BS EN 12845:2015

Incorporating corrigendum December 2015

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 12845:2015. It supersedes BS EN 12845:2004+A2:2009 which will be withdrawn on 31 December 2015.

This revision of EN 12845 has taken some time in development and as a result, the UK committee feels it may not reflect current sprinkler technology and practice. National Annex NA identifies some areas of concern and also provides guidance and material related to UK practice.

A sprinkler system designed, installed and maintained in accordance with this standard is capable of providing protection of property and for the safety of people, including firefighters, should a fire occur in sprinkler-protected premises.

It should be noted that this standard no longer uses the term 'life safety'. For the avoidance of doubt and to clarify issues that have frequently arisen, when sprinkler systems are called for to satisfy national regulations, including any references to 'life safety', such requirements are now found in Annex F: Additional measures to improve system reliability and availability.

It is anticipated that this annex will make it clear that additional equipment and facilities are usually only necessary to enhance system response or prevent the periodic closure of protected occupancies when a sprinkler system is impaired.

Attention is drawn to the *LPC Rules for Automatic Sprinkler Installations*, which incorporate the provisions of BS EN 12845.

The UK participation in its preparation was entrusted by Technical Committee FSH/18, Fixed fire fighting systems, to Subcommittee FSH/18/2, Sprinkler Systems.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Date	Text affected
31 December 2015	The corrigendum corrects the page numbering of National Annex NA.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12845

June 2015

ICS 13.220.20

Supersedes EN 12845:2004+A2:2009

English Version

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

Installations fixes de lutte contre l'incendie - Systèmes d'extinction automatique du type sprinkleur - Conception, installation et maintenance

Ortsfeste Brandbekämpfungsanlagen - Automatische Sprinkleranlagen - Planung, Installation und Instandhaltung

This European Standard was approved by CEN on 20 December 2014.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 12845:2015) has been prepared by Technical Committee CEN/TC 191 “Fixed firefighting systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2015, and conflicting national standards shall be withdrawn at the latest by December 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12845:2004+A2:2009.

It is included in a series of European Standards planned to cover:

— automatic sprinkler systems (EN 12259);

— gas extinguishing systems (EN 12094);

— powder systems (EN 12416);

— explosion protection systems (ISO 6184);

— foam systems (EN 13565);

— gas systems (EN 12094);

— hydrant and hose reel systems (EN 671);

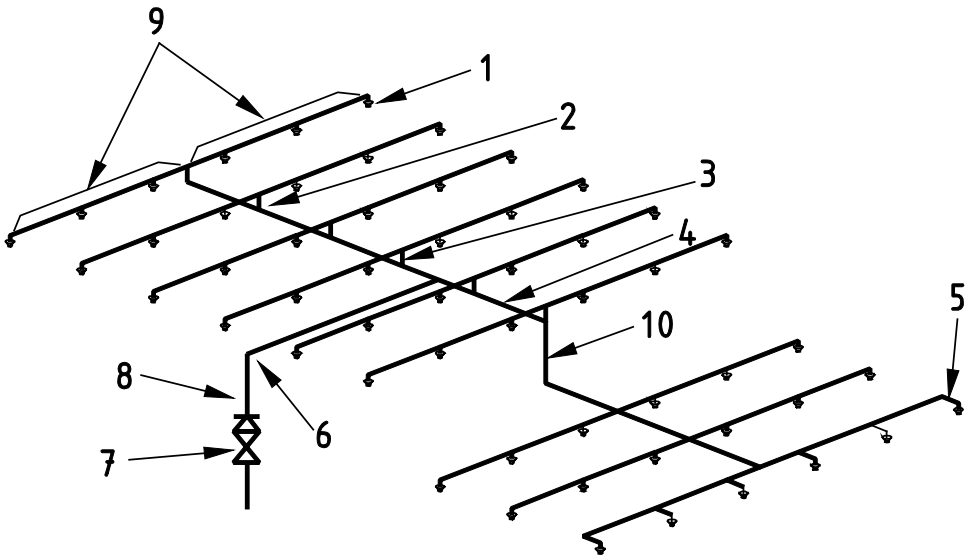
— smoke and heat control systems (EN 12101).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

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

A sprinkler system consists of a water supply (or supplies) and one or more sprinkler installations; each installation consists of a set of installation main control valves and a pipe array fitted with sprinkler heads. The sprinkler heads are fitted at specified locations at the roof or ceiling, and where necessary between racks, below shelves, and in ovens or stoves. The main elements of a typical installation are shown in Figure 1.



Key

1	sprinkler head	6	main distribution pipe
2	riser	7	control valve set
3	design point	8	riser
4	distribution pipe spur	9	range pipes
5	arm pipe	10	drop

Figure 1 — Main elements of a sprinkler installation

The sprinklers operate at predetermined temperatures to discharge water over the affected part of the area below. The flow of water through the alarm valve initiates a fire alarm. The operating temperature is generally selected to suit ambient temperature conditions.

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

The sprinkler system is intended to extend throughout the premises with only limited exceptions.

It should not be assumed that the provision of a sprinkler system entirely obviates the need for other means of fighting fires and it is important to consider the fire precautions in the premises as a whole.

Structural fire resistance, escape routes, fire alarm systems, particular hazards needing other fire protection methods, provision of hose reels and fire hydrants and portable fire extinguishers, etc., safe working and goods handling methods, management supervision and good housekeeping all need consideration.

It is essential that sprinkler systems 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 out of service extra attention should be paid to fire precautions and the appropriate authorities informed.

It is a basic assumption that this standard is for the use of companies employing personnel competent in the field of application with which it deals. Only trained and experienced personnel should undertake the design, installation and maintenance of sprinkler systems. Similarly, competent technicians should be used in the installation and testing of the equipment (see Annex M).

1 Scope

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

This European Standard covers only the types of sprinkler specified in EN 12259-1 (see Annex L).

The requirements and recommendations of this European Standard are also applicable to any addition, extension, repair or other modification to a sprinkler system. They are not applicable to water spray or deluge systems.

It covers the classification of hazards, provision of water supplies, components to be used, installation and testing of the system, maintenance, and the extension of existing systems, and identifies construction details of buildings which are the minimum necessary for satisfactory performance of sprinkler systems complying with this European Standard.

This European Standard does not cover water supplies to systems other than sprinklers. Its requirements can be used as guidance for other fixed firefighting extinguishing systems, provided that any specific requirements for other firefighting extinguishing supplies are taken into account.

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

This European Standard is intended only for fixed fire sprinkler systems in buildings and other premises on land. Although the general principles might well apply to other uses (e.g. maritime use). For these other uses additional considerations should be taken into account.

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

Sprinkler system design deviations might be allowed when such deviations have been shown to provide a level of protection at least equivalent to this European Standard, for example by means of full-scale fire testing where appropriate, and where the design criteria have been fully documented.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 54 (all parts), *Fire detection and fire alarm systems*

EN 1057, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1254 (all parts), *Copper and copper alloys — Plumbing fittings*

EN 12259-1, *Fixed firefighting systems — Components for sprinkler and water spray systems — Part 1: Sprinklers*

EN 12259-2, *Fixed firefighting systems — Components for sprinkler and water spray systems — Part 2: Wet alarm valve assemblies*

EN 12259-3, *Fixed firefighting systems — Components for automatic sprinkler and water spray systems — Part 3: Dry alarm valve assemblies*

EN 12259-4, *Fixed firefighting systems — Components for sprinkler and water spray systems — Part 4: Water motor alarms*

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

EN 50342-1, *Lead-acid starter batteries — Part 1: General requirements and methods of test*

EN 50342-2, *Lead-acid starter batteries — Part 2: Dimensions of batteries and marking of terminals*

EN 60332 (all parts), *Tests on electric and optical fibre cables under fire conditions (IEC 60332)*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

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

EN 60947-1, *Low-voltage switchgear and controlgear — Part 1: General rules (IEC 60947-1)*

EN 60947-4, *Low-voltage switchgear and control gear — Part 4: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4)*

EN ISO 3677, *Filler metal for soft soldering, brazing and braze welding — Designation (ISO 3677)*

EN ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1)*

ISO 65, *Carbon steel tubes suitable for screwing in accordance with ISO 7-1*

ISO 3046 (all parts), *Reciprocating internal combustion engines — Performance*

3 Terms and definitions

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

3.1
'A' gauge
pressure gauge connected to a town main connection, between the supply pipe stop valve and the non-return valve

3.2
accelerator
device that reduces the delay in operation of a dry alarm valve, or composite alarm valve in dry mode, by early detection of the drop in air or inert gas pressure on sprinkler operation

3.3
alarm test valve
valve through which water might be drawn to test the operation of the water motor fire alarm and/or of any associated electric fire alarm

3.4
alarm valve
non-return valve, of the wet, dry or composite type that also initiates the water motor fire alarm when the sprinkler installation operates

3.5
alarm valve, alternate
alarm valve suitable for a wet, dry or alternate installation

3.6
alarm valve, dry
alarm valve suitable for a dry installation; and/or in association with a wet alarm valve for an alternate installation

3.7
alarm valve, pre-action
alarm valve suitable for a pre-action installation

3.8
alarm valve, wet
alarm valve suitable for a wet installation

3.9
area of operation
maximum area, over which it is assumed, for design purposes, that sprinklers will operate in a fire

3.10
area of operation, hydraulically most favourable
location in a sprinkler array of an area of operation of specified shape at which the water flow is the maximum for a specific pressure measured at the control valve set

3.11
area of operation, hydraulically most unfavourable
location in a sprinkler array of an area of operation of specified shape at which the water supply pressure measured at the control valve set is the maximum needed to give the specified design density

3.12
arm pipe
pipe less than 0,3 m long, other than the last section of a range pipe, feeding a single sprinkler

3.13
authorities
organizations responsible for approving sprinkler systems, equipment and procedures, e.g. the fire and building control authorities, the fire insurers, the local water authority or other appropriate public authorities

3.14
'B' gauge
pressure gauge connected to and on the same level as an alarm valve, indicating the pressure on the upstream side of the valve

3.15
booster pump set
automatic pump supplying water to a sprinkler system from a gravity tank or town main

3.16
'C' gauge
pressure gauge connected to and on the same level as an alarm valve, indicating the pressure on the downstream side of the valve

3.17
control valve set
assembly comprising an alarm valve, a stop valve and all the associated valves and accessories for the control of one sprinkler installation

3.18
cut-off sprinkler
sprinkler protecting a door or window between two areas only one of which is protected by sprinklers

3.19
design density
minimum density of discharge, in millimetres per minute of water, for which a sprinkler installation is designed, determined from the discharge of a specified group of sprinklers, in litres per minute, divided by the area covered, in square metres

3.20
design point
point on a distribution pipe of a pre-calculated installation, downstream of which pipework is sized from tables and upstream of which pipework is sized by hydraulic calculation

3.21
distribution pipe
pipe feeding either a range pipe directly or a single sprinkler on a non-terminal range pipe more than 300 mm long

3.22
distribution pipe spur
distribution pipe from a main distribution pipe, to a terminal branched pipe array

3.23
drencher
sprayer used to distribute water over a surface to provide protection against fire exposure

3.24
drop
vertical distribution pipe feeding a distribution or range pipe below

3.25
end-centre array
pipe array with range pipes on both sides of a distribution pipe

3.26
end-side array
pipe array with range pipes on one side only of a distribution pipe

3.27
exhauster
device to exhaust the air or inert gas from a dry or alternate installation to atmosphere on sprinkler operation to give more rapid operation of the alarm valve

3.28
fire resistant compartment
enclosed volume capable of maintaining its fire integrity for a minimum specified time

3.29
fully calculated
term applied to an installation in which all the pipework is sized by hydraulic calculation

3.30
gridded configuration
pipe array in which water flows to each sprinkler by more than one route

3.31
hanger
assembly for suspending pipework from elements of building structure

3.32
high rise system
sprinkler system in which the highest sprinkler is more than 45 m above the lowest sprinkler or above the sprinkler pumps, whichever is the lower

3.33
inexhaustible sources
natural and artificial water sources such as rivers, canals and lakes which are virtually inexhaustible for reasons of capacity and climate, etc.

3.34
installation (sprinkler installation)
part of sprinkler system comprising a control valve set, the associated downstream pipes and sprinklers

3.35
installation, alternate
installation in which the pipework is selectively charged with either water or air/inert gas according to ambient temperature conditions

3.36
installation, dry (pipe)
installation in which the pipework is charged with air or inert gas under pressure

3.37
installation, pre-action
one of two types of 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

3.38
installation, wet (pipe)
installation in which the pipework is always charged with water

3.39
discharge coefficient "K"
coefficient of discharge in the formula $\boldsymbol{Q = K\sqrt{p}}$

where:

Q is the flow in litres per minute, and p is the pressure in bar

3.40
looped configuration
pipe array in which there is more than one distribution pipe route along which water might flow to a range pipe

3.41
main distribution pipe
pipe feeding a distribution pipe

3.42
maximum flow demand (Qmax)
flow at the point of intersection of the pressure-flow demand characteristic, of the most favourable area of operation of the sprinkler system, and the water supply pressure-flow characteristic, with the suction source at its normal level

3.43
mechanical pipe joint
pipe fitting other than threaded tubulars, screwed fittings, spigots and socket and flanged joint, used to connect pipes and components

3.44
multi-storey building
building comprising two or more storeys, above or below ground

3.45
node
point in pipework at which pressure and flow(s) are calculated; each node is a datum point for the purpose of hydraulic calculations in the installation

3.46
normal water level
water level at the water supply needed to give the required effect capacity in relation to the low water level, including any necessary margins

EXAMPLE For ice.

3.47
pipe array
pipes feeding a group of sprinklers

EXAMPLE Pipe arrays can be looped, gridded or branched.

3.48
pre-calculated
installation in which the pipes downstream of the design point(s) have been previously sized by hydraulic calculation

Note 1 to entry: Tables of diameters are given.

3.49
pressure maintenance pump (jockey pump)
small automatic pumpset used to replenish minor water loss and maintain system pressure

3.50
pressure tank
tank containing water under air pressure sufficient to ensure that all the water can be discharged at the necessary pressure

3.51
range pipe
pipe feeding sprinklers either directly or via arm pipes

3.52
riser
vertical distribution pipe feeding a distribution or range pipe above

3.53
sprayer
water spray nozzle that gives a downward conical pattern discharge

3.54
sprinkler (automatic)
nozzle with a thermally sensitive sealing device which opens to discharge water for fire fighting

3.55
sprinkler, ceiling or flush
pendent sprinkler for fitting partly above, but with the temperature sensitive element located below the plane of the ceiling

3.56
sprinkler, concealed
recessed sprinkler with a cover plate that disengages when heat is applied

3.57
sprinkler, conventional pattern
sprinkler that gives a spherical pattern of water discharge

3.58
sprinkler, dry pendent pattern
unit comprising a sprinkler and a dry drop pipe unit with a valve at the head of the pipe, held closed by a device maintained in position by the sprinkler head valve

3.59
sprinkler, dry upright pattern
unit comprising a sprinkler and dry rise pipe unit with a valve, at the base of the pipe, held closed by a device maintained in position by the sprinkler head valve

3.60
sprinkler, spray flat
sprinkler that gives a pattern of water discharge with a proportion of the discharge directed above the level of the deflector

3.61
sprinkler, fusible link
sprinkler which opens when a component provided for this purpose melts

3.62
sprinkler, glass bulb
sprinkler which opens when a liquid-filled glass bulb bursts

3.63
sprinkler, horizontal
sprinkler in which the nozzle directs water horizontally

3.64
sprinkler, open
sprinkler not sealed by a temperature sensitive element

3.65
sprinkler, pendant
sprinkler in which the nozzle directs water downwards

3.66
sprinkler, recessed
sprinkler in which all or part of the heat sensing element is above the lower plane of the ceiling

3.67
sprinkler rosette
plate covering the gap between the shank or body of a sprinkler projecting through a suspended ceiling, and the ceiling

3.68
sprinkler, sidewall pattern
sprinkler that gives an outward half-paraboloid pattern discharge

3.69
sprinkler, spray pattern
sprinkler that gives a downward paraboloid pattern discharge

3.70
sprinkler, upright
sprinkler in which the nozzle directs water upwards

3.71
sprinkler system
entire means of providing sprinkler protection in the premises comprising one or more sprinkler installations, the pipework to the installations and the water supply/supplies

3.72
sprinkler yoke (arms)
part of a sprinkler that retains the heat sensitive element in load bearing contact with the sprinkler head valve

3.73
staggered (sprinkler) layout
off-set layout with the sprinklers displaced one-half pitch along the range pipe relative to the next range or ranges

3.74
standard (sprinkler) layout
rectilinear layout with the sprinklers aligned perpendicular to the run of the ranges

3.75
subsidiary alternate (wet and dry pipe) extension
part of a wet installation that is selectively charged with water or air/inert gas according to ambient temperature conditions and that is controlled by a subsidiary dry or alternate alarm valve

3.76
subsidiary dry extension
part of a wet or alternate installation that is charged permanently with air or inert gas under pressure

3.77
suitable for sprinkler use
term applied to equipment or components accepted by the authorities as suitable for a particular application in a sprinkler system, either by conforming to EN product standards where available or if not by compliance with specified criteria

3.78
supply pipe
pipe connecting a water supply to a trunk main or the installation control valve set(s); or a pipe supplying water to a private reservoir or storage tank

3.79
suspended open cell ceiling
ceiling of regular open cell construction through which water from sprinklers can be discharged freely

3.80
terminal main configuration
pipe array with only one water supply route to each range pipe

3.81
terminal range configuration
pipe array with only one water supply route from a distribution pipe

3.82
trunk main
pipe connecting two or more water supply pipes to the installation control valve set(s)

3.83
water supply datum point
point on the installation pipework at which the water supply pressure and flow characteristics are specified and measured

3.84
zone
sub-division of an installation with a specific flow alarm and fitted with a monitored subsidiary stop

4 Contract planning and documentation

4.1 General

The information specified in 4.3 and 4.4 shall be provided to the user or owner as appropriate. All drawings and information documents shall carry the following information:

a) the name of the user and the owner, where known;

b) the address and location of premises;

c) the occupancy of each building;

d) the name of the designer;

e) the name of the person responsible for checking the design, who shall not be the designer;

f) date and number of issue.

4.2 Initial considerations

When preparing the outline design, consideration shall be given to aspects of building design, building systems and work procedures that might affect the performance of the sprinkler system.

Although an automatic sprinkler system usually extends throughout a building or plant, it should not be assumed that this entirely obviates the need for other means of fire protection and it is important to consider the fire precautions of the premises as a whole. Account shall be taken of possible interaction between sprinkler systems and other fire protection measures.

Where a sprinkler system or an extension or alteration to a sprinkler system is being considered for new or existing buildings and industrial plant the relevant authorities shall be consulted at an early stage.

The authorities should be consulted when the hazard classification is being determined.

4.3 Preliminary or estimating stage

At least the following information shall be provided:

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 storage 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;

c) general details of the water supplies, which if 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 estimate is based on the provision of a sprinkler system to this European Standard, based on available information.

4.4 Design stage

4.4.1 General

The information provided shall include a summary schedule (see 4.4.2), complete working drawings of the sprinkler installation(s) (see 4.4.3) and details of the water supplies (see 4.4.4).

4.4.2 Summary schedule

The summary schedule shall give the following information:

a) the name of project;

b) all drawings or document reference numbers;

c) all drawings or document issue numbers;

d) all dates of issue of drawing or documents;

e) all drawing or document titles;

f) the type(s) of installation(s) and the nominal diameter(s) of each control valve set;

g) the number or references of each control valve set in the system;

h) the number of sprinklers on each control valve set;

i) a list of the components suitable for sprinkler use included in the system, each identified by supplier's name and model/reference number. If required by the authorities, a Piping and Instrumentation Diagram (P&ID) with a list of all components included in the system, each identified by supplier’s name, model, diameter, total number and reference number should be added. For an example of a P&ID, see figure in Annex O.

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

k) a statement that the installation has been designed and will be installed in accordance with this European Standard or giving details of any deviations from its requirements and the reasons why, based on available information.

4.4.3 Installation layout drawings

4.4.3.1 General

Layout drawings shall include the following information:

a) north point indication;

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

c) construction 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, light fittings, heaters, suspended open cell ceilings, etc. which might adversely affect the sprinkler distribution;

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

h) the type and approximate location of pipe supports;

i) the location and type of control valve sets and location of water motor alarms;

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

k) the location and size of any subsidiary valves, subsidiary stop valves and drain valves;

l) the drainage slope of the pipework;

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

n) the location of all test valves;

o) the location and details of any alarm panel;

p) the location and details of any fire department inlet connections;

q) a key to the symbols used.

4.4.3.2 Pre-calculated pipework

For pre-calculated 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 18);

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

   1) in an Light Hazard (LH) installation — 225 l/min;

2) in an Ordinary Hazard (OH)installation — the flow corresponding to the appropriate design (OH) as given in Table 6;

3) in a High Hazard (HH) installation — the flow corresponding to the appropriate design density given in Table 7 or in 7.3.2.2.

NOTE See 6.2 for hazard classification.

c) The calculation as specified in 13.3, showing that:

1) in LH and OH installations, for each run of distribution pipework,

pf + ph

is no more than the appropriate value specified in 13.3.3 or 13.3.4; and/or

2) in HHP and HHS installations designed using Tables 32 to 35,

pf + pd + ps

is no more than the residual pressure available at the control valve set from the water supply when it is tested at the appropriate flow rate,

where

pd is the pressure at the design point specified in Table 7 or as appropriate, in bar;

pf is the frictional pressure loss in the distribution pipework between the design point and the control valve 'C' gauge, in bar;

ph 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, in bar;

ps is the static head loss owing to the height of the highest sprinkler in the array concerned above the control valve 'C' gauge, in bar.

4.4.3.3 Fully calculated pipework

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

a) the program name and version number;

b) the date of the worksheet or print-out;

c) the actual internal diameters of all pipes used in the calculation;

d) for each design area of operation:

1) the area identification;

2) the hazard class;

3) the specified design density in millimetres per minute;

4) the assumed maximum area of operation (area of operation) in square metres;

5) the number of sprinklers in the area of operation;

6) the sprinkler nominal orifice size in millimetres;

7) the maximum area covered per sprinkler in square metres;

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 area of operation;

   iii) the position of the hydraulically most favourable area of operation;

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

   v) the height above datum (e.g. pump axis) of each point of identified pressure value.

e) for each operating sprinkler:

   1) the sprinkler node or reference number;

   2) the nominal K-factor (see EN 12259-1);

   3) the flow through the sprinkler in litres per minute;

   4) the inlet pressure to the sprinkler or sprinkler assembly in bar.

f) for each hydraulically significant pipe:

   1) pipe node or other reference number;

   2) nominal bore in millimetres;

   3) the Hazen-Williams constant;

   4) flow in litres per minute;

   5) velocity in metres per second;

   6) length in metres;

   7) numbers, types and equivalent length in metres of fittings and components;

   8) static head change in metres;

   9) pressures at inlet and outlet in bar;

   10) friction loss in bar;

   11) indication of flow direction.

4.4.4 Water supply

4.4.4.1 Water supply drawings

The drawings shall show water supplies and pipework up to the control valve set. A key to the symbols shall be included. The position and type of stop and non-return valves and any pressure reducing valves, water meters, back flow preventers and any connections supplying water for other services, shall be indicated.

4.4.4.2 Hydraulic calculation

A hydraulic calculation shall show that the minimum water supply characteristics are capable of providing the required pressure and flow at the control valve set.

4.4.4.3 Town main

Where a town main forms one or both of the supplies or provides infill to a reduced capacity storage tank, 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 a test at a period of peak demand. At least three pressure/flow points shall be obtained. 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 control valve set.

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

f) a pressure/flow characteristic graph indicating the available pressure at any flow up to the maximum flow demand;

g) the demand pressure/flow characteristic graph for each installation for the hydraulically most unfavourable (and if required the most favourable) area of operation with pressure taken as at the control valve 'C' pressure gauge.

4.4.4.4 Automatic pump set

The following details of each automatic pump set shall be provided:

a) a pump characteristic curve for low water level 'X' (see Figures 4 and 5), showing the estimated performance of the pump or pumps under installed conditions at the control valve 'C' gauge.

b) the pump supplier's data sheet showing the following:

   1) the generated head graph;

   2) the power absorption graph;

   3) the net positive suction head (NPSH) graph showing requirements according to 10.1.a or 10.1.b;

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

c) the installer's data sheet showing the pumpset installed performance pressure/flow characteristics, at the control valve 'C' gauge for normal water level and for low water level 'X' (see Figures 4 and 5), and at the pump outlet pressure gauge for normal water level;

d) the height difference between the control valve 'C' gauge and the pump delivery pressure gauge;

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

f) the available and the specified NPSH at maximum required flow;

g) the minimum depth of water cover of submersible pumps.

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

h) the demand pressure/flow characteristic for the hydraulically most unfavourable and most favourable area of operation calculated at the control valve 'C' gauge.

4.4.4.5 Storage tank

The following details shall be provided:

a) the location;

b) the total volume of the tank;

c) the effective capacity of the tank and duration;

d) the inflow for reduced capacity tanks;

e) the vertical distance between the pump centre line and the tank low water level 'X' (see Figure 4);

f) structural details of the tank and roof;

g) the recommended frequency of scheduled repairs requiring emptying of the tank;

h) protection against freezing;

i) low and normal water levels X and N (see Figure 4);

j) height of gravity tank above the highest sprinkler.

4.4.4.6 Pressure tank

The following details shall be provided:

a) the location;

b) the total volume of the tank;

c) the volume of stored water;

d) the air pressure;

e) the height of the highest and/or hydraulically most remote sprinkler above the bottom of the tank;

f) the vertical distance of the lowest sprinklers below the bottom of the tank;

g) details of the means of refilling.

5 Extent of sprinkler protection

5.1 Buildings and areas to be protected

5.1.1 General

Where a building is to be sprinkler protected, all areas of that building or of a communicating building shall be sprinkler protected, except in the cases indicated in 5.1.2 and 5.1.3 and 5.3.

Consideration should be given to the protection of load bearing steel.

5.1.2 Permitted exceptions within a building

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

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

b) enclosed staircases and enclosed vertical shafts (e.g. lifts or service shafts) containing no combustible material and constructed as a fire resistant separation (see 5.3).

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

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

5.1.3 Necessary exceptions

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

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

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

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

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

5.2 Storage in the open air

The distance between combustible materials stored in the open air and the sprinklered building shall correspond to regulatory provisions in the place of use.

Where it is not regulated, the distance between combustible materials stored in the open air and the sprinklered building shall be no less than 10 m or 1,5 times the height of the stored material.

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

5.3 Fire resistant separation

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

No part of an unsprinklered building or section should be located vertically below a sprinklered building or section except as indicated in 5.1.2 and 5.1.3.

5.4 Protection of concealed spaces

If the height of the concealed space at roof and floor exceeds 0,8 m, measured between the underside of the roof and the top of the suspended ceiling or between the floor and the underside of the raised floor, these spaces shall be sprinkler protected.

If the height of the concealed space at roof and floor is no greater than 0,8 m, the spaces shall be sprinkler protected only if they contain combustible materials or are constructed with combustible materials. Electrical cables with voltage less than 250V, single phase, with a maximum of 15 cables per tray, are allowed.

The protection in the concealed space shall be to LH when the main hazard class is LH, and OH1 in all other cases. See 17.3 for the pipework arrangement.

5.5 Height difference between the highest and lowest sprinklers

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

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

6 Classification of occupancies and fire hazards

6.1 General

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

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

This classification depends on the occupancy and the fire load. Examples of occupancies are given in Annex A.

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

6.2 Hazard classes

6.2.1 General

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

6.2.2 Light Hazard – LH

LH includes occupancies with low fire loads and low combustibility and with no single compartment greater than 126 m^2 with a fire resistance of at least 30 min. See Annex A for examples.

6.2.3 Ordinary Hazard – OH

OH includes occupancies where combustible materials with a medium fire load and medium combustibility are processed or manufactured, See Annex A for examples.

Ordinary Hazard is sub-divided into 4 groups:

— OH1, Ordinary Hazard Group 1

— OH2, Ordinary Hazard Group 2

— OH3, Ordinary Hazard Group 3

— OH4, Ordinary Hazard Group 4

Materials might be stored in occupancies classified as OH provided the following conditions are met:

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

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

c) The maximum storage area of a single block shall not exceed 50 m^2, with a clearance around the block of not less than 2,4 m.

When the area is classified as OH4 or where the requirements of b) or c) cannot be met, storage within the area shall be treated as HHS (see 6.2.4.2).

Table 1 — Maximum storage heights for OH3 protection

Storage Category	Maximum storage height [a] m	
	Free standing or block storage (ST1 – see 6.3.2)	Storage configurations (ST2 to ST6[b] see 6.3.2)
Category I	4,0	3,5
Category II	3,0	2,6
Category III	2,1	1,7
Category IV	1,2	1,2

[a] where storage heights exceed the values in the table use HHS protection, see 6.2.4.2 and 7.2

[b] ST6 storage shall be limited to gondola shelving 1,2 m total width with a solid central barrier extending from the base to the top of the gondola shelving. All other ST6 storage requires protection in accordance with HHS protection, see 7.2.

6.2.4 High Hazard – HH

6.2.4.1 High Hazard, Process – HHP

High Hazard, Process, covers occupancies where the materials concerned have a high fire load and high combustibility and are capable of developing a quickly spreading or intense fire.

HHP is sub-divided into four groups:

— HHP1, High Hazard Process Group 1;

— HHP2, High Hazard Process Group 2;

— HHP3, High Hazard Process Group 3;

— HHP4, High Hazard Process Group 4.

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

6.2.4.2 High Hazard, Storage – HHS

High Hazard, Storage, covers the storage of goods where the height of storage exceeds the limits given in 6.2.3.

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

— HHS1, High Hazard Storage Category I;

— HHS2, High Hazard Storage Category II;

— HHS3, High Hazard Storage Category III;

— HHS4, High Hazard Storage Category IV.

NOTE Examples are given in Annex B and Annex C.

6.3 Storage

6.3.1 General

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

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

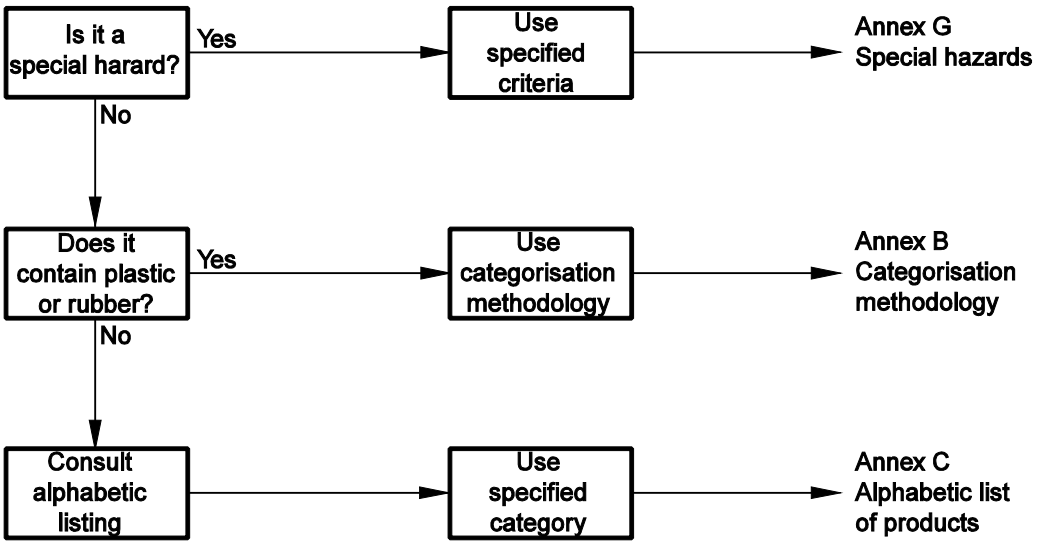


Figure 2 — Flow chart for determining the class required for storage

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

6.3.2 Storage Configuration

The storage configuration shall be classified as follows:

— ST1: free standing or block stacking;

— ST2: post pallets in single rows, with aisles not less than 2,4 m wide;

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

— ST4: palletized rack (beam pallet racking);

— ST5: solid or slatted shelves 1 m or less wide;

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

Typical examples of storage configurations are given in Figure 3.

NOTE For each storage method, there are specific limitations to storage heights depending on the type and design of sprinkler systems (see 7.2).

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

Table 2 — Protection requirements and limitations for storage configurations ST1 to ST6

Storage configuration	Hazard	Applicable conditions	Maximum storage block area m^2	Width of aisles separating rows of storage m	Minimum separation clearance around storage block area m
ST1	OH		50	[a]	2,4
	HH		150	[a]	2,4
ST2	OH		50	2,4 or greater	2,4
	HH		unlimited	2,4 or greater	[a]
ST3	OH		50	[a]	2,4
	HH		150	[a]	2,4
ST4	OH		50	1,2 or greater	2,4
	HH	without intermediate level in-rack sprinkler protection [b, c]	unlimited	1,2 or greater	[a]
		with intermediate level in-rack sprinkler protection [d]		Less than 1,2	[a]
		with intermediate level in-rack sprinkler protection [e]		greater than 1,2 but less than 2,4	[a]
		with intermediate level in-rack sprinkler protection [f]		2,4 or greater	[a]
ST5	OH		50	1,2 or greater	2,4
	HH	without intermediate level in-rack sprinkler protection [b, c]	150	less than 1,2	2,4
		with intermediate level in-rack sprinkler protection [d]	150	less than 1,2	2,4
		with intermediate level in-rack sprinkler protection [g]	Unlimited	1,2 or greater	[a]
ST6	OH	use HH protection			
	HH	with intermediate level in-rack sprinkler protection [c, h]			
			150	1,2	2,4

[a] Not applicable.

[b] intermediate level in-rack sprinkler protection is recommended.

[c] Protection method limited to risks where the ceiling sprinklers are less than 4 m above the highest level of stored goods. Where the ceiling sprinklers are more than 4 m above the highest level of stored goods, intermediate level in-rack sprinklers shall be used.

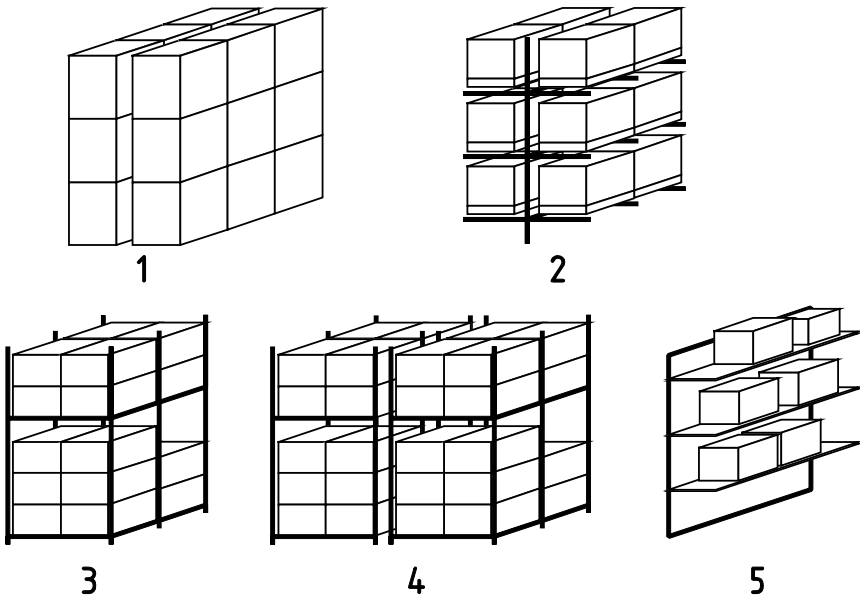
[d] Assume intermediate level in-rack sprinkler protection in three racks is hydraulically involved, see 7.2.3.3.

[e] Assume intermediate level in-rack sprinkler protection in two racks is hydraulically involved, see 7.2.3.3.

[f] Assume intermediate level in-rack sprinkler protection in one rack is hydraulically involved, see 7.2.3.3.

[g] Assume intermediate level in-rack sprinkler protection in one or two racks is hydraulically involved, see 7.2.3.3.

[h] If it is not possible to install intermediate sprinklers in ST6 storage longitudinal and transverse full height bulkheads shall be fitted longitudinally within each shelf. The full height bulkheads shall be constructed to EN 13501–1, Euroclass A1, A2 or national equivalent.



Key

1 free-standing storage (ST1)
2 palletized rack (ST4)
3 post-pallet storage (ST2)
4 post-pallet storage (ST3)
5 solid or slatted shelves (ST 5/6)

Figure 3 — Storage configuration

7 Hydraulic design criteria

7.1 LH, OH and HHP

The design density shall be no less than the appropriate value given in this clause when all the ceiling or roof sprinklers in the room concerned, or in the area of operation, whichever is the fewer, plus any in-rack sprinklers and supplementary sprinklers, are in operation. The minimum requirements for design density and area of operation for LH, OH and HHP classes are given in Table 3. For HHS systems, the requirement given in 7.2 shall be applied.

NOTE For pre-calculated systems, the design criteria are achieved by the application of water supply and piping requirements stated elsewhere in this standard (see 7.3, 9.3.2.2 and 10.7).

Table 3 — Design criteria for LH, OH and HHP

Hazard Class	Design Density mm/min	Area of Operation m^2	
		Wet or pre-action	Dry or alternate
LH	2,25	84	Not allowed Use OH1
OH1	5,0	72	90
OH2	5,0	144	180
OH3	5,0	216	270
OH4	5,0	360	Not allowed Use HHP1
HHP1	7,5	260	325
HHP2	10,0	260	325
HHP3	12,5	260	325
HHP4	deluge (see NOTE)		
NOTE Needs special consideration. Deluge systems are not covered by this standard.			

7.2 High Hazard Storage – HHS

7.2.1 General

The type of protection and determination of the design density and area of operation are dependent on the combustibility of the product (or mix of products) and its packaging (including the pallet) and the method and height of storage.

Specific limitations apply to the various types of storage methods as detailed in Clause 6.

7.2.2 Ceiling or roof protection only

7.2.2.1 General

Authorities shall be consulted for buildings exceeding 12 m, except when applying Annex P.

7.2.2.2 Storage height limits

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

Where storage heights exceed the limit intermediate levels of in-rack sprinklers shall be provided as per 7.2.3 (see Table 4).

7.2.2.3 Excessive clearance

The values from Table 4 shall be used to determine the clearance. Where the clearance, distance between the storage height and ceiling sprinkler deflector, exceeds 4 m one of the following options shall be applied:

Option 1: increase the density for the first excessive meter by 2,5 mm/min. For each additional meter increase the water density by 1 mm/min. A K-Factor of minimum K115 shall be used.

Option 2: intermediate levels of in-rack sprinklers shall be provided as per 7.2.3.

7.2.3 Intermediate level in-rack sprinklers

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

7.2.3.2 The design density for the roof or ceiling sprinklers shall be a minimum of 7,5 mm/min over an area of operation of 260 m^2. If goods are stored above the highest level of intermediate protection, the design criteria for the roof or ceiling sprinklers shall be taken from Table 5.

7.2.3.3 For the purposes of hydraulic calculation it shall be assumed that 3 sprinklers are operating simultaneously at the most hydraulically remote position on each level of in-rack sprinklers, up to a maximum of three levels. Where rack aisles are 2,4 m or more in width only one rack need be assumed to be involved. Where rack aisles are less than 2,4 m but greater than or equal to 1,2 m in width, two racks shall be assumed to be involved. Where rack aisles are less than 1,2 m in width, three racks shall be assumed to be involved.

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

7.2.3.4 In-rack sprinklers and the associated ceiling sprinklers shall always be fully calculated (see 13.1).

NOTE The minimum pressure at any operating sprinkler is 2,0 bar (see 13.4.4).

Table 4 — Design criteria for HHS with roof or ceiling protection only

Storage Configuration	Maximum permitted storage height m				Design density mm/min	Area of operation (wet or pre-action system (see NOTE) m^2
	Category I	Category II	Category III	Category IV		
ST1 Free standing or block stacking	5,3	4,1	2,9	1,6	7,5	260
	6,5	5,0	3,5	2,0	10,0	
	7,6	5,9	4,1	2,3	12,5	
		6,7	4,7	2,7	15,0	
		7,5	5,2	3,0	17,5	
			5,7	3,3	20,0	300
			6,3	3,6	22,5	
			6,7	3,8	25,0	
			7,2	4,1	27,5	
				4,4	30,0	
ST2 Post pallets in single rows ST4 Palletized racks	4,7	3,4	2,2	1,6	7,5	260
	5,7	4,2	2,6	2,0	10,0	
	6,8	5,0	3,2	2,3	12,5	
		5,6	3,7	2,7	15,0	
		6,0	4,1	3,0	17,5	
			4,4	3,3	20,0	300
			4,8	3,6	22,5	
			5,3	3,8	25,0	
			5,6	4,1	27,5	
			6,0	4,4	30,0	
ST3 Post pallets in multiple rows ST5 and ST6 Solid or slatted shelves	4,7	3,4	2,2	1,6	7,5	260
	5,7	4,2	2,6	2,0	10,0	
		5,0	3,2	2,3	12,5	
				2,7	15,0	
				3,0	17,5	

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

Table 5 — Design criteria for roof or ceiling sprinklers with in-rack sprinklers

Storage Configuration	Maximum permitted storage height above the top level of in-rack protection (see NOTE 1)				Design density	Area of operation (wet or pre-action system (see NOTE 2))
	m				mm/min	m^2
	Category I	Category II	Category III	Category IV		
ST4	3,5	3,4	2,2	1,6	7,5	
Palletized racks			2,6	2,0	10,0	
			3,2	2,3	12,5	
			3,5	2,7	15,0	260
ST5 and ST6	3,5	3,4	2,2	1,6	7,5	
Solid or slatted shelves			2,6	2,0	10,0	
			3,2	2,3	12,5	
				2,7	15,0	260

NOTE 1 The vertical distance from the highest level of in-rack sprinklers to the top of the storage.

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

7.3 Pressure and flow requirements for pre-calculated systems

7.3.1 LH and OH systems

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

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

Hazard Class	Flow	Pressure at the control valve set	Maximum demand flow	Pressure at the control valve set
	l/min	bar	l/min	bar
LH (Wet and pre-action)	225	$2,2+p_s$	—	—
OH1 Wet and pre-action	375	$1,0+p_s$	540	$0,7+ p_s$
OH1 Dry and alternate OH2 Wet and pre-action	725	$1,4+p_s$	1 000	$1,0+p_s$
OH2 Dry and alternate OH3 Wet and pre-action	1 100	$1,7+p_s$	1 350	$1,4+p_s$
OH3 Dry and alternate OH4 Wet and pre-action	1 800	$2,0+p_s$	2 100	$1,5+p_s$

NOTE p_s is the static head loss due to the height of the highest sprinkler in the array concerned above the control valve set 'C' gauge, in bar.

7.3.2 HHP and HHS systems without in-rack sprinklers

7.3.2.1 The water supply shall be capable of delivering at the highest design point not less than the appropriate flow and pressure specified in Table 7, or as modified in 7.3.2.2 to 7.3.2.5. The total requirement for the running pressure at the control valve set shall be the sum of the pressure at the design point, the

pressure equivalent of the difference in height between the control valve set and the highest sprinkler downstream of the design point and the pressure loss for the flow in the piping from the control valve set to the design point.

Table 7 — Pressure and flow requirements for pre-calculated installations designed using Tables 32 to 35

Design density mm/min	**Maximum demand flow** l/min		**Pressure at the highest design point (pd)** bar			
			Area of operation per sprinkler m^2			
	Wet or pre-action	Dry or alternate	6	7	8	9
(1) With pipe diameters in accordance with Tables 32 and 33 and sprinklers having a K-factor of 80						
7,5	2 300	2 900	—	—	1,80	2,25
10,0	3 050	3 800	1,80	2,40	3,15	3,90
(2) With pipe diameters in accordance with Tables 32 and 34 and sprinklers having a K-factor of 80						
7,5	2 300	2 900	—	—	1,35	1,75
10,0	3 050	3 800	1,30	1,80	2,35	3,00
(3) With pipe diameters in accordance with Tables 35 and 34 and sprinklers having a K-factor of 80						
7,5	2 300	2 900	—	—	0,70	0,90
10,0	3 050	3 800	0,70	0,95	1,25	1,60
(4) With pipe diameters in accordance with Tables 35 and 34 and sprinklers having a K-factor of 115						
10,0	3 050	3 800	—	—	—	0,95
12,5	3 800	4 800	—	0,90	1,15	1,45
15,0	4 550	5 700	0,95	1,25	1,65	2,10
17,5	4 850	6 000	1,25	1,70	2,25	2,80
20,0	6 400	8 000	1,65	2,25	2,95	3,70
22,5	7 200	9 000	2,05	2,85	3,70	4,70
25,0	8 000	10 000	2,55	3,50	4,55	5,75
27,5	8 800	11 000	3,05	4,20	5,50	6,90
30,0	9 650	12 000	3,60	4,95	6,50	—
NOTE If there are sprinklers in the array which are higher than the design point, the static head from the design point to the highest sprinklers should be added to pd.						

7.3.2.2 Where the area of the HHP or HHS portion of an occupancy is less than the area of operation, the flow rate in Table 7 might be proportionately reduced (see 7.3.2.6), but the pressure at the highest design point for the area shall be equal to that shown in the table, or be determined by hydraulic calculation.

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

7.3.2.4 Where the area of operation is greater than the area of HHP or HHS protection and this area is adjacent to the OH protection, the total flow rate shall be calculated as the sum of the HHP or HHS portion when reduced proportionately as in 7.3.2.2 plus the flow rate for the OH section calculated on the basis of a

design density of 5 mm/min. The pressure at the design point of the highest sprinklers in the HHP or HHS portion of the risk shall be either that shown in Table 7, or be determined by hydraulic calculation.

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

7.3.2.5 When the area of operation is fed by more than one distribution pipe, the pressure at the level of the highest sprinklers of the design points shall either be as shown in Table 7 for the appropriate design density, or be determined by hydraulic calculation. The flow rate for each distribution pipe shall be determined proportionately (see 7.3.2.6).

7.3.2.6 Where the basic area of operation for a given design density is increased or decreased as described in 7.3.2.2 to 7.3.2.7, the flow rate shall be proportionately increased or decreased (see 7.3.2.7), but the pressure at the design point shall remain unchanged.

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

$$Q_2 = Q_1 \times \frac{a_2}{a_1} \quad (1)$$

where:

Q_2 is the flow rate required or in the case of the circumstances described in 7.3.2.2 to 7.3.2.5 the flow rate in each distribution pipe, in litres per minute;

Q_1 is the flow rate required as given in Table 7, in litres per minute;

a_1 is the area of operation for design density, in square metres (see Table 4);

a_2 is the area of operation required, or in the case of the circumstances described in 7.3.2.2 to 7.3.2.5 the area served by each distribution pipe, in square metres.

8 Water supplies

8.1 General

8.1.1 Duration

Water supplies shall be capable of automatically furnishing at least the required pressure/flow conditions of the system. If the water supply is used for other firefighting systems, see 9.6.4, except as specified in the case of pressure tanks, each water supply shall have sufficient capacity for the following minimum durations:

— LH 30 min
— OH 60 min
— HHP 90 min
— HHS 90 min

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

8.1.2 Continuity

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

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

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

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

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

8.1.3 Frost protection

The feed pipe and the control valve set shall be maintained at a minimum temperature of 4 °C.

8.2 Maximum water pressure

8.2.1 Except during testing, water pressure shall not exceed 12 bar at equipment connections or locations identified in 8.2.1.1 and 8.2.1.2. The pressure in pumped systems shall take into account any increase in driver speed and pressure due to closed valve condition.

8.2.1.1 All types of sprinklers system

a) sprinklers;

b) multiple jet controls;

c) water flow detectors;

d) dry pipe and pre-action alarm valves;

e) accelerators and exhausters;

f) water motor alarms;

g) zone control valves.

8.2.1.2 Sprinkler systems where the height difference between the highest and lowest sprinkler heads does not exceed 45 m:

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

b) wet alarm valves;

c) stop valves;

d) mechanical pipe joints

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

a) pump outlets;

b) riser and distribution pipes.

8.3 Connections for other services

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

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

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

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

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

The sprinkler system pumps shall be separate from any hydrant system pumps unless a combined water supply in accordance with 9.6.4 is used.

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

Water supply type	Acceptable number, size and purpose of connection(s)
Town main. Main and supply pipe greater than or equal to 100 mm	one, no more than 25 mm diameter, for non-industrial use
Town main. Main and supply greater than or equal to 150 mm	one, no more than 40 mm diameter, for non-industrial use or: one, no more than 50 mm diameter, for fire hose reels, to which might be made a further connection (close to the first connection, and fitted with a stop valve close to the feed end), no more than 40 mm, for non-industrial use.
Elevated private reservoir, gravity tank or automatic pump	one, no more than 50 mm diameter, for fire hose reels.

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

8.4 Housing of equipment for water supplies

Water supply 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. The water supplies, stop valves and control valve sets shall be installed so that they are safely accessible even in a fire situation. All components of the water supplies and control valve sets shall be installed so that they are secured against tampering and are adequately protected against freezing.

8.5 Test facility devices

8.5.1 General

Sprinkler systems shall be permanently provided with devices for measuring pressure and flow for checking compliance with 7.3 and Clause 10 and comply with the following:

a) All devices included in a test unit shall be suitable for their purpose and be installed in accordance with the manufacturer's instructions. Manufacturer's instructions shall include requirements for the minimum lengths of straight pieces of pipe up and downstream of the flow measuring device and maximum flow velocity.

b) The flow measuring device shall be installed at a suitable location for easy access and readings in a frost-proof area.

c) All flow measuring devices shall have an error to within ± 5 % of its maximum flow. If the device could be influenced during transportation, installation or continuous use, it shall be re-checked before any test results are used to evaluate the available flow.

d) In case the calculated system is used, the capacity of the flow measuring device shall be chosen so that both the system demand for both the most unfavourable and most favourable area can be measured. The flow measuring device shall in addition have a measuring capacity of at least 140 % of the maximum flow demand (see 7.3). Where the system demand is provided by more than one pump running in parallel, the capacity of the flow measuring device can be chosen according to the capacity of the largest pump. In this case the individual readings might be added if the suction and discharge layout will not affect the result.

e) Pressure readings to be used for the pressure/flow test curve shall only be made by an accurate test gauge (± 1,6 %).

f) A minimum of three (3) pressure/flow readings shall be carried out to create a test curve. In addition to this, a pressure reading shall be made with no flow, i.e. the static pressure.

   Where the water supply is by an automatic pump or pumps, the flow measuring device shall be installed at the pump house (see 8.5.2 below). In this case, 8.5.1 is not applicable.

   Where the water supply is not by an automatic pump or pumps, the flow measuring device shall be installed at the control valve sets (see 8.5.3 below).

8.5.2 At pump house

A flow measuring device shall be permanently installed and shall be capable of checking each water supply. If the testing apparatus is not permanently fitted, it shall be available on site at all times. Pressure gauges shall be located upstream and downstream of the pump on a straight piece of pipe. Where the system demand is provided by more than one pump running in parallel, the capacity of the flow measuring device can be chosen according to the capacity of the largest pump. In this case the individual readings might be added if the suction and discharge layout will not affect the result.

8.5.3 At control valve sets

Where the water supply is not by an automatic pump or pumps, a flow measuring device shall be permanently available on site (fixed or mobile) and shall be capable of checking each water supply. Where two or more control valve sets are installed together, the device needs to be installed only at the hydraulically most remote set, or, when the installations belong to different hazard classes, at the control valve set which requires the highest water flow.

In all cases, the appropriate allowance shall be made for the pressure losses between the water source and the control valve set(s) using the calculation methods specified in 13.2.

Facilities shall be provided for the disposal of test water.

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

8.6 Water supply test

8.6.1 General

The test facility specified in 8.5.2 shall be used. Each supply to the installation shall be tested independently with all other supplies isolated.

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

8.6.2 Storage tank and pressure tank supplies

The stop valves controlling the flow from the water supply to the installation shall be fully opened. Automatic pump starting shall be checked by fully opening the installation drain and test valve. The flow shall be verified in accordance with Clause 7. The supply pressure measured on the 'C' gauge shall be verified as being at least the appropriate value specified in Clause 7.

8.6.3 Town main, booster pump, elevated private reservoir and gravity tank supplies

The stop valves controlling the flow from the supply to the installation shall be fully opened. Automatic pump starting shall be checked by fully opening the installation drain and test valve. The drain and test valve shall be adjusted to give the flow specified in Clause 7. When the flow is steady the supply pressure measured on the 'C' gauge shall be verified as being at least the appropriate value specified in Clause 7.

9 Type of water supply

9.1 General

Water supplies shall be one or more of the following:

a) Town mains in accordance with 9.2;

b) Storage tanks in accordance with 9.3;

c) Inexhaustible sources in accordance with 9.4;

d) Pressure tanks in accordance with 9.5.

9.2 Town mains

The town main shall be capable of satisfying the requirements for pressure, flow and duration taking into account any extra flow required for manual firefighting purposes (hydrants, hose reels, etc.). A pressure switch shall be installed and shall operate an alarm when the pressure in the supply drops to a predetermined value. The switch shall be positioned upstream of any non-return valve and shall be equipped with a test valve (see Annex I and H.2.5).

In some cases the water quality makes it necessary to fit strainers on all connections from town mains. Strainers should have a cross-sectional area of at least 1,5 times the nominal area of the pipe and should not allow objects greater than 6 mm diameter to pass.

NOTE 1 The water demand for manual firefighting purposes are usually determined by the authority. It might be necessary to take into account extra flow required for fire brigade purposes.

NOTE 2 The agreement of the water authority will usually be needed for town main connections.

9.3 Storage tanks

9.3.1 General

Storage tanks shall be one or more of the following:

— pump suction tank;

— gravity tank;

— reservoir.

9.3.2 Water volume

9.3.2.1 General

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

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

— a reduced capacity tank (see 9.3.4), where the required water volume is supplied jointly by the effective capacity of the tank plus the automatic infill.

The effective capacity of a tank shall be calculated by taking the difference between the normal water level and the lowest effective water level. If the tank is not frost proof the normal water level shall be increased by at least 1,0 m and ice venting shall be provided. In the case of enclosed tanks, easy access shall be provided.

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

9.3.2.2 Pre-calculated systems

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

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

Group	**Height h of the highest sprinkler above the lowest sprinkler** (see NOTE) m	**Minimum water volume** m^3
LH – (Wet or pre-action)	h ≤ 15	9
	15 < h ≤ 30	10
	30 < h ≤ 45	11
OH1 – Wet or pre-action	h ≤ 15	55
	15 < h ≤ 30	70
	30 < h ≤ 45	80
OH1 – Dry or alternate	h ≤ 15	105
OH2 – Wet or pre-action	15 < h ≤ 30	125
	30 < h ≤ 45	140
OH2 – Dry or alternate	h ≤ 15	135
OH3 – Wet or pre-action	15 < h ≤ 30	160
	30 < h ≤ 45	185
OH3 – Dry or alternate	h ≤ 15	160
OH4 – Wet or pre-action	15 < h ≤ 30	185
	30 < h ≤ 45	200
OH4 – Dry or alternate	Use HH protection	
NOTE Excluding sprinklers in the sprinkler valve room.		

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

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

Design density not exceeding mm/min	Minimum water volume m^3	
	Wet systems	Dry systems
7,5	225	280
10,0	275	345
12,5	350	440
15,0	425	530
17,5	450	560
20,0	575	720
22,5	650	815
25,0	725	905
27,5	800	1000
30,0	875	1090

9.3.2.3 Calculated systems

The minimum effective water volume shall be calculated by multiplying the maximum flow demand (Q_{max}) by the duration specified in 8.1.1.

9.3.3 Refill rates for full capacity tanks

The water source shall be capable of refilling the tank in no more than 36 h.

The outlet of any feed pipe shall be not less than 2,0 m horizontally from the suction pipe inlet.

9.3.4 Reduced capacity tanks

The following conditions shall be met for reduced capacity tanks:

a) the inflow shall be from a town main and shall be automatic, via at least two mechanical float valves. The inflow shall not adversely influence the pump suction. The failure of a single float valve shall not impair the required infill rate;

b) the effective capacity of the tank shall be no less than that shown in Table 11;

c) the tank capacity plus the inflow shall be sufficient to supply the system at full capacity as specified in 9.3.2;

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

e) the inflow arrangement shall be accessible for inspection.

Table 11 — Minimum effective capacity of reduced capacity tanks

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

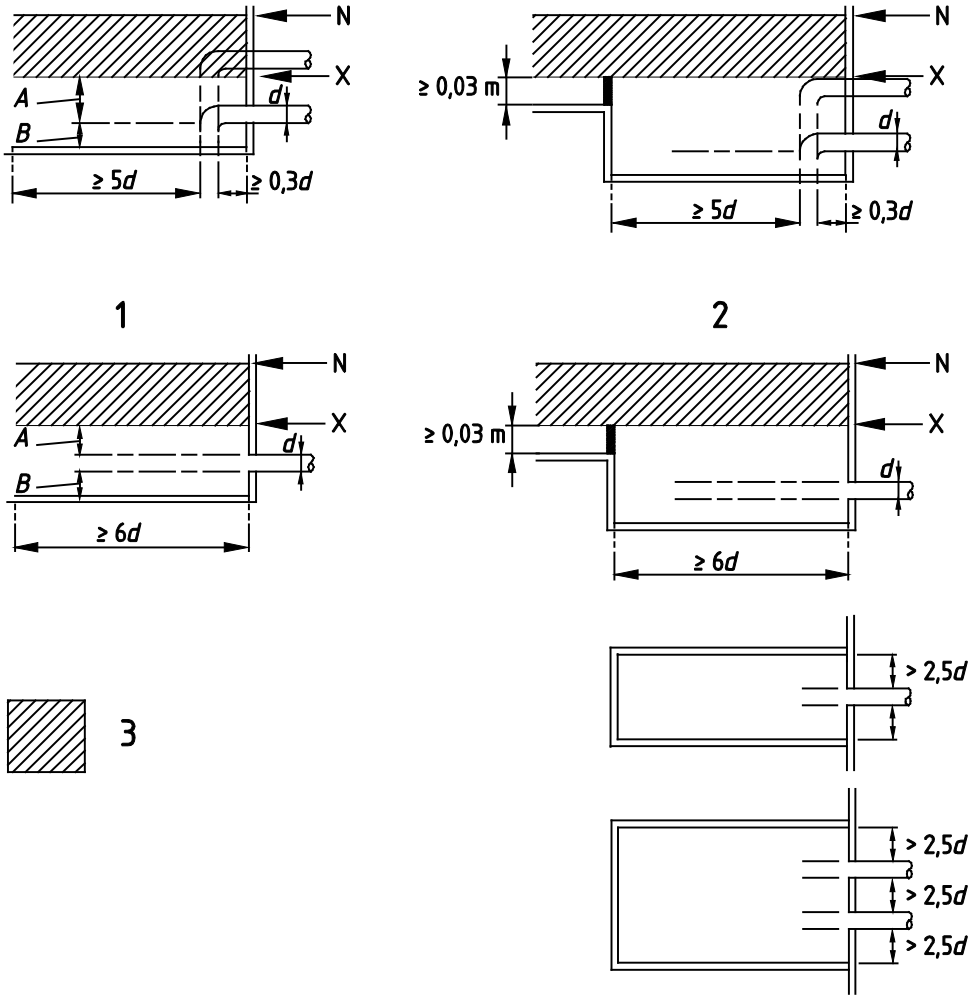
9.3.5 Effective capacity of tanks and dimensions of suction chambers

The effective capacity of storage tanks shall be calculated as shown in Figure 4, where:

N is the normal water level;

X is the low water level;

d is the nominal diameter of the suction pipe.



Key

1	without sump	*A*	minimum dimension from the suction pipe to the low minimum dimensions water level
2	with sump	*B*	minimum dimension from the suction pipe to the bottom of the sump
3	effective capacity		

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

Table 12 specifies minimum dimensions for the following:

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

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

If a vortex inhibitor is installed with the minimum dimensions specified in Table 12, dimension *A* might be reduced to 0,10 m.

A tank might be provided with a sump in order to maximize the effective capacity (See Figure 4).

Table 12 — Suction pipe inlet clearances

Nominal diameter of suction pipe *d*	***B* minimum**	**Without vortex inhibitor**	**With vortex inhibitor**	
		***A* minimum**	**Minimum dimension of vortex inhibitor**	**A minimum**
mm	m	m	m	m
65	0,08	0,25	0,20	0,10
80	0,08	0,31	0,20	0,10
100	0,10	0,37	0,40	0,10
150	0,10	0,50	0,60	0,10
200	0,15	0,62	0,80	0,10
250	0,20	0,75	1,00	0,10
300	0,20	0,90	1,20	0,10
400	0,30	1,05	1,20	0,10
500	0,35	1,20	1,20	0,10

9.3.6 Strainers

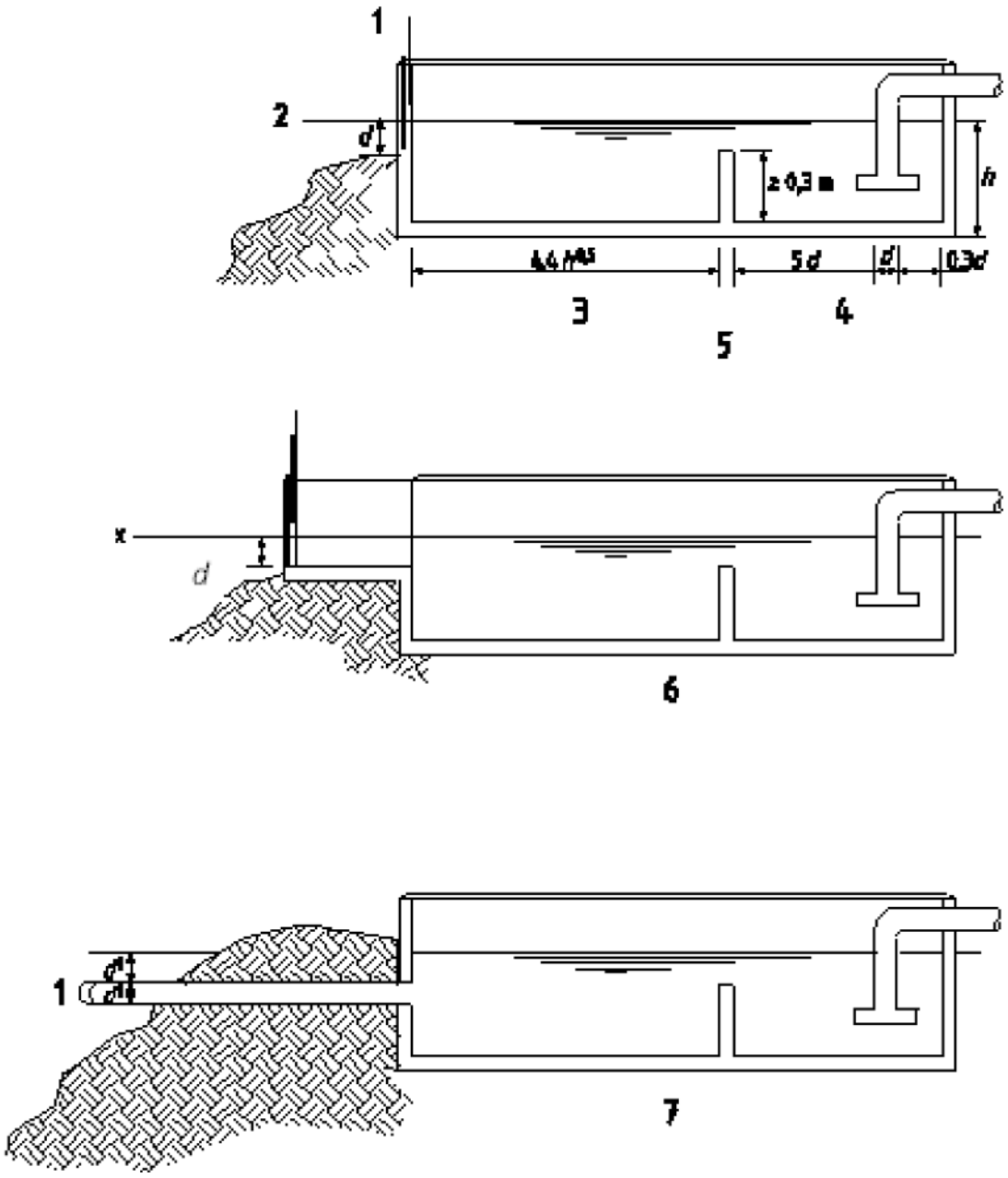
In the case of pumps under suction lift conditions, a strainer shall be fitted upstream of the foot valve on the pump suction pipe. It shall be fitted so that it can be cleaned without the tank having to be emptied.

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

Strainers shall have a cross-sectional area of at least 1,5 times the nominal area of the pipe and shall not allow objects greater than 5 mm diameter to pass.

9.4 Inexhaustible sources – settling and suction chambers

9.4.1 Where a suction or other pipe draws from a settling or suction chamber fed from an inexhaustible source, the design and dimensions in Figure 5 shall apply, where D is the diameter of the suction pipe, d is the diameter of the inlet pipe and d^1 is the water depth at the weir. Pipes, conduits and the bed of open-topped channels shall have a continuous slope towards the settling or suction chamber of at least 1:125. The diameter of feed pipes or conduit shall not be less than as given in Table 13. The suction chamber dimensions shall be as specified in 9.3.5.



Key

1	strainers	4	suction chambers	7	conduit or pipe feed
2	lowest known water level 'X'	5	weir feed		
3	settling chamber	6	open channel feed		

Figure 5 — Settling and suction chambers

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

Nominal diameter of feed pipes, or minimum dimension of conduits (*d*) mm	**Maximum flow of pump** (*Q*) l/min
200	500
250	940
300	1 570
350	2 410
400	3 510
500	6 550
600	10 900
For dimensions not included in the table, the following equation should be used: d ≥ 21,68 Q0,357	

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

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

The dimension of the suction chamber and the location of suction pipes from the walls of the chamber, the submergence below the lowest known water level (making any necessary allowances for ice) and clearance from the bottom shall conform to 9.3.5 and Figures 4 and 5.

The settling chamber shall have the same width and depth as the suction chamber and a length of at least 10*d* where *d* is the minimum bore of the pipe or conduit, and no less than 1,5 m.

The system shall be designed so that the mean water velocity does not exceed 0,2 m/s at any point between the inlet to the settling chamber and the pump suction pipe inlet.

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

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

The screen shall be strong enough to withstand the weight of water should it become obstructed and shall have a mesh not greater than 12,5 mm. Two screens shall be provided, with one in use and the other in a raised position ready for interchange when cleaning is necessary.

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

9.4.6 Where the suction inlet draws from a walled off area of the bed of a river, canal, lake etc., the wall itself shall be extended above the water surface with an aperture screening arrangement. Alternatively, the space between the top of the wall and the water surface shall be enclosed with a screen. Screens shall be as specified in 9.4.4.

9.4.7 Excavation of the bed of the lake etc., to create the necessary depth for a pump suction inlet is not recommended, but if unavoidable the area shall be enclosed with the largest screen practicable, having sufficient clear area as specified in 9.4.4.

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

9.5 Pressure tanks

9.5.1 General

The pressure tank shall be reserved for the sprinkler system and/or the water spray system.

The pressure tank shall be accessible for external and internal inspection. It shall be protected against corrosion both internally and externally.

The discharge pipe shall be situated at least 0,05 m above the bottom of the tank.

9.5.2 Housing

The pressure tank shall be housed in a readily accessible position in either:

a) a sprinkler protected building;

b) a separate sprinkler protected building of Euroclass A1 or A2 or an equivalent in existing national classification systems construction used solely for the housing of fire protection water supplies and equipment;

c) an unprotected building situated in a 60 min fire resistant compartment with no combustible materials.

When the pressure tank is housed in a sprinkler protected building the area shall be enclosed by fire resistant construction of no less than 30 min.

The pressure tank and housing shall be maintained at a temperature of at least 4 °C.

9.5.3 Minimum capacity (water)

The minimum volume of water in a pressure tank for a single supply shall be 15 m^3 for LH and 23 m^3 for OH1.

The minimum volume of water in a pressure tank for duplicate supplies shall be 15 m^3 in LH and OH (all groups).

9.5.4 Air pressure and contents

9.5.4.1 General

The air space shall not be less than one third of the pressure tank volume.

Pressure in the tank shall not exceed 12 bar.

The air pressures and water flow rates from the tank shall be sufficient to satisfy the sprinkler installation demand requirements, up to the point of exhaustion.

9.5.4.2 Calculation

The air pressure to be maintained in the tank shall be determined from the following formula:

$$P = (P1 + P2 + 0{,}1\ h)\ (Vt / Va) - P1 \quad (2)$$

where:

p is the gauge pressure, in bar;

p_1 is atmospheric pressure, in bar (assume $p_1 = 1$);

p_2 is the minimum pressure required at the highest sprinkler at pressure tank exhaustion, in bar;

h is the height of the highest sprinkler, or of the hydraulically most remote sprinkler, above the bottom of the pressure tank (i.e. negative if the highest sprinkler is below the tank), in metres;

V_t is the total volume of the tank, in cubic metres;

V_a is the volume of air in the tank, in cubic metres.

For pre-calculated systems p_2 shall be taken from Table 6, plus any friction losses between the design point and pressure tank.

9.5.5 Charging with air and water

Pressure tanks used as a single supply shall be provided with means for automatically maintaining the air pressure and water level. The air and water supplies shall be capable of filling and pressurizing the tank completely in no more than 8 h.

The water supply shall be capable of topping up with water at the gauge pressure (p in 9.5.4) of the pressure tank with a flow of at least 6 m^3/h.

9.5.6 Control and safety equipment

9.5.6.1 The tank shall be fitted with a pressure gauge and the correct gauge pressure p shall be marked on the gauge.

The tank shall be fitted with suitable safety devices to ensure that the highest permitted pressure is not exceeded.

9.5.6.2 A gauge glass shall be fitted to indicate the water level. Stop valves shall be fitted at each end of the gauge glass and they shall normally be kept closed and a drain valve shall also be provided.

The gauge glass shall be protected against mechanical damage and shall be marked with the correct water level.

9.5.6.3 An automatic warning system shall be provided to indicate failure of devices to restore either the correct air pressure or water level. Alarms shall be given visually and audibly at the installation control valve or a permanently manned location.

9.6 Choice of water supply

9.6.1 Single water supplies

The following constitute acceptable single water supplies:

a) a town main;

b) a town main with one or more booster pumps;

c) a pressure tank (LH and OH1 only);

d) a gravity tank;

e) a storage tank with one or more pumps;

f) an inexhaustible source with one or more pumps.

9.6.2 Superior single water supplies

Superior single water supplies are single water supplies which provide a higher degree of reliability. They include the following:

a) a town main fed from both ends, fulfilling the following conditions:

   — each end shall be capable of satisfying the flow demands of the system;

   — it shall be fed from two or more water sources;

   — it shall be independent at any point on a single, common trunk main;

   — if only one end gives the required pressure, a single booster pump shall be installed. If both ends cannot give the required pressure, two or more booster pumps shall be installed.

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

   — the tank shall be full capacity;

   — there shall be no entry for light or foreign matter;

   — suitable clean (see 8.1.2) water shall be used;

   — the tank shall be painted or given other corrosion protection which reduces the need for emptying the tank for maintenance to periods of no less than 10 years.

c) an inexhaustible source with two or more pumps.

9.6.3 Duplicate water supplies

Duplicate water supplies shall consist of two single water supplies where each supply is independent of the other. Each of the supplies forming part of a duplicate supply shall conform to the pressure and flow characteristics given in Clause 7.

Any combination of single supplies (including superior single supplies) might be used, with the following limitations:

a) no more than one pressure tank shall be used for OH^-systems;

b) one storage tank of the reduced capacity type might be used (see 9.3.4).

9.6.4 Combined water supplies

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

NOTE Some countries might not allow sprinkler systems to be fed from a combined supply.

Combined supplies shall fulfil the following conditions:

a) the systems shall be fully calculated;

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

c) the duration of the supply shall be no less than that required for the most demanding system;

d) duplicate pipe connections shall be installed between the water supplies and the systems.

9.7 Isolation of water supply

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

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

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

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

10 Pumps

10.1 General

The sprinkler pumps shall conform to the relevant European Standard.

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

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

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

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

10.2 Multiple pump arrangements

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

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

Where more than one pump is installed in a superior or duplicate water supply, no more than one shall be driven by an electric motor.

10.3 Compartments for pumpsets

10.3.1 General

Pumpsets shall be housed in a compartment having a fire resistance of no less than 60 min, used for no other purpose than fire protection. It shall be one of the following (in order of preference):

a) a separate building;

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

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

10.3.2 Sprinkler protection

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

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.

10.3.3 Temperature

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

— 4 °C for electric motor driven pumps;

— 10 °C for diesel engine driven pumps.

10.3.4 Ventilation

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

10.4 Maximum temperature of water supply

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

10.5 Valves and accessories

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

In the case of booster pumps a by-pass shall be installed around the pumps with a non-return valve and two stop valves all of the same diameter as the trunk main.

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

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

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

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

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

10.6 Suction conditions

10.6.1 General

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

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

— the pump centre line shall be no more than 2 m above the low water level of the suction tank (level *X* in 9.3.5).

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

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

10.6.2 Suction pipe

10.6.2.1 General

The pump suction shall be connected to a straight or taper pipe at least two diameters long. The taper pipe shall have a horizontal top side and a maximum included angle not exceeding 20°.

The suction piping, including all valves and fittings, shall be designed in such a way as to ensure that the available NPSH (calculated at the maximum anticipated water temperature) at the pump inlet exceeds the required NPSH by at least 1 m at the maximum pump flow as shown in Table 14.

Table 14 — Pump pressure and flow rating

Pipework	Hazard Class	Rated pump flow	Pump inlet condition
Pre-calculated	LH/OH	Pressure and flow requirements from Table 6	For tanks, with water supply at low water level (see X in Figure 4). For booster pumps, with minimum town main pressure.
	HH	Pressure and 1,4 – flow required from Table 7	
Fully calculated	All	Maximum pressure and flow required for the most favourable area	

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

A foot valve shall be fitted where the centre line of the pump is above the low water level (see 9.3.5).

10.6.2.2 Positive head

In positive head conditions, the diameter of the suction pipe shall be no less than 65 mm. Furthermore, the diameter shall be such that a velocity of 1,8 m/s is not exceeded when the pump is operating at maximum demand flow.

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

10.6.2.3 Suction lift

In suction lift conditions, the diameter of the suction pipe shall be no less than 80 mm. Furthermore, the diameter shall be such that a velocity of 1,5 m/s is not exceeded when the pump is operating at maximum demand flow.

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

The height from the low water level (see 9.3.5) to the centre line of the pump shall not exceed 3,2 m.

The suction pipe shall be positioned in the tank or reservoir in accordance with Figure 4 and Table 12 or Figure 5 and Table 13, as appropriate. A foot valve shall be fitted at the lowest point on the suction pipe. Each pump shall have automatic priming arrangements in accordance with 10.6.2.4.

10.6.2.4 Pump priming

Each pump shall be fitted with a separate automatic priming arrangement.

The arrangement shall consist of a tank situated at a higher level than the pump and with a pipe connection sloping from the tank to the delivery side of the pump. A non-return valve shall be fitted to this connection. Figure 6 shows two examples. Example A with Low level switch and example B with Low level valve for pump starting.

The tank, the pump and the suction pipework shall be kept constantly full of water even where there is leakage from the foot valve referred to in 10.6.2.3. Should the water level in the tank fall to 2/3 of the normal level, the pump shall start. Alternatively an alarm shall be sent to a permanently attended location ensuring immediate action.

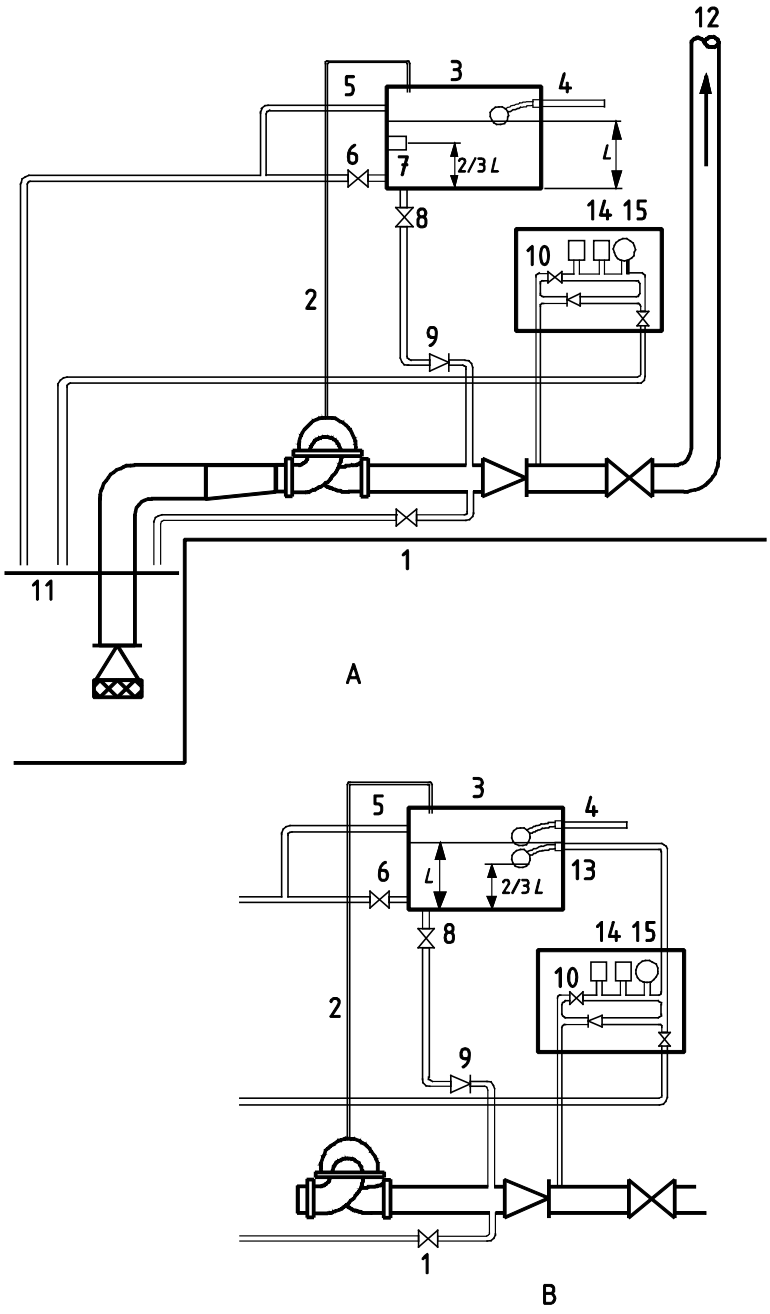
10.6.2.5 Pressure maintenance pump

A pressure maintenance pump might be installed to avoid starting one of the main pumps unnecessarily or to maintain the system pressure above control valve sets in the case of water supplies such as town mains with fluctuating pressure.

NOTE Some water authorities might not allow pressure maintenance pumps on systems with town main connections.

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

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



Key

1	test drain and valve	9	priming supply non-return valve
2	pump air bleed and min flow line	10	pump start arrangement
3	pump priming tank	11	suction tank
4	inflow	12	installation trunk main
5	over flow	13	low level valve for pump starting
6	drain valve	14	pressure switches for pump starting
7	low level switch for pump starting	15	pressure gauge
8	priming supply stop valve		

Figure 6 — Pump priming arrangement for suction lift

The size of the priming tank and the pipe shall be in accordance with Table 15.

Table 15 — Pump priming tank capacity and pipe size

Hazard Class	Minimum tank capacity litres	Minimum diameter of priming pipe mm
LH	100	25
OH, HHP and HHS	500	50

10.7 Performance characteristics

10.7.1 Pre-calculated systems – LH and OH

Where the pumps take water from a storage tank, the characteristic of pre-calculated LH and OH systems shall conform to Table16.

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

Hazard Class	Sprinkler height *h* above the control valve set(s) m	Nominal data		Characteristic			
		Pressure bar	Flow l/min	Pressure bar	Flow l/min	Pressure bar	Flow l/min
LH (Wet or pre-action)	$h \leq 15$	1,5	300	3,7	225	—	—
	$15 < h \leq 30$	1,8	340	5,2	225	—	—
	$30 < h \leq 45$	2,3	375	6,7	225	—	—
OH1 Wet or pre-action	$h \leq 15$	1,2	900	2,2	540	2,5	375
	$15 < h \leq 30$	1,9	1 150	3,7	540	4,0	375
	$30 < h \leq 45$	2,7	1 360	5,2	540	5,5	375
OH1 Dry or alternate	$h \leq 15$	1,4	1 750	2,5	1 000	2,9	725
OH2 Wet or pre-action	$15 < h \leq 30$	2,0	2 050	4,0	1 000	4,4	725
	$30 < h \leq 45$	2,6	2 350	5,5	1 000	5,9	725
OH2 Dry or alternate	$h \leq 15$	1,4	2 250	2,9	1 350	3,2	1 100
OH3 Wet or pre-action	$15 < h \leq 30$	2,0	2 700	4,4	1 350	4,7	1 100
	$30 < h \leq 45$	2,5	3 100	5,9	1 350	6,2	1 100
OH3 Dry or alternate	$h \leq 15$	1,9	2 650	3,0	2 100	3,5	1 800
OH4 Wet or pre-action	$15 < h \leq 30$	2,4	3 050	4,5	2 100	5,0	1 800
	$30 < h \leq 45$	3,0	3 350	6,0	2 100	6,5	1 800

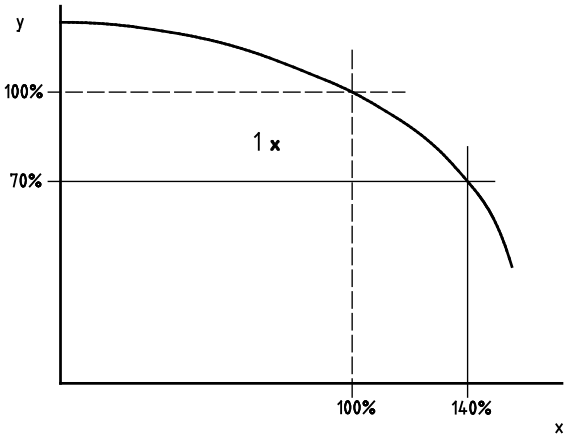
NOTE 1 The pressures shown are as measured at the control valve set(s).

NOTE 2 In the case of buildings which exceed the heights shown, it should be proved that the pump characteristics are adequate for supplying the flows and pressures specified in 7.3.1.

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

The nominal pump flow and pressure for HHP and HHS pre-calculated systems shall conform to 7.3.2.

In addition the pump shall be capable of supplying 140 % of this flow at a pressure of no less than 70 % of the pressure at the design pump flow (see Figure 7a).



Key

1X flow and pressure demand

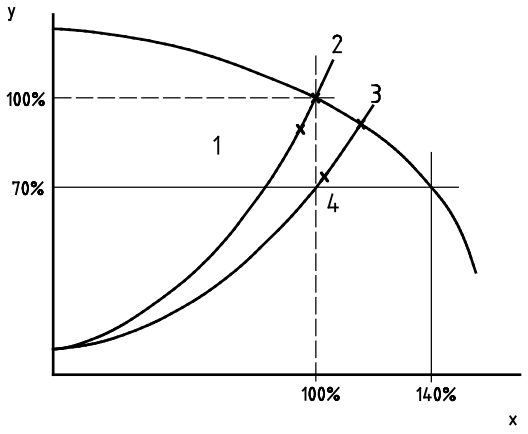
X flow

Y pressure

Figure 7a — Typical pump curve for pre-calculated system

10.7.3 Calculated systems

When measured by the pumpset supplier's test facility, the pumpset shall provide a pressure at least 0,5 bar higher than that required for the most unfavourable area. The pumpset shall also be capable of providing the flow and pressure of the most favourable area at all water supply water levels.



Key

1 most unfavourable area

2 design pump flow

3 maximum flow demand (Qmax) flow

4 most favourable area

Figure 7b — Typical pump curve for calculated system

10.7.4 Pressure and water capacity of boosted town mains

A test shall be carried out to show that the unboosted supply provides a flow rate equal to the maximum demand flow plus 20 %, at a pressure of at least 0,5 bar, as measured at the pump inlet. This test shall be carried out at a time of maximum demand on the main.

10.7.5 Pressure switches

10.7.5.1 Number of pressure switches

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

10.7.5.2 Pump start

The first pumpset shall start automatically when the pressure in the trunk main falls to a value of no less than 0,8*p*, where *p* is the pressure at the closed valve condition. Where two pumpsets are installed, the second pump shall start before the pressure falls to a value of no less than 0,6*p*. Once the pump has started, it shall continue to run until stopped manually.

10.7.5.3 Testing the pressure switches

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

10.8 Electrically driven pumpsets

10.8.1 General

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

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

10.8.1.3 After starting, the pump shall operate at nominal capacity within 15 s.

10.8.2 Electricity supply

The supply to the pump controller shall be solely for use of the sprinkler system and separate from all other connections. Where permitted by the electrical utility, the electrical supply to the pump controller shall be taken from the input side of the main switch on the incoming supply to the premises and where this is not permitted, by a connection from the main switch.

The fuses in the pump controller shall be of high rupturing capacity, capable of carrying the start current of the sprinkler pump for a period of no less than 20 s. The sprinkler pump controller shall only supply the pump itself (see note).

NOTE In some countries additional components required for operating the sprinkler system can be connected to the supply for the pump controller in accordance with local regulations.

Cables to the terminal board of the motor or to the connection of submersible pumps shall be laid in one piece. Connection points outside the switchgear for sprinkler systems and the low voltage main distribution are not permitted. A terminal box shall be located in the direct vicinity of the pump motor, if – in the case of

two power sources – the cables from the switchgears to the sprinkler pump motor are outside the sprinkler equipment room, not buried and separate.

To each cable one load only (switchgear, equipment, etc.) shall be connected.

The cables shall be flame-retardant and have a burning behaviour in accordance with EN 60332, test type B or C. The diameter of the conductor shall be 2,5 mm^2 Cu minimum.

Cables required for operating the sprinkler system shall be selected and laid so as to keep them functional in the case of fire.

Flame-retardant cables (see above) might be used without any further requirements, provided that they are laid as follows:

a) buried with a covering of 70 cm minimum;

b) in floors and walls made of non-combustible materials with sufficient covering, e.g. in concrete with a covering of 10 cm;

c) in sprinkler pump rooms; or

d) in the main electrical switchboard operating rooms provided this room is fitted with sprinkler or is in accordance with 5.1.2 c).

Otherwise the cables shall be laid as follows:

e) fire-resistant cables E 90 with additional testing by the authorities, functionality under exposure to water and protection against mechanical damage, designed as follows:

   — in false ceiling spaces in accordance with 5.4 immediately underneath the rough ceiling;

   — in enclosed shafts and ducts made of non-combustible materials; or

   — on cable trays that are fully enclosed in a non-combustible material.

Where E 90 cables are used, they shall be laid in accordance with the relevant approval.

For each cable the approved fasteners shall be used in compliance with the installation instructions (see certificate by material testing institute).

Where sprinkler systems are powered by two electrical power sources, the cables to the controller should be laid at a distance of minimum 3 m from each other.

10.8.3 Main switchboard

10.8.3.1 The main switchboard for the premises shall be situated in a fire compartment used for no other purpose than for electrical power supplies.

The electrical connections in the main switchboard shall be such that the supply to the pump controller is not isolated when isolating other services.

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

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

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

10.8.4 Installation between the main switchboard and the pump controller

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

10.8.5 Pump controller

10.8.5.1 The pump controller shall be able to:

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

b) start the motor on manual actuation;

c) stop the motor by manual actuation only.

The controller shall be equipped with an ammeter.

In the case of submersible pumps, a nameplate with its characteristics shall be affixed to the pump controller.

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

10.8.5.3 Contacts shall conform to utilization category AC-3 of EN 60947-1 and EN 60947-4.

10.8.6 Monitoring of pump operation

10.8.6.1 The following conditions shall be monitored (see Annex I):

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

— pump on demand;

— pump running;

— start failure.

10.8.6.2 All monitored conditions shall be visually indicated individually in the pump room. Pump running and a fault alarm shall also be audibly and visually indicated at a location permanently attended by responsible personnel.

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

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

10.9 Diesel engine driven pumpsets

10.9.1 General

The diesel engine shall be capable of operating continuously at full load at site elevation with a rated continuous power output in accordance with ISO 3046.

The pump shall be fully operational within 15 s of the beginning of any starting sequence. Horizontal pumps shall have a direct drive.

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

10.9.2 Engines

The engine shall be capable of starting at an engine room temperature of 5 °C.

It shall be provided with a governor to control the engine speed to ± 5 % of its rated speed under normal load conditions, and be constructed so that any mechanical device fitted to the engine which could prevent the engine starting automatically, will return to the starting position.

10.9.3 Cooling system

The cooling systems shall be one of the following types:

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

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

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

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

10.9.4 Air filtration

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

10.9.5 Exhaust system

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

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

10.9.6 Fuel, fuel tank and fuel feed pipes

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

— 3 h for LH;

— 4 h for OH;

— 6 h for HHP and HHS.

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

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

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

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

The fuel tank vent should be terminated outside the building.

10.9.7 Starting mechanism

10.9.7.1 General

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

It shall be possible to start the diesel engine both automatically, upon receipt of a signal from the pressure switches, and manually by means of a push button on the pump controller. It shall be possible to shut down the diesel engine only manually; engine monitoring devices shall not cause the engine to stop.

The rated voltage of the batteries and starter motor shall be no less than 12 V.

10.9.7.2 Automatic starting system

The automatic starting sequence shall make six attempts to start the engine, each one of 5 s to 10 s duration, with a maximum pause of 10 s between each attempt. The starting device shall reset itself automatically. It shall function independently of the line power supply.

The system shall switch over automatically to the other battery after each starting attempt. The control voltage shall be drawn from both batteries simultaneously. Facilities shall be provided to prevent one battery having an adverse effect on the other.

10.9.7.3 Emergency manual starting system

Emergency manual start facilities, independent from the controller should be provided to run the diesel engine manually. Facilities shall be provided to prevent one battery having an adverse effect on the other.

10.9.7.4 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 cover over the emergency manual start facilities 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 online after an automatic engine start followed by a shut down or after six repeated unsuccessful attempts to start automatically. Either of the two conditions shall cause the indicator lamp to light and bring the manual start test button online in parallel with the emergency manual start push button.

When a manual start test 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.

10.9.7.5 Starter motor

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

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

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

Speed sensors shall have a direct coupling to, or be gear-driven by, the engine. Flexible drives shall not be used.

10.9.8 Electric starter motor batteries

Two separate battery power supplies shall be provided and shall be used for no other purpose. Batteries shall be either open nickel-cadmium prismatic rechargeable cells conforming to EN 60623 or lead-acid positive batteries conforming to EN 50342-1 and EN 50342-2.

The electrolyte for lead-acid batteries shall conform to EN 50342-1 and EN 50342-2.

Batteries shall be selected, used, charged and maintained in accordance with the requirements of this standard and with the supplier's instructions.

A hydrometer, suitable for checking the density of the electrolyte, shall be provided.

10.9.9 Battery chargers

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

Chargers for lead acid batteries should provide a float voltage of (2,25 ± 0,05) V per cell. The nominal charging voltage should be suitable for local conditions (climate, regular maintenance, etc.). A boost charge facility should be provided for charging to a higher voltage not exceeding 2,7 V per cell. The charger output should be between 3,5 % and 7,5 % of the 10 h capacity of the battery.

Chargers for open nickel-cadmium prismatic batteries should provide a float voltage of (1,445 ± 0,025) V per cell. The nominal charging voltage should be suitable for local conditions (climate, regular maintenance, etc.). A boost charge facility should be provided for charging to a higher voltage not exceeding 1,75 V per cell. The charger output should be between 25 % and 167 % of the 5 h capacity of the battery.

10.9.10 Siting of batteries and chargers

Batteries shall be mounted on stands.

The chargers might be mounted with the batteries. Batteries and chargers shall be located in readily accessible positions where the likelihood of contamination by oil fuel, damp, pumpset cooling water, or of

damage by vibration is minimal. The battery shall be as close as possible to the engine starter motor, subject to the above constraints, in order to minimize voltage drop between the battery and starter motor terminal.

10.9.11 Starter alarm indication

The following conditions shall each be indicated both locally and at a responsibly manned location (see Annex I) by warning lights:

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

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

c) pump running;

d) diesel controller fault;

The warning lights shall be appropriately marked.

10.9.12 Tools and spare parts

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

a) two sets of fuel filter elements and seals;

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

c) two sets of belts (where used);

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

e) two injector nozzles.

10.9.13 Engine tests and exercising

10.9.13.1 Supplier's test and certification of results

Each complete engine and pumpset shall be tested by the supplier for no less than 1,5 h at the rated flow. The following shall be recorded on the test certificate:

a) the engine speed with the pump churning;

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

c) the pump churning pressure;

d) the suction head at the pump inlet;

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

f) the ambient temperature;

g) the cooling water temperature rise at the end of the 1,5 h run;

h) the cooling water flow rate;

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

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

10.9.13.2 Site commissioning test

When commissioning an installation the automatic starting system of the diesel engine shall be activated with the fuel supply isolated for the six cycles each of no less than 5 s cranking and no less than 10 s rest. After completion of the six starting cycles the fail to start alarm shall operate. The fuel supply shall than be restored and the engine shall start when the manual start test button is operated.

11 Installation type and size

11.1 Wet pipe installations

11.1.1 General

Except where covered by 11.1.2, wet pipe installations are permanently charged with water under pressure. Wet pipe installations shall be installed only in premises where there is no possibility of frost damage to the installation, and where the ambient temperature will not exceed 95 °C.

Only wet pipe installations shall be used for grid and loop systems.

11.1.2 Protection against freezing

11.1.2.1 General

Parts of the installation subject to freezing might be protected by anti-freeze liquid or electrical trace heating or subsidiary dry pipe or alternate extensions (see 11.5).

11.1.2.2 Protection by anti-freeze liquid

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

11.1.2.3 Protection by electrical trace heating

The trace heating system shall be monitored for power supply failure and failure of the heating element(s) or sensor(s) (see Annex I). The piping shall be provided with a Euroclass A1 or A2 or equivalent in existing national classification systems insulation.

Duplicate heating elements shall be provided over the unheated pipework. Each of the two elements shall be capable of maintaining the pipework at the minimum temperature of not less than 4 °C. Each trace heating circuit shall be electrically monitored and switched by separate circuits. Trace heating tape shall not crossover other lengths of trace heating tape. Trace heating tape shall be affixed on the other side of the pipe to the sprinkler heads. Trace heating tape shall terminate within 25 mm from the pipe ends. All trace heated pipework shall be lagged with Euroclass A1 or A2 or equivalent in existing national classification systems insulating material of not less than 25 mm thick with a water resistant covering. All ends shall be sealed to prevent ingress of water. Trace heating tape shall have a maximum rating of 10 W/m.

11.1.3 Size of installations

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

Table 17 — Maximum protected area in wet pipe and pre-action installations

Hazard class	Maximum protected area per control valve set m^2
LH	10 000
OH, including any LH sprinklers	12 000, except as allowed in Annexes D and F.
HH, including any OH and LH sprinklers	9 000

11.2 Dry pipe installations

11.2.1 General

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

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

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

11.2.2 Size of installations

The maximum time between a single sprinkler opening and water discharging shall not exceed the value in Table 18. The test shall be carried out using the remote test valve specified in 15.5.2.

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

NOTE Experience showed that with an accelerator a volume of no more than 4 m^3 for LH or OH and a volume of 3 m^3 for HH occupancies is expected to fulfil requirements of 11.2.2

Table 18 — Maximum water delivery time – Dry and alternate installations

Maximum water delivery time s	
LH	OH and HH
90	60

11.3 Alternate installations

11.3.1 General

Alternate installations incorporate either an alternate alarm valve or a composite set comprising a wet alarm valve and a dry alarm valve. During the winter months the installation pipework downstream of the alternate or dry alarm valve is charged with air or inert gas under pressure and the remainder of the system upstream of the alarm valve with water under pressure. At other times of the year the installation operates as a wet pipe installation.

11.3.2 Size of installations

The maximum time between a single sprinkler opening and water discharging shall not exceed the value in Table 18.

11.4 Pre-action installations

11.4.1 General

11.4.1.1 Acceptable Types of pre-action installation

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

11.4.1.2 Type A pre-action installation

This is an otherwise normal dry pipe installation in which the control valve set is activated by an automatic fire detection system but not by the operation of the sprinklers.

The air/inert gas pressure in the installation shall be monitored at all times (see Annex I). At least one quick opening manually operated valve shall be installed in an appropriate position to enable the pre-action valve to be activated in an emergency.

In the event of a fault in the fire detection system, the installation shall operate as an ordinary dry pipe system.

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

11.4.1.3 Type B pre-action installation

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

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

11.4.1.4 Sprinkler systems with more than one pre-action installation

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

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

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

11.4.2 Automatic detection system

The detection system shall be installed in all rooms and compartments protected by the pre-action sprinkler system and shall conform to the relevant parts of EN 54 or, in their absence, with appropriate specifications valid in the place of use of the sprinkler system.

11.4.3 Size of installations

The number of sprinklers controlled by a pre-action alarm valve shall not exceed that shown in Table 17 (number of sprinkler heads in the given area).

11.5 Subsidiary dry pipe or alternate extension

11.5.1 General

Subsidiary dry pipe or alternate extensions shall conform to 11.2 and 11.3 except that they will be of limited extent and form extensions to normal wet installations.

They shall be installed only as follows:

a) as a dry pipe or alternate extension to a wet pipe installation in small areas where there is possible frost damage in an otherwise adequately heated building;

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

11.5.2 Size of subsidiary extensions

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

11.6 Subsidiary water spray extension

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

Water spray extensions might be connected to a sprinkler installation, provided that the connection is no greater than 80 mm and that the additional water demand is taken into consideration when designing the water supplies (see Clause 8).

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

12 Spacing and location of sprinklers

12.1 General

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

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

a) for LH and OH:

   — 0,3 m for flat spray sprinklers;

   — 0,5 m in all other cases.

b) for HHP and HHS:

   — 1,0 m.

12.1.3 Sprinklers shall be installed as specified by the supplier.

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

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

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

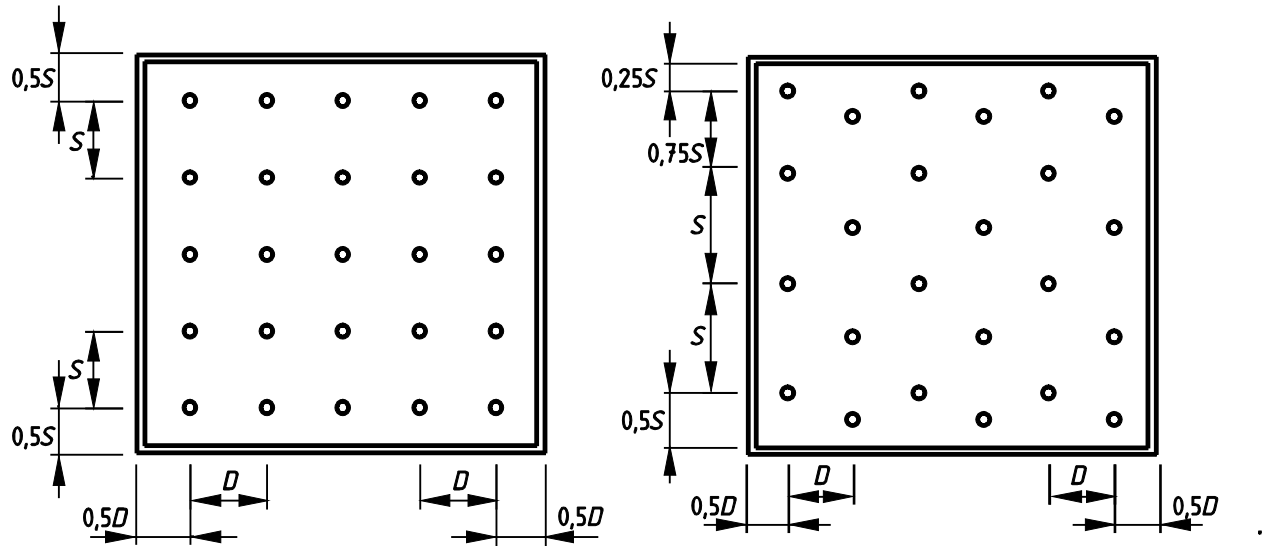
12.2 Maximum area of coverage per sprinkler

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

NOTE Examples are given in Figure 8 where dimensions *S* and *D* are the distance between sprinklers in opposing planes.

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

Hazard class	**Maximum area per sprinkler**	**Maximum distances as shown in Figure 8 m**		
		Standard layout	Staggered layout	
	m^2	S and D	S	D
LH	21,0	4,6	4,6	4,6
OH	12,0	4,0	4,6	4,0
HHP and HHS	9,0	3,7	3,7	3,7



Key

S distance between sprinklers D distance between sprinklers

Figure 8 — Ceiling sprinkler spacing

Table 20 — Maximum coverage and spacing for sidewall sprinklers

Hazard class	Maximum area per sprinkler m^2	Spacing along walls		Room width (*w*) m	Room length (*l*) m	Rows of sidewall sprinklers	Spacing pattern (horizontal plane)
		Between sprinklers m	Sprinkler to end of wall m				
LH	17,0	4,6	2,3	$w \leq 3,7$	any	1	single line
				$3,7 < w \leq 7,4$	≤ 9,2	2	standard
					> 9,2	2	staggered
				$w > 7,4$	any	2 (see note 1)	standard
OH	9,0	3,4 (see note 2)	1,8	$w \leq 3,7$	any	1	single line
				$3,7 < w \leq 7,4$	≤ 6,8	2	standard
					> 6,8	2	staggered
				$w > 7,4$	any	2	standard (see note 1)

NOTE 1 An additional row or rows of roof or ceiling sprinklers is required.

NOTE 2 This can be increased to 3,7 m provided the ceiling has a fire resistance of no less than 120 min.

NOTE 3 The sprinkler deflectors should be located between 0,1 m and 0,15 m below the ceiling and between 0,05 m and 0,15 m horizontally from the wall.

NOTE 4 There should be no obstruction at the ceiling within a square extending along the wall 1,0 m on each side of the sprinkler and 1,8 m perpendicular to the wall.

12.3 Minimum distance between sprinklers

Sprinklers shall not be installed at intervals of less than 2 m except in the following cases:

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

— intermediate sprinklers in racks (see 12.5.3);

— escalators and stairwells (see 12.4.11).

12.4 Location of sprinklers in relation to building construction

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

— 2,0 m for standard spacing;

— 2,3 m for staggered spacing;

— 1,5 m where the ceiling or roof is open-joisted or the rafters are exposed;

— 1,5 m from the open face of open-faced buildings;

— 1,5 m where the external walls are of combustible material;

— 1,5 m where the external walls are of metal, with or without combustible linings or insulating materials;

— half the maximum distance given in Tables 19 and 20.

12.4.2 Sprinklers shall be installed not lower than 0,3 m below the underside of combustible ceilings or 0,45 m below Euroclass A1 or A2 or an equivalent in existing national classification systems roofs or ceilings.

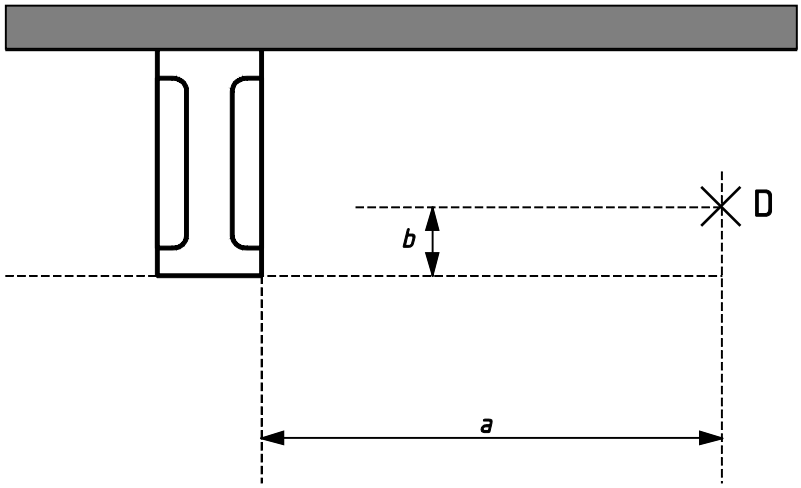
Where possible, sprinklers shall be situated with the deflector between 0,075 m and 0,15 m below the ceiling or roof except when ceiling, flush or recessed sprinklers are used. Where circumstances make it unavoidable to use the maximum distances of 0,3 m and 0,45 m, the area involved shall be as small as possible.

12.4.3 Sprinklers shall be installed with their deflectors parallel to the slope of the roof or ceiling. Where the slope is greater than 30° to the horizontal plane, a row of sprinklers shall be fixed at the apex or not more than 0,75 m radially from it.

12.4.4 The distance from the edge of a canopy to the nearest sprinklers shall not exceed 1,5 m.

12.4.5 Skylights with a volume greater than 1 m^3 measured above the normal ceiling level shall be sprinkler protected unless the distance from the normal ceiling level to the top of the skylight does not exceed 0,3 m, or there is a tightly fitting frame and glass fitted level with the roof or ceiling.

12.4.6 Beams and similar obstructions



Key

D deflector
b distance from underside of beam
a distance from beam

Figure 9 — Sprinkler location relative to beams

When the deflector (at D in Figure 9) is positioned above the level of the underside of beams or similar obstructions, one of the following solutions shall be adopted in order to ensure that effective discharge of the sprinklers is not impaired:

a) the dimensions shown in Figure 9 shall conform to the values specified in Figure 10;

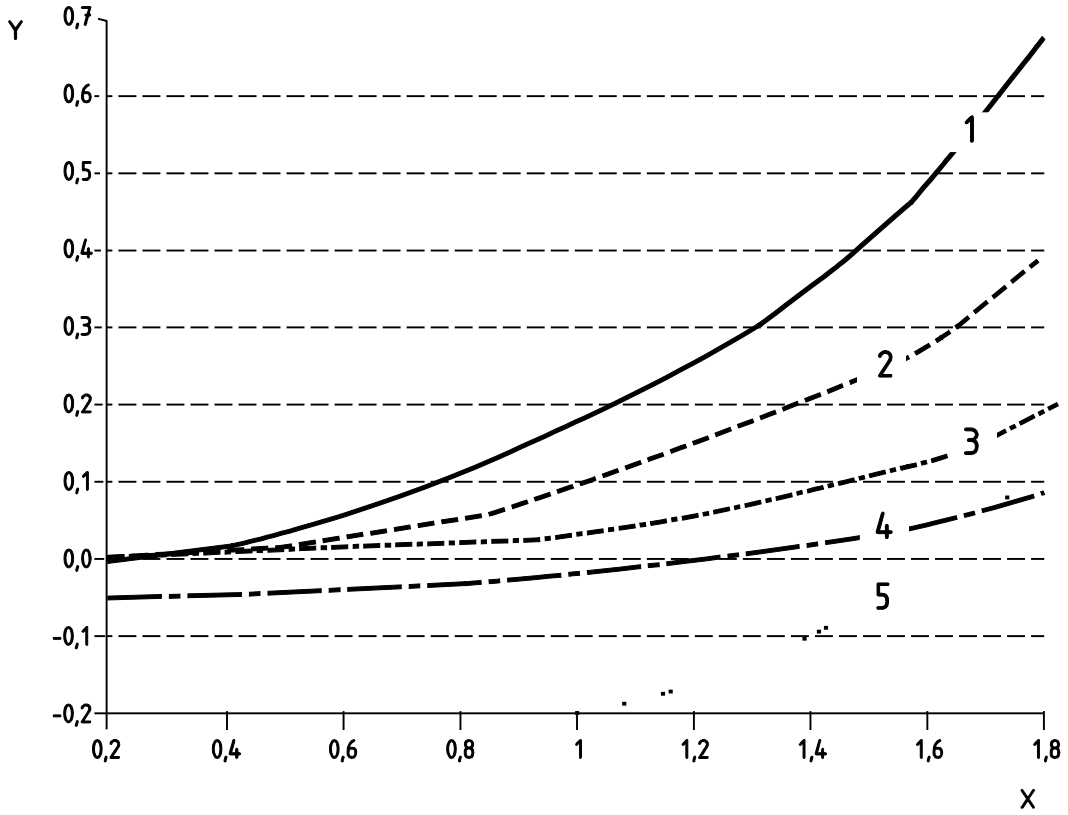
b) the spacing requirements of 12.4.7 shall be applied;

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

Sprinklers shall be positioned directly above girders or beams no wider than 0,2 m at a vertical distance of not less than 0,15 m.

In all cases, the ceiling clearances specified in 12.4.2 are applicable.

If none of the above solutions are feasible, e.g. because it results in a large number of sprinklers, the beams might be underdrawn and sprinklers installed underneath the flat ceiling thus formed.



Key

1 spray pendant

2 conventional upright

3 spray upright

4 flat spray

5 conventional pendant

X minimum horizontal distance (a) from beam to sprinkler, in m

Y height of deflector (b) above (+) or below (-) beam, in m

Figure 10 — Distance of sprinkler deflector from beams

12.4.7 Beams and bays

Where narrow bays are formed between beams spaced at not more than 1,5 m between centres, where the beams are above 450 mm (case of non-combustible construction A1 and A2) or 300 mm (case of combustible construction above A2) in depth, the following spacing shall be used:

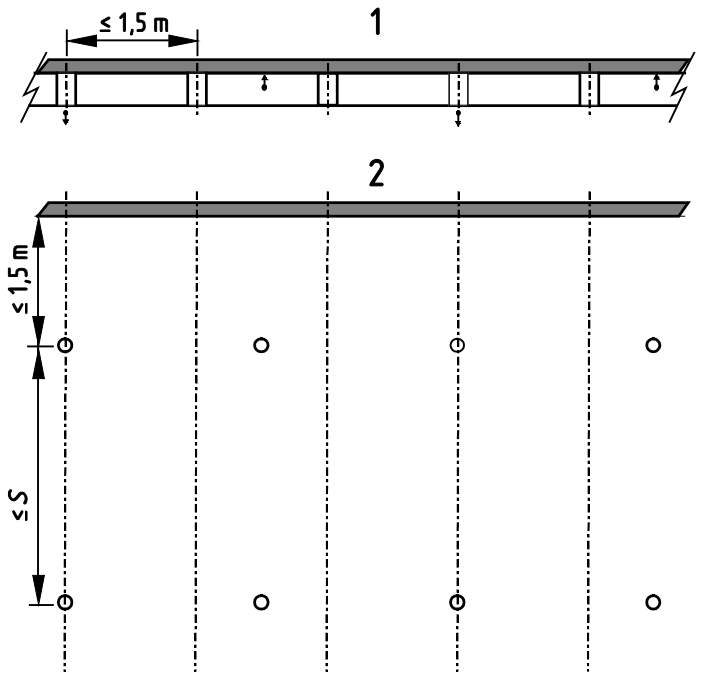
— one row of sprinklers shall be installed in the centre of each third bay, with another row underneath the centre line of the beam separating the two unprotected bays (see Figures 11 and 12);

— the maximum distance between sprinklers in the other direction, i.e. along the bay (*S* in Figures 11 and 12), shall be in accordance with the rules for the hazard class involved (see 12.2);

— sprinklers shall be installed at a distance no greater than 1 m from walls parallel to the beams and no greater than 1,5 m from walls perpendicular to the beams;

— sprinklers installed inside bays shall be placed so that the deflectors are between 0,075 m and 0,15 m below the underside of the ceiling.

Where the beam depth is above 0,7 m the case shall be submitted to authority.

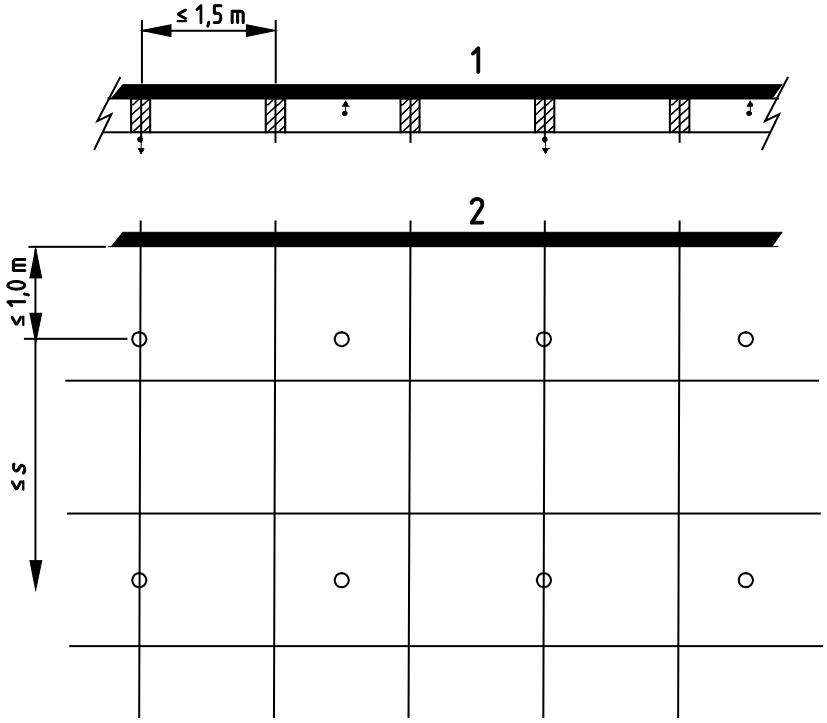


Key

1 ceiling

2 wall

Figure 11 — Beam and bay spacing (beams in one direction only)



Key

1 ceiling

2 wall

Figure 12 — Beam and bay spacing (beams in both directions)

12.4.8 Roof trusses

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

a) directly above or below the truss where the flange of the truss is no more than 0,2 m wide;

b) not less than 0,3 m laterally from truss members where the flange of the truss is not more than 0,1 m wide;

c) not less than 0,6 m laterally from truss members where the flange of the truss is greater than 0,1 m wide.

12.4.9 Columns

If roof or ceiling sprinklers are installed closer than 0,6 m to one side of a column, another sprinkler shall be installed on the opposite side of the column within 2 m of the column.

12.4.10 Platforms, ducts, etc.

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

a) rectangular, more than 0,8 m wide and less than 0,15 m from adjacent walls or partitions;

b) rectangular and more than 1,0 m wide;

c) circular, more than 1,0 m in diameter and less than 0,15 m from adjacent walls or partitions;

d) circular and more than 1,2 m in diameter.

12.4.11 Escalators and stair wells

The number of sprinklers shall be increased around the ceiling opening formed by escalators, stairs etc. Sprinklers shall be neither more than 2 m nor less than 1,5 m away from each other. If, owing to the design of the structure, e.g. girders, the minimum distance of 1,5 m cannot be maintained, smaller spacing might be used provided adjacent sprinklers are not able to wet each other.

The horizontal distance between the sprinklers and the opening in the ceiling shall not exceed 0,5 m. These sprinklers shall be capable of providing the minimum flow rate per sprinkler for the rest of the ceiling protection.

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

12.4.12 Vertical shafts and chutes

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

At least one sprinkler shall be installed at the top of all shafts except where the shaft is incombustible and inaccessible and contains materials in accordance with Euroclass A1 or equivalent in existing national classification systems except electrical cabling.

12.4.13 Suspended ceilings

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

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

12.4.14 Suspended open cell ceilings

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

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

b) the minimum dimension of the ceiling openings is not less than 0,025 m or not less than the depth of the suspended ceilings, whichever is the greater;

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

d) there are no storage areas below the ceiling.

In such cases, sprinklers shall be installed as follows:

— the sprinkler spacing above the ceiling shall not exceed 3 m;

— the vertical distance between any conventional or spray sprinkler deflector and the top of the suspended ceiling shall be not less than 0,8 m for sprinklers other than flat spray sprinklers and not less than 0,3 m if flat spray sprinklers are used;

— supplementary sprinklers shall be installed to discharge below obstructions (e.g. light fittings) exceeding 0,8 m in width.

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

12.5 Intermediate sprinklers in HH occupancies

12.5.1 General

Sprinklers protecting double row racks shall be installed in the longitudinal flue spaces, preferably in the intersection with the transverse flue (see Figures 13 and 14).

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

It shall be ensured that water from sprinklers operating at intermediate levels can penetrate the goods stored. The distance between goods stored in racking and placed back to back (the longitudinal flue space) shall be at least 0,15 m, and if necessary pallet stops fitted.

The distance between goods stored in racking and placed side by side (transverse flue space) shall be at least 0,1 m.

The clearance between the sprinkler deflectors and the top of the storage shall be not less than 0,10 m for flat spray sprinklers and 0,15 m for other sprinklers.

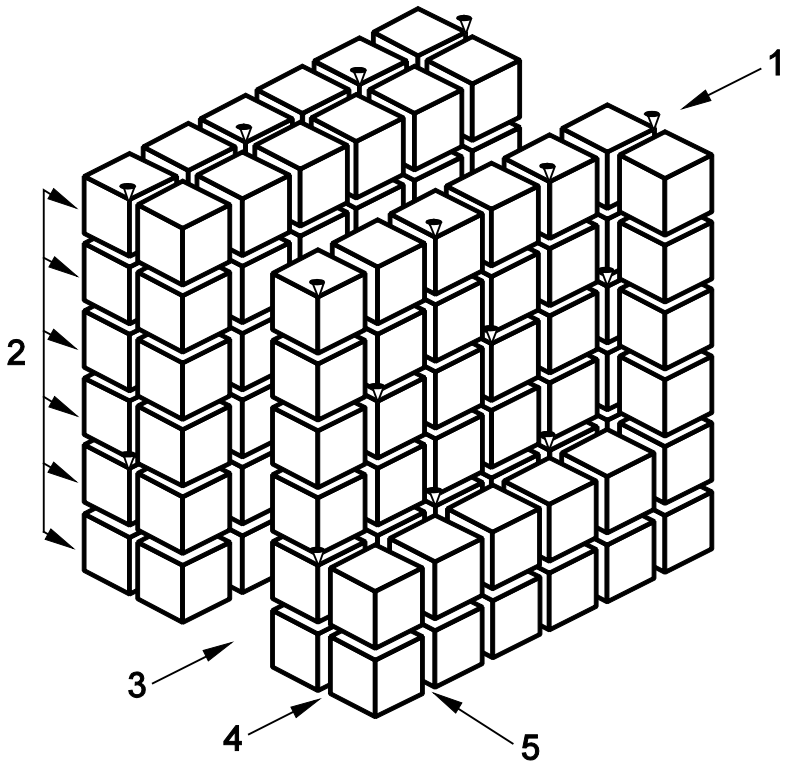
12.5.2 Maximum vertical distance between sprinklers at intermediate levels

The vertical distance from the floor to the lowest intermediate level and between levels shall not exceed 3,50 m or two tiers, whichever is the lesser, as shown in Figures 13 and 14. An intermediate level shall be installed above the top level of storage except where all the roof or ceiling sprinklers are situated at less than 4 m above the top of the storage.

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

12.5.3 Horizontal position of sprinklers at intermediate levels

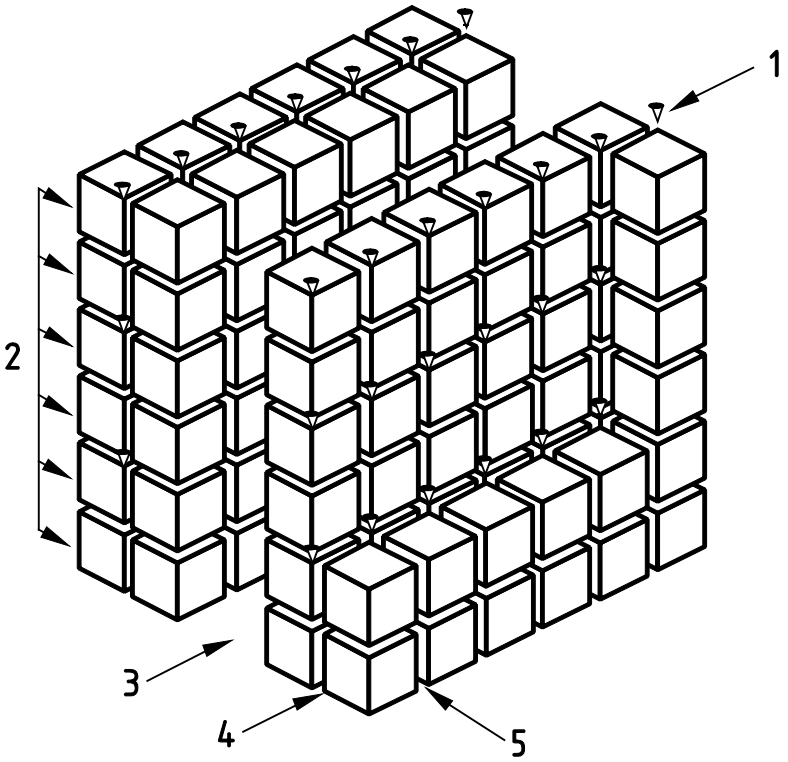
In the case of Category I or II goods, sprinklers shall where possible be installed in the longitudinal flue at the intersection with every second transverse flue, with the sprinklers staggered with respect to the next highest row (see Figure 13). The horizontal distance between sprinklers shall not exceed 3,75 m. The product of the horizontal and vertical distances between sprinklers shall not exceed 9,8 m^2.



Key

1	sprinkler row	4	longitudinal flue
2	tiers	5	transverse flue
3	aisle		

Figure 13 — Location of rack intermediate level sprinklers – Category I or II



Key

1 sprinkler row

2 tiers

3 aisle

4 longitudinal flue

5 transverse flue

Figure 14 — Location of rack intermediate level sprinklers – Category III or IV

In the case of Category III or IV goods, sprinklers shall be installed in the longitudinal flue at the intersection with each transverse flue (see Figure 14). The horizontal distance between sprinklers shall not exceed 1,9 m and the product of the horizontal distance and the vertical distance between sprinklers shall not exceed 4,9 m^2.

12.5.4 Numbers of rows of sprinklers at each level

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

One row of sprinklers per level shall be installed for every 3,2 m of rack width. They shall be installed in the flue spaces wherever possible.

12.5.5 HHS intermediate sprinklers in non-shelved racks

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

a) single row racks no more than 3,2 m wide shall be protected by single rows of sprinklers fitted at the tier levels shown in Figures 13 and 14;

b) double row racks no more than 3,2 m wide shall be protected by sprinklers centrally in the longitudinal flue space, at the stack ends, and at the tier levels shown in Figures 13 and 14;

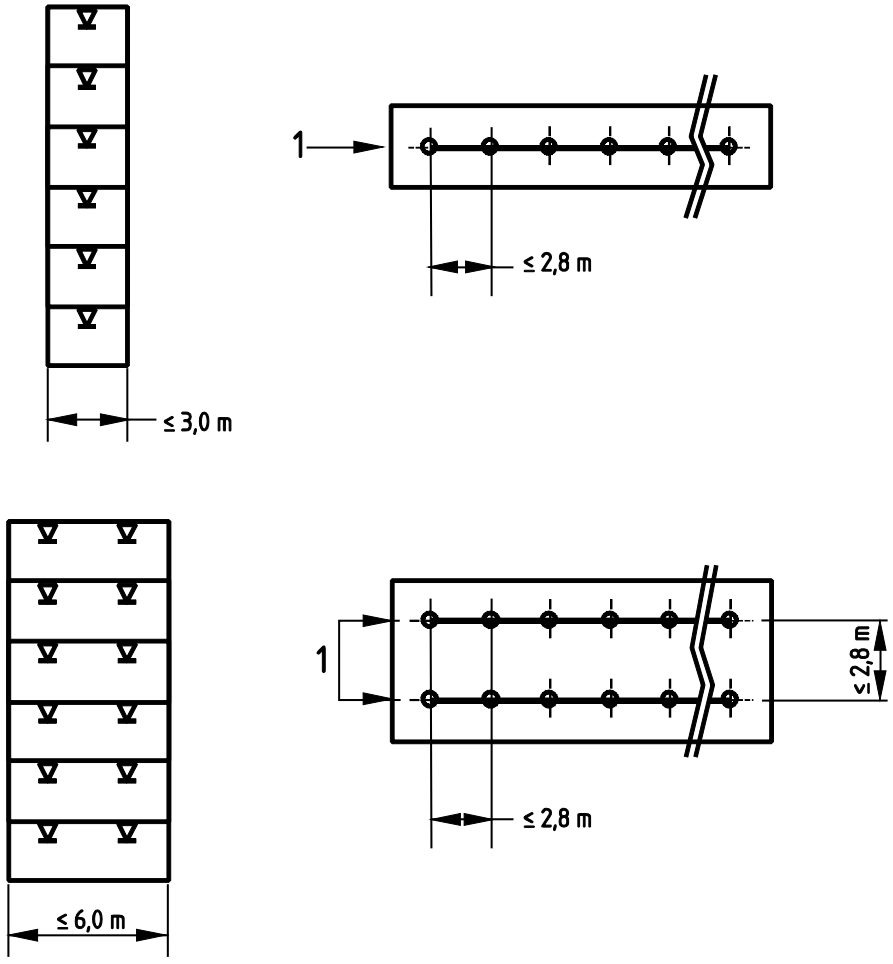
c) double or multiple row racks more than 3,2 m wide, but no more than 6,4 m wide shall be protected by two rows of sprinklers installed no more than 3,2 m apart. Each row shall be the same distance from the nearest shelf edge. The sprinklers at a particular level in each line shall be located in the same set of transverse flues.

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

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

Where intermediate sprinklers are required, they shall be installed above each shelf (including the top shelf if the roof or ceiling sprinklers are more than 4 m above the goods or water access to the goods is restricted), and located as shown in Table 21 and Figure 15. The vertical distance between rows shall not exceed 3,5 m.

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



Key

1 sprinkler row

Figure 15 — Location of intermediate sprinklers in type ST5 and ST6 storage

The distance from the end of the shelf parallel to the range pipe lines to the nearest sprinkler shall be half the sprinkler spacing along the range lines or 1,4 m, whichever is the less.

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

Shelf width s in m	Rows of sprinklers	Maximum distance between sprinklers along rows m	Maximum distance between rows of sprinklers m
ST5: s ≤ 1,0	1	2,8	—
ST6: 1,0 < s ≤ 3,0	1	2,8	—
ST6: 3,0 < s ≤ 6,0	2	2,8	2,8

13 Pipe sizing and layout

13.1 General

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

— pre-calculated systems, where the diameters are partly taken from tables and partly calculated (see 13.3);

— fully calculated systems, where all diameters are determined by hydraulic calculation (see 13.4).

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

— layouts with intermediate level HHS sprinklers;

— gridded or looped layouts.

13.2 Calculation of pressure losses in pipework

13.2.1 Pipe friction loss

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

$$p = \frac{6,05 \times 10^5}{C^{1,85} \times d^{4,87}} \times L \times Q^{1,85} \quad (3)$$

where:

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

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

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

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

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

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

Table 22 — C values for various types of pipe

Type of pipe	Value of C
cast iron	100
ductile iron	110
mild steel	120
galvanized steel	120
spun cement	130
cement lined cast iron	130
stainless steel	140
copper	140
reinforced glass fibre	140
NOTE The list is not exhaustive.	

The pressure loss due to velocity might be ignored.

13.2.2 Static pressure difference

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

$$p = 0{,}098h \quad (4)$$

where:

p is the static pressure difference, in bar;

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

13.2.3 Velocity

The water velocity shall not exceed:

— 6 m/s through any valve, flow monitoring device or/and strainer;

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

for the stabilized flow condition for the hydraulically most favourable and unfavourable area of operation.

13.2.4 Pressure loss through fittings and valves

The pressure loss due to friction in valves, and in fittings where the direction of water flow is changed through 45° or more, shall be calculated using the formula specified in 13.2.1. The appropriate equivalent length shall be one of the following:

a) as specified by the equipment supplier;

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

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

Table 23 — Equivalent length of fittings and valves

Fittings and valves	**Equivalent length of steel straight pipe for a *C* value of 120 [a] (m)**										
	Nominal diameter (mm)										
	20	25	32	40	50	65	80	100	150	200	250
90° screwed elbow (standard)	0,76	0,77	1,0	1,2	1,5	1,9	2,4	3,0	4,3	5,7	7,4
90° welded elbow (r/d = 1,5)	0,30	0,36	0,49	0,56	0,69	0,88	1,1	1,4	2,0	2,6	3,4
45° screwed elbow (standard)	0,34	0,40	0,55	0,66	0,76	1,0	1,3	1,6	2,3	3,1	3,9
Standard screwed tee or cross (flow through branch)	1,3	1,5	2,1	2,4	2,9	3,8	4,8	6,1	8,6	11,0	14,0
Gate valve - straight way	—	—	—	—	0,38	0,51	0,63	0,81	1,1	1,5	2,0
Alarm or non-return valve (swinging type)	—	—	—	—	2,4	3,2	3,9	5,1	7,2	9,4	12,0
Alarm or non-return valve (mushroom type)	—	—	—	—	12,0	19,0	19,7	25,0	35,0	47,0	62,0
Butterfly valve	—	—	—	—	2,2	2,9	3,6	4,6	6,4	8,6	9,9
Globe valve					16,0	21,0	26,0	34,0	48,0	64,0	84,0

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

C-value¤	100¤	110¤	120¤	130¤	140¤
Factor¤	0,714¤	0,85¤	1,00¤	1,16¤	1,33¤

13.2.5 Accuracy of calculations

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

Table 24 — Accuracy of hydraulic calculations

Quantity	Unit	Accurate to
Length	m	0,01
Height	m	0,01
Equivalent length	m	0,01
Flow	l/min	1,0
Pressure loss	mbar/m	1,0
Pressure	mbar	1,0
Velocity	m/s	0,1
Area	m^2	0,01
Density of water application	mm/min	0,1

13.2.5.2 The calculations shall balance as follows:

— the algebraic sum of pressure loss in a loop shall equal (0 ± 1) mbar;

— where water flows join at a junction, the calculation shall balance to ± 1 mbar;

— the algebraic sum of water flow at a junction shall equal (0 ± 0,1) l/min.

13.3 Pre-calculated systems

13.3.1 General

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

13.3.1.2 Range pipe sizes and the maximum number of sprinklers fed by each size of pipe in the range shall be as specified in Table 30, except in the case of Light Hazard, where Table 27 specifies only the pipes feeding the last three or four sprinklers on each range.

13.3.1.3 The size of all pipes upstream of each design point shall be calculated as specified in 13.3.3.2 for Light Hazard and 13.3.4.2 for Ordinary Hazard.

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

13.3.2 Location of Design Points

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

— a range pipe;

— a riser or drop connecting ranges to distribution pipes;

— a pipe feeding a single sprinkler.

The maximum number of sprinklers downstream of each design point shall be as specified in Tables 25 and 26.

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

Table 25 — Location of design points – LH

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

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

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

NOTE 1 Figure 16 illustrates typical range pipe arrays.

NOTE 2 Examples of pipe layouts with the appropriate design points are given in Figure 17 for LH, Figure 18 for OH and Figures 19, 20 and 21 for HHP and HHS.

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

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

13.3.3 Light Hazard - LH

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

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

Table 27 — Range pipe diameters for LH installations

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

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

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

Number of sprinklers on a range or in a room	Maximum friction loss including changes in direction (see Note) bar	For range and distribution pipe loss, see:
≤ 3	0,9	Table 29 columns 2 and 3
≥ 4	0,7	Table 29 column 3
≥ 3 in a single line, in a narrow room or range at a roof apex	0,7	Table 29 column 3
NOTE In buildings with more than one floor, the pressure loss can be increased by an amount equivalent to the static pressure between the level of the sprinklers concerned and the level of the sprinklers on the highest floor.		

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

NOTE Figure 17 shows an example of a pipe layout in a LH installation with design points from which the piping is to be fully calculated.

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

Diameter mm	Loss of pressure in pipe mbar/m	
Column 1	Column 2 (100 l/min)	Column 3 (225 l/min)
25	44	198
32	12	52
40	5,5	25
50	1,7	7,8
65	0,44	2,0

13.3.4 Ordinary Hazard - OH

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

Table 30 — Range pipe diameters in OH installations

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

Table 31 — Distribution pipe diameters in OH installations

Distribution pipes	Layout	Diameter mm	Maximum number of sprinklers fed
At extremities of installation:	2-end-side	32	2
		40	4
		50	8
		65	16
	All others	32	3
		40	6
		50	9
		65	18
Between design points and the control valve set	All	To be calculated in accordance with 13.3.4.2	

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

NOTE Figure 18 gives an example of a pipe layout in OH with the design points from which the piping is to be fully calculated.

13.3.4.2 The pipe diameters between the design point in the most remote area of the installation and the control valve set shall be calculated to ensure that the total pressure loss due to friction with a flow of 1 000 l/min does not exceed 0,5 bar, except as modified in 13.3.4.3 and 13.3.4.4.

13.3.4.3 In buildings with more than one floor, or where there are a number of different levels, e.g. platforms or lean-to's, the 0,5 bar loss in pressure from the design point might be increased by an amount equivalent to the static pressure due to the height difference between the highest sprinkler point in the building and the remote area design point on the floor concerned.

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

13.3.4.4 Where the same system includes both OH3 or OH4 and HHP or HHS areas, all connected to a common water supply, the maximum friction loss of 0,5 bar might be increased by 50 % of the available extra pressure, as indicated in the following example for OH3.

EXAMPLE (for an OH3 installation): Pressure required at the control valve set excluding static pressure (Table 6 for OH3)	1,4 bar
Pressure difference due to the difference in height between the highest sprinkler and the control valve set	1,2 bar
Required pressure at the control valve set	2,6 bar
Pressure available at the control valve set for the flow appropriate in HH e.g.	6,0 bar
Extra pressure which might be used:	
50 % of (6,0 - 2,6) =	1,7 bar
The pipework shall be sized to allow for a maximum pressure loss of:	
$0,5 + 1,7\ (1000/1350)^2$ =	1,43 bar

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

13.3.5.1 The pipe shall be sized according to:

— the design density;

— the spacing of the sprinklers;

— the K-factor of sprinkler used;

— the pressure/flow characteristic of water supply. No pipe shall have a nominal diameter of less than 25 mm.

13.3.5.2 For installations with water supplies which conform to Table 7 (1) and with sprinklers having a K-factor of 80, the pipe sizes for range pipes and distribution pipes shown in Tables 32 and 33 shall apply.

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

NOTE Figure 19 gives an example of a pipe layout in accordance with Tables 32 and 33 and design points from which the pipe diameters are to be fully calculated.

Table 32 — Range pipe diameters for HH installations with pressure and flow characteristics as given in Table 7 (1 or 2)

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

Table 33 — Distribution pipe diameters downstream of the design point, in HH installations with pressure and flow characteristics as given in Table 7 (1)

Distribution pipes	Diameter mm.	Maximum number of sprinklers fed by distribution pipe
Pipes at extremities of installation	32	2
	40	4
	50	8
	65	12
	80	18
	100	48
Pipes between the design points and the control valve set	To be calculated in accordance with 13.3.5	

13.3.5.3 For installations with water supplies, which conform to Table 7 (2) or as modified by 7.3.2.6 and with sprinklers having a K-factor of 80, the sizes for range pipes and distribution pipes shall be determined from Tables 32 and 34.

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

NOTE Figure 20 gives an example of a pipe layout in accordance with Tables 32 and 34 and design points from which the pipe diameters are to be fully calculated.

Table 34 — Distribution pipe diameters downstream of the design point in HH installations with pressure and flow characteristics as given in Table 7 (2, 3 or 4)

Distribution pipes	Diameter mm.	Maximum number of sprinklers on distribution pipes
Pipes at extremities of system	50	4
	65	8
	80	12
	100	16
	150	48
Pipes between the design points and the control valve set	To be calculated in accordance with 13.3.5	

13.3.5.4 For installations with water supplies which conform to the requirements shown in Table 7 (3) and with sprinklers having a K-factor of 80, and as shown in Table 7 (4) with sprinklers having a K-factor of 115, the sizes for range pipes and distribution pipes shall be determined from Tables 34 and 35.

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

NOTE Figure 21 gives an example of a pipe layout in accordance with Tables 34 and 35 and design points from which the pipe diameters are to be fully calculated.

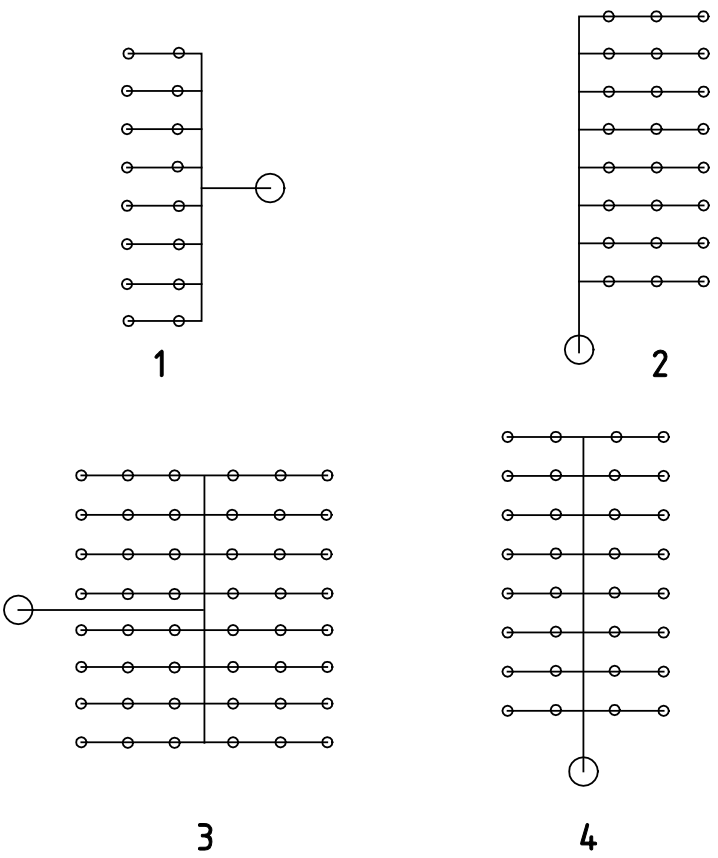
Table 35 — Range pipe diameters for HH installations with pressure and flow characteristics as given in Table 7 (3 or 4)

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

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

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

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



Key

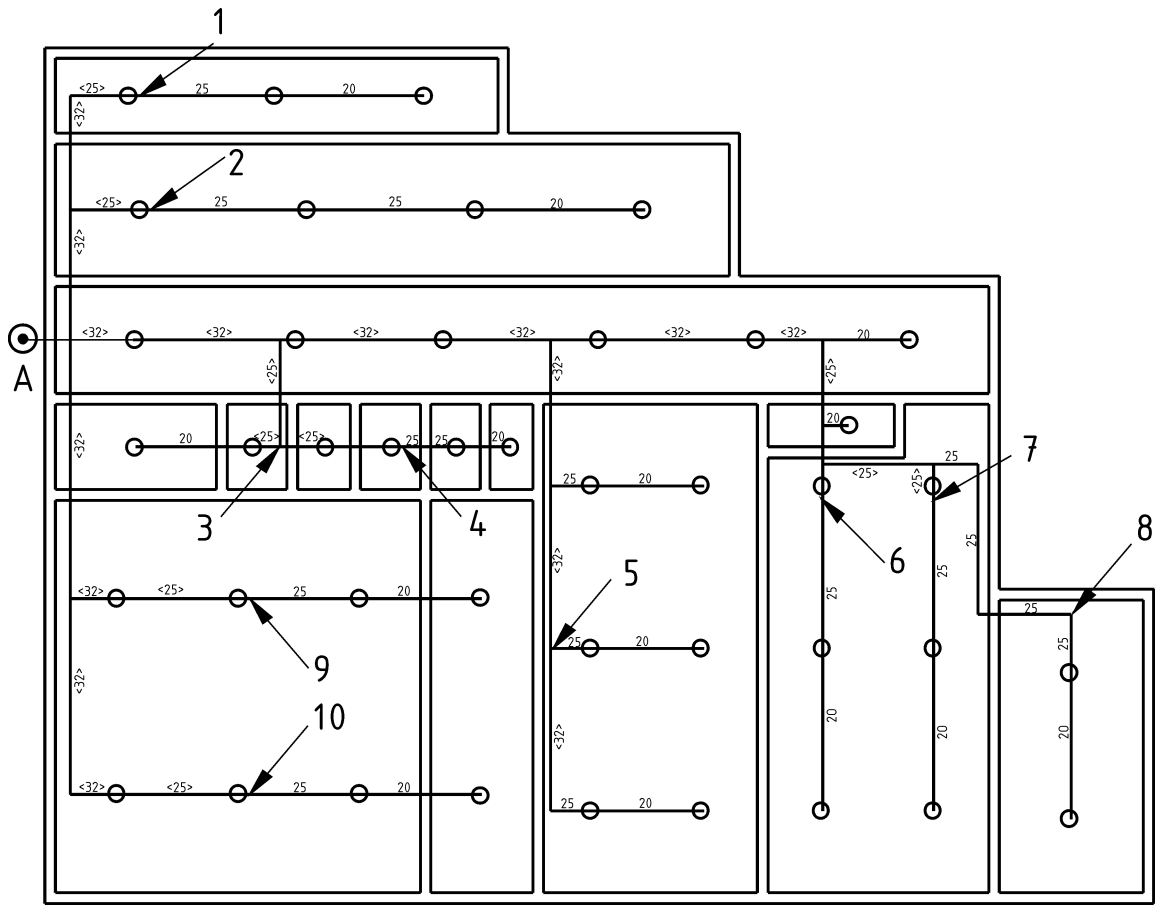
1 2-end-side with central feed

2 3-end-side with end feed

3 3-end-centre with central feed

4 2-end-centre with end feed

Figure 16 — Examples of range pipe arrays



Key

A control valve set

pressure loss between control valve set and:

1 (2 sprinkler point) = 0,7 bar

2 (3 sprinkler point) = 0,7 bar

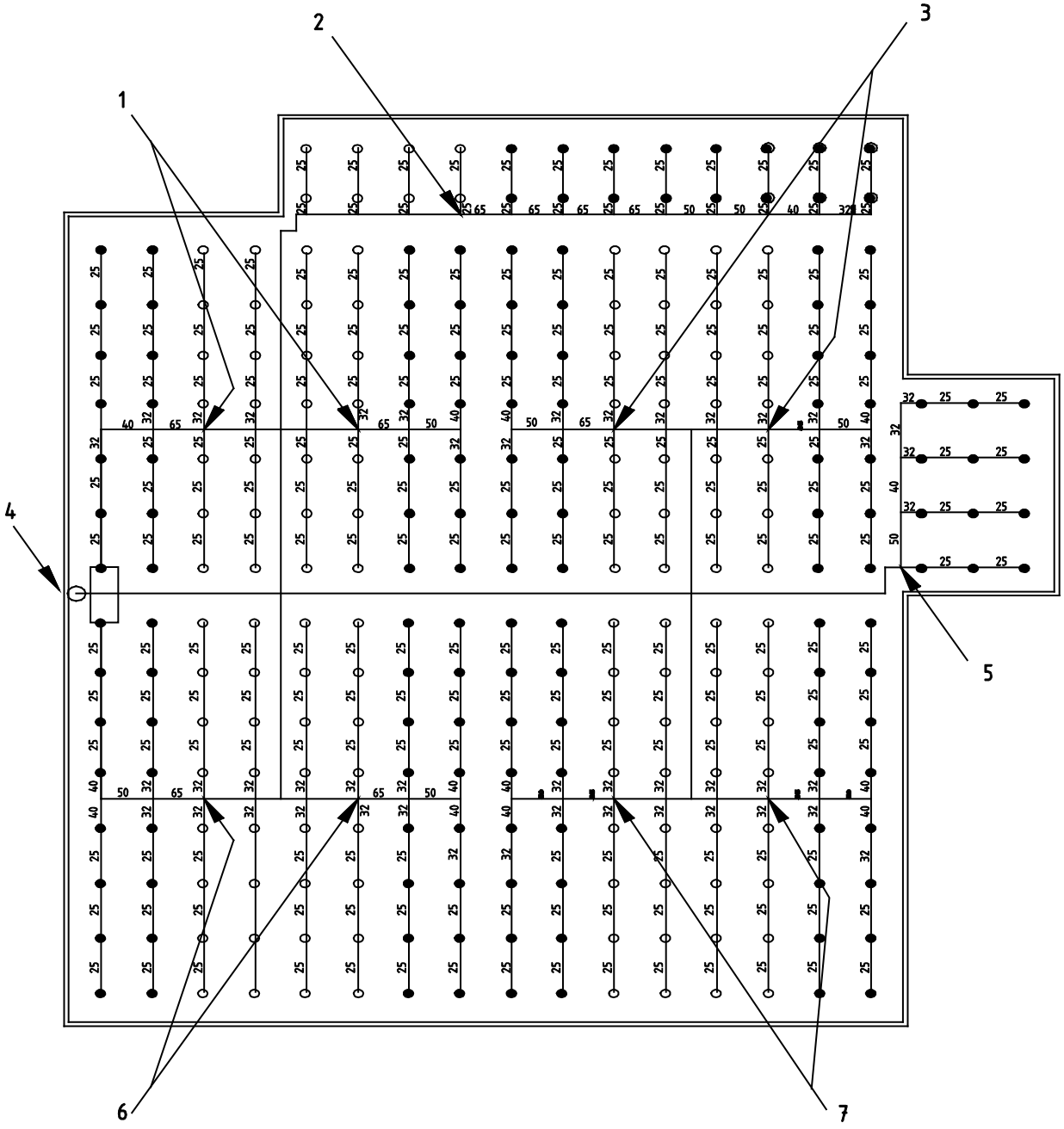
3, 4, 5, 6, 7, 8, 9 and 10 (2s sprinkler point) = 0,9 bar

Dimensions shown as < 25 > or < 32 > indicate probable pipe sizes resulting from calculation.

Pipe sizes are in mm.

Figure 17 — Example of application of design points in a LH installation

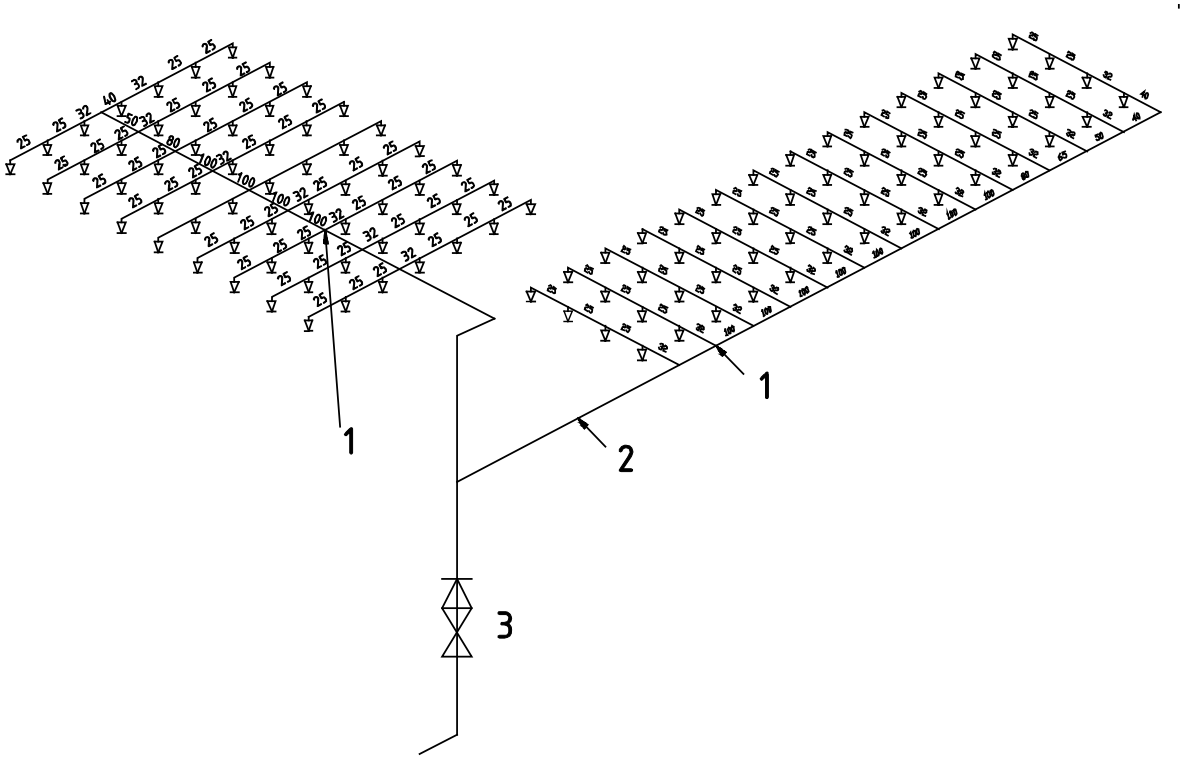
Dimensions in millimetres



Key

1, 2, 3, 5, 6 and 7	design points
4	control valve set

Figure 18 — Example of application of design points (1 to 7) in an OH installation



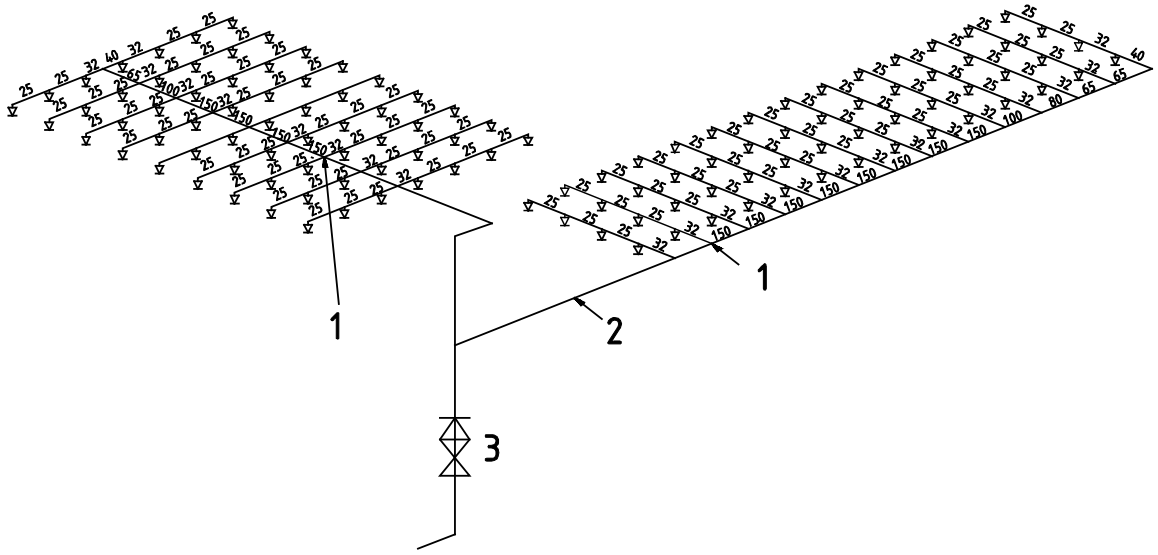
Key

1 48 sprinkler point

2 distribution pipe spur

3 control valve set

Figure 19 — Example of application of design points in a high hazard installation with pipe sizes from Tables 32 and 33



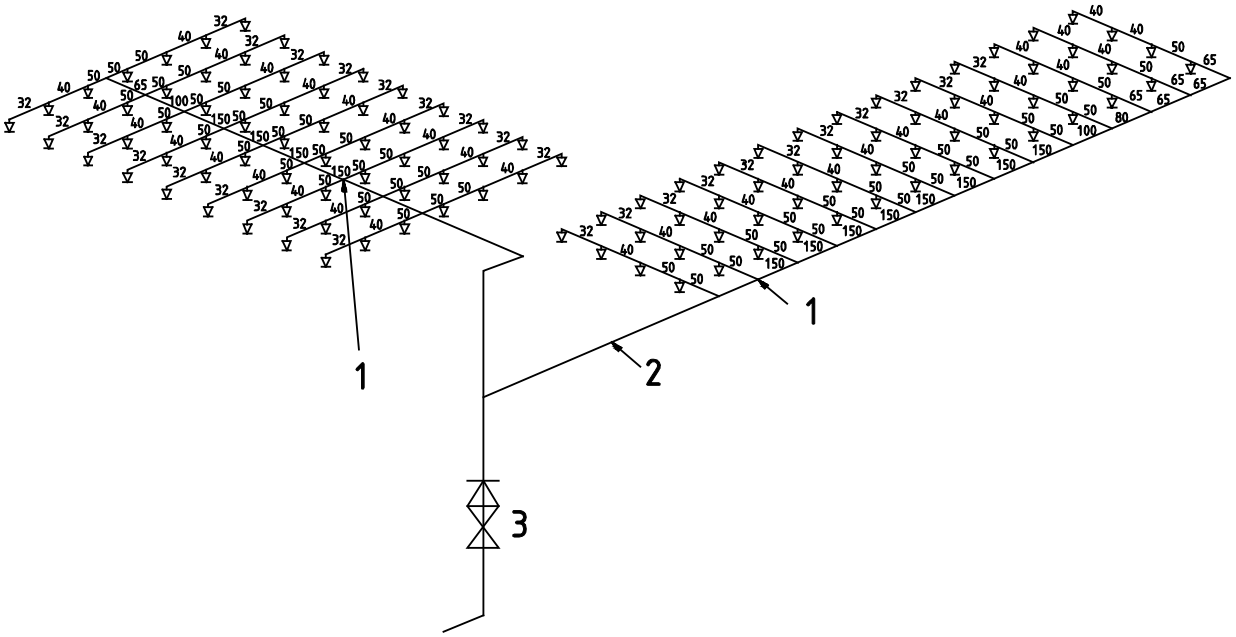
Key

1 48 sprinkler point

2 distribution pipe spur

3 control valve set

Figure 20 — Example of application of design points in a high hazard installation with pipe sizes from Tables 32 and 34



Key

1 48 sprinkler point

2 distribution pipe spur

3 control valve set

Figure 21 — Example of application of design points in a high hazard installation with pipe sizes from Tables 34 and 35

13.4 Fully calculated systems

13.4.1 Design density

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

The density of discharge from each area of operation, or the entire protected area, whichever is the smaller, containing the relevant group of four sprinklers, with each water supply or supply combination available, shall be not less than the design density specified in Clause 7.

The area covered by each sprinkler shall be defined by the centre-lines drawn midway between adjacent sprinklers at right angles to the line joining the sprinklers and by the boundary of the area covered or half the distance to the closest sprinkler, whichever is the greater (see Figure 22). Where in-rack sprinklers are installed, the calculation shall be carried out taking into account the simultaneous flow and pressure requirement for roof or ceiling sprinklers and the intermediate level sprinklers.

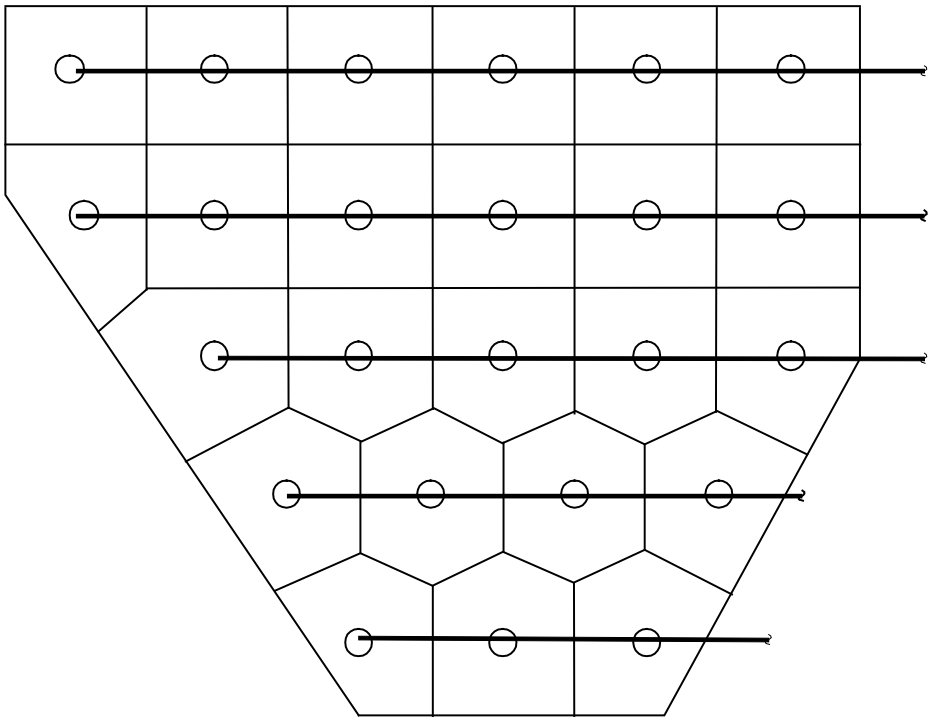


Figure 22 — Determination of area covered per sprinkler

13.4.2 Locations of the area of operation

13.4.2.1 Hydraulically most unfavourable location

Variations in sprinkler spacing, layout, elevation, range centres, sprinkler orifice size and pipe sizes, as well as all possible locations, whether on the distribution pipes or between distribution pipes where these are connected by range pipes, shall be considered when determining the hydraulically most unfavourable location of the area of operation (See Figures 23, 25 and 26).

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

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

13.4.2.2 Hydraulically most favourable location

All possible locations, whether on the distribution pipes, or between distribution pipes where these are connected by range pipes, shall be considered when determining the hydraulically most favourable location of the area of operation (See Figures 23 to 26).

13.4.3 Shape of the area of operation

13.4.3.1 Hydraulically most unfavourable location

The area of operation shall be as near as possible rectangular, symmetrical with respect to the sprinkler layout (see Figure 23) and as follows:

a) In the case of terminal and looped configurations, the far side of the area shall be defined by the range, or pair of ranges where there is an end-centre layout. Sprinklers not constituting a full range or pair of

ranges shall be grouped as close as possible to the distribution pipe on the next upstream range row to the rectangular area (see Figures 23 and 25);

b) In the case of gridded configurations where ranges run parallel to the ridge of a roof having a slope greater than 6°, or along bays formed by beams greater than 1,0 m deep, the far side of the area shall have a length *L* parallel to the ranges, such that *L* is greater than or equal to two times the square root of the area of operation;

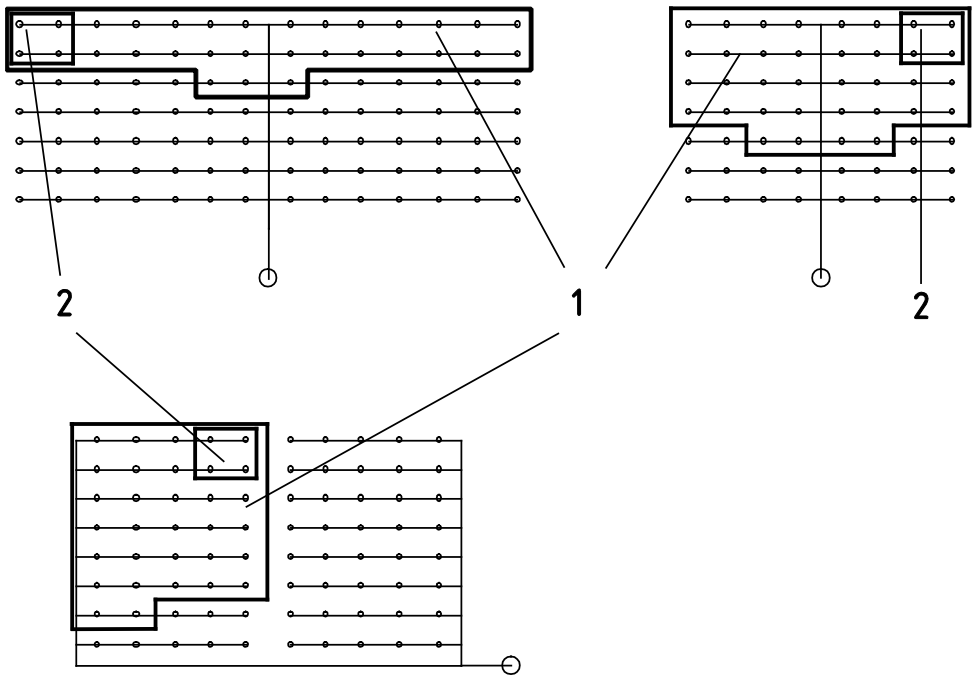
c) In the case of all other gridded configurations the far side of the area shall have a length *L* parallel to the ranges, such that *L* is greater than or equal to 1,2 times the square root of the area of operation.

13.4.3.2 Hydraulically most favourable location

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

a) In the case of terminal and looped configurations, the area shall where possible include sprinklers on one distribution pipe only. The number of sprinklers calculated to be operating on ranges, or pairs of ranges in end-centre installations, shall be located on each range or pair of ranges at the hydraulically most favourable location. Sprinklers not forming a full range or pair of ranges shall be located on the next range row at the hydraulically closest locations (see Figures 24 and 26).

b) In the case of gridded configurations, the area shall be located on ranges at the hydraulically most favourable location. Sprinklers not forming a full range length shall be located on the next range row at the hydraulically closest locations (see Figure 23).

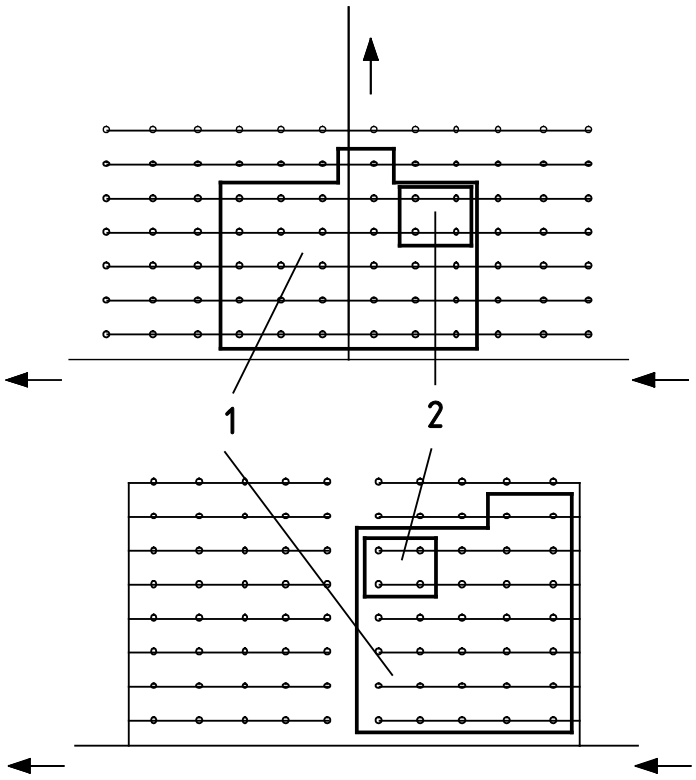


Key

1 most unfavourable area

2 four sprinkler under consideration'

Figure 23 — Most unfavourable areas of operation in one-sided and two-sided pipe layouts

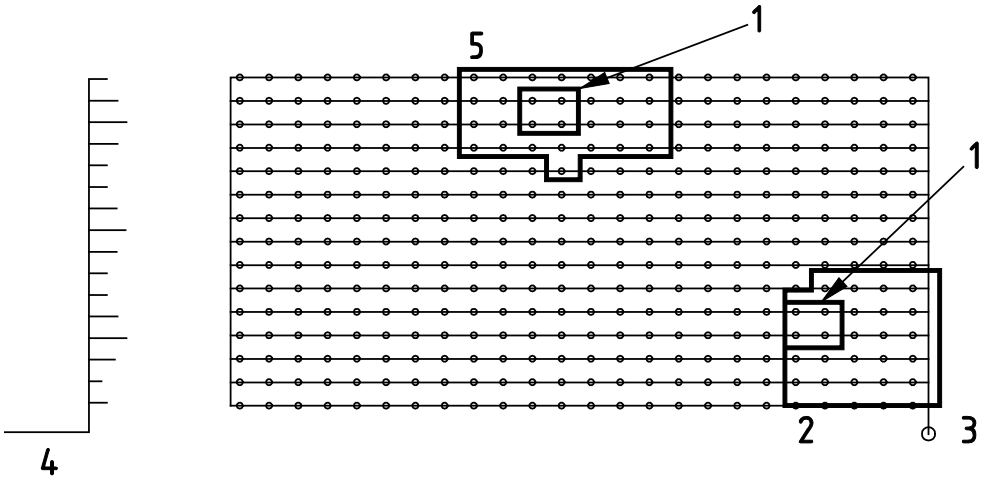


Key

1 most favourable area

2 four sprinkler under consideration'

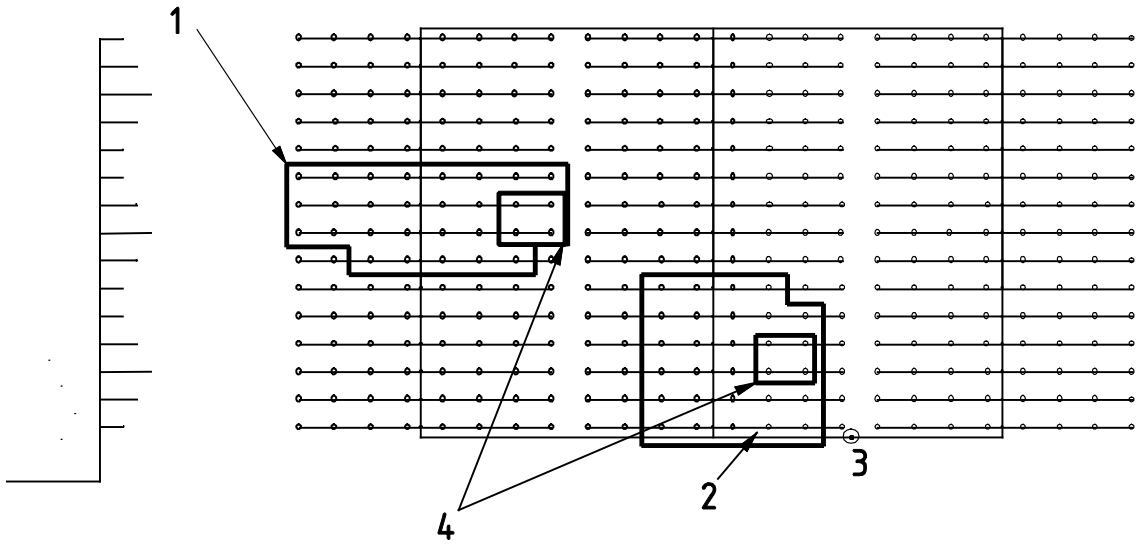
Figure 24 — Most favourable areas of operation in one-sided and two-sided pipe layouts



Key

1 four sprinklers under consideration
2 most favourable area
3 riser
4 elevation
5 most unfavourable area

Figure 25 — Most favourable and unfavourable areas of operation in gridded pipe layout



Key

1 most unfavourable area
2 most favourable area
3 riser
4 four sprinklers under consideration

Figure 26 — Most favourable and unfavourable areas of operation in a looped pipe layout

13.4.4 Minimum sprinkler discharge pressure

The pressure at the hydraulically most unfavourably situated sprinkler, when all the sprinklers in the area of operation are in operation, shall be not less than that required to achieve the density specified in 13.4.1 or the following, whichever is the higher:

— 0,70 bar in LH;

— 0,35 bar in OH;

— 0,50 bar in HHP and HHS except for in-rack sprinklers;

— 1,00 bar for K 115 in-rack sprinklers;

— 2,00 bar for K 80 in-rack sprinklers.

13.4.5 Minimum pipe diameters

The pipe diameter shall not be less than as shown in Table 36.

Table 36 — Minimum pipe diameters

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

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

Upright sprinklers shall not be connected to any pipe with a diameter greater than 65 mm, or 50 mm if lagged. Pendent sprinklers shall not be directly connected to any pipe with a diameter greater than 80 mm. For larger diameters an arm pipe shall be fitted so that the distance from the sprinkler deflector to the edge of the main pipe is not less than 1,5 times the diameter of this pipe.

14 Sprinkler design characteristics and uses

14.1 General

NOTE This standard covers only the use of the types of sprinkler specified in EN 12259–1.

Only new (i.e. unused) sprinklers shall be used. They shall not be painted except as allowed by EN 12259-1. They shall not be altered in any respect or have any type of ornamentation or coating applied after dispatch from the production factory, except as specified in 14.9.

14.2 Sprinkler types and application

14.2.1 General

Sprinklers shall be used for the various hazard classes in accordance with Table 37a, and as specified in 14.2.2 to 14.2.4.

Table 37a — Sprinkler types and K-factors for various hazard classes

Hazard class	Design density mm/min	Sprinkler Type	Nominal K-factor
LH	2,25	conventional, spray, ceiling, flush, flat spray, recessed, concealed, and sidewall	57
OH	5,0	conventional, spray, ceiling, flush, flat spray, recessed, concealed, and sidewall	80 or 115
HHP and HHS ceiling or roof sprinklers	≤ 10	conventional, spray	80, 115 or 160
	> 10	conventional, spray	115 or 160
HHS intermediate sprinklers in high piled storage		conventional, spray, and flat spray	80 or 115

14.2.2 Ceiling, flush, recessed and concealed pattern

Ceiling, flush, recessed and concealed sprinklers shall not be installed in OH4, HHP or HHS areas. Sprinklers without fixed deflectors, e.g. with retracted deflectors which drop to the operating position on actuation, shall not be fitted in the following situations:

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

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

c) in racks or under shelves.

14.2.3 Sidewall pattern

Sidewall sprinklers shall not be installed in:

- HH installations except for the protection of corridors, cable ducts and columns.
- OH storage areas
- above suspended ceilings.

They might only be installed under flat ceilings.

14.2.4 Flat spray pattern

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

14.3 Flow from sprinklers

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

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

where:

Q is the flow in litres per minute;

K is the constant given in Table 37a;

P is the pressure in bar.

14.4 Sprinkler temperature ratings

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

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

NOTE 1 Under normal conditions in temperate climates a rating of 68 °C or 74 °C is suitable.

NOTE 2 Sprinklers are colour coded in accordance with EN 12259–1 to indicate their temperature rating as specified in Table 37b.

Table 37b — colour code for sprinklers

Glass bulb sprinklers		**Fusible link sprinklers**	
Nominal operating temperature ° C	Liquid colour code	Nominal operating temperature within range ° C	Yoke arms colour code
57	orange	57 to 77	uncoloured
68	red	80 to 107	white
79	yellow	121 to 149	blue
93	green	163 to 191	red
100	green	204 to 246	green
121	blue	260 to 302	orange
141	blue	320 to 343	black
163	mauve		
182	mauve		
204	black		
227	black		
260	black		
286	black		
343	black		

14.5 Sprinkler thermal sensitivity

14.5.1 General

Sprinklers of different sensitivities shall be used in accordance with Table 38. Where sprinklers are situated in racks, the sprinklers at the ceiling shall have a sensitivity equal to or of slower response than the sprinklers situated in the racks.

Table 38 — Sprinkler sensitivity ratings

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

NOTE Most types of sprinkler are rated, in descending order of sensitivity, as one of the following types (see EN 12259–1):

— quick response;

— special response;

— standard response 'A'.

14.5.2 Interaction with other measures

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

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

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

14.6 Sprinkler guards

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

14.7 Sprinkler water shields

Sprinklers installed in racks, or under perforated shelves, platforms, floors or similar locations, where water from a higher sprinkler or sprinklers might cause wetting close to the bulb or fusible element, shall be fitted with a metal water shield with a minimum diameter of 0,075 m.

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

14.8 Sprinkler rosettes

Rosettes shall be made of metal or thermosetting plastic. 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 of the sprinkler.

14.9 Corrosion protection of sprinklers

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

The anti-corrosion treatment shall not be applied to sprinkler bulbs.

15 Valves

15.1 Control valve set

Each installation shall have a control valve set in accordance with EN 12259-2 or EN 12259-3.

15.2 Stop valves

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

— close in the clockwise direction;

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

— be secured in the right position by a strap and padlock or secured in an equivalent manner.

Stop valves shall not be installed downstream of the control valve set except as specified in this standard. In order to facilitate testing and maintenance, a stop valve might be installed downstream of the control valve if monitored.

15.3 Ring main valves

Where sprinkler systems are fed by a ring main supply pipe arrangement on the premises, stop valves shall be installed to isolate the ring into sections, in such a way that no section shall include more than 4 control valve sets.

15.4 Drain valves

Drain valves shall be fitted as specified in Table 39 to allow drainage from pipework as follows:

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

b) immediately downstream of any subsidiary alarm valve;

c) immediately downstream of any subsidiary stop valve;

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

e) any pipe, with the exception of 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 the pipework and sized as specified in Table 39. The outlet shall be no more than 3 m above the floor and shall be fitted with a suitable plug.

Table 39 — Minimum size of drain valves

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

15.5 Test valves

15.5.1 Alarm and pump start test valves

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

a) the hydraulic alarm and any electric alarm pressure switch by drawing water from the immediate downstream side of the following:

   — a wet alarm valve, and any downstream main stop valves;

   — an alternate 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:

   — an alternate alarm valve;

   — a dry pipe alarm valve;

   — a pre-action alarm valve.

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

d) an automatic pump starting device;

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

15.5.2 Remote test valves

A test facility shall be provided, incorporating a test valve with any associated fittings and pipework, delivering a flow equivalent to the discharge from a single sprinkler, connected at the hydraulically most remote location on a distribution pipe.

15.6 Flushing connections

Flushing connections, with or without permanently installed valves, shall be fitted on the spur ends of the installation distribution pipes.

Flushing connections shall be of the same size as the distribution pipe. For pipes bigger than DN40 flushing connections of DN40 might be used, if connected to the lower side of the distribution pipe. Flushing connections shall be fitted with a suitable plug.

It might be desirable in certain cases to fit flushing connections on ranges, e.g. in the form of a blank tee.

In addition to their use for periodic flushing of the pipework, flushing connections might be used to check that water is available and for carrying out pressure and flow tests.

Pipework, which is completely full of water, might be damaged by the increase in pressure due to temperature rises. If complete venting of air in an installation is likely to occur, e.g. in the case of a gridded layout with flushing connections at the extremities, consideration shall be given to the fitting of pressure relief valves.

NOTE Excessive trapped air in a wet pipe installation might cause unacceptable alarm activation time and in the case of gridded pipe configurations, create a hydraulic imbalance. Means could be provided to reduce the volume of trapped air in the installation.

15.7 Pressure gauges

15.7.1 General

Pressure gauge scale divisions shall not exceed:

a) 0,2 bar for a maximum scale value less than or equal to 10 bar;

b) 0,5 bar for a maximum scale value greater than 10 bar.

The maximum scale value shall be of the order of 150 % of the maximum pressure.

15.7.2 Water supply connections

Each town main connection shall be fitted with a pressure gauge between the supply pipe stop valve and the non-return valve, ('A' gauge).

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

15.7.3 Control valve set

A pressure gauge shall be fitted at each of the following locations:

a) immediately upstream of each control valve set, ('B' gauge);

b) immediately downstream of each control valve set, ('C' gauge);

c) immediately downstream of each alternate or dry subsidiary control valve set, but upstream of any stop valve.

The 'B' gauge on dry alarm valves shall have an indicator showing the maximum pressure attained.

15.7.4 Removal

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

16 Alarms and alarm devices

16.1 Water flow alarms

16.1.1 General

Each control valve set shall be provided with a water motor alarm in accordance with EN 12259-4 and an electrical device for remote alarm indication, both located as close as possible to the alarm valve. A single alarm motor and gong might be installed common to a group of wet alarm valves provided that these are situated in the same valve room and an indicator is fitted to each alarm valve to show when it is operating.

Each water motor alarm gong shall be prominently marked with the number of the installation.

16.1.2 Water motor and gong

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

16.1.3 Piping to water motor

The piping shall be 20 mm diameter galvanized steel or non-ferrous metallic material. The equivalent length of pipe between the alarm valve and the water motor shall be no more than 25 m assuming an equivalent length of 2 m for each change of direction.

The pipe shall be fitted with a stop valve located within the premises and shall be provided with a permanent drain through an orifice of no more than 3 mm in diameter. The orifice plate might be integral with the pipe fitting, and shall be made either of stainless steel or of a non-ferrous material.

16.2 Electrical water flow and pressure switches

16.2.1 General

Electrical devices to detect the operation of sprinkler systems shall be either water flow switches conforming to EN 12259-5 or pressure switches.

16.2.2 Water flow alarm switches

Water flow alarm switches shall only be used in wet installations. A test connection shall be fitted downstream of each switch to simulate the operation of a single sprinkler. It shall be fitted with a drain. The draw-off pipe shall be galvanized steel or copper.

The pressure/flow characteristic of the fully opened test valve and draw-off pipe shall be equal to that of the smallest nominal bore sprinkler supplied through the flow switch. Any orifice plate shall be at the pipe outlet and shall be either stainless steel or non-ferrous material.

The test pipe outlet shall be positioned relative to the drainage system in such a way that the flow of water can be seen during tests.

16.2.3 Dry and pre-action systems

Each installation shall be provided with a low air/gas pressure alarm, to provide a visual and audible warning in accordance with Annex I.

16.3 Fire brigade and remote central station alarm connection

The equipment for automatic transmission of alarm signals from a sprinkler installation to a fire brigade or remote manned centre shall be capable of being checked for:

a) continuity of the connection;

b) continuity of the connection between the alarm switch and the control unit.

If a direct connection to the fire brigade exists, the testing procedure should be agreed with the authorities in order to avoid false calls.

17 Pipework

17.1 General

17.1.1 Underground piping

Pipes shall be laid in accordance with the supplier's recommendations and shall have sufficient corrosion resistance.

NOTE The following types of pipe are recommended: cast iron, ductile iron, spun cement, reinforced glass fibre, polyethylene high density.

Adequate precautions shall be taken to prevent damage to piping, for example by passing vehicles.

17.1.2 Above ground piping

Piping downstream of control valves shall be steel, copper (see 17.1.9) or other material in accordance with appropriate specifications valid in the place of use of the system. When steel pipes with a nominal diameter equal to or less than 150 mm are threaded, cut-grooved or otherwise machined, they shall have a minimum wall thickness in accordance with ISO 65. When steel pipe ends are formed without significantly reducing the wall thickness, e.g. by roll-grooving or pipe end preparation for welding, they shall have a minimum wall thickness in accordance with ISO 4200 range D.

When mechanical pipe joints are used, the minimum wall thickness shall also be in accordance with the manufacturer’s recommendations.

Copper pipes shall be in accordance with EN 1057.

For dry, alternate or pre-action installations, galvanized steel should preferably be used.

17.1.3 Welding of steel pipe

Pipes and fittings less than 50 mm in diameter shall not be welded on site except if the installer uses an automatic welding machine. In no case shall welding, flame cutting, soldering or any other hot work be carried out *in situ*.

Welding of sprinkler pipework shall be carried out in such a way that:

— all joints are welded continuously;

— the inside of the weld does not interfere with the flow of water;

— the piping is deburred and the slag removed.

Welders shall be approved in accordance with EN ISO 9606-1.

17.1.4 Flexible pipes and joints

If relative movement is likely to occur between different sections of pipework within the sprinkler system, e.g. owing to expansion joints or in the case of certain types of racking, a flexible section or joint shall be fitted at the point of connection to the distribution main. It shall meet the following requirements:

a) before installation, it shall be capable of withstanding a test pressure of four times the maximum working pressure or 40 bar, whichever is the greater, and shall not include parts which, when subject to fire, might impair either the integrity or the performance of the sprinkler system;

b) flexible pipes shall contain a continuous pressure-retaining stainless steel or non-ferrous metal inner tube;

    1) flexible pipes shall not be fitted in the fully extended position;

    2) flexible pipes and joints shall not be used to take up misalignment between a distribution main and the feed pipes to intermediate sprinklers.

17.1.5 Concealment

Pipes shall be installed in such a way that they are easily accessible for repairs and alterations. They shall not be embedded in concrete floors or ceilings.

Wherever possible, piping should not be installed in concealed spaces, which make inspection, repairs and modifications difficult.

17.1.6 Protection against fire and mechanical damage

Piping shall be installed in such a way that the pipes are not exposed to mechanical damage. Where pipes are installed above gangways with low headroom, or at intermediate levels, or in other similar situations, precautions shall be taken against mechanical damage.

Where it is unavoidable for water supply pipework to pass through an unsprinklered building, it shall be installed at ground level and shall be enclosed to protect against mechanical damage, with appropriate fire resistance.

17.1.7 Painting

Non-galvanized ferrous pipework shall be painted if environmental conditions make it necessary. Galvanized piping shall be painted wherever the coating has been damaged, e.g. by threading.

NOTE Extra protection might be needed for unusually corrosive conditions.

17.1.8 Drainage

Means shall be provided to enable all the pipework to be drained. Where this cannot be done through the drain valve at the control valve set, extra valves shall be fitted in accordance with 15.4.

In the case of dry, alternate and pre-action installations, range pipes shall have a slope towards the distribution pipe of at least 0,4 % and distribution pipes shall have a slope towards the appropriate drain valve of at least 0,2 %.

NOTE In cold climates where severe freezing conditions are possible, it can be necessary to incorporate a slope on wet systems and to increase the slope for dry systems.

Range pipes shall only be connected to the side or top of distribution pipes.

17.1.9 Copper pipe

Copper pipes might be used only in wet pipe systems for LH, OH1, OH2 and OH3 downstream of any steel piping. Copper pipes shall be joined either by mechanical joints or by hard soldering, using fittings according to EN 1254.

For hard soldering, copper to copper joints and joints involving alloys of copper and zinc (brass) or copper, tin and zinc (gunmetal) shall be made according to EN ISO 3677. Hard solder connections shall only be carried out by properly trained personnel.

Copper to steel joints shall be flanged, using stainless steel bolts. Piping shall not be bent on site. Precautions shall be taken to avoid galvanic corrosion.

17.2 Pipe supports

17.2.1 General

Pipe supports shall be fixed directly to the building or, if necessary, to machines, storage racks or other structures. They shall not be used to support any other installations. They shall be of the adjustable type in order to secure an even load-bearing capability. Supports shall completely surround the pipe and shall not be welded to the pipe or fittings.

The part of the structure to which the supports are secured shall be capable of supporting the pipework (see Table 40). Pipes greater than 50 mm diameter shall not be supported from corrugated steel sheet or aerated concrete slabs.

Distribution pipes and risers shall have a suitable number of fixed points to take account of axial forces. No part of any support shall be made of combustible material. Nails shall not be used.

Supports for copper pipes shall be provided with a suitable lining with sufficient electrical resistance, in order to prevent contact corrosion.

17.2.2 Spacing and location

Supports shall be spaced no more than 4 m apart on steel pipe and 2 m apart on copper pipe except in the case of pipes of over 50 mm diameter, in which case these distances might be increased by 50 % provided that one of the following conditions is met:

— two independent supports are fitted directly to the structure;

— a support is used which is capable of bearing a load 50 % greater than that called for in Table 40.

When mechanical pipe joints are used:

— there shall be at least one support within 1 m of each joint;

— there shall be at least one support on each pipe section.

The distance from any terminal sprinkler to a support shall not exceed

— 0,9 m for 25 mm diameter piping;

— 1,2 m for piping greater than 25 mm diameter.

The distance from any upright sprinkler to a support shall not be less than 0,15 m. Vertical pipes shall have additional supports in the following cases:

— pipes more than 2 m long;

— pipes more than 1 m long feeding single sprinklers.

Pipes that are at a low level or otherwise vulnerable to mechanical impact shall be separately supported except for the following cases:

— horizontal pipes less than 0,45 m long feeding individual sprinklers;

— drop or rise pipes less than 0,6 m long feeding individual sprinklers.

17.2.3 Design

Pipe supports shall be designed in accordance with the requirements of Table 40 and Table 41.

Table 40 — Design parameters for pipe supports

Nominal pipe diameter (*d*) **mm**	**Minimum load capacity at 20 °C (see note 1)** **kg**	**Minimum cross section (see note 2)** **mm^2**	**Minimum length of anchor bolt (see note 3)** **mm**
$d \leq 50$	200	30 (M8)	30
$50 < d \leq 100$	350	50 (M10)	40
$100 < d \leq 150$	500	70 (M12)	40
$150 < d \leq 200$	850	125 (M16)	50
NOTE 1 When the material is heated to 200 °C the load bearing capacity should not deteriorate more than 25 %.			
NOTE 2 The nominal cross section of threaded rods should be increased so that the minimum cross section is still achieved.			
NOTE 3 The length of anchor bolts depends on the type used and the quality and type of material into which they are to be fixed. The values given are for concrete.			

Table 41 — Minimum dimension of flat iron rods and clips

Nominal pipe diameter (*d*) **mm**	**Flat iron rods**		**Pipe clips**	
	galvanized mm	**ungalvanized** mm	**galvanized** mm	**ungalvanized** mm
$d \leq 50$	2,5	3,0	25 × 1,5	25 × 3,0
$50 < d \leq 200$	2,5	3,0	25 × 2,5	25 × 3,0

17.3 Pipework in concealed spaces

17.3.1 General

Where sprinkler protection is required in concealed spaces such as false ceilings and floors, the pipework shall be designed as follows.

17.3.2 False ceilings above OH occupancies

Sprinklers above the ceiling might be fed from the same range pipes as the sprinklers below the ceiling. In pre-calculated systems, the sprinklers shall be taken cumulatively for the purposes of determining pipe diameters.

17.3.3 All other cases

The sprinklers in the concealed space shall be fed from separate range pipes. In the case of pre-calculated systems, the diameter of distribution pipes feeding sprinklers both inside and outside the concealed space shall be not less than 65 mm.

18 Signs, notices, and information

18.1 Block plan

A block plan of the premises shall be placed close to a main entrance or elsewhere, where it can readily be seen by the fire brigade or others responding to an alarm. The plan shall show:

a) the installation number and the location of the corresponding control valve set and water motor alarm;

b) each separate area of hazard classification, the relevant hazard class and, where appropriate, the maximum storage height;

c) by means of colour shading or hatching the area covered by each installation and, if required by the fire brigade, indication of routes through the premises to those areas;

d) the location of any subsidiary stop valves.

18.2 Signs and notices

18.2.1 Location plate

A location plate of weather-resistant material and lettering shall be fixed on the outside of the external wall as close as practical to the entrance nearest the control valve set(s). The plate shall bear the wording

'SPRINKLER STOP VALVE'

in letters no less than 35 mm high, and

'INSIDE'

in letters no less than 25 mm high. The wording shall be in white letters on a red background.

18.2.2 Signs for stop valves

A sign shall be fitted close to the main and any subsidiary stop valves bearing the words

'SPRINKLER CONTROL VALVE'

The sign shall be rectangular with white letters no less than 20 mm high on a red background.

Where the stop valve is enclosed in a room with a door the sign shall be fixed on the outside of the door, and a second sign, bearing the words 'Keep door locked ', shall be fixed on the inside of the door. The second sign shall be circular with white letters no less than 5 mm high, on a blue background.

18.2.3 Control valve set

18.2.3.1 General

Where the sprinkler system comprises more than one installation each control valve set shall be prominently marked with the number identifying the installation it controls.

18.2.3.2 Control valve sign

A durable notice shall be fixed to the rise pipe next to each control valve set. The notice shall include the following information:

— the installation number;

— the hazard classification or classifications of the installation;

— for each hazard class area within an installation:

1) the design requirements (area of operation and density of discharge);

2) the pressure-flow requirement at flow test facilities for the most unfavourable and most favourable areas of operation or at the pump delivery pressure gauge for the most unfavourable and most favourable areas of operation whichever is applicable;

18.2.4 Water supply connections to other services

A label shall be fixed to stop valves controlling water supplies from sprinkler system supply pipes or trunk mains to other services; it shall be appropriately marked; e.g. 'Firefighting hose reels', 'Domestic water supply' in raised or embossed lettering.

18.2.5 Suction and booster pumps

18.2.5.1 General

A nameplate shall be fixed to each suction or booster pump, carrying the following information:

a) the output pressure in bar, and the corresponding rated speed and flow in litres per minute, at the inlet condition and flow rating specified in Table 16;

b) the maximum power absorbed at the relevant speed at any value of flow.

18.2.5.2 Fully calculated installations

An installer's data sheet shall be displayed beside the pump, giving the following information:

a) the pump supplier's data sheets;

b) a schedule listing the technical data specified in 4.4.4.4;

c) a copy of the installer's pump characteristics sheet, similar in presentation to Figure 7b;

d) the pressure loss, at flow $Q_{max.}$, between the pump outlet and the most hydraulically remote control valve set.

18.2.6 Electric switches and control panels

18.2.6.1 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).

18.2.6.2 Diesel pumpset

The alarms specified in 10.8.6.1 and 10.9.11 at both the pump controller and the responsibly manned location shall be marked as appropriate:

a) diesel fire pump starter switched off;

b) diesel fire pump failure to start;

c) pump running;

d) diesel controller fault.

The manually operated shut-down mechanism (see 10.9.7.1) shall be labelled as follows:

'SPRINKLER PUMP SHUT-OFF'

18.2.6.3 Electric motor driven fire pump

Each switch on the dedicated power feed to an electric sprinkler fire pump motor shall be labelled as follows:

'SPRINKLER PUMP MOTOR SUPPLY -

NOT TO BE SWITCHED OFF IN THE EVENT OF FIRE'

18.2.7 Testing and operating devices

All valves and instruments used for testing and operation of the system shall be appropriately labelled. Corresponding identification shall appear in the documentation.

19 Commissioning

19.1 Commissioning tests

19.1.1 Pipework

19.1.1.1 Dry pipework

Dry pipework shall be tested pneumatically to a pressure of no less than 2,5 bar for no less than 24 h. Any leakage that results in a loss of pressure greater than 0,15 bar for the 24 h shall be corrected.

If climatic conditions do not allow the hydrostatic test specified in 19.1.1.2 to be carried out immediately after the pneumatic test, it should be carried out as soon as conditions permit.

19.1.1.2 All pipework

All installation pipework shall be hydrostatically tested for no less than 2 h, to a pressure of no less than 15 bar, or 1,5 times the maximum pressure to which the system will be subjected, (both measured at the installation control valves), whichever is the greater.

Any faults disclosed, such as permanent distortion, rupture or leakage, shall be corrected and the test repeated.

Care shall be taken not to subject any system components to pressure higher than those recommended by the supplier.

19.1.2 Equipment

The system shall be tested once as specified in 20.2.2 and 20.3.2 (i.e. making the tests, which will be made on a routine weekly and quarterly basis) and any faults shall be corrected.

19.1.3 Water supplies

Water supplies shall be tested once as specified in 8.6, and diesel engine driven pumps shall be tested as specified in 20.2.2.5.

19.2 Completion certificate and documents

The installer of the system shall provide the user with the following:

— a completion certificate stating that the system conforms to all appropriate requirements of this standard, or giving details of any deviation from the requirements;

— a complete set of operating instructions and 'as-built' design documents including identification of all valves and instruments used for testing and operation and a user's programme for inspection, and checking (see 20.2) and a service and maintenance schedule (see 20.3).

Unless other requirements exist in the jurisdiction of the installation, all installations, whether new or modified, should be inspected by a third party after completion and the authorities should receive a resulting certificate of completion and relevant design documents.

20 Maintenance

20.1 General

20.1.1 Introduction

The user shall appoint an individual and a substitute, who after they have been given the necessary instructions, shall ensure that the system remains in working condition. The name, address and telephone number of the person responsible for the system, as well as those of his or her substitute, shall be prominently displayed in the sprinkler valve room.

20.1.2 Programmed work

The user shall carry out a programme of inspection and checks (see 20.2), arrange a test, service and maintenance schedule (see 20.3) and keep records including a logbook which shall be held on the premises.

The user shall arrange for the test, service and maintenance schedule to be carried out under contract by the system installer or a similarly qualified company.

After an inspection, check, test, service or maintenance procedure the system, and any automatic pumps, pressure tanks and gravity tanks shall be returned to the proper operational condition.

If appropriate, the user should notify interested parties of the intent to carry out tests and/or of the results.

20.1.3 Precautions while carrying out work

See Annex J for precautions to be taken while the system is not operational or after a sprinkler operation.

20.1.4 Replacement sprinklers

A stock of spare sprinklers shall be kept on the premises as replacements for operated or damaged sprinklers. Spare sprinklers, together with sprinkler spanners as supplied by the supplier, shall be housed in a cabinet or cabinets located in a prominent and easily accessible position where the ambient temperature does not exceed 27 °C.

The number of spare sprinklers per system shall be no less than:

a) 6 for LH installations;

b) 24 for OH installations;

c) 36 for HHP and HHS installations.

The stock shall be replenished promptly after spares are used.

Where installations contain high-temperature sprinklers, sidewall or other variations of sprinkler pattern or contain multiple controls, an adequate number of these spares shall also be maintained.

20.2 User's programme of inspection and checking

20.2.1 General

The installer shall provide the user with a documented inspection and checking procedure for the system. The programme shall include instruction on the action to be taken in respect of faults, operation of the system, with particular mention of the procedure for emergency manual starting of pumps, and details of the weekly routine of 20.2.2.

20.2.2 Weekly routine

20.2.2.1 General

Each part of the weekly routine shall be carried out at intervals of no more than 7 days.

20.2.2.2 Checks

The following shall be checked and recorded:

a) all water and air pressure gauge readings on installations, trunk mains and pressure tanks;

The pressure in the pipework in dry, alternate and pre-action installations should not fall at a rate of more than 1,0 bar per week.

b) all water levels in elevated private reservoirs, rivers, canals, lakes, water storage tanks (including pump priming water tanks and pressure tanks);

a) the correct position of all main stop valves.

20.2.2.3 Water motor alarm test

Each water motor alarm shall be sounded for no less than 30 s.

20.2.2.4 Automatic pump starting test

Tests on automatic pumps shall include the following;

a) fuel and engine lubricating oil levels in diesel engines shall be checked;

b) water pressure on the starting device shall be reduced, thus simulating the condition of automatic starting;

c) when the pump starts, the starting pressure shall be checked and recorded;

d) the oil pressure on diesel pumps shall be checked, as well as the flow of cooling water through open circuit cooling systems.

20.2.2.5 Diesel engine restarting test

Immediately after the pump start test of 20.2.2.4, diesel engines shall be tested as follows:

a) the engine shall be run for 20 min, or for the time recommended by the supplier. The engine shall then be stopped and immediately restarted using the manual start test button;

b) the water level in the primary circuit of closed circuit cooling systems shall be checked.

Oil pressure (where gauges are fitted), engine temperatures and coolant flow shall be monitored throughout the test. Oil hoses shall be checked and a general inspection made for leakage of fuel, coolant or exhaust fumes.

20.2.2.6 Trace heating and localized heating systems

Heating systems to prevent freezing in the sprinkler system shall be checked for correct function.

20.2.3 Monthly routine

The electrolyte level and density of all lead acid cells (including diesel engine starter batteries and those for control panel power supplies) shall be checked. If the density is low the battery charger shall be checked and, if this is working normally, the battery or batteries affected shall be replaced.

20.3 Service, testing and maintenance schedule

20.3.1 General

20.3.1.1 Procedures

In addition to the schedule given in this clause any procedures recommended by component suppliers shall be carried out.

20.3.1.2 Records

A signed, dated report of the inspection shall be provided to the user and shall include advice of any rectification carried out or needed, and details of any external factors, e.g. weather conditions, which could have affected the results.

20.3.2 Quarterly routine

20.3.2.1 General

The following checks and inspections shall be made at intervals of no more than 13 weeks.

20.3.2.2 Review of hazard

The effect of any changes of structure, occupancy, storage configuration, heating, lighting or equipment etc. of a building on hazard classification or installation design shall be identified in order that the appropriate modifications might be carried out.

20.3.2.3 Sprinklers, multiple controls and sprayers

Sprinklers, multiple controls and sprayers affected by deposits (other than paint) shall be carefully cleaned. Painted or distorted sprinkler heads, multiple controls or sprayers shall be replaced.

Any petroleum jelly coatings shall be checked. Where necessary the existing coatings shall be removed and the sprinklers, multiple controls or sprayers shall be coated twice with petroleum jelly (in the case of glass bulb sprinklers to the sprinkler body and yoke only).

Particular attention shall be paid to sprinklers in spray booths, where more frequent cleaning and/or protective measures might be necessary.

20.3.2.4 Pipework and pipe supports

Pipework and hangers shall be checked for corrosion and painted as necessary.

Bitumen-based paint on pipework, including the threaded ends of galvanized pipework and hangers, shall be renewed as necessary.

NOTE Bitumen-based paint might need renewal at intervals varying from 1 year to 5 years according to the severity of the conditions.

Tape wrapping on pipes shall be repaired as necessary.

The pipework shall be checked for electrical earthing connections. Sprinkler pipework shall not be used for earthing electrical equipment and any earthing connections from electrical equipment shall be removed and alternative arrangements made.

20.3.2.5 Water supplies and their alarms

Each water supply shall be tested with each control valve set in the system. The pump(s), if fitted, in the supply shall start automatically and the supply pressure at the appropriate flow rate shall be no less than the appropriate value in accordance with Clause 10, recognizing any changes required by 20.3.2.2.

20.3.2.6 Electrical supplies

Any secondary electrical supplies from diesel generators shall be checked for satisfactory operation.

20.3.2.7 Stop valves

All stop valves controlling the flow of water to sprinklers shall be operated to ensure that they are in working order, and securely refastened in the correct mode. This shall include the stop valves on all water supplies, at the alarm valve(s) and all zone or other subsidiary stop valves.

20.3.2.8 Flow Alarms

Flow alarms (flow switches or/and pressure switches) shall be checked for correct function.

20.3.2.9 Replacement

The number and condition of replacement parts held as spare shall be checked.

20.3.3 Half-yearly routine

20.3.3.1 General

The following checks and inspections shall be made at intervals of no more than 6 months.

20.3.3.2 Dry alarm valves

The moving parts of dry alarm valves, and any accelerators and exhausters, in dry pipe installations and subsidiary extensions shall be exercised in accordance with the supplier's instructions.

NOTE Alternate installations need not be tested in this way since they are exercised twice a year as a result of the changeover from wet to dry operation and back.

20.3.3.3 Fire brigade and remote central station alarm

The electrical installation shall be checked.

20.3.4 Yearly routine

20.3.4.1 General

The following checks and inspection shall be made at intervals of no more than 12 months.

20.3.4.2 Flow test

20.3.4.2.1 Automatic pump flow test

Each water supply pump in the installation shall be tested at the full load condition (by means of the test line connection coupled to the pump delivery branch downstream of the pump outlet non-return valve) and shall give the pressure/flow values stated on the nameplate.

Appropriate allowances shall be made for pressure losses in the supply pipe and valves between the source and each control valve set.

20.3.4.2.2 Flow test where no pump is installed

Each water supply in the installation shall be tested at the full load condition by means of the test line connection coupled to the water supply upstream of the control valve set and shall meet the required flow/pressure values.

Appropriate allowances shall be made for pressure losses in the supply pipe and valves between the water supply and each control valve set.

20.3.4.3 Diesel engine failed-to-start test

The failed-to-start alarm shall be tested to be in accordance with 10.9.7.2.

Immediately after this test the engine shall be started using the manual starting system.

20.3.4.4 Float valves on water storage tanks

Float valves on water storage tanks shall be checked to ensure they function correctly.

20.3.4.5 Pump suction chambers and strainers

Pump suction strainers and settling chamber and their screens shall be inspected at least annually and cleaned as necessary.

20.3.5 3 Yearly routine

20.3.5.1 General

The following checks and inspections shall be made at intervals of no more than 3 years.

20.3.5.2 Storage and pressure tanks

With the exception of tanks designed not to need maintenance within 10 years (See 9.6.2 b), all tanks shall be internally inspected and if necessary drained and cleaned. They shall be examined for corrosion based on the manufacturer's recommendations and all tanks shall be repainted and/or have the corrosion protection refurbished, as necessary.

20.3.5.3 Water supply stop valves, alarm and non-return valves

All water supply stop valves, alarm and non-return valves shall be dismantled, examined and replaced or overhauled as necessary.

20.3.6 10 yearly routine

At no more than 10 year intervals, all storage tanks shall be cleaned and examined internally and the fabric attended to as necessary.

NOTE Cleaning of tanks usually requires them to be drained, but alternative solutions might be acceptable to save water.

21 Third party inspection

The sprinkler system shall be periodically inspected at least once a year by a third party. The inspection report shall assess whether the system is in accordance with this standard, with regard to maintenance, operation and adequacy for the risk involved. A list of deviations shall be issued for action.

Annex A
(normative)

Classification of typical hazards

Tables A1, A.2 and A.3 contain lists of minimum hazard classification. They shall also be used as guidance for occupancies not specifically mentioned. They shall be read in conjunction with 6.2.

Table A.1 — Light Hazard occupancies

Schools and other educational institutions (certain areas) *see* 6.2.2
Offices (certain areas) *see 6.2.2*
Prisons

Table A.2 — Ordinary Hazard occupancies

Occupancy	**Ordinary hazard group**			
	OH1	**OH2**	**OH3**	**OH4**
Glass and ceramics			Glass factories	
Chemicals	Cement works	Photographic film factories	Dyers works soap factories Photographic laboratories Paint application shops with water based paint	
Engineering	Sheet metal product factories	Metal working	Electronics factories Radio equipment factories Washing machine factories Car workshops	
Food and beverages		Abattoirs, meat factories Bakeries Biscuit factories Breweries Chocolate factories Confectionery *Dairies* Factories	Animal fodder factories Corn mills Dehydrated vegetable and soup factories Sugar factories	Alcohol distilleries
Miscellaneous	Hospitals Hotels Libraries (excluding book stores) Restaurants Schools (see	Laboratories (physical) Laundries Car parks Museums	Broadcasting studios (small) Railway stations Plant (technical) room Farm building	Cinemas and theatres Concert halls tobacco factories Film and TV Production Studio

Occupancy	Ordinary hazard group			
	OH1	**OH2**	**OH3**	**OH4**
	6.2.2) Offices (see 6.2.2)			
Paper			Book binding factories cardboard factories paper factories	Waste paper processing
Shops and offices	Data processing (computer room, excluding tape storage) Offices see 6.2.2		Department stores shopping centre	Exhibition halls[a]
Textiles and clothing		Leather goods factories	Carpet factories (excluding rubber and foam plastics) Cloth and clothing factories fibre board factories Footwear factories (excluding plastics and rubber) Knitting factories linen factories Mattress factories (excluding foam plastics) Sewing factories weaving mills Woolen and worsted mills	Cotton mills Flax preparation plants Hemp preparation plants
Timber and wood			Woodworking factories Furniture factories (without foam plastics) Furniture showrooms Upholstery (without foam plastics) factories	Saw mills Plywood factories
NOTE Where there is painting or other similar high fire load areas in a OH1 or OH2 occupancy, they should be treated as OH3.				
[a] Excessive clearance shall be taken into consideration.				

Table A.3 — High Hazard Process occupancies

HHP1	HHP2	HHP3	HHP4
Floor cloth and linoleum manufacture	Fire lighter manufacture	Cellulose nitrate manufacture	Firework manufacture
Resin, lamp black and turpentine manufacture	Tar distilling	Rubber tyres for cars and lorries	
Rubber substitute manufacture	Depots for buses, un-laden lorries and railway carriages	Manufacture of material factor m3 (see table b.1) foam plastics, foam rubber and foam rubber goods manufacture (excluding m4 see table b.1)	
Wood wool manufacture	Candle wax and paraffin manufacturers		
Match manufacturers	Paper machine halls		
Paint application shops with solvent	Carpet factories including rubber and foam plastics		
Refrigerator factories	Saw mill		
Printing works	Chipboard manufacturing (1)		
Cable factories for PP/PE/PS or similar burning characteristics other than OH3	Paint, colour and varnish manufacture		
Injection moulding (plastics) for PP/PE/PS or similar burning characteristics other than OH3			
Plastics factories and plastic goods (excluding foam plastics) for PP/PE/PS or similar burning characteristics other than OH3			
Rubber goods factories synthetic fibre factories (excluding acrylic)			
Rope factories			
Carpet factories including unexpanded plastics			
footwear factories including plastics and rubber			
NOTE Additional object protection might be necessary.			

Annex B
(normative)

Methodology for categorizing stored goods

B.1 General

NOTE The overall fire hazard of stored goods (defined as a product and its packaging) is a function of its heat release rate (kW) which in turn is a function of its heat of combustion (kJ/kg) and its burning rate (kg/sec).

The heat of combustion is determined by the material or mix of materials in the goods. The burning rate is determined by both the materials involved and the configuration of the material.

The material shall be analysed to determine a material factor. Where necessary the material factor shall be modified according to the configuration of the goods to determine the category. If no modification is required, the material factor shall be the sole determinant of the category.

B.2 Material factor (M)

B.2.1 General

Figure B.1 shall be used to determine the material factor when goods consist of mixtures of materials. When using Figure B.1, the stored goods shall be considered to include all packaging and pallet material. For the purpose of this evaluation, rubber shall be treated in the same way as plastic.

The following four material factors shall be used in determining the category.

B.2.2 Material Factor 1

Non-combustible products in combustible packaging and low or medium combustibility products in combustible/non-combustible packaging. Products having little plastic content as defined below:

— unexpanded plastics content less than 5 % by mass (including the pallet);

— expanded plastics content less than 5 % by volume.

EXAMPLE

— metal parts with/without cardboard packaging on wood pallets;

— powdered foods in sacks;

— canned foods;

— non-synthetic cloth;

— leather goods;

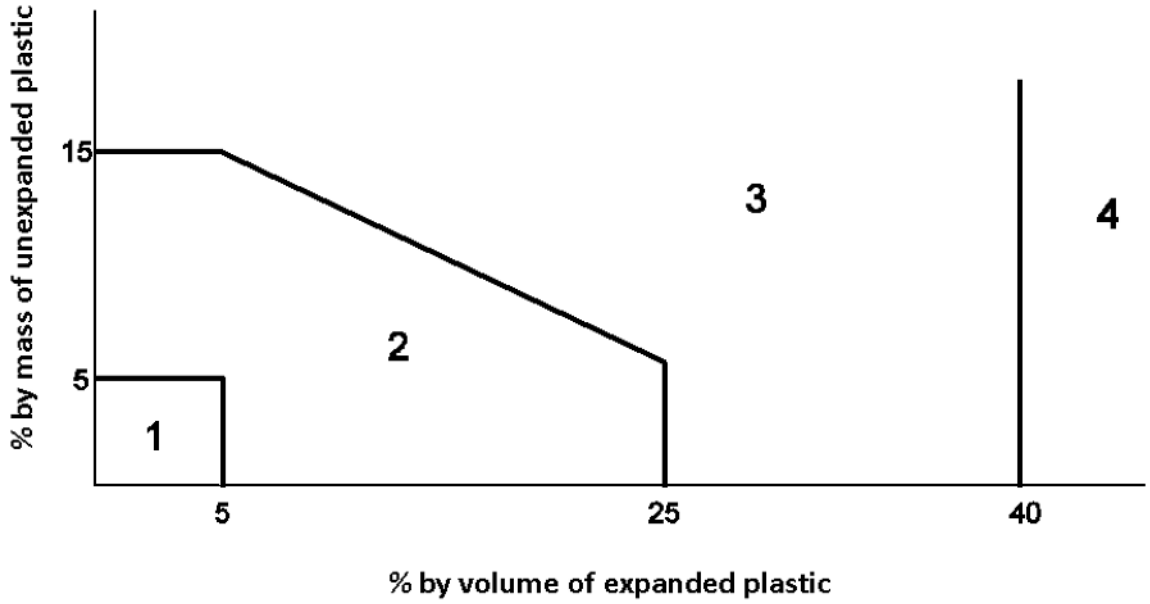
— wood products;

— ceramics in cardboard/wood cases;

— metal tools in cardboard/wood packaging;

— cartonned plastic or glass bottles of non-flammable liquids;

— large electrical appliances (with little packaging).



Key

1 material factor 1

2 material factor 2

3 material factor 3

4 material factor 4

x % by volume of expanded plastic

y % by mass of unexpanded plastic

Figure B.1 — Material factor

B.2.3 Material factor 2

Goods having a higher energy content than Material factor 1 goods, for instance those containing plastics in greater quantities as defined in Figure B.1.

EXAMPLE

— wood or metal furniture with plastic seats;

— electrical equipment with plastic parts or packaging;

— electric cables on reels or in cartons;

— synthetic fabrics.

B.2.4 Material factor 3

Materials which are predominantly unexpanded plastic (see Figure B.1) or materials of a similar energy content.

EXAMPLE

— car batteries with no electrolyte;

— plastic brief cases;

— personal computers;

— unexpanded plastic cups and cutlery.

B.2.5 Material factor 4

Materials which are predominantly expanded plastic (more than 40 % by volume) or materials of a similar energy content (see Figure B.1).

EXAMPLE

— foam mattresses;

— expanded polystyrene packaging;

— foam upholstery.

B.3 Storage configuration

B.3.1 Effect of storage configuration

After determining the material factor, the storage configuration shown in Column 1 of Table B.1 shall be referred to determine the most appropriate Categorization. If an appropriate category is also given in Table C.1 the higher of the two values shall be used.

Table B.1 — Categories as a function of storage configuration

Storage configuration	Material Factor			
	1	2	3	4
Exposed plastic container with non-combustible contents	Cat. I,II,III	Cat. I,II,III	Cat. I,II,III	Cat. IV
Exposed plastic surface – unexpanded	Cat. III	Cat. III	Cat. III	Cat. IV
Exposed plastic surface – expanded	Cat. IV	Cat. IV	Cat. IV	Cat. IV
Open structure	Cat. II	Cat. II	Cat. III	Cat. IV
Solid block materials	Cat. I	Cat. I	Cat. II	Cat. IV
Granular or powdered material	Cat. I	Cat. II	Cat. II	Cat. IV
No special configuration	Cat. I	Cat. II	Cat. III	Cat. IV
NOTE See B.3.2 to B.3.8 for explanations of the storage configurations.				

The storage configurations in the table are as follows:

B.3.2 Exposed plastic container with non-combustible content

This applies only to plastic containers containing non-combustible liquids or solids in direct contact with the container.

NOTE This configuration does not apply to metal parts in plastic storage boxes.

Category I : Containers with non-combustible liquids;

Category II : Small (≤50 l) containers with non-combustible solids;

Category III : Large (>50 l) containers with non-combustible solids.

EXAMPLE

— plastic bottles of soft drinks or liquids with less than 20 % alcohol,

— plastic tubs or drums of inert powder such as talcum.

NOTE The non-combustible contents act as a heat sink and reduce the rate of burning of the containers. Liquids are more effective than solids since they conduct heat more efficiently.

B.3.3 Exposed plastic surface – unexpanded

The category shall be increased to III or IV when the commodity has exposed plastic surfaces comprising one or more sides or more than 25 % of the surface area.

EXAMPLE

— metal parts in PVC storage bins;

— shrink wrapped tinned foods.

For polypropylene and polyethylene storage bins, see G.8.

B.3.4 Exposed plastic surface – expanded

Exposed expanded plastics are more severe than unexposed plastics. They shall be treated as Category IV.

B.3.5 Open structure

Materials having very open structures generally present a higher hazard than materials with a closed structure. The high surface area together with high air access encourages rapid burning.

The increase in hazard can be very substantial particularly with ordinary combustibles.

EXAMPLE

— cardboard has a Material Factor of 1;

— in card flats it is Category I;

— in empty boxes assembled it is Category II (due to ready air access);

— in rolls stored vertically it is either Category III or greater (Special Risk) depending on the storage method (closely stacked, banded or unbanded etc.).

B.3.6 Solid block materials

Materials in solid block form have a low surface area to volume/mass ratio. This reduces the burning rate and permits a reduction in category.

EXAMPLE

— blocks of solid rubber, vinyl floor tiles in block storage.

NOTE This configuration does not apply to blocks of expanded plastics (Category IV).

B.3.7 Granular or powdered materials

NOTE 1 Granular materials excluding expanded plastics that will spill out during a fire tend to smother the fire and are thus less hazardous than their basic material counterparts.

EXAMPLE

— plastic granules used for injection moulding stored in cardboard boxes.

NOTE 2 This configuration does not apply to rack storage.

B.3.8 No special configuration

No special configuration are goods that have none of the above characteristics, e.g. cartonned goods.

Annex C
(normative)

Alphabetical listing of stored products and categories

Table C.1 shall be used to determine the category of stored products where any packaging, with or without pallets, is no more hazardous than a cardboard box or a single layer of corrugated cardboard wrapping.

Table C.1 — Stored products and categories

Product	Category	Comments
Adhesives	III	With flammable solvents special protection required
Adhesives	I	Without solvent
Asphalt paper	II	In horizontal rolls
Asphalt paper	III	In vertical rolls
Batteries, dry cell	II	—
Batteries, wet cell	II	Empty plastic accumulators require special protection
Beer	I	—
Beer	II	Containers in wooden crates
Books	II	—
Candles	III	—
Canvas, tar-impregnated	III	—
Carbon black	III	—
Cardboard (all types)	II	Stored flat
Cardboard (except corrugated)	II	Rolls stored horizontally
Cardboard (except corrugated)	III	Rolls stored vertically
Cardboard (corrugated)	III	Rolls stored horizontally
Cardboard (corrugated)	IV	Rolls stored vertically
Cardboard cartons	III	Empty, heavyweight, made up boxes
Cardboard cartons	II	Empty, lightweight, made up boxes
Carpet tiles	III	—
Carpets, without plastic	II	Storing in racks requires in-rack sprinklers
Cartons, waxed, flats	II	—
Cartons, waxed, made-up	III	—
Cellulose	II	Baled, without nitrite and acetate
Cellulose pulp	II	—
Ceramics	I	—
Cereals	II	Boxed
Charcoal	II	Excluding impregnated charcoal

Product	Category	Comments
Cloth, synthetic	III	Stored flat
Cloth, wool or cotton	II	—
Clothes	II	—
Coconut matting	II	—
Confectionery	II	—
Cork	II	—
Cotton, baled	II	Special measures, such as an increased area of operation, might be necessary
Crockery	I	—
Electrical appliances	I	Predominantly metal construction with ≤ 5 % by mass of plastic
Electrical appliances	III	Others
Electrical cable or wire	III	Storage in racks requires in-rack sprinklers
Esparto	III	Loose or baled
Fertilizer, solid	II	might require special measures
Fibreboard	II	—
Firelighters (barbecue)	III	—
Flax	II	Special measures, such as an increased area of operation, might be necessary
Flour	II	In sacks or paper bags
Foods, tinned	I	In cardboard boxes and trays
Foodstuffs	II	In sacks
Furniture, upholstered	II	With natural fibres and materials but excluding plastics
Furniture, wooden	II	—
Furs	II	Flat in boxes
Glass fibre	I	Un-fabricated
Glassware	I	Empty
Grain	I	In sacks
Hemp	II	Special measures, such as an increased area of operation, might be necessary
Hides	II	—
Jute	II	—
Knitwear	II	See clothes
Laminated board	II	—
Leather goods	II	—
Linen	II	—
Linoleum	III	—
Matches	III	—

Product	**Category**	**Comments**
Mattresses	IV	With expanded plastic
Mattresses	II	Other than expanded plastics
Meat	II	Chilled or frozen
Metal goods	I	—
Milk powder	II	In bags or sacks
Office material	III	—
Paints	I	Water based
Paper	II	Sheets stored horizontally
Paper	III	Mass < 5 kg/100 m^2, (e.g. tissue paper), rolls stored horizontally
Paper	IV	Mass < 5 kg/100 m^2, (e.g. tissue paper), rolls stored vertically
Paper	III	Mass ≥ 5 kg/100 m^2, (e.g. newspaper), rolls stored vertically
Paper	II	Mass ≥ 5 kg/100 m^2, (e.g. newspaper), rolls stored horizontally
Paper, bitumen coated	III	—
Paper, pulp	II	Rolled or baled
Paper, waste	III	Special measures might be necessary, such as an increased area of operation
Pillows	II	Feather or down
Rags	II	Loose or baled
Resins	III	Excluding flammable liquids
Roof felt in rolls	II	Horizontal storage
Roof felt in rolls	III	Vertical storage
Rope synthetic	II	—
Shoes	II	≤ 5 % by mass of plastic
Shoes	III	With plastic > 5 % by mass
Soap, water soluble	II	—
Alcohol	I	≤ 20 % degree proof of alcohol
Alcohol	III	> 20 % degree proof of alcohol in bottle only . Other cases see Annex G
String/rope natural fibres	II	—
Sugar	II	In bags or sacks
Textiles	—	See cloth
Timber, sawn	III	In ventilated stacks
Timber, sawn	II	Not in ventilated stacks
Timber, un-sawn	II	—

Product	Category	Comments
Tobacco	II	Leaf and finished goods
Tyres stored horizontally	IV	Tyres stored horizontally are covered in Annex P
Vegetable fibres	II	Special measures such as an increased area of operation might be necessary
Wax (paraffin)	IV	—
Wicker work	III	—
Wood	—	See timber
Wood, chipboard, plywood	II	Stored flat, excluding ventilated stacks
Wood pulp	II	Baled
Wood veneer sheets	III	—
Wood wool	IV	Baled

Annex D
(normative)

Zoning of sprinkler installations

D.1 General

This annex specifies requirements particular to the sprinkler protection of buildings when zoning is adopted. It applies only to OH sprinkler installations of the wet pipe type.

NOTE Zoning is optional except where required elsewhere in this standard (see Annex E and Annex F).

D.2 Zoning of installations

Wet pipe Ordinary Hazard sprinkler installations might be zoned or unzoned.

The protected floor area to be controlled by any one wet control valve set in Ordinary Hazard might exceed that shown in Table 17, with the following restrictions:

a) the protected floor area to be controlled by any one wet control valve set on any one floor shall not exceed 12 000 m^2;

b) the installation shall be zoned in accordance with D.3;

c) zoned installations shall not include any hazard greater than OH3;

d) car parks and areas involving the unloading and storage of goods shall be on a separate unzoned installation;

e) the building shall be sprinkler protected throughout on all floors;

f) the protected floor area to be controlled by any one control valve set shall not exceed 120 000 m^2.

D.3 Requirements for zoned installations

D.3.1 Extent of zones

The protected floor area per zone shall be no greater than 6 000 m^2.

D.3.2 Zone subsidiary stop valves

Each zone shall be independently controlled by a single zone subsidiary stop valve, installed in a readily accessible position at the floor level of the zone it controls. Each valve shall be secured open and be labelled to identify the area of protection it controls.

D.3.3 Flushing Valves

Each zone shall be fitted with a valve no less than 20 mm nominal diameter, either on the end of the distribution pipe hydraulically most remote from the water supply, or on the end of each distribution pipe spur, as appropriate. The valve outlet shall be fitted with a brass plug cap.

D.3.4 Monitoring

Zoned sprinkler installations shall be provided with tamper-proof devices to monitor the status of:

a) each stop valve (i.e. either fully open or not fully open), including subsidiary stop valves, capable of interrupting the flow of water to sprinklers;

b) water flow into each zone immediately downstream of each zone subsidiary stop valve, to indicate the operation of each zone, by means of a water flow alarm switch capable of detecting a flow equal to or greater than that from any single sprinkler;

c) water flow through each main installation control valve set.

D.3.5 Zone test and drainage facilities

Permanent test and drainage facilities shall be provided immediately downstream of the water flow alarm switch on each zone. The test facility shall simulate operation of any single sprinkler head. Adequate provision shall be made for the disposal of waste water.

D.3.6 Installation control valve set

The control valve set of a zoned sprinkler installation shall have two stop valves, one on each side of a single alarm valve with a bypass connection of the same nominal bore around all three valves, fitted with a normally closed stop valve (see Figure D.1). Each of the three stop valves shall be fitted with tamper proof devices to monitor their status.

D.3.7 Installation monitoring and alarms

The monitoring devices required by D.3.4 and D.3.6 shall be electrically connected to a control and indicating panel, installed at an accessible location on the premises, where the following indications and warnings shall be given:

a) green visual indicators to indicate that each monitored stop valve is in its correct operational position;

b) audible devices and amber visual indicators to indicate that one or more control valve sets are not fully open;

c) audible devices and amber visual indicators to indicate that one or more zone subsidiary stop valves are not fully open;

d) audible devices and amber visual indicators to indicate that the static pressure in any trunk main supplying the system has fallen to a value 0,5 bar or more below the normal static pressure;

e) audible devices and red visual indicators to indicate that water is flowing into the installation;

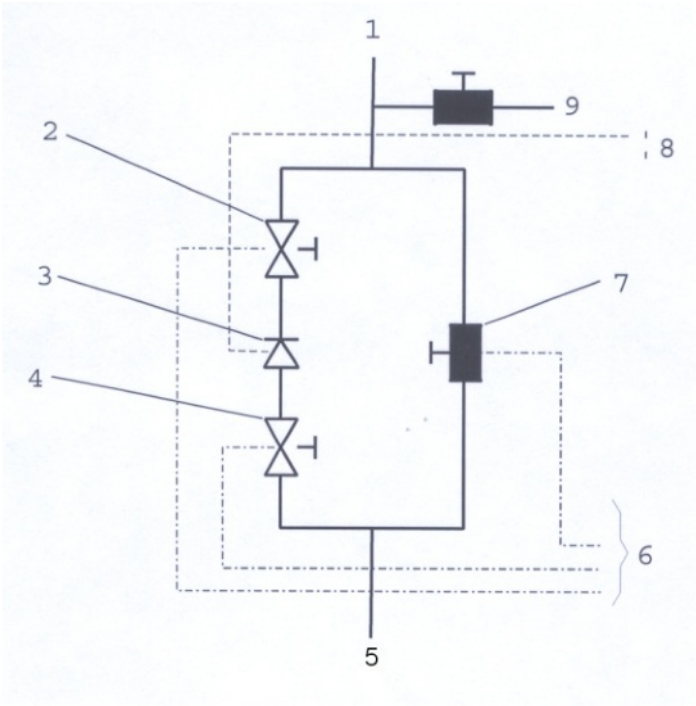
f) audible devices and red visual indicators to indicate that water is flowing into one or more zones. Facilities shall be provided at the indicator panel for silencing the audible alarms but the visual indicators shall continue to operate until the installation is restored to the normal standby condition.

Fire and fault signals shall be indicated at a permanently manned location (see Annex I).

Any change in the panel alarm or fault indication after the audible alarm has been silenced shall cause it to resume sounding until it is again silenced or the panel reset to the normal standby condition.

D.4 Block plan

Where installations are arranged in zones, the site block plan shall additionally indicate the positions of the zone control valves.



Key

1	to installation	6	installation monitoring facility
2	downstream stop valves	7	bypass stop valve
3	alarm valves	8	alarm devices
4	upstream stop valves	9	test connection
5	from water supply		

Figure D.1 — Control valve bypass arrangement for zoned building installations

Annex E
(normative)

Special requirements for high rise systems

E.1 General

The requirements of this annex shall be applied to the sprinkler protection of multi-storey buildings with a height difference between the highest and lowest sprinkler exceeding 45 m.

The requirements are applicable to buildings intended for use with occupancies where the hazard is classified as no greater than OH3. Special fire engineering solutions are needed for high rise systems with hazards greater than OH3, and specialist advice should be sought.

E.2 Design criteria

E.2.1 Hazard group

High rise sprinkler systems shall conform to the requirements for Ordinary Hazard Group III protection.

E.2.2 Subdivision of high rise sprinkler systems

High rise sprinkler systems shall be sub-divided into sprinkler installations so that the height difference between the highest and lowest sprinkler on any one installation does not exceed 45 m (see Figures E.1 and E.2).

E.2.3 Standing water pressures at non-return and alarm valves

The minimum standing pressure at any non-return or alarm valve inlet shall be no less than 1,25 times the static head difference between the valve and the highest sprinkler on the installation.

Non-return valves controlling installation flow shall operate correctly with a ratio of service pressure to installation pressure not exceeding 1,16:1, as measured by valve lift and pressure equalization upstream of the non-return valve.

E.2.4 Calculation of distribution pipework for pre-calculated systems

The main distribution pipes, including risers and drops, between the highest design point in an installation and the zone subsidiary stop valve at the same floor level shall be sized by hydraulic calculations. The maximum friction loss shall not exceed 0,5 bar at a flow of 1000 l/min (see 13.3.4.2).

Where sprinkler protection is at various floor levels in an installation, the allowable pressure loss between the design points and zone subsidiary stop valves on lower levels might be increased by an amount equal to the difference in static head gain between the sprinklers at the level concerned and the highest sprinkler in the installation.

E.2.5 Water pressures

Pipework, fittings, valves and other equipment shall be capable of withstanding the maximum pressure likely to be encountered.

To overcome the problem of pressures in excess of 12 bar, hydraulic alarm gongs might be driven via a pressure reducing valve or from a secondary water supply such as a town main, controlled by a diaphragm valve connected to the main installation control valve alarm port.

E.3 Water supplies

E.3.1 Types of water supplies

The system shall have at least one superior single water supply.

E.3.2 Pressure and flow requirements for pre-calculated installations

The water supply shall be designed to achieve a minimum pressure and flow condition at the zone subsidiary stop valve outlet as specified in Table 6, taking P_S to be the pressure difference equivalent to the height of the highest sprinkler above the installation zone subsidiary stop valve.

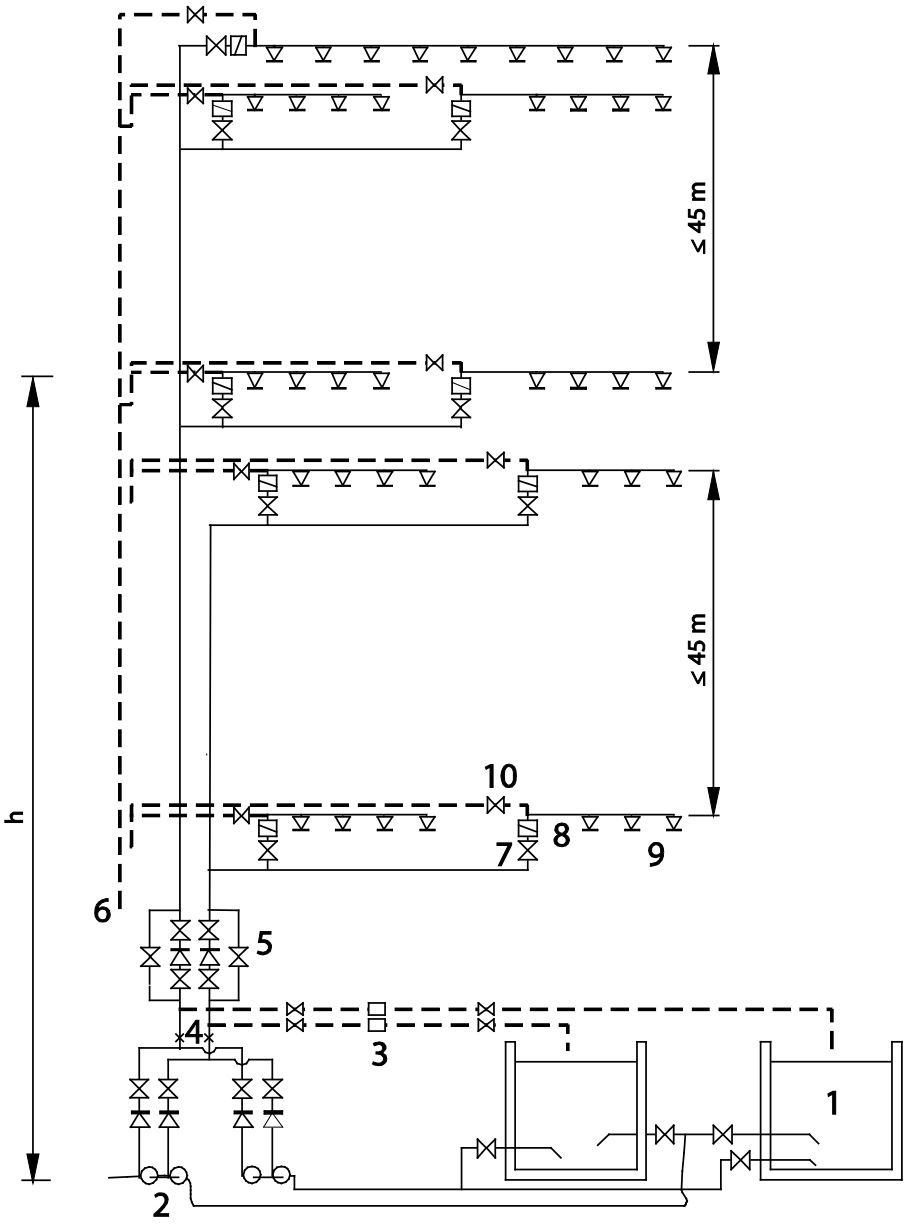
E.3.3 Water supply characteristics for pre-calculated installations

The water supply characteristics shall be determined by a hydraulic calculation of the pipework upstream of the zone subsidiary stop valve outlet, at the higher and lower flow rates specified in Table 6, and shall include calculations at the water supply datum point.

E.3.4 Pump performance for pre-calculated installations

Automatic pumps shall have characteristics in accordance with Table 16.

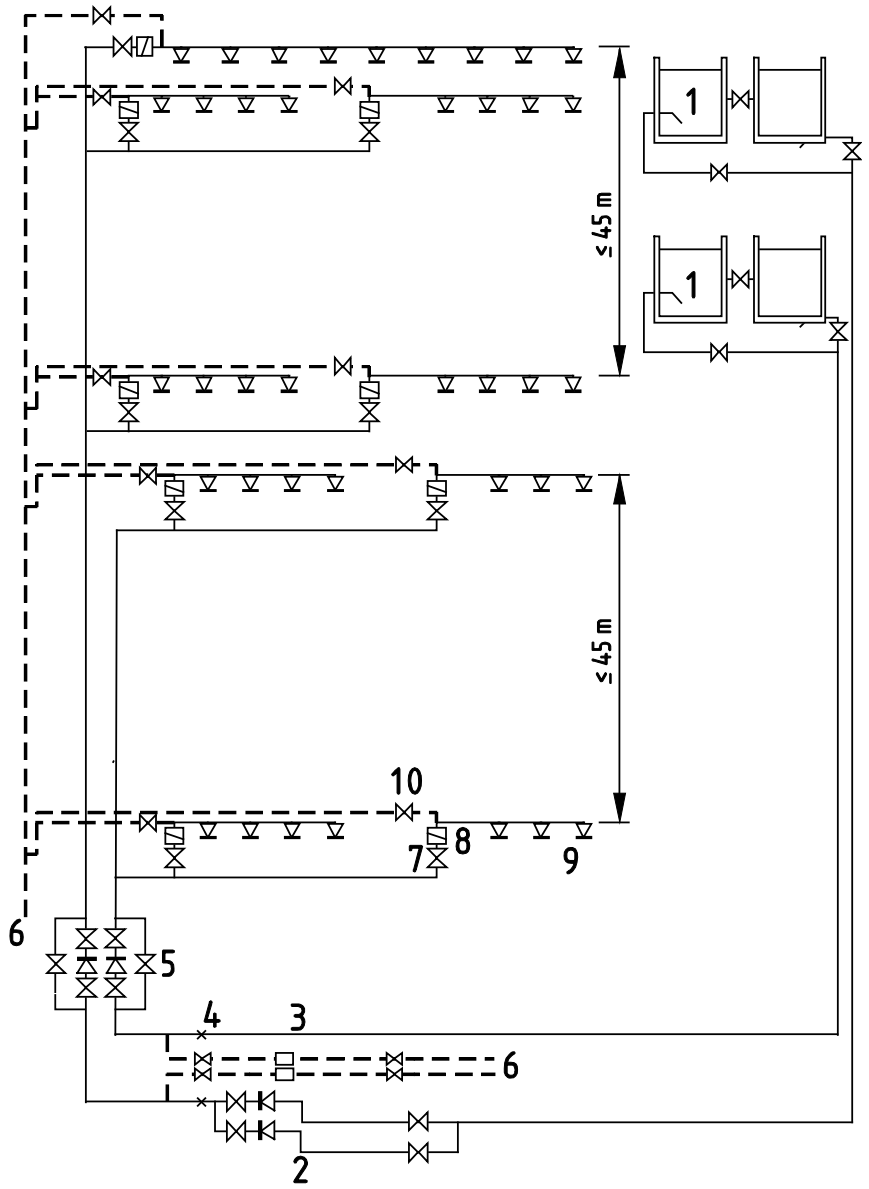
NOTE Pressures are taken at the pump outlet or the relevant stage of multi-stage pumps, on the delivery side of any orifice plat.



Key

1	storage tank	6	flow test and zone drainage
2	multistage pump	7	zone subsidiary stop valve
3	flow meter	8	water flow alarm switch
4	water supply datum point	9	sprinkler head
5	alarm valve station (with bypass arrangement)	10	water flow alarm switch rest valve and zone drain valve

Figure E.1 — Typical layout of high rise system with pump supply



Key

1	storage tank	6	flow test and zone drainage
2	multistage pump	7	zone subsidiary stop valve
3	flow meter	8	water flow alarm switch
4	water supply datum point	9	sprinkler head
5	alarm valve station (with bypass arrangement)	10	water flow alarm switch rest valve and zone drain valve

Figure E.2 — Typical layout of high rise system with gravity tanks and booster pumps

Annex F
(normative)

Additional measures to improve system reliability and availability

F.1 General

Where required by national regulations, the following clauses apply.

F.2 Subdivision into zones

In order to minimize the unprotected area in case of impairment, installations shall be subdivided into zones, in accordance with Annex D, with a maximum of 2 400 m^2 protected floor area.

This requirement applies only with LH and OH.

F.3 Wet pipe installations

Sprinkler installations shall be of the wet pipe type and any subsidiary dry pipe or alternate extension shall comply with 11.5.

F.4 Sprinkler type and sensitivity

Quick response sprinklers shall be used, except that standard 'A' and special response might be used in rooms no less than 500 m^2 in area or no less than 5 m in height.

F.5 Control valve set

During servicing and maintenance of the installation alarm valves, the sprinkler installation shall be fully operational in all aspects.

NOTE In some countries duplicate installation control valve sets are required.

F.6 Water supplies

The system shall have at least one superior single water supply.

NOTE In some countries duplicate supplies are required.

F.7 Additional measures for theatres

In theatres with separated stages (i.e. where there is a safety curtain between the stage and auditorium) the safety curtain shall be provided with a line of drenchers controlled by a quick opening valve (e.g. a plug valve) fitted in an accessible position. The water supply for the drenchers shall be taken upstream of any control valve set. The stage shall be protected by a water spray installation with automatic and manual activation. Alternatively, stages with a total height no greater than 12 m might be protected by sprinklers.

All workshops, dressing rooms, scenery, storerooms and spaces below the stage shall be sprinklered.

F.8 Additional precautions for maintenance

Only one zone of a multi-zone installation shall be shut down at a time. An installation or zone shall be shut down for the minimum time necessary for maintenance.

The partial or complete shut-down of a sprinkler installation shall be avoided wherever possible. Only the smallest part of the installation necessary shall be isolated.

When a zone (or zones) is charged or recharged with water after draining, the flushing valve(s) (see D.3.3) shall be used to check that water is available in the zone (or zones).

Individual alarm valves in a duplicate control valve set, where required, shall be separately serviced, provided the water supply to the installation is maintained.

The following procedure shall be followed before servicing duplicate control valve sets:

— the stop valves to the duplicate alarm valve shall be opened. The stop valves to the alarm valve to be serviced shall be closed and an alarm test (see 20.2.2.3) carried out immediately on the other alarm valve;

— if water is not available, the stop valve shall be opened immediately, and the fault rectified before proceeding.

Annex G
(normative)

Protection of special hazards

G.1 General

The additional requirements of this annex shall be used for the protection of the products specified.

G.2 Aerosols

The following design of protection (see Table G.1) shall be used when aerosol products are segregated from other types of product and are contained in cages.

NOTE Sprinkler protection might not be effective where such products are not contained in cages.

Table G.1 — Protection criteria for aerosol storage

	Maximum storage or tier height		Ceiling sprinkler temperature	Density	Area of operation
	m		°C	mm/min	m^2
	alcohol based	hydrocarbon based			
ST1 Free standing and block storage	1,5	—	141	12,5	260
	—	1,5	141	25,0	300
ST4 Palletized rack	tiers ≤ 1,8	—	141	12,5 plus in- rack sprinklers	260
	—	tiers ≤ 1,8	141	25,0 plus in- rack sprinklers	300

In-rack sprinklers shall be a quick response type with a temperature in accordance with 14.4.

G.3 Clothes in multiple garment hanging storage

G.3.1 General

This annex contains special requirements for the protection of intensive hanging garment stores having multiple rows or garment racks at two or more levels. They might have automatic or semi-automatic garment delivery, picking or transportation systems. Access to elevated garment storage levels within the warehouse is usually by walkways and ramps. A common feature of hanging garment storage is that there is no fire separation between the decks. Walkways, aisles, ramps and garment racks create a significant obstruction to ceiling level sprinkler protection. Protection of hanging garments stored in carousels or vertical blocks without aisles, and of other configurations than described in G.3 is beyond the scope of this annex.

G.3.2 Categorization

The requirements of this annex shall be applied to all types of garments, irrespective of their storage category.

G.3.3 Sprinkler protection other than at ceiling

Sprinkler protection shall be in accordance with the requirements for in-rack sprinklers.

Each garment rack shall be limited to two rows of hanging garments (side by side) and a storage height of 3,5 m between intermediate levels of sprinklers. Each rack shall be separated by an aisle of at least 0,8 m width. The garment racks shall be protected by a single row of sprinklers. The spacing between the sprinkler rows shall not exceed 3,0 m.

The sprinklers installed directly above the garment racks shall be stagger-spaced in the vertical plane, at horizontal intervals of not more than 2,8 m along the length of the rack. There shall be a sprinkler not more than 1,4 m from the rack end. The clearance between the top of the garments and the sprinkler deflector shall be at least 0,15 m (see Figure G.1).

Except as modified below, each sprinkler row protecting garment storage racks shall be capped by a continuous solid horizontal baffle of at least the length and width of the garment row. The baffle shall be of a Euroclass A1 or A2 or an equivalent in existing national classification systems material.

The upper level of sprinkler rack protection and baffle might be omitted providing the clearance between the top of the garments and the deflectors of the ceiling sprinklers does not exceed 3 m height.

Sprinklers shall be installed below all access ramps, main aisles, walkways and transportation routes, with the exception of aisles, not exceeding 1,2 m wide, between sprinkler protected garment storage rows.

G.3.4 Sprinklers in operation

The number of rack sprinklers assumed to be in operation shall be as follows:

Rows:	3
Levels:	≤ 3
Sprinklers per row:	3

Where there are more than 3 levels of sprinkler protection, 3 rows of 3 sprinklers on 3 protected levels shall be assumed to operate. Where there are 3 levels or less, 3 rows of 3 sprinklers shall be assumed to operate on all protected levels.

G.3.5 Ceiling sprinklers

Ceiling sprinklers shall be designed to provide a density of 7,5 mm/min over an area of operation of 260 m^2, providing the uppermost level of racks is capped and protected by rack sprinklers.

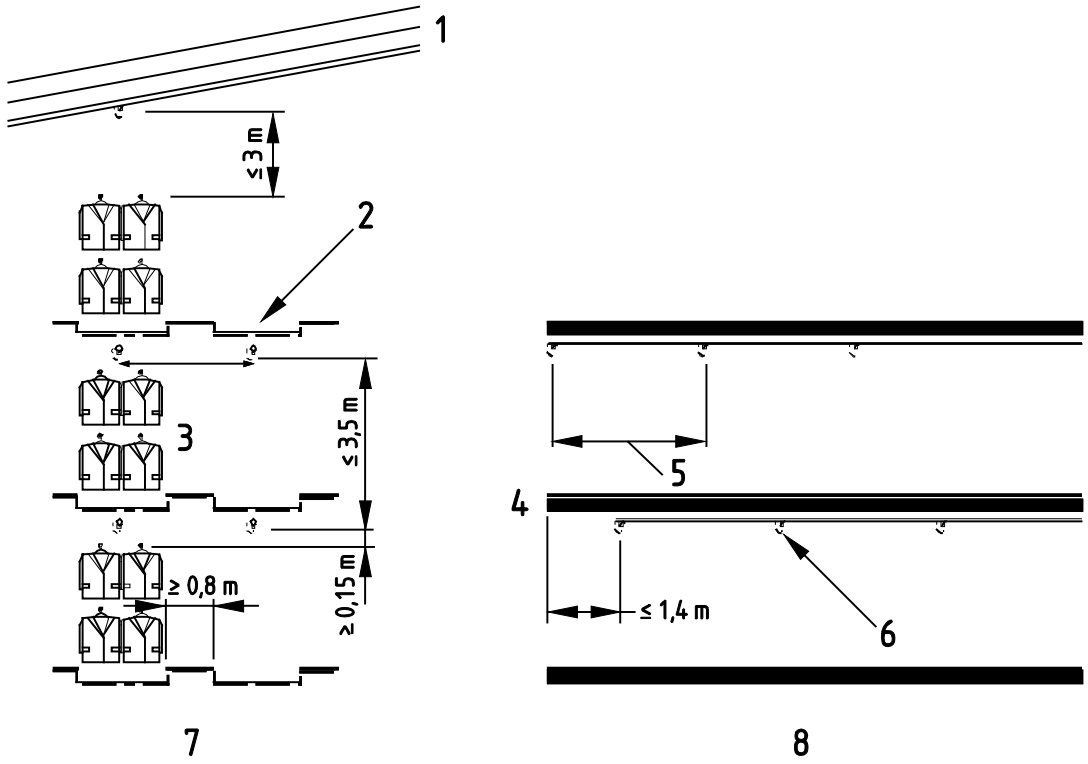
If the uppermost level or the capping is omitted, the ceiling sprinklers shall be designed on the basis of at least Category III goods. The stack height shall be measured from above the uppermost intermediate level sprinklers to the top of the hanging garments.

G.3.6 Automatic shutdown

Operation of the sprinkler system shall automatically stop all automated distribution systems within the warehouse.

G.3.7 Control valve set

All installations shall be of the wet pipe type.



Key

1	ceiling	5	max sprinkler pitch
2	baffle	6	sprinkler head
3	aisle	7	end view
4	rack end	8	aisle view

Figure G.1 —Typical sprinkler protection of garment racks

G.4 Flammable liquid storage

Flammable liquids shall be classified into four classes according to their flash point (FP) and boiling point (BP), as shown in Tables G.2, G.3 and G.4.

Table G.2 — Flammable liquids in metal drums (ST1) with a capacity > 20 l and ≤ 208 l

Class	Properties °C	Drum orientation	Permitted storage	Ceiling sprinklers	
				Density mm/min	Area of operation m^2
1	FP ≥ 100	on side on end	≤ 12 drums high ≤ 6 drums high	10	450
2	FP < 100	on side on end	≤ 6 drums high ≤ 2 drums high	25	450
3	FP < 35	on side on end	≤ 3 drums high ≤ 1 drum high	25	450
4	FP < 21 and BP < 35	on side or on end	1 drum high	25	450

Table G.3 — Flammable liquids in metal drums (ST4) with a capacity > 20 l and ≤ 208 l

Class	Properties °C	Drum orientation	Intermediate sprinkler levels	Ceiling sprinklers	
				Density mm/min	Area of operation m^2
1	FP ≥ 100	on side on end	each 12th tier each 6th tier	10 10	450
2	FP < 100	on side on end	each 6th tier each tier	25 10	450
3	FP < 35	on side on end	each 3rd tier each tier	25 10	450
4	FP < 21 and BP < 35	on side or on end	each tier	25	450
NOTE This table applies to drums stored at a height of one drum per tier.					

Table G.4 — Flammable liquids in metal drums (ST1, ST5, ST6) with a capacity ≤ 20 l

Class	Properties °C	Type of storage	Maximum permitted storage height m	Ceiling sprinklers	
				Density mm/min	Area of operation m^2
1	FP ≥ 100	ST1 ST5/6	5,5 4,6	10 7,5	450
2	FP < 100	ST1 ST5/6	4,0 4,6	12,5	450
3	FP < 35	ST1	1,5	12,5	450
4	FP < 21 and BP < 35	ST5/6	2,1	12,5	450

G.5 Idle pallets

Idle pallets stored in solid piles or on pallets shall be protected with ceiling sprinklers in accordance with Table G.5. Pallets stored in racks shall be protected with ceiling and in-rack sprinklers in accordance with Table G.6.

Table G.5 — Protection of idle pallets (ST1)

Type of pallet	Maximum permitted storage height m	Ceiling sprinklers (see Table 4)	Special requirements
Wood and cellulose material pallets	3,8	As for Category IV	
Plastic pallets	3,3	25 mm/min over 300 m^2	Storage in 60 min fire resistant compartment

Table G.6 — Protection of rack storage of pallets (ST4, ST5, ST6)

Type of pallet	In-rack sprinklers	Ceiling sprinklers (see Table 4)	Special requirements
Wood and cellulose material pallets. Non-expanded high density polyethylene pallets with solid deck	Category IV	As per Category IV. Sprinklers rated at 93 °C or 100 °C	60 min fire resistant compartment when storage height > 3,8 m
All other plastic pallets	Category IV, including one level of sprinklers above top level of storage, sprinklers with K = 115 and minimum operating pressure of 3 bar	25 mm/min over 300 m^2	Storage in 60 min fire resistant compartment

G.6 Spirit based liquors in wooden barrels

Barrels might be stored to a height not exceeding 4,6 m with ceiling sprinklers only. For greater storage heights intermediate sprinklers shall be installed in accordance with Category III/IV requirements. In both cases the ceiling sprinklers shall be installed to give a density of spray of 15 mm/min over an area of operation of 360 m^2.

Drainage or bunding should be provided to limit the spread of liquid spills.

NOTE For the purposes of this standard, spirituous liquor is defined as that containing more than 20 % alcohol.

G.7 Non-woven synthetic fabric

G.7.1 Free standing storage

Ceiling sprinklers shall be installed using the criteria shown in Table G.7.

NOTE For storage heights above 4,1 m consideration might be given to the use of special technology sprinklers (see Annex L).

Table G.7 — Non-woven synthetic fabric – design criteria with roof or ceiling protection only

Storage Configuration	Maximum permitted storage height (see NOTE 1) m	Minimum design density mm/min	Area of operation (wet or pre-action system) (see NOTE 2) m^2
ST1 Free standing or block stacking	1,6	10,0	
	2,0	12,5	
	2,3	15,0	
	2,7	17,5	260
	3,0	20,0	
	3,3	22,5	
	3,6	25,0	
	3,8	27,5	
	4,1	30,0	300
NOTE 1 The vertical distance from the floor to the sprinkler deflectors, minus 1 m, or the highest value shown in the table, whichever is the lower.			
NOTE 2 Dry and alternate installations should be avoided.			

G.7.2 Rack storage

In-rack sprinklers shall be used in accordance with Category IV requirements. Ceiling sprinklers shall have a minimum design density of 12,5 mm/min over 260 m^2.

G.8 Polypropylene or polyethylene storage bins

G.8.1 General

The following requirements shall be met unless other types of sprinkler protection are shown to be valid by appropriate fire testing.

G.8.2 Classification

Polypropylene and polyethylene storage containers shall be classified as HHS Category IV.

G.8.3 Palletized rack storage (ST4)

In-rack sprinklers shall have a horizontal spacing not exceeding 1,5 m. The vertical distance between in-rack sprinklers shall not exceed 2 m. The ceiling sprinklers shall have a sensitivity rating of 'Special' and in-rack sprinklers shall have a sensitivity of 'Special' or 'Quick'.

G.8.4 All other storage

The maximum storage height shall not exceed 3 m. Only non-inflammable pallets, for example steel pallets, shall be used. The stack height per pallet shall not exceed 1 m and the uppermost storage container on each pallet shall be closed with a lid. The sprinklers shall have a sensitivity rating of 'Special' or 'Quick'.

G.8.5 Foam additive

A suitable film forming foam, used in accordance with the supplier's recommendation, shall be added to the sprinkler water.

NOTE In full scale fire tests, AFFF (aqueous film forming foam) has been shown to be effective.

Annex H
(normative)

Sprinkler systems monitoring

H.1 General

The aim of monitoring sprinkler systems is to ensure the continuous operability of the main functions of the system, i.e. those whose failure might impair the correct automatic operation of the system in case of fire, and the raising of a supervisory alarm to allow corrective measures to be taken. This annex specifies requirements, which are additional to those elsewhere in the standard.

All devices used for monitoring shall have at least IP 54 protection as specified in EN 60529. No more than 15 non-addressable supervisory alarm devices shall be connected to a common indication.

All signalling and alarm circuits shall be fully supervised and a fault alarm shall be given in the event of short or open circuit where this corresponds to a fault.

Control and indicating equipment shall be in accordance with any provision valid in the country in use.

H.2 Functions to be monitored

H.2.1 General

The following shall be monitored in addition to all monitoring requirements specified elsewhere in this standard (see Annex I):

H.2.2 Stop valves controlling water flow to sprinklers

The position of all stop valves, the closing of which could prevent adequate water flowing to the sprinklers, including water supply valves, control valve sets, subsidiary valves and sectional valves, shall be monitored.

For normally open valves, the alarm shall activate once the valve starts to close.

H.2.3 Other stop valves

The position of all stop valves, the closing of which could prevent the correct operation of an alarm or indicating device, e.g. pressure switch, hydraulic alarm, flow switch shall be monitored.

For normally open valves, the alarm shall activate once the valve starts to close.

H.2.4 Liquid levels

All critical liquid levels, including water storage tanks and engine fuel tanks. An indication shall be given before a water storage level drops more than 10 % below its nominal fill level, or before a fuel level drops more than 25 % below its nominal fill level. In the case of pressure tanks a further indication shall be given before the level reaches 10 % above its nominal fill level.

H.2.5 Pressures

Pressures, including at water supplies and downstream of all dry and alternate control valve sets. On town main supplies an indication shall be given if the static pressure drops below the calculated running pressure.

In all other cases an indication shall be given when the static pressure drops by more than 20 % below the tested level.

H.2.6 Electrical power

The power supply to electrical pump sets or other critical electrical equipment. An indication shall be given if one or more phases fail at any point in the main supply, or in the control circuit or an electric or diesel pump controller or any other critical control equipment.

H.2.7 Temperature

Minimum temperature of the sprinkler valve and pump room. An indication shall be given if the temperature drops below the minimum required level.

Annex I
(normative)

Transmission of alarms

I.1 Functions to be monitored

Alarms, as specified in this standard, shall be connected to an alarm panel in the sprinkler control room or pump room and be transmitted onwards depending on the importance of the alarm.

Alarms shall be transmitted to a permanently attended location, on or off the premises, and B-Type Alarms (Technical Alarms) in addition might be transmitted to a responsible person (See 20.1) in such a way that immediate corrective action can be taken. If a direct connection to the fire brigade exists, the alarm transmission procedure should be agreed with the authorities.

Table I.1 — Type of alarm for transmission

Alarm	Clause	Alarm type
Water flow alarm	16.1.1	A
Low pressure in town main	9.2	B
Water flow detector in pump room	10.3.2	A
Low level priming tank	10.6.2.4	B
Electric pump set	10.8.6.1	
— on demand		B
— start failure		B
— running		A
— power not available		B
Diesel pump set	10.9.11	
— automatic mode off		B
— start failure		B
— running		A
— fault in controller		B
Trace heating circuits	11.1.2.3	B
Low pressure		
— pre-action Type A system	11.4.1.2	B
— dry pipe and pre-action systems	16.2.3	B
Zoned systems	D.3.7	
— open control valve		B
— partially closed control valve		B
— partially open subsidiary valve		B
— low mains pressure		B
— water flow in installation		A

— water flow in zone		A
Monitored sprinkler systems	Annex H	
— partially closed stop valves		B
— liquid levels		B
— low pressure		B
— power failure		B
— low temperature in pump room		B

I.2 Alarm levels

Signals from water flow alarms and/or alarms valves shall be shown as fire alarms (Alarm level A in Table I.1). Subject to local conditions, a signal indicating that the sprinkler pump is running can alternatively be treated as a trouble alarm. Technical faults such as a power failure, which could prevent the system operating correctly in case of fire, shall be shown as trouble alarms (Alarm level B in Table I.1).

Annex J
(informative)

Precautions and procedures when a system is not fully operational

J.1 Minimizing the effects

Maintenance, alterations and repair of systems which are not fully operational should be carried out so as to minimize the time and extent of non-operation.

When an installation is rendered inoperative the user should implement the following measures:

a) the authorities and any central monitoring station should be informed;

b) alterations and repairs to an installation or its water supply (except where Annex F has been applied) should be carried out during normal working hours;

c) supervisory staff in the areas affected should be notified and the area should be patrolled continuously;

d) any hot work should be subject to a permit system. Smoking and naked lights should be prohibited in affected areas during the progress of the work;

e) when an installation remains inoperative outside working hours all fire doors and fire shutters should remain closed;

f) fire extinguishing appliances should be kept in readiness, with trained personnel available to handle them;

g) as much as possible of the installation should be retained in an operative condition by blanking off pipework feeding the part or parts where work is taking place;

h) in the case of manufacturing premises, when the alterations or repairs are extensive, or it is necessary to disconnect a pipe exceeding 40 mm nominal diameter, or to overhaul or remove a main stop valve, alarm valve or non-return valve, every effort should be made to carry out the work while the machinery is stopped;

i) any pump which is out of commission should be isolated by means of the valves provided;

j) where possible parts of installations should be reinstated to provide some protection overnight by using blinders and blanks within the pipework – the blinders and blanks should be fitted with visible indicator tags numbered and logged to aid timely removal.

J.2 Planned shut-down

Only the user should give permission for a sprinkler installation or zone to be shut down for any reason other than an emergency.

Before a system is wholly or partly shut down every part of the premises should be checked to ensure that there is no indication of fire.

Where premises are subdivided into separate occupancies constituting buildings in communication or at risk, protected by common sprinkler systems or installations, all occupiers should also be advised that the water is to be turned off.

Particular attention should be given to situations where installation pipework passes through walls or ceilings where these could feed sprinklers in areas needing special consideration.

J.3 Unplanned shut-down

When an installation is rendered inoperative as a matter of urgency or by accident, the precautions in J.1 should be observed as far as they are applicable with the least possible delay. The authorities concerned should also be notified as soon as is possible.

J.4 Action following sprinkler operation

J.4.1 General

Following shut-down after operation of an installation, the operated sprinkler heads should be replaced by heads of the correct type and temperature rating, and the water supply restored. Unopened sprinklers around the area in which operation took place should be checked for damage by heat or other cause and replaced as necessary.

The water to an installation or zone of an installation that has operated should not be shut off until all fire has been extinguished.

The decision to shut down an installation or zone which has operated because of a fire should be taken only by the fire service.

Components removed from the system should be retained by the user for possible examination by an authority.

J.4.2 Installations protecting cold storage warehouses (air circulation refrigeration)

The installation should be dismantled for drying out after each operation.

Annex K
(informative)

Twenty-five year inspection

After 25 years the pipes and the sprinklers should be inspected.

The pipework should be thoroughly flushed out and hydrostatically tested to a pressure equal to the maximum static pressure or 12 bar, whichever is the higher.

The pipework should be internally and externally inspected. At least one metre length of range pipe should be inspected per 100 sprinklers. Two pipe sections of at least one metre length of each pipe diameter should be inspected.

All defects which might adversely affect the performance of the system should be eliminated.

In the case of wet pipe systems at least one sprinkler installation per building should be checked. If several wet control valve sets are installed in one building only 10 % need be inspected. In the case of dry pipe systems, such a reduction of the number of installations to be checked is not allowed.

A number of sprinklers should be removed and tested to ensure that they are fully functional. Table K.1 specifies the scope of sampling as a function of the total number of sprinklers installed.

Table K.1 — Number of sprinkler of each available type to be tested

Total number of sprinklers installed	Number of sprinklers to be inspected
≤ 5 000	20
≤ 10 000	40
≤ 20 000	60
≤ 30 000	80
≤ 40 000	100

The sprinklers should be evaluated for the following:

a) operation;

b) operation temperature;

c) variation of K-factor;

d) spray obstacles;

e) lodgement;

f) thermal sensitivity.

Annex L
(informative)

Special technology

This European Standard covers only the types of sprinkler specified in EN 12259-1. During the years preceding the preparation of this standard special technologies were being developed for special applications, including in particular the following:

— specific storage application sprinklers;

Residential sprinklers;

— Extended coverage sprinklers;

— Special in-rack sprinklers.

The engineering of such applications is currently very specialized. It is intended that they will be included in future editions of this standard.

Annex M
(informative)

Independent certification body

It is usual in European countries, for companies given the responsibility to design, install and maintain sprinkler systems in accordance with this current European Standard, to be certified in this field by an independent certification body.

Annex N
(normative)

Control Mode Specific Application Sprinklers: CMSA

N.1 Introduction

N.1.1 General

Control Mode Specific Application Sprinklers have K-factors equal to or greater than K160. These sprinklers can be applied for special storage risk or for high hazard risks.

These sprinklers which operate in Control Mode for Specific Applications, known as CMSA – Sprinklers, might also be known as large drop sprinklers. The term CMSA-Sprinkler or CMSA Protection will be used within this annex.

CMSA Sprinklers are mainly used to control fires within storage risks. It can be anticipated that with proper design the ceiling will experience a 3 min average temperature of less than 300 °C, to ensure that unprotected steel structures will not collapse. There is little room for error in the design and installation of these sprinkler systems; the design principles and the operating characteristics are significantly different from standard sprinkler protection. CMSA sprinklers might be unable to cope with adverse design features and non-compliances, which might be common practice when installing standard sprinkler protection. It is therefore essential that all the requirements of this annex are complied with, without exception, when applying CMSA-Protection.

Protection of storage configurations other than those mentioned in this annex need to be proven by full scale fire tests.

All of EN 12845 applies, except those portions dealing with water demands and water supplies and other subjects or modifications specifically addressed by this annex.

This annex specifies requirements and recommendations for the design and installation of CMSA sprinkler systems in buildings. The protection of aerosols, flammable and combustible liquids, laced storage of rubber tyres and storage of candles are not included in this annex.

N.1.2 Definitions

Sprinkler, Control Mode Specific Application *(CMSA sprinkler)*

A sprinkler with a minimum K-Factor of 160, pendent or upright that is capable of providing large water quantities to penetrate the fire plume with high momentum.

All other definitions shall conform to this European Standard.

N.1.3 General

All CMSA sprinklers shall be approved by authorities.

N.1.4 Sprinkler type and temperature rating

Both pendent and upright standard response CMSA sprinklers might be used.

Where ambient temperature allows (see 14.4), for wet systems sprinklers with a temperature rating of 68 °C to 74 °C shall be used.

In dry systems sprinklers with a temperature rating of 141 °C shall be used.

N.1.5 Water demand

Design CMSA sprinkler systems to provide the number of sprinklers at the minimum specified pressure for the specific occupancy.

The location of the sprinklers to be supplied simultaneously shall be determined as defined in 13.4.3.1 and 13.4.3.2.

N.2 Sprinkler location

N.2.1 Sprinkler spacing

Limit the area of CMSA sprinklers to a minimum of 7,5 m^2 and a maximum of 9 m^2. Limit the distance between range pipes and between sprinklers on range pipes to no more than 3,7 m nor less than 2,4 m. For open joist construction, limit the maximum distance to 3,0 m.

N.2.2 Range pipe sizes

The nominal diameter of range pipe (including riser nipples) shall not be less than DN32.

Where upright CMSA sprinklers are used, the nominal diameter of range pipe shall not be greater than 50 mm, except starter pieces, which might be a nominal diameter of DN65.

Range pipes with a nominal diameter of DN65 and above are acceptable when riser nipples are provided to elevate the sprinkler deflectors above the centerline of the pipe according to Table N.1.

Table N.1 — Minimum distance from upright CMSA sprinkler deflector to range pipe

Range pipe nominal diameter mm	**Minimum distance** mm
65	330
80	380
100	460

N.2.3 Minimum clear space below sprinklers

Maintain at least 1 m between ceiling sprinkler deflectors and the top of storage.

N.2.4 Excessive clearance

As the design Tables N.5 to N.10 gives both maximum ceiling height and maximum storage height, the clearance concern is already included in the design criteria and, consequently, 7.2.2.3 does not apply.

N.2.5 Distance of sprinklers below ceiling

Position sprinklers in accordance with Table N.2.

NOTE The preferred distance below ceiling is 180 mm.

Table N.2 — Minimum and maximum distances of deflectors below ceiling for various construction types

Construction type	Minimum distance mm	Maximum distance mm
Smooth ceiling (ceiling free from significant irregularities)	150	200
Joist, beam and girder, Concrete T	150	300
Ceiling with bays of a maximum of 25 m^2 in size (panel construction)	150	360

N.2.6 Location of sprinklers in beam and girder, concrete T and panel construction

Under beam and girder construction, Concrete T and under panel construction, the branch lines might run across the beams, but locate the sprinklers in the bays and not under the beams. Limit the maximum distance above the bottom of beams to the values specified in Table N.3. At the same time the maximum distance to ceiling based on Table N.2 shall be applied. A panel construction exists when beams or joists create bays smaller than 25 m^2.

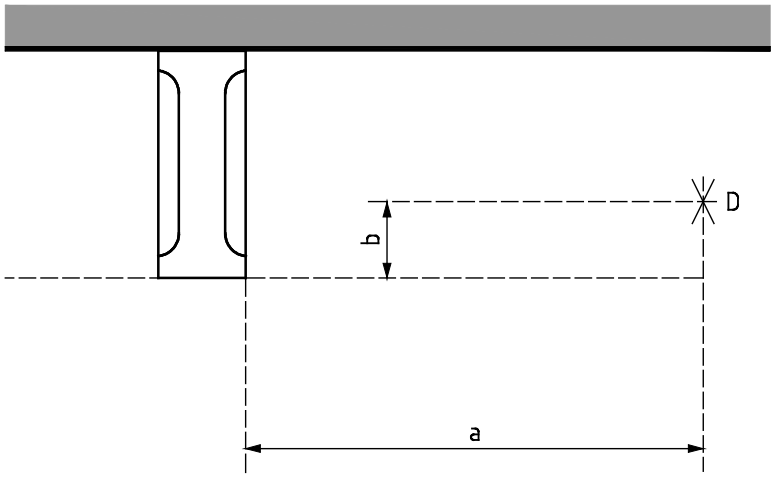
N.2.7 Obstructions to sprinkler distribution

N.2.7.1 General

Effective protection requires direct and prompt attack upon the burning fuel by the sprinkler discharge. Sprinklers shall be located to ensure that building elements do not create obstructions to the sprinkler distribution.

N.2.7.2 Obstructions located at the ceiling

Where sprinkler deflectors are located above the bottom of beams, girders, ducts, fluorescent lighting fixtures, or other obstructions located at the ceiling, position the sprinklers so the maximum distance from the bottom of the obstruction to the deflectors does not exceed the value specified in Table N.3. Use Figure N.1 in conjunction with Table N.3 in positioning sprinkler deflectors.



Key

D deflector

a distance from beam/joist

b distance from underside of beam/joist

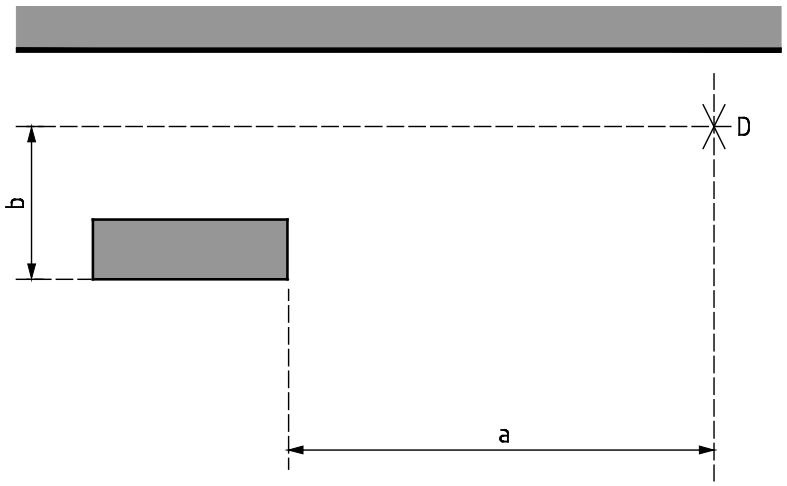
Figure N.1 — Position of deflector when located above bottom of beam or other obstruction located at the ceiling

Table N.3 — Position of deflector when located above bottom of beam, joist or other obstruction

Distance (a)	Maximum *d*istance from underside of beam/joist (b)
Less than 0,3 m	0 mm
0,3 m to less than 0,5 m	40 mm
0,5 m to less than 0,6 m	80 mm
0,6 m to less than 0,8 m	140 mm
0,8 m to less than 0,9 m	200 mm
0,9 m to less than 1,1 m	250 mm
1,1 m to less than 1,2 m	300 mm
1,2 m to less than 1,4 m	380 mm
1,4 m to less than 1,5 m	460 mm
1,5 m to less than 1,7 m	560 mm
1,7 m to less than 1,8 m	660 mm
1,8 m	780 mm

N.2.7.3 Obstructions located below the sprinklers

Position sprinklers with respect to fluorescent lighting fixtures, ducts, and other obstructions located entirely below the sprinklers so the minimum horizontal distance from the near side of the obstruction to the centre of the sprinkler is not less than the value specified in Table N.4, as illustrated in Figure N.2. If obstruction is combustible and sprinklers are positioned so that the combustible obstruction is not protected, provide additional protection. For this purpose lesser K-Factor sprinklers with same temperature rating are permitted.



Key

D deflector

a distance to side of obstruction

b distance deflector above bottom of obstruction

Figure N.2 — Position of sprinkler in relation to obstructions located entirely below the sprinklers

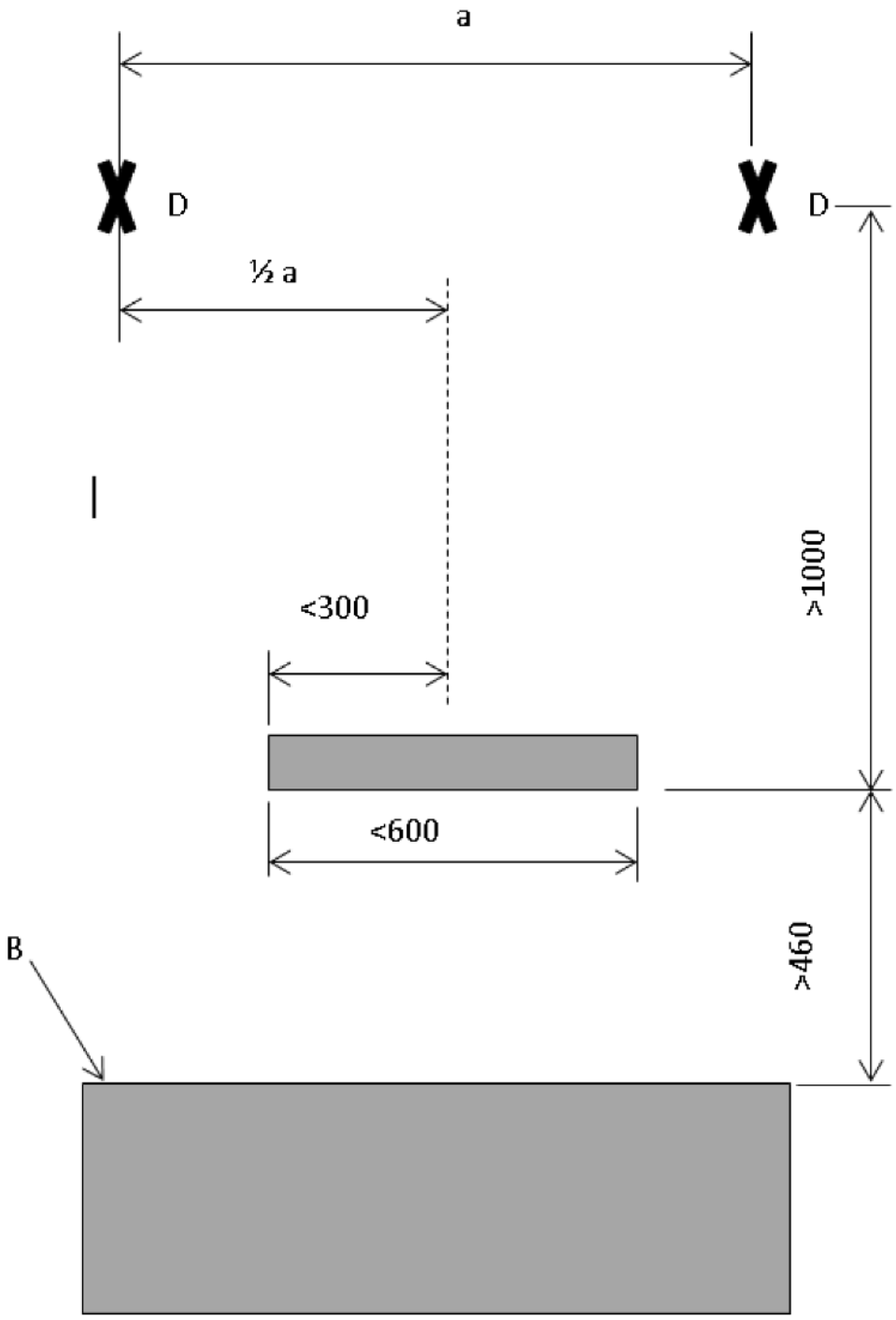
Table N.4 — Position of sprinklers in relation to obstructions located entirely below the sprinklers

Distance deflector above bottom of obstruction	Minimum distance to side of obstruction
Less than 150 mm	0,5 m
150 mm to less than 300 mm	0,9 m
300 mm to less than 460 mm	1,2 m
460 mm to less than 610 mm	1,5 m
610 mm to less than 760 mm	1,7 m
760 mm to less than 910 mm	1,8 m

When the bottom of the obstruction is located 0,91 m or more below the sprinkler deflectors, position sprinklers so that the obstruction is centred between adjacent sprinklers, as shown in Figure N.3.

For obstruction less than 600 mm width, the extension to either side of the midpoint between sprinklers might not exceed 300 mm. Maintain at least an 460 mm clearance between the top of storage and the bottom of the obstruction. If the extension to either side of the midpoint between sprinklers exceed 300 mm, install one or more lines of sprinklers below obstructions.

For obstruction 600 mm width and above, install one or more lines of sprinklers below obstructions.



Key

B top of the storage

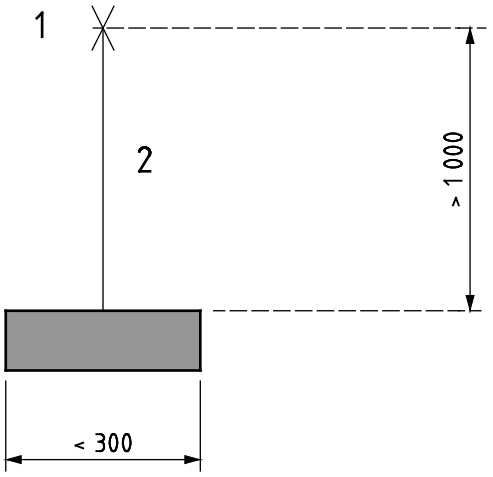
D deflector

a distance between sprinklers

Figure N.3 — Position of sprinklers in relation to obstructions located 1000 mm or more below deflectors

N.2.7.4 Obstructions parallel to and directly below range pipe

In the special case of an obstruction running parallel to and directly below a range pipe, locate the sprinkler at least 1 m above the top of the obstruction, as illustrated in Figure N.4. Limit the obstruction to a width less than 300 mm and a maximum extension of 150 mm to either side of the centreline of the range pipe.



Key

1 sprinkler

2 centreline of branch

Figure N.4 — Position of sprinklers in relation to obstructions running parallel to and directly below range pipes

N.3 Design

The design of CMSA sprinkler systems is based on the K-Factor and nominal temperatures. Smoke vents shall be on manual operation only. No interpolation between storage height and design criteria is permitted as clearance is already considered in the design.

Design criteria shall be in accordance with Tables N.5 to N.10.

Table N.5 — Protection of indoor storage ST1 of Idle Wood Pallets

Nominal K-Factor	Maximum storage height	Maximum ceiling height	Type of system	Number of design sprinklers by minimum pressure in bar				Duration	Tempe-rature
				1,5 bar	1,7 bar	2,1 bar	3,5 bar		
	m	m						min	
160	6,1	10,7	Wet				15	90	68 °C
			Dry				25	120	141 °C
240	6,1	10,7	Wet	15				90	68 °C
			Dry	25				120	141°C
280	6,1	10,7	Wet		15			90	68 °C
280	6,1	12,2	Wet			15		90	141 °C

Table N.6 — Protection of idle plastic pallets (ST1)

Nominal K-Factor	Maximum storage height	Maximum ceiling height	Type of system	Number of design sprinklers by minimum pressure in bar		Duration	Tempe-rature
				1,5 bar	3,5 bar		
	m	m				min	
160	3,0	7,6	Wet		25	120	68 °C
240	3,0	7,6	Wet	25		120	68 °C

Table N.7 — Design criteria for free standing storage (ST 1) of HHS1, HHS2 and HHS3 excluding plastics

Commodity	Max Storage height	Max ceiling	K-factor	Type	Number of Sprinklers	Pressure	Duration	Tempe-rature
	m	m				bar	min	
HHS1/ HHS2	7,6	9,1	280	Wet	15	1,1	90	68 °C
	9,1	10,7				1,7		
	10,7	12,2				2,1		
HHS1/ HHS2	9,1	12,2	160	Wet	15	1,7	90	68 °C
				Dry	25	1,7	120	141 °C
			240	Wet	15	1,0	90	68 °C
				Dry	25	1,0	120	141 °C
HHS3[a]			160	Wet	20	3,5	120	68 °C
				Dry	25	3,5	120	141 °C
			240	Wet	20	1,5	120	68 °C
				Dry	25	1,5	120	141 °C

[a] less than 5 % expanded and unexpanded plastic (PE,PS,PP) per storage unit.

Table N.8 — Design criteria for free standing storage (ST 1) of HHS 3 and HHS 4

Commodity	Max Storage height m	Max ceiling height m	K-factor	Type	Number of Sprinklers	Pressure in bar	Duration min	Tempe-rature
HHS 3	6,1	12,2	160	Wet	15	3,5	90	68 °C
				Dry	25	3,5	120	141 °C
			240	Wet	15	1,5	90	68 °C
				Dry	25	3,5	120	141 °C
HHS3	7,6	9,1	160	Wet	20	3,5	120	68 °C
				Dry	30	3,5	120	141 °C
			240	Wet	15	1,5	90	68 °C
				Dry	25	1,5	120	141 °C
HHS3 excluding expanded plastic	6,1	9,1	280	Wet	15	1,1	90	68 °C
	6,1	10,7				1,7		
	6,1	12,2				2,1		
	7,6	9,1				1,1		
	7,6	10,7				1,7		
	7,6	12,2				2,1		
	9,1	10,7				1,7		
	10,7	12,2				2,1		
HHS4 Excluding rubber tyres	6,1	9,1	160	Wet	25	3,5	120	68 °C
			240	Wet	25	1,5	120	68 °C
HHS4 Excluding rubber tyres	4,6	10,7	160	Wet	25	3,5	120	68 °C
			240	Wet	25	1,5	120	68 °C

Table N.9 — Design criteria for single, double, and multiple-row racks for palletized rack storage (ST4) of HHS1, HHS2 and HHS 3 commodities excluding plastics

Commodity	Max Storage height m	Max. ceiling height m	K-factor	Type	Number of Sprinklers	Pressure bar	Duration min	Temperature
HHS1	6,1	12,2	160	Wet	15	1,7	90	68 °C
				Dry	25	1,7	120	141 °C
			240	Wet	15	1,0	90	68 °C
				Dry	25	1,0	120	141 °C
	7,6	13,7	160	Wet	20	2,8	120	68 °C
				Dry	30	2,8	120	141 °C
			240	Wet	20	1,4	120	68 °C
				Dry	30	1,4	120	141 °C
	10,7	12,2	160	Wet	36[a]	3,8	120	68 °C
				Dry	36[a]	3,8	120	141 °C
			240	Wet	36[a]	1,5	120	68 °C
				Dry	36[a]	1,5	120	141 °C
HHS2	6,1	12,2	160	Wet	15	1,7	90	68 °C
				Dry	25	1,7	120	141 °C
			240	Wet	15	1,0	90	68 °C
				Dry	25	1,0	120	141 °C
	7,6	12,2	160	Wet	20	3,5	120	68 °C
				Dry	25	3,5	120	141 °C
			240	Wet	20	1,5	120	68 °C
				Dry	25	1,5	120	141 °C
HHS2	7,6	9,1	280	Wet	15	1,1	90	68 °C
	9,1	10,7				1,7		
	10,7	12,2				2,1		
HHS3[b]	6,0	7,6	160	Wet	15	3,5	90	68 °C
				Dry	25	3,5	120	141 °C
			240	Wet	15	1,5	90	68 °C
				Dry	25	1,5	120	141 °C
	7,6	9,0	240	Wet	25	1,5	120	68 °C
				Dry	40	1,5	120	141 °C

[a] This design is based on the 6 most remote sprinklers on the most remote range pipes

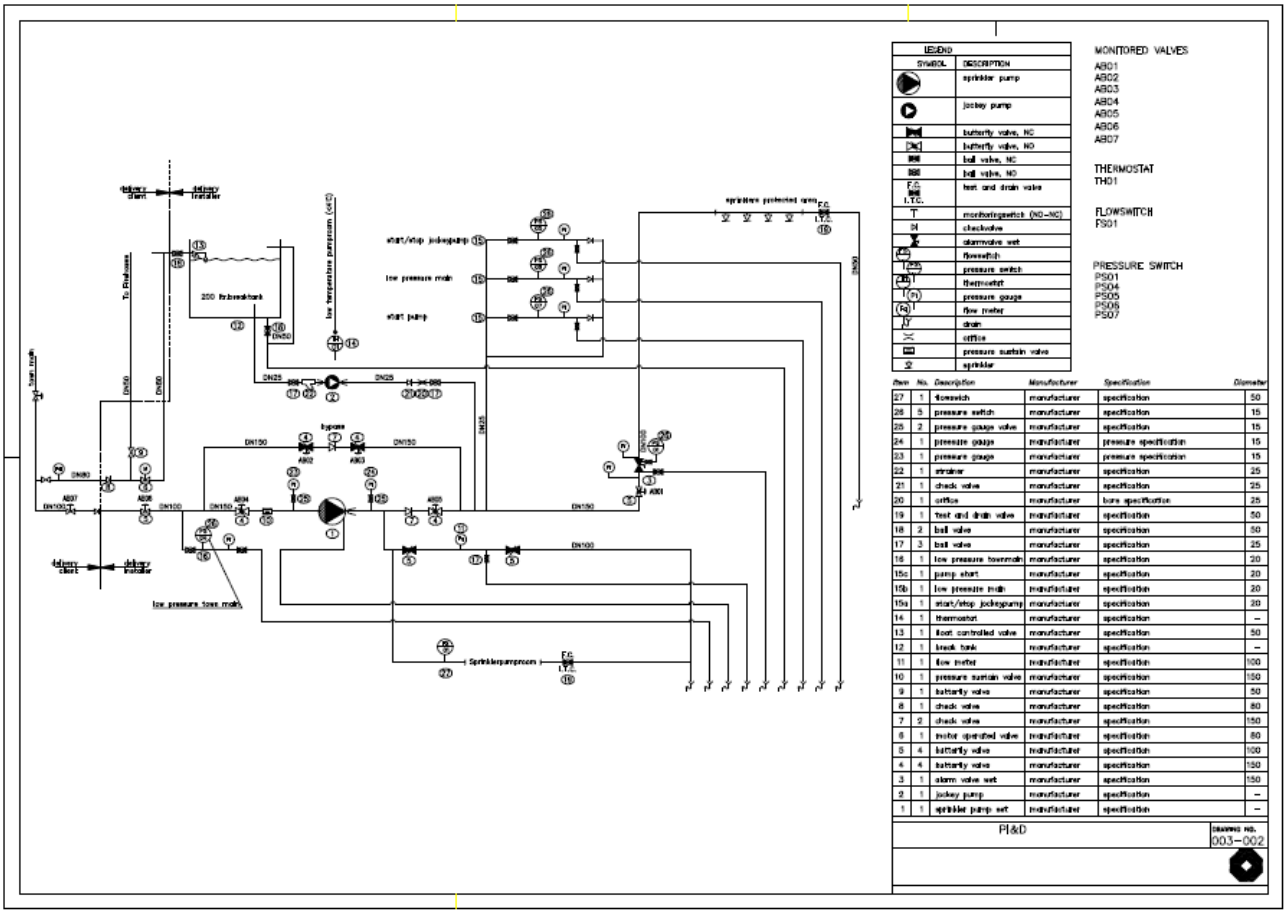
[b] less than 5 % expanded and unexpanded plastic (PE,PS,PP) per storage unit.

Table N.10 — Design criteria for single-, double-, and multiple-row racks for palletized rack (ST4) for HHS 3 and HHS 4

Commodity	Max Storage height m	Max ceiling height m	K-factor	Type	Number of Sprinklers	Pressure bar	Duration m	Tempe-rature
HHS3	6,1	7,6	160	Wet	15	3,5	90	68 °C
				Dry	25	3,5	120	141 °C
			240	Wet	15	1,5	90	68 °C
				Dry	25	1,5	120	141 °C
HHS3 except exposed plastic	6,1	9,1	280	Wet	15	1,1	90	68 °C
	6,1	10,7				1,7		
	6,1	12,2				2,1		
	7,6	9,1				1,1		
	7,6	10,7				1,7		
	7,6	12,2				2,1		
	9,1	10,7				1,7		
	10,7	12,2				2,1		
HHS4	3,0	7,6	160	Wet	25	3,5	120	68 °C
				Dry	40	3,5	120	141 °C
			240	Wet	25	1,5	120	68 °C
				Dry	40	1,5	120	141 °C

Annex O
(informative)

Example of P&ID



Annex P
(normative)

ESFR sprinkler protection

P.1 Introduction

ESFR (Early Suppression Fast Response) sprinklers are ceiling sprinklers which have the capability of suppressing fires within storage risks. There is little room for error in the design and installation of ESFR sprinkler systems; the design principles and the operating characteristics are significantly different from standard sprinkler protection. ESFR sprinklers might be unable to cope with adverse design features and non-compliances, which might be common practice when installing standard sprinkler protection. Design and installation deviations from this standard might not just result in a reduced effectiveness, but rather in a total system failure. It is therefore essential that all the requirements of this annex are complied with, without exception, when applying ESFR protection.

P.2 Scope

This annex specifies requirements and recommendations for the design and installation of ESFR sprinkler systems in buildings. It covers occupancies, storage arrangements, installation design, building requirements and the management of protected buildings which is essential to ensure satisfactory performance of ESFR sprinkler systems.

The protection of aerosols, flammable and combustible liquids, laced storage of rubber tyres and storage of candles is outside the scope of this annex.

P.3 Definitions

P.3.1 Sprinkler, ESFR pattern

A thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and density over a designated area to provide early suppression of a fire when installed on the appropriate sprinkler piping with a suitable water supply.

P.3.2 Suppression mode

Suppression mode is achieved, if equilibrium has been achieved between burning commodity and sprinkler discharge so that ceiling level temperature do not increase and horizontal fire spread has been eliminated and fire on vertical surfaces of burning commodity has been suppressed.

P.3.3 Classification of goods

For the design of ESFR sprinkler systems the standard classification system within EN 12845 have been replaced by four different categories of plastics:

— Cartoned unexpanded

— Exposed unexpanded

— Cartoned expanded

— Exposed expanded

For goods containing no plastics at all, or very small amounts of plastics (i.e. Category I and II), the design criteria for cartoned unexpanded plastics shall be used.

If the protected commodity contains more than 15 % by weight, or more than 25 % by volume, of a category requiring higher design demands, this higher category shall be used.

Minor numbers of single pallet loads of a higher design category might be allowed within the protected area without changing the design criteria. However, if more than 15 pallet loads of a higher category are stored within 9 000 m^2, the design shall be based on this higher category.

P.3.4 Ceiling height

The ceiling height shall be taken as the maximum vertical distance measured from the floor to the underside of the ceiling. In the case of corrugated metal ceilings with a depth of less than 75 mm, the measurement can be made to the lowest point on the corrugation.

P.3.5 Laced tyre storage

Tyre storage, often on pallets, where the tyres are stored in layers angled from the horizontal so that alternating layers dovetail together, in a compact combination, see Figure P.1.

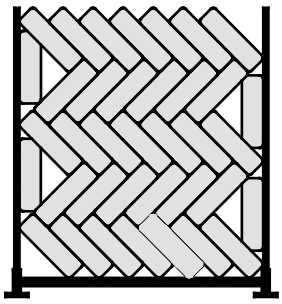


Figure P.1 —Laced tyre storage

P.3.6 Paper categories, based on weight

— Heavyweight: ≥ 100 g/m^2;

— Medium weight: ≥ 50 g/m^2 and < 100 g/m^2;

— Lightweight: < 50 g/m^2.

P.4 Contract arrangements

Before installation the design documentation of all ESFR systems shall be reviewed by the relevant authority, unless installer certification systems, valid at the place of the concerned system installation, allow for alternative methods. Documentation in accordance with 4.3–4.4 shall be provided to the relevant authority.

The information provided at this preliminary or estimating stage should include an assessment to establish ability to conform to critical requirements.

P.5 General

P.5.1 All ESFR sprinklers shall be approved by authorities.

P.5.2 ESFR sprinkler protection shall only be used in buildings where the property, storage systems and contents are controlled by appropriate management systems. The management system documentation shall include procedures for at least the following:

a) risk assessment controls for incoming goods;

b) routine checking and inspection procedures;

c) sprinkler system maintenance contract with a qualified company;

d) maintenance of an outline specification for the building and fire protection with a record of any changes which might influence the performance of the sprinkler system;

e) regular review of methods of storage;

f) regular review of hazard;

g) regular review of compliance with ESFR installation requirements;

h) dealing with non-compliances.

The critical review of the hazard and storage methods specified in (a), (b), (d), (e), (f) and (g) above should, at least, be in accordance with Clause 20.

Regular review of hazards should include checking that aisles and flues in storages conform to respective requirements.

The written procedures should encompass actions to be taken if major non-compliances occur and should include informing relevant authorities such as fire authorities and leading insurers.

P.6 Occupancies and fire hazards

ESFR sprinklers might be used to protect storages in accordance with Tables P.2 to P.16. Table P.1 provides a reference guide to Tables P.2 to P.16.

ESFR sprinklers shall not be used to protect areas where one of the following is present:

a) commodities and storage configurations which have not been assessed or tested by the appropriate authority for protection with ESFR sprinkler protection;

b) open top containers which might retain water;

c) automatic heat and smoke venting;

d) solid shelving larger than 2 m^2 per shelf

NOTE ESFR sprinkler protection might be used in conjunction with manually operated smoke ventilation systems, suitable only for heat and smoke ventilation purposes, operated by the fire brigade.

P.7 Racked, shelved and post pallet storage

P.7.1 Longitudinal and transverse flues

Storages shall have longitudinal and transverse flues, which are:

a) continuous for the full height of each block of storage;

b) vertically aligned;

c) free of stored goods;

d) regularly spaced and having dimensions as follows:

— transverse flues shall be at least 0,15 m wide; and

— longitudinal flues shall be at least 0,15 m wide.

NOTE See Figure 13 and Figure 14.

P.7.2 Shelving

Single and double row shelved racks shall comply with one of the following:

a) slatted shelves shall have shelf open areas, uniformly interspaced, of at least 50 % of the shelf plan area. The distance between openings shall not exceed 0,15 m; or

b) grated or mesh type shelves shall have uniform openings of at least 50 % of the shelf plan area. The horizontal distance between openings shall not exceed 0,15 m;

c) shelves less open than as defined in a) and b) shall be considered as solid shelves.

P.7.3 In-rack sprinklers for ESFR systems

In some cases additional in-rack sprinklers are required. This means that ceiling only protection is not able to cool and/or control fire spread. In these cases one line of in-rack sprinklers shall be provided close to 1/2 the storage height of the rack. The in-rack sprinklers shall be positioned at each intersection of the transversal and longitudinal flue. Sprinklers need to be positioned within 150 mm of the centerline of the flue. All flues need to be protected.

P.7.4 Design requirements

Minimum operating pressure for the ESFR sprinklers included in the design area, see P.10.5, shall be taken from the appropriate Tables P.2 to P.16. For guidance on the appropriate table, see Table P.1.

Table P.1 — Guide to ESFR sprinkler use

	Storage method			
	ST1	ST2/ST3	ST4	ST5
Commodity	Table reference			
Plastics				
Unexpanded cartoned	P.2	P.3	P.3	P.2
Unexpanded exposed	P.4	P.5	P.5	P.4
Expanded cartoned	P.6	P.7	P.7	P.6
Expanded exposed	P.8	P.9	P.9	P.8
Rubber tyres		P.14	P.14	
Paper rolls stored on end:				
Medium weight	P.10	—	—	—
Tissue paper	P.11			
Heavy weight	P.12	—	—	—
Heavy weight plastic coated	P.13	—	—	—
Commodities stored under mezzanines	P.15	P.16	P.16	—

Table P.2 —Unexpanded plastic in cartons, ST1 or ST5 storage

Storage applications: ST1 Free standing or block storage ST5 Shelving				
Commodities: Plastics: Cartoned unexpanded				
Maximum storage height m	Maximum ceiling height m			
	9,1	10,7	12,2	13,7
	Sprinkler minimum operating pressure bar			
	ESFR pendent sprinkler nominal k-factor 200			
7,6	3,5	5,2	5,2	6,2
9,1	†	5,2	5,2	6,2
10,7	†	†	5,2	6,2
	ESFR pendent sprinkler nominal k-factor 240			
7,6	2,4	3,6	3,6	4,3
9,1	†	3,6	3,6	4,3
10,7	†	†	3,6	4,3
	ESFR upright sprinkler nominal k-factor 200			
7,6	3,5	5,2	†	†
9,1	†	5,2	†	†
	ESFR upright sprinkler nominal k-factor 240			
7,6	2,4	3,6	†	†
9,1	†	3,6	†	†
	ESFR pendent sprinkler nominal k-factor 320			
7,6	1,7	2,4	3,1	3,5
9,1	†	2,4	3,1	3,5
10,7	†	†	3,1	3,5
12,2	†	†	†	3,5
	ESFR pendent sprinkler nominal k-factor 360			
7,6	1,4	2,1	2,7	3,5
9,1	†	2,1	2,7	3,5
10,7	†	†	2,7	3,5
12,2	†	†	†	3,5
† – Not applicable				

Table P.3 — Unexpanded plastic in cartons, ST2, ST3 or ST4 storage

Storage applications: ST2/ST3 Post pallets ST4 Palletized racking				
Commodities: Plastics: cartoned unexpanded				
Maximum storage height m	**Maximum ceiling height** m			
	9,1	10,7	12,2	13,7
	Sprinkler minimum operating pressure Bar			
	ESFR pendent sprinkler nominal k-factor 200			
7,6	3,5	5,2	5,2	6,2 + 1 level of in-rack
9,1	†	5,2	5,2	6,2 + 1 level of in-rack
10,7	†	†	5,2	6,2 + 1 level of in-rack
12,2	†	†	†	6,2 + 1 level of in-rack
	ESFR pendent sprinkler nominal k-factor 240			
7,6	2,4	3,6	3,6	4,3+ 1 level of in-rack
9,1	†	3,6	3,6	4,3 + 1 level of in-rack
10,7	†	†	3,6	4,3 + 1 level of in-rack
12,2	†	†	†	4,3 + 1 level of in-rack
	ESFR upright sprinkler nominal k-factor 200			
7,6	3,5	5,2	†	†
9,1	†	5,2	†	†
	ESFR upright sprinkler nominal k-factor 240			
7,6	2,4	3,6	†	†
9,1	†	3,6	†	†
	ESFR pendent sprinkler nominal k-factor 320			
7,6	1,7	2,4	3,1	3,5
9,1	†	2,4	3,1	3,5
10,7	†	†	3,1	3,5
12,2	†	†	†	3,5
	ESFR pendent sprinkler nominal k-factor 360			
7,6	1,4	2,1	2,7	3,5
9,1	†	2,1	2,7	3,5
10,7	†	†	2,7	3,5
12,2	†	†	†	3,5
† – Not applicable				

Table P.4 — Exposed unexpanded plastic, ST1 or ST5 storage

Storage applications: ST1 Free standing or block storage ST5 Solid or slatted shelves				
Commodities: Plastics: exposed unexpanded				
Maximum storage height m	Maximum ceiling height m			
	9,1	10,7	12,2	13,7
	Sprinkler minimum operating pressure Bar			
	ESFR pendent sprinkler nominal k-factor 200			
7,6	3,5	5,2	5,2	6,2
9,1	†	5,2	5,2	6,2
10,7	†	†	5,2	6,2
	ESFR pendent sprinkler nominal k-factor 240			
7,6	2,4	3,6	3,6	4,3
9,1	†	3,6	3,6	4,3
10,7	†	†	3,6	4,3
	ESFR upright sprinkler nominal k-factor 200			
7,6	3,5	†	†	†
	ESFR upright sprinkler nominal k-factor 240			
7,6	2,4	†	†	†
	ESFR pendent sprinkler nominal k-factor 320			
7,6	2,4	3,5	3,5	4,3
9,1	†	3,5	3,5	4,3
10,7	†	†	3,5	4,3
	ESFR pendent sprinkler nominal k-factor 360			
7,6	2,4	3,5	3,5	4,3
9,1	†	3,5	3,5	4,3
10,7	†	†	3,5	4,3
† – Not applicable				

Table P.5 — Exposed unexpanded plastic, ST2, ST3 or ST4 storage

Storage applications: ST2/ST3 Post pallets ST4 Palletized racking				
Commodities: Plastics: exposed unexpanded				
Maximum storage height m	Maximum ceiling height m			
	9,1	10,7	12,2	13,7
	Sprinkler minimum operating pressure Bar			
	ESFR pendent sprinkler nominal k-factor 200			
7,6	3,5	5,2	5,2	6,2 + 1 level of in-rack
9,1	†	5,2	5,2	6,2 + 1 level of in-rack
10,7	†	†	5,2	6,2 + 1 level of in-rack
12,2	†	†	†	6,2 + 1 level of in-rack
	ESFR pendent sprinkler nominal k-factor 240			
7,6	2,4	3,6	4,1	4,3 + 1 level of in-rack
9,1	†	3,6	4,1	4,3 + 1 level of in-rack
10,7	†	†	4,1	4,3 + 1 level of in-rack
12,2	†	†	†	4,3 + 1 level of in-rack
	ESFR pendent sprinkler nominal k-factor 320			
7,6	2,4	3,5	4,1	4,3+ 1 level of in-rack
9,1	†	3,5	4,1	4,3+ 1 level of in-rack
10,7	†	†	4,1	4,3+ 1 level of in-rack
12,2	†	†	†	4,3+ 1 level of in-rack
	ESFR pendent sprinkler nominal k-factor 360			
7,6	2,4	3,5	4,1	4,3+ 1 level of in-rack
9,1	†	3,5	4,1	4,3+ 1 level of in-rack
10,7	†	†	4,1	4,3+ 1 level of in-rack
12,2	†	†	†	4,3 + 1 level of in-rack
† – Not applicable				

Table P.6 — Expanded plastic in cartons, ST1 or ST5 storage

Storage applications: ST1 Free standing or block storage ST5 Solid shelving				
Commodities: Plastics: cartoned expanded				
Maximum storage height m	**Maximum ceiling height** m			
	9,1	**10,7**	**12,2**	**13,7**
	Sprinkler minimum operating pressure Bar			
	ESFR pendent sprinkler nominal k-factor 200			
7,6	3,5	†	†	†
	ESFR pendent sprinkler nominal k-factor 240			
7,6	2,4	†	†	†
	ESFR upright sprinkler nominal k-factor 200			
7,6	3,5	†	†	†
	ESFR upright sprinkler nominal k-factor 240			
7,6	2,4	†	†	†
	ESFR pendent sprinkler nominal k-factor 320			
7,6	2,4	†	†	†
	ESFR pendent sprinkler nominal k-factor 360			
7,6	2,4	†	†	†
† – Not applicable				

Table P.7 — Expanded plastic in cartons, ST2, ST3 or ST4 storage

Storage applications: ST2/ST3 Post pallets ST4 Palletized racking				
Commodities: Plastics: cartoned expanded				
Maximum storage height m	**Maximum ceiling height** m			
	9,1	**10,7**	**12,2**	**13,7**
	Sprinkler minimum operating pressure Bar			
	ESFR pendent sprinkler nominal k-factor 200			
7,6	3,5	†	†	†
	ESFR pendent sprinkler nominal k-factor 240			
7,6	2,4	†	†	†
	ESFR upright sprinkler nominal k-factor 200			
7,6	3,5	†	†	†
	ESFR upright sprinkler nominal k-factor 240			
7,6	2,4	†	†	†
	ESFR pendent sprinkler nominal k-factor 320			
7,6	2,4	†	†	†
	ESFR pendent sprinkler nominal k-factor 360			
7,6	2,4	†	†	†
† – Not applicable				

Table P.8 — Exposed expanded plastic, ST1 or ST5 storage

Storage applications: ST1 Free standing or block storage ST5 Solid shelving				
Commodities: Plastics: exposed expanded				
Maximum storage height m	**Maximum ceiling height** m			
	7,6	**9,1**	**10,7**	**12,2**
	Sprinkler minimum operating pressure bar			
	ESFR pendent sprinkler nominal k-factor 200			
6,1	3,5	6,9	†	†
7,6	†	6,9	†	†
	ESFR pendent sprinkler nominal k-factor 240			
6,1	2,4	6,9	†	†
7,6	†	6,9	†	†
	ESFR pendent sprinkler nominal k-factor 320			
6,1	1,7	4,8	†	†
7,6	†	4,8	†	†
	ESFR pendent sprinkler nominal k-factor 360			
6,1	1,4	4,8	†	†
7,6	†	4,8	†	†
	ESFR upright sprinkler nominal k-factor 200			
6,1	3,5	†	†	†
	ESFR upright sprinkler nominal k-factor 240			
6,1	2,4	†	†	†
† – Not applicable				

Table P.9 — Exposed expanded plastic, ST2, ST3 or ST4 storage

Storage applications: ST2/ST3 Post pallets ST4 Palletized racking				
Commodities: Plastics: exposed expanded				
Maximum storage height m	**Maximum ceiling height** m			
	7,6	**9,1**	**10,7**	**12,2**
	Sprinkler minimum operating pressure Bar			
	ESFR pendent sprinkler nominal k-factor 200			
6,1	5,2	6,9	†	†
7,6	†	6,9	†	†
	ESFR pendent sprinkler nominal k-factor 240			
6,1	3,6	4,8	†	†
7,6	†	4,8	†	†
	ESFR pendent sprinkler nominal k-factor 320			
6,1	3,6	4,8	†	†
7,6	†	4,8	†	†
	ESFR pendent sprinkler nominal k-factor 360			
6,1	3,6	4,8	†	†
7,6	†	4,8	†	†
† – Not applicable				

Table P.10 — Medium weight paper rolls on end, ST1 storage

Storage applications: ST1 Free standing or block storage			
Commodities: Paper rolls stored on end – Medium weight paper [a, b, c, d]			
Maximum storage height m	**Maximum ceiling height** m		
	9,1	**10,7**	**12,2**
	Sprinkler minimum operating pressure Bar		
	ESFR pendent sprinkler nominal k-factor 200		
6,1	6,1	6,1	6,1
	ESFR pendent sprinkler nominal k-factor 240		
6,1	3,4	5,2	5,2
	ESFR pendent sprinkler nominal k-factor 320		
6,1	1,7	†	†
	ESFR pendent sprinkler nominal k-factor 360		
6,1	1,4	2,1	2,7

† – Not applicable

[a] Medium weight paper – non-absorbent paper or board with a hard or smooth surface weighing more than 49 g/m^2 and less than 98 g/m^2.

[b] Protection not suitable for light weight paper weighing less than 49 g/m^2 such as toilet paper or paper towelling.

[c] Suitable for paper rolls with or without steel bands or steel wires to prevent the paper from unrolling.

[d] Not suitable for protecting paper roll storages where the roll stacks are separated in both directions by 100 mm or more.

Table P.11 — Rolls of tissue paper on end, ST1 storage [f]

Storage applications: ST1 Free standing or block storage			
Commodities: Paper rolls stored on end – Tissue paper [a, b,c]			
Maximum storage height m	**Maximum ceiling height** m		
	9,1		**12,2**
	Sprinkler minimum operating pressure Bar		
	ESFR pendent sprinkler nominal k-factor 200		
7,6	5,1[d]		5,1[e]

[a] Tissue paper – lightweight paper weighing less than 49 g/m^2 such as toilet paper or paper towelling.

[b] Suitable for paper rolls with or without steel bands or steel wires to prevent the paper from unrolling.

[c] Not suitable for protecting paper roll storages where the roll stacks are separated in both directions by 100 mm or more.

[d] Minimum operating pressure for the required number of ESFR sprinkler included in the design, i.e. 16 sprinklers

[e] Minimum operating pressure the required number of ESFR sprinkler included in the design, i.e. 25 sprinklers

[f] This particular ESFR protection scheme is not designed for suppression, but rather for control of a fire

Table P.12 — Heavy weight paper rolls stored on end, ST1 storage

Storage applications: ST1 Free standing or block storage			
Commodities: Paper rolls stored on end – heavy weight paper [a, b]			
Maximum storage height m	**Maximum ceiling height** m		
	9,1	**10,7**	**12,2**
	Sprinkler minimum operating pressure **bar**		
	ESFR pendent sprinkler nominal k-factor 200		
7,6	3,4	5,2	5,2
9,1	†	5,2	5,2
	ESFR pendent sprinkler nominal k-factor 240		
7,6	2,4	3,6	3,6
9,1	†	3,6	3,6

† – Not applicable

[a] Heavy weight paper – non-absorbent paper or board weighing 98 g/m^2 or more.

[b] Where the paper roll stacks are separated in both directions by 100 mm or more the paper rolls shall have steel bands or steel wires to prevent the paper from unrolling, otherwise protection suitable for paper rolls with or without steel bands or steel wires.

Table P.13 — Plastic coated heavy weight paper, ST1 storage

Storage applications: ST1 Free standing or block storage			
Commodities: Paper rolls stored on end – plastic coated heavy weight paper [a, b]			
Maximum storage height m	**Maximum ceiling height** m		
	9,1	**10,7**	**12,2**
	Sprinkler minimum operating pressure Bar		
	ESFR pendent sprinkler nominal k-factor 200		
6,1	3,4	5,2	5,2
	ESFR pendent sprinkler nominal k-factor 240		
6,1	2,4	3,6	3,6

[a] Heavy weight paper – non-absorbent paper or board weighing 98 g/m^2 or more.

[b] Where the paper roll stacks are separated in both directions by 100 mm or more the paper rolls shall have steel bands or steel wires to prevent the paper from unrolling, otherwise protection suitable for paper rolls with or without steel bands or steel wires.

Table P.14 — Rubber tyres, ST3 or ST4 storage

Storage applications: ST3 Post pallets in multiple rows [a] ST4 Palletized racking [a]		
Commodities: Rubber tyres		
Maximum storage height m	**Maximum ceiling height** m	
	9,1	**12,2**
	Sprinkler minimum operating pressure bar	
	ESFR pendent sprinkler nominal k-factor 200	
7,6	3,5[b]	†
	ESFR pendent sprinkler nominal k-factor 240	
7,6	2,4[b]	†
	ESFR pendent sprinkler nominal k-factor 320	
7,6	1,7[b]	†
	ESFR pendent sprinkler nominal k-factor 360	
7,6	1,4[b]	†
9,1	†	5,2

[a] Open bottomed storage systems only.

[b] Tyres might be stored on side or on tread, but not laced.

Table P.15 — Various commodities on mezzanines, ST1 storage

Storage applications: Mezzanines with: ST1 Free standing or block stacking,	
Commodities: Plastics: cartoned unexpanded Plastics: exposed unexpanded Plastics: cartoned expanded Plastics: exposed expanded Paper rolls stored on end – Medium weight paper [a, b, c,d]	
Maximum storage height m	**Maximum ceiling height** **m**
	≤ 4,5
	Sprinkler minimum operating pressure Bar
	ESFR pendent sprinkler nominal k-factor 200
[e]	3,5

[a] Medium weight paper – non-absorbent paper or board with a hard or smooth surface weighing more than 49 g/m^2 and less than 98 g/m^2.

[b] Protection not suitable for light weight paper weighing less than 49 g/m^2 such as toilet paper or paper towelling.

[c] Suitable for paper rolls with or without steel bands or steel wires to prevent the paper from unrolling.

[d] Not suitable for protecting paper roll storages where the roll stacks are separated in both directions by 100 mm or more.

[e] Maximum storage height not greater than roof or ceiling height minus one metre.

Table P.16 — Various commodities on mezzanines, ST3 and ST4 storage

Storage applications: Mezzanines with: ST3 Post pallets in multiple rows [1] ST4 Palletized racking	
Commodities: Plastics: cartoned unexpanded Plastics:exposed unexpanded Plastics: cartoned expanded Plastics: exposed expanded	
Maximum storage height m	**Maximum ceiling height** m
	≤ 4,5
	Sprinkler minimum operating pressure bar
	ESFR pendent sprinkler nominal k-factor 200
NOTE 1	3,7
	ESFR pendent sprinkler nominal k-factor 240
NOTE 1	2,4
NOTE Maximum storage height not greater than roof or ceiling height minus one metre.	

P.8 Building requirements

P.8.1 Roof or ceiling slope

The roof or ceiling slope shall not exceed $9^1/_2°$ (170 mm/m).

P.8.2 Measures required to correct excessive roof or ceiling slope

Where roof or ceiling slopes exceed $9^1/_2°$, the roof of or ceiling shall be under-drawn with a suspended ceiling. The suspended ceiling shall be of non-combustible construction, having an acceptable slope. ESFR sprinklers shall be deployed below the suspended ceiling. Standard sprinkler protection shall be employed in the roof or ceiling space in accordance with the relevant clauses of this standard.

NOTE Ceiling slope influences the movement of hot gases across the ceiling and therefore influences the operation of sprinkler heads during a fire. Excessive ceiling slope might result in the operation sprinklers remote from the fire whilst delaying the operation of sprinklers in close proximity to the fire.

P.8.3 Ceiling strength

Ceilings and any sub-ceilings shall be firmly secure and shall be capable of withstanding a vertical upward thrust of 50 N/m^2.

NOTE Ceiling materials considered suitable are 10 mm gypsum board, corrugated and sheet steel and mineral tiles.

P.8.4 Sky lights

Sky lights shall be flush to the ceiling or underdrawn at the ceiling level. Sky lights shall be capable of withstanding a temperature of 300 °C for a period of at least 5 min.

Additional sprinklers need to be installed in skylights with a volume greater than 1 m^3, measured above the normal ceiling level, when the distance from the normal or suspended ceiling level to the top of the deflector exceeds the maximum allowable distance between the ESFR sprinkler and ceiling, see Table P.19. Any additional sprinkler shall also be of the ESFR type.

P.8.5 Powered ventilation

Coordinate the location of sprinklers and the design of powered heating, ventilation and air conditioning for buildings protected by suppression mode sprinklers so that the air velocity at the sprinklers does not exceed 1,52 m/s (5 ft/s).

If it is not possible to meet this requirement, at least one of the following measures shall in this case be adopted to mitigate the effects of air movement on ESFR sprinklers in the event of fire:

a) where powered ventilation is employed, the buildings shall be protected by a fire alarm installation approved by the relevant authority. The powered ventilation shall be stopped and any dampers closed automatically in response to the fire detection system alarm; or

b) the horizontal distance between stored goods and the perimeter of the extraction ventilator openings shall be not less than L (in m) given by the formula:

$$L = {}^1/_2 S + d \qquad \text{(P.1)}$$

where

S is the sprinkler spacing (in m);

d is the ventilator duct diameter (in m).

or

c) install a horizontal sub-ceiling below the extraction ventilator openings. ESFR sprinklers shall be located below the sub-ceiling in accordance with the normal spacing requirements, see Figure P.2. The sub-ceiling shall have a minimum diameter or cross-sectional dimension W given by either of the Formulae (P.2) and (P.3).

If the ventilation airflow rate is known:

$$W = Q / 283\, h \qquad \text{(P.2)}$$

If the ventilation airflow rate is unknown:

$$W=2,6A^*/h \qquad \text{(P.3)}$$

where

Q is the ventilator air flow rate (in m^3/min);

*A** is the ventilator opening area (in m^2)

h is the vertical distance between ceiling and top of the sub-ceiling (m).

Ceiling sprinklers shall be a horizontal distance of at least 0,7 times the sprinkler spacing from the perimeter of the sub-ceiling.

Powered ventilators and fire dampers should preferably be stopped before the first sprinkler operates. Fire detection systems should be either:

(i) aspirating smoke detectors installed in all ventilation ducts extracting from the ESFR protected risk; or

(ii) a fire detection system of detection performance equivalent to an aspirating smoke detection system.

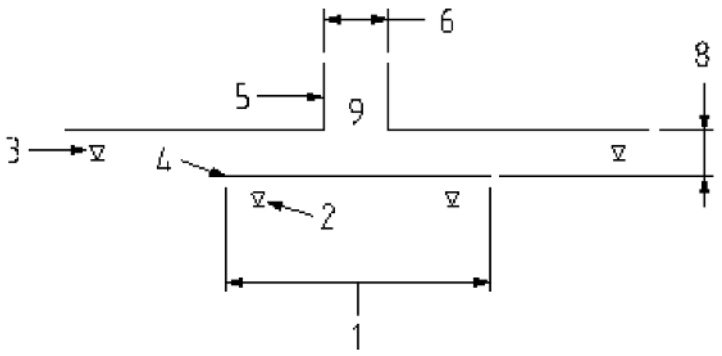
If the air flow rate through the ventilator is not known then the duct velocity should be measured using a suitable device such as Pitot tube and micromanometer. The air flow rate Q (in m^3/min) through a circular section duct might be calculated using the formula:

$$Q = 49 / 60 \times A \times V$$

where

A is the cross-sectional area of a circular duct (in m^2)

V is the maximum velocity through the duct (in m/min)



Key

1 sub-ceiling dimension – W (in m)

2 sub-ceiling sprinkler

3 roof or ceiling sprinkler

4 sub-ceiling

5 ventilator

6 ventilator diameter – D (in m)

7 ceiling

8 vertical distance between sub-ceiling and ventilator – h (in m)

9 ventilator air flow rate – Q (in m^3/min)

Figure P.2 — Sprinklered sub-ceiling below a ventilator

P.8.6 Walkways and conveyors

Walkways and conveyors, not exceeding 3,0 m width, shall be protected underneath by a centrally located single row of ESFR sprinklers or spray pattern sprinklers. The sprinklers shall be spaced not more than 3,0 m apart. Walkways and conveyors exceeding 3,0 m width shall be treated as mezzanines.

P.8.7 Sprinkler protection beneath mezzanines

Where the height of the mezzanines above the floor exceeds 4,5 m, the underside of the mezzanines shall be protected by ESFR sprinklers. Where the height of the mezzanines above the floor is 4,5 m or less. ESFR or appropriate spray pattern sprinkler protection might be employed.

Where mezzanines have openings into the protected building, the storage beneath the mezzanine shall not be closer to the open face than:

a) the outside line of sprinklers beneath the mezzanine, if there is no vertical smoke curtain of at least 600 mm depth; or

b) within the bounds of a 600 mm deep smoke curtain.

Where spray pattern sprinkler protection is used below low mezzanines, it should fully conform to the appropriate clauses of EN 12845. See also P.10.4.

P.9 ESFR sprinkler installation design

P.9.1 Installation type

Sprinkler installations shall be of the wet-pipe type.

P.9.2 Sprinkler nominal k-factor

The sprinklers used shall be in accordance with Table P.17.

Table P.17 — Sprinkler K-factor

Sprinkler nominal k-factor $L / min^{-1}.bar^{-1/2}$	**Sprinkler pattern**
115	Spray
200 and 242	ESFR
320 and 360	ESFR

P.9.3 Temperature ratings thermal sensitivity and colour codings

ESFR sprinklers and any spray pattern sprinklers below walkways and mezzanines shall have a quick thermal sensitivity rating. All sprinklers shall have one of the temperature ratings given in Table P.18 and be correspondingly colour coded.

Table P.18 — ESFR sprinkler temperature ratings and colour codings

Glass bulb sprinklers		Fusible link sprinklers	
Temperature rating °C	**Colour of bulb liquid**	**Temperature rating** °C	**Colour of yoke arms**
68	Red	68 to 74	uncoloured
93	Green	93 to 100	white

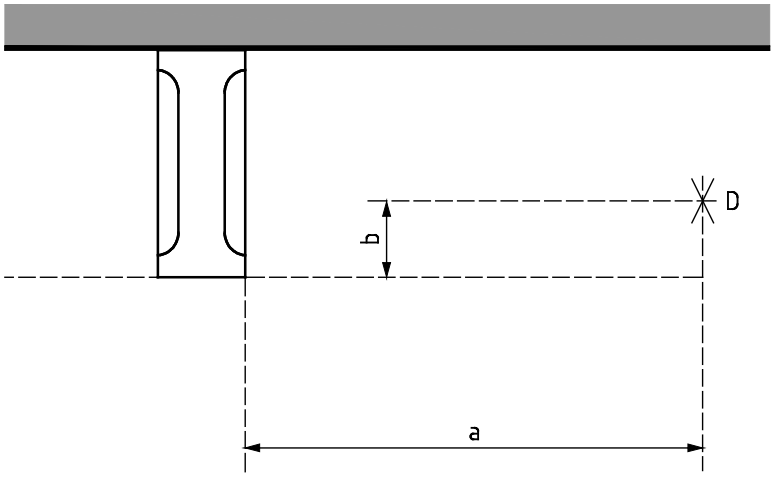
P.9.4 ESFR sprinkler location relative to obstructions at or near the ceiling or roof

Pendent ESFR sprinklers shall be located at the appropriate horizontal distance from obstructions at the ceiling or roof such as beams, ducts, joists, distribution pipes, range pipes or light fittings as given in Table P.19.

ESFR sprinklers should be located no closer than 0,1 m horizontally from the bottom near side edge of joists, trusses or similar obstructions. In some instances it might be advantageous to vary ESFR sprinkler spacings across the ceiling to avoid obstructions to the sprinkler water distribution.

Table P.19 — ESFR sprinkler location relative to ceiling obstructions such as beams or joists

Distance 'a' [1]		Distance 'b' [1]
Minimum horizontal distance from sprinkler axis to side of obstruction		**Maximum height of ESFR sprinkler deflector above (+) bottom of obstruction**
Greater than mm	**Less than mm**	**mm**
100	300	0
300	500	40
500	600	75
600	800	140
800	900	200
900	1100	250
1100	1200	300
1200	1400	380
1400	1500	460
1500	1700	560
1700	1800	660
1800	1850	790
NOTE See Figure P.3		



Key

D deflector

a distance from beam/joist

b distance from underside of beam/joist

Figure P.3 — Position of deflector when located above bottom of beam or other obstruction located at the ceiling

P.9.5 Upright ESFR sprinklers shall be located at the appropriate horizontal distance from obstructions at the ceiling or roof such as beams, ducts, joists, distribution pipes, range pipes or light fittings. See individual listings for each sprinkler type.

P.9.6 ESFR sprinklers shall be permitted for use in buildings with all types of ceiling construction. Where the depth of solid structural members (beams, stem, etc.) exceed 300 mm, ESFR sprinklers shall be installed in each bay formed by the solid structural members. Minimum sprinkler spacing and area of coverage shall comply with the requirements of Table P.20.

P.10 Pipe sizing

P.10.1General

ESFR sprinkler installations shall be fully hydraulically calculated.

NOTE Any pipe layout might be used, subject to the sprinkler spacing and layout requirements. No provisions have been made for determining pipe sizes using pre-calculated pipe sizing tables.

P.10.2Minimum pipe sizes

The nominal bore of distribution pipes and range pipes shall not be less than 25 mm.

P.10.3Minimum ESFR sprinkler flow pressure

The calculated discharge pressure of any ESFR sprinkler, when all the design sprinklers at ceiling level plus any additional sprinklers under obstructions are operating, shall not be less than as given in Tables P.2 to P.16.

P.10.4The number of sprinklers assumed to be operating

The number of roof or ceiling ESFR sprinklers assumed to be operating shall be twelve (12) where the ceiling height exceeds 4,5 m. For low ceiling heights, such as mezzanines where the height is 4,5 m or less, the

number of ESFR sprinklers assumed to be operating shall be six (6). Any sprinklers below obstructions, or a specified number of in-rack sprinklers beneath the roof or ceiling ESFR sprinkler assumed area of operation shall be included in the hydraulic calculations if they are fed from the same installation as the roof or ceiling sprinklers under consideration.

P.10.5Shape of design sprinkler area

To determine the water supply capacity and for pipe sizing purposes, the shape of the design sprinkler area shall be taken as four adjacent sprinklers operating on each of three adjacent range pipes, plus any additional sprinklers as specified in P.10.4. Where ESFR sprinklers are used to protect storage areas beneath mezzanines and where the design number of sprinklers is reduced to six ESFR sprinklers, then three sprinklers shall be assumed to operate on each of two ranges.

Where range pipes have fewer than the designated number of ESFR sprinklers per range, all the sprinklers should be assumed to be operating, and the number of ranges involved should be increased to compensate.

P.10.6Sprinklers beneath obstructions

Any additional ESFR sprinklers beneath obstructions within the design area, shall be assumed to be operating, at not less than the specified ESFR sprinkler flow pressure as defined in Tables P.2 to P.16.

NOTE See also P.7.3 for additional intermediate sprinkler requirements.

P.11 Sprinkler spacing and location

P.11.1ESFR sprinkler area of coverage

The area of coverage and spacing of ESFR sprinklers shall conform to Table P.20.

Table P.20 — ESFR sprinkler spacing

Ceiling height	Distance between sprinklers		Area of coverage per sprinkler	
	Minimum	Maximum	Minimum	Maximum
m	m	m	m^2	m^2
≤ 9	2,4	3,7	6,0	9
> 9 ≤ 13,7	2,4	3	6,0	9

P.11.2Obstructions

Elimination of obstructions is critical to the success of suppression mode sprinklers. There can be cases where a slight extension in sprinkler spacing and coverage in isolated areas can eliminate obstructions. If increasing spacing between two adjacent heads on ranges or between two adjacent ranges can eliminate obstructions, then the following extensions are allowable:

a) In buildings up to 9,1 m high, the maximum spacing of 3,7 m and area of coverage might be increased to 10,7 m^2 for those sprinklers that need to be moved in order to be at least 300 mm from joists.

b) In buildings over 9,1 mm and up to 12,2 m high, the maximum spacing of 3,0 m might be increased to 3,4 m, with a maximum area of coverage of 10,2 m^2, for those sprinklers that need to be moved in order to be at least 300 mm from bar joists.

NOTE These extensions apply only to a maximum of two adjacent sprinklers on ranges or two adjacent ranges.

P.11.3Sprinkler positioning relative to roof and ceilings

Sprinklers shall be located beneath the ceiling in accordance with Table P.21.

Table P.21 — Sprinkler distance from the underside of the ceiling

Sprinkler nominal k-factor l.min-1.bar-1/2	Sprinkler pattern	Vertical distance from the underside of the ceiling to the sprinkler deflector	
		Not less than mm	Not more than mm
115	Spray	75	150
200 and 240 -pendent	ESFR	150	360
200 and 240 -upright	ESFR	75	150
320 and 360	ESFR	150	460

P.11.4Sprinkler orientation relative to the floor or pipework

ESFR sprinklers shall be installed with the waterway axes perpendicular to the ceiling.

P.11.5Clear space below sprinklers

Throughout the protected area the clear space below ESFR sprinklers (including any mezzanines) shall be at least 1,0 m.

P.11.6Sprinkler location relative to draught or smoke curtains

Where draught or smoke curtains are fitted at the ceiling level, forming bays, the draught or smoke curtain shall be treated as a boundary.

P.11.7Positioning of ESFR sprinklers relative to draught or smoke curtains

Where draught or smoke curtains are required by the fire authorities within ESFR sprinkler arrays, the sprinklers on either side of the draught or smoke curtain should be of equal distance (± 200 mm), from the smoke curtain.

NOTE The distance of sprinklers from the draught or smoke curtain might vary along the length of the draught or smoke curtain if there are changes in sprinkler spacing.

P.11.8ESFR sprinkler protection adjacent to areas protected by standard sprinklers

Where ESFR sprinkler protection adjoins areas protected by standard sprinklers the following measures shall be complied with:

a) where ESFR and the adjacent non-ESFR sprinklers are at the same ceiling height or where ESFR sprinklers are installed at a greater ceiling height than non-ESFR sprinklers, smoke curtains shall be installed at the ceiling separating ESFR and non-ESFR sprinklers. The smoke curtains shall be at least 600 mm deep and shall be located at the midpoint between the ESFR and non-ESFR sprinklers. The smoke curtain shall be made of non-combustible material.

b) an aisle 1,2 m wide, free of all stored goods, shall be maintained between ESFR protected areas and those protected by non-ESFR sprinklers. The centre of the aisle shall coincide with the midpoint between the ESFR and non-ESFR sprinklers.

P.12 Water supplies

P.12.1 Pump drive and power arrangements

See 10.1.

P.12.2 Pump selection

For each ESFR system there shall be:

a) at least two full capacity suction pumps, one of which shall be diesel driven. Each pump when operating alone shall provide not less than Q_{max}. for the design number of sprinklers, at sprinkler head operating pressures of not less than that specified in Tables P.2 to P.16 plus any flow needed for pump cooling. The pumps shall have compatible pressure flow characteristics so that when operating in parallel neither pump shall be overloaded at any point within the specified range of output flows; or

b) three half capacity suction pumps, two of which shall be diesel driven. 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. A flow of Q_{max} for the design number of sprinklers, at sprinkler head operating pressure of not less than that specified in Tables P.2 to P.16, plus any flow needed for pump cooling, shall be provided by any combination of two pumps operating in parallel.

Where the water supply is providing protection to storages containing high value goods or their loss would be critical, or where there are multiple buildings or storage, additional pumping capacity should be considered.

P.12.3 Duration

The water source for ESFR sprinklers shall have a system design capacity of not less than 60 min of duration based on Q_{max}.

Bibliography

EN 671 (all parts), *Fixed fire fighting systems — Hose systems*

EN ISO 9001, *Quality management systems — Requirements (ISO 9001)*

EN ISO 17769-1, *Liquid pumps and installation — General terms, definitions, quantities, letter symbols and units — Part 1: Liquid pumps (ISO 17769-1)*

National Annex NA
(informative)

Guidance and material related to UK practice

NA.1 General

The following guidance and material concerning design and installation of fixed fire sprinkler systems is provided in relation to UK practice.

NA.2 Guidance related to pumps and supplies of water and electricity

NA.2.1 Connections from the fire sprinkler water supply

It is normal practice in the UK for the water supply to fire sprinkler equipment to be reserved solely for use by the fire sprinkler system. If the water supply is being considered for use for other purposes, such as connections to be taken from the fire sprinkler water supply to feed other services, consultation with the authorities having jurisdiction (which might include the insurers) is recommended.

NA.2.2 Pump curve stability

In the UK, only pumps with a stable H(Q) curve are recommended for use for sprinkler systems (i.e. ones for which the maximum head and shut-off are coincidental and the total head declines continuously with increasing rate of flow).

NA.2.3 Electric pump power supplies

It is recommended that electrically driven pumps are connected to the electricity supply for the building so that this cannot be inadvertently isolated from the incoming supply mains to achieve constant availability (see subclause 10.8.2).

NA.3 Material related to UK practice

NA.3.1 Early Suppression Fast Response (ESFR)

ESFR is a specialized and evolving approach to sprinkler protection design which may be employed as a loss prevention measure in the UK. Refer to the *LPC Rules for Automatic Sprinkler Installations*, TB209 – ESFR sprinkler protection, for the appropriate guidance. Issues include, but are not limited to, obstructions and ceiling heights.

NA.3.2 Selection of sprinkler head K-factors

Larger K-factor sprinklers may be more effective in controlling and suppressing fires by operating fewer sprinkler heads. Further details may be found in the *LPC Rules for Automatic Sprinkler Installations*, TB207 – Selection of sprinkler heads, and/or the sprinkler head manufacturer’s data sheets.

NA.3.3 Scotland specific guidance

In Scotland, specific guidance, published by the Scottish Government, is available in respect of the storage of wooden barrels containing spirit based liquors. This is '*Whisky Maturation Warehouses – Storage Buildings (Class 1) – Automatic Fire Suppression Systems*' and is available at http://www.gov.scot/Resource/0046/00469548.pdf.

Note: It is beyond the scope of the technical committee responsible for this document [BS EN 12845] to consider the suitability of the alternative requirements proposed by the Scottish Government.

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