.3.2 *Superior supply.* Suction pumps providing a superior supply shall draw water from either:

a) a suction tank type B not dependent on inflow, and complying with **17.4.11.6**; or

b) a suction tank type C dependent upon inflow, and complying with **17.4.11.6**; the inflow shall be from a town main complying with **17.1.2.1** b) and **17.1.2.1** c), and **17.1.2.2**, and if the tank capacity is not less than two-thirds of the capacity specified for a tank not dependent on inflow for the hazard class, with **17.1.4**.

17.4.3.3 *Suction pump as duplicate supply.* Suction pumps providing a duplicate supply shall draw water from either:

a) a suction tank type A not dependent on inflow, and complying with **17.4.11.6**; or

b) each of two suction tanks type B not dependent on inflow, and complying with **17.4.11.6**; or

c) each of two suction tanks type C dependent upon inflow, and complying with **17.4.11.6**. The inflow shall be from a town main complying with **17.1.4**; or

d) a virtually inexhaustible source, such as a river, canal, lake, etc.

COMMENTARY AND RECOMMENDATIONS ON **17.4.3**.
Potable water supplies are preferred to rivers, lakes, canals, etc.

17.4.4 *Water sources for booster pumps.* Booster pumps shall draw water from either a town main or an elevated private reservoir.

COMMENTARY AND RECOMMENDATIONS ON **17.4.4**.
The agreement of the water authority will normally be needed before a booster pump can be connected to a town main. The water authority or water undertaker will normally require that the pump cannot draw vacuum under any water demand condition.

17.4.5 *Pump set housing*

17.4.5.1 Pump sets shall be housed as follows (in order of preference):

a) in a separate building used for no other purpose; or

b) in a building adjacent to, but separated by a wall of fire resistance not less than 2 h from, a protected building and with direct outside access; or

c) in a room or enclosure, which shall be as small as is practical, enclosed by elements of construction of fire resistance not less than 2 h and with direct outside access.

COMMENTARY AND RECOMMENDATIONS ON **17.4.5.1**.
Pump sets and associated equipment should be sited to avoid, and if necessary should be protected from, mechanical damage.

17.4.5.2 Houses for diesel pumps shall be sprinkler-protected. Where it is impractical to provide sprinkler protection from the installation control valve sets in the premises, sprinkler protection shall be provided from the nearest accessible point on the downstream side of the outlet check valve of the pump via a subsidiary stop valve, secured in the open position together with a flow alarm device (see **27.2**) suitable for sprinkler service to provide visible and audible indication of the operation of the sprinklers. The alarm equipment shall be installed either at the installation control valves or at a responsibly manned location such as a gatehouse.

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.

17.4.5.3 The pump house shall be maintained at or above temperatures of 4 °C for electric motor driven pumps, or 10 °C for diesel engine driven pumps.

17.4.5.4 Pump houses for diesel engine driven pumps shall be provided with adequate ventilation for engine aspiration.

COMMENTARY AND RECOMMENDATIONS ON **17.4.5.4**.
With the engine(s) operating on full load the equilibrium temperature rise above ambient should not exceed 10 °C. Adequate ventilation for unsealed engine starting batteries is also essential.

17.4.6 *Pump performance*

17.4.6.1 *General.* The pump shall operate up to a flow equal to any flow needed for cooling (see **17.4.13.3**) plus the appropriate maximum flow rate specified in Table 27. The outlet pressure shall fall with increased output (stable characteristic).

If a flow limiting outlet orifice plate is used it shall comply with **24.1.3**, and be integral with the pump outlet, or fixed to the pump outlet in such a way that it remains so fixed.

The k factor of a non-integral orifice plate shall be calculated from:

$$k = \frac{Q}{P^{1/2}}$$

where

Q = the flow rate (in L/min);

P = the pressure drop across the orifice plate with flow Q (in bar).

The closed outlet pressure of a suction pump with the water supply at normal maximum level shall not exceed 10 bar except for high-rise building systems. The closed outlet pressure of a booster pump with the town main at anticipated maximum pressure shall not exceed 10 bar.

In selecting pump characteristics allowance shall be made for increase in pressure as flow reduces owing to increase in driver shaft speed. Allowance shall also be made for increase or decrease in pressure caused by variation of water supply level at the pump suction flange.

COMMENTARY AND RECOMMENDATIONS ON **17.4.6.1**. *See **17.4.7** for pump head conditions.*

17.4.6.2 *Pump nameplate rating.* The nominal pressure, flow (excluding cooling water flow) and corresponding shaft speed rating shall be as given in Table 26.

COMMENTARY AND RECOMMENDATIONS ON **17.4.6.2**. *See **31.4.1** for pump name plate marking.*

17.4.6.3 *Precalculated pipe size installation.* An automatic suction pump shall operate continuously at any flow rate up to the maximum specified in Table 26 with a net positive suction head of not more than 5.38 m of water.

The flow at the nominal pressure rating shall be within + 5 % of that specified in the tables.

COMMENTARY AND RECOMMENDATIONS ON **17.4.6.3**. *In high-rise installations the friction loss between a section control valve and the pump is equivalent to that in the supply pipe of normal installations; it is allowed for in the specification and is therefore disregarded here.*

The data given in Table 16, Table 17, Table 18, Table 19 and Table 28 assume that a pump is to supply water only to the sprinkler installation and any hydraulic hose reels for firefighting purposes only.

17.4.6.4 *Fully hydraulically calculated installation pipework.* An automatic suction pump shall operate continuously at any flow rate up to the maximum given in Table 27 with the water supply at normal maximum level (see **18.3** for $Q_{max.}$). The pump shall operate with a net positive suction head of not more than 5.38 m of water, under any flow condition up to $Q_{max.}$.

Table 27 — Pump maximum power absorption for driver sizing

Installation pipework design	Pump installation type	Type of pump drive	Flow range to be examined for maximum pump power absorption. Zero to stated value
			L/min
Precalculated	Suction or Booster	Electric or diesel	Max. value in appropriate line of column 5 of Table 28 or for high hazard as given in Table 26
Fully calculated	Suction	Electric	Flow corresponding to zero pump outlet pressure[a]
		Diesel	$Q_{max.}$ (see **18.3** and Table 26)
	Booster	Electric	Flow corresponding to zero pump outlet pressure[a]
		Diesel	$Q_{max.}$ (see **18.3** and Table 26)

[a] Outlet pressure at delivery side of any outlet orifice plate.

Table 28 — Pump pressure and flow for light-and ordinary-hazard (precalculated) installations

Hazard class	Height difference from pump (low rise) or lowest sprinkler in installation (high rise) to highest sprinkler in installation		Nominal rating including any outlet orifice plate		Characteristic not less than			
					High flow		Low flow	
	more than	not more than	Pressure at pump outlet	Flow	Pressure at "C" gauge	Flow	Pressure at "C" gauge	Flow
	m	m	bar	L/min	bar	L/min	bar	L/min
Light	0	15	1.5	300	3.7	225	—	—
	15	30	1.8	340	5.2	225	—	—
	30	45	2.3	375	6.7	225	—	—
Ordinary, Group I	0	15	1.2	900	2.2	540	2.5	375
	15	30	1.9	1 150	3.7	540	4.0	375
	30	45	2.7	1 360	5.2	540	5.5	375
Ordinary, Group II	0	15	1.4	1 750	2.5	1 000	2.9	725
	15	30	2.0	2 050	4.0	1 000	4.4	725
	30	45	2.6	2 350	5.5	1 000	5.9	725
Ordinary, Group III, non-high rise	0	15	1.4	2 250	2.9	1 350	3.2	1 100
	15	30	2.0	2 700	4.4	1 350	4.7	1 100
	30	45	2.5	3 100	5.9	1 350	6.2	1 100
Ordinary, Group III, high rise	0	15	1.4 + S[a]	2 250	2.9 + S[a]	1 350	3.2 + S[a]	1 100
	15	30	2.0 + S[a]	2 700	4.4 + S[a]	1 350	4.7 + S[a]	1 100
	30	45	2.5 + S[a]	3 100	5.9 + S[a]	1 350	6.2 + S[a]	1 100
Ordinary, Group IIIS	0	15	1.9	2 650	3.0	2 100	3.5	1 800
	15	30	2.4	3 050	4.5	2 100	5.0	1 800

[a] S is the pressure equivalent to the height difference between the pump and the lowest sprinkler in the installation.

COMMENTARY AND RECOMMENDATIONS ON **17.4.6.4**.
To ensure that the commissioned installation conforms to the above requirements, it is usual at the design stage, to check that the pressure at the pump outlet flange measured with the water supply source at low level "X" (see Figure 23) and at the installation demand flow rate (that is the flow needed to give the minimum discharge density at the most hydraulically remote AMAO plus that for any intermediate sprinklers) is not less than 0.5 bar plus the pressure calculated to provide the flow.

*This requirement for net positive suction head (NPSH) applies to pump performance (see **17.4.10**) which specifies the maximum NPSH for the pipework. The roof or ceiling sprinkler minimum pressure requirement of* **24.3.4** *is to be satisfied at a pressure-flow point on or below the intercept of the installation characteristic for any AMAO position on curve 5 of Figure 20.*

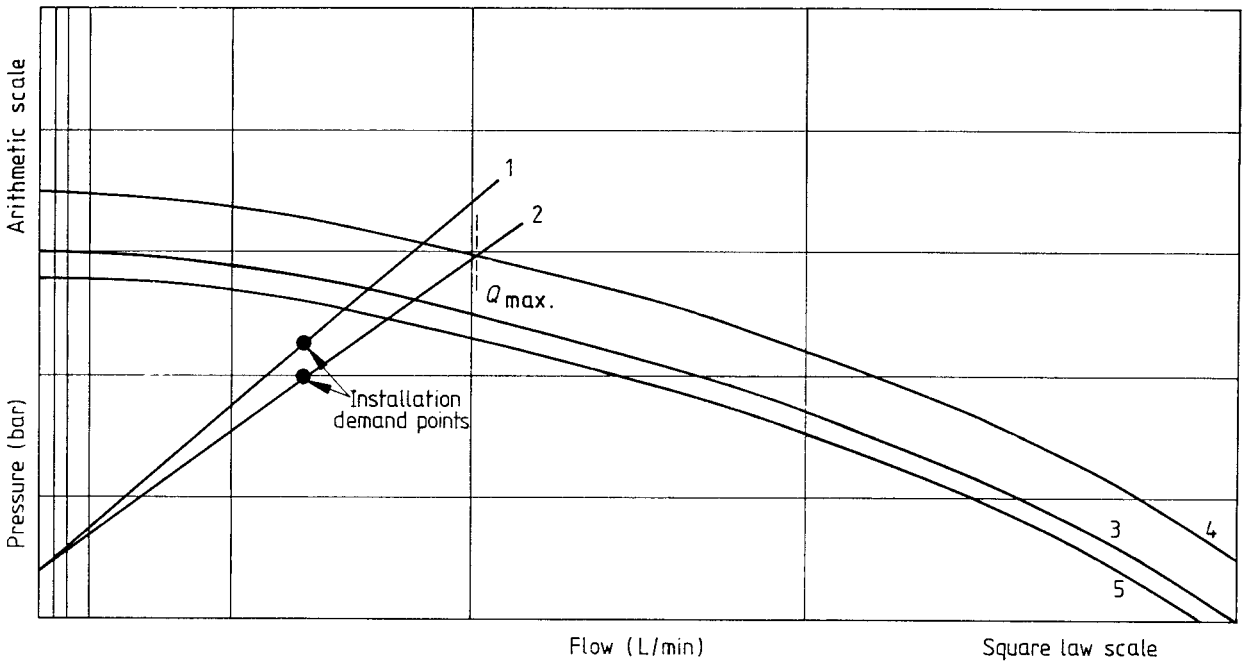
17.4.7 *Suction conditions.* A pump shall be regarded as being under positive suction head if it draws water from either:

a) a stored water supply where not more than 2 m depth of water or one-third of the effective capacity whichever encompasses the smaller water volume is contained between the pump centre line and the low water level "X" (see Figure 23); or

b) a natural unlimited water supply such as a river, canal, lake, etc. where the centre line of the pump is at least 0.85 m below the lowest known water level;

otherwise it shall be regarded as being under suction lift.

COMMENTARY AND RECOMMENDATIONS ON **17.4.7**.
Positive suction head is the preferred suction condition.



Key:

1 Hydraulically most unfavourable location
2 Hydraulically most favourable location
3 Site performance — low water level 'X' (at pump outlet)
4 Site performance — tank full (at 'C' gauge)
5 Site performance — low water level 'X' (at 'C' gauge)

Maximum predicted flow ($Q_{max.}$) 3 010 L/min	Hazard Name and location of protected premises	Title. Installer's data sheet Hydraulic summary
Maximum flow to NPSH 5.38 m 5 200 L/min	Installing engineers	Drawn Doc. Ref. Issue
		Checked
		Date

Figure 20 — Typical installer's pump data sheet

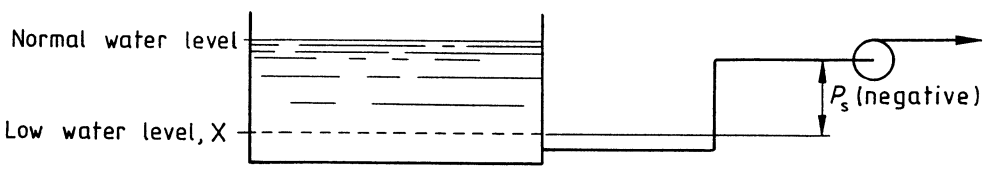


Figure 21 — Measurement of negative suction head

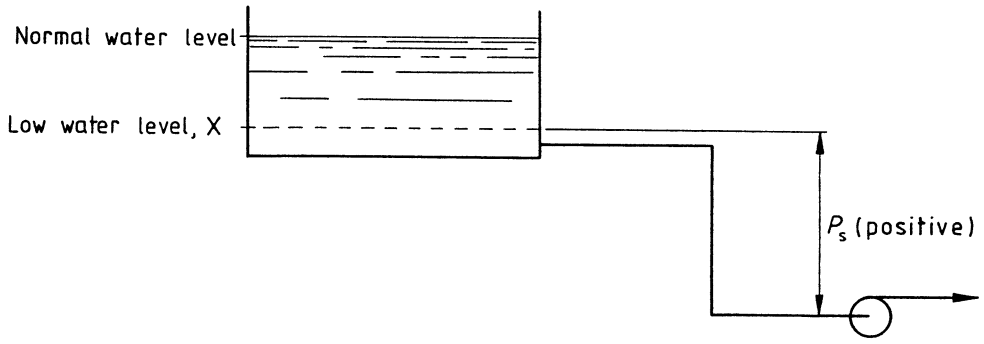


Figure 22 — Measurement of positive suction head

17.4.8 ***Positive suction head conditions***

17.4.8.1 *Suction pipe.* It shall not be possible for air to be trapped in the pipe.

The suction pipes to different pumps shall only be inter-connected if each individual pump suction inlet and each suction pipe connection to its water supply is fitted with a stop valve (retained in position by means other than the pump inlet flange). Any connection between suction pipes shall be upstream of the stop valve at the pump suction inlet and shall be of the same nominal inside diameter as the individual suction pipes.

For fully hydraulically calculated pipework the suction pipe and fittings shall be sized to give a maximum water velocity of 1.8 m/s at Q_{max}.

For precalculated pipework the equivalent length of the suction pipe and fittings shall be not more than 30 m, and the suction pipe and fittings shall be sized as specified in Table 29.

Table 29 — Suction pipe size: positive suction head condition

Hazard class	Minimum nominal size of suction pipe[a]
	mm
Light	65
Ordinary, groups I and II	150
Ordinary, groups III and IIIS	200
High	3.43 $Q^{1/2}$ where Q is the flow rate given in Table 27

[a] A larger size may be needed to meet the requirements of **17.4.10**.

17.4.8.2 *Air release.* A manual or automatic air vent shall be provided to release any air trapped in the upper part of the pump case, and arrangements shall be made to automatically prevent any pump in operation drawing air from any associated non-operating pump or pumps, for example through the pump air venting means, the pump priming tank connection (if fitted) or the pump anti-overheating circulating water pipe.

The inlet suction valve, and valves to isolate the priming tank (if any), air vent and anti-overheating circulating water pipe from the pump installation normally shall be strapped open.

17.4.8.3 *Foot valve.* A foot valve shall be fitted to the suction pipe as follows:

a) where not less than one-sixth of the effective stored water capacity is contained between the centre line of the pump and the low water level "X" (see Figure 23); or

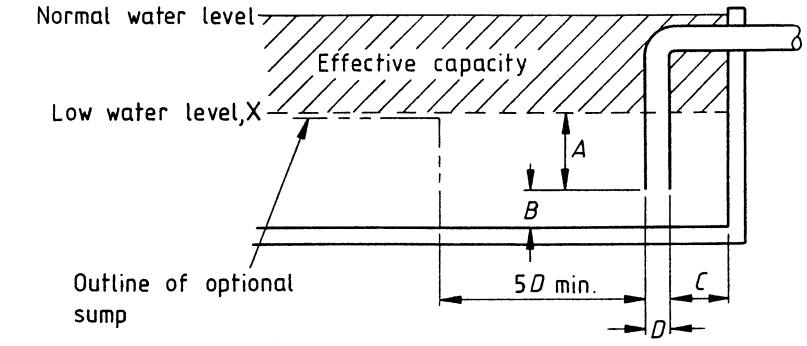
b) where the pump centre line is not more than 0.85 m below the lowest known water level of an unlimited natural supply.

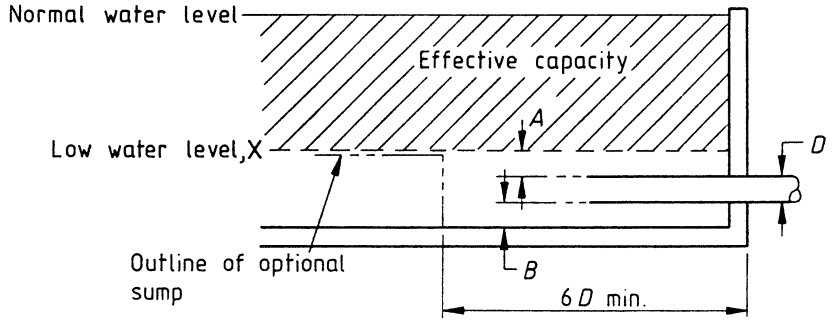
17.4.9 ***Suction lift conditions***

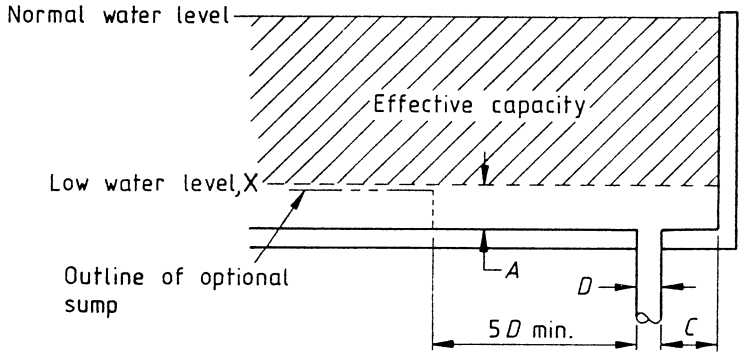
17.4.9.1 *Suction pipe.* Each pump shall have a separate suction pipe, of equivalent length not more than 30 m, with the upper inside surface either horizontal or with a continuous rise to the pump to avoid air locks.

For fully hydraulically calculated pipework the suction pipe and fittings shall be sized to give a maximum water velocity of 1.5 m/s at $Q_{max.}$.

For precalculated pipework the suction pipe and fittings shall be sized as specified in Table 30.







NOTE 1 Provision of a sump effectively increases capacity because low water level "X" can be at the level of the main base of the tank.

NOTE 2 See Table 32 for values of *A*, *B* and *C*.

Dimension "A" is the distance between low water level "X", and the highest point of water entry into the pipe.

Dimension "B" is the distance between the base of the tank, or sump if provided, and the lowest edge of the pipe, or in case (a) if a vortex inhibitor is fitted, the underside of the upper flange to the vortex inhibitor.

Dimension "C" is the distance from the wall to the nearer edge of the pipe bore, or if a vortex inhibitor is fitted, the near periphery of the vortex inhibitor.

Figure 23 — Effective capacity of suction tanks

Table 30 — Suction pipe size: suction lift condition

Hazard class	Minimum nominal size of suction pipe[a]
	mm
Light	80
Ordinary, groups I and II	150
Ordinary, groups III and IIIS	200
High	3.76 $Q^{1/2}$ where Q is the flow rate given in Table 28

[a] A larger size may be needed to meet the requirements of **17.4.10**.

17.4.9.2 *Air release.* An automatic air vent shall be provided to release any air trapped in the upper part of the pump case.

17.4.9.3 *Foot valve.* A foot valve shall be fitted at the lowest point on the suction pipe.

17.4.9.4 *Maximum lift.* The height between the low water level "X" (see Figure 23) and the centre line of the pump shall be not more than 3.7 m.

17.4.9.5 *Priming.* Each pump shall have a separate dedicated automatic priming device. The device shall be supplied with water from a dedicated elevated tank, fed automatically from a source separate to that supplying the sprinkler installation.

For each priming device:

a) the priming pipe shall be run as directly as practicable from the priming tank to the pump with a check valve in close proximity to the pump;

b) the priming device shall maintain the pump case and the suction pipework filled with water even if serious leakage from the foot valve is occurring. The pump shall automatically start, and the "pump running" alarm (see **17.4.2.4**) shall operate if the water level in the priming tank is not maintained by its normal source;

c) the priming system shall not permit water to pass directly or indirectly from a pressure tank or gravity tank into the pump suction pipe, except as permitted in d) below;

d) water for priming purposes shall only be supplied from a tank of capacity in excess of the minimum specified in Table 31.

e) where priming water is provided by a connection from a branch on a town main forming a supply to the sprinkler installation, the connection shall be made on the town main side of the check valve which is upstream of any pressure tapping for a sprinkler pump automatic starting device;

f) the size of the priming tank and of the priming pipe connection shall comply with the requirements of Table 31.

Table 31 — Pump priming tank capacity and pipe size

Hazard class	Minimum capacity of tank	Minimum nominal bore of priming pipe
	L	mm
Light	100	25
Ordinary and high	500	50

COMMENTARY AND RECOMMENDATIONS ON **17.4.9.5**.
It is important to ensure that the check valve on the priming pipe connection referred to in a) is of a type which opens satisfactorily with the low head of water available from the priming tank.

17.4.10 *NPSH for fully hydraulically calculated pipework.* With a flow of $Q_{max.}$ into the pump the net positive suction head (NPSH) at the pump inlet flange at low water level "X" (see Figure 23) shall be not less than 5.88 m at any flow rate up to $Q_{max.}$.

COMMENTARY AND RECOMMENDATIONS ON **17.4.10**.
Note that the P_s may be negative in a particular installation, although the NPSH should be positive. Figure 21 and Figure 22 illustrate the measurement of the variable P_s of the NPSH formula.

NPSH may be calculated as follows:

$$NPSH = P_s + P_a - P_v - P_f;$$
$$= P_s - P_f + 9.884$$

where

P_s *is the suction head measured from the low water level "X" (see Figure 21 and Figure 22) to the pump centre line or impeller eye* (in m);

P_a *is the absolute atmospheric pressure, assumed to be 10.194 at sea level* (in m);

P_v *is the water vapour pressure assumed to be 0.310 in the UK* (in m);

P_f *is the friction loss in suction pipework, i.e. pipes, fittings, valves etc. at flow rate $Q_{max.}$* (in m).

17.4.11 ***Pump suction tanks, jackwells and suction pits***

17.4.11.1 *Effective capacity of suction tanks.* The effective capacity of a pump suction tank shall be calculated using a value for depth between the normal full water level and the low water level "X" (see Figure 23). Low water level "X" shall be taken as the underside of the upper flange or plate of any vortex inhibitor or if a vortex inhibitor is not fitted, as dimension "A", given in Table 32, above the suction pipe inlet.

COMMENTARY AND RECOMMENDATIONS ON **17.4.11.1**.
The vortex inhibitor should be suitable for sprinkler service.

*Dimension "A" is considered to be the lowest level to which water may be drawn by a pump to avoid creating a vortex and drawing air. Example (b) in Figure 23 will not apply to normal vortex inhibitors. Clause **16** specifies minimum capacities of pump suction tanks.*

17.4.11.2 *Suction pipe clearances and sump dimensions in suction tanks.* Suction pipe arrangements and clearances shall be as shown in Figure 23. The width of any sump shall be not less than 3.6*D* and the suction pipe shall be central along the width.

17.4.11.3 *Suction tank fittings.* A tank shall be fitted with a rigid roof, which shall not be made of timber, a contents gauge, overflow pipe(s) and drainage facilities. A safe means of access shall be provided.

Ball valves shall be readily accessible for exercising, testing and maintenance.

Table 32 — Suction pipe inlet clearances

Nominal suction pipe size (Dimension "D" in Figure 23)	Dimension "A" (Figure 23) not less than	Dimension "B" (Figure 23) not less than	Dimension "C" (Figure 23) not less than
mm	mm	mm	mm
65	250	80	20
80	310	80	24
100	370	100	30
150	500	100	45
200	620	150	60
250	750	150	75
300	875	200	90
350	1 000	200	105

Where necessary, baffles shall be provided at the point of entry of supply water to prevent the pump entraining air.

17.4.11.4 *Frost protection of suction tanks.* Tanks, float valve assemblies and feed pipes shall be protected from frost damage where necessary. Withdrawable element immersion heaters shall have automatic electric supply cut-off facilities which operate when the heater is exposed to the atmosphere.

17.4.11.5 *Corrosion protection of suction tanks.* All external steelwork, including any steel roof of a concrete tank, shall be protected against corrosion.

COMMENTARY AND RECOMMENDATIONS ON **17.4.11.5**.
Steel tanks should be internally protected as recommended in BS 5493. Where alternative protection is used the lining should be applied and maintained in accordance with the advice of the manufacturer of the product.

17.4.11.6 *Types of suction tank.* Suction tanks shall be one of the following types.

Type A. Not dependent on inflow, fed from a potable water supply, and suitable for sprinkler service without emptying, cleaning, maintenance or repair for a period of not less than 15 years.

Type B. Not dependent on inflow.

Type C. Dependent on inflow.

Type D. Dependent on inflow, fed from a potable water supply, and suitable for sprinkler service without emptying, cleaning, maintenance or repair for a period of not less than 15 years.

COMMENTARY AND RECOMMENDATIONS ON **17.4.11.6**.
Concrete tanks designed and constructed in accordance with BS 5337, with rigid roofs of concrete, metal or glass fibre reinforced plastics are suitable for sprinkler service as type A tanks.

17.4.11.7 *Pump jackwells and suction pits.* The design and dimensions of jackwells and suction pits fed from a virtually inexhaustible source such as a river, canal, lake, etc. shall be as shown in Figure 24 and as given in Table 33.

Pipes, conduits and open-topped channels shall have a continuous fall towards the jackwell or suction pit of at least 1 in 125.

The diameter of the feed pipe or conduit shall be not less than:

$$d' = 21.68\ Q^{0.357}$$

where

d' = minimum bore of pipe or conduit (in mm);

Q = maximum flow output of the pump (in L/min) (see Table 26).

Each suction inlet shall be provided with a separate suction and settling chamber.

The settling chamber shall have the same width and depth as the suction chamber.

Suction pipe clearances shall be not less than as given in **17.4.11.2** for suction tanks.

Screens shall be provided at the inlet to a weir or channel feed settling chamber (see Figure 24). The screens shall be removable, of wire mesh or perforated metal having in either case an aggregate clear area below the low water level "X" of 150 mm^2 for each L/min of pump maximum flow output as given in Table 26, and of sufficient strength to withstand the water pressure should it become obstructed.

Inlet pipes or conduits feeding a jackwell or suction pit shall be provided with a strainer having an aggregate clear opening area of at least $1.25\ \pi\ {d_1}^2$. The openings shall prevent the passage of a 25 mm diameter sphere.

Provision shall be made for the jackwell to be isolated for cleaning and maintenance.

Where the suction inlet draws water from a walled-off area of the bed of a river, canal, lake, etc., the wall shall extend above the water surface with an aperture screening arrangement as specified above or alternatively the space between the top of the wall and the water surface shall be enclosed with a screen having sufficient area as specified above. The screen shall be arranged to prevent ingress of windborne debris and of sunlight, and shall be capable of being raised for cleaning.

COMMENTARY AND RECOMMENDATIONS ON **17.4.11.7**.

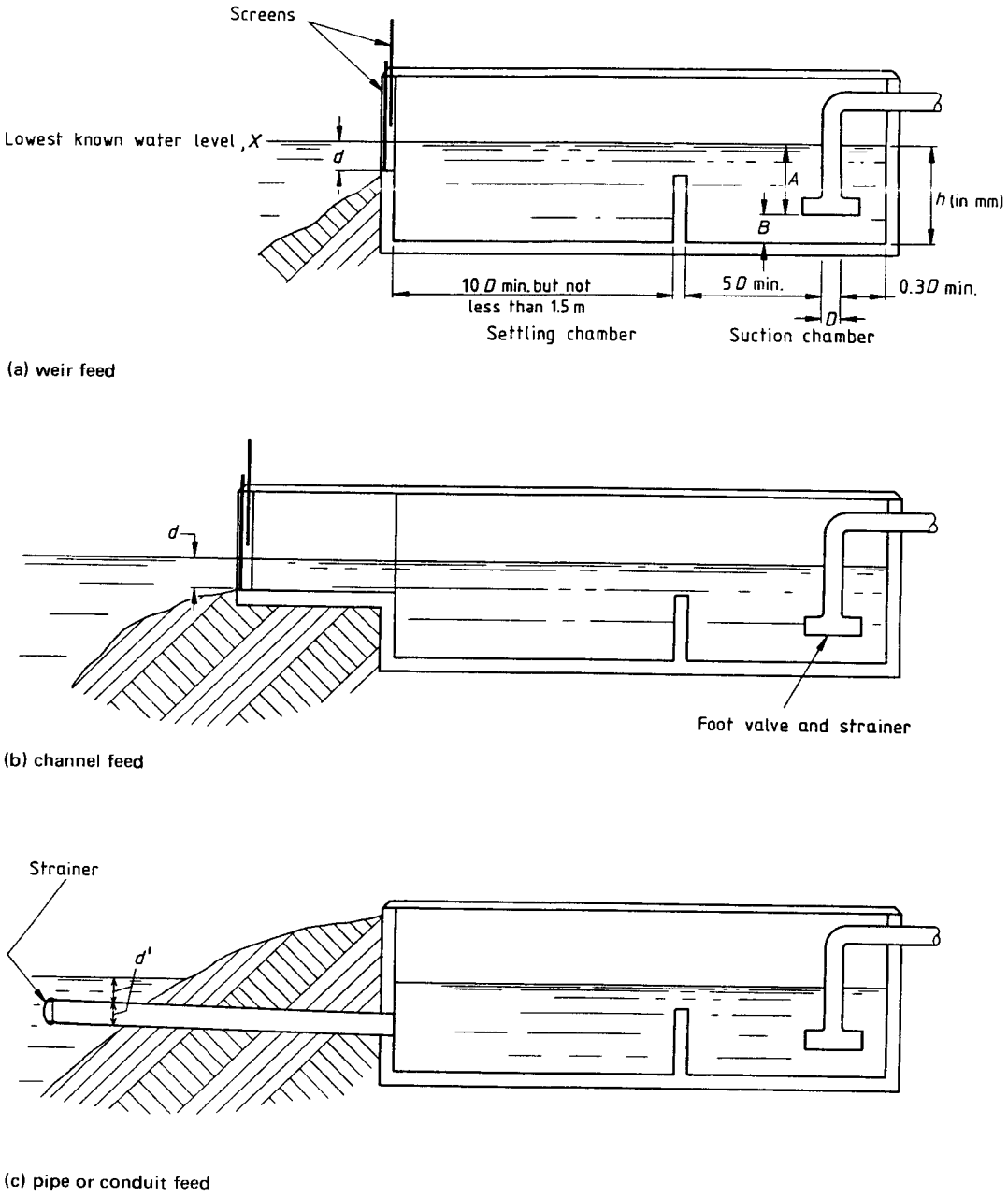
Two screens should be provided, one in use and the other in a raised position, so that an interchange may be made when cleaning.

Excavation of the bed of the river, canal, lake, etc. to create the necessary depth for a pump suction inlet should be avoided wherever possible. Where it is unavoidable the area should be enclosed with the largest screen practicable, the screen having sufficient clear area as specified above. In such cases the authorities concerned should be consulted at the planning stage.

Table 33 — Minimum width of settling chambers, suction pits, open channels and weirs for various water depths

Water depth[a] more than 250 mm and not more than 500 mm		Water depth[a] more than 500 mm and not more than 1 000 mm		Water depth[a] more than 1 000 mm	
Width	**Maximum flow (from Table 26)**	**Width**	**Maximum flow (from Table 26)**	**Width**	**Maximum flow (from Table 26)**
mm	L/min	mm	L/min	mm	L/min
88	280	82	522	78	993
125	497	112	891	106	1 687
167	807	143	1 383	134	2 593
215	1 197	176	1 960	163	3 631
307	2 064	235	3 159	210	5 647
334	2 342	250	3 506	223	6 255
410	3 157	291	4 481	254	7 825
500	4 185	334	5 592	286	9 577
564	4 953	361	6 340	306	10 749
750	7 261	429	8 307	353	13 670
1 113	12 054	527	11 415	417	18 066
1 167	12 792	539	11 816	425	18 635
1 500	17 379	600	13 903	462	21 411
2 000	24 395	667	16 271	500	24 395
4 500	60 302	819	21 949	581	31 142
		1 000	29 173	667	38 916
				2 000	2 03 320

[a] Dimension *d* in Figure 24.



NOTE d is water depth at weir
D is suction pipe size
d' is inlet pipe size

Figure 24 — Jackwells or suction pits

17.4.12 *Electric motor driven pumps*

17.4.12.1 *Power supply.* The power supply circuit for the motor shall be separate from all other circuits in the premises.

Each connection to the power supply shall be via an isolating protective device, e.g. an isolating switch-fuse, reserved solely for sprinkler service and independent of any other main or sub-main circuit. Such devices shall be secured against unauthorized operation and shall, except for maintenance, be kept locked on.

Switchrooms supplying power to sprinkler pump motors shall be situated where access by the fire brigade is readily available.

COMMENTARY AND RECOMMENDATIONS ON **17.4.12.1**.
The switches controlling the supply should be readily accessible to the fire brigade.

***31.5.3** specifies the labelling of any switch in the power supply to pumps.*

17.4.12.2 *Supply indicator lamps.* Duplicate indicator lamps shall be provided in the vicinity of the pump to show that power is available for the motor. Where the supply is A.C. the failure of any one phase of the supply shall be indicated.

COMMENTARY AND RECOMMENDATIONS ON **17.4.12.2**.
The indicator lamps should be placed so that they can be readily seen by maintenance personnel.

17.4.12.3 *Automatic power failure alarm.* Visual and audible automatic warning of power failure to the motor starting switch, or in the case of an A.C. supply failure of any one phase, shall be given at an area with responsible manning.

COMMENTARY AND RECOMMENDATIONS ON **17.4.12.3**.
*The alarms should be located at a continuously manned location such as a gatehouse (see **27.4**).*

17.4.12.4 *Electric circuit protection.* The electricity supply shall be fitted with high rupturing capacity fuses capable of carrying the stalled motor current for a period of not less than 75 % of the period needed for the motor windings to fail.

Any no-volt release mechanism shall be of the automatic resetting type so that on restoration of the supply the motor can be restarted automatically if the trunk main pressure falls.

Magnetic and thermal overload trips shall not be used.

17.4.12.5 *Cables and cable routes.* Motor supply cables inside buildings shall be:

a) category AWX or SWX cables complying with BS 6387; or

b) mineral-insulated copper-sheathed cables complying with BS 6207; or

c) protected from direct exposure to fire.

External overhead cables shall not be used within 6 m of any window, door or other opening in:

1) any sprinkler-protected building; or

2) any building within 15 m of a sprinkler-protected building.

Where there are two or three electrically driven pumps, failure (by mechanical breakdown or fire damage) of equipment or cables supplying any pump shall not affect the supply to the other pumps.

COMMENTARY AND RECOMMENDATIONS ON **17.4.12.5**.
*All wiring associated with the electric motor driven pump, including the monitoring circuits (see **17.4.12.2** and **17.4.12.3**) should be in accordance with the Regulations for Electrical Installations (Wiring Regulations) (15th Edition, 1981, IEE).*

To protect cables from direct exposure to fire they should 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 not less than 30 min, or they should be given additional direct protection.

17.4.13 *Diesel engine driven pumps*

17.4.13.1 *General.* A diesel engine shall be capable of operating continuously at full load at site elevation for a period of 6 h with a rated output in accordance with BS 5514 of not less than that specified in **17.4.1.1**.

The engine and equipment shall:

a) be of the mechanical injection type starting without the use of wicks, cartridges, heater plugs or ether at an engine room temperature of 4 °C;

b) accept full load within 15 s of the initiation of the start signal;

c) be naturally aspirated, super-charged or turbo-charged;

d) have a manually operated shut-down mechanism;

e) be provided with a governor to control engine speed within ± 4.5 % of rated speed under any condition of load up to the full load rating;

f) be fitted with a device to measure running time and a tachometer.

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

17.4.13.2 *Air intake.* The engine air intake shall be as follows:

a) fitted with a filter of adequate size to prevent the entry of foreign matter; and

b) protected from water discharge from the sprinklers fitted in the engine room (see **17.4.5.1**).

17.4.13.3 *Cooling system*. The engine shall be cooled by one of the following methods:

a) by an open circuit water system only where the sprinkler pump is fed from a source of potable water. Water from the sprinkler pump shall be fed into the engine cylinder jackets via a device to limit the water pressure to a value specified by the engine manufacturer. The device shall be provided with a manually operated bypass; or

b) by a closed circuit water system, cooled by water taken from the pump to a heat exchanger. This water supply shall be fed to the heat exchanger via a pressure reducing device where the safe operating pressure of the heat exchanger is less than the pump churning pressure with the pump water source at the highest level. The device shall be provided with a manually operated bypass.

The water shall be circulated by an auxiliary pump belt driven from the engine. The capacity of the closed circuit shall be not less than that recommended by the engine manufacturer; or

c) by a close circuit water system, cooled by a frame- or the engine-mounted radiator with a fan belt driven from the engine. The water shall be circulated by an auxiliary pump driven by the engine and the capacity of the closed circuit shall be not less than that recommended by the engine manufacturer; or

d) directly by air from a fan belt driven from the engine.

The pump shall provide the cooling water necessary to prevent the pump overheating whilst churning and any water necessary for charge air cooling.

Cooling water pipes shall be of steel or copper.

Open circuit and secondary cooling water shall discharge at not less than 150 mm above an open tundish so that the discharge water is visible.

Cooling system belt drives shall be fitted with not less than twice the minimum number of belts necessary for correct operation.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.3**. *Pump capacity is determined by the water requirements for the system (see clause **15**) and for all cooling purposes as specified here.*

17.4.13.4 *Exhaust system*. The engine exhaust shall be fitted with a silencer. The total back pressure of the exhaust system shall not exceed the engine manufacturer's recommendation. Where the exhaust system rises above the engine manifold means shall be provided to prevent any condensate flowing into the engine.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.4**. *The engine exhaust system should be lagged or guarded as necessary for personnel safety. Attention is drawn to the need to ensure that the point of egress of the exhaust pipe from the engine house does not involve any fire risk to the structure, and that exhaust fumes cannot be drawn into the engine house or into any occupied building.*

17.4.13.5 *Fuel and lubricant systems.* Each diesel engine shall have a separate fuel pump from a separate welded steel fuel tank complying with BS 814.

When filled to capacity there shall be sufficient fuel in the tank to run the engine on full load for not less than the following periods:

a) in a light-hazard installation, 3 h;

b) in an ordinary-hazard installation, 4 h;

c) in a high-hazard installation, 6 h.

and there shall be a reserve supply sufficient to run the engine on full load for not less than a further 6 h.

The fuel tank shall be fitted with the following:

1) a sludge and sediment trap;

2) a fuel gauge in a readily visible position. The fuel gauge shall not be of the glass or plastics tube type. Damage or fracture of any part of the fuel gauge system shall not result in fuel spillage;

3) an inspection and cleaning hole, normally sealed.

Any valve in the fuel feed pipe between the fuel tank and the engine shall be adjacent to the tank and shall normally be locked in the open position.

A filter, accessible for cleaning, shall be fitted in the fuel line between the tank and the fuel pump.

Fuel pipes shall be metal. Soldered joints shall not be used.

Suitable means such as screwed plugs shall be provided to bleed the entire fuel system of air. Air relief cocks shall not be used.

Pipes carrying lubricating oil shall be of steel or copper. Soldered joints shall not be used.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.5**. *Arrangements should be made to prevent leakage or spillage during filling, of fuel or lubricant, onto electrical control panels, or parts of the exhaust system which may become hot.*

17.4.13.6 *Starting mechanism*. The starting mechanism shall be as follows:

a) *General*. Independent automatic and manual starting systems shall be provided except that the starter motor may be common.

The rated voltage of the batteries and starter motor shall be either:

1) 24 V for engines of capacity more than 1640 cc; or

2) 24 V or 12 V for engines of capacity not more than 1640 cc.

The starter motor and each (i.e. automatic and manual) battery power source shall have the design capacity to rotate the engine at 0 °C and 760 mm mercury atmospheric pressure for not less than 10 cycles each of not less than 15 s cranking and not more than 10 s rest. At the end of the energized part of each cycle the engine cranking speed shall be not less than 120 r/min whilst power is applied.

b) *Automatic starting system*. The automatic starting system shall normally draw power from a battery reserved for this purpose. If at any stage during the starting sequence the battery has insufficient output to crank the engine, further cranking shall be provided automatically from the battery which is normally connected to provide the manual starting system. A manual facility shall be provided to permit the preselection of either battery for the automatic starting system.

The automatic start facility shall remain functional at all times except when the engine is rotating under its own power, and shall be initiated by the opening of a normally closed circuit by a device responding to a fall in water pressure in the trunk main or supply pipe.

c) *Emergency manual starting system*. Emergency manual start facilities shall be provided. Starting power shall be drawn from both sets of batteries in parallel.

The emergency manual start push button or pull handle shall be protected by a quick access front.

d) *Test facility for manual starting system*. A manual start test button and indicator lamp shall be provided to permit periodic testing of the manual electric start system without breaking the frangible cover over the emergency start button. The starter panel shall be marked, adjacent to the lamp, with the wording:

"Operate manual start test button if lamp is lit."

The manual start test button shall only be brought on line after an automatic engine start followed by a shut down or after six repeated unsuccessful attempts to start automatically [see **17.4.13.11** b)]. Either of the two conditions shall cause the indicator lamp to light and bring the manual start test button on line in parallel with the emergency manual start push button. The power shall only be drawn from the manual start battery.

When a test manual start has been carried out, the circuit used for this purpose shall automatically become inoperable and the indicator lamp shall be extinguished.

The automatic start facility shall be available, even when the manual start test button circuit is activated.

e) *Starter motor*. The electric starter motor shall incorporate a movable pinion which will engage automatically with the flywheel gear ring. 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 a failure to engage, the starter motor shall automatically make repeated attempts to achieve engagement.

When the engine starts the starter motor pinion shall withdraw from the flywheel gear ring automatically by means initiated by an electro-mechanical speed sensor.

Pressure switches, for example on the engine lubricating system or water pump outlet, shall not be used as a means of de-energizing the starter motor.

Centrifugal speed switches or voltage generators used for sensing shall have a direct coupling to, or be gear driven by, the engine; flexible drives shall not be used.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.6**.

BS 5839-2 gives design features for manual call points which may be appropriate for the manual start push button [see c)].

Where a frangible glass front is used, this should be of the type which when broken does not leave jagged or sharp edges which might cause injury when the emergency manual start system is used.

17.4.13.7 *Engine starter batteries and chargers.* Engine starter batteries and chargers shall be as follows:

a) *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 BS 6260 or lead acid Plante positive batteries complying with BS 6290-1-2.

The electrolyte for lead acid Plante batteries shall comply with BS 3031.

Batteries shall be selected, used, charged and maintained in accordance with the requirements of these specifications and with any manufacturer's instructions.

A hydrometer, suitable for checking the density of the electrolyte (see **34.3.6** or **35.2.6**), shall be provided.

b) *Battery chargers.* Each starter battery shall be provided with an independent continuously connected fully automatic constant potential charger. It shall be possible to remove either charger whilst leaving the other operational.

Chargers for lead acid Plante batteries shall provide a float voltage of 2.25 ± 0.05 V per cell. The nominal charging voltage shall be suitable for local conditions (climate, regular maintenance, etc.). A boost charge facility shall be provided for charging to a higher voltage not exceeding 2.7 V per cell. The charger output shall be between 3½ % and 7½ % of the 10 h capacity of the battery.

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

c) *Siting of batteries and their chargers.* Batteries shall be mounted on stands or stillages.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.7**. *The chargers may be mounted with the batteries. Batteries and chargers should be located in readily accessible positions where the likelihood of contamination by oil, fuel, damp, pump set cooling water, or of damage by vibration is minimal The battery should be as close as possible to the engine starter motor subject to the above constraints, to minimize voltage drop between the battery and starter motor terminals.*

17.4.13.8 *Starter alarm indication.* The following conditions shall each be indicated both locally and at a responsibly manned location by both a red warning light and an audible alarm:

a) the use of any switch which prevents the pump starting automatically; and/or

b) the failure of the engine to start by the end of the six cyclic attempts (see **17.4.13.6**); and

c) pump running.

The warning lights shall be appropriately marked (see **31.5.2**).

17.4.13.9 *Engine fuel oil.* The engine fuel oil shall be class A2 in accordance with BS 2869 or equivalent.

17.4.13.10 *Tools and spare parts.* A standard kit of tools as recommended by the engine and pump manufacturers shall be provided together with the following spare parts:

a) two sets of fuel filters, elements and seals;

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

c) two sets of belts (where used);

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

e) two injector nozzles.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.10**. *Spare parts should be replaced as necessary. Tools and parts should be available at all times.*

17.4.13.11 *Engine tests and exercising.* Engine tests and exercising shall be as follows:

a) *Supplier's test and certification of results.* Each complete engine and pump set shall be tested on the supplier's test bed for not less than 1.5 h at the rated flow given in Table 28.

The following shall be recorded on the test certificate:

1) the engine speed with the pump churning;

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

3) the pump churning pressure;

4) the suction head at the pump inlet;

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

6) the ambient temperature;

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

8) the cooling water flow rate;

9) the lubricating oil temperature rise at the end of the test run;

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

b) *Site commissioning test.* When commissioning an installation the automatic starting system of any diesel engine driven pump set shall be activated with the fuel supply isolated for the six cycles each of not less than 15 s cranking and not 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 then be restored and the pump set shall start when the manual start test button is operated.

COMMENTARY AND RECOMMENDATIONS ON **17.4.13.11**.
The insurers usually ask for 10 days' notice of the suppliers test so that it may be witnessed by a representative if required. They also usually ask for copies of the test certificate.

17.5 Pressure tanks

17.5.1 *General.* A pressure tank shall not provide the water supply for more than one sprinkler system.

17.5.2 *Pressure tank as superior supply.* A pressure tank used as a superior supply shall have means, suitable for sprinkler service, for automatic maintenance of the air pressure and water level under standing conditions.

An automatic warning system, suitable for sprinkler service, to indicate failure of the devices to restore either the correct air pressure or water level within the design period shall be provided. These alarms shall be given both visually and audibly at the installation control valves or at a location with responsible manning, e.g. in the gatehouse.

Power for the warning system shall be taken from a sub-circuit switched separately from any feeding the air compressor or water pump supplying the pressure tank (see **27.4.4**).

COMMENTARY AND RECOMMENDATIONS ON **17.5.2**.
*It is recommended that this alarm arrangement also be fitted in cases where a pressure tank forms a duplicate supply; where it is not fitted daily tank inspections are specified (see **34.2.3**) and fire hose reels cannot be supplied (see Table 5).*

17.5.3 *Construction.* Pressure tanks shall comply with the requirements for class II vessel specified in BS 5500.

17.5.4 ***Housing***

17.5.4.1 A pressure tank shall be housed either in a readily accessible position in a sprinkler-protected building or in a separate building of non-combustible construction used solely for the housing of fire protection water supplies and equipment.

17.5.4.2 Pressure tank houses situated shall be sprinkler-protected. Where it is impracticable to provide sprinkler protection from the installation control valve sets in the premises, sprinkler protection shall be provided from the nearest accessible point on the downstream side of any tank outlet check valve, via a subsidiary stop valve, secured in the open position, together with a flow alarm device suitable for sprinkler service, to provide visible and audible indication of the operation of the sprinklers.

The alarm equipment shall comply with clause **27**, and shall be installed either by the installation control valves or at a responsible manned location such as a gatehouse.

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

17.5.4.3 The pressure tank and house shall be maintained at or above a temperature of 4 °C.

17.5.5 *Pressure tank fittings.* Pressure tanks shall be provided with:

a) an air pressure gauge, duplicated in cases where the air pressure is not automatically maintained (see **17.5.2**); and

b) a water level gauge glass, with stop valves, normally kept shut, on both connections to the gauge glass; and

c) stop and check valves, on both the water and air supply connection pipes, fitted as close as practicable to the pressure tank with the stop valve on the pressure tank side of the check valve; and

d) a safety valve suitable for sprinkler pressure tank service; and

e) a drain valve of size not less than 50 mm.

The safety valve shall be fitted in such a position that the valve seat is water-sealed and it shall have a connection from the tank above the water line to permit the rapid escape of air in the event of operation.

The outlet from the safety valve shall be an open end which will allow any leakage to be seen readily.

The safety valve shall be set by the installing engineers, and the valve shall be so constructed that it can be tested without the setting being altered. The setting mechanism shall be protected from alteration by unauthorized persons.

17.5.6 *Air pressures and contents.* Under standing conditions the volume of the air space, *P,* shall be not less than 1/3 the volume of the tank.

The standing air pressure in the tank shall be not more than 10 bar.

At the point when the tank just exhausts of water the pressure at the installation "C" gauge shall be not less than as specified in clause **15**.

COMMENTARY AND RECOMMENDATIONS ON **17.5.6**.

For precalculated installations the specified starting pressure is given by:

a) *where the tank base is above or level with the highest sprinkler*

$$P = \frac{(1 + P_2)}{R} - 1;\ or$$

b) *where the tank base is below the highest sprinkler*

$$P = \frac{(1 + P_2 + 0.1h)}{R} - 1$$

where

P *is the standing air pressure to be maintained in the tank (in bar);*

P_2 *is the minimum gauge pressure specified in Table 34 (in bar);*

h *is the height from tank base to highest sprinkler (in m);*

$$R = \frac{\textit{volume of the air space in tank under standing conditions}}{\textit{volume of tank}}$$

It is assumed that atmospheric pressure is 1 bar *(absolute). Table 35 gives the minimum working air pressure for tanks having proportions of air of one-third, one-half and two-thirds, when* P_f = 0.3 bar.

17.5.7 *Pressure tanks with interconnection to town mains.* The lining of a pressure tank supplied directly from a town main, or forming a duplicate supply with a town main, shall comply with BS 6920-1.

Table 34 — Minimum pressure at highest sprinkler when pressure tank just empties (precalculated installations)

Hazard class	Pressure at highest sprinkler P2 (see 17.5.6)
	bar
Light	$1.9 + P_f$[a]
Ordinary, Group I	$0.7 + P_f$[a]
Ordinary, Group II	$1.1 + P_f$[a]
Ordinary, Group III	$1.4 + P_f$[a]
Ordinary, Group IIIS	$1.7 + P_f$[a]

[a] P_f = 0.3 bar, or the pressure loss between the outlet from the tank and the installation C gauge at the maximum rate of flow (given in Table 15 for each ordinary-hazard class and 225 L/min for light-hazard), whichever is the greater.

Table 35 — Pressure tank minimum air pressures (P_f = 0.3 bar) (precalculated installations)

Hazard class	Air space in tank Volume of tank (R)	Minimum air pressure
		bar
Light	One-third	$8.6 + 0.30h$
Light	One-half	$5.4 + 0.20h$
Light	Two-thirds	$3.8 + 0.15h$
Ordinary, Group I	One-third	$5.0 + 0.30h$
Ordinary, Group I	One-half	$3.0 + 0.20h$
Ordinary, Group I	Two-thirds	$2.0 + 0.15h$
Ordinary, Group II	One-third	$6.2 + 0.30h$
Ordinary, Group II	One-half	$3.8 + 0.20h$
Ordinary, Group II	Two-thirds	$2.6 + 0.15h$
Ordinary, Group III	One-third	$7.1 + 0.30h$
Ordinary, Group III	One-half	$4.4 + 0.20h$
Ordinary, Group III	Two-thirds	$3.0 + 0.15h$
Ordinary, Group IIIS	One-third	$8.0 + 0.30h$
Ordinary, Group IIIS	One-half	$5.0 + 0.20h$
Ordinary, Group IIIS	Two-thirds	$3.5 + 0.15h$

*h is the height (in m) of the highest sprinkler above the tank base.
h = 0 if all sprinklers are below the tank base.

18 Hydraulic calculation and pipe sizing tables

18.1 General

Pipe size and layout shall be based on either:

a) full hydraulic calculation in which case the basic hydraulic performance shall be as specified in clause **14**. Notwithstanding the density requirements of this clause, no roof or ceiling sprinkler in a fully hydraulically designed system shall discharge at a pressure less than that required in **24.3.4** with the AMAO positioned anywhere in the pipe layout; or

b) only for installations not including intermediate sprinklers, the pipe sizing tables with hydraulic calculation of portions of the feed pipework as specified in clause **24**.

COMMENTARY AND RECOMMENDATIONS ON **18.1**.
Any extensions to a precalculated installation should not be fully hydraulically calculated.

18.2 Calculation of pipework losses

18.2.1 *Static pressure difference.* The static pressure difference between two interconnecting points in a system shall be calculated from:

static pressure difference, $p = 0.1\ h$ (bar)

where h is the vertical distance between the points (in m).

18.2.2 *Pipe friction loss.* Frictional pressure loss in pipes shall be calculated from the Hazen-Williams formula:

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

For pipes listed in Table 36 this can be simplified to:

$p = k \times \mathrm{L} \times Q^{1.85}$

where

p = loss of pressure in pipe (in bar);
Q = flow rate through pipe (in L/min);
d = mean bore of pipe (see Table 36) (in mm);
C = a constant for the type and condition of the pipe (see below);
k = a constant for the size, type and condition of the pipe (see Table 36);
L = equivalent length of pipe and fittings (in m).

The following valves of C shall be used in sprinkler installation and town main calculations:

pipe type	*C*
cast iron	100
ductile iron	110
mild steel	120
galvanized steel	120
spun cement	130
copper	140
unplasticized PVC	140
asbestos cement	140

18.2.3 *Fitting and valve friction losses.* Frictional pressure loss in valves and fittings where the direction of water flow is changed through 45° or more shall be calculated by the method of **18.2.2** using the appropriate equivalent length given in Table 37.

COMMENTARY AND RECOMMENDATIONS ON **18.2**.
Losses due to velocity head and the change of direction into sprinklers and sprinkler dry drop or riser assemblies are disregarded here but are taken into account in the sprinkler "k" factor.

18.3 Calculation of the maximum flow demand of a fully hydraulically calculated installation

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

18.3.2 At any pressure, P, the flow demand, Q, of the installation shall be taken as the sum of:

a) the flow to the roof or ceiling sprinklers with the AMAO in the hydraulically most favourable location; plus

b) the flow to any non-rack intermediate sprinklers associated with (a); plus

c) the simultaneous hydraulically balanced flow to any rack or shelf sprinklers in their specified number and hydraulically most favourable location.

Table 36 — Mean size and values of "k" of various pipes

Nominal size	Steel pipe											
	See BS 1387								See BS 3600 Wall thickness: 5.0 mm for 150 mm pipe 5.4 mm for 200 mm pipe 7.1 mm for 250 mm pipe			
	Not galvanized medium		Not galvanized heavy		Galvanized medium		Galvanized heavy		Not galvanized		Galvanized	
	mean size	value of k	mean size	value of k	mean size	value of k	mean size	value of k	mean size	value of k	mean size	value of k
	mm		mm		mm		mm		mm		mm	
20	21.63	2.71×10^{-5}	20.41	3.60×10^{-5}	21.46	2.82×10^{-5}	20.24	3.75×10^{-5}	—	—	—	—
25	27.31	8.72×10^{-6}	25.68	1.18×10^{-5}	27.14	8.99×10^{-6}	25.51	1.22×10^{-5}	—	—	—	—
32	35.97	2.28×10^{-6}	34.34	2.86×10^{-6}	35.80	2.33×10^{-6}	34.17	2.93×10^{-6}	—	—	—	—
40	41.86	1.09×10^{-6}	40.23	1.32×10^{-6}	41.69	1.11×10^{-6}	40.16	1.33×10^{-6}	—	—	—	—
50	52.98	3.46×10^{-7}	51.36	4.02×10^{-7}	52.86	3.51×10^{-7}	51.19	4.09×10^{-7}	—	—	—	—
65	68.67	9.78×10^{-8}	67.04	1.10×10^{-7}	68.50	9.90×10^{-8}	66.87	1.11×10^{-7}	—	—	—	—
80	80.68	4.46×10^{-8}	79.06	4.92×10^{-8}	80.51	4.51×10^{-8}	78.89	4.97×10^{-8}	—	—	—	—
100	105.14	1.23×10^{-8}	103.31	1.34×10^{-8}	104.97	1.24×10^{-8}	103.14	1.35×10^{-8}	—	—	—	—
150	155.32	1.84×10^{-9}	154.30	1.90×10^{-9}	155.15	1.85×10^{-9}	154.13	1.91×10^{-9}	158.30	1.67×10^{-9}	158.13	1.68×10^{-9}
200	—	—	—	—	—	—	—	—	208.30	4.40×10^{-10}	208.13	4.42×10^{-10}
250	—	—	—	—	—	—	—	—	258.80	1.52×10^{-10}	258.63	1.53×10^{-10}

	Cast iron pipe							
	Cast iron flanged See BS 2035 Class C		Cast grey iron (Cast flanges) See BS 4622		Centrifugally cast ductile iron (Screwed flanges) See BS 4772		Centrifugally cast iron See BS 1211 Class C	
	mean size	value of k	mean size	value of k	mean size	value of k	mean size	value of k
	mm		mm		mm		mm	
50	51.95	5.33×10^{-7}	—	—	—	—	—	—
80	77.41	$7.64 \times 10–8$	81.23	6.05×10^{-8}	83.31	4.48×10^{-8}	81.90	5.81×10^{-8}
100	102.87	1.91×10^{-8}	100.45	2.15×10^{-8}	103.33	1.53×10^{-8}	107.33	1.56×10^{-8}
150	153.96	2.69×10^{-9}	150.50	3.00×10^{-9}	154.68	2.20×10^{-9}	159.73	2.25×10^{-9}
200	205.01	6.66×10^{-10}	200.50	7.41×10^{-10}	205.23	5.55×10^{-10}	211.62	5.71×10^{-10}
250	256.00	2.26×10^{-10}	250.60	2.50×10^{-10}	256.03	1.89×10^{-10}	263.49	1.96×10^{-10}

	Copper pipe See BS 2871-1 Table X	
	mean size	value of k
	mm	
22	20.21	2.84×10^{-5}
28	26.21	8.01×10^{-6}
35	32.63	2.75×10^{-6}
42	39.63	1.07×10^{-6}
54	51.63	2.95×10^{-7}
76.1	73.22	5.38×10^{-8}
108	105.12	9.24×10^{-9}
133	130.37	3.24×10^{-9}
159	155.37	1.38×10^{-9}

NOTE The values of C used to calculate k are those listed in **18.2.2**.

Table 37 — Equivalent length of fittings and valves

Fitting and valves	Equivalent length of medium grade steel straight pipe (in m) (*C* value 120[a]) according to BS 1387										
	Nominal diameter (mm)										
	20	25	32	40	50	65	80	100	150	200	250
	m	m	m	m	m	m	m	m	m	m	m
90° screw elbow	0.63	0.77	1.04	1.22	1.46	1.89	2.37	3.04	4.30	5.67	7.42
90° welded elbow (r/d = 1.5)	0.30	0.36	0.49	0.56	0.69	0.88	1.10	1.43	2.00	2.64	3.35
45° screwed elbow	0.34	0.40	0.55	0.66	0.76	1.02	1.27	1.61	2.30	3.05	3.89
Standard screwed Tee or cross (Flow through branch)	1.25	1.54	2.13	2.44	2.91	3.81	4.75	6.10	8.61	11.34	14.85
Gate valve — straightway (flanged fitting)	—	—	—	—	0.38	0.51	0.63	0.81	1.13	1.50	1.97
Alarm or non return valve (swinging) flanged fitting	—	—	—	—	2.42	3.18	3.94	5.07	7.17	9.40	12.30
Alarm or non return valve (mushroom) flanged fitting	—	—	—	—	12.08	18.91	19.71	25.36	35.88	47.27	61.85
Butterfly valve (flanged fitting)	—	—	—	—	2.19	2.86	3.55	4.56	6.38	8.62	9.90
Globe valve — straightway (flanged fitting)	—	—	—	—	16.43	21.64	26.80	34.48	48.79	64.29	84.11

NOTE For all other pipe joints and fittings see manufacturer's data sheets.

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

C value	100	110	130	140
Factor	0.714	0.850	1.160	1.330

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

a) by calculation (as specified in **18.3.2**) of sufficient values of Q to determine the intercept of the installation characteristic curve with the water supply characteristic curve; or

b) by calculation (as specified in **18.3.2**) of a single value of Q, from the equation:

$$P = (P_o - 0.1h)\left(\frac{Q}{Q_o}\right)^2 + 0.1h$$

where

P is the pressure at flow Q measured at the datum point (in bar);

P_o is the pressure corresponding to the calculated installation flow demand measured at the datum point (in bar);

Q is the flow demand at pressure P (in L/min);

Q_o is the calculated installation flow demand for pressure P_o (in L/min);

h is the height of the highest sprinkler in the AMAO under consideration above the datum point (in m).

Extrapolate the pressure-flow demand graph to intersect the water supply pressure-flow characteristic. The point of intersection gives $Q_{max.}$.

18.3.4 The maximum flow demand shall be taken as the flow, $Q_{max.}$, at the point of intersection of the pressure-flow demand characteristic of the installation and the water supply pressure-flow characteristic at either low water level "X" (curve 3 in Figure 20) or in the tank full condition (curve 4 in Figure 20) whichever gives the higher value.

18.3.5 At the maximum flow demand the pressure at the datum point shall be not less than:

a) for town mains, as specified in **17.1.1.4**;

b) for water supplies except town mains, P_o.

COMMENTARY AND RECOMMENDATIONS ON **18.3**.
*It is necessary to ascertain $Q_{max.}$ to verify the suitability of water supplies and their storage capacities (for a typical case see Figure 20). The installation demand curve for a fully hydraulically calculated installation will originate from a pressure-flow calculation for the AMAO in the hydraulically most favourable position, i.e. where the flow rate into the installation AMAO will be highest for a given available pressure. This calculation will usually be based on the minimum allowable average density at the most unfavourably placed group of four sprinklers in the AMAO. The total flow given by the calculation will therefore be less than the actual flow $Q_{max.}$ produced by the water supply (particularly as the water supply also has to satisfy the minimum pressure requirement of **18.4** and **24.3.4**, and in the case of pump supplies the requirements of **17.4.6.4**, i.e. in Figure 20 curve 3 may be above curve 4 where the water supply is unlimited).*

*See clause **25** for sprinkler flow characteristics, clause **24** for AMAO shapes and positions, and clause **14** for basic hydraulic performance (AMAO areas, discharge densities, etc.)*

18.4 Calculation of maximum installation pressure demand (fully hydraulically calculated installations)

The calculation shall be made as follows.

Make a pressure-flow calculation for the minimum allowable density from the most remote group of four sprinklers in the AMAO hydraulically most remote from the installation control valves (see clause **14** and **24.3.4**). Where there are both roof or ceiling sprinklers and intermediate sprinklers, use the true hydraulically most unfavourable locations of each taken together, irrespective of their actual locations in the building. Extrapolate the result onto the water supply pressure-flow characteristic graph as described in **18.3**.

The water supply pressure at the point of intersection of the graphs shall be not less than that given by the minimum density calculation, except in the case of town main supplies where an excess supply pressure requirement over that for minimum density is specified (see **17.1.1.4** and **17.4.6.4**).

18.5 Hydraulic balance calculations

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

a) the calculated flow rate(s) into the junction are within ± 2 L/min of the calculated flow rate(s) out of the junction;

b) all values of the pressure calculated for the junction are within ± 0.005 bar of the mean value.

18.5.2 *Overall balance.* For each position of the AMAO the sum of the calculated sprinkler discharge values of all sprinklers discharging simultaneously (using the calculated nozzle pressure in each case to establish the outlet flow) shall be within ± 1 % of the hydraulically calculated total flow into the installation.

19 Pressure-flow tests on water supplies

19.1 Test facility

An installation, unless its control valve set is sited adjacent to more hydraulically unfavourable (relative to the water supply) control valve set of an installation of the same hazard class, shall be permanently provided with devices, suitable for sprinkler service, for measuring pressure and flow for compliance with **19.2** and as specified in **35.2.5**. It shall be possible to read the control valve "C" gauge at the same time as the measuring devices.

Adequate facilities shall be provided for the disposal of test water (see commentary and recommendations on **17.4.2.5**).

COMMENTARY AND RECOMMENDATIONS ON **19.1**.
*The test facility should normally utilize the installation drain pipework (see **20.1.6**).*
Pressure-flow tests are conducted as follows:

a) *full flow rate tests*

1) *acceptance tests (see clause **10**);*

2) *quarterly test of town main, elevated private reservoir and gravity tank supplies (see **35.2.5**);*

3) *tests of suspected deteriorating automatic pump and pressure tank installation feed mains (see **35.2.5**);*

b) *periodic check tests*

1) *quarterly reduced flow rate test of automatic pump and pressure tank supplies to ascertain the condition of the feed mains (see **35.2.5**).*

*As automatic pump and pressure tank supplies are designed specifically to meet the pressure-flow conditions required by the hazard it is not normally considered necessary to call for practical flow tests except to test the condition of the feed mains and to check the pump performance at the bypass test facility (see **17.4.2.5**).*

*Where there are town main or automatic pump supplies for fully hydraulically calculated pipe size installations, only a fraction of the available town main or pump supply pressure is regarded as being available to meet the pressure-flow requirements (see **18.4**. **17.1.1.4** and **17.4.6.4**).*

*Where the supply is solely by automatic pump or pumps and these are immediately adjacent to the installation control valves the pump outlet test facility (see **17.4.2.5**) may suffice for pressure-flow testing, correcting the pressure obtained in the flow test to the equivalent value at the control valve "C" gauge using the calculation methods of **18.2**.*

Dry or alternate control valve sets (main or tail-end) may have an additional flow test valve arrangement of unspecified flow loss characteristic fitted below the alarm valve, downstream of the main stop valve, to facilitate informal supply pressure testing. Such flow test valves and pipework should have a nominal diameter of 40 mm for light-hazard installations and of 50 mm for ordinary-and high-hazard installations.

19.2 Full flow rate test

When tested the water flow and pressure shall be as specified in clause **15**.

Section 5. Components and installation design

20 Valves

20.1 Stop, test, drain and flushing valves

20.1.1 *General*

20.1.1.1 Stop, test, drain and flushing valves shall be fitted as specified in **20.1.2** to **20.1.7**.

20.1.1.2 Stop, test, drain and flushing valves shall comply with the appropriate standard and size range of Table 38, or be otherwise suitable for sprinkler service.

Any valve exceeding a nominal bore of 50 mm controlling a system supply main connection from a water authority's or undertaker's main shall be fitted immediately downstream of the point of connection and shall comply with BS 5163.

Stop valves, except those fitted by the water authority on a town main branch, controlling water flow to sprinklers shall be right-handed (i.e. the handwheel or key shall be rotated clockwise to close the valve); the direction of opening and closing shall be marked and an open/shut indicator fitted.

Test drain and flushing valves shall be right-handed.

Butterfly valves shall be of the gear-operated type.

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

COMMENTARY AND RECOMMENDATIONS ON **20.1.1**.

Water authority stop valves may be left-handed.

*See **17.1.1.3** for town main branch connection stop valves.*

Where modified valves need to be installed, as far as possible the constructional features should comply with the relevant British Standard.

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.

20.1.2 *Main stop valves*

20.1.2.1 *Installations except life safety installations.* One, and only one, main stop valve shall be fitted immediately upstream of the main alarm valve of an installation which is not a life safety installation.

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

COMMENTARY AND RECOMMENDATIONS ON **20.1.2.1**.

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.

20.1.2.2 *Life safety installations.* The installation main control valve set shall have only either:

a) two stop valves, one on each side of a single alarm valve with a bypass connection of the same nominal bore around all three, itself fitted with a normally closed stop valve (see Figure 25); or

b) 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 26. The alarm valves in each leg shall have interconnected feeds to a common fire alarm arrangement.

COMMENTARY AND RECOMMENDATIONS ON **20.1.2.2**.

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.

20.1.3 *Water supply stop valves*

20.1.3.1 *Elevated private reservoirs, gravity tanks and pressure tanks.* A stop valve shall be fitted upstream of and close to the non-return valve.

20.1.3.2 *Automatic pumps.* Each automatic pump shall be fitted with a stop valve downstream of the delivery check valve. A further stop valve, retained by a means other than the pump flange, shall be fitted in the suction pipe if the maximum water supply level is above the level of the lower edge of the pump inlet. The distance between the stop valve flange face and the pump flange face shall be not less than four pipe diameters and the pipe taper shall not exceed 15°.

COMMENTARY AND RECOMMENDATIONS ON **20.1.3.2**.

The stop valve in the suction pipe allows the pump to be removed without lowering the water level.

20.1.4 *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 main 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 under hoods over the dry ends of paper-making machines where it is necessary to turn off the sprinklers to enable machine cylinders to be changed. The valve shall be secured open.

Table 38 — BS specifications and size ranges for stop, test, drain and flushing valves

Specification	Valve nominal size range to be used (sizes inclusive)	
	Screwed ends	Flanged ends[a]
	mm	mm
BS 1010-2	6 to 50	—
BS 5150	13 to 150	10 to 1 000
BS 5151	—	40 to 1 000
BS 5152 (single purpose valves only)	13 to 150	10 to 450
BS 5154 (single purpose valves only)	6 to 75[b]	10 to 80
BS 5155 (gear operated valves only)	—	40 to 2 000
BS 5156 (drain and test valves only)	6 to 75	10 to 300
BS 5157	—	40 to 600
BS 5159	6 to 100	10 to 600
BS 5160 (single purpose valves only)	—	10 to 450
BS 5163	—	50 to 600

[a] Including wafer valves clamped between flanges.
[b] Nominal size range includes compression ends in accordance with BS 864-2, 10 mm to 54 mm.

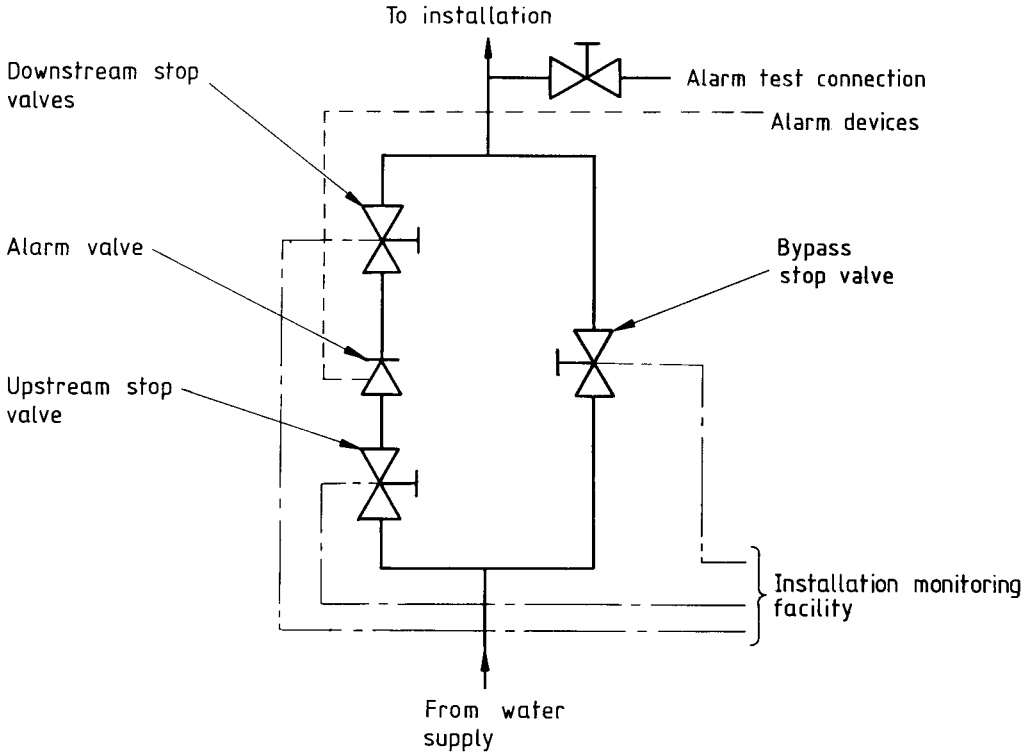


Figure 25 — Alarm valve and bypass arrangement for life safety installations

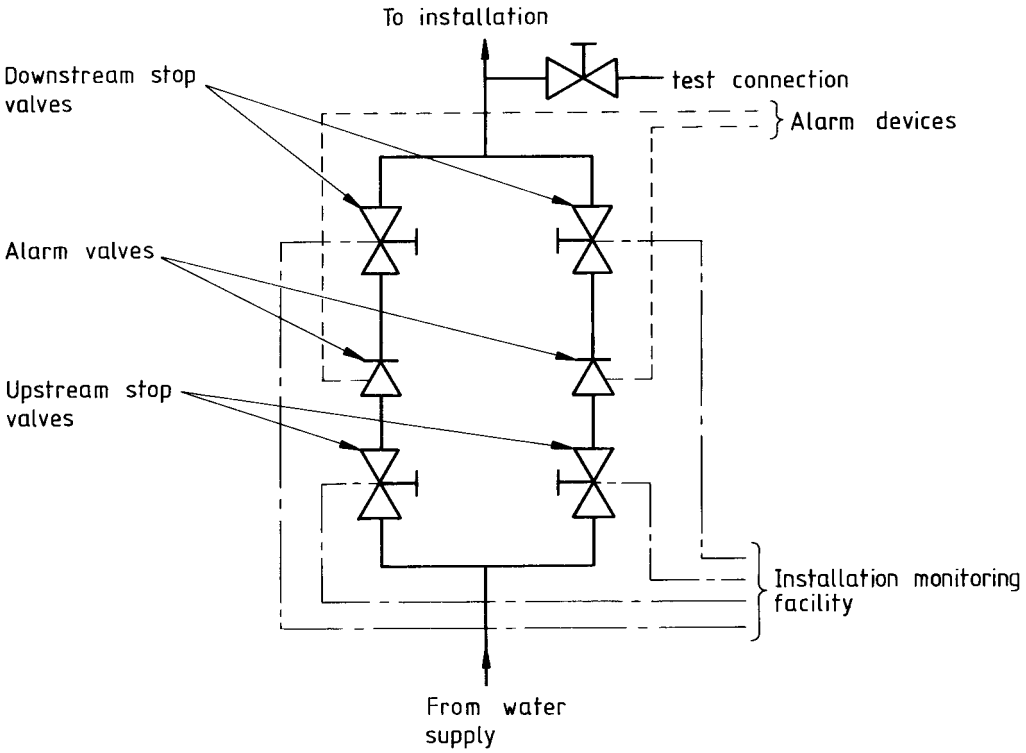


Figure 26 — Duplicate alarm valve arrangement for life safety installations

d) 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.

e) 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.

f) Each zone of an installation.

COMMENTARY AND RECOMMENDATIONS ON **20.1.4**.

*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 (see **17.4.5.2** and **17.5.4.2**).*

Subsidiary stop valves should be enclosed by a door fitted with a lock with a square ended key socket 8 mm × 8 mm *and* 25 mm *deep.*

Subsidiary stop valves should be accessible at the floor level they control and should be sited in a protected stairway enclosure or the lobby of a firefighting stair. When the valve is secured open a strap and padlock should be used.

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.

20.1.5 *Test valves and cocks*

20.1.5.1 *Alarm and pump start test valve.* Test valves (15 mm nominal size) shall be provided, as appropriate, to test:

a) the hydraulic alarm and any electric alarm pressure switch by drawing water from the downstream side of:

i) a wet alarm valve, and any downstream main stop valve(s) (see **20.1.2.2**); or

ii) an alternate or composite wet and dry alarm valve;

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) an alternate alarm valve; or

ii) a composite alarm valve; or

iii) a dry pipe alarm valve;

c) any water flow alarm switch installed downstream of the main installation control valve set. The test valve shall be connected downstream of the water flow alarm;

d) an automatic starting device on a pump (see **17.4.2.1**);

e) any pump or pressure tank house sprinkler alarm flow switch installed upstream of the installation control valve (see **17.4.5.2** and **17.5.4.2**).

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

20.1.5.2 *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;

b) on town mains, pressure tank, gravity tank or elevated private reservoir supplies, upstream of the check valve and downstream of the water supply stop valve;

c) immediately upstream of the check valve on a water supply feed pipe or trunk subject to any requirements of the water authority.

20.1.6 *Drain valves.* Drain valves sized as specified in Table 39 shall be fitted to allow drainage from:

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

b) immediately downstream of any tail-end alarm valve; and

c) immediately downstream of any subsidiary stop valve; and

d) between a dry pipe or tail-end installation alarm valve and any subsidiary stop valve installed for testing [see **20.1.4** b)]; and

e) any pipe other than drop pipes to single sprinklers in a wet installation which cannot be drained through another drain valve.

The valves shall be fitted at the lower end of permanent pipework sized as specified in Table 39. The outlet shall be not more than 3 m above the floor and shall be fitted with a brass plug.

20.1.7 ***Flushing valves***

20.1.7.1 *Pumped water supply.* Where a suction pump uses water from a non-potable source such as a canal, river, lake etc., flushing valves shall be fitted at the spur ends of the installation distribution pipes.

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

Table 39 — Minimum size of drain valves and pipe

Valve draining principally	Minimum bore of valve and pipe
	mm
An ordinary- and/or high-hazard installation	50
An installation alarm valve on a light-hazard installation	40
A tail-end installation	50
A zone	50
Trapped distribution pipes more than 80 mm bore	50
Trapped distribution pipes more than 50 mm but not more than 80 mm bore	32
Trapped distribution pipes not more than 50 mm bore	20
Trapped range pipes more than 50 mm bore	25
Trapped range pipes not more than 50 mm bore	20
Trapped pipework between dry-or-tail-end alarm valve and a subsidiary stop valve installed for testing purposes	13

20.1.7.2 *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 brass plug cap.

COMMENTARY AND RECOMMENDATIONS ON **20.1.7**.

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 valve(s) 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.*

WARNING. Pipework completely full of water may be damaged by the increase in pressure caused by an increase in ambient temperature. If complete venting of the air in an installation may occur, for example in gridded installation with flushing valves at the extremities, consideration should be given to the fitting of pressure relief valves.

20.2 Check valves

20.2.1 *General.* Check valves complying with the appropriate standard and size range of Table 40, or otherwise suitable for sprinkler service, shall be fitted on each water supply pipe to a trunk main.

Where the source is an elevated private reservoir or a gravity tank the check valve shall be not less than 5 m below the base of the reservoir or tank.

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

20.2.3 Water supply check valves shall be readily accessible for testing and maintenance. Where the check valve is below ground level an inspection chamber shall be provided.

COMMENTARY AND RECOMMENDATIONS ON **20.2.**

Where modified valves need to be installed, as far as possible the constructional features should comply with the relevant British Standard.

In high-rise buildings the check valves should be suitable for the installation working pressure.

20.3 Alarm valves

20.3.1 *General.* A sprinkler installation shall be fitted with a suitable main alarm valve suitable for sprinkler service to control the water supply to the installation.

A dry pipe alarm valve applied to an alternate installation shall have a wet pipe alarm valve fitted immediately on the upstream side.

The main installation alarm valve(s) shall be fitted immediately downstream of the main stop valve (see **20.1.2**).

Table 40 — BS specifications and size ranges for check valves

Specification	Valve nominal size range to be used (sizes inclusive)	
	Screwed ends	Flanged ends
	mm	mm
BS 5153	13 to 150	10 to 1 000
BS 5154 (single purpose valves only)	6 to 75	10 to 80
BS 5160 (single purpose valves only)	—	10 to 450

COMMENTARY AND RECOMMENDATIONS ON **20.3.1.**

In high-rise buildings the alarm valves should be suitable for the installation working pressure.

Wet, composite 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.

20.3.2 *Life safety installations.* Life safety installations shall be fitted with a wet alarm valve or valves (see Figure 25).

20.3.3 *Tail-end extensions.* Tail-end extensions shall be fitted with either a dry or composite alarm valve to retain the air pressure.

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

COMMENTARY AND RECOMMENDATIONS ON **20.3.4.**

A valve serving an area exposed to normal winter 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.

20.4 Accelerators and exhausters

20.4.1 Accelerators and exhausters shall be suitable for sprinkler service.

20.4.2 The accelerator or exhauster shall be fitted as close as is practicable to the alarm valve. Its connections to the alarm valve and to the installation pipework shall be fitted with stop valves, which can be secured, open or closed as appropriate, by securing straps.

An accelerator or exhauster shall be located so that any restriction orifice or other operating part likely to be affected cannot become flooded under normal standing conditions by priming water, main installation valve leakage or installation pipework back drainage.

Accelerators and exhausters shall be resistant to freezing, or shall be installed sufficiently close to the main installation control valve set as to share in its frost protection, or ambient temperature control shall be provided.

20.5 Preaction, recycling and deluge valves

Preaction, recycling and deluge valves shall be suitable for sprinkler service.

20.6 Multiple controls

Multiple controls installed to control medium-velocity or high-velocity sprayers, open sprinklers or open drenchers or to operate a pressure switch shall be suitable for sprinkler service.

20.7 Pressure-reducing valves

Pressure-reducing valves shall be suitable for sprinkler service and shall only be fitted on the water supply branch from town main.

The controlling mechanism shall be operated from the low pressure side.

COMMENTARY AND RECOMMENDATIONS ON **20.7**.
Pressure-reducing valves are not recommended for this purpose except where there is no alternative.

21 Pipe and pipe fittings

21.1 Materials and manufacturing specifications

21.1.1 *Pipes and fittings.* Pipes and fittings shall comply with the appropriate standard(s) of Table 41.

COMMENTARY AND RECOMMENDATIONS ON **21.1.1**.
Water authorities (under section 17 of the Water Act, 1945) do not permit water supplied by them, even if taken from a water authority cistern, to be conveyed by PVC pipe complying with BS 3506, or upstream of an alarm valve by medium grade pipe complying with BS 1387.

21.1.2 *Flanges and bolting.* Flanges and bolting shall comply with BS 2035 or BS 4504, as appropriate.

21.1.3 *Mechanical joints.* Mechanical joints shall be made and used as recommended by the manufacturer and shall be suitable for sprinkler service.

COMMENTARY AND RECOMMENDATIONS ON **21.1.3**.
*See **22.8.4** for support of mechanically joined pipe.*

21.2 Protection of pipework

21.2.1 ***Corrosion protection***

21.2.1.1 Underground ferrous pipes shall be suitably protected against corrosion.

COMMENTARY AND RECOMMENDATIONS ON **21.2.1.1**.
The water authority will normally have requirements for the corrosion-protection of pipes carrying water supplied by the authority, even if taken from a cistern.

21.2.1.2 Non-galvanized ferrous pipes for use above ground shall be supplied to site with one external coat of paint or varnish, and fittings shall be coated, and pipes shall be further coated, as soon as practicable after installation.

21.2.1.3 Above-ground ferrous pipework in premises designated in **5.5** b) and/or elsewhere where corrosive conditions exist shall be thoroughly cleaned and then protected by a suitable coating.

COMMENTARY AND RECOMMENDATIONS ON **21.2.1.3**.
Although galvanized pipes may be suitable without further coating, any thread exposed after installation should be covered by cold galvanizing paint.

Special coatings will be necessary for non-galvanized pipes.

*See commentary and recommendations on **35.2.4.1** for maintenance of coatings.*

21.2.2 ***Protection from damage***

21.2.2.1 *General.* Underground pipes shall be protected from the effects of vehicular traffic.

Sprinkler pipework shall not be located where it is liable to be damaged by forklift trucks or other mobile equipment. Above gangways the pipes not above the maximum equipment height shall be fitted with adequate guards.

Pipework and the sprinklers within racks or under shelves shall be located so as to be protected against mechanical damage.

Where mobile equipment is used, guard rails shall be provided and safety guide lines shall be marked out on the floor around pipe risers.

21.2.2.2 *Water supply pipework in unsprinklered building.* Water supply pipework in an unsprinklered building shall be installed at ground level and shall be enclosed by dwarf brick walls covered by concrete slabs.

COMMENTARY AND RECOMMENDATIONS ON **21.2.2.2**.
It is highly undesirable to route water supply pipework through an unsprinklered building.

21.2.2.3 *Underground plastics pipe.* Plastics pipe shall be laid as recommended either in CP 312-1 or by the manufacturer.

COMMENTARY AND RECOMMENDATIONS ON **21.2.2.3**.
Particular care is needed where plastics pipe is laid under roads, and in trench preparation, bedding, infilling and back filling.

Table 41 — Specifications for pipes and fittings

Use and location	Pipe	Fittings	Comments
Below ground	BS 1387		Heavy grade see notes 3 and 4 preferably galvanized
	BS 2035	BS 2305	See note 1
	BS EN 1057	BS EN 1254-3	
	BS 3601		
	BS 4622		See note 1
	BS EN 545	BS EN 545	
	WIS 4-32-03	WIS 4-32-04	For PE 100 (HPPE) the SDR shall not be more than 13.6. For PE 80 (MDPE) the SDR shall not be more than 11. See notes 5 and 6.
	WIS 4-32-09	WIS 4-32-14	
	WIS 4-32-13	WIS 4-32-15	
Above ground, upstream of alarm valve		BS 143/1256 (BS EN 10242)	
	BS 1387		
		BS 1740-1	
	BS 2035	BS 2035	See note 2
	BS EN 1057	BS EN 1254-1	No pipe bending. For light hazard and small bore monitoring and test pipework
		BS EN 1254-2	
	BS 3601		
	BS 4127		
	BS 4622	BS 4622	See note 2
	BS EN 545	BS EN 545	
Above ground downstream of alarm valve		BS 143/1256 (BS EN 10242)	
	BS 1387		
		BS 1740-1	
	BS 2035	BS 2035	See note 2
	BS EN 1057	BS EN 1254-1	No pipe bending. For light hazard and small bore monitoring and test pipework
		BS EN 1254-2	
	BS 3602		
	BS 4127		
	BS 4622	BS 4622	See note 2
	BS EN 545	BS EN 545	

NOTE 1 Suitable for pump suction pipework with integral flanges.
NOTE 2 Suitable only with integral flanges.
NOTE 3 Suitable only with integral flanges or grooved pipe mechanical joints.
NOTE 4 Precautions should be taken to provide satisfactory protection against external corrosion.
NOTE 5 The WIS standard are currently being revised and the revised standards should be referred to where available. The WIS standards will eventually be superseded by the BS EN 12201 series of standards.
NOTE 6 Blue PE pipe is used for potable water; black PE pipe is used for non-potable water.

21.2.2.4 *Hazardous processes and explosion hazards.* Trunk mains to installation(s) covering buildings with hazardous processes and/or explosion hazards shall be either outside the building(s) or alternatively shall be protected against possible damage from building collapse.

21.2.3 *Pipe concealment.* Sprinkler pipes shall not be embedded in concrete floors or ceilings of a building.

COMMENTARY AND RECOMMENDATIONS ON **21.2.3.**
Sprinkler pipes should not be concealed in any situation where difficulty or undue expense would be involved in making alterations or additions to the system. Concealment is particularly troublesome in multiple tenancies where partitions are frequently required to be moved to suit the tenants, with consequent need to move sprinklers to ensure effective distribution of water.

21.2.4 *Protection from freezing.* Underground pipe shall be set at a sufficient depth to prevent the contained water freezing.

COMMENTARY AND RECOMMENDATIONS ON **21.2.4**.
The local water undertaking should be consulted for advice.

21.2.5 *Pipework drainage.* All installation pipework above ground shall be installed at not less than the designed slope to drain.

The slope to drain of distribution and range pipework shall be not less than as given in Table 42.

COMMENTARY AND RECOMMENDATIONS ON **21.2.5**.
*Where possible the pipework should slope to drain through the installation control valve drain valve. Where this cannot be achieved trapped sections of pipework, other than single sprinklers situated on drop pipes below suspended ceilings, should slope to the point of connection of another drain valve (see **20.1.6**).*

Deluge installation pipework which can drain thoroughly through the open nozzles need not be sloped to drain.

Table 42 — Installation pipework slope to drain

Installation type	Pipe size	Slope to drain
	mm	mm/m horizontal run of pipe
Wet	any	2
All others	not more than 40	12
All others	more than 40	4

21.2.6 *Pipework within storage racking.* If relative movement may occur between sprinkler pipework within free-standing storage racking and distribution pipework attached to the building structure, a flexible section or swivel joint shall be fitted at the point of connection to the distribution main.

Flexible pipe and swivel joints shall be capable of with-standing 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, may impair either the integrity or the performance of the sprinkler system.

Flexible pipes shall contain a continuous pressure-retaining stainless steel or non-ferrous metal inner tube.

Flexible pipes shall not be fitted in the fully extended condition.

Flexible pipes and swivel joints shall not be used to take up misalignment between a distribution main and the feed pipes to intermediate sprinklers.

COMMENTARY AND RECOMMENDATIONS ON **21.2.6**.
Relative movement of the racking and of the building structure may occur owing to wind effects, thermal movement, etc.

21.3 Welding

21.3.1 *Standards.* All welding of sprinkler pipework shall comply with the requirements of:

a) BS 2640; or

b) BS 2971; or

c) the Heating and Ventilating Contractors' Association Manual "Welding of carbon steel pipework"[5];

except that set-in type branches or sockets or cut-and-shut bends shall not be used.

COMMENTARY AND RECOMMENDATIONS ON **21.3.1**.
Welding off site is preferred for reasons of safety and quality control. Welding on site should be carried out observing appropriate safety precautions (see Appendix C).

21.3.2 *General.* Pipes and sockets of less than 50 mm nominal bore shall not be welded in situ.

Where welds are made in situ the welder's identification mark shall be stamped on the pipework adjacent to the completed weld.

The length of outlets and sockets welded directly onto a pipe which will be installed downstream of an alarm valve shall be as given in Table 43. The pipe outlet face shall not be welded to adjoining installation pipework.

Flanges fitted to the face of an outlet, shall comply with BS 2640, BS 2971 or the Heating and Ventilating Contractors' Association Manual.

21.3.3 *Welding of galvanized pipework.* Before galvanized pipe is welded the zinc coating on both pipes, on the ends, and outsides over a distance of 25 mm from the joint, shall be removed by grinding.

After pressure testing as specified in **10.1.1** the exposed metal and weld shall be coated with two coats of a zinc rich paint complying with BS 4652.

[5] Available from Publications Department, Heating and Ventilating Contractors' Association, Old Mansion House, Eamont Bridge, Penrith, Cumbria CA10 2BX.

Table 43 — Length of welded outlets

Branch pipe nominal bore	Permissible length of 60° to 90° (inclusive) welded outlets from crotch to tube or socket face	
	Minimum	Maximum
mm	mm	mm
20	20	40
25	25	50
32	27	55
40	27	55
50	32	65
65	35	70
80	37	75
100	42	130
150	50	310
200	50	400

22 Pipework supports

22.1 Design and construction

22.1.1 *General.* Pipe supports and support fittings shall be manufactured from components and materials complying with one or more of the appropriate following standards.

BS 84; BS 970-1; BS 1083; BS 1449-1 and BS 1449-2; BS 1452; BS 1494-2; BS 1580-1 and BS 1580-2; BS 1768; BS 3643-2; BS 3692; BS 4190; BS 4360; BS 6681.

The same thread form shall be used for each component of an assembly.

Where unified threads are used (see BS 1580) the threaded components shall be code marked as follows:

a) *bolts and nuts:* by a circular recess in the upper surface of the head of a bolt, or by a line of contiguous circles on one or more of the flats parallel to the axis of either a bolt or nut;

b) *eye rods and stud bolts:* by a line of contiguous circles stamped at the centre of the non-threaded portion of the rod or stud shank.

Sprinkler pipes shall be supported from the building structure, which itself shall be capable of supporting the additional load of the water-filled pipework and shall not impair the performance of sprinklers under fire conditions.

Sprinkler supports shall not be used to support any other objects except where primary support is designed for the suspension of piped services.

Sprinkler pipes shall not be supported from ceiling sheathing or cladding or from any associated suspension system.

Pipes below ductwork shall be either supported from the building structure or from a steel angle supporting the ductwork adequate to support the combined weight of the ductwork and the water filled-sprinkler pipes (see **22.1.3**).

Only pipes of 50 mm nominal bore or less shall be suspended from metal deck roofs, e.g. roofs which have a cross section of trapezoidal form.

All parts shall be true to shape and free from burrs and sharp edges. Bolt holes shall be accurately located and free from distortion.

Hangers, other than toggle hangers, which may be attached to the swivel rod by rivet, shall be held together by bolts, or threaded rod, with nuts and washers.

Hangers shall not be welded or secured directly to sprinkler pipework (for example into a redundant tee or cross fitting).

Spring clips and other hangers relying on the elasticity of their materials as the means of retention shall not be used.

Open hooks shall not be used.

Where pipework rests on a support it shall be secured in position.

The thickness of all parts of pipe supports shall be not less than:

1) 1.2 mm for stainless steel grade 3 045 15 in accordance with BS 1449-2; or

2) 3.0 mm for all other ferrous materials.

COMMENTARY AND RECOMMENDATIONS ON **22.1.1**.

Wherever possible sprinkler pipes should be supported from non-combustible building elements. Where combustible building elements are used for support, extra protection may be provided by the appropriate use of sprinkler siting or type.

Typical supports are shown in Figure 27.

In selecting suitable pipe supports consideration should be given to the following:

a) *thermal movement of pipework, pipe supports and structure,*

b) *relative movement between elements of structure to which pipes are attached, e.g. building roof movement (possibly wind generated) relative to a sprinkler-protected platform or duct below;*

*It may be necessary to use flexible pipe or swivelling couplings to allow relative movement of the two parts of the installation (see **21.2.6**).*

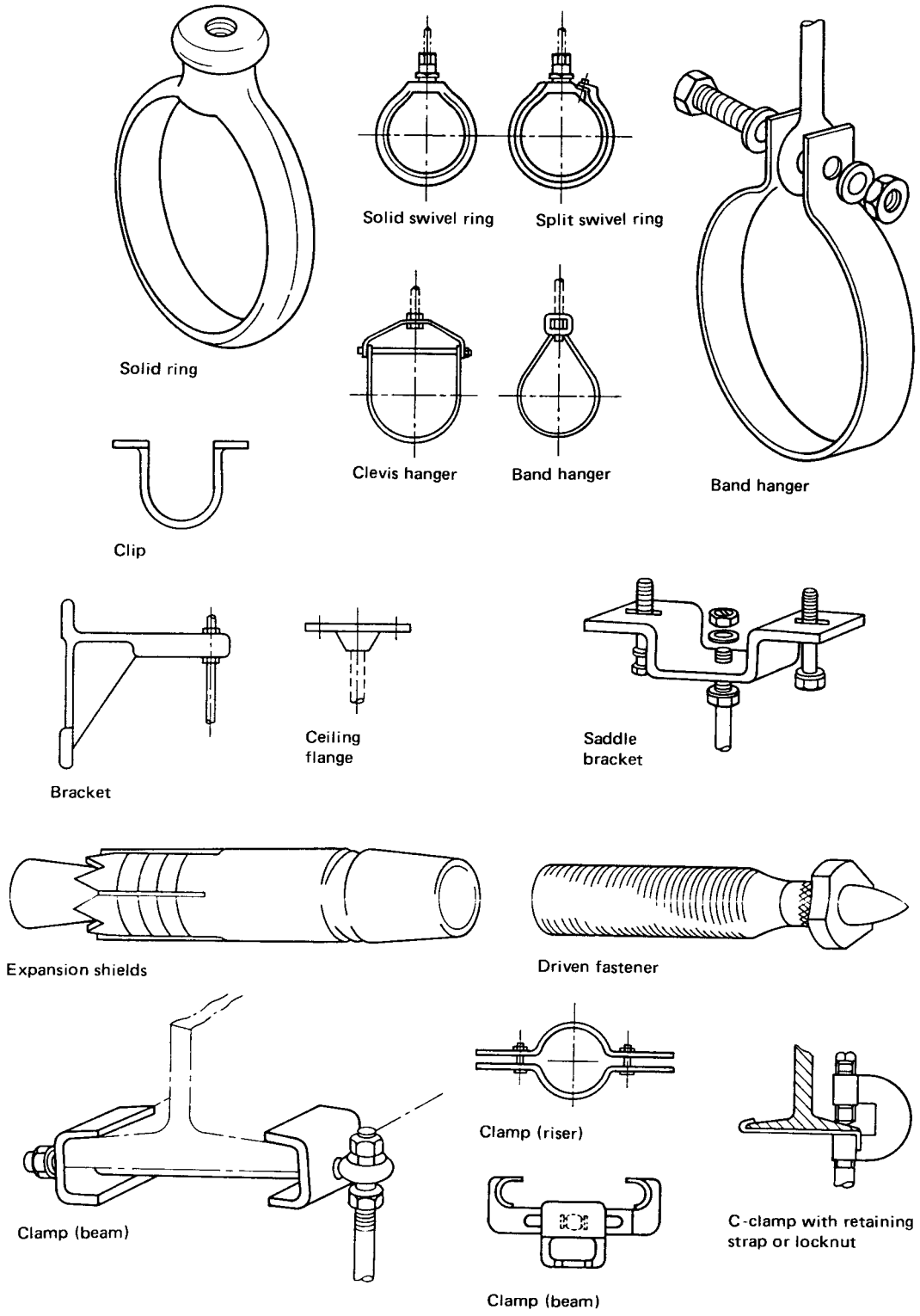


Figure 27 — Some common types of pipe hanger equipment

c) *reaction caused by the sudden filling of pipework, pumping effects and water discharge from sprinklers (particularly when the water is aerated);*

d) *uniformity of supporting effort;*

e) *vibration;*

f) *possible mechanical damage from movement of plant or machinery;*

g) *maintenance of installation integrity under fire conditions.*

22.1.2 *Corrosion protection.* Pipe supports in premises or parts of premises where corrosive conditions exist, and in particular in premises specified in **5.5** b), shall be of stainless steel or shall be suitably corrosion-protected.

COMMENTARY AND RECOMMENDATIONS ON **22.1.2**.
*See commentary and recommendations on **21.2.1.3** and on **35.2.4.1**. Suitable methods of protection are given in DD 24.*

22.1.3 *Strength.* There shall be no failure or damage to a support assembly when the appropriate proof load given in Table 44 is applied, gradually through the appropriate size mandrel, to the pipe clip. Except for any initial movement caused by application of the premeasurement load, the bedding-down extension shall not exceed 5.0 mm as the load increases from the premeasurement load to the proof load.

COMMENTARY AND RECOMMENDATIONS ON **22.1.3**.
This requirement will be met by assemblies in which:

a) *pipe clips are made from rolled strip, cast or malleable iron and comply with Table 45; and*

b) *sling rods and "U" bolts comply with Table 46; and*

c) *fasteners comply with Table 47 or Table 48.*

Table 44 — Test loads for support assemblies

Pipe nominal bore		Premeasurement load	Proof test load
greater than	not greater than		
mm	mm	N	N
—	50	150	1 500
50	65	200	1 650
65	80	400	3 400
80	100	500	5 200
100	150	1 000	10 200
150	200	1 000	16 250
200	250	1 000	25 000

22.2 Cantilever supports

Cantilever supports and any supplementary supporting steelwork shall comply with BS 3974-1 and BS 3974-2.

22.3 Brackets

The reactive force on any fixing screw or bolt of a bracket shall not exceed the value of the load supported.

22.4 Split ring assemblies

Split ring assemblies shall be secured by bolts and nuts.

22.5 Eye rods

Eye rods shall be formed from mild steel bar (see **22.1.1** for material and threading). The eye shall be either:

a) made separately from square bar and attached to the circular cross-section rod by screwing or welding; or

b) forged integrally; or

c) a loop hot or cold formed by stamping the end of the rod.

22.6 Toggle support

Toggle supports shall only be used for the support of pipes of 65 mm nominal bore or less, and only where no alternative type of hanger can be utilized. They shall only be used for support of ranges under ceilings of hollow tile or metal lath and plaster.

22.7 Fasteners

22.7.1 *General.* The manufacturer's recommended maximum safe working loads shall not be exceeded.

Fasteners and plug inserts shall be made of steel.

Fasteners shall give a stable fixing and shall not be used in mortar.

When fixed as recommended by the manufacturer the fastening and the building element shall not fail or suffer damage when the appropriate test load of Table 49 is applied gradually. There shall be no movement as the load is increased from the premeasurement load to the test load.

COMMENTARY AND RECOMMENDATIONS ON **22.7.1**.
*The authorities listed in **3.1** may ask for tests to be carried out on fastenings.*

22.7.2 *Fastening to timber.* Wood screws and nails shall not be used for fixing hangers. Explosively powered fasteners shall not be used in timber.

Coach screws, coach bolts and bolts shall be located at least 10 shank diameters apart (centre to centre) and the complete thread of coach screws shall be engaged in the structural timberwork. Pilot holes of the diameter and depth recommended by the manufacturer shall be drilled before fitting coach screws.

Table 45 — Minimum dimensions of pipe clips

Pipe nominal bore		Minimum material cross section		Maximum hole size in clip
greater than	not greater than	Non-corrosion-protected ferrous, other than stainless steel	Corrosion-protected, stainless steel or non ferrous	
mm	mm	mm	mm	mm
—	65	20 × 3.0	20 × 1.2	11
65	100	25 × 3.0	25 × 1.2	11
100	150	32 × 3.0	32 × 1.6	13
150	200	40 × 3.0	40 × 2.0	18
200	250	50 × 3.0	50 × 2.0	22

Table 46 — Sling rods and "U" bolts

Pipe Nominal bore		Minimum diameter of single sling rod or bolt
greater than	not greater than	
mm	mm	mm
—	100	10
100	150	12
150	200	16
200	250	20

Table 47 — Coach screw, coach bolt and bolt fasteners

Pipe nominal bore		Bolt and coach diameter × length	Coach screw diameter × length	Minimum number per support assembly
over	not greater than			
mm	mm	mm	in	
—	50	10 × 65	⅜ × 2½	One
50	65	10 × 65	⅜ × 2½	Two
65	100	10 × 100	⅜ × 4	Two
100	150	10 × 150 or 12 × 100	⅜ × 6	Two
150	200	12 × 150	—	Two
200	250	16 × 200	—	Two

Table 48 — Drill or non-drill fasteners in concrete, brickwork or blockwork: drill or non-drill anchor minimum diameters

Pipe nominal bore		Minimum diameter, single fixing	Minimum diameter, double fixing
over	not greater than		
mm	mm	mm	mm
—	65	10	10
65	100	—	10
100	200	—	10
200	250	—	12

Table 49 — On-site test loads for fasteners

Pipe nominal bore		Premeasurement load	Test load
over	not greater than		
mm	mm	N	N
—	50	150	600
50	65	200	800
65	80	400	1 700
80	100	500	2 600
100	150	1 000	5 100
150	200	1 000	8 100
200	250	1 000	12 900

Where the shank of a coach screw or bolt enters the structural timberwork, clearance shall be drilled for the appropriate length to prevent the timeberwork splitting.

Coach screws, coach bolts and bolts fixed in the side of a timber joist shall be not less than:

a) 65 mm above the lower edge of the joist when supporting pipes of 65 mm nominal bore or less; or

b) 80 mm above the lower edge when supporting pipes greater than 65 mm nominal bore.

22.7.3 *Fastenings to concrete, brick or blockwork.* Expansion shield fasteners shall be used in brickwork or blockwork.

When drilling the building structure care shall be taken to avoid crumbling of the structure around the hole. Holes in the face of a concrete beam shall be sufficiently distant from the lower edge to avoid the reinforcing rods, and to prevent flaking of the concrete.

Explosively powered fasteners shall not be used in concrete, brickwork or blockwork.

COMMENTARY AND RECOMMENDATIONS ON **22.7.3**.
Expanding all-steel fasteners or set-in fasteners may be used in structural grade concrete.

22.7.4 *Fastening to steelwork.* Drilling, bolting, welding or explosively powered fastening shall be used, provided that the structure is satisfactory for the purpose.

Explosively powered fasteners shall only be used in steelwork thicker than 5 mm and for shear load applications. The manufacturer's safety instructions shall be observed.

Powered fasteners shall have a minimum thread diameter of 10 mm; when supporting pipes of 80 mm nominal bore or over, two shall be used for each support assembly.

22.8 Pipe support spacing and location

22.8.1 *Spacing.* The distance between pipe supports measured along the line of connected pipes (whether the pipes run vertically, nominally horizontally or at some intermediate angle, or change direction) shall be not less than as given in Table 50.

Table 50 — Maximum distance between pipe supports

Pipe nominal bore		Maximum support spacing
over	not greater than	
mm	mm	m
—	65	4.0
65	100	6.1
100	250	6.5

Branching pipes shall not rely on each other for support.

Pipework shall be restrained against twisting.

COMMENTARY AND RECOMMENDATIONS ON **22.8.1**.
*Nominally horizontal includes pipes with a slope to drain (see **21.2.5**).*

Where pipes change direction the support spacing dimension is taken along the axis of the connected pipes, and not directly across the angle from support to support.

Pipes which are as follows need not be separately supported unless they are at low level or otherwise vulnerable to mechanical impact:

a) *horizontal arm pipes less than 450 mm long; or*

b) *drop or rise pipes less than 600 mm long feeding individual sprinklers.*

22.8.2 *Location on range pipes.* At least one support shall be provided for as follows:

a) each pipe run connecting adjacent sprinklers; and

b) the pipe run connecting the distribution pipe and the first sprinkler on the range pipe.

Pipe supports shall not be closer than 150 mm to any sprinkler axial centre line.

The first support on a range pipe shall be not more than 2.0 m from the distribution pipe.

The last support on a range pipe shall be not more than 1.5 m from:

1) the range pipe end; or

2) where there is a horizontal arm pipe 450 mm or more long, the arm pipe end; or

3) where there is a drop or rise pipe 600 mm or more long, the drop or rise pipe end.

22.8.3 *Location on distribution pipes.* The first support on a nominally horizontal distribution pipe shall be not more than 2.0 m from a main distribution pipe.

The last support on a nominally horizontal distribution pipe shall be not more than 450 mm from the end.

Distribution pipe rise or drop pipes shall be secured to the building structure as follows:

a) directly; or

b) indirectly at the adjacent nominally horizontal part of the pipe within 300 mm of the rise or drop.

COMMENTARY AND RECOMMENDATIONS ON **22.8.3**.
Distribution rise or drop pipes less than 1.0 m *in length connecting directly to range pipes need not have supports or securement.*

22.8.4 *Location on mechanically joined pipe.* There shall be at least one pipe support for each mechanical joint in a pipe run.

Each section of pipe between two adjacent mechanical joints shall be supported by either:

a) one support which shall not be located within the central one-third of the section length; or

b) two supports which shall be not less than one-third of the section length apart.

Elbows and reducers shall have at least one pipe support not more than one-third of the length of the supported pipe away from the fitting.

Tees and crosses shall have pipe supports on at least two of the connected pipe lengths, each not more than one-third of the length of the relevant supported pipe away from the fitting.

23 Pipework in cold storage warehouses

23.1 Installation pipework design

23.1.1 *General.* Installation pipework shall be above ground and accessible. The pipework shall be readily dismantleable.

At the point of entry of the pipework into the cold chamber and otherwise where practicable, a change of pipe direction shall be made by a tee having one branch sealed off.

COMMENTARY AND RECOMMENDATIONS ON **23.1.1**.
*This allows for inspection of pipework for freedom from ice or other obstruction and for thorough purging of moisture after valve operation (see **33.2**).*

23.1.2 *Pipe joints.* Pipe joints shall be compression or preferably flange jointed.

23.1.3 *Pipe supports.* Pipe supports shall be such as to facilitate easy removal of the pipework.

COMMENTARY AND RECOMMENDATIONS ON **23.1.3**.
Hangers of the split ring type secured by hexagonal head bolts and hexagonal nuts are recommended.

23.2 Installation pipework gas charge

The installation pipework downstream of the dry system installation control valve and of any tail-end control valve(s) shall be pressurized with dry nitrogen gas or air drawn across the freezers of lowest temperature in the plant or through a chemical dehydrator.

Nitrogen cylinders shall be fitted with a pressure-reducing valve to control the pressure to not more than 8 bar. A pressure relief valve shall be fitted, to operate at not more than 9 bar.

The air/gas pressure in a series of tail-end installations, on one set of main installation control valves operating on the dry pipe or alternate wet and dry pipe principle, shall be not less than the air pressure in the feed pipe(s) between the main installation control valve and the tail-end dry pipe valves.

Differential dry pipe valves used in tail-end installations connected to an installation operating on the dry pipe or alternate wet and dry principle shall be suitable for sprinkler service and shall retain air pressure in the installation pipework between the main control valves and the underside of the tail-end dry pipe or valves.

24 Pipe sizing and sprinkler array design

24.1 General

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

COMMENTARY AND RECOMMENDATIONS ON **24.1.1**.
*See also **8.3.4.2**.*

24.1.2 *Installation pipework.* All pipework downstream of a main installation control valve set, i.e. main distribution, distribution and range pipes, shall be designed in accordance with the relevant requirements of **24.2** and **24.3**.

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

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

Where upright or pendent conventional or spray sprinklers are fitted within 400 mm of the pipe axis alongside a pipe of nominal size greater than 65 mm, the deflector shall be not more than the appropriate distance given in Table 51 above the lower edge of the pipe.

Where a sprinkler is fitted in a drop from a pipe of nominal bore greater than 65 mm, the horizontal centre line of the exposed portion of the sprinkler detector element shall be not less than 75 mm below the lower edge of the pipe.

The vertical centre line of detection elements of sidewall sprinklers fed from the side of and spraying away from a pipe larger than 65 mm nominal bore, shall be not less than 75 mm distant from the side of the pipe.

COMMENTARY AND RECOMMENDATIONS ON **24.1.2**.
*See **26.3.2** where there is an adjacent wall.*

24.1.3 *Orifice plates.* An orifice plate used to hydraulically balance an installation, or to accommodate pump characteristics, shall:

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

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

c) be of brass with a plain central hole without burrs, and of a thickness complying with Table 52;

d) have an identification tag, projecting beyond any flanges between which it is clamped, on which is clearly stamped the nominal pipe diameter and the orifice k factor (see Appendix B).

Table 51 — Location of sprinklers alongside feed pipes larger than 65 mm nominal size

Minimum horizontal distance from pipe centre line to sprinkler centre line	Maximum height of sprinkler deflector above lower edge of pipe	
	Conventional sprinkler installed upright	Spray sprinkler (upright or pendent) and conventional sprinkler installed pendent
mm	mm	mm
100	0	17
200	17	40
400	34	100

NOTE Dimension may be interpolated.

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

The relationship between orifice size, the flow rate and the pressure loss shall be calculated using the data given in Appendix B.

COMMENTARY AND RECOMMENDATIONS ON **24.1.3**.
*Orifice plates in horizontal pipe runs may form trapped pipework which will require a drain valve (see **20.1.6**).*

24.1.4 *Protection in concealed spaces.* Concealed spaces above ceilings or below floors, where ordinary or high hazard protection for the space below the ceiling or above the floor is specified (see **26.6**), shall be protected as specified for ordinary hazard.

Table 52 — Orifice plate thickness according to pipe nominal bore

Pipe nominal bore		Orifice plate thickness
over	not greater than	
mm	mm	mm
—	80	3
80	150	6
150	200	9

The maximum area of sprinkler coverage and the pipework design shall be as given in Table 53.

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

1) Concealed space above or below a light-hazard class installation. A separate pipe runs from the control valves.

2) Concealed space above a precalculated ordinary-hazard class installation. If the concealed sprinklers are fed individually from the pipework below, the range and distribution pipes in the installation shall be sized by taking the room and concealed space sprinklers cumulatively (see **24.2.3**); alternatively if two feed pipes are used, one for the concealed space and one for the room sprinklers, the common feed pipe shall have a nominal bore of not less than 65 mm.

3) Concealed space below a precalculated ordinary-hazard class installation. Two feed pipes, one for the concealed space and one for the room sprinklers, shall be used fed by a common feed pipe of not less than 65 mm nominal bore.

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

5) Protection in a space above or below a fully hydraulically calculated installation. The pressure/flow characteristics of the installation shall be satisfactory under each of the following operating conditions:

i) when the appropriate density and AMAO are needed wholly in the room;

ii) when the appropriate density and AMAO given in Table 53 are needed wholly in the concealed space;

Table 53 — Sprinkler protection of concealed spaces

Class of protection in room		Concealed space pipework design		Concealed space maximum area per sprinkler, or treat as hazard class listed
Pipework design method	Hazard class	Nominal size as for hazard class listed	AMAO as for hazard class listed	
				m^2
Precalculated	Light	Light	—	Light
	Ordinary	Ordinary Ordinary	— —	21 Ordinary
	High	Ordinary Ordinary	— —	21 Ordinary
Fully calculated	Light	—	Light	Light
	Ordinary	— —	Ordinary, group I or II Ordinary, group as room	21 Ordinary
	High	— —	Ordinary, group III Ordinary, group III	21 Ordinary

iii) in the case of a gridded or looped installation layout in the room, when 50 % of the AMAO relevant to the concealed space is in simultaneous operation with that for the room.

COMMENTARY AND RECOMMENDATIONS ON **24.1.4**.

*Hydraulic calculations, formulae and requirements, together with pipework losses are to be found in clause **18**; installation pressure and flow requirements in clause **15**. See clause **2** and Figure 2 for terms referring to the various types of range pipe array.*

24.2 Precalculated sprinkler pipe arrays

24.2.1 *General*

24.2.1.1 Range pipe sizes and the maximum number of sprinklers fed by each size of pipe in the range shall be neither more nor less than as specified in **24.2.2**, **24.2.3**, and **24.2.4** according to range pipe layout (except in the case of light-hazard where the pipes feeding the terminal three sprinklers on a range only are specified).

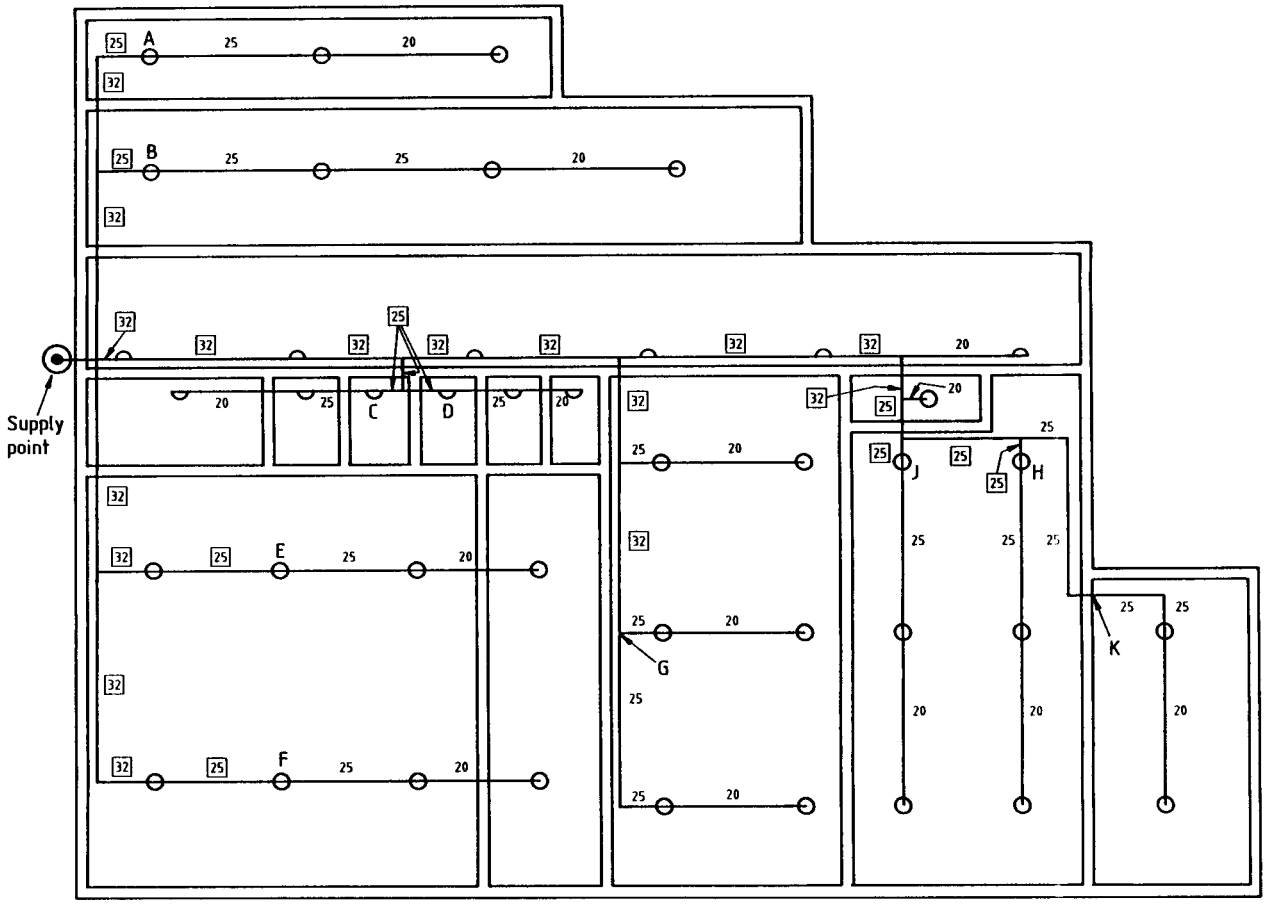
24.2.1.2 The size of distribution feed pipes, including in light-hazard installations any which are partly range pipes because of the three sprinkler limitation, shall be as specified in the tables from the terminal point(s) up to the design point(s).

24.2.1.3 Feed pipe between the installation main control valves and the design point shall be hydraulically calculated on the basis of a maximum flow loss (specified in the appropriate subclause), corrected for static head gain for design points not at the highest level, at a particular flow rate.

24.2.1.4 Where the number of sprinklers in an array in a room, or in an area protected by a distinct group of sprinklers having its own distribution pipe spur, is less than or equal to the number of sprinklers for which the distribution pipes are hydraulically designed, the design point shall be positioned at the point of connection to the distribution pipe of the range of the array which is hydraulically nearest to the installation control valves (see C in Figure 29).

24.2.1.5 Where the number of sprinklers in an array in a room on a distribution pipe terminal spur exceeds the number for which the distribution pipes are hydraulically designed, the design point shall be positioned at the point of connection to the range or ranges immediately upstream of the group of ranges containing not more than the maximum specified number of sprinklers beyond the design point (see Figure 28 to Figure 32).

24.2.1.6 Risers or drops, connecting ranges to distribution pipes, and pipes longer than 300 mm connecting single sprinklers to distribution pipes, shall be considered to be distribution pipes and sized accordingly. The design point shall be positioned at the point of connection of the riser, drop or single sprinkler pipe to the horizontal distribution pipe run when designing the hydraulically determined length of feed pipe (see Figure 1 where pipe A is sized according to the distribution pipe tables).



NOTE 1 Pressure loss between supply point and: A (two sprinkler point) is 0.7 bar
B (three sprinkler point) is 0.7 bar
C, D, E, F, G, H, J and K (two sprinkler points) is 0.9 bar

NOTE 2 Dimensions shown as [25] or [32] indicate probable pipe sizes resulting from hydraulic design of arrangement.

NOTE 3 Pipe sizes are in mm.

Figure 28 — Example of application of design points in a light-hazard installation

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

COMMENTARY AND RECOMMENDATIONS ON **24.2.1.** *The maximum number of sprinklers beyond the design point is specified in Table 54, Table 58, Table 62 and Table 63.*

Note that the water supply running pressures are specified relative to the height of the highest sprinkler above the control valve "C" gauge, and not to the height of the highest design point.

24.2.2 *Light hazard*

24.2.2.1 Range and terminal spur distribution pipe sizes. The nominal size of range pipe and terminal distribution pipes, i.e. distribution pipes downstream of the design point, shall be as given in Table 54.

COMMENTARY AND RECOMMENDATIONS ON **24.2.2.1.** *Light-hazard installations differ from ordinary- or high-hazard installations in that sprinklers may be fed directly from distribution pipes (see Figure 28).*

24.2.2.2 *Distribution pipe (except terminal spurs).* All pipe-work between the installation main control valves and the design point at each extremity of an installation array at the highest level shall be sized by hydraulic calculation using the values of Table 55 and Table 56.

The design point shall be the two sprinkler point, except where a range carries four or more sprinklers and either runs along the apex of a ridge roof or is the only line along a narrow room or corridor, in which case it shall be the three sprinkler point.

Where there are more than two sprinklers on any range pipe the pressure loss between the two sprinkler point and the entry point from the distribution pipe to the range shall be calculated using column A of Table 56. The loss of pressure in distribution pipework between the point of entry to the range pipe at the extremity of the installation and the installation main control valve set shall be calculated using column B of Table 56.

Where the sprinkler arrays in an installation are at different levels the specified maximum total pressure loss between the control valve "C" gauge and a design point lower than the highest design point shall be increased by the difference in static pressure between that particular design point and the highest design point, subject to the distribution pipe nominal pipe bore being not less than the minimum nominal pipe bore specified in Table 54 for the range pipe fed from the design point.

Table 54 — Light-hazard range pipe and terminal distribution pipe sizes

Pipe material	Nominal size	Maximum length[a]	Maximum number of sprinklers allowed on pipe of size stated
	mm	m	
Copper	15	1[b]	1
	22	8	1
	22	N/A	3[c]
	28		
Steel	20	8	1
	25	N/A	3[c]

[a] Including allowance for changes of direction (see Table 56).
[b] No elbows fitted; 500 mm if one elbow fitted.
[c] The limit of three sprinklers does not preclude the use of 25 mm nominal bore steel or 28 mm copper pipe between the 2/3 sprinkler design point and the installation control valves if hydraulic calculation shows this to be possible, nor does it follow that 25 mm steel or 22 mm copper pipe may be used between the 3rd and 4th sprinklers where the two sprinkler point is the design point.

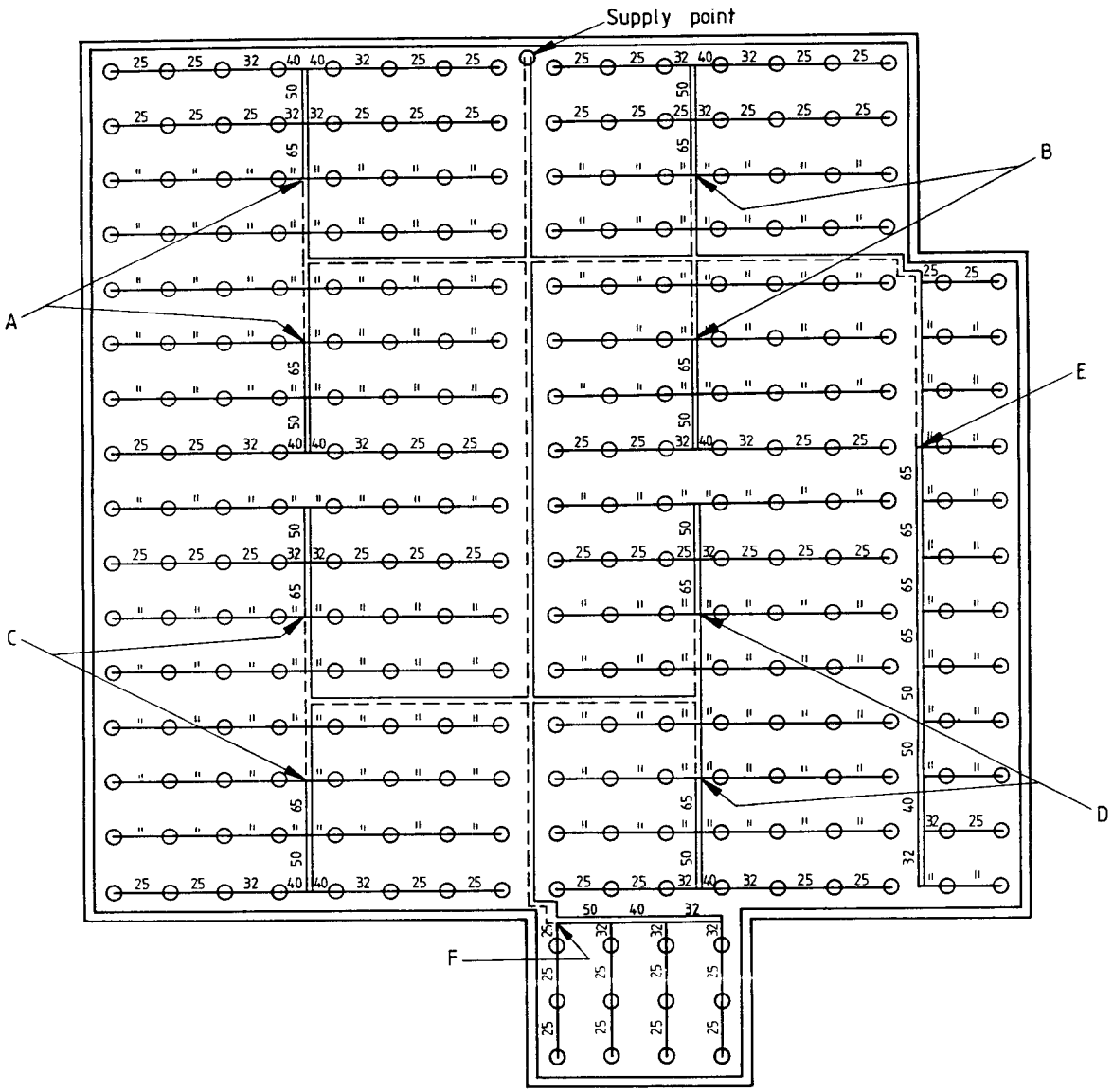
Table 55 — Maximum pipe flow loss between installation control valve set and each design point in light-hazard installations

Design point	Maximum friction loss including changes of direction	Range and distribution pipe loss
	bar	
Two sprinkler point	0.9	See columns A and B of Table 56
Three sprinkler point	0.7	See column B of Table 56
Two sprinkler point in narrow room or range at roof apex each with single line of three sprinklers	0.7	See column B of Table 56

Table 56 — Pressure loss per unit length of pipe for design flow rates in light-hazard installations

Pipe type	Nominal size	Pressure loss/unit length	
		Column A	Column B
	mm	mbar/m	mbar/m
Steel complying with BS 1387 Medium grade	20	135	606
	25	44	200
	32	12	51
	40	5.5	25
	50	1.7	7.8
	65	0.49	2.2
Copper complying with Table X of BS 2871-1:1971	15	976	4 381
	22	142	638
	28	40.1	179
	35	13.8	62
	42	5.3	25
	54	1.5	6.6
	76	0.27	1.2

NOTE 1 The equivalent length of an elbow, bend or tee where the water is turned through an angle shall be taken as 2 m in using the table or in using clause **18** data.
NOTE 2 Where heavy grade steel tube complying with BS 1387 is used calculate the pressure loss from the data in clause **18** using a flow rate of 100 L/min in place of column A and 225 L/min in place of column B.



NOTE 1 Pipe sizes are in min.

NOTE 2 There are 276 sprinklers spaced on a 3.46 m square grid (one per 12 m^2). The hydraulic lengths between the supply point and design points are approximately as follows:

A: 46 m;
B: 43 m;
C: 64 m;
D: 71 m;
E: 69 m;
F: 72 m.

The maximum size of distribution pipe is 100 mm; valves are 100 mm.

Figure 29 — Example of application of design points in an ordinary-hazard installation

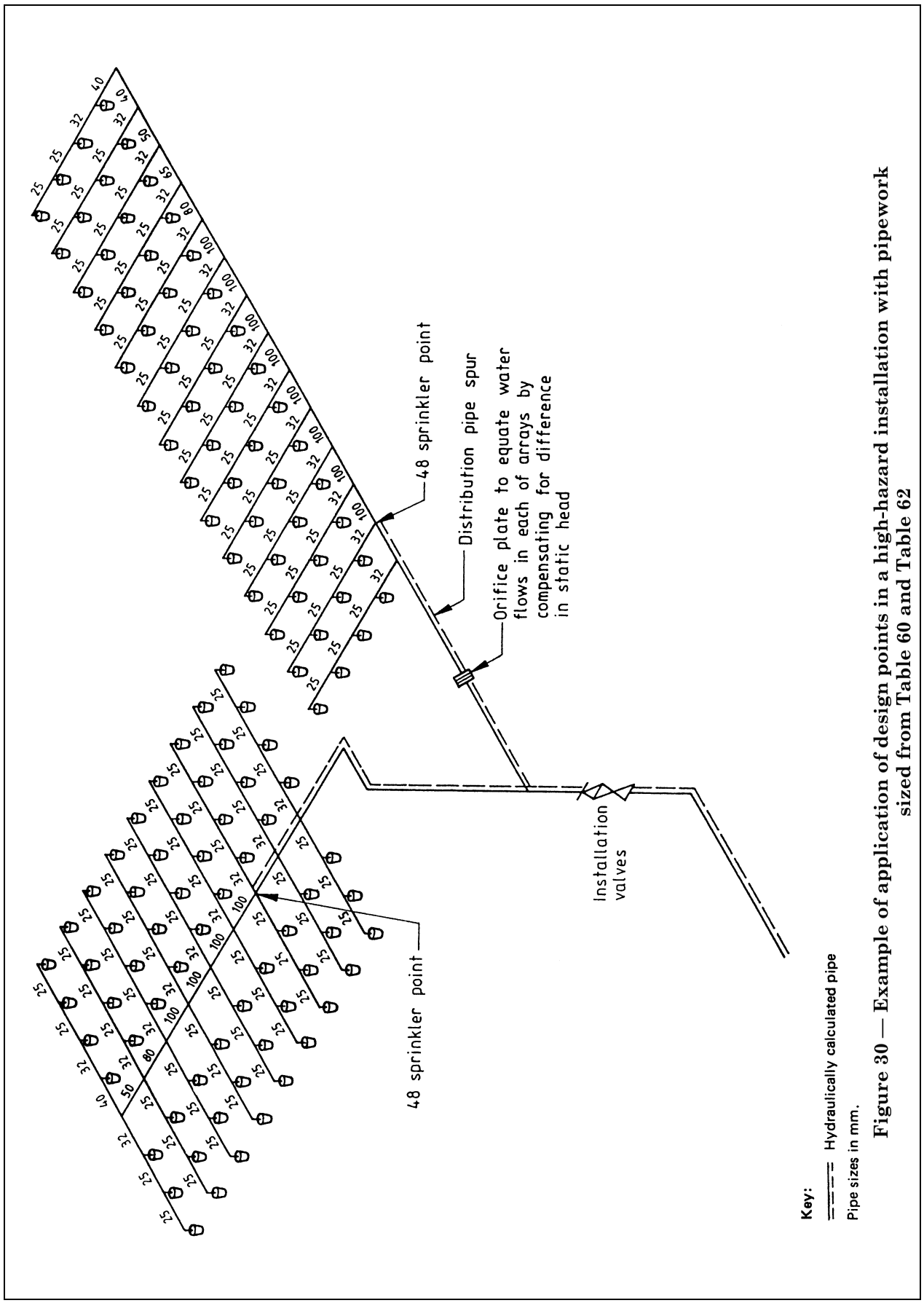
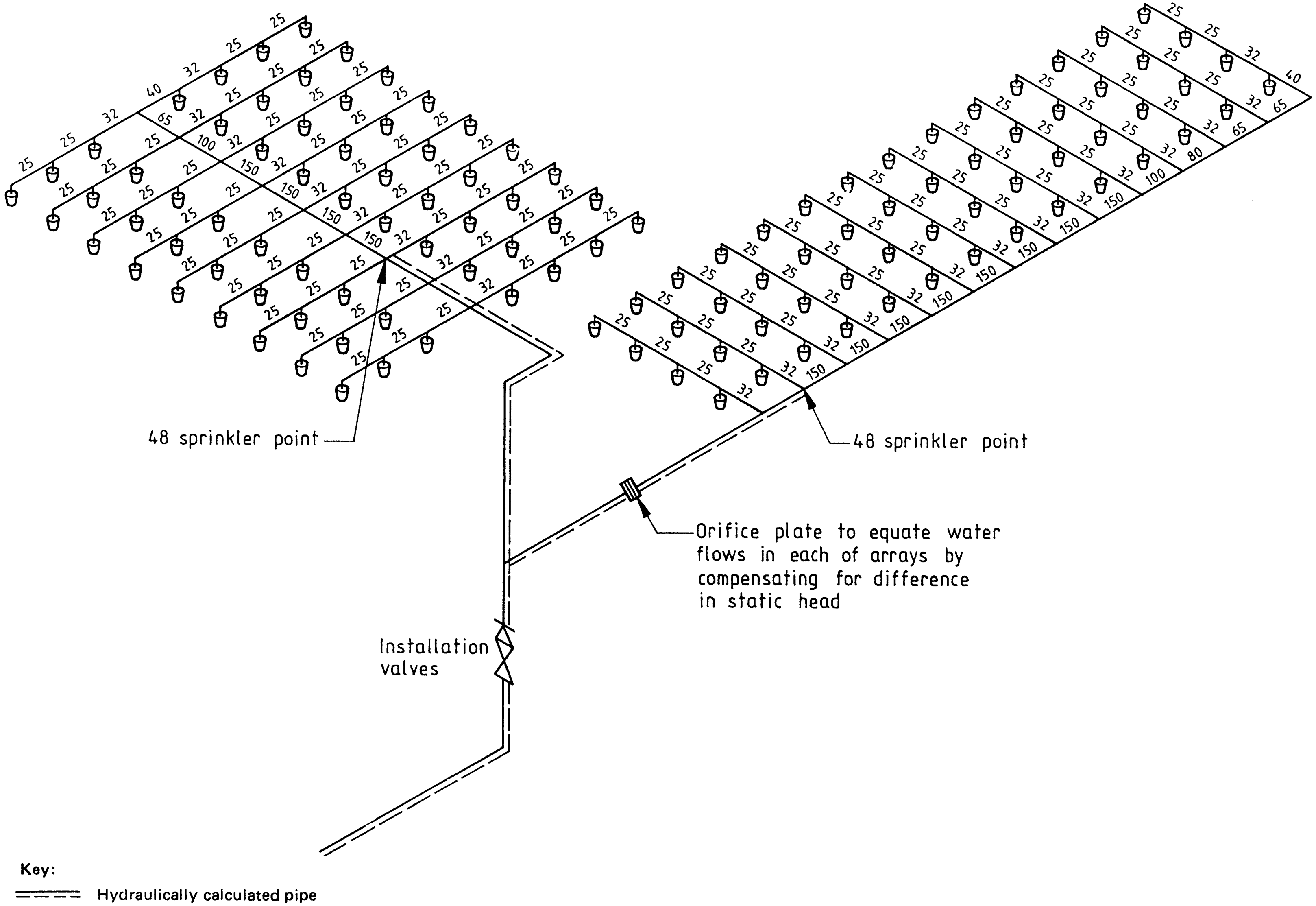
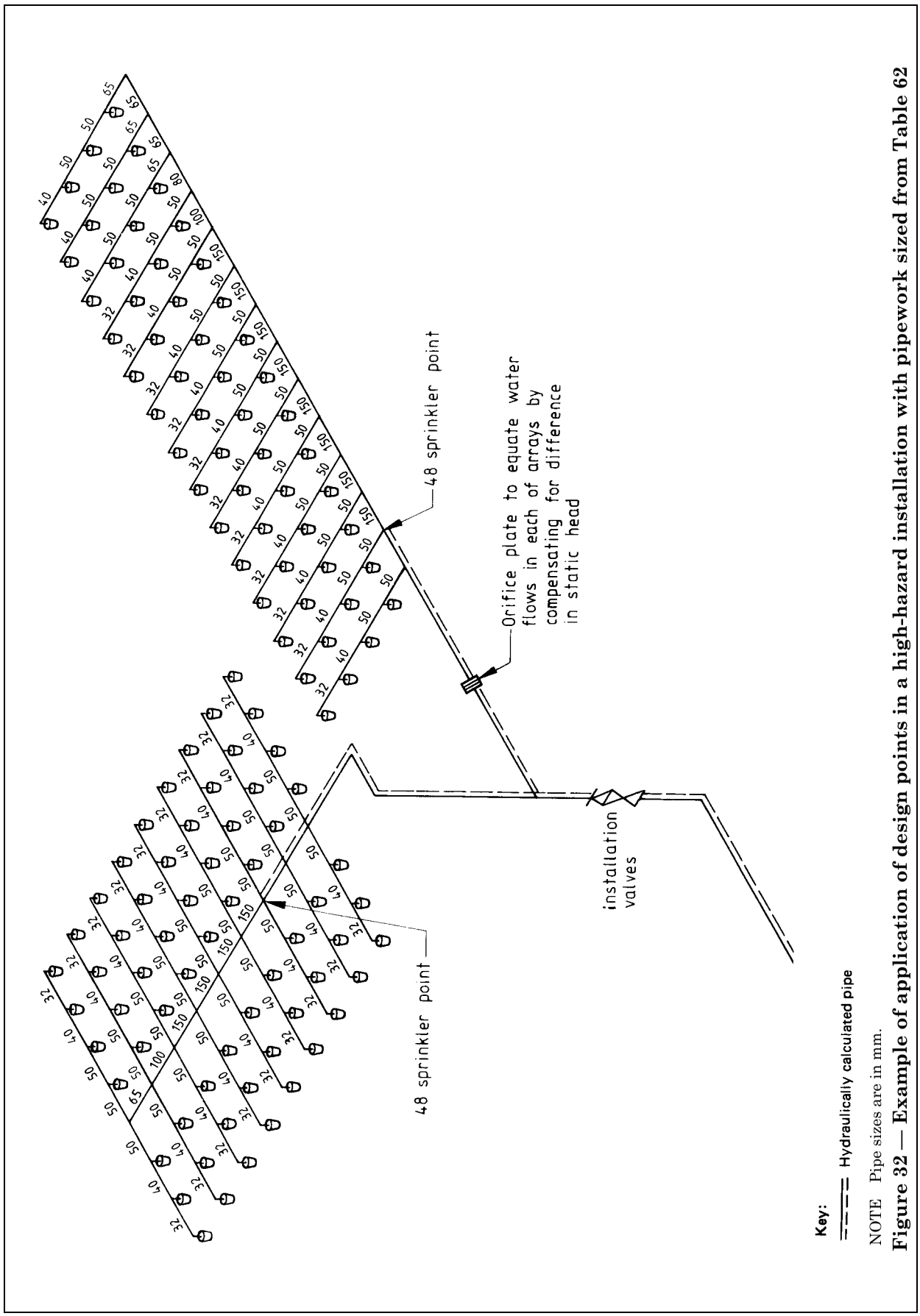


Figure 30 — Example of application of design points in a high-hazard installation with pipework sized from Table 60 and Table 62



NOTE Pipe sizes are in mm.

Figure 31 — Example of application of design points in a high-hazard installation with pipework sized from Table 60 and Table 63



NOTE Pipe sizes are in mm.

Figure 32 — Example of application of design points in a high-hazard installation with pipework sized from Table 62

Table 57 — Range pipe nominal sizes for various pipe layouts in ordinary-hazard installations

Range pipe layout	Pipe nominal size	Maximum number of sprinklers to be fed by pipe of size listed
	mm	
a) Ranges at remote end of each distribution pipe spur		
1) last two ranges in two end-side layout	25	1
	32	2
2) last three ranges in three end-side layout	25	2
	32	3
3) last range in all other layouts	25	2
	32	3
	40	4
	50	9
b) All other ranges	25	3
	32	4
	40	6
	50	9

24.2.3 ***Ordinary hazard***

24.2.3.1 *Range pipe and terminal distribution pipe sizes.* Range pipe nominal bores shall be as given in Table 57.

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

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

Table 58 — Distribution pipe nominal sizes in ordinary-hazard installations, and maximum number of sprinklers downstream of design point

Pipe layout	Distribution pipe nominal size	Maximum number of sprinklers to be fed by pipe of size listed
	mm	
a) Two end-side layout	32	2
	40	4
	50	8
	65[a]	16[a]
b) All other layouts	32	3
	40	6
	50	9
	65[a]	18[a]

[a] This does not preclude the use of 65 mm nominal bore pipe between the 16/18 sprinkler point and the installation main control valves if it complies with the hydraulic calculation requirements (see **24.2.3.2**).

Precalculated distribution pipe nominal bores downstream of the design point shall comply with Table 58.

24.2.3.2 *Distribution pipe (except terminal pipe).* The main distribution and distribution pipes (including all risers and drops), between

in low-rise installations, the highest design point in the installation and the sprinkler installation main control valve set, or

in high-rise installations, the highest design point in each zone and the zone subsidiary stop valve at the same floor valve

shall be sized by hydraulic calculation based on the values of Table 59. The maximum friction loss shall not exceed 0.5 bar at a flow rate of 1 000 L/min.

The feed pipe for all other design points (secondary design points) in the installation shall be similarly sized by hydraulic calculation. The friction loss in any part of the feed pipe not common with that feeding the highest design point (referred to in the previous paragraph) may be increased by not more than the pressure equivalent of the height between the design point under consideration and the highest design point.

The design point shall be the 16 sprinkler point for two end-side sprinkler range pipe layouts and the 18 sprinkler point for all other layouts.

Where the sprinkler arrays in an installation are at different levels the specified maximum total pressure loss between the control valve "C" gauge and a design point lower than the highest design point shall be increased by the difference in static pressure between that particular design point and the highest design point, subject to the distribution pipe nominal pipe bore being not less than the minimum nominal pipe bore specified in Table 58 for the range pipe fed from the design point.

Table 59 — Pressure loss per unit length of pipe for design flow rates in ordinary-hazard installations

Pipe nominal bore (BS 1387: Medium grade)	Pressure loss per unit length
mm	mbar/m
65	35
80	16
100	4.4
150	0.65
200	0.16

NOTE 1 The equivalent length of an elbow, bend or tee where the water is turned through an angle shall be taken as 3 m when using the table or clause **18** data.
NOTE 2 Where heavy grade steel pipework is used calculate the pressure loss from the data in clause **18** using a flow rate of 1 000 L/min.

COMMENTARY AND RECOMMENDATIONS ON **24.2.3.2**.
The 65 mm *minimum nominal diameter feed pipe limitation, and the requirement that pipes may only diminish in size in the direction of water flow to the sprinklers, may result in the feed pipe friction loss being less than* 0.5 bar *plus any static pressure gain.*

Where feed pipe losses are calculated as specified for a secondary design point the pipe friction in the feed pipe from the valves to the secondary design point will be not more than 0.5 bar *plus the static head difference between that design point and the highest design point in the installation.*

*Indication of the highest sprinkler above the datum point, and details of the hydraulically most remote design point, are given on the wall-mounted block plan (see **29.1**).*

Table 60 — Range pipe nominal sizes for various pipe layouts, for high-hazard installations with sprinklers of 15 mm nominal size and pressure-flow characteristics as given in Table 16 or Table 17

Range pipe layout	Pipe nominal size	Maximum number of sprinklers to be fed by pipe of size listed
	mm	
a) Ranges at remote end of each distribution pipe spur		
1) Two end-side, last two ranges	25	1
	32	2
2) Three end-side, last three ranges	25	2
	32	3
3) All other layouts, last range	25	2
	32	3
	40	4
b) All other ranges	25	3
	32	4

24.2.4 ***High hazard***

24.2.4.1 *Range pipe and terminal distribution pipe sizes.* Range pipe nominal bores shall be as given in Table 60 or Table 61 depending upon the sprinkler nominal size and the table in which the water supply pressure-flow characteristic is specified (i.e. Table 16, Table 17, Table 18 or Table 19).

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

Precalculated distribution pipe nominal bores downstream of the design point shall be as given in Table 62 or Table 63 depending upon the sprinkler head nominal size and the table in which the water supply pressure-flow characteristic is specified (i.e. Table 16, Table 17, Table 18 or Table 19).

24.2.4.2 *Distribution pipe upstream of the design point.* The main distribution and distribution pipes between each sprinkler design point and the main installation control valve set shall be sized by hydraulic calculation using the pipe friction loss per unit length given in Table 64 for the flow specified in **15.2.3**.

The design point shall be the 48 sprinkler point or if appropriate as specified in **15.2.3**, **15.2.4** or **24.2.1.4**.

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

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

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

b) fitting an orifice plate complying with **24.1.3** in the particular distribution pipe (see Figure 30 to Figure 32).

24.3 Fully hydraulically calculated pipe arrays

24.3.1 *General.* The requirements of this clause apply to pipe arrays sized by full hydraulic calculation.

COMMENTARY AND RECOMMENDATIONS ON **24.3.1**.
*Any pipe layout may be used subject to the sprinkler spacing and location requirements of this clause and clause **26**.*

24.3.2 *Minimum pipe sizes.* The nominal bore of main and other distribution pipes, and range pipes shall be not less than as follows:

a) in a light-hazard installation	20 mm (steel), or 22 mm (copper), or as given in Table 54 for single sprinklers
b) in an ordinary or high-hazard installation	25 mm

24.3.3 *Maximum range pipe size.* The nominal bore of range pipes shall be not more than 65 mm, except where individual sprinklers are connected to pipes exceeding 65 mm nominal bore when the arrangement shall comply with **24.1.2**.

Table 61 — Range pipe nominal sizes for various pipe layouts, in high-hazard installations with sprinklers of 15 mm nominal size and pressure-flow characteristics as given in Table 18, or of 20 mm nominal size and pressure-flow characteristics asgiven in Table 19

Range pipe layout	Pipe nominal size	Maximum number of sprinklers to be fed by pipe of size listed
	mm	
a) End-side arrangements		
1) Last three ranges	40	1
	50	3
	65	6
2) Other ranges	32	1
	40	2
	50	4
	65	6
b) End-centre arrangements		
1) Two end-centre layout		
i) Last three ranges	32	1
	40	2
ii) Other ranges	32	2 (32 mm feed to each)
2) Three and four end-centre layouts, all ranges	32	1
	40	2
	50	4

Table 62 — Distribution pipe nominal sizes feeding various numbers of sprinklers downstream of the design point, in high-hazard installations with sprinklers of 15 mm nominal size and pressure-flow characteristics as given in Table 16

Distribution pipe nominal size	Maximum number of sprinklers to be fed by pipe of size listed
mm	
32	2
40	4
50	8
65	12
80	18
100	48[a]

[a] This does not preclude the use of 100 mm nominal size pipe between the design point and the installation main control valves if it complies with the hydraulic calculation requirements (see **24.2.4.2**).

Table 63 — Distribution pipe nominal sizes feeding various numbers of sprinklers downstream of the design point in high-hazard installations with sprinklers of 15 mm nominal size and pressure-flow characteristics as given in Table 17 or Table 18, or sprinklers of 20 mm nominal size and pressure-flow characteristics as given in Table 19

Range pipe layout	Distribution pipe nominal size	Maximum number of sprinklers to be fed by pipe of size listed
	mm	
Four end-side	65	8
All other layouts	50	4
	65	8
	80	12
	100	16
	150	48[a]

[a] This does not preclude the use of 150 mm nominal size pipe between the design point and the installation main control valves if it complies with hydraulic calculation requirements (see **24.2.4.2**).

24.3.4 *Density of discharge.* The minimum density of discharge from each AMAO, 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 **14**.

Where possible the density of discharge shall be taken as the total flow from a group of four sprinklers which are most closely adjacent (in standard layout four sprinklers lying on the corners of a matrix cell square or rectangle, or in a staggered layout four sprinklers on the corners of a notional parallelogram), in L/min divided by four times the area (in m^2) of the notional square, rectangle or parallelogram on the corners of which the sprinklers lie. Where fewer than four sprinklers are in open communication, the minimum density shall be taken as the lowest value of the flow from any sprinkler divided by the area covered by the sprinkler. The area covered shall be taken as that 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 (see Figure 33).

COMMENTARY AND RECOMMENDATIONS ON **24.3.4**.

*Where the boundary is irregular the nearby sprinkler layout is also irregular, the density of discharge should be taken as the flow from four sprinklers, divided by the sum of the areas (see **24.3.6.3**) covered by each sprinkler.*

24.3.5 *Minimum sprinkler flow pressure.* The calculated discharge pressure at roof or ceiling sprinkler, or an intermediate sprinkler, other than a rack or shelf sprinkler, when all the sprinklers in an AMAO plus the required number of any intermediate sprinklers are discharging simultaneously, and the predicted pressure at the "C" gauge is available from the supply, shall be not less than as given in Table 65.

COMMENTARY AND RECOMMENDATIONS ON **24.3.5**.

*Note that the predicted pressure at the "C" gauge in the case of a town main is only a proportion of that actually available (see **17.1.1.4**). Where there are pumped supplies the requirements of **17.4.6.4** may affect the pump pressure rating.*

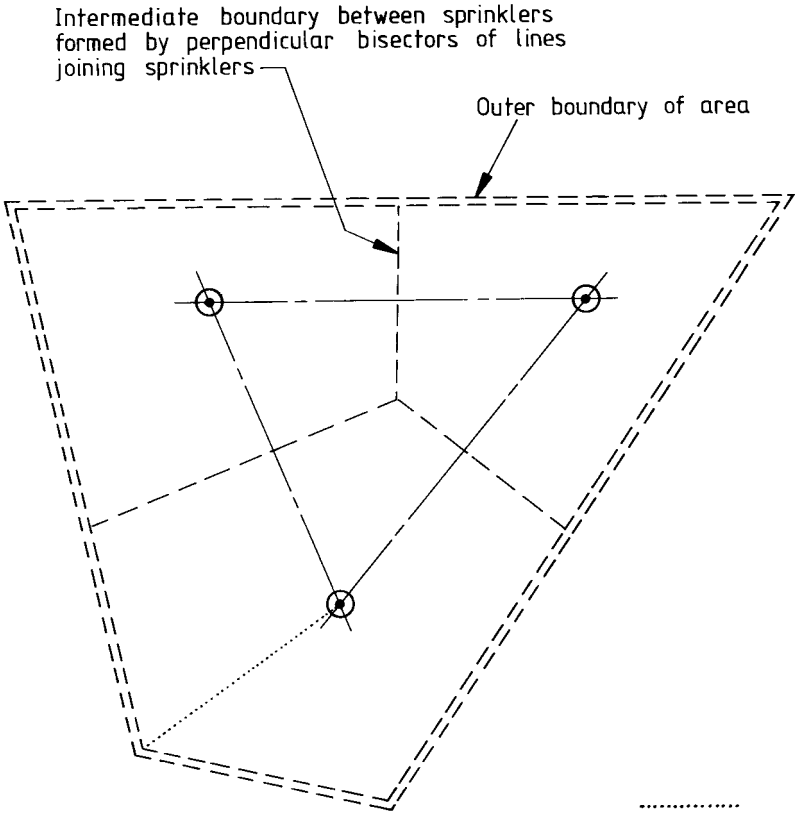


Figure 33 — Area covered by individual sprinklers where less than four sprinklers are in open communication

Table 64 — Pressure loss per unit length of pipe for design flow rates in high-hazard installations

Flow rate	Pressure loss per unit length			
	100 mm nominal size Medium grade pipe complying with BS 1387	150 mm nominal size Medium grade pipe complying with BS 3601	200 mm nominal size 5.4 mm wall complying with BS 3601	250 mm nominal size 7.1 mm wall complying with BS 3601
L/min	mbar/m	mbar/m	mbar/m	mbar/m
1 000	4.4	0.65	0.16	0.054
1 500	9.3	1.4	0.35	0.12
2 000	16	2.4	0.59	0.20
2 300	21	3.0	0.76	0.25
3 050	34	5.1	1.3	0.43
3 800	52	7.7	1.9	0.64
4 550	72	11	2.7	0.90
4 850	82	12	3.0	1.0
6 400	140	20	5.1	1.7
7 200	170	25	6.3	2.1
8 000	210	31	7.7	2.6
8 800	250	36	9.1	3.0
9 650	290	43	11	3.6

NOTE 1 Values may be interpolated.
Where another grade of pipe is used calculate the pressure loss from the data in clause **18** using the appropriate flow rate.
NOTE 2 The equivalent length of an elbow, bend or tee where the water is turned through an angle shall be taken as 3 m when using the table or clause **18** data.

*Note that where there are sprinklers at levels other than that of the roof or ceiling (i.e. in racks), simultaneous operation of AMAOs may be specified (see clause **14**) and the design density is to be achieved by each relevant AMAO simultaneously.*

*See **14.6.3** for the relative positions of AMAOs for roof or ceiling sprinklers and intermediate sprinklers.*

*See **14.6.2** for intermediate level rack or shelf sprinkler pressures, which are higher than those given in Table 65.*

Table 65 — Minimum sprinkler discharge pressure for non-rack sprinklers in fully hydraulically calculated installations

Hazard class	Minimum pressure at any discharging sprinkler
	bar
Light	0.7
Ordinary	0.35
High	0.5

24.3.6 *Number of sprinklers in AMAO*

24.3.6.1 *AMAO.* The AMAO shall be either:

a) as specified for each layout in clause **14**; or

b) the area in open communication (i.e. where sprinklers may be expected to operate during the same fire incident) of the hazard class concerned;

whichever is the smaller.

Where different hazard classes are in adjacent areas and in open communication the AMAO of the highest class shall apply and any excess area specified in clause **14** shall be assumed to be in operation in the hydraulically least favourable position in an adjacent part of the lesser hazard area.

Where the total area in open communication is less than the AMAO specified in clause **14**, the whole area shall be assumed to be in simultaneous operation.

COMMENTARY AND RECOMMENDATIONS ON **24.3.6.1**.
It is essential that the lower-hazard area operates with its own appropriate AMAO contained wholly within it, or with the total area in operation where this is less.

24.3.6.2 *Number of sprinklers in AMAO.* The number of sprinklers in simultaneous operation shall be integral and not less than N, given by the equation:

$$N = \frac{A}{a} + R$$

where

A is the roof or ceiling sprinkler AMAO (in m^2);

a is the mean floor area covered by each roof or ceiling sprinkler in the AMAO under consideration (in m^2);

R is the number of sprinklers located under obstructions in the area of operation.

COMMENTARY AND RECOMMENDATIONS ON **24.3.6.2**.
*See **26.8** for sprinkler under extensive platforms, when it may be necessary to include the roof/ceiling sprinklers in the hydraulic calculations relating to the platform sprinklers.*

24.3.6.3 *Area covered by individual sprinkler.* In a square or rectangular matrix array the area covered by an individual sprinkler not on the boundary of the array shall be the floor area contained by a notional square or rectangle formed by the two centre lines between the sprinkler and the two adjacent sprinklers on the range, and the two centre lines between the range pipe carrying the sprinkler and the two adjacent range pipes [see Figure 34(a)].

In a staggered array the area covered by an individual sprinkler shall be that of the floor area contained by a notional parallelogram formed by the centre lines between the range pipe carrying the sprinkler and the two adjacent range pipes and the lines joining points on the range pipe sections midway between the sprinkler and each of the two adjacent sprinklers on the range and the corresponding positions on the two adjacent ranges [see Figure 34(b)].

COMMENTARY AND RECOMMENDATIONS ON **24.3.6.3**.
*Where a sprinkler is on the boundary of the area concerned, the area covered between it and the adjacent sprinklers away from the boundary should be calculated using **24.3.6.3**, and the area covered on the boundary side of the sprinkler determined using the layout plan by the following procedure:*

a) *draw lines joining the sprinklers along the boundary;*

b) *draw perpendicular to the lines, from the mid-point of each of the lines between adjacent sprinklers, to the boundary;*

c) *measure the area between the boundary, the projected centre lines and the lines joining the sprinkler to the adjacent pair of boundary sprinklers.*

*This area added to the area (calculated as specified in **24.3.6.3**) between the sprinkler and those further from the boundary is the area covered by the sprinkler.*

Where sprinklers adjacent to irregular boundary sprinklers are as a result irregularly spaced, and also where as a result the number of sprinklers per range pipe varies, the procedure shown in Figure 34 may be adopted to establish the area per sprinkler.

24.3.7 *Locations of AMAO*

24.3.7.1 *Hydraulically most unfavourable location.* Changes in sprinkler spacing, array design, elevation, range centres, sprinkler nominal 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 AMAO.

COMMENTARY AND RECOMMENDATIONS ON **24.3.7.1**.
Full calculation for each possible location is necessary except where it is obvious that an array is similar to another array under consideration and is hydraulically nearer the water supply.

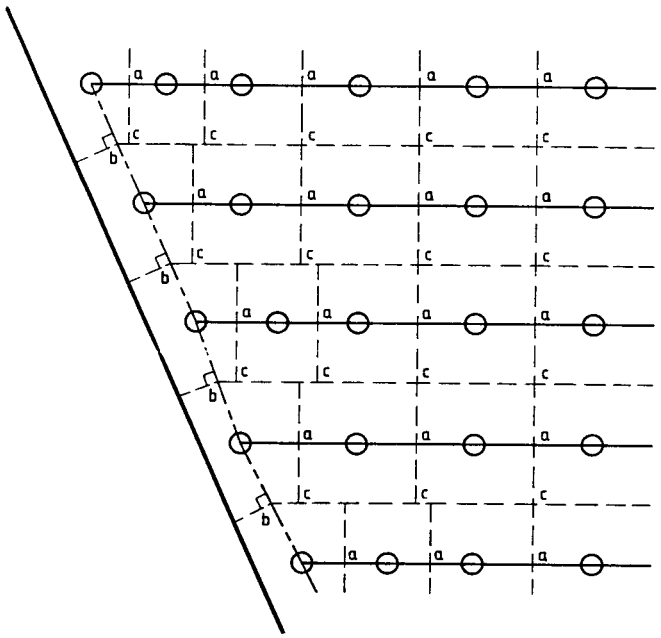
24.3.7.2 *Hydraulically most favourable location.* All possible locations, whether on the distribution pipes, or between distribution pipes where these are connected by ranges, shall be considered for the hydraulically most favourable location of the AMAO.

COMMENTARY AND RECOMMENDATIONS ON **24.3.7**.
*See the commentary and recommendations on **24.3.5**.*

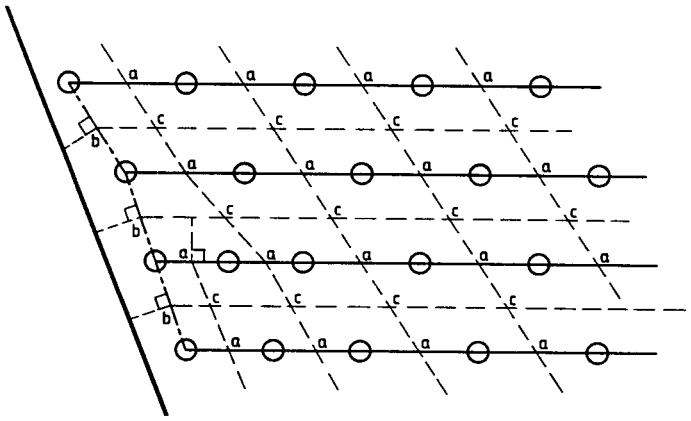
*Continuous operation of the maximum AMAO or AMAOs at the relevant hydraulically most unfavourable locations creates the most adverse pressure condition. This is used to establish that the minimum sprinkler discharge pressure and the required density averaged over any four adjacent sprinklers are achieved (see **24.3.4**).*

Continuous operation of the AMAO or AMAOs at the hydraulically most favourable location(s) in the installation gives the flow rate which is used to determine that the design is compatible with the water supply pressure-flow characteristic(s).

Proof of the correct position of the hydraulically most favourable AMAOs in the case of gridded installations entails displacing the area of operation by one sprinkler pitch in each direction along ranges and by one range pipe in each direction along distribution pipes. In any layout it may be necessary to examine other possible locations because of sloping range effects, changes of sprinkler pitch or range spacing, changes of sprinkler elevation or orifice size, change of range pipe size or irregular layout owing to building constraints.



(a) standard layout



(b) staggered layout

Key:

right angle	zone boundary line
a mid-point along range pipe	range pipe
b mid-point between sprinklers	intermediate boundary line (between areas covered by adjacent sprinklers)
c mid-point between ranges	drawing construction line
	sprinkler

Figure 34 — Area covered by individual sprinklers (large arrays)

24.3.8 ***Shape of AMAO***

24.3.8.1 *Hydraulically most unfavourable location.* The following shall be considered.

a) *Terminal spur and looped distribution pipe installations with spur ranges.* In the hydraulically most unfavourable location the shape of the maximum AMAO shall be as near as possible rectangular. One side shall be defined by the range, or range pair where there is an end-centre arrangement.

Sprinklers not constituting a full range or range pair shall be grouped as close as possible to the distribution pipe on the next upstream range row to the rectangular area (see Figure 35 and Figure 36).

b) *Gridded installations.* Where ranges run parallel to the ridge of a roof which has a slope greater than 6°, or along bays formed by beams greater than 1.0 m deep, the shape of the AMAO for the hydraulically most unfavourable location shall be rectangular with a length (L) greater than or equal to twice the square root of its area, i.e.:

$$L \geq 2 \times A^{1/2}$$

In all other cases the shape of the AMAO shall be rectangular with a length (L) greater than or equal to 1.2 times the square root of its area, i.e.:

$$L \geq 1.2 \times A^{1/2}$$

where

L is dimension of area parallel to range pipes (in m);

A is AMAO (in m^2).

both measured in the horizontal plane.

The AMAO shall be either symmetrical with respect to the sprinkler layout matrix; or substantially symmetrical with any sprinklers not forming a full range length grouped on the more favourably placed adjacent range at the hydraulically most favourable end of the area (see Figure 37).

24.3.8.2 *Hydraulically most favourable location.* The following shall be considered.

a) *Terminal spur and looped distribution pipe installations with spur ranges.* In the hydraulically most favourable location the shape of the AMAO shall be as near as possible square, and shall where possible comprise sprinklers on one distribution pipe only. The number of sprinklers calculated to be operating on ranges, or range pairs in end-centre installations, shall be located on each range or range pair at the hydraulically most favourable location. Sprinklers not constituting a full range or range pair shall be located on the next range row at the hydraulically closest locations (see Figure 35 and Figure 36).

b) *Gridded installations.* The AMAO shall be as nearly as possible square and located equidistant from contained lines of sprinklers on each opposite side.

The number of sprinklers calculated to be operating shall be located on ranges at the hydraulically most favourable location, with any sprinklers to make up the AMAO, as in a) above, located on the next range row at the hydraulically closest locations (see Figure 37).

COMMENTARY AND RECOMMENDATIONS ON **24.3**.
*See clause **18** and subclauses headed "Fully hydraulically calculated installations" in other relevant clauses. The requirements of **24.3.2** may also be applied to deluge installations.*

25 Sprinkler, multiple control and sprayer design characteristics and uses

25.1 General

Sprinklers, multiple controls, sealed or unsealed medium-velocity sprayers and high-velocity sprayers installed in sprinkler installations shall be suitable for fire protection service.

Only new sprinkler and medium-velocity sprayers shall be used. Multiple controls shall be either new or reconditioned and pressure tested by the original manufacturer.

Sprinkler heads, multiple controls and medium-or high-velocity sprayers shall not be painted except for identification purposes. They shall not be altered in any respect nor have any type of ornamentation or coating (other than as specified in **25.11**) applied after despatch from the production factory.

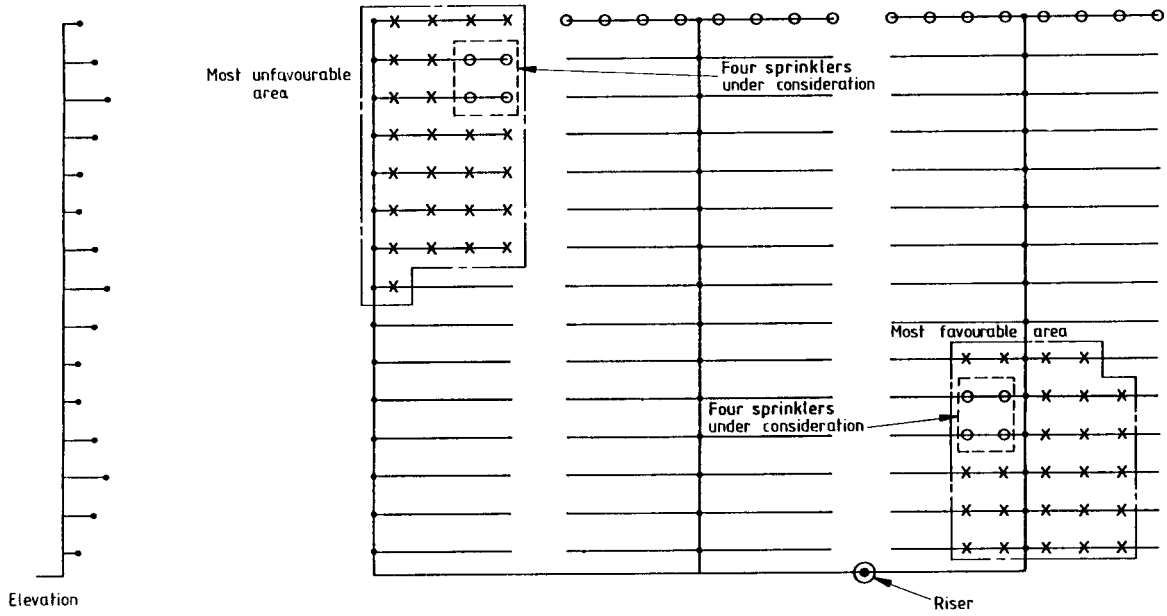


Figure 35 — Typical hydraulically most favourable/unfavourable locations of AMAO in an installation with terminal main distribution piping

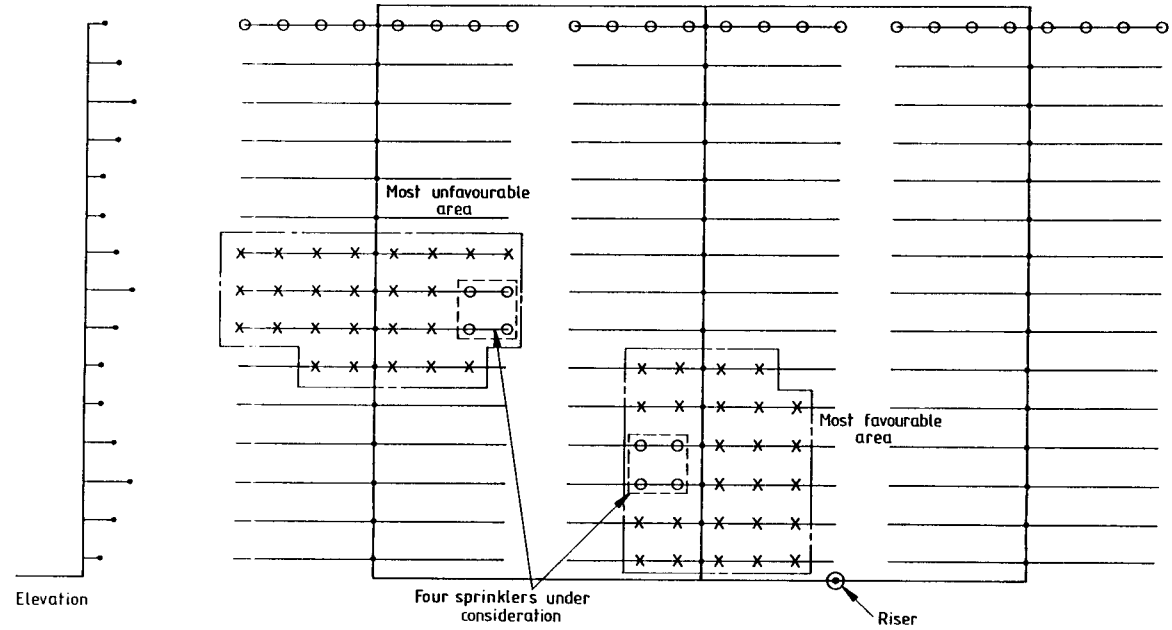


Figure 36 — Typical hydraulically most favourable/unfavourable locations of AMAO in an installation with looped distribution piping

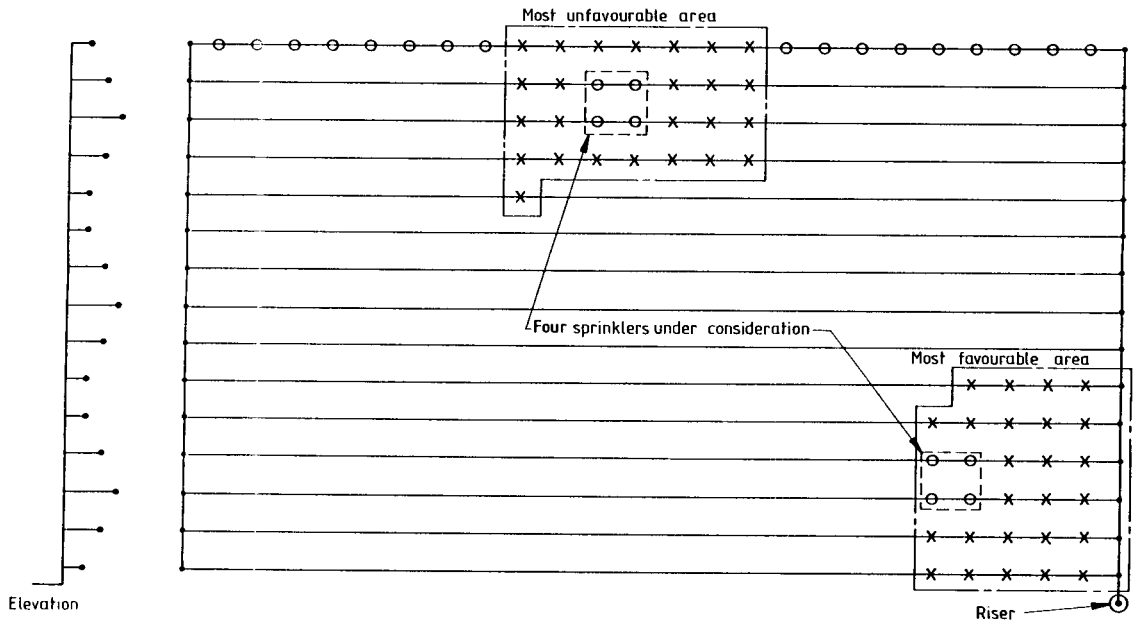


Figure 37 — Typical hydraulically most favourable/unfavourable locations of AMAO in an installation with gridded piping

25.2 Sprinkler types and applications

25.2.1 *Types.* Sprinklers shall be of the following types:

a) conventional pattern (see **2.65**);

b) spray pattern (see **2.77**);

c) ceiling or flush pattern (see **2.63**);

d) recessed pattern (see **2.74**);

e) concealed pattern (see **2.64**);

f) sidewall pattern (see **2.76**).

25.2.2 *Applications.* Sprinklers shall be selected for use in accordance with Table 66, and as specified in **25.2.3**, **25.2.4** and **25.2.5**.

COMMENTARY AND RECOMMENDATIONS ON **25.2.2**.
Conventional pattern sprinklers may be installed as needed under roofs, ceilings, platforms, shelves, etc. and in racks and concealed spaces.

25.2.3 *Spray pattern.* Spray pattern sprinklers shall not be used as follows:

a) in high-hazard, high-piled storage applications; or

b) as roof or ceiling sprinklers in ordinary-or high-hazard applications where there is exposed structural steelwork or where the roof or ceiling or its support structure is of combustible material.

25.2.4 *Ceiling or flush, recessed and concealed pattern.* Ceiling or flush, recessed and concealed sprinklers shall be installed only in light-or ordinary-hazard areas.

Those sprinklers without fixed deflectors, that is with retracted deflectors that drop to the normal position on actuation, shall not be fitted as follows:

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

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

c) in racks or under shelves.

COMMENTARY AND RECOMMENDATIONS ON **25.2.4**.
Typical applications are hotel lobbies and dining rooms, offices, boardrooms, and parts of retail stores. Ceiling or flush sprinklers and concealed pattern sprinklers may respond more slowly than conventional or spray pattern sprinklers.

25.2.5 *Sidewall pattern.* Sidewall sprinklers shall not be installed in high-hazard applications or above suspended ceilings.

Table 66 — Sprinkler types and sizes for various hazard classes

Hazard class and sprinkler location	Pattern of sprinkler	Sprinkler nominal orifice size	
		Precalculated installations	Fully hydraulically calculated installations
		mm	mm
Light hazard	Any	10	10
Ordinary hazard	Conventional Spray Ceiling or flush Recessed Concealed	15	10 or 15
	Sidewall	15	15
High hazard Ceiling or roof sprinklers	Conventional or spray	15 or 20	15 or 20
High hazard Intermediate sprinklers in piled storage	Conventional	—	15

COMMENTARY AND RECOMMENDATIONS ON **25.2.5**.
Sidewall pattern sprinklers may be used under flat ceilings or roofs as a substitute for conventional or spray pattern sprinklers in offices, entrance halls, shop windows, lobbies, corridors, etc; or where condensate from centrally installed pipework and sprinklers might drip onto product below, e.g. in drying ovens and under hoods over papermaking machines; or under platforms, etc. where headroom is low.

25.3 Multiple controls

The temperature-sensitive element of a multiple control shall have one of the temperature ratings given in Table 67 or Table 68.

Table 67 — Fusible link sprinkler ratings and colour code

Temperature rating	Colour of yoke arms
°C	
57/77	Natural (uncoloured)
80/107	White
121/141	Blue
163/191	Red
204/246	Green
260/302	Orange
320/343	Black

Table 68 — Glass bulb sprinkler temperature ratings and colour code

Temperature rating	Colour of bulb liquid
°C	
57	Orange
68	Red
79	Yellow
93	Green
141	Blue
182	Mauve
227/260	Black

25.4 Medium- and high-velocity sprayers

25.4.1 *Medium-velocity sprayer.* A medium-velocity sprayer of the sealed type shall be of one of the temperature ratings, and shall be appropriately colour coded, as given in Table 67 or Table 68.

25.4.2 *High-velocity sprayer.* A high-velocity sprayer shall be of the open (unsealed) type. Any means employed to prevent ingress of foreign matter into the nozzle shall be removable without detriment to the water spray discharge pattern by the commencement of water discharge, and shall be fitted in the manufacturer's works and shall be suitable for sprinkler use.

25.5 Sprinkler size and k factor

25.5.1 *Sprinkler nominal orifice size.* A sprinkler shall have a nominal orifice size of 10 mm, 15 mm or 20 mm, and the *k* factor shall be as given in Table 69.

COMMENTARY AND RECOMMENDATIONS ON **25.5.1**.
*The orifice size (in mm) is marked on the body or deflector of the sprinkler (see **31.6**).*

The k factor is given by the formula:

$k = Q/\sqrt{P}$

where

Q = *the flow through the sprinkler orifice (in* L/min*);*

P = *the pressure at entry to the sprinkler shank or in the case of pendent or upright dry sprinklers at the entry to the drop or rise pipe (in bar).*

25.5.2 *Shank thread.* The shank thread nominal size shall be related to the nominal orifice size as given in Table 69.

COMMENTARY AND RECOMMENDATIONS ON **25.5.2**.
This prevents inadvertent interchange between sprinklers of different orifice size and water flow performance when replacing sprinklers in an installation.

25.5.3 *Water flow calculations.* The water flow through a sprinkler shall be calculated from:

$Q = k\sqrt{P}$

using the mean value, given in Table 69, of the k factor.

COMMENTARY AND RECOMMENDATIONS ON **25.5.3**.
For dry sprinklers (pendent or upright) the k factor inludes the friction loss in the drop or rise pipe of the unit. However the static head gain or loss in the drop or rise pipe respectively has to be allowed for in the calculation.

25.6 Temperature ratings and colour coding

Sprinklers shall have one of the temperature ratings given in Table 67 or Table 68 and shall be correspondingly colour coded.

25.7 Selection of temperature rating

25.7.1 *General.* The temperature rating of a sprinkler shall be not less than 30 °C greater than the highest expected ambient temperature of the location.

COMMENTARY AND RECOMMENDATIONS ON **25.7.1**.
For normal conditions in temperate climates sprinkler temperature ratings of 68/74 °C *should be installed. Unventilated concealed spaces and unventilated shop or show windows should be given special consideration; the sprinkler temperature rating may need to be higher than elsewhere in the premises.*

25.7.2 *High-piled storage hazards with intermediate sprinklers.* In high-hazard installations protecting high-piled storage with intermediate sprinklers, the roof or ceiling sprinklers shall have a temperature rating of 141 °C.

COMMENTARY AND RECOMMENDATIONS ON **25.7.2**.
Intermediate sprinklers within or at the top of racks (palletized or shelved) should be rated in accordance with ambient temperature and not at 141 °C *as specified for the roof or ceiling sprinklers.*

25.7.3 *Glazed roofs and plastics roof lights.* Under glazed roofs or where there are roof lights of PVC, or similar plastics material, the sprinkler rating shall be either 79 °C to 100 °C, or 141 °C for high-piled storage.

COMMENTARY AND RECOMMENDATIONS ON **25.7.3**.
Solar heating may cause high ambient temperatures.

See ***26.9.4*** *for restrictions on sprinkler protection under plastics roof lights.*

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

25.8 Sprinkler guards

Any sprinkler, other than ceiling or flush sprinkler, installed in a position at risk of accidental damage shall be fitted with a metal guard suitable for sprinkler service.

COMMENTARY AND RECOMMENDATIONS ON **25.8**.
It is particularly important in cold stores and in racks to ensure that sprinklers are installed in positions where there is no likelihood of mechanical damage through movements of goods.

Table 69 — Sprinkler nominal threads, orifice sizes and k factors

Sprinkler nominal orifice size	Sprinkler nominal thread size	Mean value of k factor	Limiting values of k factor			
			Dry sprinklers		All other sprinklers	
			Not less than	Not more than	Not less than	Not more than
mm	mm					
10	10	57	52	62	54	60
15	15	80	74	86	76	84
20	20	115	106	124	109	121

25.9 Sprinkler water shields

A sprinkler installed in a rack or under a perforated shelf, platform or the like, where water from a higher sprinkler or sprinklers (including roof or ceiling sprinklers) may cause wetting in close proximity to the bulb or fusible element, shall be fitted with a metal water shield of nominal diameter 75 mm.

The water shield shall not be attached directly to an upright sprinkler deflector or yoke assembly. Any bracket support shall form a minimal obstruction to the sprinkler water distribution.

25.10 Sprinkler rosettes

Sprinkler rosettes shall be of metal or thermosetting plastics material and shall be suitable for sprinkler service.

Rosettes 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.

25.11 Corrosion-protection of sprinklers and multiple controls

Sprinklers and multiple controls used in premises identified in b) and c) of the commentary and recommendations to **5.5** or elsewhere where corrosive vapours are prevalent shall either:

a) have corrosion-resistant coatings applied by the manufacturer which are suitable for sprinkler service; or

b) be coated twice with good-quality petroleum jelly once before and once after installation.

The anti-corrosion treatment shall not be applied to the body of any glass bulb.

25.12 Frost protection of sprinklers

Plastics or paper or other covers shall not be fitted over sprinklers in wet or alternate installation to prevent frost damage.

COMMENTARY AND RECOMMENDATIONS ON **25.12**.
*The practice of fitting covers over sprinklers as a protection against frost is undesirable as it slows down the operation of the sprinklers, and may impair the distribution of water. Covers may be necessary in hazards such as paint spray booths (see **35.2.3**).*

26 Sprinkler spacing, arrangement and location

26.1 Maximum spacing between sprinklers and maximum area protected per sprinkler

26.1.1 *General.* All measurements of distance between sprinklers or of areas covered by groups of individual sprinklers shall be taken in the horizontal plane.

COMMENTARY AND RECOMMENDATIONS ON **26.1.1**.
Although the dimensions for sprinkler spacing and area are taken in a horizontal plane, in hydraulic calculations the dimensions are true lengths, measured along the slope of a pipe.

26.1.2 *Orientation.* Sprinklers shall be installed upright or pendent as recommended by the manufacturer, with the deflector parallel to the slope of the roof, ceiling or pitch line of stairs.

COMMENTARY AND RECOMMENDATIONS ON **26.1.2**.
Sprinklers are therefore orientated upright or pendent relative not to the horizontal plane but to the roof ceiling or staircase.

26.1.3 *Sprinklers installed under roofs, ceilings and platforms*

26.1.3.1 A line of sprinklers shall be fitted at the apex (and any sub-apex formed by a wall or partition) if:

a) the slope of the ceiling or roof is greater than 1 in 3 (i.e. is greater than 18½° to the horizontal); and

b) the ranges run parallel to the roof ridge, i.e. the sprinklers are not valley fed, with the axis of the sprinkler positioned vertically;

unless there is a row of sprinklers not more than 750 mm distant radially from the apex or sub-apex.

26.1.3.2 Where sprinklers are installed under roofs, ceilings, platforms or similar planar surfaces, the area covered by a sprinkler and the distance between adjacent sprinklers shall be not more than as given in Table 70, for non-sidewall sprinklers, or Table 71 for sidewall sprinklers, or Table 71 and **26.1.3.3** for combinations of sidewall and non-sidewall sprinklers.

26.1.3.3 Where both sidewall and ceiling sprinklers are used the ceiling sprinklers shall be installed in standard layout. The layout shall be staggered relative to the sidewall sprinklers which shall be directly opposite the sprinklers on opposite walls.

The boundary of the sidewall sprinkler coverage shall be taken as not more than 3.7 m from, and parallel to, the walls against which the sidewall sprinklers are mounted. The space between the sidewall sprinkler boundaries parallel to the opposite walls is to be protected by the ceiling sprinklers in standard layout (see Table 70).

COMMENTARY AND RECOMMENDATIONS ON **26.1.3**.

Staggered spacing is used only in ordinary-hazard installations (see Table 70 and Figure 38) and where sidewall sprinklers are used on either side of a room over certain lengths and widths in light-hazard installations (see Table 71).

Where sidewall sprinklers are installed under non-fire resisting ceilings, the spacing along walls is reduced (see Table 71).

Figure 39 shows typical sidewall sprinkler layouts.

When an ordinary-hazard installation is to be upgraded to high hazard, using 12 m^2 *maximum coverage area, it is essential that either the installation be fully hydraulically calculated or the correct column of Table 16, Table 17, Table 18 or Table 19 be used.*

26.1.4 ***Intermediate sprinklers in high-hazard occupancies***

26.1.4.1 *High-hazard intermediate sprinklers in non-shelved racks.* Intermediate sprinklers shall be provided for palletized rack storage and multiple row drive through storage (see type S5 in Table 1) as specified in Table 72 as follows.

a) Single row racks not more than 3.2 m wide shall be protected by single rows of sprinklers fitted or on the side of the stack not used for access.

b) Racks more than 3.2 m wide, but not more than 6.0 m wide, shall be protected by two rows of sprinklers. The rows shall be not more than 3.2 m apart and the rows shall be the same distance from their nearer shelf edge. The sprinklers at a particular level in each line shall be located in the same set of transverse flues.

c) Double row racks not more than 3.2 m wide centrally in the longitudinal flue space shall be protected by sprinklers, at the stack ends, and at the tier levels specified in Table 72.

d) Where any rack or structural steelwork will significantly interfere with the water distribution from a sprinkler, an additional sprinkler shall be provided to compensate.

COMMENTARY AND RECOMMENDATIONS ON **26.1.4.1**.

Type S5 covers racked storage heights in excess of those in Table 1 or where the aisles between stacks are less than 1.2 m *wide, and intermediate sprinklers are specified. See also* ***5.4.3****.*

Table 70 — Maximum coverage and maximum spacing for non-sidewall sprinklers

Hazard class	Maximum area coverage per sprinkler ($S \times D$ in Figure 38)	Maximum distance between sprinklers			
		Spacing pattern (see Figure 38)			
		Standard layout		Staggered layout	
		Along range *"S"* in Figure 38	Between ranges *"D"* in Figure 38	Along range *"S"* in Figure 38	Between ranges *"D"* in Figure 38
	m^2	m	m	m	m
Light	21, see note 1	4.6, see note 1	4.6, see note 1	—	—
Ordinary	12, see note 2	4.0, see note 2	4.0, see note 2	4.6, see note 2	4.0, see note 2
High	9, see note 3	3.7	3.7	—	—

NOTE 1 In attics, basements, boiler rooms, kitchens, laundries, storage areas and workrooms the maximum area coverage shall be 9.0 m^2, and the maximum spacing 3.7 m, or above the suspended ceilings of open construction, 3.0 m.

NOTE 2 In cold storage warehouses using the air circulation method of refrigeration, corn, provender and rice mills not using pneumatic conveying, film and television production studios, the stage areas of theatres and above open suspended ceilings, the area coverage of a sprinkler shall be not more than 9.0 m^2 and the spacing between sprinklers, along and between ranges shall be not more than 3.0 m. See **5.5**, **26.9.1** and **26.9.2**.

NOTE 3 12 m^2 where there is no exposed structural steelwork, and where there is a clear space of not less than 2 m below the sprinklers.

Table 71 — Maximum coverage and maximum spacing for sidewall sprinklers

Hazard class	Maximum area coverage per sprinkler	Spacing along walls		Room width		Room length	Number of rows of sidewall sprinklers	Spacing pattern (horizontal plane)
		Between sprinklers	Sprinkler to wall end	more than	not more than			
	m^2	m	m	m	m	m		
Light	17	4.6	2.3	—	3.7	Any	1	Single line
				3.7	7.4	Not more than 9.2	2	Standard
						More than 9.2	2	Staggered
				7.4	—	Any	2[a]	Standard
Ordinary	9	3.4[b]	1.8	—	3.7	Any	1	Single line
				3.7	7.4	Not more than 6.8[c]	2	Standard
						More than 6.8[c]	2	Staggered
				7.4	—	Any	2	Standard[a]

[a] Additional row or rows of roof or ceiling sprinklers required.
[b] 3.7 m if the ceiling has a fire resistance of not less than 2 h.
[c] 7.4 m if the ceiling has a fire resistance of not less than 2 h.

Table 72 — Location of intermediate sprinklers in type S5 storage (beam pallet racking)

Highest category of goods in the rack	Location of rows at least at	Maximum vertical distance between rows	Each transverse flue and stack ends protected at least at	Maximum distance between sprinklers in row	Minimum clearance between sprinkler deflector in any row and storage immediately below	Illustrated in
		m		m	mm	
I or II	every other tier (see note 2)	3.5	every fourth tier	2.8	150	Figure 41
III	every other tier (see note 2)	3.5	every alternate tier	1.4	150	Figure 42
IV	every tier	2.3	every alternate tier	2.8	150	Figure 43

NOTE 1 See Figure 40 for an illustration of the terms "flue", "row" and "tier".
NOTE 2 Where the number of tiers is odd the rows of sprinklers shall be provided at each even-numbered tier, and if the goods in the top tier are not protected by the roof or ceiling sprinklers, for example if the top surface of the goods is more than 3.0 m below the roof or ceiling sprinklers, also above the top tier.

14.4.5.2 *deals with racks where the roof or ceiling sprinklers are not more than* 3 m *above the stored goods.*

Intermediate sprinklers in racks usually need to be fitted with water shields (see ***25.9****).*

Requirements for racking more than 6.0 m *in width are not given in this specification. The fire insurer and/or the fire authority should be consulted at the planning stage.*

Figure 40 gives the terms used.

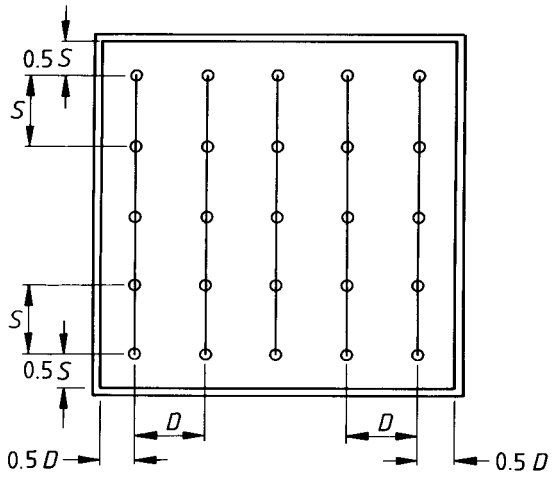
Figure 41 to Figure 43 show typical rack protection arrangements for the various categories of high-hazard goods.

See ***21.2.2*** *for protection of pipes and sprinklers from damage.*

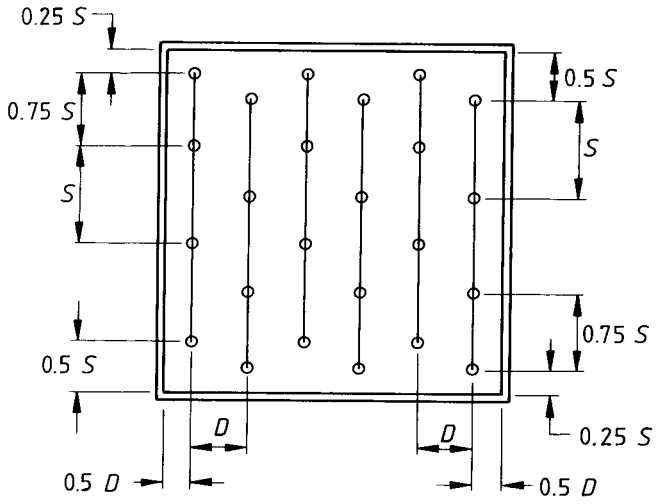
26.1.4.2 *High-hazard, intermediate sprinklers below solid or slatted shelves in racks.* Intermediate sprinklers shall be provided above each shelf (including the top shelf if the roof or ceiling sprinklers are more than 3 m above the goods and water access to the goods is restricted), as given in Table 73. The maximum goods heights per shelf shall be as specified in Table 1.

Single rows of sprinklers shall be central above shelves Double rows shall be positioned so that the rows are the same distance from their nearer shelf edge.

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



(a) Standard layout (rectangular matrix)



(b) Staggered layout for ordinary hazard systems where *S* is to exceed 4 m

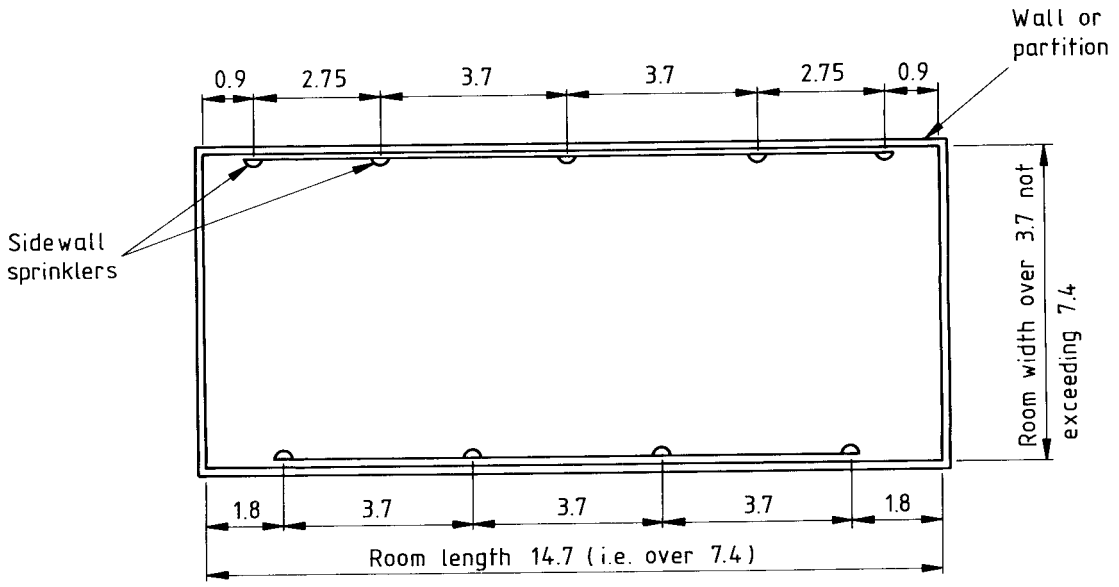
Key:

S is spacing between sprinklers on range pipes

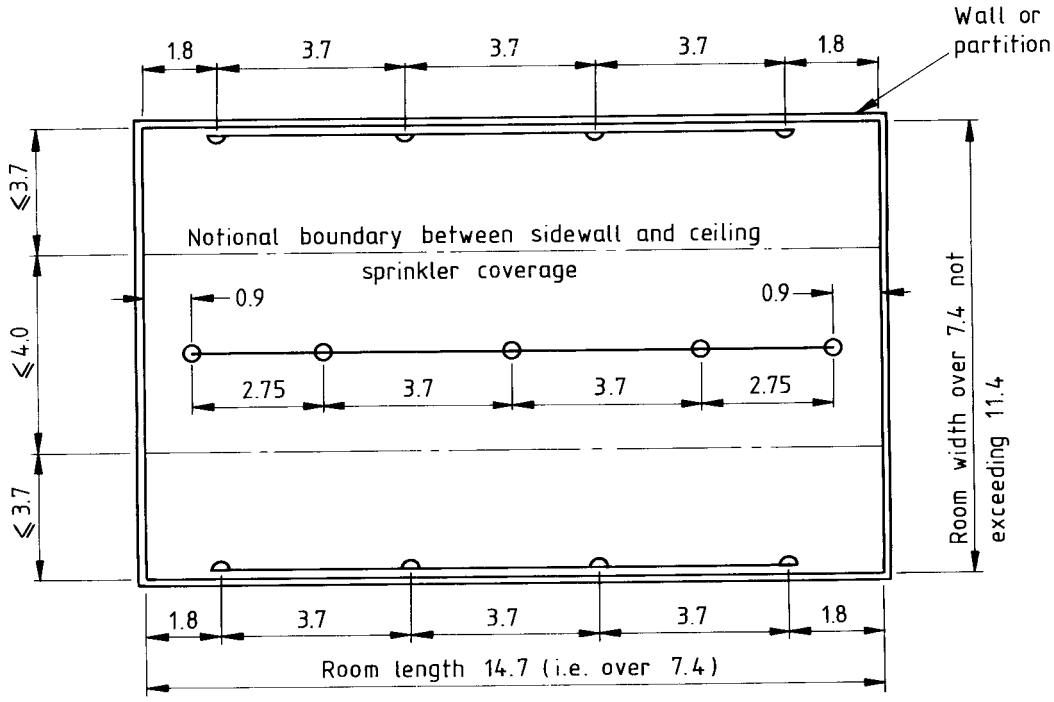
D is spacing between range pipes

All dimensions shown are in metres.

Figure 38 — Ceiling sprinkler spacing



(a) Rooms over 3.7 m but not more than 7.4 m wide



(b) Rooms more than 7.4 m but not more than 11.4 m wide

All dimensions shown are in metres.

Figure 39 — Sidewall sprinkler spacing

COMMENTARY AND RECOMMENDATIONS ON **26.1.4.2**. *See Figure 44 for an illustration of the application of Table 73.*

Shelves over 1.0 m *wide but not exceeding* 6.0 m, *constitute type S7 storage (see Table 1).*

*Where shelves are slatted sprinkler water shields may be needed (see **25.9**).*

26.1.4.3 *High-hazard, intermediate sprinklers in racks or below walkways in potable spirit barrel stores.* The following shall be considered.

a) *Class S9.* Where intermediate sprinklers are provided below walkways (see **14.5.1**) the sprinklers shall be spaced not more than 3.5 m apart along the walkways and shall be placed under walkways at not greater than 6.5 m vertical separation, with a row of sprinklers under the lowest walkway which shall not be more than 6.5 m from the floor.

The area coverage per intermediate sprinkler shall be not more than 11 m^2.

The sprinklers shall be staggered in relation to the rows immediately above and below. A sprinkler shall be positioned at the end of the stack in each alternate vertical layer (see Figure 45).

There shall be a clear space of not less than 0.5 m between each sprinkler deflector and the level of the highest part of the barrels below.

b) *Class S10.* Where intermediate sprinklers are provided in barrel stacks (see **14.5.2**) the sprinklers shall be spaced not more than 7.0 m apart along range lines. The area coverage per intermediate sprinkler shall be not more than 7.0 m^2. A range line shall be installed over each vertical gap between barrel ends. At each level the sprinklers in each row shall be staggered in relation to the adjacent rows.

A sprinkler shall be positioned at the end of the stack at any given level in each alternate vertical gap (see Figure 46).

There shall be a clear space of 0.5 m from the deflector of each intermediate sprinkler to the top of the barrels in the layer immediately below.

COMMENTARY AND RECOMMENDATIONS ON **26.1.4.3**. *See Figure 45 and Figure 46 for illustrations of the application of intermediate sprinklers to type S9 and S10 storage.*

The distance between adjacent walkways at a given level in type S9 storage is controlled by the walk way sprinkler maximum area coverage of 11 m^2 *and the maximum spacing between sprinklers requirement of* 3.5 m.

*See **14.6** for minimum intermediate sprinkler flow pressure and the numbers of sprinklers assumed to be in simultaneous operation.*

*Water shields may be needed (see **25.9**).*

26.2 Minimum spacing between sprinklers

Sprinklers shall not be spaced less than 2.0 m apart except as follows:

a) either where the heat-sensitive elements of the sprinklers are protected from wetting by an adjacent sprinkler, either by a sheet metal baffle not less than 200 mm wide and 150 mm high located midway between the sprinklers (when the baffle is fitted on the range pipe its top edge shall extend above the sprinkler deflector by 50 mm to 75 mm), or by an intervening constructional feature; or

b) where the sprinkler spacing in a rack is determined by the distance between transverse flues in the racks (see Table 72).

26.3 Maximum sprinkler spacing from boundaries

26.3.1 *Non-sidewall sprinklers*

26.3.1.1 Standard layout shall be used and no part of the boundary shall be more than 1.5 m from a line projected along the range lines, or perpendicular to the range lines through the sprinklers, where the following apply:

a) ceilings are open joisted; or

b) the roof has rafters exposed; or

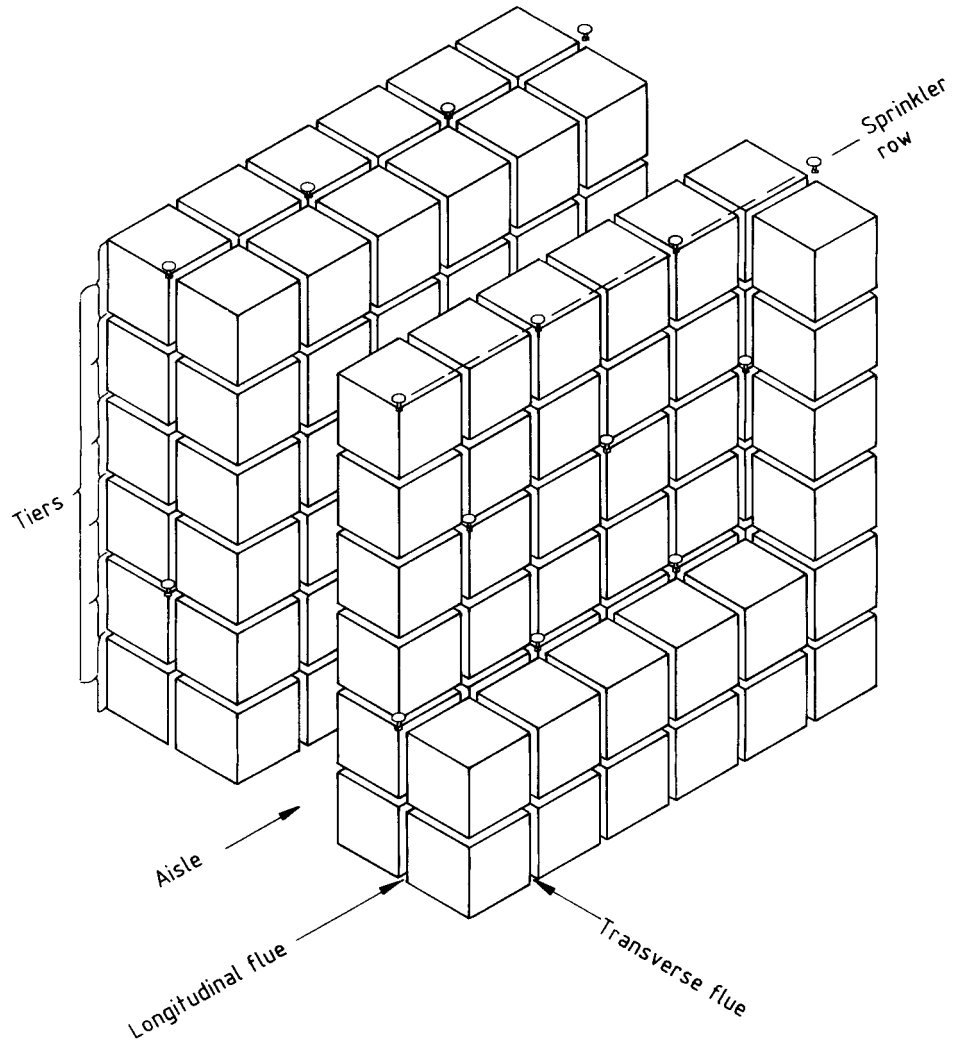
c) external walls are of combustible material; or

d) external walls are of asbestos cement or metal, with a combustible lining; or

e) external walls are of metal (whether on wood or metal frame with or without combustible lining) protected with a coating of bitumen, tar or pitch or with material impregnated with bitumen, tar or pitch; or

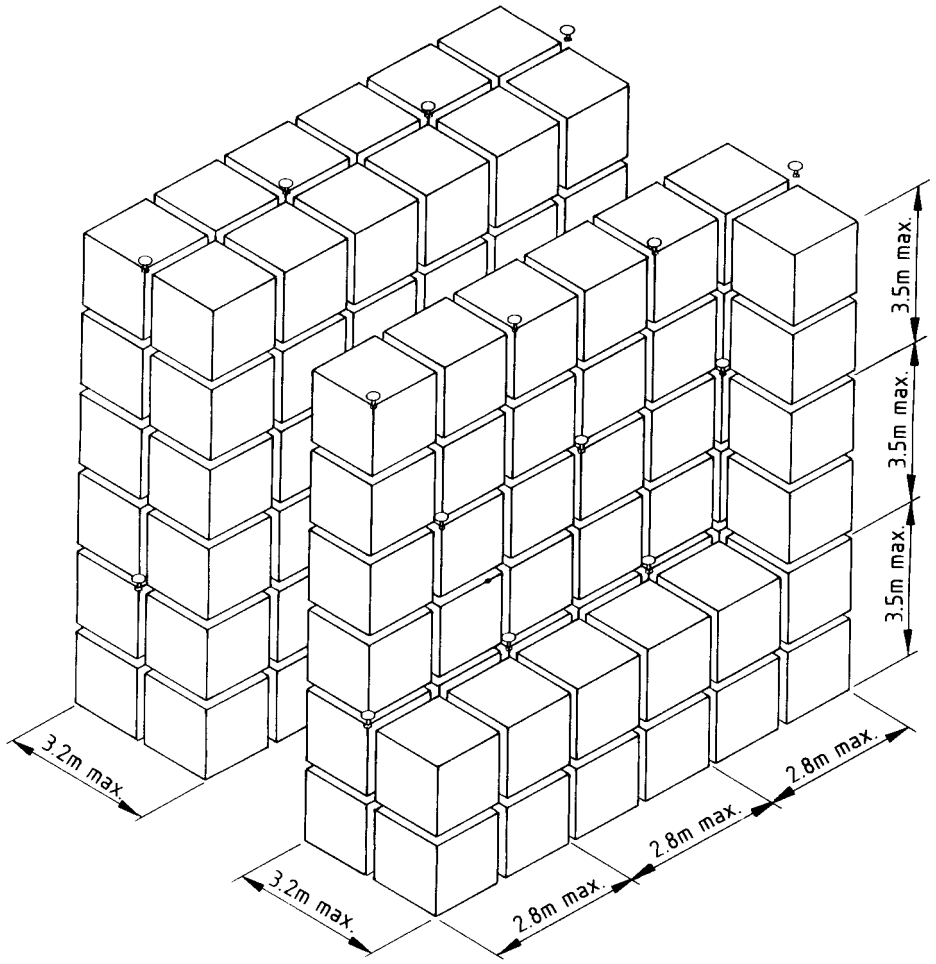
f) the boundary is the open face of a building.

26.3.1.2 Where the boundary is a notional boundary or wall between hazards of differing classes the sprinkler/boundary spacing shall be as specified in Table 74 or Table 75 as appropriate.



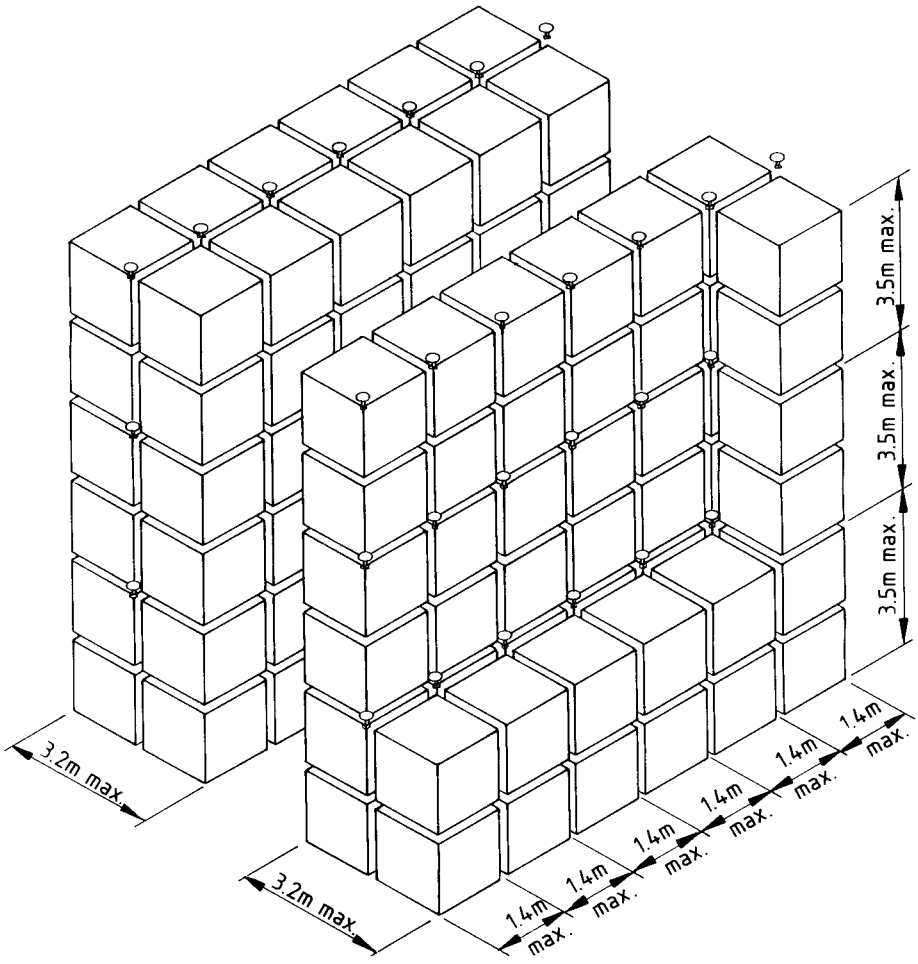
NOTE Type S5 stacking illustrated.

Figure 40 — Terminology for type S5 storage (beam pallet racking)



NOTE Where the number of tiers is odd and the goods in the top tier are more than 3.0 m below the roof or ceiling sprinklers (or are otherwise not protected by them), the rows of sprinklers shall be provided above each even-numbered tier, and above the top tier.

Figure 41 — Sprinkler locations for type S5 storage, category I or II goods (beam pallet racking)



NOTE Where the number of tiers is odd and the goods in the top tier are more than 3.0 m below the roof or ceiling sprinklers (or are otherwise not protected by them), the rows of sprinklers shall be provided above each even-numbered tier, and above the top tier.

Figure 42 — Sprinkler locations for type S5 storage, category III goods (beam pallet racking)

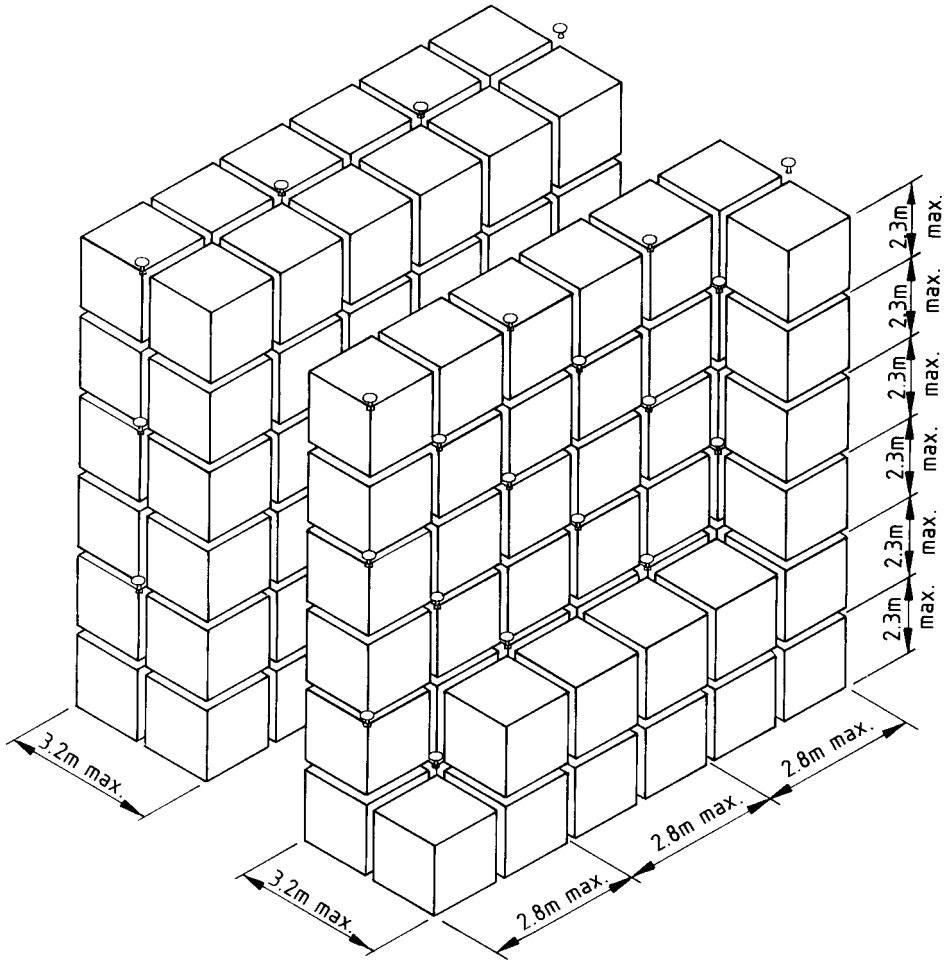
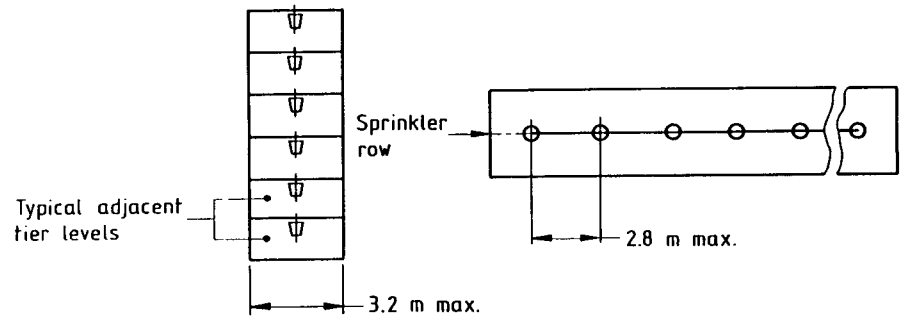


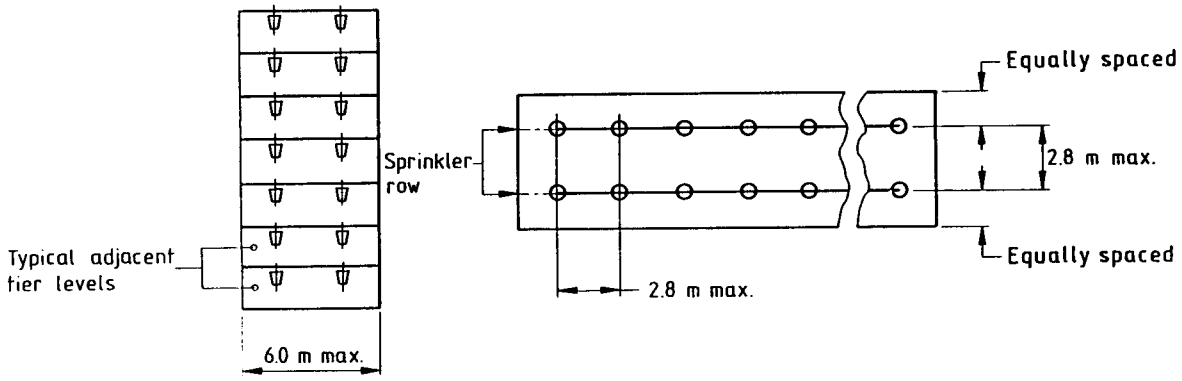
Figure 43 — Sprinkler locations for type S5 storage, category IV goods (beam pallet racking)

Table 73 — Location of intermediate sprinklers in type S7 storage (shelved racks)

Goods high-hazard category	Shelf width		No. of rows of sprinklers	Maximum distance between sprinklers along rows	Maximum distance between sprinkler rows	Minimum clearance between sprinkler deflector in any row and storage immediately below
	over	not exceeding				
	m	m		m	m	mm
All	1.0	3.2	1	2.8	—	150
All	3.2	6.0	2	2.8	2.8	150



(a) Shelves not more than 3.2 m wide



(b) Shelves more than 3.2 m, but not more than 6 m, wide

NOTE In addition, a row of intermediate sprinklers may be required above the top shelf (see **26.1.4.2**).

Figure 44 — Sprinklers locations for type S7 storage (shelved racks)

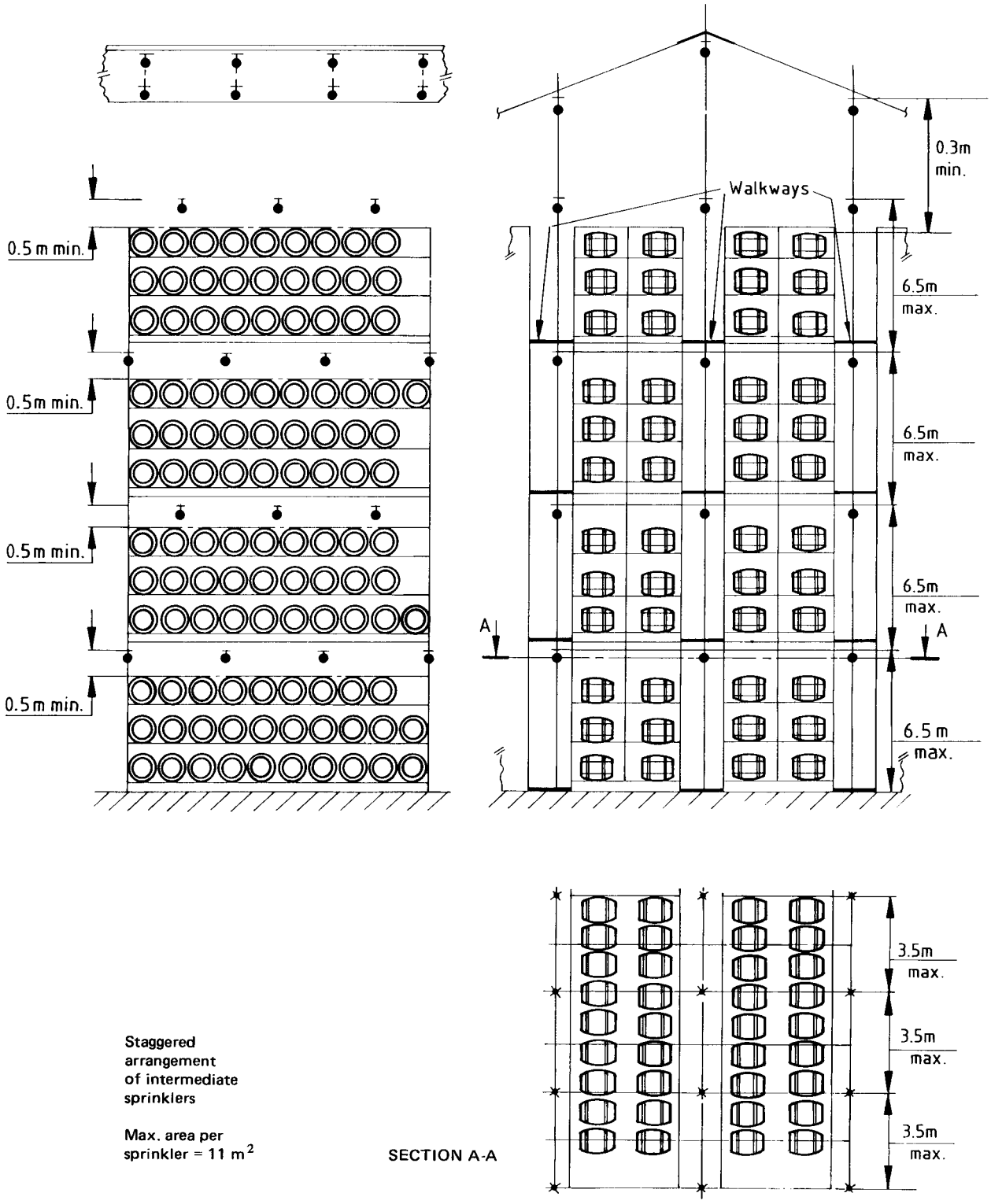


Figure 45 — Sprinkler locations for type S9 storage (potable spirits in barrels in double racks with aisles and walkways)

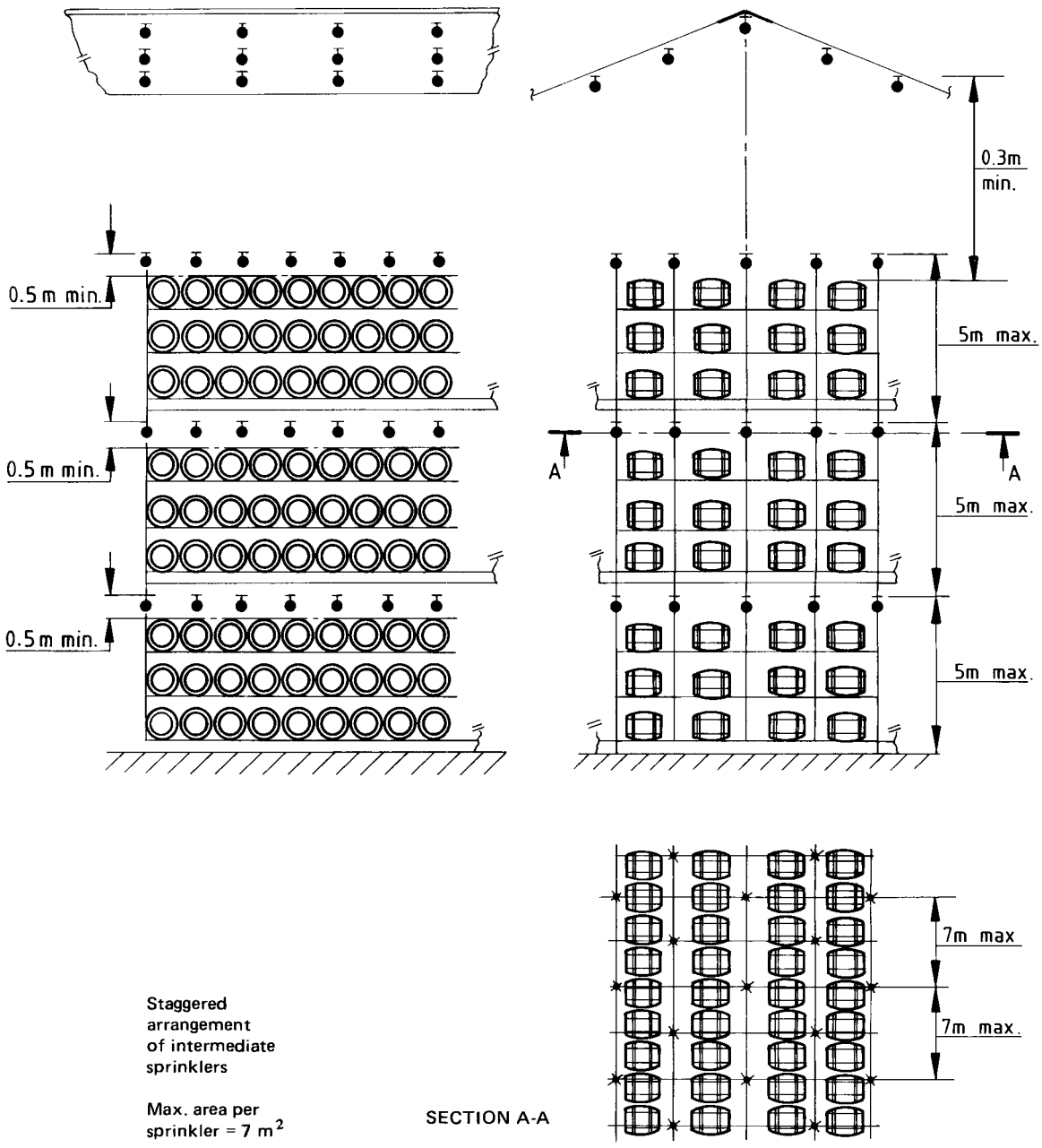


Figure 46 — Sprinkler locations for type S10 storage (potable spirits in barrels in racks with aisles and walkways)

Table 74 — Maximum nearest distance of sprinklers in standard layout from a boundary perpendicular or parallel to range lines

Hazard class	Maximum distance between sprinkler and nearest point on a boundary	
	Measured perpendicular to range pipe	Measured along line of range pipe
	m	m
Light	$0.5D$[a]	$0.5S$[a]
Ordinary	$0.5D$[a]	$0.5S$[a]
High	$0.5D$[a]	$0.5S$[a]

[a] See Figure 38 for *D* and *S*.

Table 75 — Maximum nearest distance of sprinklers in a staggered layout from a boundary perpendicular or parallel to range lines

Hazard class	Maximum distance between sprinkler and nearest point on boundary	
	Range parallel to boundary	Range perpendicular to boundary
	m	m
Ordinary	$0.5D$[a]	0.5 S[a] and 0.25 S[a] on alternate range lines

[a] See Figure 38 for *D* and *S*.

26.3.1.3 Where the boundary is irregular or is not perpendicular or parallel to a line of sprinklers, no part of the boundary shall be more than $\frac{1}{2}(S^2 + D^2)^{1/2}$ from a sprinkler.

COMMENTARY AND RECOMMENDATIONS ON **26.3.1**.

See Figure 38 for an explanation of S *and* D.

Where the boundaries are parallel and at right angles to the ranges, the conditions specified are met when the distances between sprinklers and the nearest point on a boundary are as given in Table 74 or Table 75 as appropriate.

Where fewer than four sprinklers are fitted in a space any allowable pair of dimensions S *and* D *from Table 70 (subject to* ***26.2****) may be used to calculate the notional diagonal (see Figure 33).*

See ***26.1.4.2*** *for boundary distance from intermediate sprinklers in S7 storage.*

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

26.4 Clear space below sprinklers

Throughout the protected area the clear space below the level of non-intermediate sprinkler deflectors shall be not less than:

a) for high-piled combustible stock (see Table 1): 1.0 m;

b) for potable spirit barrel storage: 0.3 m;

c) for sprinklers above open suspended ceilings: 0.8 m;

d) for other than a), b) or c): 0.5 m.

Where goods are stored below sloping roofs or ceilings with the top of the goods following the slope, roof trusses shall be accessible at all times to the water discharge if sprinklers operate.

26.5 Sprinkler location relative to building structure and plant

26.5.1 *Roofs and ceilings*

26.5.1.1 *Roofs and ceilings, without bays or beams.*

The following shall apply.

a) *Sprinklers, other than sidewall and ceiling or flush pattern sprinklers.* The deflector of a sprinkler other than a sidewall or ceiling/flush sprinkler shall be:

1) not less than 75 mm below the underside of the roof or ceiling; and

2) not more than as given in Table 76 below the roof or ceiling; and

3) not more than as given in Table 76 below any exposed rafter or joist.

b) *Sidewall sprinklers.* The deflector of a sidewall sprinkler shall be not less than 100 mm and not more than 150 mm below the ceiling.

COMMENTARY AND RECOMMENDATIONS ON **26.5.1.1**.

Sprinklers located in the hottest gas layer, e.g. 75 mm *to* 100 mm *below a flat ceiling, give faster response. It is for this reason that ceiling or flush, recessed and concealed sprinklers are not suitable for life safety applications.*

26.5.1.2 *Roofs and ceilings, with beams but without bays.*

The following shall apply.

a) *Sprinklers other than sidewall sprinklers.* Where a beam or joist is so deep that a sprinkler cannot be located below the beam or joist as specified in **26.5.1.1** it shall be located above the base of the beam or joist, at a distance below the ceiling as specified in **26.5.1.1**, at the appropriate horizontal distance as given in Table 77 from the beam or joist.

Table 76 — Maximum distance of non-sidewall sprinkler deflector below roof or ceiling

Type of construction	Measuring point	Maximum distance below measuring point
		mm
Plane surface roof or ceiling of combustible material or of asbestos cement sheeting, wired glass and similar frangible elements	Plane of underside of roof or ceiling	300, preferably 150
Combustible roof with exposed common rafters	Lower surface of rafters	150
Combustible ceiling with open joists	Lower surface of joists	150
Plane surface, non-combustible ceiling, not less than 75 mm thick	Plane of underside of ceiling	450, preferably 150
Arched non-combustible ceiling	Underside of crown of arch	450, preferably 150
Non-combustible ceiling less than 75 mm thick, affixed to underside of a floor with 2 h fire resistance	Plane of underside of ceiling	450, preferably 150
Non-combustible roof[a] and supports, excluding asbestos cement sheeting, wired glass and similar frangible elements	Plane of underside of ceiling	450, preferably 150

[a] A hollow block or concrete roof may be covered externally with a weatherproofing material, with or without a layer of heat-insulating material between it and the roof, provided that there is no intervening air space.

Table 77 — Sprinkler location relative to beams and joists

Minimum horizontal distance from sprinkler vertical axis to side of beam or joist (see dimension *a* in Figure 47)	Maximum height of sprinkler deflector above (+) or below (–) bottom of beam or joist (see dimension *b* in Figure 47)			
	Conventional sprinkler		Spray sprinkler	
	Installed upright	Installed pendent	Installed upright	Installed pendent
mm	mm	mm	mm	mm
200	– 20	See note 2	See note 2	See note 2
400	0	See note 2	0	0
600	+ 30	See note 2	+ 20	+ 60
800	+ 60	See note 2	+ 30	+ 120
1 000	+ 100	– 200	+ 50	+ 200
1 200	+ 140	– 170	+ 100	+ 280
1 400	+ 190	– 120	+ 130	+ 360
1 600	+ 260	– 30	+ 160	+ 470
1 800	+ 390	+ 170	+ 180	+ 670

NOTE 1 Dimensions may be interpolated.
NOTE 2 Not applicable. These types are not used at these horizontal distances.

b) *Sidewall sprinklers.* Any beam or other obstruction below the ceiling within a rectangle centred on the sprinkler, of dimensions $A \times 2B$ (see Table 78) shall not exceed the depth given in Table 78.

Any obstruction below the plane of the ceiling within a rectangle 1 m either side of a sprinkler by 1.8 m from the wall shall be regarded as a boundary.

26.5.1.3 *Roofs and ceilings with bays and/or deep beams.* Where the depth of a beam or joist (see dimension *C* in Figure 47) exceeds 300 mm for combustible ceilings or 450 mm for non-combustible ceilings, or other obstructions form ceiling bays so that the requirements of **26.5.1.1** and/or **26.5.1.2** cannot be met, then the obstruction or the beam or joist shall be regarded as a boundary.

COMMENTARY AND RECOMMENDATIONS ON **26.5.1.3**. *Sprinkler protection of roofs and ceilings with beams or joists closer than* 1.8 m *centre to centre is not covered by this specification.*

Table 78 — Minimum distance of sidewall sprinklers from beams under flat ceilings

Depth of beam		Minimum horizontal distance, sprinkler/wall to beam	
greater than	not greater than	Perpendicular to wall Dimension *A*	Parallel to wall either side of sprinkler Dimension *B*
mm		m	m
0	100	1.8	1.0
100	125	2.1	1.2
125	150	2.4	1.4
150	175	2.7	1.6
175	200	3.0	1.8

26.5.2 *Columns*

26.5.2.1 *General.* Where a roof or ceiling sprinkler is less than 0.6 m from the face of a column another sprinkler shall be located not more than 2.0 m from the opposite side of the column.

COMMENTARY AND RECOMMENDATIONS ON **26.5.2.1**.
Sprinklers should be located as far as possible from columns.

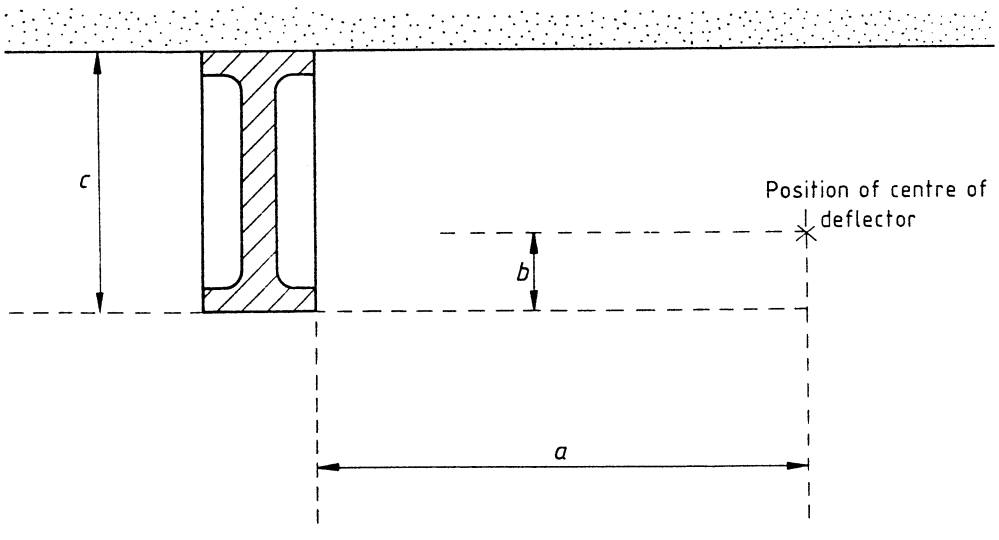
26.5.2.2 *High-piled storage, types S2, S3, S4, S5, S6 and S7.* Any column, of less than 2 h fire resistance, surrounded by high-piled storage of class S2, S3, S4, S5, S6 or S7, shall have provision for cooling spray from small orifice narrow angle sealed sprayers. There shall be one sprayer located on each side of the column at the level of the top of the storage with lower opposed pairs of sprayers, at intervals not exceeding 4.5 m, to the base of the column. Where there are obstructions to water downflow sprayers shall be located immediately below each obstruction.

The sprayers shall be directed to wet the surface area of the structural member (with water impinging on any column web) at a rate of 10 mm/min related to the surface area of the structure over a 4.5 m length.

COMMENTARY AND RECOMMENDATIONS ON **26.5.2.2**.
*The water for column protection is added to that required for the normal installation (see **15.1.2**).*

26.5.3 *Girders*

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



Key:
a minimum horizontal distance
b distance of deflector above (+) or below (–) bottom of beam or joist
c depth of beam or joist

Figure 47 — Sprinkler location relative to beams

26.5.3.2 Where the top flange of a girder is more than 200 mm nominal width sprinklers shall be positioned not less than 1.2 m from the side of the girder (viewed in plan).

26.5.4 ***Roof trusses***

26.5.4.1 Where the truss members are not more than 100 mm wide sprinklers shall be positioned either not less than 0.3 m from the side of the truss (viewed in plan), or equidistant from each side of the truss with the deflector not less than 150 mm above any truss member.

26.5.4.2 Where the truss members are more than 100 mm and less than 200 mm wide, sprinklers shall be positioned either not less than 0.6 m from the side of the truss (viewed in plan) or equidistant from each side of the truss with the deflector not less than 150 mm above any truss member.

26.5.4.3 Where the truss members are more than 200 mm wide sprinklers shall be positioned not less than 0.6 m from the side of the truss (viewed in plan).

26.6 Concealed spaces

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

26.6.2 *Intermediate floor spaces.* Concealed spaces between floors and ceilings shall be sprinkler-protected as follows:

a) if any part of the concealed space is more than 0.8 m deep; and

b) either;

1) if they are not wholly of non-combustible construction; and/or

2) if they contain combustible material.

26.6.3 *Space under lowest floor.* Sprinkler protection shall be installed in each space under the lowest floor in a building where the floor is combustible and:

a) the space is accessible for storage purposes or entrance of unauthorized persons; and/or

b) the space is not protected against accumulation of debris; and/or

c) the space contains equipment such as steam pipes, electric wiring (except cables in conduit or mineral insulated copper-sheathed cables suitably earthed), shafting or conveyors; and/or

d) the floor over the space is not sealed against liquid spillage; and/or

e) flammable liquid is stored on the floor above.

26.6.4 *Cold-storage warehouses (air circulation refrigeration).* Sprinklers shall be fitted above any false ceiling within the cold chamber forming a plenum for the air circulating system.

COMMENTARY AND RECOMMENDATIONS ON **26.6**.

Attention is drawn to the requirements of the Building Regulations 1985 which will apply to the construction of new buildings.

It is strongly recommended that suitable fire or draught stops be installed at approximately 15 m *intervals for horizontal division, and at each floor level for vertical division, in roof spaces and in concealed spaces between floors and ceilings not covered by* ***26.6.1*** *or* ***26.6.2*** *(i.e. not more than* 0.8 m *deep) where these are of combustible construction.*

See ***24.1.4*** *for requirements relating to sprinkler protection in concealed spaces. See* ***26.9.3*** *for protection of voids above or below computer rooms.*

26.7 Concealed spaces in plant

26.7.1 *Bins and silos.* Where practicable bins and silos, except as given in **4.2.1** a), containing sawdust, wood flour, pulverized coal or similar easily ignited material which can be extinguished by water shall be internally protected by sprinklers.

COMMENTARY AND RECOMMENDATIONS ON **26.7.1**.

Where the contents of bins or silos are liable to swell when wetted with the risk of bursting the container, the authority concerned should be consulted at the planning stage (see ***3.1****).*

26.7.2 ***Corn, rice, provender and oil mills***

26.7.2.1 A sprinkler shall be fitted at the head of each dust trunk. Sprinklers shall be installed not more than 3.0 m apart in all dust trunks which are constructed of combustible material and which are installed more than 30° from the vertical.

26.7.2.2 Tiers of cyclones (centrifuges), or similar plant, separated by less than 1.0 m shall be protected by sprinklers located in the interspace as shown in Figure 48.

26.7.3 ***Elevators, rope or strap races, gearing boxes and dust receivers***

26.7.3.1 Elevators, other than pneumatic elevators or slow-moving endless chain, ring, loop or fork elevators capable of operating only when the elevator is full, shall be fitted with a sprinkler. The sprinkler shall be in the box at the top, located to discharge over the head and both legs or shafts of the elevator.

26.7.3.2 Rope or strap races, gearing boxes and enclosed belt or shaft machine drives of combustible construction or communicating between floors, shall be fitted with internal sprinklers.

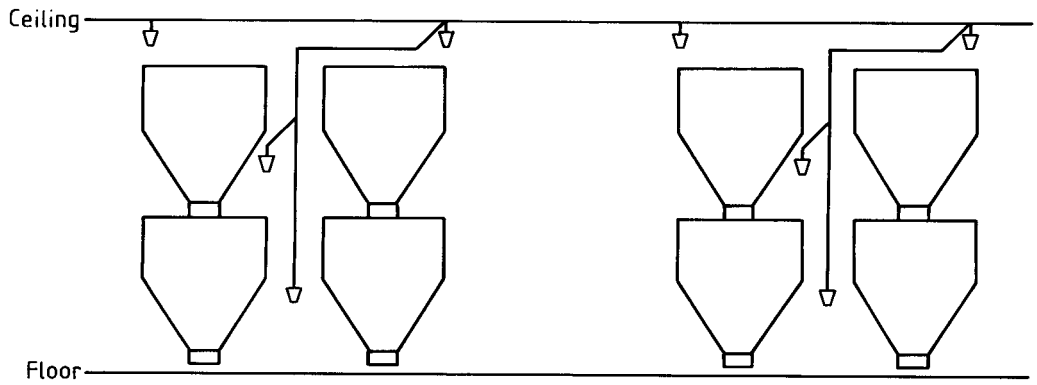


Figure 48 — Protection of tiered conical plant, e.g. cyclone dust collectors

26.7.3.3 Dust cyclones and dust collection chambers and boxes either inside the protected building, or outside and directly above any protected building with a combustible roof, shall be fitted with internal sprinklers.

COMMENTARY AND RECOMMENDATIONS ON **26.7.3**.

Dust collection chambers and boxes not more than 10 m *from the protected building, and with trunking which runs to inside the protected building, should be sprinkler-protected.*

At least one sprinkler should be fitted inside trunking where it leaves the protected building to dust cyclones and dust collection chambers and boxes which are:

a) *above non-combustible roofs, or*

b) *more than* 10 m *from the protected building.*

26.7.4 *Escalators.* Sprinklers shall be installed:

a) in the passenger carrying space; and

b) below the ceiling below the escalator; and

c) between the ceiling below the escalator and the passenger carrying space; and

d) in the escalator boot; and

e) in the motor space.

26.7.5 *Hoists, lift wells and enclosed chutes through floors.* Hoists, lift wells and enclosed chutes inside or in communication with sprinklered buildings, not covered by **4.2.2.1** a), shall be fitted with sprinklers. Sprinklers at the head of lift wells shall be fitted with metal guards (see **25.8**).

COMMENTARY AND RECOMMENDATIONS ON **26.7.5**.

*Lifts complying with BS 5655:1 are covered by **4.2.2.1** a) and are therefore not required to be fitted with sprinklers, and that standard specifies that they shall not be fitted.*

26.7.6 *Machinery pits and production lines.* Machinery pits in which combustible waste may accumulate, and the undersides of production lines shall be fitted with sprinklers.

26.7.7 *Enclosed paint lines (enclosed), drying ovens and drying enclosures.* Sprinklers shall be provided inside enclosed paint lines, drying ovens and drying enclosures.

COMMENTARY AND RECOMMENDATIONS ON **26.7.7**.

*Sidewall sprinklers may be used for the protection (see **25.2.5**).*

26.8 Obstructions below sprinklers

26.8.1 *Platforms, heating panels etc.* Sprinklers shall be provided under the following:

a) internal overhead platforms;

b) heating panels;

c) galleries;

d) walkways;

e) stagings other than in film or television studios (see **26.9.1**);

f) stairs and stairways other than those exceptions covered by **4.2.2.1** a);

g) chutes;

which are either:

1) more than 0.8 m wide and less than 150 mm from adjacent walls or partitions; or

2) more than 1.0 m wide.

26.8.2 *Suspended ceilings*

26.8.2.1 *Suspended imperforate ceilings.* A material used as an imperforate film below the sprinkler protection, e.g. to produce diffused lighting shall not be subject to partial collapse under incipient fire conditions. The material and its means of suspension shall be suitable for sprinkler use; thermoplastics materials shall not be used for imperforate suspended ceilings above storage areas or in high-hazard occupancies.

26.8.2.2 *Suspended open ceilings.* The requirements of this specification shall not be applied where:

a) suspended open ceilings are used above storage areas or in high-hazard occupancies;

b) the suspended open ceiling will prevent the efficient operation, or detract from the fire control, of the sprinklers installed above;

c) the ceiling supports are combustible;

d) the ceiling and its supports may drip molten particles under fire conditions;

e) the structural integrity of the ceiling and of any equipment, such as light fittings, installed within the volume above it may be affected by operation of the sprinkler installation;

f) the total plan area of the openings in the suspended open ceiling is less than 70 % of the ceiling plan area;

g) services installed in the suspended ceiling, such as light fittings, reduce the open plan area of the ceiling below 60 % of the total ceiling plan area.

h) the minimum dimension of the ceiling openings is less than 25 mm or the vertical thickness of the suspended ceiling whichever is the greater.

Obstructions within the ceiling void likely to cause significant interference with water distribution shall be treated as boundaries for the purpose of sprinkler spacing.

Where any obstruction, for example a light fitting, is more than 800 mm wide supplementary sprinklers shall be provided to discharge below the obstruction.

COMMENTARY AND RECOMMENDATIONS ON **26.8.2.2**.
The design of sprinkler systems to protect buildings which do not meet a) to h) is outside the scope of this specification.

The ceiling should be of non-combustible construction and should not collapse before operation of the sprinklers.

*See Table 70 for sprinkler coverage where suspended ceilings may be used. See **26.4** for the clear space dimension to be maintained between sprinkler deflector and the top of the suspended ceiling.*

26.8.3 *Ducts.* Sprinklers shall be fitted below ducts which are:

a) rectangular and more than 0.8 m and less than 150 mm from adjacent walls or partitions; or

b) circular and more than 1.0 m in diameter and less than 150 mm from adjacent walls or partitions; or

c) rectangular and more than 1.0 m in width; or

d) circular and more than 1.2 m in diameter.

26.8.4 *Hoods over papermaking machines.* The sprinklers shall be fitted under hoods or shields over the dry ends of papermaking machines.

COMMENTARY AND RECOMMENDATIONS ON **26.8.4**.
*Sidewall sprinklers may be used (see **25.2.5**). See also **25.7.4**.*

26.8.5 *Storage racks.* Sprinklers shall be fitted to protect goods stored in racks.

COMMENTARY AND RECOMMENDATIONS ON **26.8.5**.
*See **26.1.4** for specific requirements relating to high-hazard occupancies.*

26.8.6 *Work tables.* Sprinklers shall be fitted below work tables where there is a power source or where combustible process waste may accumulate.

26.9 Sprinkler location for specific hazards

26.9.1 *Film and television studios*

26.9.1.1 Sprinklers shall be fitted under

a) solid or slatted platforms (except those used for temporary platforms etc. in connections with sets, but including those for lighting and other equipment) if these are more than 0.8 m wide; and

b) walkways, connecting stairs, including those used for lighting or other equipment.

26.9.1.2 Sprinklers shall be fitted in concealed spaces or cavities more than 100 mm deep between combustible linings and walls and roofs.

COMMENTARY AND RECOMMENDATIONS ON **26.9.1.2**.
Any electric cables in the spaces should be run in screwed steel conduit or be of the mineral insulated metal sheathed type.

26.9.2 *Theatres and similar premises.* In addition to sprinklers at the roof or ceiling, sprinklers shall be fitted under the grid, the flies, the stage and any other obstruction to the discharge from the roof or ceiling sprinklers.

COMMENTARY AND RECOMMENDATIONS ON **26.9.2**.
Where movable scenery is in use (for example under fly gallery floors) and there are projecting sprinklers particular care should be taken that the scenery can be moved safely and that the sprinklers are protected from damage. Sprinklers should be sited with particular care where personnel may work in close proximity for example under the grid, to reduce the risk of impact and injury.

Stage floors are subject to frequent modification with some parts being removed and others replaced and account should be taken of this when sprinkler pipework is fitted under the stage.

26.9.3 *Computer areas.* In computer areas concealed spaces forming cableways not fitted with either a carbon dioxide total flooding system complying with BS 5306-4 or an automatic halon system complying with BS 5306-5 shall be fitted with sprinklers.

26.9.4 *Plastics roof lights.* Sprinklers shall not be installed directly below roof lights of PVC, or plastics of similar thermal behaviour and shall only be installed where:

a) the area of each rooflight does not exceed 5 m^2;

b) the distance between individual rooflights is not less than 1.8 m;

c) the total area of the rooflights in any communicating part of the building does not exceed 15 % of the plan area of such part of the building.

COMMENTARY AND RECOMMENDATIONS ON **26.9.4**.
The design of sprinkler systems to protect areas under plastics roof lights outside these limits is not covered by this specification.

27 Alarms and alarm devices

27.1 Water motor alarms

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

COMMENTARY AND RECOMMENDATIONS ON **27.1.1**.
In addition hydraulic alarms may be fitted to subsidiary manual deluge installation control valves and as an option for subsidiary computer room protection.

*See **20.1.5** for hydraulic alarm test valves.*

The water supply motor alarm of a high-rise installation may be driven by the town main or other secondary supply, controlled by a diaphragm valve connected to the main installation control alarm valve port.

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

27.1.3 *Pipework to water motor.* The pipework shall be galvanized, medium grade complying with BS 1387. The equivalent length of pipe between the alarm valve and the water motor shall be not more than 25 m assuming an equivalent length of 3 m for each change of direction. The nominal size shall be not less than:

15 mm for equivalent lengths less than or equal to 6 m; and

20 mm for equivalent lengths greater than 6 m.

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

COMMENTARY AND RECOMMENDATIONS ON **27.1.3**.
Non-corroding material is specified to avoid blockage by corrosion. The permanent drain should be situated in a frost-proof area, and should drain into a waste pipe tundish to avoid the danger of the drain pipe becoming blocked by ice. Care should be taken to avoid waste water discharge into the premises.

27.1.4 *Prevention of false and intermittent alarms.* Any device to reduce the frequency of false or intermittent alarms (see **2.37**) fitted to the installation shall be suitable for sprinkler service.

COMMENTARY AND RECOMMENDATIONS ON **27.1.4**.
False alarms caused by wide fluctuations of town mains pressure may be prevented by the use of a retard chamber, or a jockey pump.

Intermittent alarms may be caused by an excessive amount of air trapped in the installation. Reduction of the amount of air will reduce the frequency of alarms, but it is essential that some air be retained to prevent dangerous overpressure caused by temperature changes. Intermittent alarms may be prevented by the use of an air bottle arrangement on the pipe to the water motor.

27.2 Electric water flow and water and air pressure switches

27.2.1 ***General***

27.2.1.1 Electric water flow alarm switches and water and air pressure alarm switches fitted to sprinkler installations shall be suitable for sprinkler service.

27.2.1.2 Either an electric water flow alarm switch or an electric alarm pressure switch shall be fitted where an electric alarm device to indicate operation of sprinklers is specified.

27.2.2 *Water flow alarm switches.* A water flow alarm switch shall detect any flow equal to, or more than, that from any single sprinkler. A test facility shall be fitted immediately downstream of the switch. The test facility shall simulate operation of a single sprinkler and shall be fitted with a drain.

The draw-off pipe shall be galvanized mild steel medium grade complying with BS 1387, or copper complying with Table X of BS 2871-1:1971.

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 above a drain system so that the flow of water can be seen during a test run.

COMMENTARY AND RECOMMENDATIONS ON **27.2.2**.
Non-corroding material is specified to avoid blockage by corrosion.

27.2.3 *High-rise installations.* A water flow alarm switch shall be fitted to each zone of a high-rise installation, immediately downstream of the subsidiary stop valve.

27.2.4 ***Cold storage warehouses***

27.2.4.1 An electric alarm device to indicate operation of sprinklers shall be fitted downstream of each tail-end extension alarm valve.

27.2.4.2 Each discrete section of the installation pipework shall be provided with a low air/gas pressure alarm. These shall provide a visual and audible warning in an area with responsible manning.

COMMENTARY AND RECOMMENDATIONS ON **27.2.4**.
Where a dry installation control valve set feeds one or more tail-end dry extensions, a low gas/air pressure switch should be fitted immediately downstream of the main valve set and also on each tail-end valve set.

COMMENTARY AND RECOMMENDATIONS ON **27.2**.
*Water flow switches are specified for sprinklers in remote pump or pressure tank houses where the sprinklers have water supply arrangements as specified in **17.4.5.2** and **17.5.4.2** respectively; they are also an option to an alarm valve pressure switch as the required subsidiary alarm in tail-end cold store protection.*

Water flow switches may be used to detect sprinkler operation in computer areas which are part of a larger area protected by an installation.

*Water flow switches should be fitted to detect flow into a zone or other part of an installation fitted with a subsidiary stop valve (see **20.1.4**).*

Electric water pressure switches may be used to initiate fire alarms, additional to the water motor alarms, by connection to the hydraulic alarm system of installation control valve sets.

*Pressure switches to monitor trunk main pressure on suction and booster pump water supplies are specified in **17.4.2.4**.*

*Pressure switches may also be fitted to monitor air pressure in alternate and dry installations. Air/gas pressure monitoring for pre-action installation is specified in **6.7.2.1**.*

*See **27.6** for transmission of alarms to fire brigades.*

27.3 Stop valve mode indicator switches

27.3.1 *General.* Indicator switches provided to monitor the mode of stop valves (i.e. either fully open or not fully open) shall be fitted with a tamper detection device which will cause the mode change alarm to operate.

COMMENTARY AND RECOMMENDATIONS ON **27.3.1**.
*Stop valve indicator switches are specified for all main and subsidiary water supply valves in life safety installations (see **27.4.5.1**). They are also used, as an option to the use of a subsidiary interlocking valve, where computer areas are protected as part of a larger area protected by a single installation and are recommended for all subsidiary stop valves (see **20.1.4**).*

27.3.2 *Life safety systems.* All stop valves on the premises which control the flow of water to sprinklers, i.e. stop valves at any point in the water supply pipework, whether part of the main installation control valve set, including the bypass valve (see **20.1.2.2**) or upstream or downstream of it, shall be fitted with a tamper-proof electric switch to indicate that the valve is in the correct operational mode.

27.4 Indicator panels and alarms

27.4.1 *General.* Indicator panels and alarms shall comply with the appropriate requirements and recommendations of BS 5839-1 and BS 5839-4.

27.4.2 *Electrically driven suction and booster pumps.*

Separately switched sub-circuits shall be used to supply both:

a)

1) the pump(s); and

2) any mains powered mains failure alarm system; and

b)

1) any pump which will be the first to start when the water supply pressure drops to the appropriate pressure; and

2) any mains powered low supply pressure alarm system.

Any battery for automatic power failure alarm (see **17.4.12.3**) shall be trickle-charged and shall have a capacity to provide an alarm of 72 h duration. The battery shall not be used for automatic starting of a diesel engine driven pump or for any non-fire protection purpose.

COMMENTARY AND RECOMMENDATIONS ON **27.4.2**.

*See **17.4.2.4** for trunk main pressure alarm.*

27.4.3 *Diesel engine driven suction and booster pumps.* Any battery power supply for the indicator panel or alarm system shall not be supplied from batteries provided to start the diesel engine(s).

COMMENTARY AND RECOMMENDATIONS ON **27.4.3**.

*See **17.4.2.4** for trunk main pressure alarm.*

*See **17.4.13.8** for diesel start system alarm requirements. The alarm may be battery or mains powered.*

27.4.4 *Pressure tanks.* Separately switched sub-circuits shall be used to supply:

a) the water supply pump and/or air compressor; and

b) any mains powered alarm system for water level and air pressure.

COMMENTARY AND RECOMMENDATIONS ON **27.4.4**.

*See **17.5.2** for pressure tank alarm requirements.*

27.4.5 ***Life safety***

27.4.5.1 *Alarms and indications.* Monitoring devices shall be provided to give alarms or indications that:

a)

1) the downstream and upstream stop valves to each installation control main valve set are fully open [see **20.1.2.2** a)]; or

2) where the arrangement of **20.1.2.2** b) is used, that one of the pairs of stop valves on either side of an alarm valve has both stop valves fully open and that the stop valves on each side of the duplicate alarm valve are closed; and

b) each zone subsidiary stop valve (see **20.1.4**) is fully open;

c) 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; and

d) water flow equivalent to that from one or more sprinklers into the installation is taking place.

27.4.5.2 *Indicator panel.* The monitoring devices specified in **27.4.5.1** shall be connected electrically to an indicator panel suitable for sprinkler use where the following indications shall be given:

a) by means of the necessary number of green visual indicators that the devices specified in **27.4.5.1** a) and b) are in the normal condition;

b) by means of audible and visible warnings by the necessary number of yellow visual indicators that:

1) either the downstream or upstream or both main installation control valve set stop valves are not fully open in the leg (in the arrangement of Figure 25), or in one leg (in the arrangement of Figure 26). One visual indicator per valve set is sufficient;

2) any zone control stop valve is not fully open (one visual indicator per zone is sufficient);

3) the mains static water pressure in the trunk main is low [see **27.4.5.1** c)].

c) by means of audible and visible (red indicator) warnings, that water is flowing into the installation at a rate exceeding $20 \, {}^{+\,37}_{-\,0}$ L/min.

Facilities may 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 standing condition.

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 standing condition.

COMMENTARY AND RECOMMENDATIONS ON **27.4.5.2**.

The facilities for silencing the audible alarm should be for use by a designated person or persons.

27.4.5.3 *Power supplies.* The indicating equipment shall be mains powered but standby power supply complying with **5.2** of BS 5839-4:1988 shall be immediately available in the event of failure of the normal power supply.

27.4.6 *Computer areas.* A subsidiary stop valve, controlling that part of an installation protecting a computer area, shall be electrically monitored at a continuously manned position. Closure or partial closure of the valve shall be signalled by a visible and by an audible alarm.

COMMENTARY AND RECOMMENDATIONS ON **27.4.6**.
Local indication of sprinkler operation in the computer area may be given either by provision of a subsidiary alarm valve and hydraulic motor alarm or of a water flow switch suitable for sprinkler service.

COMMENTARY AND RECOMMENDATIONS ON **27.4**.
*Indicator panels should be located in the premises in a position where they may be readily observed by the designated personnel and where they may be located quickly by the fire brigade; possible sites are a central control room, a gatehouse, the reception area, by the installation valves, etc. If the area where a panel is located is not continuously responsibly manned it may be desirable to provide repeater units for all or some of the indications, e.g. in a remote manned centre or in the night quarters of the caretaker (see also **27.5** and **27.6**).*

27.5 Linking to general alarm systems

Where a sprinkler installation is provided with a device or devices which will automatically operate electric powered audible alarms for the purpose of general alert or building evacuation, the device(s), the alarm, the linking control and the indicating equipment shall comply with BS 5839-4.

27.6 Systems for transmission of alarms to a fire brigade

27.6.1 *General.* Any system provided to automatically transmit, on operation of the sprinkler installation, an alarm to a fire brigade or to a remote manned centre, shall comply with **27.6.2** to **27.6.7** inclusive and shall be suitable for sprinkler service.

27.6.2 *Transmission system.* There shall be a direct connection from the alarm signalling device to:

a) a permanently manned public fire brigade watch-room or control room, or a public fire brigade control terminating in a watchroom or control room; or

b) a permanently manned suitable central fire alarm depot, communicating directly with the public fire brigade or public fire brigade control as in item a); or

c) a permanently manned watchroom of a suitable private fire brigade.

27.6.3 *Equipment and installation.* The alarm equipment including the alarm switch and control unit shall be suitable for sprinkler service. The installation shall be carried out by manufacturers of automatic fire alarm installations or of sprinkler installations competent for such work or by contractors supervised by them.

COMMENTARY AND RECOMMENDATIONS ON **27.6.3**.
BS 5839-1 covers installation of alarm systems.

27.6.4 *Method of operation.* An alarm signal shall be initiated by:

a) a flow of water into a sprinkler installation causing operation of an electrical alarm pressure switch connected to the alarm valve hydraulic alarm system; and/or

b) the use of a water flow alarm switch in the pipework downstream of a main installation control valve set or in a remote fire pump or pressure tank house protected by sprinklers connected to the water supply pipe; and/or

c) detection of a fall of pressure in the installation pipework downstream of a main installation control valve set by use of an electric alarm pressure switch.

27.6.5 *Mounting of pressure switches.* Pressure switches used for transmission of alarms to the fire brigade shall be mounted on a vertical pipe not less than 300 mm long.

An alarm pressure switch on the sprinkler hydraulic alarm motor feed pipe shall be upstream from the stop valve controlling flow of water to the sprinkler alarm motor.

27.6.6 *Monitoring.* Circuits to the fire brigade or central fire alarm station shall be continuously monitored, and any loss of continuity shall be indicated by means of duplicate warning lights and an audible warning on an indicating panel conspicuously placed (see commentary and recommendations on **27.4**).

COMMENTARY AND RECOMMENDATIONS ON **27.6.6**.
The connection to the fire brigade may be switched off during hydraulic testing of the water supply.

27.6.7 *Power supply.* The power supply shall comply with **5.2** of BS 5839-4:1988.

COMMENTARY AND RECOMMENDATIONS ON **27.6**.
Auto-diallers or digital communicators should not be used for transmission of a fire alarm to a fire brigade.

*Arrangements should be made to avoid false alarms (see **27.1.4**).*

***25.3.5.1** specifies that a notice be located at the installation main control valves where there is transmission of a fire alarm to a fire brigade or remote manned centre.*

27.7 Wiring of monitoring, indicating and alarm circuits

Wiring of monitoring, indicating and alarm circuits shall comply with the recommendations of clause **17** of BS 5839-1:1988.

28 Pressure gauges

28.1 General and specification

28.1.1 Pressure gauges fitted to sprinkler installations shall comply with BS 1780.

28.1.2 The scale subdivision shall not exceed:

a) 0.2 bar for a maximum scale value up to and including 10 bar;

b) 0.5 bar for a maximum scale value of more than 10 bar, up to and including 16 bar;

c) 1.0 bar for a maximum scale value more than 16 bar.

COMMENTARY AND RECOMMENDATIONS ON **28.1.2**.
The maximum scale value should be of the order of 150 % *of the known maximum pressure to be applied.*

28.2 Application of pressure gauges

28.2.1 *Installation control valves*

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

a) immediately downstream of the alarm valve (designated the "C" gauge); and

b) immediately upstream of the main control stop valve (designated the "B" gauge).

28.2.1.2 *Tail-end control valve sets.* A pressure gauge shall be fitted immediately downstream of the tail-end valve but upstream of any subsidiary stop valve(s) (see **20.1.4**).

28.2.2 *Water supply connections*

28.2.2.1 *Town main.* Each town main connection shall be fitted with a pressure gauge between the supply pipe stop valve and the check valve (designated the "A" gauge).

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

COMMENTARY AND RECOMMENDATIONS ON **28.2.2**.
*See **17.5.5** for pressure tank gauges.*

28.3 Removal

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

Section 6. Signs, notices, information and colour coding

29 Block plan

29.1 General

A block plan of the premises shall be placed close to an entrance where it can be readily seen, for example by the fire brigade or others responding to an alarm.

The plan shall show:

a) the installation number and the location of the corresponding main stop valve(s);

b) the height in metres above the "C" gauge of the highest sprinkler fed from each set of installation control valves for each hazard class;

c) each separate area of hazard classification, the relevant hazard class and the maximum storage height (see clause **5**);

d) which installations are fully hydraulically calculated;

e) for each precalculated installation:

1) the height in metres above the "C" gauge of each design point used in size calculation of the distribution pipework; and

2) the minimum pressure required at the "C" gauge when carrying out a water supply proving test;

f) 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;

g) the location of subsidiary stop valves.

29.2 Life safety

Where installations are arranged in zones (see **6.3.3**) the site block plan shall additionally indicate the positions of the zone control valves.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **29**. *The preferred location for the block plan is close to the main entrance to the premises.*

30 Signs and notices

30.1 Location plate

A location plate suitable for sprinkler service, 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 installation main control valve set(s).

The plate shall bear the wording

"SPRINKLER STOP VALVE"

in letters not less than 35 mm high, and

"INSIDE"

in letters not less than 25 mm high. The wording shall be in white letters and the background shall be red.

COMMENTARY AND RECOMMENDATIONS ON **30.1**. *The plate should be a fire equipment sign complying with BS 5499-1.*

30.2 Signs for stop valves

A sign shall be fitted close to the main and any subsidiary stop valves bearing the words

"Sprinkler control valve"

COMMENTARY AND RECOMMENDATIONS ON **30.2**. *The sign should be a fire equipment sign complying with BS 5499-1 and should be rectangular with white letters not less than* 20 mm *high, on a red background.*

Where the stop valve is enclosed by a door the sign should be on the outside of the door, and a second sign, bearing the words "Keep locked shut" should be on the inside of the door. The sign should be a mandatory sign complying with BS 5499-1, circular with white wording not less than 5 mm *high, on a blue background.*

31 Marking and colour coding

31.1 Main installation control valves

31.1.1 *General.* Where the sprinkler system comprises more than one installation each alarm valve shall be prominently marked with the number identifying the installation it controls.

31.1.2 *Fully hydraulically calculated pipework installations.* In fully hydraulically calculated installations a durable notice shall be fixed to the rise pipe next to each main control valve set.

The notice shall include the following information:

a) the installation number;

b) the hazard classification or classifications of the areas protected by the installation;

c) for each hazard class area within an installation:

1) the design requirements (AMAO and minimum density of discharge);

2) the pressure-flow requirement at the "C" gauge for the most unfavourable and most favourable AMAO's;

3) the pressure-flow requirement at the pump delivery pressure gauge for the most unfavourable and most favourable AMAO's;

4) the height of the highest sprinkler above the level of the "C" gauge;

5) the height difference between the "C" gauge and the pump delivery pressure gauge;

6) the location and size of any orifice plate(s).

COMMENTARY AND RECOMMENDATIONS ON **31.1.2**. *A typical notice is shown in Figure 49.*

Installation No.				Hydraulic data					
Hazard class	Design specification			Installation demand					
	Area of operation	Density of discharge	Height of highest sprinkler[a]	Most unfavourable AMAO			Most favourable AMAO		
				Flow	Pressure		Flow	Pressure	
					C gauge	Pump gauge		C gauge	Pump gauge
	m^2	mm/min	m	L/min	bar	bar	L/min	bar	bar
Orifice plate details:									
INSTALLING ENGINEERS									
Name Address				Reference number and date installed					
[a] Measured from installation C gauge.									
Height difference between the C gauge and the pump delivery guage is m									

Figure 49 — Typical installation notice for fully hydraulically designed pipework

31.2 Water motor alarm gong

Each water motor alarm gong shall be prominently marked with the number of the installation.

31.3 Water supply connections to other services

Stop valves controlling water supplies from sprinkler system supply pipes or trunk mains to other services (see **12.3**) shall be appropriately labelled; e.g. "Firefighting hose reels", "Domestic water supply" etc.

COMMENTARY AND RECOMMENDATIONS ON **31.3**.
The labels should preferably have raised or embossed lettering and may be wired to the stop valves, or otherwise fixed to inhibit unauthorized removal.

31.4 Suction and booster pumps

31.4.1 *General.* A nameplate shall be fixed to each suction or booster pump, carrying the following information:

a) the output pressure, and the corresponding rated speed and flow (L/min), in bar at the inlet condition and flow rating specified in Table 26; and

b) the maximum power absorbed at the relevant speed at any value of flow between zero and the maximum specified in Table 27 at the inlet conditions specified in Table 26.

Where an orifice plate not integral with the pump outlet is used the pump nameplate shall state that the performance is that of the pump and orifice plate combination, and the k factor of the required orifice plate shall be given (see **17.4.6.1**).

COMMENTARY AND RECOMMENDATIONS ON **31.4.1**.
*See **17.4.6.2** for pump rating.*

31.4.2 *Fully hydraulically calculated pipework installations.* The following installer's data sheet information shall be displayed alongside the pump:

a) the pump manufacturer's data sheets, similar in presentation to Figure 5 (a) and/or Figure 5 (b);

b) a schedule listing the technical data specified in Figure 49;

c) a copy of the installer's data sheet, similar in presentation to Figure 20, showing $Q_{max.}$;

d) the pressure loss, at flow $Q_{max.}$, between the pump outlet and the most hydraulically remote installation "C" gauge.

31.5 Electric switches and control panels

31.5.1 *Alarms transmitted to the fire brigade.* Where water flow into an installation initiates an automatic alarm to the fire brigade, a notice to that effect shall be fixed adjacent to the alarm test valve(s).

31.5.2 *Diesel engine driven pump.* The alarms specified in **17.4.13.8** at both the diesel engine controller and the responsibly manned location shall be marked as appropriate:

a) diesel fire pump failure to start; and/or

b) diesel fire pump starter switched off; and

c) pump running.

The manually operated shut-down mechanism [see **17.4.13.1** d)] shall be labelled:

"SPRINKLER PUMP SHUT-OFF"

31.5.3 *Electric motor driven fire pump.* Each switch on the dedicated power feed to an electric sprinkler fire pump motor shall be labelled:

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

31.6 Sprinklers

The nominal orifice size (in mm) shall be marked on the sprinkler body or deflector.

31.7 Testing and operating devices

All valves and instruments used for testing and operation of the system shall be appropriately labelled.

COMMENTARY AND RECOMMENDATIONS ON **31.7**.
*Corresponding identification is required in the documentation. See **10.3** c).*

31.8 Colour coding

Any colour coding used for pipework and fittings shall comply with BS 1710.

COMMENTARY AND RECOMMENDATIONS ON **31.8**.
*Colour coding of sprinklers is specified in **25.6**.*

Section 7. Upkeep of the system

32 General arrangements

32.1 Programmed work

The user shall carry out a programme of inspection and checks (see clause **34**), arrange a test, service and maintenance schedule (see clause **35**) and keep appropriate records including a logbook which shall be held on the premises.

COMMENTARY AND RECOMMENDATIONS ON **32.1**.

*The user should, if appropriate, notify interested parties of the intent to carry out tests and/or of the results. Interested parties may include the owners or occupiers of buildings, and the authorities specified in **3.1**.*

Pump suction strainers and settling chamber screens should be inspected regularly and cleaned as necessary.

The user may choose to have the test, service and maintenance schedule carried out under contract by the system installer, his agent or an accredited sprinkler servicing organization.

It is essential that after an inspection, check, test, service or maintenance procedure the system, in particular automatic pumps, pressure tanks and gravity tanks, is in the proper operational condition.

32.2 Replacement sprinklers

A stock of spare sprinklers shall be kept on the premises as replacements for operated or damaged sprinklers.

Spare sprinklers (and sprinkler spanners) as supplied by the manufacturer shall be housed in a cabinet or cabinets located in a prominent and easily accessible position(s) where ambient temperature does not exceed 38 °C.

The number of spare sprinklers shall be not less than:

a) six if there are not more than two, or nine if there are more than two, light-hazard installations;

b) 24 if there are one or two, or 36 if there are more than two, ordinary-hazard installations;

c) 36 if there are one or two, or 54 if there are more than two, high-hazard installations.

The stock shall be replenished promptly after spares are used.

COMMENTARY AND RECOMMENDATIONS ON **32.2**.

The numbers specified are a minimum. Where installations contain high-temperature sprinklers, sidewall or other variations of sprinkler pattern or contain multiple controls, an adequate number of spares should be maintained. Advice may be sought from the fire authority or the insurers.

32.3 Precautions and procedures when a system is not fully operational

32.3.1 *Minimizing the effects*

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

COMMENTARY AND RECOMMENDATIONS ON **32.3.1.1**.

When an installation is rendered inoperative the user should implement compensatory measures.

*Alterations and repairs to an installation or its water supply (except possibly a life safety installation [see **32.4.3**)] should be carried out during normal working hours.*

Supervisory staff in the areas affected should be notified so that the best possible use may be made of the hand extinguishing appliances in case of fire. The area affected should be patrolled continuously.

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.

When an installation remains inoperative outside working hours all fire doors and fire shutters should be closed for the period concerned.

Arrangements should be made to have fire extinguishing appliances in special readiness with sufficient trained personnel available to handle them.

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

COMMENTARY AND RECOMMENDATIONS ON **32.3.1.2**.

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.

32.3.1.3 In the case of manufacturing premises, where 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 check valve, every effort shall be made to carry out the work whilst the machinery is stopped.

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

32.3.2 *Planned shut-down*

32.3.2.1 Only the user shall give permission for a sprinkler installation or zone to be shut down for any reason other than an emergency (see **32.3.3** and **32.4.2**).

COMMENTARY AND RECOMMENDATIONS ON **32.3.2.1**.
*Some of the authorities specified in **3.1** may ask to be informed whenever a sprinkler installation is shut down.*

32.3.2.2 Before a system is wholly or partly shut down every part of the premises shall be checked to ensure that there is no indication of fire.

32.3.2.3 Where premises are subdivided into separate occupancies constituting buildings in communication or at risk (see **4.1**) protected by common sprinkler systems or installations, the various occupiers shall also be advised that the water is to be turned off.

COMMENTARY AND RECOMMENDATIONS ON **32.3.2.3**.
Particular attention should be given to situations where installation pipework passes through walls or ceilings as these may feed sprinklers in areas needing special consideration, or notification of further personnel may be needed if the water is turned off.

32.3.3 *Unplanned shut-down.* When an installation is rendered inoperative as a matter of urgency or by accident, the precautions in **32.3.2** shall as far as they are applicable be observed with the least possible delay. The authorities concerned shall also be notified as soon as is possible.

32.4 Additional precautions for life safety systems

32.4.1 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, but if this is not possible only the smallest part of the installation necessary shall be isolated.

32.4.2 The fire authority shall be advised of any intention to shut-down all, or part, of an installation, and immediately when emergency shut-down is necessary, except where there are contingency plans previously agreed with the fire authority and insurers covering compensating actions. The plans shall be put into effect immediately following the shut-down.

COMMENTARY AND RECOMMENDATIONS ON **32.4.2**.
The fire authority may wish to restrict access to the premises until the sprinkler installation is fully operational.

32.4.3 Duplicate installation control valve sets (see Figure 26) may have the alarm valves separately serviced at any time, provided the water supply to the installation is maintained.

Single alarm valves on an installation shall be shut down for servicing when the premises are not open for business and are occupied only by essential maintenance and security staff, and with the bypass stop valve opened (see Figure 25).

COMMENTARY AND RECOMMENDATIONS ON **32.4.3**.
The following procedure should be used before servicing duplicate alarm valves.

*Check, and if necessary open, the stop valves to the standby alarm valve. Close one of the stop valves to the alarm valve to be serviced and immediately carry out an alarm test (see **34.3.3**) on the other alarm valve.*

If water is not available open the stop valve immediately, and rectify the fault before proceeding.

32.4.4 When a zone (or zones) is charged, or recharged with water after draining, the flushing valve(s) (see **20.1.7.2**) shall be used to check that water is available in the zone (or zones).

33 Action following sprinkler operation

33.1 General

Following shut-down after operation of an installation, the operated sprinkler heads shall 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 shall be checked for damage by heat or other cause and replaced as necessary.

COMMENTARY AND RECOMMENDATIONS ON **33.1**.
The water to an installation or zone of an installation that has operated should not be shut off until any 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.

33.2 Installations protecting cold storage warehouses (air circulation refrigeration)

The installation shall be dismantled for drying out after each operation.

34 User's programme of inspection and checking

34.1 General

The installer shall provide to the user an inspection and checking programme for the system. The programme shall include instruction on the action to be taken in respect of faults, operation of the system in particular the procedure for emergency manual starting of any pumps, and details of the routines of **34.2** and **34.3**.

34.2 Daily routine

34.2.1 The daily routine shall be carried out on each day that the premises are in normal use.

34.2.2 *Fire brigade and remote central station alarm connection.* If the circuits are not continuously monitored, the equipment for automatic transmission of alarm signals from a sprinkler installation to a fire brigade or remote manned centre (see **27.6**) shall be checked for:

a) continuity of the connection; and

b) continuity of the connection between the alarm switch and the control unit.

COMMENTARY AND RECOMMENDATIONS ON **34.2.2**.

*The testing procedure should be agreed with the fire authority to avoid false calls. The fire service may carry out the test and may be prepared to give an undertaking to do so. See **34.3.8** for checks on continuously monitored equipment.*

34.2.3 *Pressure tank.* If not automatically controlled the water level and air pressure in a pressure tank providing a duplicate supply shall be checked and immediately corrected if necessary.

34.3 Weekly routine

34.3.1 *General.* Each part of the weekly routine shall be carried out at intervals of not more than 7 days.

34.3.2 *Checks.* The following shall be checked and recorded:

a) all water and air pressure gauge readings on installations, trunk mains and pressure tanks; and

b) all water levels in elevated private reservoirs, rivers, canals, lakes, water storage tanks (including pump priming water tanks) and pressure tanks.

34.3.3 *Water motor alarm test.* Each water motor alarm shall be sounded for not less than 30 s.

COMMENTARY AND RECOMMENDATIONS ON **34.3.3**.

This verifies that the alarm will not ring intermittently.

*The test may also automatically test any fire brigade connection (see **34.2.2**).*

34.3.4 *Automatic pump starting test.* Tests on automatic pumps shall include instructions to:

a) check the fuel and engine lubricating oil levels in diesel engines;

b) reduce water pressure on the starting device, thus simulating the condition of automatic starting;

c) when the pump starts record the starting (cut-in) pressure, and check that this is correct;

d) on diesel pumps, check the oil pressure where gauges are fitted, and the flow of cooling water through open circuit cooling systems.

34.3.5 *Diesel engine restarting test.* Immediately after the pump start test of **34.3.4**, diesel engines shall be tested as follows:

a) run the engine for 30 min, or for the time recommended by the manufacturer, whichever is the longer; shut down the engine and immediately use the manual start test button and check that the engine restarts (see **17.4.13.6**);

b) check the water level in the primary circuit of closed circuit cooling systems.

COMMENTARY AND RECOMMENDATIONS ON **34.3.5**.

Oil pressure (where gauges are fitted), engine temperatures and coolant flow should be monitored throughout the test. Oil hoses should be checked and a general check made for leakage of fuel, coolant or exhaust fumes.

34.3.6 *Lead acid Plante batteries.* The electrolyte level and density of all lead acid Plante 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.

34.3.7 *Life safety.* The mode (fully open or fully closed as the case may be) monitoring system for stop valves (including zone valves) on life safety installations shall be tested for satisfactory operation.

The weekly alarm test (see **34.3.3**) shall be carried out without alteration of the setting of stop valves to duplicate installation control valve sets.

34.3.8 *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 (see **27.6**) shall be checked for:

a) continuity of the connection; and

b) continuity of the connection between the alarm switch and the control unit,

if the circuits are continuously monitored.

COMMENTARY AND RECOMMENDATIONS ON **34.3.8**.
The testing procedure should be agreed with the fire authority to avoid false calls. The fire service may carry out the test and may be prepared to give an undertaking to do so.

34.3.9 *Trace heating and localized heating systems.* Heating systems to prevent freezing in the sprinkler system shall be checked for correct function.

35 Service and maintenance schedule

35.1 General

35.1.1 *Procedures.* In addition to the schedule given in this clause any procedures recommended by component manufacturers shall be carried out.

35.1.2 *Records.* Each routine of the schedule shall be carried out by a competent person who shall provide to the user a signed, dated report of the inspection and advise any rectification carried out or needed, and advise any external factors, e.g. weather conditions, which may have affected the results.

35.2 Quarterly routine

35.2.1 *General.* The checks and inspections of **35.2.2** to **35.2.5** shall be made at intervals of not more than 13 weeks.

COMMENTARY AND RECOMMENDATIONS ON **35.2.1**.
*Before sprinkler engineers test any installation in any way that might release water, they may wish to obtain an indemnity, signed by the person owning the work site or premises at that time. This should also indemnify them from claim of tenants of the owner (see **32.3.2.3** regarding separate occupancies).*

35.2.2 *Review of hazard*

35.2.2.1 The effect of any changes of structure, occupancy, heating, lighting or equipment of a building on hazard classification or installation design shall be considered.

35.2.2.2 There shall be no potential interference with sprinkler water distribution and in particular roof trusses shall be accessible to water discharge from sprinklers. The clearance between the top of goods and sprinklers shall be as specified in clause **26**.

COMMENTARY AND RECOMMENDATIONS ON **35.2.2**.
Where there are significant changes the authorities should be consulted. Changes in the type, packaging or the height or method of stacking of goods may have a significant effect on sprinkler system efficiency.

Changes in temperature conditions may mean fitting sprinklers of different temperature ratings.

Obstructions may mean resiting sprinklers.

35.2.3 *Sprinklers, multiple controls and sprayers.* Sprinklers, multiple controls and sprayers not free from deposits (except paint) shall be carefully cleaned. Painted or distorted sprinkler heads, multiple controls or sprayers shall be replaced.

In the occupancies listed in b) and c) of the commentary and recommendations to **5.5** 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 good-quality petroleum jelly (in the case of glass bulb sprinklers to the sprinkler body and yoke only).

COMMENTARY AND RECOMMENDATIONS ON **35.2.3**.
Particular attention should be paid to sprinklers in spray booths, where more frequent cleaning and/or protective measures may be necessary.

35.2.4 *Pipework and hangers*

35.2.4.1 Pipework and hangers shall be checked for corrosion and painted as necessary,

COMMENTARY AND RECOMMENDATIONS ON **35.2.4.1**.
*Bitumen-based paint on pipework, including the threaded ends of galvanized pipework, and hangers in the occupancies listed in b) of the commentary and recommendations to **5.5** should be renewed as necessary,*

Bitumen-based paint may need renewal at intervals varying from 1 to 5 years according to the severity of the condition.

Tape wrapping on pipes should be repaired as necessary.

35.2.4.2 The pipework shall be checked for electrical earthing connections.

COMMENTARY AND RECOMMENDATIONS ON **35.2.4.2**.
*Sprinkler pipework is not to be used for earthing electrical equipment (see **7.3**) and any earthing connections from electrical equipment should be removed and alternative electrical arrangements made.*

35.2.5 *Water supplies and their alarms.* Each water supply shall be tested with each installation 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 not less than the appropriate value given in clause **15**. Corrective action shall be taken if necessary.

COMMENTARY AND RECOMMENDATIONS ON **35.2.5**.
Corrective action also should be taken if the pressure is significantly lower than the value recorded at commissioning.

35.2.6 ***Electrical supplies***

35.2.6.1 *Open nickel-cadmium batteries.* The electrolyte level and density of all open nickel-cadmium cells (including those in 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 necessary repaired or replaced. If the charter is working normally, the battery or batteries affected shall be replaced.

35.2.6.2 *Secondary electrical supplies from diesel generators.* The system shall be checked for satisfactory operation.

35.2.7 *Stop valves.* All stop valves controlling the flow of water to sprinklers shall be manipulated to ensure that they are in working order, and securely refastened in the correct mode.

COMMENTARY AND RECOMMENDATIONS ON **35.2.7**.
This includes the stop valves on all water supplies, at the alarm valve(s) and all zone or other subsidiary stop valves.

35.2.8 *Flow switches.* Flow switches shall be checked for correct function.

35.2.9 *Replacement parts.* Replacement parts held as spare shall be checked for number and condition.

35.3 Half-yearly routine

35.3.1 *General.* The checks and inspections of **35.3.2** and **35.3.3** shall be made at intervals of not more than 6 months.

35.3.2 *Dry alarm valves.* Dry alarm valves, and any accelerators and exhausters, in dry pipe installations and tail-end extensions shall be exercised.

COMMENTARY AND RECOMMENDATIONS ON **35.3.2**.
Either remove the inspection cover plate and manually operate the moving parts or, if a screw-down diaphragm interlocking key type subsidiary stop valve complying with BS 5156 is fitted downstream of the alarm valve (see **20.1.3.2***), close the subsidiary stop valve, prime the space between the dry pipe valve clack and the underside of the subsidiary valve with water, and open the installation drain valve.*

Alternate systems need not be tested in this way since they are exercised twice a year as a result of the change-over from wet to dry operation, and back.

35.3.3 *Fire brigade and remote central station alarm.* The electrical installation shall be checked.

35.4 Yearly routine

35.4.1 *General.* The checks and inspections of **35.4.2** and **35.4.3** shall be made at intervals of not more than 12 months.

35.4.2 *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 back pressure valve (see **17.4.2.5**)] and shall give the nameplate pressure/flow values.

COMMENTARY AND RECOMMENDATIONS ON **35.4.2**.
Allow for pressure losses in the supply pipe and valves between the source and the "C" gauge of each installation and calculate these in accordance with the requirements of ***18.2****.*

35.4.3 ***Diesel engine fail-to-start test***

35.4.3.1 The fail-to-start alarm shall operate after the sixth cycle of cranking, when the following sequence is carried out:

a) the fuel supply is isolated;

b) the engine is cranked for not less than 15 s;

c) cranking is stopped for not less than 10 s and not more than 15 s;

d) (b) and (c) are repeated a further five times.

35.4.3.2 The engine shall start immediately when, after the test of **35.4.3.1** is carried out and the fuel supply restored, the manual starting system is operated.

35.4.4 *Float valves on water storage tanks* Float valves on water storage tanks shall be checked for correct function.

35.5 3-yearly routine

35.5.1 *General.* The checks and inspections of **35.5.2** and **35.5.3** shall be made at intervals of not more than 3 years.

35.5.2 *Suction, gravity and pressure tanks.* All tanks shall be examined externally for corrosion. Type B and C suction tanks (see **17.4.11.6**) 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.

COMMENTARY AND RECOMMENDATIONS ON **35.5.2**.
Type A and D tanks should be drained, cleaned as necessary and examined internally for corrosion if external examination indicates that this is advisable.

*See **17.4.11.5** for painting and corrosion-protection of suction tanks.*

35.5.3 *Water supply stop valves, alarm and check valves.* All water supply stop valves, alarm and check valves shall be examined and replaced or overhauled as necessary.

35.6 15-yearly routine

At not more than 15-year intervals, Type A and D pump suction tanks (see **17.4.11.6**) shall be drained, cleaned as necessary, examined internally and the fabric attended to as necessary.

Appendix A Water supply pressure test

A.1 General

A.1.1 Use the test facility specified in clause **19**.

A.1.2 Test each supply to the installation independently with all other supplies isolated.

A.2 Suction pump and pressure tank supplies

Fully open the stop valves controlling the flow from the supply to the installation. Open the installation drain and test valve fully and check that the pump(s) if fitted start automatically. Check that the flow is as specified in clause **15** and that recorded during the commissioning test. Record the supply pressure measured on the "C" gauge. Compare this with the appropriate value specified in clause **15** and the value recorded during the commissioning test.

A.3 Town main, booster pump, elevated private reservoir and gravity tank supplies

Fully open the stop valves controlling the flow from the supply to the installation. Open the drain and test valve and check that the pump(s), if fitted, have started automatically. Manipulate the drain and test valve to give the appropriate flow specified in clause **15**. When the flow is steady record the supply pressure measured on the "C" gauge. Compare this with the appropriate value specified in clause **15** and the value recorded during the commissioning test.

Appendix B Orifice plate design

B.1 General

Table 79 and Table 80 may be used to size orifices used to achieve hydraulic balance (see **24.1.3** and **24.2.4.2**).

The tables give the orifice diameter for medium grade pipe complying with BS 1387 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 79 and 5 000 L/min for Table 80).

B.2 Use of Table 79 and Table 80

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:

$$P_o = P_x \left(\frac{500}{Q_x}\right)^2$$ when using Table 79, and

$$P_o = P_x \left(\frac{5\,000}{Q_x}\right)^2$$ when using Table 80,

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

Table 79 — Orifice plates for 50 mm and 65 mm medium grade pipes complying with BS 1387

Pressure loss P_o	**Pipe nominal bore** (mm)		**Orifice k factor**
	50	**65**	
	Orifice diameter		
bar	mm	mm	
2.5	25.9	—	316
2.25	26.5	—	333
2.0	27.1	—	354
1.75	27.9	—	378
1.5	28.8	—	408
1.25	29.6	—	447
1.0	30.9	—	500
0.9	31.5	—	527
0.8	32.2	34.5	559
0.7	32.8	35.3	598
0.6	33.7	36.3	645
0.5	34.7	37.6	707
0.4	35.9	39.3	791
0.3	37.5	41.2	913
0.2	39.7	44.2	1 118
0.1	42.7	49.1	1 581
0.05	—	53.6	2 236

NOTE 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.

NOTE 2 The k factor for the orifice is marked on the plate (see **24.1.3**).

Table 80 — Orifice plates for 80, 100, 150 and 200 mm medium grade pipes complying with BS 1387

Pressure loss P_o	Pipe nominal bore (mm)				Orifice k factor
	80	100	150	200	
	Orifice diameter				
bar	mm	mm	mm	mm	
35	41.9	—	—	—	845
30	43.0	—	—	—	913
25	44.8	—	—	—	1 000
20	46.4	—	—	—	1 118
15	48.9	—	—	—	1 291
10	52.3	56.2	—	—	1 581
9	53.2	57.6	—	—	1 667
8	54.1	59.0	—	—	1 768
7	55.3	60.4	—	—	1 890
6	56.6	62.0	—	—	2 041
5	58.2	63.9	—	—	2 236
4	59.8	66.5	—	—	2 500
3	62.0	69.7	—	—	2 887
2	65.0	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

NOTE See notes to Table 79.

Appendix C Precautions when carrying out hot work

C.1 General

Many fires and explosions have been caused by the careless arid incorrect use of gas and electric welding or cutting apparatus, and by blow lamps and blow torches. The consequences are likely to be more severe when the hot work is on a sprinkler system which of necessity will be wholly or partially non-operational.

It is recommended that installers consult the user and the insurers before carrying out hot work to agree appropriate precautions.

C.2 Equipment

Equipment should be compatible; in some cases this is essential, for example never attempt to use a high-pressure blow-pipe with low-pressure acetylene. Gas welding and cutting equipment should be fitted with hoses complying with BS 5120 and safety devices complying with BS 6158. Hoses for use with LPG should comply with BS 3212. Cylinders for LPG should be of the vapour withdrawal type.

The electric supply to electric arc welding apparatus should be by a power circuit, suitable socket and plug with a cable of adequate current rating. The cable should be as short as possible with all connections properly made to avoid sparking.

C.3 Personnel

At least two persons should be present during hot work; they should be suitably trained or supervised by a trained person. All personnel should be instructed in the method of raising the fire alarm. A person trained in the use of the fire protection equipment provided should be present during, and for 1 h after, hot work.

C.4 Storage of gas cylinders

Gas cylinders not in use should be stored outdoors in a well-ventilated, wired-off structure secure from unauthorized interference. Full and empty cylinders should be in separate stores. Oxygen cylinders should be in stores separate from fuel-gas cylinders and other combustible materials.

C.5 Preparation of work area

If possible bring items to be welded or cut to a prepared safe area rather than carry out hot work in situ. In either case prepare the work area as follows.

a) Remove combustible materials, where possible.

b) Check the far side of walls and partitions for combustible materials and take appropriate action, and where possible check the internal construction of metal- or foil-faced partitions which may have combustible cores.

c) Cover any combustible materials remaining within 15 m with non-combustible blankets or screens.

d) Either wet down combustible floors before covering with sand or cover overlapping non-combustible sheets. Ensure that gaps in flooring are covered so that sparks cannot fall into concealed spaces.

e) Check that the water supply to any sprinkler system intended to be functional is not turned off, and that any hose reels are functional.

f) Provide portable fire extinguishers and wet sacking for immediate use in the work area.

g) Remove non-aqueous solvents from the area and ventilate to eliminate cleaning residues and vapours.

NOTE Dangers are not restricted to flammable solvents; halogenated solvents decompose in flames and welding arcs to produce toxic vapours.

C.6 Hot work procedures

During hot work the following precautions should be observed.

a) Avoid contact of hot welding rod ends, slag and other hot waste with combustible materials. Use a metal bin containing sand for hot waste.

b) Use the correct ignition procedure for gas cutting and welding apparatus, in particular allow the gas to purge lines of air and to reach working pressure before ignition.

c) Only light blow lamps and blow torches in the open, and follow the manufacturers' instructions, in particular those regarding preheating of vaporization tubes.

d) Do not leave ignited gas blow pipes, blow lamps or blow torches unattended, and extinguish them immediately work ceases.

e) Allow blow lamps to cool before changing cylinders (LPG) or filling (paraffin or petrol), and carry out the operation outside.

C.7 Subsequent procedures

When the hot work is completed the work area and the far side of walls and partitions should be checked continually for not less than an hour for signs of fire or hot materials.

C.8 Hot work permit

If requested by the user the person supervising the hot work should obtain a hot work permit, issued by a person authorized by the user, before starting hot work. The typical permit shown in Figure 50 is suitable.

A further work permit should be obtained after any break in the work, e.g. for meals.

APPLIES ONLY TO AREA SPECIFIED BELOW

Building ______________________________ floor __________

Nature of the job (including exact location) ______________________________

____

The above location has been examined and the precautions listed on the reverse side have been taken

Date __________ Time of issue of permit __________ Time of expiry of permit __________

Signature of person issuing permit ______________________________

Signature of person to whom permit is issued ______________________________

Time started ______________ Time finished ______________

FINAL CHECK

Work area and all adjacent areas to which sparks and heat might have spread (such as floors above and below and on opposite sides of walls) were inspected continuously for at least one hour after the work was completed and were found fire safe

SIGNATURE OF EMPLOYEE CARRYING OUT THE FIRE WATCH __________

AFTER SIGNING RETURN PERMIT TO PERSON WHO ISSUED IT

☐ (The person carrying out this check should tick the appropriate boxes below)

☐ Where sprinklers are installed that these are operative
Cutting and welding equipment in good repair and adequately secured

PRECAUTIONS WITHIN 15 m OF WORK

☐ Floor swept clean of combustible materials

☐ Combustible floors protected by wetting down and covering with damp sand of sheets of non-combustible material

☐ Combustible materials and flammable liquids protected with non-combustible curtains of sheets

☐ All wall and floor openings covered with sheets of non-combustible material. All gaps in walls and floors through which sparks could pass covered with sheets of non-combustible material

☐ Where work is above floor level, non-combustible curtains of sheets suspended beneath the work to collect sparks

WORK ON WALLS OR CEILINGS

☐ Combustible constructions protected by non-combustible curtains or sheets

☐ Combustibles moved away from far side and clear of any metal likely to conduct heat (where metal beams are being worked on, and extend through walls or partitions, precautions must be taken on the far side of such a wall)

WORK ON ENCLOSED EQUIPMENT (Tanks, containers, ducts, collectors, etc.)

☐ Equipment cleaned of all combustibles

☐ Containers purged of flammable vapours

FIRE WATCH

☐ Provision for the attendance of an employee during and for one hour after completion of work, such employee being supplied with extinguishers or small bore hose and trained in the use of such equipment and in sounding an alarm

SIGNATURE OF PERSON CARRYING OUT THE ABOVE CHECK ______________________________

Figure 50 — Typical hot work permit

Subject Index

NOTE Regarding the numbering of clauses, see BS 3700.

Publications referred to

BS 78, *Specification for cast iron spigot and socket pipes (vertically cast) and spigot and socket fittings.*

BS 78-2, *Fittings.*

BS 84, *Parallel screw threads of Whitworth form.*

BS 143 & BS 1256, *Specification for malleable cast iron and cast copper alloy threaded pipe fittings.*

BS 476, *Fire tests on building materials and structures.*

BS 476-8, *Test methods and criteria for the fire resistance of elements of building.*

BS 476-22, *Methods for determination of the fire resistance of non-loadbearing elements of construction.*

BS 814, *Specification for mild steel and tinplate drums (light duty: fixed ends).*

BS 864, *Capillary and compression tube fittings of copper and copper alloy.*

BS 864-2, *Specification for capillary and compression fittings for copper tubes.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes.*

BS 970-1, *General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels.*

BS 1010, *Specification for draw-off taps and stopvalves for water services (screw-down pattern).*

BS 1010-2, *Draw-off taps and above-ground stopvalves.*

BS 1083, *Specification for precision hexagon bolts, screws and nuts (B.S.W. and B.S.F. threads).*

BS 1192, *Construction drawing practice.*

BS 1211, *Specification for centriffugally cast (spun) iron pressure pipes for water, gas and sewage.*

BS 1387, *Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.*

BS 1449, *Steel plate, sheet and strip.*

BS 1449-1, *Specification for carbon and carbon-manganese plate, sheet and strip.*

BS 1449-2, *Specification for stainless and heat-resisting steel plate, sheet and strip.*

BS 1452, *Specification for grey iron castings.*

BS 1494, *Specification for fixing accessories for building purposes.*

BS 1494-2, *Sundry fixings.*

BS 1580, *Specification for Unified screw threads.*

BS 1580-1, *Diameters 1/4 in and larger.*

BS 1580-2, *Diameters 1/4 in and larger.*

BS 1635, *Graphical symbols and abbreviations for fire protection drawings.*

BS 1710, *Specification for identification of pipelines and services.*

BS 1740, *Specification for wrought steel pipe fittings (screwed BS 21 R-series thread).*

BS 1740-1, *Metric units.*

BS 1768, *Specification for Unified precision hexagon bolts, screws and nuts (UNC and UNF threads). Normal series.*

BS 1780, *Specification for bourdon tube pressure and vacuum gauges.*

BS 2035, *Specification for cast iron flanged pipes and flanged fittings.*

BS 2640, *Specification for Class II oxy-acetylene welding of carbon steel pipework for carrying fluids.*

BS 2869, *Fuel oils for non-marine use.*

BS 2869-2, *Specification for fuel oil for agricultural and industrial engines and burners (Classes A2, C1, D, E, F, G and H).*

BS 2871, *Specification for copper and copper alloys. Tubes.*

BS 2871-1, *Copper tubes for water, gas and sanitation.*

BS 2971, *Specification for class II arc welding of carbon steel pipework for carrying fluids.*

BS 3031, *Specification for sulphuric acid for use in lead-acid batteries.*

BS 3212, *Specification. Flexible rubber tubing and hose (including connections where fitted and safety recommendations) for use in LPG vapour phase and LPG/air installations.*

BS 3505, *Specification for unplasticized PVC pipe for cold water services.*

BS 3506, *Specification for unplasticized PVC pipe for industrial uses.*

BS 3600, *Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes.*

BS 3601, *Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes.*

BS 3602, *Steel pipes and tubes for pressure purposes: carbon and carbon manganese steel with specified elevated temperature properties.*

BS 3602-1, *Specification for seamless and electric resistance welded including induction welded tubes.*

BS 3602-2, *Specification for submerged arc welded tubes.*

BS 3643, *ISO metric screw threads.*

BS 3643-2, *Specification for selected limits of size.*

BS 3692, *Specification for ISO metric precision hexagon bolts, screws and nuts. Metric units.*

BS 3700, *Recommendations for preparing indexes to books, periodicals and other documents.*

BS 3974, *Specification for pipe supports.*

BS 3974-1, *Pipe hangers, slider and roller type supports.*

BS 3974-2, *Pipe clamps, cages, cantilevers and attachments to beams.*

BS 4190, *Specification for ISO metric black hexagon bolts, screws and nuts.*

BS 4346, *Joints and fittings for use with unplasticized PVC pressure pipes.*

BS 4360, *Specification for weldable structural steels.*

BS 4504, *Specification for flanges and bolting for pipes, valves and fittings. Metric series.*

BS 4622, *Specification for grey iron pipes and fittings.*

BS 4652, *Specification for metallic zinc-rich priming paint (organic media).*

BS 4772, *Specification for ductile iron pipes and fittings.*

BS 5120, *Specification for rubber hoses for gas welding and allied processes.*

BS 5150, *Specification for cast iron wedge and double disc gate valves for general purposes.*

BS 5151, *Specification for cast iron gate (parallel slide) valves for general purposes.*

BS 5152, *Specification for cast iron globe and globe stop and check valves for general purposes.*

BS 5153, *Specification for cast iron check valves for general purposes.*

BS 5154, *Specification for copper alloy globe, globe stop and check, check and gate valves.*

BS 5155, *Specification for butterfly valves.*

BS 5156, *Specification for diaphragm valves.*

BS 5157, *Specification for steel gate (parallel slide) valves.*

BS 5159, *Specification for cast iron and carbon steel ball valves for general purposes.*

BS 5160, *Specification for steel globe valves, globe stop and check valves and lift type check valves.*

BS 5163, *Specification for predominantly key-operated cast iron gate valves for waterworks purposes.*

BS 5306, *Fire extinguishing installations and equipment on premises.*

BS 5306-0, *Guide for the selection of installed systems and other fire equipment.*

BS 5306-1, *Hydrant systems, hose reels and foam inlets.*

BS 5306-3, *Code of practice for selection, installation and maintenance of portable fire extinguishers.*

BS 5306-4, *Specification for carbon dioxide systems.*

BS 5306-5, *Halon systems.*

BS 5306-6, *Foam systems.*

BS 5306-7, *Specification for powder systems.*

BS 5337, *Code of practice for the structural use of concrete for retaining aqueous liquids.*

BS 5422, *The use of thermal insulating materials.*

BS 5490, *Specification for classification of degrees of protection provided by enclosures.*

BS 5493, *Code of practice for protective coating of iron and steel structures against corrosion.*

BS 5499, *Fire safety signs, notices and graphic symbols.*

BS 5499-1, *Specification for fire safety signs.*

BS 5500, *Specification for unfired fusion welded pressure vessels.*

BS 5514, *Reciprocating internal combustion engines: performance.*

BS 5588, *Fire precautions in the design, construction and use of buildings.*

BS 5588-10, *Code of practice for enclosed shopping complexes*[6)].

BS 5655, *Lifts and service lifts.*

BS 5655-1, *Safety rules for the construction and installation of electric lifts.*

BS 5750, *Quality systems.*

BS 5839, *Fire detection and alarm systems for buildings.*

BS 5839-1, *Code of practice for system design, installation and servicing.*

BS 5839-2, *Specification for manual call points.*

BS 5839-4, *Specification for control and indicating equipment.*

BS 5908, *Code of practice for fire precautions in chemical plant.*

BS 5970, *Code of practice for thermal insulation of pipework and equipment (in the temperature range – 100 °C to + 870 °C).*

BS 6158, *Specification for safety devices for fuel gases and oxygen or compressed air for welding, cutting and related processes.*

BS 6207, *Specification for mineral-insulated copper-sheathed cables with copper conductors.*

BS 6260, *Specification for open nickel-cadmium prismatic rechargeable single cells.*

BS 6290, *Lead-acid stationary cells and batteries.*

BS 6290-1, *Specification for general requirements.*

BS 6290-2, *Specification for lead-acid high performance Planté positive type.*

BS 6351, *Electric surface heating.*

BS 6351-3, *Code of practice for the installation, testing and maintenance of electric surface heating systems.*

BS 6387, *Specification for performance requirements for cables required to maintain circuit integrity under fire conditions.*

BS 6681, *Specification for malleable cast iron.*

BS 6700, *Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.*

BS 6920, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water.*

BS 6920-1, *Specification.*

CP 312, *Code of practice for plastics pipework (thermoplastics material).*

CP 312-1, *General principles and choice of materials.*

DD 24, *Recommendations for methods of protection against corrosion on light section steel used in building.*

[6)] Under revision.

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