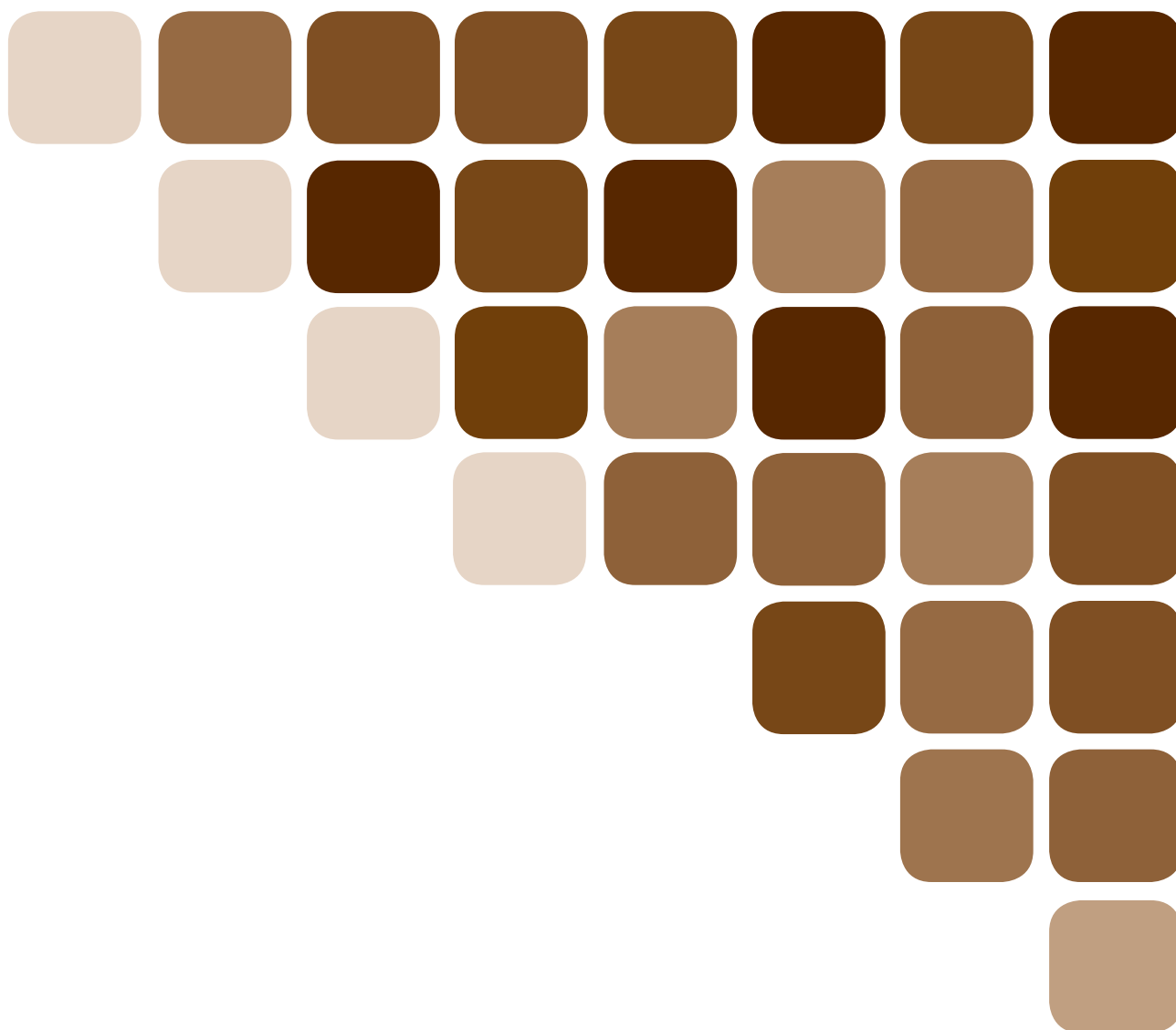


CEA 4001  
Sprinkler Systems: Planning and Installation



# PROPERTY INSURANCE

## Prevention Specifications

CEA 4001: (February 2009)

(EFSAC endorsed)

This technical rule contains updated specifications and more details compared with the previous edition (August 2006) and also by comparison with the European Standard EN 12845. The main updated requirements are highlighted in yellow.

### About the CEA

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## 0 Foreword

*These specifications prepared by*

- *the CEA, the European insurance and reinsurance federation, in the framework of the traditional loss prevention work by European insurers and in line with the EC Commission's group exemption regulation in co-operation with*
- *the European Committee of the Manufacturers of Fire Protection and Safety Equipment and Fire Fighting Vehicles (EUROFEU)*

*are aimed at providing the conditions for a Europe wide uniform high level of personal and property protection with at least the same level of efficiency and reliability as given by EN 12845:2004, even if specific differences appear between the 2 documents.*

*CEA Member Associations have agreed to adopt these specifications and to withdraw any contradicting specification of their own.*

*With the explicit endorsement of the*

- *European Fire and Security Advisory Council (EFSAC)*

*it is confirmed that these specifications document the latest state of the art.*

## 1 General

### 1.1 Scope

These Rules specify requirements and give recommendations for the design, installation and maintenance of fixed fire sprinkler systems in buildings and industrial plant, and particular requirements or sprinkler systems which are integral to measures for the protection of life.

The requirements and recommendations of these Rules are also applicable to any addition, extension, repair or other modification to a sprinkler system.

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

The requirements concerning water supplies may be applicable as guidance, to be used with experienced judgement for other fixed, fire fighting systems where no other CEA specifications exist.

These Rules do not deal with water spray deluge systems.

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.

These Rules are 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.

They are intended only for fixed fire sprinkler systems in buildings and other premises on land. Although the general principles may well apply to other uses (e.g. maritime use), for these other uses additional considerations will almost certainly have to be taken into account.

## 1.2 Aims

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.

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

In some life safety applications, an authority might specify sprinkler protection only in certain designated areas, and solely to maintain safe conditions for the evacuation of persons.

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 extinguishing means, 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.

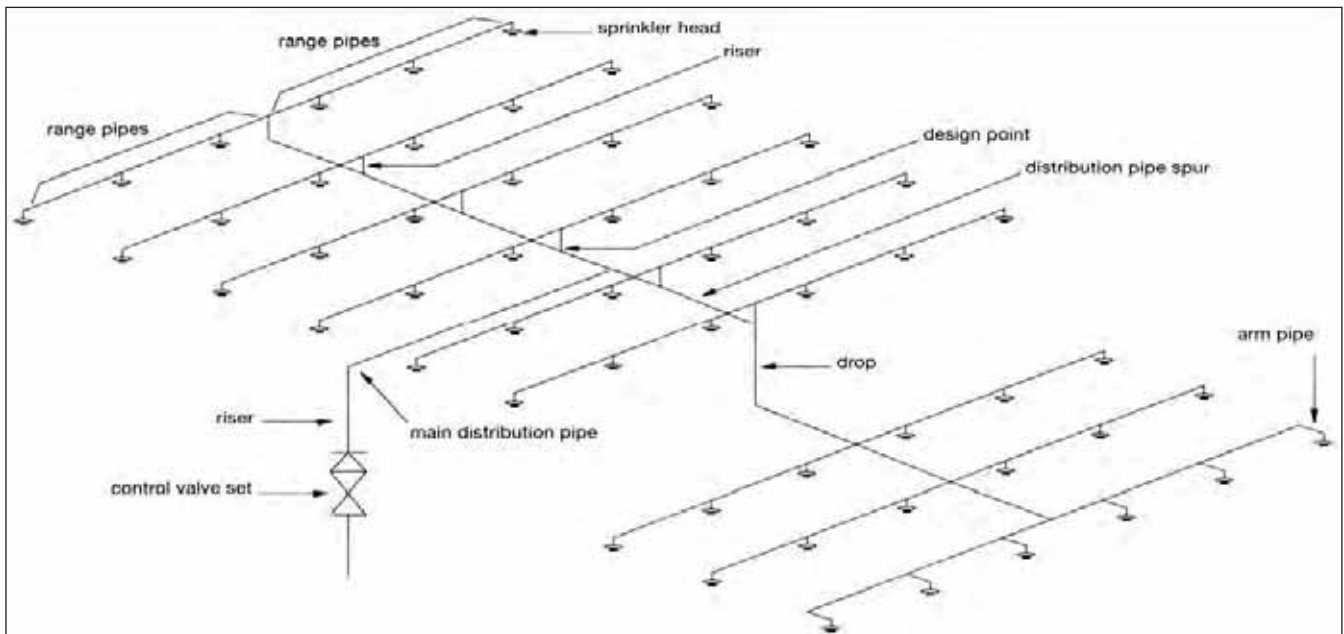
When sprinkler systems are out of service extra attention should be paid to fire precautions and the appropriate authorities informed.

## 1.3 Description

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 other specified places. The main elements of a typical installation are shown in Figure 1.

The sprinklers operate at predetermined temperatures to discharge water over the affected part of the area below. The flow of water through the alarm valve initiates a fire alarm.





***Figure 1 Main elements of a sprinkler installation***

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.

#### 1.4 Approvals

##### 1.4.1 Approved installers and components

Sprinkler systems shall be installed in accordance with the specifications by approved installers using approved components and using approved methods for sizing pipework as specified in annex G.

If the installation of a system involves more than one approved installer, one of them shall be responsible for the entire installation.

If local requirements make sub-contracting necessary such as installation of electrical supplies or town mains connections, the approved installer shall inform the sub-contractor of any special requirements for sprinkler installations to satisfy this specification.

##### 1.4.2 Completion

The approved installer shall send a completion statement to the authorities when the system is finally installed. The authorities' inspector will then carry out the approval inspection. The same procedure will apply to existing systems where alterations have been made.

##### 1.4.3 Third party inspection

During the inspection, the shut down period shall be in accordance with 18.1.3.

##### 1.4.3.1 Annual Inspection

The sprinkler system shall be periodically inspected at least once a year by the authorities' inspector.

The inspection report shall confirm that the system is in accordance with the rules, well maintained and in full working order. Any faults and deficiencies shall be noted in the inspection report and the authorities shall specify the time limits for rectification.

#### 1.4.3.2 Long-term Reliability Inspection

The pipes and the sprinkler's heads shall be inspected in great detail at least every 25 years for wet installations and 15 years for dry or alternate installations.

##### 1.4.3.2.1. Pipes

The pipework shall be internally and externally inspected. At least one range pipe shall be inspected per 100 sprinklers over an appropriate length. Not less than two-range pipe lengths per control valve set shall be examined. Other pipes shall be inspected if the range pipe examined exhibits an unacceptable level of corrosion or tuberculation.

The pipework shall be hydrostatically tested to a pressure equal to the maximum static pressure or 12 bar, whichever is the higher pressure for a period of 2 hours and, where possible, the pipe work shall be thoroughly flushed out.

All defects which can adversely affect the hydraulic performance of the system shall be eliminated. The national authorities shall evaluate the pipe defects.

##### 1.4.3.2.2 Sprinklers

A number of sprinklers shall be removed and inspected. Table 1 specifies the scope of sampling as a function of the total number of sprinklers installed in the premises.

**Table 1 :Minimum number of sprinklers per type to be inspected**

Total number of sprinklers installed (n)	Minimum number of sprinklers to be inspected (batch)
$n < 5000$	20
$5000 < n < 10000$	40
$10000 < n < 20000$	60
$20000 < n < 30000$	80
$n > 30000$	100

Sprinklers removed for inspection shall be visually inspected:

The following tests shall be carried out on samples selected from the batch of sprinklers:

- Operating temperature;
- Function and minimum operating pressure;
- Leak resistance;
- K factor;

And where appropriate:

- Thermal response.

The authorities shall evaluate the results in function of the demand characteristics of the installation and, if necessary, the sprinklers shall be changed.

#### 1.4.4 Responsible person

The owners shall appoint a responsible person and a substitute, who after they have been given the necessary instructions by the installer, shall ensure that the system remains in working condition. The name, address and telephone number of the person responsible for the installation, as well as those of his or her substitute, shall be prominently displayed in the sprinkler valve room.

The owner shall ensure that:

- the installation conforms to the rules at all times;
- the installation is in working order at all times;
- the installation is checked, maintained and tested in accordance with the installers' instructions and the CEA rules;
- the installation is inspected, by contract, at least once a year by one of the authorities' inspectors appointed by the insurers;
- any faults or deficiencies are corrected within the time limits laid down by the authorities.

## 2 Definitions

For the purposes of these rules, the following definitions apply.

### **'A' gauge**

A pressure gauge connected to a town main connection, between the supply pipe stop valve and the check valve.

### **accelerator**

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

### **alarm test valve**

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

### **alarm valve**

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

### **alarm valve, alternate**

An alarm valve suitable for a wet, dry or alternate installation.

### **alarm valve, dry**

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

installation.

**alarm valve, pre-action**

An alarm valve suitable for a pre-action installation.

**alarm valve, wet**

An alarm valve suitable for a wet installation.

**area of operation**

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

**area of operation, hydraulically most favourable**

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

**area of operation, hydraulically most unfavourable**

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

**arm pipe**

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

**authorities**

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

**'B' gauge**

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

**booster pump**

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

**'C' gauge**

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

**control valve set**

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

**design density**

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

**design point**

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

**detector sprinkler**

A sealed sprinkler mounted on a pressurized pipeline used to control a deluge valve. Operation of the

detector sprinkler causes loss of air or inert gas pressure to open the valve.

**distribution pipe**

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

**distribution pipe spur**

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

**drop**

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

**end-centre array**

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

**end-side array**

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

**escutcheon plate**

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

**exhauster**

A 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.

**fire resisting compartment**

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

**fully calculated**

A term applied to an installation in which all the pipework is sized by hydraulic calculation by the approved sprinkler contractor.

**gridded configuration**

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

**hanger**

An assembly for suspending pipework from elements of building structure.

**high rise system**

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

**installation (sprinkler installation)**

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

**installation, alternate**

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

**installation, dry (pipe)**

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

**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.

**installation, wet (pipe)**

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

**jockey pump**

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

**life safety**

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

**looped configuration**

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

**main distribution pipe**

A pipe feeding a distribution pipe.

**maximum flow demand ( $Q_{max}$ )**

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

**mechanical pipe joint**

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

**multiple control**

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

**multi-storey building**

A building comprising two or more storeys, above or below ground.

**node**

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

**pipe array**

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

**pre-calculated**

A term applied to an installation in which the pipes down-stream of the design point(s) have been previously sized by hydraulic calculation. Tables of diameters are given.

**range pipe**

A pipe feeding sprinklers either directly or via arm pipes.

**riser**

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

**sprinkler, (automatic)**

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

**sprinkler, ceiling or flush pattern**

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

**sprinkler, concealed**

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

**sprinkler, conventional pattern**

A sprinkler that gives a spherical pattern of water discharge.

**sprinkler, dry pendent pattern**

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

**sprinkler, dry upright pattern**

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

**sprinkler, fusible link**

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

**sprinkler, glass bulb**

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

**sprinkler, horizontal**

A sprinkler which the nozzle directs water horizontally.

**sprinkler, pendent**

A sprinkler in which the nozzle directs water downwards.

**sprinkler, recessed**

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

**sprinkler, sidewall pattern**

A sprinkler that gives an outward half-paraboloid pattern discharge.

**sprinkler, spray pattern**

A sprinkler that gives a downward paraboloid pattern discharge.

**sprinkler, upright**

A sprinkler in which the nozzle directs water upwards.

**sprinkler system**

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

**sprinkler yoke (arms)**

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

valve.

**staggered (sprinkler) layout**

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

**standard (sprinkler) layout**

A layout with sprinkler on adjacent range pipes forming a rectangle.

**subsidiary alternate (wet and dry pipe) extension**

A part of a wet installation that is selectively charged with water or air/inert gas according to ambient temperature conditions and which is controlled by a subsidiary dry or alternate alarm valve.

**subsidiary dry extension**

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

**supply pipe**

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

**suspended open cell ceiling**

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

**terminal main configuration**

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

**terminal range configuration**

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

**trunk main**

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

**water supply datum point**

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

**zone**

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

**3 Contract planning and documentation**

**3.1 General**

Sprinkler systems, extensions and modifications shall be carried out by companies using components who and which are approved by the insurers (see Annex I).

The information specified in 3.3 and 3.4 shall be available to the user. All drawings and information documents shall carry the following information:

- a) the name of the user and the owner;



- b) the address and location of premises;
- c) the occupancy of each building;
- d) the name of the designer;
- e) the name of the person responsible for checking the design, who shall not also be the designer;
- f) date and number of issue.

### 3.2 Initial Considerations

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

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.

### 3.3 Preliminary or estimating stage

The information provided shall include the following:

- a) a general specification of the system; and
- b) a block plan of the premises showing:
  - 1) the type(s) of installation(s) and the hazard class(es) and 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) particulars 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 installation will comply fully with these rules or giving details of any deviations from their requirements and the reasons therefore.

### 3.4 Design stage

#### 3.4.1 General

The information provided shall include a summary schedule (see 3.4.2), complete working drawings of the sprinkler installation(s) (see 3.4.3) and details of the water supplies (see 3.4.4).

### 3.4.2 Summary schedule

The summary schedule shall give the following information:

- a) the name of project;
- b) all drawing or document reference numbers;
- c) all drawing or document issue numbers;
- d) all dates of issue of drawings or documents;
- e) all drawing or document titles;
- f) the type(s) of installation(s) and the nominal diameter(s) of each control valve set;
- g) the number or references of each installation main control valve set in the system;
- h) the number of sprinklers on each control valve set;
- i) the piping volume in the case of dry or alternate installations;
- j) the height of the highest sprinkler on each control valve set;
- k) a statement that the installation will comply fully with these rules or giving details of any deviations from their requirements and the reasons therefore;
- l) a list of approved components, included in the system each identified by manufacturer's name and model/reference number.

### 3.4.3 Installation layout drawings

#### 3.4.3.1 General

The scale shall be not less than 1:200. 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) constructional details of floors, ceilings, roofs, exterior walls and walls separating sprinklered and non-sprinklered areas;
- d) sectional elevations of each floor of each building showing the distance of sprinklers from ceilings, structural features, etc. which affect the sprinkler layout or the water distribution from the sprinklers;

- e) the location and size of concealed roof or ceiling voids, offices and other enclosures sealed at a level lower than the roof or ceiling proper;
- f) indication of trunking, stagings, platforms, machinery, light fittings, heaters, suspended open cell ceilings etc. which may adversely affect the sprinkler distribution;
- g) the sprinkler type(s) and temperature rating(s);
- h) the 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 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.

*NOTE: details of other services should not appear on sprinkler drawings except insofar as they are necessary for the correct installation of the sprinkler system.*

#### 3.4.3.2 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 H4);
- 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 LH installation 2251/min;
  - 2) in an OH installation 10001/min;
  - 3) in an HH installation the low corresponding to the design density given in Table 8;
- c) the calculation as specified in G.2, showing that:
  - 1) in LH and OH installations, for each run of distribution pipework;
 
$$p_f - p_h$$

is not more than the appropriate value specified in G.2.3 or G. 2.4; and/or

- 2) in HHP and HHS installations designed using Tables G11 to G14;

$$p_f + p_d + p_s$$

is not 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

$P_d$  is the pressure at the design point specified in Tables 8 or as appropriate, in bar;

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

$p_h$  is the static pressure between the level of the highest design point on the floor concerned and the level of the highest design point in the top storey, in bar;

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

#### 3.4.3.3 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 print-out:

- a) the program name and version number, if applicable;
- 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:

- the node or pipe reference scheme used to identify pipes, junctions, sprinkler heads and fittings which need hydraulic consideration;
- the position of the hydraulically most unfavourable area of operation;
- the position of the hydraulically most favourable area of operation;
- the four sprinklers upon which the design density is based;
- the height above datum of each point of identified pressure value;

e) for each operating sprinkler:

- 1) the sprinkler node or reference number;
- 2) the nominal K factor;
- 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;
- 2) nominal bore in millimetres;
- 3) the pipe constant for type and condition (see G1.1.) (e.g. Hazen Williams constant);
- 4) flow in litres per minute;
- 5) velocity in metres per second;
- 6) length in metres;
- 7) numbers, types and equivalent lengths of fittings;
- 8) static head change in metres;
- 9) pressures at inlet and outlet in bar;
- 10) friction loss in bar;
- 11) indication of flow direction.

### 3.4.4 Water supply

#### 3.4.4.1 Water supply drawings

The drawings shall show water supplies and pipework therefrom up to the installation control valves. The drawings shall be on an indicated scale of not less than 1: 100. A key to the symbols shall be included.

The position and type of stop and check valves and any pressure reducing valve, water meter, water lock and any connection supplying water for other services, shall be indicated.

#### 3.4.4.2 Hydraulic calculation

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

#### 3.4.4.3 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 test points shall be shown. The graph shall be corrected for friction losses and static head difference between the test location and either the control valve 'C' gauge or the suction tank infill valve, as appropriate;
- d) the date and time of the town main test;
- e) the location of the town main test point relative to the installation control valve; and 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.

#### 3.4.4.4 Automatic pump set

Where automatic pump sets form one or more of the water supplies 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 manufacturer's data sheet showing the following:
  - 1) the generated head graph;
  - 2) the power absorption graph;

- 3) the net positive suction head (NPSH) graph;
- 4) a statement of the power output of each prime mover;
- c) the installer's data sheet showing the pump set installed performance pressure/flow characteristics, at the control valve 'C' gauge for normal water level and for low water level 'X' (see Figures 4 and 5), and at the pump outlet pressure gauge for normal water level;
- d) the height difference between the control valve 'C' gauge and the pump delivery pressure gauge;
- e) the installation number and the hazard classification(s);
- f) the available and the specified NPSH at maximum required flow;
- g) the minimum depth of water cover in the case of submersible pumps; In addition where the pipework is fully calculated the following 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.

#### 3.4.4.5 Pressure tank

The following details shall be provided:

- a) the location;
- b) the total volume;
- c) the volume of stored water;
- d) the air pressure;
- e) the height of the highest sprinkler above the bottom of the tank;
- f) details of the means of replenishment.

#### 3.4.4.6 Water storage tank

The following details shall be provided:

- a) the location;
- b) the total volume;
- c) the volume and duration of stored water;
- d) inflow for reduced capacity tanks;
- e) vertical distance between the pump centre line and the tank low water level 'X';
- f) structural details of the tank and roof;

- g) anticipated frequency of schedule repairs requiring emptying of the tank.

#### 3.4.5 Electrical installation for electrically driven pumps

The following details shall be provided:

- a) protection of the cable against mechanical damage;
- b) protection of the cable against fire;
- c) layout drawing of the electrical installation.

#### 3.5 Commencement of installation works

Before the commencement of any works for new installations or an extension to an existing installation, the installer shall send a written notification to the authorities.

### **4 Extent of sprinkler protection**

#### 4.1 Buildings and areas to be protected

All areas of a building or of a communicating building shall be sprinkler protected, except in the cases indicated hereunder.

Any openings communicating between a sprinklered and an unsprinklered building or section shall be closed automatically in the event of fire to provide a fire resistance equivalent to that of the fire resisting compartment.

##### 4.1.1 Permitted exceptions within a building

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

- a) washrooms and toilets (but excluding cloakrooms) which are made of non-combustible materials and which are not used to store combustible materials;
- b) enclosed staircases containing no combustible material and constructed as fire resisting compartments;
- c) enclosed vertical shafts (e.g. lifts or service shafts) containing no combustible material and constructed as fire resisting compartments;
- d) rooms protected by other automatic extinguishing systems, (e.g. gas, powder and water spray), designed and installed in accordance with CEA rules;
- e) the ceiling above the wet end of paper machines. The lower level and adjacent areas where we usually find all the cable trays, hydraulics pumps and other technical equipment are not considered as wet part and shall be sprinkler protected. .

Other permitted exceptions can be allowed by the authorities.



#### 4.1.2 Necessary exceptions

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

- a) silos or bins containing substances which expand on contact with water;
- b) in the vicinity of industrial furnaces or kilns, salt baths, smelting ladles or similar equipment if the hazard would be increased by the use of water in extinguishing a fire;
- c) areas, room or places where the water discharged from a sprinkler might present a hazard.

In these cases, other automatic extinguishing systems shall be considered, designed and installed in accordance with CEA rules.

#### 4.2 Compartmentation and separation

4.2.1 Compartmentation between a sprinkler protected area and a non-protected area shall be in accordance with national regulations. Compartmentation and separation between combustible materials stored in the open air and in sprinklered buildings shall be in accordance with national regulations.

4.2.2 When there are no national regulations, the following should be applied.

*NOTE 1: for a single owner or occupier, the separation between combustible materials stored in open air and the sprinklered building should be not less than 10m or 1,5 times the height of the stored material, whichever is the greater.*

*NOTE 2: the separation between a sprinkler protected area and a non-protected area should be at least 60 minutes fire resistant and constructed of non-combustible materials.*

*NOTE 3: sprinkler protection should be provided in any adjacent building which is within 10m of the protected building and constitutes an exposure hazard.*

### **5 Classification of occupancies and fire hazards**

#### 5.1 General

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

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

This classification depends on the occupancy and the fire load and shall be in accordance with Annex A.

#### 5.2 Hazard classes

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

### 5.2.1 Light Hazard - LH

Covers non-industrial occupancies with low fire loads and combustibility and with no single area greater than 126m<sup>2</sup> with a fire resistance of at least 30 minutes.

### 5.2.2 Ordinary Hazard - OH

Covers trading and industrial occupancies where combustible materials with a medium fire load and medium combustibility are processed or manufactured.

Ordinary Hazard - OH, 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 may be stored in occupancies classified as OH1, 2 and 3 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 2 shall not be exceeded.

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

- c) Blocks of storage including surrounding aisles shall not exceed 216m<sup>2</sup> or an area specified by the authorities. Blocks of storage shall be separated by aisles all around (see table 2). The aisle shall be kept free of storage.

**Table 2: Maximum storage heights for OH occupancies**

Storage category	Maximum storage height h (m)		Width of aisles surrounding blocks of storage (m)
	Free standing or block storage (ST1)	All other cases	
I	4,0	3,5	2,0
II	3,0	2,6	2,0
III	2,1	1,7	2,0
IV	1,2	1,2	2,0
<i>NOTE: for storage heights exceeding these values, see 5.2.4.</i>			

### 5.2.3 High Hazard, Process - HHP

Covers trading and industrial occupancies where the materials concerned have a high fire load and high combustibility and are capable of developing a quickly spreading or intense fire.

High Hazard, Process risks - HHP, is sub-divided into 4 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.

#### 5.2.4 High Hazard, Storage - HHS

Covers the storage of goods where the height of storage exceeds the limits given in 5.2.2.

High Hazard, Storage - HHS, is sub-divided into 4 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.

### 5.3 Storage

#### 5.3.1 General

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

To determine the required design criteria for stored goods the procedure shown in Figure 2 shall be followed.

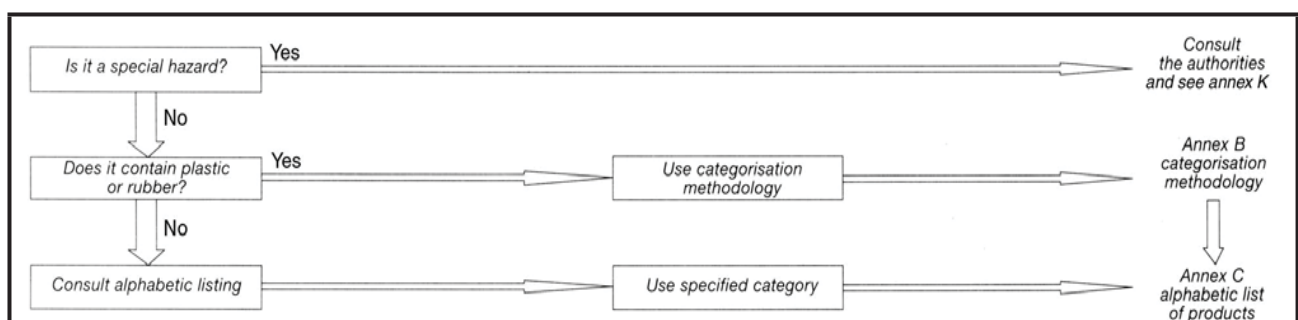
*NOTE 1: where large scale fire test data is available, it may be appropriate to use such data to establish design criteria.*

*NOTE 2: the method described in annex M is one of the methods which may be used to determine the risk of product in storage conditions in the following conditions:*

- for new material;
- for new packaging;
- for new storage configuration;
- for new product configuration;
- to redefine the classification of one product in the case of bad experience.

*NOTE 3: if, for technical reasons, intermediate sprinklers cannot be used, EFSR sprinklers can be use in accordance with annex L. In this case, the storage configuration shall be approved by the authorities”.*

**Figure 2- Flow chart for determining the class required for storage**



### 5.3.2 Storage Methods

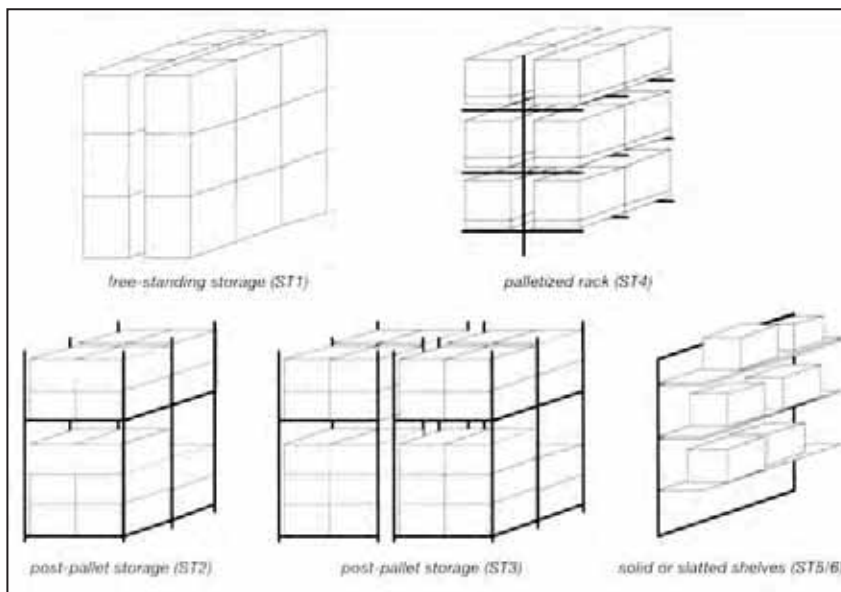
Methods of storing goods are classified as follows:

- ST1: free standing or block stacking;
- ST2: post or box pallets in single rows (i.e. with aisles no less than 2,4m wide);
- ST3: post or box pallets in multiple (including double) rows;
- ST4: palletised rack (beam pallet racking);
- ST5: solid or slatted shelves 1m or less wide;
- ST6: solid or slatted shelves over 1m and not more than 6m wide.

Typical examples of storage methods are given in Figure 3.

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

**Figure 3 - Types of storage method**



In order for sprinkler protection to be effective, the limitations and protection requirements of Table 3 shall be met.

***Table 3: Limitations and protection requirements for different storage methods***

Storage Configuration ST	Limitations	Protection requirements in addition to sprinklers at ceiling or roof
ST1	Storage shall be confined to blocks not exceeding 150 m <sup>2</sup> in plan area (see note 2).	None
ST2	Aisle between rows shall be not less than 2,4 m wide.	None
ST3	Storage shall be confined to blocks not exceeding 150 m <sup>2</sup> in plan area (see note 2).	None
ST4	Aisle separating rows are not less than 1,2m wide.	Intermediate sprinklers are recommended. (1)
	Aisle separating rows are less than 1,2m wide.	Intermediate sprinklers are required
ST5	Either the aisle separating rows shall be not less than 1,2m wide or storage blocks shall be not more than 150m <sup>2</sup> in plan area (see note 2).	Intermediate sprinklers are recommended. (1)
ST6	Either the aisle separating rows shall be not less than 1,2m wide or storage blocks shall be not more than 150 m <sup>2</sup> in plan area (see note 2).	Intermediate sprinklers are required or, if this is impossible, continuous non-combustible full height vertical bulkheads fitted longitudinally and transversally within each shelf.
NOTE 1: when the ceiling clearance is greater than 4m, in-rack sprinklers shall be used. NOTE 2: storage blocks shall be separated by aisles not less than 2,4m wide.		

#### 5.4 Protection of concealed spaces

If the height of the concealed space at roof and floor exceeds 0,8m, 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 0,8m, 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 15.3 for the pipework arrangement.

## **6Hydraulic design criteria**

### **6.1 General**

The design density shall be not less than the appropriate value given in this clause when all the ceiling or roof sprinklers in the room concerned, or in the 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 4. For HHS systems, 6.2 shall be applied.

*NOTE: for pre-calculated systems, the correct design criteria are assumed to be achieved by the application of water supply and piping requirements elsewhere in these rules.*

**Table 4: Design density and area of operation for LH, OH and HHP**

Hazard class	Design density (minimum) mm/min	Area of operation m <sup>2</sup>	
		Wet or pre-action	Dry or alternate
LH	2,2	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	Special consideration apply		

Areas of different densities in open communication shall be separated by a zone of at least 2 sprinkler rows wide of the higher density extending into the designed area of lower density.

### **6.2 High Hazard Storage - HHS**

#### **6.2.1 General**

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

Specific limitations apply to the various types of storage methods as detailed in Clause 5.

#### **6.2.2 Ceiling or roof protection only**

Table 5 specifies the appropriate design density and area of operation according to the category and maximum permitted storage height for the various types of storages 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. Storage heights exceeding these limits require that intermediate levels of in-rack sprinklers be provided as per 6.2.3 below. The distance between the maximum permitted storage height and the roof or ceiling sprinklers should not exceed 4m.

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

#### 6.2.3 Intermediate level in-rack sprinklers

- 6.2.3.1 Where more than 50 intermediate level sprinklers are installed in the racks, roof or ceiling sprinklers shall be installed with a separate set of control valves.
- 6.2.3.2 The design density for the roof or ceiling sprinklers shall be a minimum of 7,5mm/min over an area of operation of 260 m<sup>2</sup>. 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 6.
- 6.2.3.3 It shall be assumed that 3 heads are operating simultaneously on each level of in-rack sprinklers, up to a maximum of three levels, at the most hydraulically remote position. Where rack aisles are no less than 2,4m in width only one rack need be assumed to be involved. Where rack aisles are less than 2,4m but no less than 1,2m in width, two racks shall be assumed to be involved. Where rack aisles are less than 1,2m in width, three racks shall be assumed to be involved.

**Table 5: Design criteria for HHS with roof or ceiling protection only**

Storage methods	Maximum permitted storage height <sup>(1)</sup> m				Minimum design density	Area of operation (wet or pre-action system <sup>(2)</sup> )
	category I	category II	category III	category IV	mm/min	m <sup>2</sup>
ST1 free standing or block stacking	5,3 6,5 7,6	4,1 5,0 5,9 6,7 7,5	2,9 3,5 4,1 4,7 5,2	1,6 2,0 2,3 2,7 3,0	7,5 10,0 12,5 15,0 17,5	260
			5,7 6,3 6,7 7,2	3,3 3,6 3,8 4,1 4,4	20,0 22,5 25,0 27,5 30,0	300
ST2 post pallets in single rows and ST4 Palletised racks	4,7 5,7 6,8	3,4 4,2 5,0 5,6 6,0	2,2 2,6 3,2 3,7 4,1	1,6 2,0 2,3 2,7 3,0	7,5 10,0 12,5 15,0 17,5	260
			4,4 4,7 5,3 5,7 6,0	3,3 3,6 3,8 4,1 4,4	20,0 22,5 25,0 27,5 30,0	300
ST3 post or box pallets in multiple rows and ST5/ST6 solid or slatted shelves	4,7 5,7	3,4 4,2 5,0	2,2 2,6 3,2	1,6 2,0 2,3 2,7 3,0	7,5 10,0 12,5 15,0 17,5	260
<p><i>NOTE 1: the vertical distance from the floor to the sprinkler deflectors, minus 1m or the highest value shown in the table, whichever is the lower.</i></p> <p><i>NOTE 2: dry and alternate systems should be avoided on High Hazard storages especially with the more combustible products (the higher categories) and the higher storages. Should it nonetheless be necessary to install a dry or alternate system, the area of operation shall be increased by 25%.</i></p>						



**Table 6: Design criteria for roof sprinklers with in-rack protection**

Storage methods	Maximum permitted storage height above highest level of intermediate sprinklers <sup>(1)</sup> m				Minimum design density mm/min	Area of operation (wet or pre-action system) <sup>(2)</sup> m <sup>2</sup>
	category I	category II	category III	category IV		
ST4 palletized rack	3,5	3,5	2,2 2,6 3,2 3,5	1,6 2,0 2,3 2,7	7,5 10,0 12,5 15,0	260
ST5 and ST6 solid or slatted shelves	4,7 5,7	3,4 4,2 5,0	2,2 2,6 3,2	1,6 2,0 2,3 2,7 3,0	7,5 10,0 12,5 15,0 17,5	260

*NOTE 1: the vertical distance from the highest level of in-rack sprinklers to the roof or ceiling sprinklers, minus 1m.*

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

### 6.3 Pressure and flow requirements for precalculated systems

#### 6.3.1 LH and OH systems

The water supply shall be capable of providing the flows and pressures at each installation control valve set as specified in Table 7. The pressure loss due to friction and static between the water supply and each control valve set shall be calculated separately.

**Table 7: Pressure and flow requirements for precalculated LH and OH systems**

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

*NOTE : Ps is the pressure difference equivalent to the height of the highest sprinkler above the control valve set.*

### 6.3.2 HHP and HHS systems without in-rack sprinklers

*NOTE: in-rack sprinklers must always be fully calculated (see G.3).*

The water supply shall be capable of delivering at the highest design point not less than the appropriate flow and pressure specified in table 8, or as modified in 6.3.2.1 to 6.3.2.4.

The total requirement for the 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 8: Pressure and flow requirements for installations designed using Tables G11 to G14***

Design density mm/min	Flow required l/min		Pressure at the highest design point bar			
			Area of operation per sprinkler m <sup>2</sup>			
	Wet or pre-action	Dry or alternate	6	7	8	9
(1) With pipe diameters in accordance with Tables G11 & G12 and sprinklers having a K factor of 80						
7,5	2 300	2 900	-	-		2,25
10,0	3 050	3 800	1,80			3,90
(2) With pipe diameters in accordance with Tables G11 & G13 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 Table G13 & G14 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 G13 & G14 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	-

6.3.2.1 Where the area of the HHP or HHS portion of an occupancy is less than the area of operation, the flow rate in Table 8 can be proportionately reduced, (see 6.3.2.5), but the pressure at the highest sprinklers in the area shall either be equal to that shown in the table for the appropriate flow rate or be determined by hydraulic calculation.

6.3.2.2 When the HHP or HHS portion of occupancy involves less than 48 sprinklers, the flow rate and

appropriate pressure shown in Table 8 shall be available at the level of the highest sprinklers at the point of entry to the HHP or HHS area of sprinklers.

6.3.2.3 Where the design area of operation is greater than the area of HHP or HHS protection and this area is adjacent to the OH protection, the total flow rate shall be calculated as the sum of the HHP or HHS portion when reduced proportionately as in 6.3.2 plus the flow rate for the OH section calculated on the basis of a design density of 5mm/min. The pressure at the level of the highest sprinklers in the HHP or HHS portion of the risk shall be either that shown in Table 8, or be determined by hydraulic calculation.

6.3.2.4 When the design 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 8 for the appropriate design density, or be determined by hydraulic calculation. The flow rate for each distribution pipe shall be determined proportionately (see 6.3.2.5).

6.3.2.5 Where the basic design area of operation for a given design density is increased due to special circumstances, the flow rate shall be proportionately increased, (see 6.3.2.6), but the pressure at the design point shall remain unchanged.

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

$$Q_2 = Q_1 \frac{a_2}{a_1}$$

where:

$Q_2$  is the flow rate required, or in circumstances described in 6.3.2.4 the flow rate in each distribution pipe, in litres per minute;

$Q_1$  is the flow rate required as given in Table 8, in litres per minute;

$a_1$  is the area of operation for design density, in square metres;

$a_2$  is the area of operation required, or in circumstances described in 6.3.2.4 the area served by each distribution pipe, in square metres.

## 6.4 Pipe sizing and layout

### 6.4.1 Pipe sizing

Pipe sizes shall be determined in accordance with Annex G using one of the following methods:

- pre-calculated systems, where the diameters are partly taken from tables and partly calculated, using the method shown in G. 1 and G.2;
- fully calculated systems, where all diameters are determined by hydraulic calculation, using the method shown in G. 1 and G.3.

The CEA member shall decide which method or methods shall be used in their country, except that the following shall always be fully calculated:

layouts with intermediate level HHS sprinklers;

gridded or looped layouts.

## 6.4.2 Maximum system pressure

Sprinkler systems shall be designed in such a way as to ensure that sprinkler heads are never subjected to a pressure in excess of 12 bar except during pressure testing of the pipework, when the pressure shall not exceed 15 bar.

## 7 Water Supplies - General

### 7.1 Suitability

#### 7.1.1 Time of operation

Water supplies shall be capable of furnishing automatically at least the requisite pressure/flow conditions of the system. Except as specified in the case of pressure tanks, each water supply shall have a minimum water volume for the following minimum durations:

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

*NOTE 1: in the case of town mains, inexhaustible sources and all pre-calculated systems, the duration is implicit in the requirements given in these rules.*

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

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

*NOTE 2: water supplies should preferably be under the control of the user, or else the reliability and right of use should be guaranteed by the organisation having control.*

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

*NOTE 3: where there is no suitable fresh water source available, a salt or brackish water supply may be used provided the installation is normally charged with fresh water.*

*NOTE 4: in certain countries, the authorities may accept reduced duration.*

#### 7.1.2 Frost protection

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

### 7.2 Connections for other services

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

- a) as specified in Table 9;
- b) through a stop valve fitted upstream of the installation control valve set(s), as close as is practical to the point of connection to the sprinkler system supply pipe; and

- c) if the system is not a high rise system; and
- d) if the system is not protecting a multi-storey building.

The sprinkler system pumps shall be separate from any hydrant system pumps unless a properly designed combined water supply is used (see 8.6.4).

### 7.3 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.

### 7.4 Test facility devices

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

#### 7.4.1 At control valve sets

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

- a) where two or more control valve sets are installed together, the device need be installed only at the hydraulically most remote set, or, when the installations belong to different hazard classes, at the control valve set which requires the highest water flow;
- b) where the water supply is by an automatic pump or pumps, the flow measuring device may be installed at the pumphouse.

In all cases, the appropriate allowance must be made for the pressure losses between the water source and the control valve set(s) using the calculation methods specified in G.1.

Adequate facilities shall be provided for the disposal of test water.

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

#### 7.4.2 At water supplies

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

The testing apparatus shall be of adequate capacity and shall be installed in accordance with the manufacturer's instructions. Care shall be taken with the distance from valves and fittings. The apparatus shall be installed in a frost-proof area.

### 7.5 Pressure/flow tests on water supplies

For both precalculated and fully calculated installations, the water supply shall be tested at least at the installation maximum flow demand (Q max).

### 7.6 Water supply pressure test

### 7.6.1 General

Use the test facility specified in clause 7.4.

Test each supply to the installation independently with all other supplies isolated.

### 7.6.2 Storage pump and pressure tank supplies

Fully open the stop valves controlling the flow from the supply to the installation. Open the installation drain and test valve fully and check that pump(s) if fitted start automatically. Check that the flow is as specified in clause 6.3 and that recorded during the commissioning test. Record the supply pressure measured on the C gauge. Compare this with the appropriate value specified in clause 6.3 and the value recorded during the commissioning test.

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

Fully open the stop valves controlling the flow from the supply to the installation. Open the drain and test valve and check that the pump(s), if installed, have started automatically. Manipulate the drain and test valve to give the appropriate flow specified in clause 6. When the flow is steady record the supply pressure measured on the C gauge. Compare this with the appropriate value specified in clause 6 and the value recorded during the commissioning test.

### 7.7 Water contamination protection

Where a water contamination problem arises, consideration shall be given in accordance with national regulation and/or the CEA recommendations given in the document entitled « Recommendations for the Fire Protection of Stores Containing Hazardous Substances ».

***Table 9: 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 not less than 100mm	one, not more than 25mm diameter, for non-industrial use
Town main. Main and supply pipe not less than 150mm	one, not more than 40mm diameter, for non-industrial use or one, not more than 50mm diameter, for fire hose reels, to which may be made a further connection (close to the first connection, and fitted with a stop valve close to the feed end) not more than 40mm, for non-industrial use.
Elevated private reservoir, gravity tank or automatic pump	one, not more than 50mm, for fire hose reels.

## **8 Choice of water supply**

### 8.1 General

This chapter describes the various water supplies and combinations. National authorities shall determine the acceptabilities of these in respect of the hazard classifications and sprinkler installation.

Water supplies shall be one or more of the following:

- a) town mains (see 8.2);
- b) water storage tanks (see 8.3);
- c) inexhaustible sources (see 8.4);
- d) pressure tanks (see 8.5).

## 8.2 Town mains

### 8.2.1 General

The town main shall be capable of satisfying the requirements for pressure, flow and duration.

*NOTE: it may be necessary to take into account extra flow required for fire brigade purposes.*

Consideration shall be given to fitting strainers on all connections from town mains.

In the case of single water supplies, consideration shall be given to the installation of a pressure switch on the supply connection which shall operate an alarm system when the pressure in the supply drops to a predetermined value. The switch shall be positioned on the supply side of any back pressure valve and shall be equipped with a test valve.

### 8.2.2 Boosted mains

If booster pumps are used, they shall be installed in accordance with the requirements of clause 9.

*NOTE: the agreement of the water authority will normally be needed before a booster pump can be connected to a town main. The water authority or water undertaker will normally require that the pump cannot draw vacuum under any water supply and demand condition.*

Stop valves shall be fitted in the pump suction and delivery pipes as well as back pressure valves in the pump delivery. Where a single pump is supplied, a by-pass connection shall be provided with at least the same dimension as the water supply connection to the pump and be fitted with a back pressure valve and two stop valves. The pump or pumps shall be reserved solely for fire protection.

## 8.3 Water storage tanks

### 8.3.1 General

Water storage tanks, where used, shall be one or more of the following:

- pump suction tank;
- gravity tank;
- reservoir.

### 8.3.2 Minimum water volume

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 minimum water volume. The tank may be divided into two sections;
- a reduced capacity tank (see 8.3.4), where the required minimum 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 1,0m and ice venting provided. In the case of enclosed tanks, easy access shall be provided.

### 8.3.2.1 Precalculated systems

Table 10 specifies the minimum effective volume of water required for LH and OH precalculated systems. The quantities of water indicated shall be reserved solely for the use of the sprinkler system.

***Table 10: Minimum water volume for precalculated LH and OH systems***

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

Table 11 specifies the minimum quantity of water required for precalculated HHP or HHS systems. The water volume indicated shall be reserved solely for the use of the sprinkler system.



***Table 11: Minimum water volume for precalculated HHP and HHS systems***

Design density not exceeding mm/min	Minimum water volume m <sup>3</sup>	
	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	1 000
30,0	875	1 090

#### 8.3.2.2 Calculated systems

The minimum water volume shall be calculated by multiplying the maximum demand flow by the following operating times:

- LH 30 minutes
- OH 60 minutes
- HH 90 minutes

#### 8.3.3 Refill rates for full capacity tanks

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

The outlet of any feed pipe shall be situated at least 2,0m away from the pump inlet, measured horizontally.

#### 8.3.4 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;
- b) the effective capacity of the tank shall be no less than that shown in Tables 12;
- c) the tank capacity plus the inflow shall be sufficient to supply the system at full capacity as specified in 8.3.2;
- d) it shall be possible to check capacity of the inflow;
- e) the inflow arrangement shall be accessible for inspection.

***Table 12: Minimum capacity of reduced capacity tanks***

Hazard Class	Minimum capacity m <sup>3</sup>
LH - Wet or pre-action	5
OH1 - Wet or pre-action	10
OH1 - Dry or alternate OH2 - Wet or pre-action	20
OH2 - Dry or alternate OH3 - Wet or pre-action	30
OH3 - Dry or alternate OH4 - Wet or pre-action	50
HHP and HHS	70, but in no case less than 10% of the full capacity

#### 8.3.5 Effective capacity of tanks and dimensions of suction chambers

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

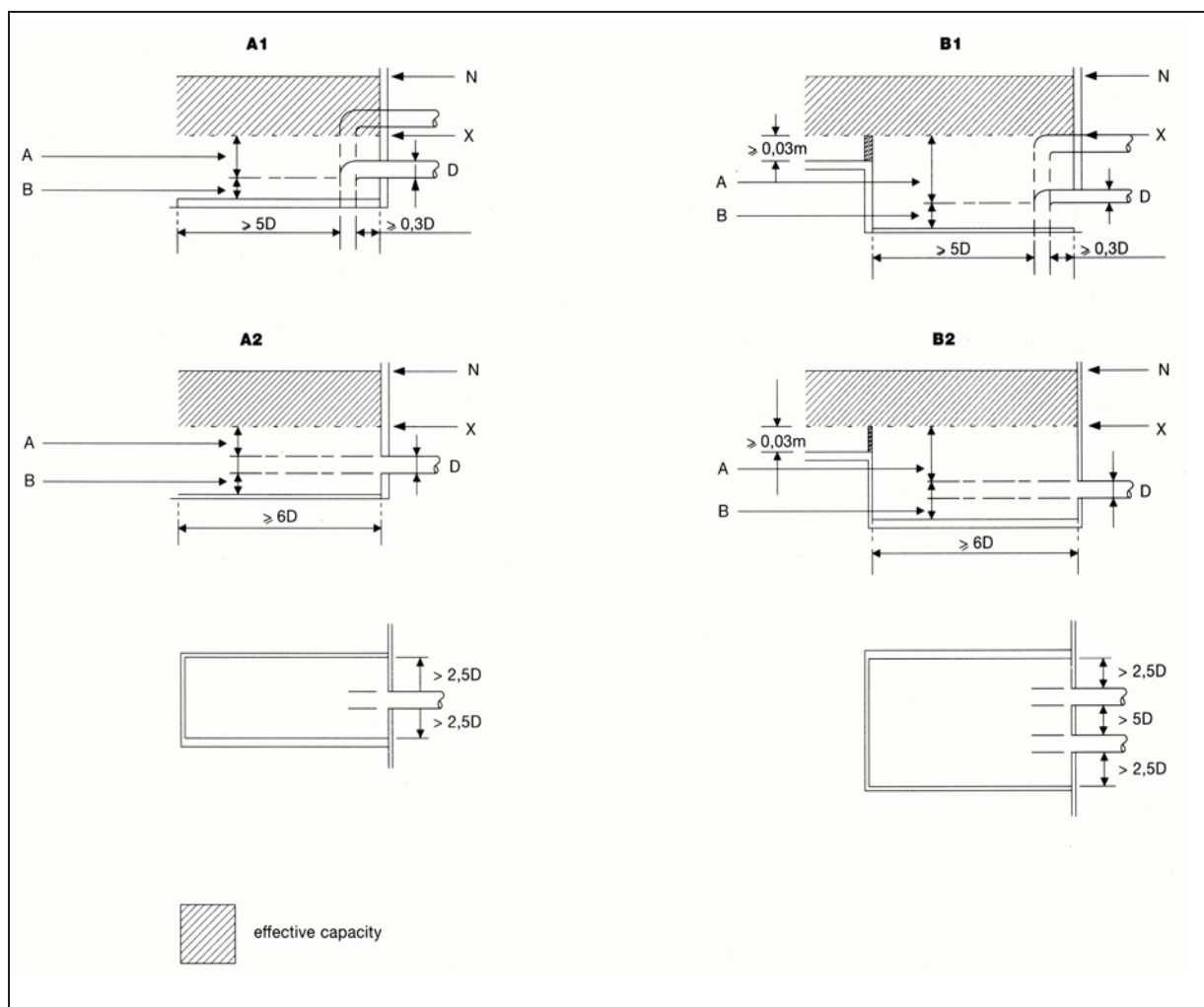
- N is the normal water line;
- X is the low water level;
- D is the diameter of the suction pipe.

Table 13 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 13, dimension 'A' may be reduced to 0,10m.

**Figure 4- Effective capacity of suction tanks and dimensions of suction chamber**



**Table 13: Suction pipe inlet clearances**

Nominal diameter of suction pipe 'D' mm	Distance 'A' minimum m	Distance 'B' minimum m	Minimum dimension of vortex inhibitor m
65	0,25	0,08	0,20
80	0,31	0,08	0,20
100	0,37	0,10	0,40
150	0,50	0,10	0,60
200	0,62	0,15	0,80
250	0,75	0,15	1,00
300	0,90	0,20	1,20
400	1,05	0,20	1,20
500	1,20	0,20	1,20

A tank may be provided with a sump in order to maximise the effective capacity (See Figure 4). In this case the sump width shall be not less than 3,6 times the nominal diameter of the suction pipe.

### 8.3.6 Strainers

In the case of pumps under suction lift conditions, a strainer shall be fitted upstream of the back pressure 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 5mm diameter to pass.

#### 8.4 Inexhaustible sources

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

##### 8.4.1 Settling chambers and suction pits

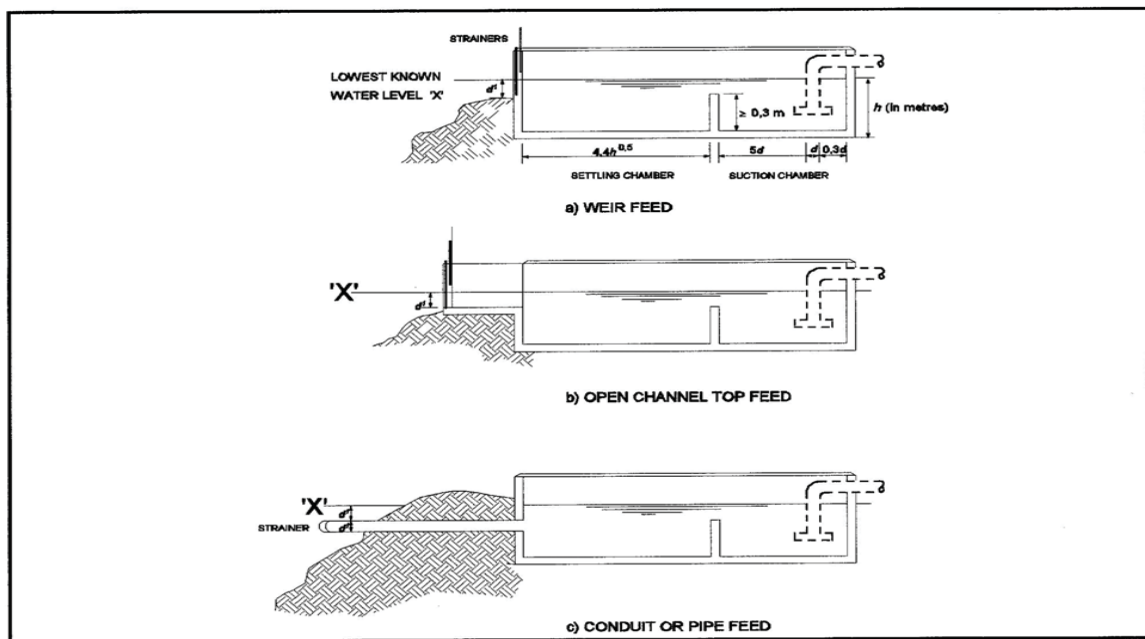
8.4.1.1 Where a suction or other pipe draws from a settling chamber or suction pit fed from an exhaustible source, the design and dimensions in Figure 5 shall apply. Pipes, conduits and the bed of open-topped channels shall have a continuous slope towards the settling chamber or suction pit of at least 1:125. The 0,357 diameter of feed pipes or conduit shall be determined by the following formula  $d = 21,68 \sqrt[3]{Q}$  where:

d: internal diameter in mm;

Q: flow in l/min. The suction chamber dimensions shall be as specified in 8.3.5.

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

*Figure 5 – Jackwells or suction pit*



8.4.1.2 The inlet to pipes or conduit shall be submerged at least 1 diameter below the lowest known water level. The depth 'd' of water in open channels or weirs (including the weir between the settling chamber and suction chamber) below the lowest known water level of the water source shall be not less than that specified in Table 14 for the corresponding width 'w' and flow, where the flow is the maximum flow output of the pump, i.e. the nominal flow for LH, OH and the maximum design flow for HHP and HHS. 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, their submergence below the lowest known water level (making any necessary allowances for ice) and clearance from the bottom shall conform to 8.3.5 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  $10d$  where  $d$  is the minimum bore of the pipe or conduit, and not less than 1,5m.

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

8.4.1.4 Before entering the settling chamber the water shall first pass through a removable screen of wire mesh or perforated metal plate having an aggregate clear area below the water level of  $150\text{mm}^2$  for each 1/min of pump nominal flow in the case of LH or OH or maximum design flow for HHP or HHS.

8.4.1.5 The inlet to the pipe or conduit feeding the settling chamber or suction pit shall be provided with a strainer having an aggregate clear opening 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 restrict the passage of a 25mm diameter sphere. Provision shall be made for the settling chamber to be isolated for periodical cleaning and maintenance. Duplicate supplies shall be provided with separate suction and settling chambers. The screen shall be strong enough to withstand the weight of water should it become obstructed and have a mesh not greater than 12,5mm.

**Table 14: Minimum width of settling chambers, suction pits, open channels and weirs**

0,25m < d* < 0,5m		0,5m < d* < 1,0m		d* < 1,0m	
width m	maximum flow l/min	width m	maximum flow l/min	width m	maximum flow l/min
0,088	280	0,082	522	0,078	993
0,125	497	0,112	891	0,106	1 690
0,167	807	0,143	1 380	0,134	2 590
0,215	1 200	0,176	1 960	0,163	3 630
0,307	2 060	0,235	3 160	0,210	5 650
0,334	2 340	0,250	3 510	0,223	6 260
0,410	3 160	0,291	4 480	0,254	7 830
0,500	4 190	0,334	5 590	0,286	9 580
0,564	4 950	0,361	6 340	0,306	10 750
0,750	7 260	0,429	8 310	0,353	13 670
1,110	12 050	0,527	11 420	0,417	18 070
1,170	12 800	0,539	11 820	0,425	18 640
1,500	17 380	0,600	13 900	0,462	21 410
2,000	24 400	0,667	16 270	0,500	24 400
4,500	60 300	0,819	21 950	0,581	31 140
		1,000	29 170	0,667	38 910
				2,000	203 300

\* Dimension d in Figure 5.  
NOTE : for dimensions not included in this table, the conduit shall be designed such that the water velocity does not exceed 0,2m/s.

Two screens shall be provided, with one in use and the other in a raised position ready for interchange when cleaning is necessary.

8.4.1.6 Where the suction inlet draws from a walled off area of the bed of the river, canal, lake etc., the wall itself shall be extended above the water surface with an aperture screening arrangement. Alternatively, the space between the top of the wall and the water surface shall be enclosed with a screen. Screens shall be as specified in 8.4.1.4.

8.4.1.7 Excavation of the bed of the lake etc., to create the necessary depth for a pump suction inlet is not recommended, but if unavoidable the area shall be enclosed with the largest screen practicable, but in any case having sufficient clear area as specified in 8.4.1.4.

## 8.5 Pressure tanks

### 8.5.1 General

A pressure tank is a tank containing water under air pressure which shall be sufficient to ensure that all the water can be discharged at the necessary pressure.

The pressure tank shall be reserved solely for the sprinkler system.

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

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

### 8.5.2 Housing

The pressure tank shall be housed either in a readily accessible position in a sprinkler protected building or in a separate sprinkler protected building of non-combustible construction used solely for the housing of fire protection water supplies and equipment. 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 minutes.

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

#### 8.5.3 Minimum capacity (water)

The minimum quantity of water in a pressure tank for a single supply shall be 15m<sup>3</sup> for LH and 23m<sup>3</sup> for OH1.

The minimum quantity of water in a pressure tank for duplicate supplies shall be 15 m<sup>3</sup> in LH and OH (all groups).

#### 8.5.4 Air pressure and contents

##### 8.5.4.1 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.

##### 8.5.4.2 Calculation

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

$$P = (P_1 + P_2 + 0,1h) \frac{V_t}{V_a} - P_1$$

where:

P is the gauge pressure, in bar;

P<sub>1</sub> is atmospheric pressure, in bar (assume P<sub>1</sub> = 1);

p<sub>2</sub> is the minimum pressure required at the highest sprinkler at pressure tank exhaustion, in bar. For precalculated systems this value shall be taken from Tables 7 and 8, plus any additional pressure losses between the control valve set and pressure tank (Table 7) or between the design point and pressure tank (Table 8), but ignoring static pressure;

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

V<sub>t</sub> is the total volume of the tank, in cubic metres; V<sub>a</sub> is the volume of air in the tank, in cubic metres.

#### 8.5.5 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 pressurising the tank completely in no more than 8 hours.

The water supply shall be capable of topping up with water at the gauge pressure (P in 8.5.4) of the pressure tank with a flow of at least  $6\text{m}^3/\text{hr}$ .

#### 8.5.6 Control and safety equipment

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

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.

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

### 8.6 Type of water supply

An example of the choice of the water supply is given in annex N. The authorities shall be consulted to determine the choice of water supply.

#### 8.6.1 Single water supplies

The water supply shall conform to the pressure, flow and duration requirements given in clauses 8 and 6.

The following constitute acceptable single water supplies:

- a) town main;
- b) town with one or more booster pumps;
- c) pressure tank (LH and OH I only);
- d) gravity tank;
- e) storage tank with one or more pumps;
- f) inexhaustible source with one or more pumps.

#### 8.6.2 Superior single water supplies

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

- a) town main fed from both ends, where each end is capable of satisfying the pressure and flow demands of the system. The town main pipe network shall be fed from two or more water sources and shall not be dependent at any point on a single, common trunk main;  
  
If booster pumps are required, two or more shall be provided;
- b) gravity tank with no booster pump, or water 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;



potable water shall be used;

painting or other corrosion protection, which reduces the need for emptying the tank for maintenance shall be approved by the authorities (see clause 18.4.6);

- c) inexhaustible source with two or more pumps.

#### 8.6.3 Duplicate water supplies

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

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

- a) no more than one pressure tank shall be used for OH systems;
- b) no more than one storage tank of the reduced capacity type shall be used.

Two or more pumps drawing water from two independent suction tanks constitute an acceptable duplicate water supply.

#### 8.6.4 Combined water supplies

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

*NOTE: some countries may 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.

#### 8.7 Isolation of water supplies

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, back pressure 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.

## **9 Pumps**

### **9.1 General**

The pump shall have a stable H (Q) curve,

Pumps shall be driven either by electric motors or diesel engines capable of providing at least the power required complying with 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 equal to 16m or maximum suction static head plus 11 m. whichever is greater.

The coupling between the driver and the pump of horizontal 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.

Pipework shall be supported independently of the pump.

### **9.2 Multiple pump arrangements**

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

Where two pumps are installed, each one shall be capable independently of providing the specified flows and pressures.

Where three pumps are installed, each pump shall be capable of providing at least 50% of the specified flow at the specified pressure.

Where more than one pump is installed in a superior or duplicate water supply, no more than one shall be driven by an electric motor. (See clause 9.8.1.1)

### **9.3 Compartments for pumpsets**

#### **9.3.1 General**

Pumpsets shall be housed in a compartment of non-combustible construction 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.

#### **9.3.2 Sprinkler protection**

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

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

### 9.3.3 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.

### 9.3.4 Ventilation

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

## 9.4 Maximum temperature of water supply

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

## 9.5 Valves and accessories

A stop valve shall be fitted in the pump suction pipe and a non-return and a stop valve shall be fitted in the delivery pipe. In lift condition, when the centre line of the pump is above the maximum water level, a stop valve may be omitted.

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.

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

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

## 9.6 Suction conditions

### 9.6.1 General

Wherever possible, horizontal centrifugal pumps should 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 8.3.5).

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

*NOTE: Suction lift and submersible pump arrangements should be avoided and only used when it is not practicable to arrange positive suction head. It is critical that suction lift arrangements should not vary from that stated in 9.6.2 and as shown in figures 5 and 6.*

### 9.6.2 Suction pipe

#### 9.6.2.1 General

The pump suction shall be connected to a straight or taper pipe at least two diameters long. The taper pipe shall have horizontal topside and a maximum included angle not exceeding 20°. Valves shall not be fitted directly to the pump inlet.

The suction piping, including all valves and fittings, shall be designed in such a way as to ensure that the available NPSH at the pump inlet exceeds the required NPSH by at least 1 m with the maximum demand flow and maximum water temperature (see table 15).

***Table 15: Pump pressure and flow rating***

Pipework	Hazard Class	Rated pump flow	Pump inlet condition
Pre-calculated	LH/OH	Maximum demand flow from table 7	For tanks, with water supply at low water level (see <i>X</i> in Figure 4). For booster pumps, with minimum town main pressure.
	HH	1,4 x Flow Required from table 8	
Fully calculated	All	Maximum demand flow	

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

A foot valve shall be fitted where the centre line of the pump is above the low water level (see 8.3.5).

#### 9.6.2.2 Positive head

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. This velocity may be increased to 2,5m/s, if the pressure in the suction pipe is not more than 0,4 bar below ambient pressure.

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

#### 9.6.2.3 Suction lift 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. This velocity may be increased to 2,5m/s, if the pressure in the suction pipe is not more than 0,4 bar below ambient pressure.

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

The height from the low water level (see 8.3.5) to the centre line of the pump shall not exceed 3,2m.

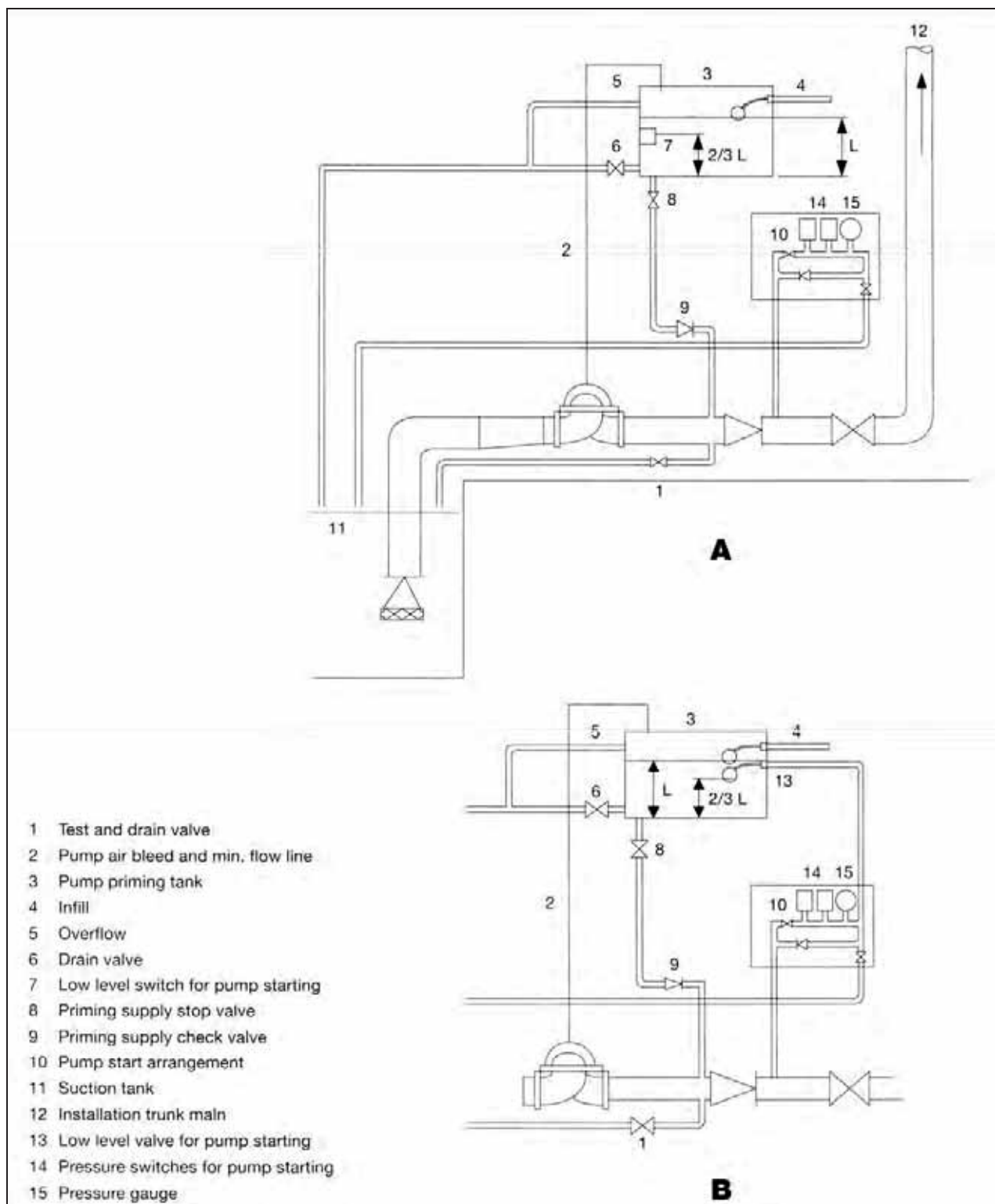
The suction pipe shall be positioned in the tank or reservoir in accordance with figure 4 and table 13 or figure 56 and table 14, as appropriate. A foot valve shall be fitted at the lowest point on the suction pipe. Each pump shall have automatic priming arrangements in accordance with 9.6.2.4.

#### 9.6.2.4 Pump priming for suction lift

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.

*Figure 5- Pump priming arrangement for suction lift*



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

If the supply to the priming tank is taken from the town main forming a supply to the sprinkler installation, the connection shall be made upstream of the non-return valve on the town main connection.

The size of the priming tank and the pipe shall be in accordance with table 16.

**Table 16: Pump priming tank capacity and pipe size**

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

## 9.7 Performance characteristics

### 9.7.1 General

The closed valve pressure shall not exceed 12 bars.

The NPSH required by the pump shall not exceed 5m at flows up to that defined in table 17

**Table 17: Pump size**

Hazard Class	Pump type	Pipework	Pump nameplate flow	Pump inlet condition
LH-OH	Suction	Pre-calculated	Nominal as table 18	Zero suction lift
LH-OH	Booster	Pre-calculated	Nominal as table 18	Zero town main pressure
HH	Suction	Pre-calculated	1,4x Flow required in Table 8	Zero suction lift
HH	Booster	Pre-calculated	1,4x Flow required in Table 8	Zero town main pressure
All hazards	Suction	Fully Calculated	Q max	Water supply at low water level
All Hazards	Booster	Fully Calculated	Q max	Zero town main pressure
<i>Note: Low water level is shown as "hm" in Figure 5</i>				

### 9.7.2 Pre-calculated systems - LH and OH

Where the pumps take water from a storage tank, the characteristic of pre-calculated LH and OH systems shall conform to table 18.

**Table 18: 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 OH2 wet or pre-action	$h \leq 15$	1,4	1 750	2,5	1 000	2,9	725
	$15 < h \leq 30$	2,0	2 050	4,0	1 000	4,4	725
	$30 < h \leq 45$	2,6	2 350	5,5	1 000	5,9	725
OH2 dry or alternative OH3 wet or pre-action	$h \leq 15$	1,4	2 250	2,9	1 350	3,2	1 100
	$15 < h \leq 30$	2,0	2 700	4,4	1 350	4,7	1 100
	$30 < h \leq 45$	2,5	3 100	5,9	1 350	6,2	1 100
OH3 dry or alternate OH4 wet or pre-action	$h \leq 15$	1,9	2 650	3,0	2 100	3,5	1 800
	$15 < h \leq 30$	2,4	3 050	4,5	2 100	5,0	1 800
	$30 < h \leq 45$	3,0	3 350	6,0	2 100	6,5	1 800
<p><i>NOTE 1: the pressures shown are as measured at the control valve set(s)</i></p> <p><i>NOTE 2: In the case of buildings which exceed the heights shown, it shall be proved that the pump characteristics are adequate for supplying the flows and pressures specified in 6.3.1.</i></p>							

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

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

#### 9.7.4 Calculated systems

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

#### 9.7.5 Pressure and water capacity of boosted town mains

If it is intended to connect a pump to a town main, a test shall first be carried out to show that it can



supply the flow rate equal to the maximum demand flow plus 20%, at a pressure of at least 1 bar, as measured at the pump inlet. This test shall be carried out at a time of maximum demand on the main.

#### 9.7.6 Pressure switches

##### 9.7.6.1 Number of pressure switches

Two pressure switches shall be provided to start each pumpset, connected in series with normally closed contacts.

##### 9.7.6.2 Pump start

The pumpset shall start automatically when the pressure in the trunk main falls to a value of not less than  $0,8 \times P$ , where  $P$  is the pressure when the pumps are churning. Where two pumpsets are installed, the second pump shall start before the pressure falls to a value of not less than  $0,6 \times P$ . Once the pump has started, it shall continue to run until stopped manually. Where one of the pumpsets is electric motor driven this shall be the first to start.

##### 9.7.6.3 Testing the pressure switches

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

#### 9.8 Electrically driven pumpsets

##### 9.8.1 General

9.8.1.1 In some countries the authorities allow two electrically driven pumps under certain conditions.

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

9.8.1.3 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 room and be up to date at all times.

9.8.1.4 The pump shall be fully operational within 15 seconds of the beginning of any starting sequence.

##### 9.8.2 Electricity supply

9.8.2.1 The supply to the pump controller shall be solely for the use of the sprinkler pumpset and separate from all other connections. Where permitted, 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 stalled motor current for a period of not less than 75 % of the time needed for the motor windings to fail and thereafter be able to carry the normal current plus 100% for a minimum of 5 hours.

9.8.2.2 All cable shall be protected against fire and mechanical damage. The protection shall be accepted by the authorities.

*NOTE 1: all wiring associated with the electric motor driven pump, including the monitoring circuits,*

*should be in accordance with the appropriate regulations for electrical installations. To protect cables from direct exposure to fire they should be run outside the building or through those parts of the building where the fire risk is negligible and which are separated from any significant fire risk by walls, partitions or floors with a fire resistance of not less than 60 min, or they should be given additional direct protection.*

*NOTE 2: it is strongly recommended that the cable be buried.*

### 9.8.3 Switchboard

9.8.3.1 The switchboard for the premises shall be situated in a fire compartment used for no other purpose than for electrical power supplies, any other location shall be approved by the authorities.

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

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

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

The letters on the notice shall be at least 10mm high and white on a red background.

### 9.8.4 Installation between the main switchboard and the pump controller

9.8.4.1 The current for calculating the correct dimension for the cable shall be determined by taking the largest possible full load current and adding 50%. The cable shall furthermore be able to carry the largest possible starting current for 10 seconds.

### 9.8.5 Pump controller

9.8.5.1 The pump controller shall be able:

- a) to start the motor automatically on receiving a signal from the pressure switches;
- b) to start the motor manually;
- c) to stop the motor by manual operation only.

The controller shall be equipped with an ammeter.

9.8.5.2 Except in the case of submersible pumps, the pump controller shall be situated in the same room (pump room) as the electric motor and pump. In the case of submersible pumps a duplicate plate with its characteristics shall be affixed to the pump controller.

9.8.5.3 Contacts shall comply with utilisation category AC-3 of IEC 947.

### 9.8.6 Monitoring of pump operation

9.8.6.1 The following conditions shall be monitored:

- power available to the motor on all three phases;
- pump on demand;
- pump running.

9.8.6.2 All monitored conditions shall be visually indicated individually in the pump room. They should also

be visually and audibly indicated at a location normally attended by responsible personnel.

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

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

## 9.9 Diesel engine driven pumps

### 9.9.1 General

A diesel engine shall be capable of operating continuously at full load at site elevation with a rated output in accordance with ISO 3046-1:1986.

The pump shall be fully operational within 15 seconds 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.

### 9.9.2 Engines

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

It shall be provided with a governor to control the engine speed to  $\pm 5\%$  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.

### 9.9.3 Cooling system

The following types of cooling systems are acceptable.

- 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 manufacturer'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 manufacturer's specification. The outlet pipe shall be open so that the discharge water is visible. The water in the closed circuit shall be circulated by an auxiliary pump driven by the engine. If the auxiliary pump is belt driven, there shall be multiple belts such 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 manufacturers;
- 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. The water in the closed circuit shall be circulated by an auxiliary pump driven by the engine. If the auxiliary pump is belt driven, there shall be multiple belts such 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 manufacturers;
- 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.

Where cooling water is taken from the pump in quantities exceeding 2% of the maximum calculated system demand rate, the flow shall be taken into account in the system calculations.

#### 9.9.4 Air filtration and intake

The air intake shall be fitted with a suitable filter.

Provision shall be made for a suitable air intake into the pump room to ensure the correct operation of the engine.

#### 9.9.5 Exhaust system

The exhaust pipe shall be fitted with a suitable silencer and the total back pressure shall not exceed the engine-maker'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.

#### 9.9.6 Fuel, fuel tank and fuel feed pipes

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

- 3 hours for LH;
- 4 hours for OH;
- 6 hours for HHP and HHS.

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

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

The fuel tank vent should be terminated outside the building.

#### 9.9.7 Starting mechanism

##### 9.9.7.1 General

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

It shall be possible to start the diesel engine both automatically, upon receipt of a signal from the pressure

switches, and manually by means of a push button on the pump controller. It shall be possible to shut down the diesel engine only manually. Engine monitoring devices shall not cause the engine to stop.

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

The starter motor and each battery power source shall have the design capacity to rotate the engine at 0°C and 760mmHg atmospheric pressure for not less than 10 cycles each of not less than 15s cranking and not more than 10s rest. At the end of the energised part of each cycle the engine cranking speed shall be not less than 120r/min while power is applied.

#### 9.9.7.2 Automatic starting system

The automatic starting sequence shall make six attempts to start the engine, each one of 5 to 10s duration, with a maximum pause of 10 seconds 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.

#### 9.9.7.3 Emergency manual starting system

Emergency manual start facilities, with starting power available from both batteries, shall be provided, with a breakable cover. Facilities shall be provided to prevent one battery having an adverse effect on the other.

#### 9.9.7.4 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 on line 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 on line in parallel with the emergency manual start push button.

When a test manual start has been carried out, the circuit used for this purpose shall automatically become inoperable and the indicator lamp shall be extinguished. The automatic start facility shall be available, even when the manual start test button circuit is activated.

#### 9.9.7.5 Starter motor

The electric starter motor shall incorporate a moveable pinion which will engage 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 fly- wheel gear ring, After a failure to engage, the starter motor shall automatically make repeated attempts to achieve engagement.

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

Centrifugal speed switches or voltage generators used for sensing shall have a direct coupling to, or be gear-driven by, the engine; flexible drives shall not be used.

#### 9.9.8 Engine starter batteries

Engine starter batteries and chargers shall be as follows:

Two separate battery power supplies shall be provided and shall be used for no other purpose. Batteries shall be either open nickel-cadmium prismatic rechargeable cells complying with IEC 623 or lead acid positive batteries complying with the appropriate IEC standards.

The electrolyte for lead acid batteries shall comply with the appropriate IEC standards.

Batteries shall be selected, used, charged and maintained in accordance with the requirements of these specifications and with any manufacturer's instructions.

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

#### 9.9.9 Battery chargers

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

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

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

#### 9.9.10 Siting of batteries and chargers

Batteries shall be mounted on stands or stillages.

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

#### 9.9.11 Starter alarm indication

The following conditions shall each be indicated both locally and at a responsibly manned location by both a red warning light and an audible alarm:

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

- b) the failure of the engine to start by the end of the six cyclic attempts;
- c) pump running.

The warning lights shall be appropriately marked.

#### 9.9.12 Tools and spare parts

A standard kit of tools and spare parts as recommended by the engine and pump manufacturers shall be provided.

#### 9.9.13 Engine tests and exercising

Engine tests and exercising shall be as follows:

##### 9.9.13.1 Supplier's test and certification of results

Each complete engine and pump set shall be tested on the supplier's test bed for not less than 1,5h at the rated flow given in Table 19. 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, 5h 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.

##### 9.9.13.2 Site commissioning test

When commissioning an installation the automatic starting system of the diesel engine driven pump set shall be activated with the fuel supply isolated for the six cycles each or not less than 15s cranking and not more than 15s or less than 10s rest. After completion of the six starting cycles the fail to start alarm shall operate. The fuel supply shall then be restored and the pump set shall start when the manual start test button is operated.

## **10 Installation type and size**

### **10.1 Wet pipe installations**

#### **10.1.1 General**

Wet pipe installations are permanently charged with water under pressure. Wet pipe installations should be installed only in premises where there is no possibility of frost damage, and where the ambient temperature will not exceed 95°C.

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

#### **10.1.2 Protection against freezing**

Pipework subject to freezing may be protected by anti-freeze liquid or electrical trace heating or subsidiary dry pipe or alternate extensions.

*NOTE 1: the size of any one anti-freeze extension should not exceed 20 sprinklers.*

*NOTE 2: the total number of sprinklers on anti-freeze extensions should not exceed 100.*

An anti-freeze solution shall be prepared with freezing point below the expected minimum temperature for the locality (see clause 18.3.3).

In the case of a trace heating system, the piping shall be provided with non-combustible insulation. Duplicate heating elements shall be provided over the complete length of the affected pipework. Even in the case of a failure of one of the two heating elements a minimum temperature of 5°C shall be maintained. Each circuit shall be electrically monitored and triggered by separate temperature sensors.

The trace heating system shall be monitored for power supply failure and failure of the heating elements or sensors.

For subsidiary dry pipe or alternate extensions, see 10.5.

***Table 19: Maximum number of sprinklers per installation - wet pipe and pre-action installations***

Hazard class	Maximum number of sprinklers
LH	500
OH, including any LH sprinkler	1 000, except as allowed in Annexes D and F
HH, including any OH and LH sprinklers	1 000

#### **10.1.3 Sprinkler orientation**

Where possible the sprinklers shall be fitted in the upright position to avoid mechanical damage and the collection of foreign matter in the sprinkler fittings and to make it easier to drain the pipe network.

#### **10.1.4 Size of installations**

The number of sprinklers to be controlled by a wet alarm valve, including any sprinklers in a subsidiary extension, shall not exceed that shown in Table 19.

### **10.2 Dry pipe installations**



### 10.2.1 General

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

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

Dry pipe installations shall only be installed where there is a possibility of frost damage or the temperature exceeds 95°C, e.g. in drying ovens.

### 10.2.2 Sprinkler orientation

All sprinklers in a dry pipe installation shall be fitted in the upright position, except where dry pendent pattern or sidewall sprinklers are used.

### 10.2.3 Size of installations

The net volume of the pipework downstream of the control valve set shall not exceed that shown in Table 20.

*NOTE: 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.*

**Table 20: Maximum size per installation - Dry and alternate installations**

	Maximum volume of pipe work (m <sup>3</sup> )
Without accelerator or exhauster	1,5
With accelerator or exhauster	4,0

## 10.3 Alternative installations

### 10.3.1 General

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

### 10.3.2 Sprinkler orientation

All sprinklers in an alternate installation shall be fitted in the upright position, except where dry pendent pattern or sidewall sprinklers are used.

### 10.3.3 Size of installations

The net volume of the pipework downstream of the control valve set shall not exceed that shown in Table 20.

## 10.4 Pre-action installations

#### 10.4.1 General

Pre-action installations are divided into two types:

##### 10.4.1.1 Pre-action installation Type A

In the event of a fire detection fault, the preaction installation shall operate as a dry pipe installation. This is a dry pipe system 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. Consideration shall be given to fit a manually operated valve in an appropriate position to enable the preaction valve to be activated in an emergency.

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

##### 10.4.1.2 Pre-action installation Type B

This is an otherwise normal dry pipe system in which the control valve set is opened 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.

*NOTE : type B pre-action installations may be installed wherever a dry pipe system is called for and the spread of fire is expected to be rapid, e.g. in high-rack storage. They may also be used instead of ordinary dry pipe systems with or without an accelerator or exhaustor.*

#### 10.4.2 Sprinkler orientation

In Type A installations sprinklers shall be installed in the upright position or, only in a frost proof building, in the up-right or pendent position. In Type B installations, sprinklers shall be installed in the upright position.

#### 10.4.3 Automatic detection system

The detection system shall be installed in all rooms and compartments protected by the pre-action sprinkler system and shall comply with the relevant parts of EN54.

#### 10.4.4 Size of installations

The number of sprinklers to be controlled by a pre-action alarm valve not exceed that shown in Table 19.

#### 10.5 Subsidiary dry pipe or alternate extension

##### 10.5.1 General

Subsidiary dry pipe or alternate extensions shall be as specified in 10.2 and 10.3 except that they will be of limited extent and form extensions to standards 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.

#### 10.5.2 Sprinkler orientation

Sprinklers in a subsidiary shall be fitted in the up-right position where there is a possibility of frost damage, except where dry pendent pattern sprinklers are used.

#### 10.5.3 Size of subsidiary extensions

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

#### 10.6 Subsidiary multiple control valve

Sprinkler system extension controlled by multiple control valve utilising sprinklers or sprayers connected to a sprinkler installation via their own actuation valve (or multiple control valve).

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

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

### 11 Spacing and location of sprinklers

#### 11.1 General

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

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

- 0,5m for LH and OH except for suspended open ceilings;
- 0,8m for suspended open ceilings;
- 1,0m for HHP and HHS.

11.1.3 Sprinklers shall be installed upright, pendent or horizontal as specified by the manufacturer.

#### 11.2 Maximum area per sprinkler

The maximum area of coverage per sprinkler shall be as given in Table 21 for sprinklers other than sidewall and in Table 22 for sidewall sprinklers.

***Table 21: Maximum coverage and spacing for sprinklers other than sidewall***

Hazard class	Maximum area per sprinkler (m <sup>2</sup> )	Maximum distances in Figure 7 (m)	
		Standard layout S and D	Staggered layout S1 / D1
LH	21,0	4,6	6.1
OH	12,0	4,0	5.0
HHP and HHS	9,0	3,7	4.4

**Table 22: Maximum coverage and spacing for sidewall sprinklers**

Hazard class	Maximum area per sprinkler m <sup>2</sup>	Spacing along walls		Room width (w) m	Room length (l) m	Rows of side wall 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
				$3,7 < w \leq 7,4$	$\leq 9,2$	2	standard
					$> 9,2$	2	staggered
				$w > 7,4$	any	2 <sup>(1)</sup>	standard
OH	9,0	3,4 <sup>(2)</sup>	1,8	$w \leq 3,7$	any	1	single line
				$3,7 < w \leq 7,4$	$\leq 6,8$	2	standard
					$> 6,8$	2	staggered
				$w > 7,4$	any	2 <sup>(1)</sup>	standard

NOTE 1: an additional row of roof or ceiling sprinklers is needed.

NOTE 2: may be increased to 3,7m provided the ceiling has a fire resistance of not less than 120 minutes.

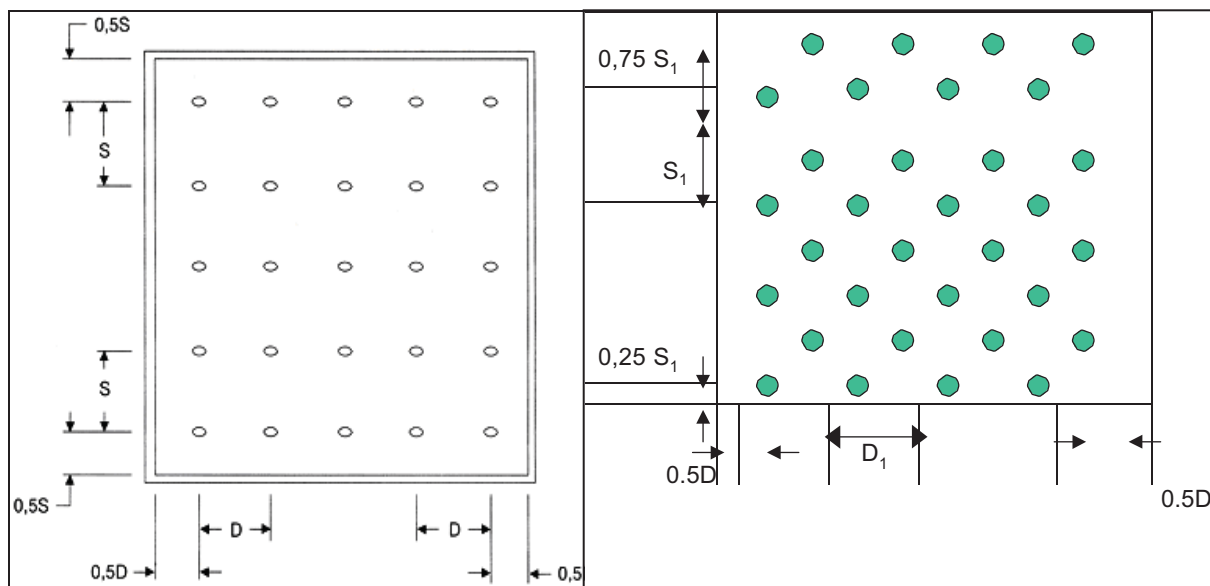
NOTE 3: the sprinkler deflectors shall be located between 0,1m and 0,15m below the ceiling and between 0,05m and 0,15m horizontally from the wall.

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

NOTE 5: where beams or girders occur, the bays thus formed shall be protected separately.

NOTE 6: see also clause 12.2.5.1.

**Figure 6 - Ceiling sprinkler spacing**



### 11.3 Minimum distance between sprinklers

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

- where arrangements are made, to prevent adjacent sprinklers from wetting each other, e.g. horizontal baffles;
- intermediate sprinklers in racks.

### 11.4 Location of sprinklers in relation to building construction

#### 11.4.1 Distance from walls

The maximum distance from walls and partitions to the sprinklers shall be the smallest value applicable from the following list:

- 2,0m for standard spacing;
- 2,3m for staggered spacing;
- 1,5m where the ceiling or roof is open joisted or the rafters are exposed;
- 1,5m from the open face of open faced buildings.

#### 11.4.2 Distance from ceiling

Sprinklers shall wherever possible be situated with the deflector between 0,075m and 0,15m below the ceiling or roof except when they are fitted in underdrawn ceilings. Where this is not practicable sprinklers may be installed at lower levels provided that the figures given in 11.4.6 are adhered to and that the height  $b$  is the maximum possible.

Sprinkler shall never be installed lower than 0,3m below the underside of combustible ceilings or 0,45m below non-combustible roofs or ceilings. Where circumstances make it unavoidable to use the maximum distances of 0,3m and 0,45m, the area involved shall be as small as possible.

#### 11.4.3 Slope of rooms

Sprinklers shall be installed with their deflectors parallel to the slope of the roof or ceiling.

Where the slope is greater than  $30^\circ$  a row of sprinklers shall be fixed at the apex or not more than 0,75m radially there from.

#### 11.4.4 Canopies

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

#### 11.4.5 Skylights

Skylights with a volume greater than  $1\text{m}^3$  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 0,3m, or there is a tight fitting frame and glass fitted level with the roof or ceiling.

#### 11.4.6 Beams, joists etc.

When the deflector is positioned above the level of the underside of beams or joists etc., the dimensions of 11.4.2, Figure 8 and Table 23 shall be observed in order to ensure that effective discharge of the sprinklers is not impaired or else the beam shall be protected on either side as though it were a wall.

The distance from girders or beams to the sprinklers shall be at least 0,2m, or alternatively sprinklers may be positioned directly above a girder or beam non wider than 0,2m at a vertical distance of at least 0,15m.

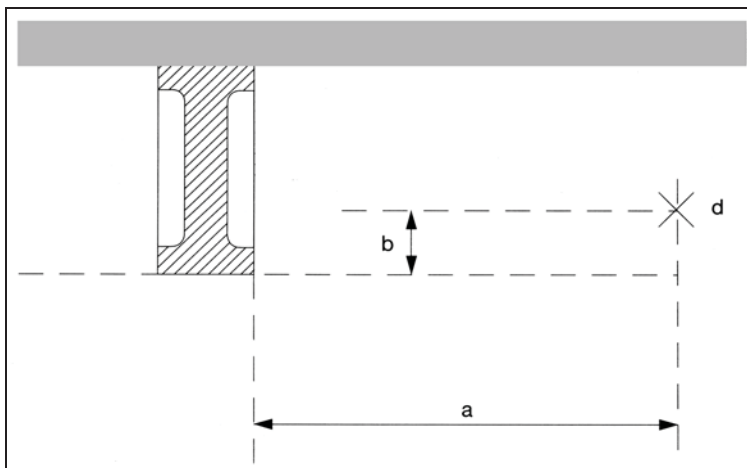
#### 11.4.7 Roof trusses

Sprinklers shall be located at least 0,3m laterally from truss members which are no more than 0,1m wide. If the width is greater than 0,1m the minimum distance shall be 0,6m. Alternatively sprinklers may be positioned directly above a truss no wider than 0,2m at a vertical distance of at least 0,15m.

#### 11.4.8 Columns

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

***Figure 7- Sprinkler location relative to beams***



**Table 23: Sprinkler location relative to beams**

Minimum horizontal distance from sprinkler vertical axis to side of beam or joist (a in figure 8)	Maximum height of sprinkler deflector (d) above (+) or below (-) bottom of beam or joist (b in figure 8) (m)			
	Conventional sprinkler		Spray sprinkler	
m	Upright	Pendent	Upright	Pendent
0,20	-0,20	not allowed	-0,02	-0,02
0,40	0,00	not allowed	0,00	0,00
0,60	0,03	not allowed	0,02	0,06
0,80	0,06	not allowed	0,03	0,12
1,00	0,10	-0,20	0,05	0,20
1,20	0,14	-0,17	0,10	0,28
1,40	0,19	-0,12	0,13	0,36
1,60	0,26	-0,03	0,16	0,47
1,80	0,39	0,17	0,18	0,67
<i>NOTE : dimensions may be interpolated</i>				

#### 11.4.9 Platforms, ducts etc.

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

- rectangular, more than 0,8m wide and less than 0,15m from adjacent walls or partitions;
- rectangular and more than 1,0m wide;
- circular, more than 1,0m in diameter and less than 0,15m from adjacent walls or partitions;
- circular and more than 1,2m in diameter.

#### 11.4.10 Escalators and stair wells

The number of sprinklers shall be increased around the ceiling opening formed by escalators, stairs etc. Sprinklers shall not be more than 2m nor less than 1,5m away from each other. If, owing to the design of the structure, e.g. girders, the minimum distance of 1,5m cannot be maintained, smaller spacing may be used provided adjacent sprinklers are not able to wet each other.

The horizontal distance between the sprinklers and the opening in the ceiling shall not exceed 0,5m.



The sprinklers in the region of the opening shall be capable of providing the minimum flow rate for sprinklers in the rest of the ceiling protection. For hydraulic calculation purposes, only the sprinklers on the longer side of the opening need be considered.

#### 11.4.11 Vertical shafts and chutes

At least one sprinkler shall be installed at the top of all shafts except where the shaft is incombustible and inaccessible and contains no combustible materials except electrical cabling.

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

#### 11.4.12 Ceiling obstructions

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 not to be subject to partial collapse under incipient fire conditions.

#### 11.4.13 Suspended open ceilings

Suspended open ceilings, i.e. ceilings having a regular open cell construction recurring throughout their design, may be used beneath LH and OH sprinkler systems not involving storage areas where the following conditions are met:

- the total plan open area of the suspended open ceiling, including light fittings, shall not be less than 70% of the ceiling plan area;
- the minimum dimension of the ceiling openings shall be no less than 0,025m or no less than the vertical thickness of the suspended ceilings, whichever is the greater;
- the structural integrity of the ceiling and any other equipment, such as light fittings within the volume above the suspended ceiling, shall not be affected by operation of the sprinkler system.

sprinklers shall be installed as follows:

- sprinkler spacing above the ceiling shall not exceed 3m;
- vertical separation between any conventional or spray sprinkler deflector and the top of the suspended ceiling shall not be less than 0,8m. This distance may be reduced to 0,3m if flat spray sprinklers are used;
- supplementary sprinklers shall be provided to discharge below light fittings or similar obstructions exceeding 0,8m in width.

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

### 11.5 Intermediate sprinklers in High Hazard occupancies

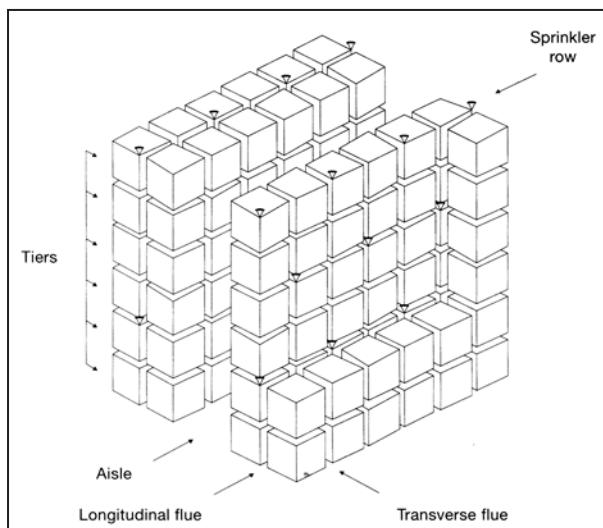
### 11.5.1 General

Sprinklers protecting double row racks shall be positioned in the longitudinal flue spaces, preferably in the intersection with the transverse flue (see Figures 9 and 10).

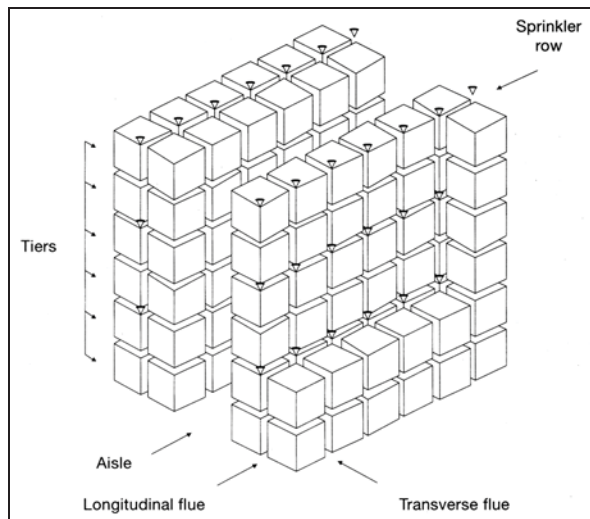
Whenever any rack or structural steelwork is likely to interfere significantly with the water discharge from the sprinklers, additional sprinklers shall be provided and taken into account in the flow calculation.

It shall be ensured that water from sprinklers operating at intermediate levels can penetrate the goods stored. The distance between goods stored in racking and placed back to back shall be at least 0,15m, and if necessary pallet stops should be fitted. There shall be a clearance of at least 0,15m from the sprinkler deflectors to the top of the storage.

*Figure 8- Location of rack intermediate level sprinklers Category I or II goods*



*Figure 9- Location of rack intermediate level sprinklers Category III or IV goods*



#### 11.5.2 Maximum vertical distance between sprinklers at intermediate levels

The vertical distance from the floor to the lowest intermediate level and between levels shall not exceed 3,50m or two tiers, whichever is the lesser, as shown in Figures 9 and 10. 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 4m above the top of the storage.

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

#### 11.5.3 Horizontal position of sprinklers at intermediate levels

In the case of Category I or II goods, sprinklers shall where possible be installed in the longitudinal flue at the intersection with every second transverse flue, with the sprinklers staggered with respect to

the next highest row (see Figure 9). The horizontal distance between sprinklers shall not exceed 3,75m and the product of the horizontal distance and the vertical distance between sprinklers shall not exceed 9,8m<sup>2</sup>.

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 10). The horizontal distance between sprinklers shall not exceed 1,9m and the product of the horizontal distance and the vertical distance between sprinklers shall not exceed 4,9m<sup>2</sup>.

#### 11.5.4 Numbers of rows of sprinklers at each level

The number of sprinkler rows per level shall be determined by the total 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.

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

#### 11.5.5 HHS intermediate sprinklers in non-shelved racks

Intermediate sprinklers shall be provided for palletised rack storage and multiple row drive through storage (see type ST4 in Table 5):

- a) single row racks not more than 3,2m wide shall be protected by single rows of sprinklers fitted on the side of the stack not used for access at the tier levels shown in Figures 9 and 10;
- b) double row racks not more than 3,2m wide shall be protected by sprinklers centrally in the longitudinal flue space, at the stack ends, and at the tier levels shown in Figures 9 and 10;
- c) double or multiple row racks more than 3,2m wide, but not more than 6,4m wide shall be protected by two rows of sprinklers installed not more than 3,2m 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.

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

Intermediate sprinklers shall be provided above each shelf (including the top shelf if the roof or ceiling sprinklers are more than 4m above the goods or water access to the goods is restricted), and located as shown in Table 24 and Figure 11. The vertical distance between rows shall not exceed 3,5m.

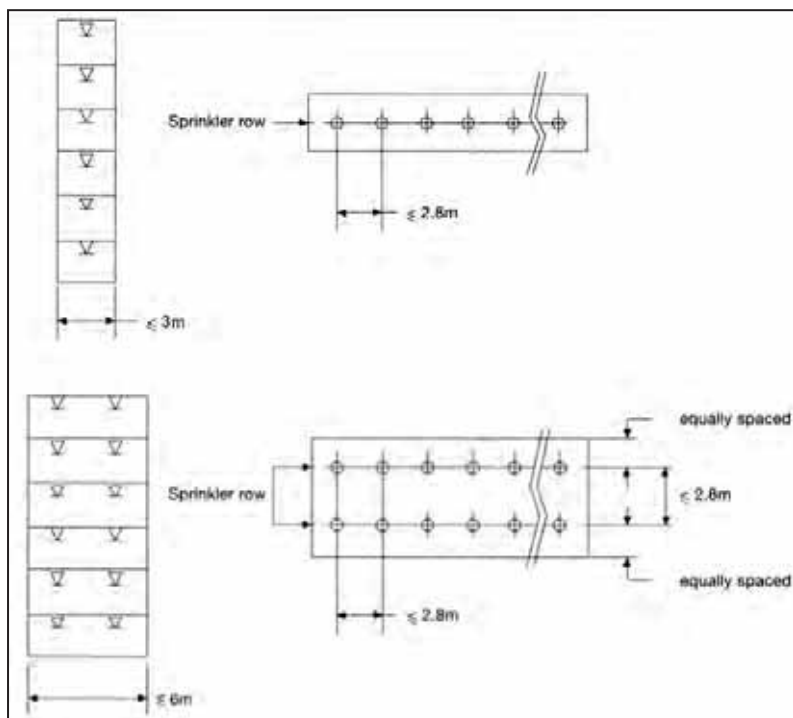
Single rows of sprinklers shall be central above shelves. Double rows shall be positioned so that each row is the same distance from the nearest shelf edge.

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 1,6m, whichever is the smaller.

**Table 24: Location of intermediate sprinklers in type ST5 and ST6 storage**

Shelf width - s m	Rows of sprinklers	Maximum distance between sprinklers along rows m	Maximum distance between rows of sprinklers m	Minimum clearance between sprinkler deflector in any row and storage immediately below m
$s \leq 1$	1	2,8	-	0,15
$1 < s \leq 3$	1	2,8	-	0,15
$3 < s \leq 6$	2	2,8	2,8	0,15

**Figure 10- Location of intermediate sprinklers in type ST5 and ST6 storage**



## 12 Sprinkler design characteristics and uses

### 12.1 General

Only new, approved sprinklers shall be used. They shall not be painted except by the original manufacturer. They shall not be altered in any respect or have any type of ornamentation or coating applied after despatch from the production factory, except as specified in 12.9.

### 12.2 Sprinkler types and application

#### 12.2.1 General

Sprinklers shall be used for the various hazard classes in accordance with Table 25, and as specified in

12.2.2 to 12.2.4.

#### 12.2.2 Ceiling or flush, recessed and concealed pattern

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

Sprinklers without fixed deflectors, i.e. with retracted deflectors which drop to the operating position on actuation, shall not be fitted:

- 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.

#### 12.2.3 Sidewall pattern

Sidewall sprinklers shall not be installed in HHP or HHS installations or above suspended ceilings. They may only be installed under flat ceilings.

#### 12.2.4 Flat spray pattern

The use of flat spray sprinklers shall be restricted to concealed spaces, suspended open ceilings and in racks.

#### 12.2.5 Extended coverage sprinkler

This type of sprinkler may be used for special protection e.g. hotel bedroom, with an approval by the authorities. Only Quick response sensitivity shall be used.

##### 12.2.5.1 Extended coverage sidewall sprinkler

Extended coverage sidewall sprinklers may be used in LH and OH1 hazards. They may be used in rooms, which have a maximum area of 126 m<sup>2</sup>, a fire resistance of the compartment of at least 30 minutes, a smooth ceiling and a maximum ceiling height of 4,1m. In one area only, sprinklers with identical response sensitivity class may be used.

The area per sprinkler must not exceed 21 m<sup>2</sup>. In rooms with a maximum width of 6,5 m, only one row of extended coverage sidewall sprinklers needs to be installed along the longitudinal wall. In rooms with a width of between 6,5 m and 11 m, two rows of extended coverage sidewall sprinklers must be installed along each of the longitudinal walls. In this case, the sprinklers must be installed staggered.

The area of operation with extended coverage sidewall sprinklers shall not be less than 126 m<sup>2</sup>.

The minimum design pressure shall be 2,5 bar for ceiling heights up to 2,8 m and 3 bar for ceiling heights between 2,8m and 4,1m.

The distance between two extended coverage sidewall sprinklers installed along the same wall shall be between 3 m and 4,5 m. Extended coverage sidewall sprinklers shall be installed at a maximum distance of 300 mm from the adjacent wall and at a distance of 100 mm to 250 mm from the ceiling. Extended coverage sidewall sprinklers shall be installed at a minimum horizontal distance of 0,5 m from

corners. »

### 12.3 Flow from sprinklers

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

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

where:

Q is the flow in litres per minute;

K is the constant given in Table 25;

P is the pressure in bar.

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

***Table 25: 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, fluch, flat, spray recessed, concealed and sidewall	57
OH	5,0	Conventional, spray, ceiling, fluch, flat spray, recessed, concealed, and sidewall	80
HHP and HHS Ceiling or roof sprinklers	10mm/min	Conventional, spray	80 or 115
	> 10mm/min ≤ 12,5 mm/min	Conventional, spray	115
	> 12,5 mm/min	Conventional, spray	115 or 160*
HHS intermediate sprinklers in high piled storage		Conventional, spray, and flat spray	80 or 115
<i>NOTE: * only for fully calculated systems and in accordance with the manufacturers data sheet.</i>			

In unventilated concealed spaces, under skylights or glass roofs etc., it may be necessary to install sprinklers with a higher operating temperature, up to 93°C or 100°C. Special consideration shall be

given to the rating of sprinklers in the vicinity of drying ovens, heaters and other equipment which gives off radiant heat.

*NOTE : sprinklers are colour coded to indicate their temperature rating as follows:*

<i>Bulb</i>	<i>°C</i>	<i>Fusible link</i>	<i>°C</i>
<i>Orange</i>	<i>57</i>	<i>-</i>	<i>-</i>
<i>Red</i>	<i>68</i>	<i>Uncoloured</i>	<i>57-77</i>
<i>Yellow</i>	<i>79</i>	<i>-</i>	<i>-</i>
<i>Green</i>	<i>93-100</i>	<i>White</i>	<i>80-107</i>
<i>Blue</i>	<i>121-141</i>	<i>Blue</i>	<i>121-149</i>
<i>Mauve</i>	<i>163-182</i>	<i>Red</i>	<i>163-191</i>
<i>Black</i>	<i>204/260</i>	<i>Green</i>	<i>204-246</i>
		<i>Orange</i>	<i>260-302</i>
		<i>Black</i>	<i>320-343</i>

## 12.5 Sprinkler Thermal sensitivity

### 12.5.1 General

Sprinklers of different sensitivities shall be used in accordance with table 26.

***Table 26: Sprinkler sensitivity ratings***

Sensitivity rating	in-rack	Ceiling above in-rack sprinklers	Dry systems	All others
Standard 'A'	No	Yes	Yes	Yes
Special	No	Yes	Yes	Yes
Quick	Yes	Yes	No	Yes
<p><i>NOTE 1: the sprinkler at the ceiling shall have a sensitivity equal to or of slower response than the sprinkler situated in the racks.</i></p> <p><i>NOTE 2: most types of sprinklers are rated, in descending order of sensitivity, as one of the following types</i></p> <ul style="list-style-type: none"> <li><i>- quick response;</i></li> <li><i>- special response;</i></li> <li><i>- standard response 'A'.</i></li> </ul> <p><i>The sprinkler sensitivities rating are specified in EN 12259 part 1.</i></p>				

### 12.5.2 Buildings with automatic smoke venting systems

Smoke vents shall be operated only manually, or else the sprinkler heads shall be selected so as to operate before the smoke vents open.

## 12.6 Sprinkler guards

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



## 12.7 Sprinkler water shields

Sprinklers installed in racks or under perforated shelves or platforms or similar locations where water from a higher sprinkler or sprinklers may cause wetting close to the bulb or fusible element, shall be fitted with a non combustible water shield.

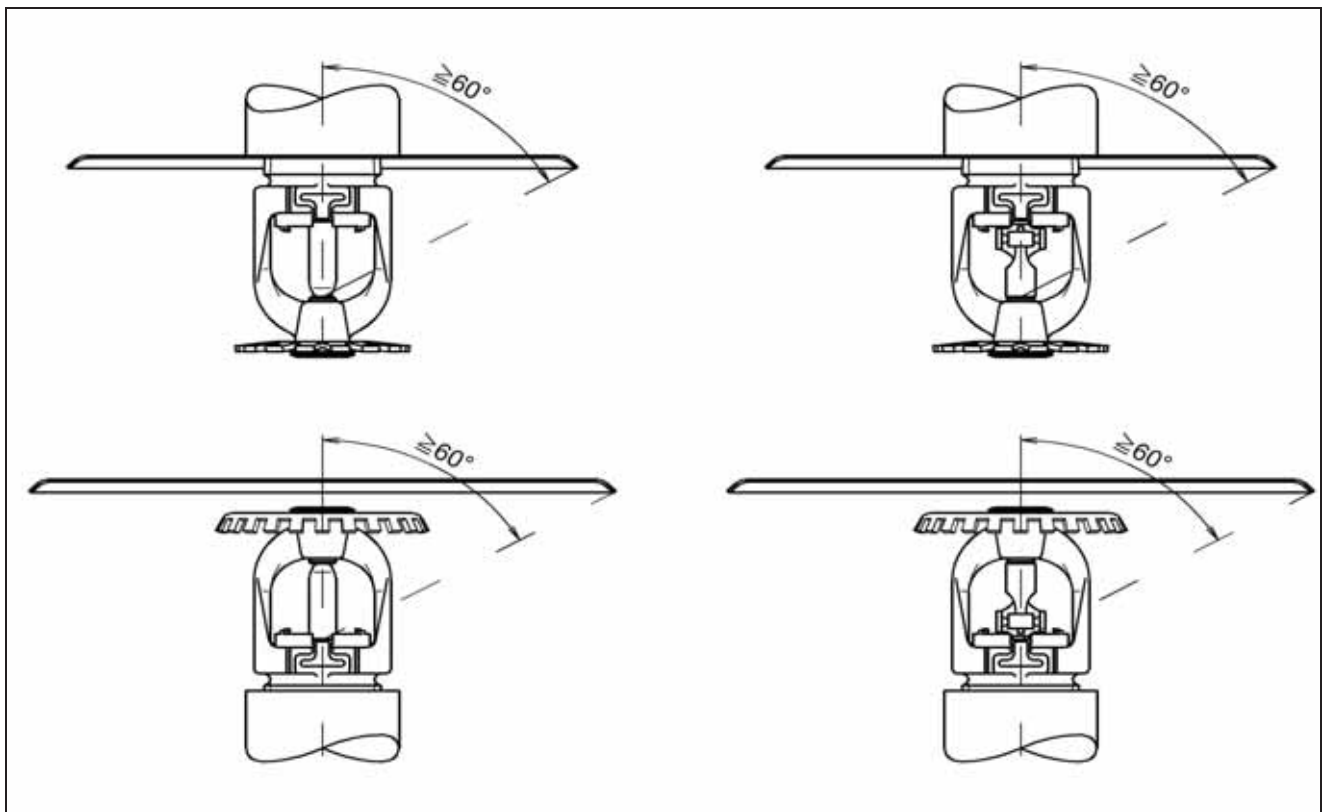
Water shields and any supports shall be designed so that they:

- do not affect the sprinkler water distribution negatively
- will prevent water from running down to the sprinkler from the underside of the shield.

The water shield can be a metal water shield with a diameter of min. 0,075m.

It shall be designed to ensure an angle of at least 60° between the sprinkler centreline and a line from the edge of the shield to the lowest visible part of the bulb or fusible element (see figure 12).

**Figure 11 : Water shield**



## 12.8 Sprinkler escutcheon plates

Escutcheon plates shall be made of metal or a thermosetting plastic material. Escutcheon plates shall not be used to support ceilings or other structures.

No part of an escutcheon plate shall project from the ceiling below the top of the visible portion of the heat sensitive element of the sprinkler.

## 12.9 Corrosion protection of sprinklers

Sprinklers installed in premises where corrosive vapours are prevalent shall be protected in one of

the following ways:

- a) with a suitable corrosion resistant coating applied by the manufacturer;
- b) with a petroleum jelly coating applied once before and once after installation.

The anti-corrosion treatment shall not be applied to sprinkler bulbs.

## **13 Valves**

### **13.1 Control Valve Set**

Each installation shall have a control valve set.

### **13.2 Stop Valves**

All normally open stop valves which may 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 open position by a strap and padlock or secured in an equivalent manner.

*NOTE 1: no stop valves are allowed downstream of the control valve set except as stated elsewhere in these rules. Stop valve downstream of the control valve set should be avoided, where possible. Where stop valves are installed downstream of the control valve set, they shall be monitored electrically.*

*NOTE 2: in locations such as high-rise buildings, where high static pressures are likely, special care should be taken to ensure that all stop, test, drain and flushing valves are suitable for the installation pressures.*

### **13.3 Ring main valves**

Where sprinkler systems are fed by a ring main supply pipe arrangement on the premises, 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.

### **13.4 Drain valves**

Drain valves shall be fitted as specified in Table 27 to allow drainage from:

- a) immediately downstream of the control valve set or of its downstream stop valve where such exists;
- 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 which cannot be drained through another drain valve, with the exception of drop pipes to single sprinklers in a wet installation.

The valves shall be fitted at the lower end of the pipework and sized as specified in Table 27. The outlet shall be not more than 3m above the floor and shall be fitted with a brass plug.

**Table 27: Minimum size of drain valves**

Valve principally draining		Minimum diameter d of valve and pipe mm
LH installation		40
OH or HHP or HHS installation		50
Subsidiary installation		50
A zone		50
Trapped distribution pipes	dia $\leq 50$	20
	50 < dia $\leq 80$	32
	dia > 80	50
Trapped range pipes	dia $\leq 50$	20
	dia > 50	25
Trapped pipework between dry or subsidiary alarm valve and a subsidiary stop valve installed for testing Purposes		15

### 13.5 Test valves

#### 13.5.1 Alarm and pump start test valves

15mm test valves shall be provided, as appropriate, to test:

- a) the hydraulic alarm and any electric alarm pressure switch by drawing water from the immediate downstream side of:
  - a wet alarm valve, and any downstream main stop valves;
  - an alternate alarm valve;
  - a pre-action 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 main control valve set. The test valve shall be connected downstream of the water flow alarm;
- d) any automatic pump starting device;
- e) any pump or pressure tank house sprinkler alarm flow switch installed upstream of the control valve set.

#### 13.5.2 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.

#### 13.6 Flushing connections

Flushing connections, with or without permanently installed valves, shall be fitted on the spur ends of the installation distribution pipes. They shall

- be at least DN50 and
- in case of distribution pipes bigger than DN50 be connected eccentrically at the bottom of the distribution pipe and
- be at least 200mm long

Flushing connections shall be fitted with a suitable plug or cap.

*NOTE 1: it may be desirable in certain cases to fit flushing connections on ranges, e.g. in the form of a blank tee.*

*NOTE 2: in addition to their use for flushing of the pipework, flushing connections may be used to check that water is available and for carrying out pressure and flow tests.*

*NOTE 3: pipework which is completely full of water may be damaged by the increase in pressure due to temperature rises. If complete venting of air in an installation is likely to occur, e.g. in the case of a gridded layout with flushing connections at the extremities, consideration should be given to the fitting of pressure relief valves or expansion vessels.*

#### 13.7 Pressure gauges

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.

*NOTE: the maximum scale value should be of the order of 150% of the known maximum pressure to be applied.*

##### 13.7.1 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.

#### 13.7.2 Control valve set

Each set of installation control valves shall have a pressure gauge fitted at each of the following points:

- a) immediately upstream of the control valve set, ('B' gauge);
- b) immediately downstream of the control valve set, ('C' gauge);
- c) immediately downstream of subsidiary control valve sets, but upstream of any stop valve.

#### 13.7.3 Removal

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

#### 13.8 Measures against over pressurisation

Where it is expected to have a pressure expansion above 12 bar in the pipework (e.g. systems with large temperature variations and antifreeze systems), an expansion vessel or a relief valve should be installed. In case of using a relief valve, it shall be installed downstream of the control valve on the riser.

Relief valves shall have a nominal diameter between 10 mm and 25 mm and operate at pressures not greater than 12 bar. For maintenance purposes, the relief valve shall be fitted with an isolation valve.

### **14 Alarms and alarm devices**

#### 14.1 Water motor alarms

##### 14.1.1 General

Each control valve set shall be provided with:

- a separate water motor alarm;
- or an electric pressure switch with an indication for each control valve set;
- or both

located as close as possible to the alarm valve.

A single alarm motor and gong may be installed common to a group of wet alarm valves provided that these are situated in the same valve room and an indicator is fitted to each alarm valve to show when it is operating.

##### 14.1.2 Water motor and gong

The water motor shall be installed with its gong on the outside of an exterior wall and with its centre line not higher than 6m 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.

#### 14.1.3 Piping to water motor

The piping shall be galvanised steel. The equivalent length of pipe between the alarm valve and the water motor shall be not more than 25m assuming an equivalent length of 2m 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 not more than 3mm in diameter. The orifice plate may be integral with the pipe fitting, and shall be made either of stainless steel or of a non-ferrous material.

### 14.2 Electrical water flow and water and air pressure switches

#### 14.2.1 General

Electrical devices to detect the operation of sprinkler systems shall be either water flow switches or pressure switches.

#### 14.2.2 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 galvanised 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.

#### 14.2.3 Dry and Pre-action systems

Each discrete section of the installation pipework should be provided with a low air/gas pressure alarm, to provide a visual and audible warning in an area with responsible manning.

### 14.3 Transmission of alarm signals to a permanently manned location

Any automatic sprinkler electrical alarm connected to a permanently manned location shall conform to EN 54-2 "Control and Indicating Equipment".

#### 14.4 Monitoring stop valve

The monitoring signal shall be transmitted to a permanently manned location.

## **15 Pipework**

### 15.1 General

#### 15.1.1 Underground piping

Pipes shall be installed in accordance with the manufacturer's instructions and shall be protected against corrosion.

*NOTE : the following types of pipe are recommended : cast iron, ductile iron, spun cement, reinforced glass fibre.*

Adequate precautions shall be taken to prevent damage to piping, for example by passing vehicles.

#### 15.1.2 Above ground piping

Piping downstream of control valves shall be steel or copper or another 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 65M. When steel pipe ends are formed without significant by 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.

Copper pipes for LH and OH1 shall be in accordance with EN 1057.

*NOTE 1: For dry, alternate or pre-action installations, galvanised steel should preferably be used.*

*NOTE 2: When mechanical pipe joints are used, Minimum wall thickness shall also be in accordance with the joint manufactures' recommendations.*

#### 15.1.3 Welding

Welders shall be approved in accordance with EN 287-1.

Welded pipe and fittings less than DN 65 mm in diameter shall be welded in the supplier factory.

The company producing welding shall have a quality management system accepted by the authorities such as ISO 9001.

An accredited laboratory accepted by the authorities shall check the following welding procedures and welding test pieces:

Socket weld procedure: Welding of sockets onto pipes smaller than DN 65 mm;

Pipe weld procedure: Welding of pipes smaller than DN 65mm including welding of pipes smaller than DN 65mm onto larger dimensioned pipes.

The quality management system shall include the following main requirements:

- The welded joint shall be made according to EN 25817, quality class D "Arc-welded joints in steel – guidance on quality levels for imperfections";
- No debris shall be left inside the pipes after the welding operation;
- The welded joint shall fully penetrate the pipe wall if no evidence according to EN 288 "specifications and approval of welding procedures for metallic materials" is provided. The welded joint shall not intrude into the pipe more than:
  - a) 1 mm average;
  - b) 1,5 mm maximum.
- Welded connections shall not cause pressure losses higher than 105 % of the loss produced in standard fittings;

- The bending strength of the welded pipe joint shall be at least 80% of the pipe bending strength;
- If robot welding machines are used, the welding operation shall be fully automatic.

#### 15.1.4 Mechanical pipe joints

Mechanical pipe joints shall be approved.

#### 15.1.5 Flexible pipes and joints

If relative movement is likely to occur between different sections of pipework within the sprinkler system, e.g. owing to expansion joints or in the case of free-standing storage racking, a flexible section or joint shall be fitted at the point of connection to the distribution main. Before installation it shall meet the following requirements.

- a) 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;
- c) Flexible pipes shall not be fitted in the fully extended position.

Flexible pipes and joints shall not be used to take up misalignment between a distribution main and the feed pipes to intermediate sprinklers.

#### 15.1.6 Concealment

Pipes shall be installed in such a way that they are easily accessible for repairs and alterations. They shall not be embedded in concrete floors or ceilings.

*NOTE: wherever possible, piping should not be installed in concealed spaces which make inspection, repairs and modifications difficult.*

#### 15.1.7 Protection against fire and mechanical damage

Piping shall be installed in such a way that the pipes are not exposed to mechanical damage. Where pipes are installed above gangways with low headroom, or at intermediate levels, or in other similar situations, precautions shall be taken against mechanical damage.

Where it is unavoidable for water supply pipework to pass through an unsprinklered building, it shall be installed at ground level and shall be enclosed by dwarf brick walls covered by concrete slabs.

#### 15.1.8 Painting

Non-galvanised ferrous pipework shall be painted. Galvanised piping shall be painted wherever the coating has been damaged, e.g. by threading.

*NOTE: extra protection may be needed for unusually corrosive conditions.*

#### 15.1.9 Drainage

Means shall be provided to enable all the pipework to be drained. Where this cannot be done



through the drain valve at the control valve set, extra valves shall be fitted in accordance with 13.4.

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%.

Range pipes shall only be connected to the side or top of distribution pipes.

## 15.2 Pipe supports

### 15.2.1 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 28). Pipes greater than 50mm diameter should not be supported from corrugated steel sheet or aerate 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.

### 15.2.2 Spacing and location

Supports shall generally be spaced no more than 4m apart on steel pipe and 2m apart on copper pipe. For pipes of over 50mm diameter these distances may be increased by 50% provided that one of the following conditions is met:

- 2 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 28. When mechanical pipe joints are used:
- there shall be at least one support within 1m 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:

- 0,9m for 25mm diameter piping;
- 1,2m for piping greater than 25mm diameter.

The distance from any upright sprinkler to a support shall not be less than

0,15m. Vertical pipes shall have additional supports in the following cases:

- pipes more than 2m long;
- pipes more than 1m long feeding single sprinklers.

The following pipes need not be separately supported unless they are at a low level or otherwise

vulnerable to mechanical impact:

- horizontal, pipes less than 0,45m long, feeding individual sprinklers;
- drop or rise pipes less than 0,6m long feeding individual sprinklers.

### 15.2.3 Design

Pipe supports shall either be approved or designed in accordance with the requirements of Tables 28 and 29.

### 15.3 Pipework in concealed spaces

Where sprinkler protection is required in concealed spaces such as false ceilings and floors, the pipework shall be designed as follows:

#### 15.3.1 False ceilings above LH or OH occupancies

Sprinklers above the ceiling may be fed from the same range pipes as the sprinklers below the ceiling.

#### 15.3.2 All other cases

The sprinklers in the concealed space shall be fed from separate range pipes. In the case of pre-calculated systems, distribution pipes feeding sprinklers both inside and outside the concealed space shall be no less than 65mm diameter.

**Table 28: Design parameters for pipe supports**

Nominal pipe diameter (d) mm	Minimum load capacity at 20°C <sup>(1)</sup> kg	Minimum cross section <sup>(2)</sup> mm <sup>2</sup>	Minimum length of anchor bolt <sup>(3)</sup> mm
d≤50	200	30 (M8)	30
50 <d≤100	350	50 (M10)	40
100<d≤150	500	70 (M12)	40
150<d≤200	850	125 (M16)	50
<i>NOTE 1: when the material is heated to 200°C the load bearing capacity shall not deteriorate more than 25%.</i>			
<i>NOTE 2: the nominal cross section of threaded rods shall be increased so that the minimum cross section is still achieved.</i>			
<i>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.</i>			

***Table 29: Minimum dimension of flat iron rods and clips***

Nominal pipe diameter (d)  mm	Flat iron rods		Pipe clips	
	galvanised mm	ungalvanised mm	galvanised mm	ungalvanised mm
d≤50	2,5	3,0	25x1,5	25x3,0
50<d≤200	2,5	3,0	25x2,5	25x3,0

## **16 Signs, notices and information**

### **16.1 Block plan**

#### **16.1.1 General**

A block plan of the premises shall be placed close to a main entrance where it can be readily seen by the fire brigade or others responding to an alarm. The plan shall show:

- the installation number and the location of the corresponding control valve set and water motor alarm;
- each separate area of hazard classification, the relevant hazard class and the maximum storage height;
- 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;
- the location of any subsidiary stop valves.

### **16.2 Signs and notices**

#### **16.2.1 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 installation main control valve set(s). The plate shall bear the wording:

'SPRINKLER STOP VALVE'

in letters not less than 35mm high, and

'INSIDE'

in letters not less than 25mm high. The wording shall be in white letters on a red background.

#### **16.2.2 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 not less than 20mm high on a red background.

Where the stop valve is enclosed in a room with a door the sign shall be fixed on the outside of the door, and a second sign, bearing the words « Keep locked shut » shall be fixed on the inside of the door. The second sign shall be circular with white letters not less than 5mm high, on a blue background.

### 16.2.3 Control valve set

#### 16.2.3.1 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.

#### 16.2.3.2 Fully calculated installations

In fully calculated installations a durable notice shall be fixed to the rise pipe next to each control valve set. The notice shall include the following information:

- a) the installation number;
- b) the hazard classification or classifications of the areas protected by the installation;
- c) 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 the 'C' gauge or flow test facilities for the most unfavourable and most favourable areas of operation;
  - 3) the pressure-flow requirement at the pump delivery pressure gauge for the most unfavourable and most favourable areas of operation;
  - 4) the height of the highest sprinkler above the level of the 'C' gauge;
  - 5) the height difference between the 'C' gauge and the pump delivery pressure gauge.

### 16.2.4 Water supply connections to other services

Stop valves controlling water supplies from sprinkler system supply pipes or trunk mains to other services shall be appropriately labelled; e.g. 'Fire fighting hose reels', 'Domestic water supply' etc. The labels shall have raised or embossed lettering and be fixed to stop valves to inhibit unauthorised removal.

### 16.2.5 Suction and booster pumps

#### 16.2.5.1 Pre-calculated installations

A nameplate shall be fixed to each suction or booster pump, carrying the following information:

- a) the output pressure, and the corresponding rated speed and flow (l/min), in bar at the inlet condition and flow rating specified in table 18;
- b) the maximum power absorbed at the relevant speed at any value of flow.

#### 16.2.5.2 Fully calculated installations

An installer's data sheet shall be displayed beside the pump, giving the following information:

- a) the pump manufacturer's data sheets;
- b) a schedule listing the technical data specified in 3.4.4.4;
- c) a copy of the installer's pump characteristics sheet, similar in presentation to Figure H1;
- d) the pressure loss, at flow  $Q_{max.}$ , between the pump outlet and the most hydraulically remote installation 'C' gauge.

#### 16.2.6 Electric switches and control panels

##### 16.2.6.1 Alarm transmission

Where water flow into an installation initiates an automatic alarm to the fire brigade or to a remote control station, a notice to that effect shall be fixed adjacent to the alarm test valve(s).

##### 16.2.6.2 Diesel engine driven pump

The alarms specified in 9.9.11 at both the diesel engine controller and the responsibly manned location shall be marked as appropriate:

- a) diesel fire pump failure to start;
- b) diesel fire pump starter switched off;
- c) pump running.

The manually operated shut-down mechanism (see 9.9.7) shall be labelled as follows:

'SPRINKLER PUMP SHUT-OFF'.

##### 16.2.6.3 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'.

#### 16.2.7 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.

## **17 Commissioning and acceptance tests**

## 17.1 Commissioning tests

### 17.1.1 Pipework

All installation pipework shall be hydrostatically tested for not less than 2 hours, to a pressure of not 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.

Dry pipework shall also be tested pneumatically to a pressure of not less than 2,5bar for not less than 24 hours. Any leakage that results in a loss of pressure greater than 0, 15 bar for the 24 hours shall be corrected.

Any faults disclosed, such as permanent distortion, rupture or leakage, shall be corrected and the test repeated.

*NOTE: if climatic conditions do not allow hydraulic testing to be carried out immediately, it should be carried out as soon as conditions permit.*

### 17.1.2 Equipment

The system shall be tested as specified in 18.3.2 and 18.4.2 (i.e. making the tests which will be made on a routine weekly and quarterly basis) and any faults shall be corrected.

### 17.1.3 Water supplies

Water supplies shall be tested as specified in 7.5, and diesel engine driven pumps shall be tested as specified in 18.3.2.5.

## 17.2 Completion certificate and documents

The installer of the system shall provide the user with the following:

- a) a completion certificate stating that the system complies with all appropriate requirements of these rules, or giving details of any deviation from the requirements;
- b) a complete set of operating instructions and "asbuilt" drawings including identification of all valves and instruments used for testing and operation and a users programme for inspection and checking (see 18.3).

## **18 Maintenance**

### 18.1 General

#### 18.1.1 Programmed work

The user shall carry out a programme of inspection and checks (see clause 18.3), arrange a test, service and maintenance schedule (see clause 18.4) and keep appropriate records including a logbook which shall be held on the premises.

If it is required by the authorities. The user shall have the test, service and maintenance schedule carried

out under contract by the system installer or a similarly qualified company.

After an inspection, check, test service or maintenance procedure the system, and any automatic pumps, pressure tanks and gravity tanks shall be returned to the proper operational condition.

*NOTE : if appropriate, the user should notify interested parties of the intent to carry out tests and/or of the results.*

#### 18.1.2 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 manufacturer, shall be housed in a cabinet or cabinets located in a prominent and easily accessible position where ambient temperature does not exceed 38°C.

The number of the spare sprinklers shall be not 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.

#### 18.1.3 Precautions and procedures when a system is not fully operational

##### 18.1.3.1 Minimising the effects

Maintenance, alterations and repair of systems which are not fully operational shall be carried out such as to minimize the time and extent of non-operation.

When an installation is rendered inoperative the user shall implement the following measures:

- a) the fire authorities shall be informed if the alarm is connected to the fire brigade;
- b) alterations and repairs to an installation or its water supply (except possibly a life safety installation (see Annex F) shall be carried out during normal working hours;
- c) any hot work shall be subject to a permit system. Smoking and naked lights shall be prohibited in affected areas during the progress of the work;
- d) when an installation remains inoperative outside working hours all fire doors and fire shutters shall remain closed;
- e) fire extinguishing appliances shall be kept ready, with trained personnel available to handle them;
- f) as much as possible of the installation shall be retained in an operative condition by blanking

of pipework feeding the part or parts where work is taking place;

- g) in the case of manufacturing premises, when the alterations or repairs are extensive, or it is necessary to disconnect a pipe exceeding 40mm nominal diameter, or to overhaul or remove a main stop valve, alarm valve or check valve, every effort shall be made to carry out the work while;
- h) any pump which is out of commission shall be isolated by means of the valves provided.

*NOTE :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.*

#### 18.1.3.2 Planned shut-down

Only the user shall 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 shall 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 shall also be advised that the water is to be turned off.

Particular attention shall be given to situations where installation pipework passes through walls or ceilings where these may feed sprinklers in areas needing special consideration.

#### 18.1.3.3 Unplanned shut-down

When an installation is rendered inoperative as a matter of urgency or by accident, the precautions in 18.1.3.1 shall be observed as far as they are applicable with the least possible delay. The authorities shall also be notified as soon as is possible.

### 18.2 Action following sprinkler operation

#### 18.2.1 General

Following shut-down after operation of an installation, the operated sprinkler heads shall be replaced by heads of the correct type and temperature rating, and the water supply restored. Unopened sprinklers around the area in which operation took place shall be checked for damage by heat or other cause and replaced as necessary.

The water to an installation or zone of an installation that has operated shall not be shut off until all fire has been extinguished.

The decision to shut down an installation or zone which has operated because of fire shall be taken only by the fire service.

Components removed from the system shall be retained by the user for possible examination by an authority.



### 18.2.2 Installations protecting cold storage warehouses (air circulation refrigeration)

The installation shall be dismantled for drying out after each operation.

## 18.3 User's programme of inspection and checking

### 18.3.1 General

The installer shall provide the user with an inspection and checking programme for the system. The programme shall include instruction on the action to be taken in respect of faults, operation of the system, with particular mention of the procedure for emergency manual starting of pumps, and details of the weekly routine of 18.3.2.

### 18.3.2 Weekly routine

#### 18.3.2.1 General

Each part of the weekly routine shall be carried out at intervals of not more than 7 days.

#### 18.3.2.2 Checks

The following shall be checked and recorded:

- a) all water and air pressure gauge readings on installations, trunk mains and pressure tanks;

*NOTE : 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);
- c) the correct position of all main stop valves.

#### 18.3.2.3 Water motor alarm test

Each water motor alarm shall be sounded for not less than 30s and simultaneously the fire brigade connection shall be checked.

#### 18.3.2.4 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.

#### 18.3.2.5 Diesel engine restarting test

Immediately after the pump start test of 18.3.2.4, diesel engines shall be tested as follows:

- a) the engine shall be run for 20 min, or for time recommended by the manufacturer, whichever is the greater; 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.

#### 18.3.2.6 Lead acid batteries

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.

#### 18.3.2.7 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 checked for:

- a) continuity of the connection;
- b) continuity of the connection between the alarm switch and the control unit.

*NOTE: the testing procedure shall be agreed with the alarm signal recipient.*

#### 18.3.2.8 Trace heating and localised heating systems

Heating systems to prevent freezing in the sprinkler system shall be checked for correct function.

### 18.3.3 Special consideration

The specific gravity of the anti-freeze solution shall be verified quarterly for permanent cold storage and yearly, before winter for unheated areas.

## 18.4 Service and maintenance schedule

### 18.4.1 General

#### 18.4.1.1 Procedures

In addition to the schedule given in this clause any procedures recommended by component manufacturers shall be carried out.

#### 18.4.1.2 Records

Each routine of the schedule shall be carried out by a competent person who shall provide the user

with a signed, dated report of the inspection and advise of any rectification carried out or needed, and advise of any external factors, which may have affected the results.

#### 18.4.2. Quarterly routine

##### 18.4.2.1 General

The following checks and inspections shall be made at intervals of not more than 13 weeks.

##### 18.4.2.2 Review of hazard

The effect of any changes of structure, occupancy, storage configuration, heating, lighting or equipment etc. of a building on hazard classification or installation design shall be identified in order that the appropriate modifications may be carried out.

##### 18.4.2.3 Sprinklers, multiple controls and sprayers

Sprinklers, multiple controls and sprayers affected by deposits (other than paint) shall be carefully cleaned. Painted or distorted sprinklers heads, multiple controls or sprayers shall be replaced.

Any petroleum jelly coatings shall be checked. Where necessary the existing coatings shall be removed and the sprinklers, multiple controls or sprayers shall be coated twice with petroleum jelly (in the case of glass bulb sprinklers to the sprinkler body and yoke only).

Particular attention shall be paid to sprinklers in spray booths, where more frequent cleaning and/or protective measures may be necessary.

##### 18.4.2.4 Pipework and pipe supports

Pipework and hangers shall be checked for corrosion and painted as necessary

Bitumen-based paint on pipework, including the threaded ends of galvanised pipework, and hangers shall be renewed as necessary.

*NOTE : bitumen-based paint may need renewal at intervals varying from 1 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.

##### 18.4.2.5 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 not less than the appropriate value in accordance with clause 9, recognising any changes required by 18.4.2.2.

##### 18.4.2.6 Electrical supplies

The electrolyte level and density of all open nickel-cadmium cells (including those in diesel engine starter batteries and those for control panel power supplies) shall be checked. If the density is low the battery charger shall be checked and if necessary repaired or replaced. If the charger is working normally, the battery or batteries affected shall be replaced.

Any secondary electrical supplies from diesel generators shall be checked for satisfactory operation.

#### 18.4.2.7 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.

#### 18.4.2.8 Flow switches

Flow switches shall be checked for correct function.

#### 18.4.2.9 Replacement parts

Replacement parts held as spare shall be checked for number and condition.

### 18.4.3 Half-yearly routine

#### 18.4.3.1 General

The following checks and inspections shall be made at intervals of not more than 6 months.

#### 18.4.3.2 Dry alarm valves

Dry alarm valves, and any accelerators and exhausters, in dry pipe installations and subsidiary extensions shall be exercised in one of the following ways, as appropriate:

- a) the inspection cover plate shall be removed and the moving parts shall be operated manually;
- b) if a screw-down diaphragm interlocking key type subsidiary stop valve is fitted downstream of the alarm valve, subsidiary stop valve shall be closed, the space between the dry pipe valve clack and the underside of the subsidiary valve shall be primed with water, and the installation drain valve shall be opened.

*NOTE: alternate installations need not be tested in this way since they are exercised twice a year as a result of the change-over from wet to dry operation and back.*

#### 18.4.3.3 Fire brigade and remote central station alarm

The electrical installation shall be checked.

### 18.4.4 Yearly routine

#### 18.4.4.1 General

The following checks and inspection shall be made at intervals of not more than 12 months.

#### 18.4.4.2 Automatic pump flow test

Each water supply pump in the installation shall be tested at the full load condition (by means of the test line connection coupled to the pump delivery branch downstream of the pump outlet back pressure valve) and shall give the pressure/flow values stated on the nameplate.

*NOTE : Appropriate allowances shall be made for pressure losses in the supply pipe and valves between the source and the 'C' gauge of each installation.*

#### 18.4.4.3 Diesel engine failed-to-start test

The failed-to-start alarm shall operate after the sixth cycle of cranking, when the following sequence is carried out :

- a) the fuel supply shall be isolated;
- b) the engine shall be cranked for not less than 15s;
- c) cranking shall be stopped for not less than 10s and not more than 15s;
- d) (b) and (c) shall be repeated a further five times;
- e) the fuel supply shall be restored.

Immediately after this test the engine shall be started using the manual starting system.

#### 18.4.4.4 Float valves on water storage tanks

Float valves on water storage tanks shall be checked for correct function.

#### 18.4.4.5 Pump suction strainers

Pump suction strainers and settling chamber screens shall be inspected at least annually and cleaned as necessary.

### 18.4.5 3 Yearly routine

#### 18.4.5.1 General

The following checks and inspections shall be made at intervals of not more than 3 years.

#### 18.4.5.2 Storage and Pressure tanks

All tanks, except single superior supplies, shall be examined externally and internally. The tanks shall be cleaned and/or repainted and/or have the corrosion protection refurbished, as necessary.

#### 18.4.5.3 Water supply stop valves, alarm and non-return valves

All water stop valves, alarm and non-return valves shall be examined and replaced or overhauled as necessary.

### 18.4.6 15 yearly routine

At not more than 15 year intervals, all storage tanks shall be drained, cleaned, examined internally and the fabric attended to as necessary.

## Annex A

# Classification of Typical 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.

**Table 30: Light Hazard occupancies (A.1)**

Schools and other educational institutions (certain areas)  
Offices (certain areas)  
Prisons Hotels certain areas (see 5.2.1)

**Table 31: Ordinary Hazard occupancies (A.2)**

Occupancy	Ordinary Hazard group			
	OH1	OH2 <sup>(1)</sup>	OH3 <sup>(2)</sup>	OH4
Glass and ceramics			<ul style="list-style-type: none"> <li>glass factories</li> </ul>	
Chemicals	<ul style="list-style-type: none"> <li>cement works</li> </ul>	<ul style="list-style-type: none"> <li>photographic laboratories</li> <li>photographic film manufacturers</li> </ul>	<ul style="list-style-type: none"> <li>dyers works</li> <li>soap factories</li> <li>Photographic film manufacturers</li> <li>Paint application shops with water</li> </ul>	
Mechanical Engineering	<ul style="list-style-type: none"> <li>sheet metal product factories</li> </ul>	<ul style="list-style-type: none"> <li>Metal working</li> </ul>	<ul style="list-style-type: none"> <li>electronics factories</li> <li>radio equipment factories</li> <li>washing machine factories</li> <li>Car workshops</li> </ul>	
Food and beverages (3)		<ul style="list-style-type: none"> <li>Abattoirs, meat factories</li> <li>Bakeries</li> <li>Biscuit factories</li> <li>Breweries</li> <li>Chocolate factories</li> <li>Confectionery factories</li> <li>Dairies (milk)</li> </ul>	<ul style="list-style-type: none"> <li>animal fodder factories</li> <li>corn mills</li> <li>dehydrated vegetable and soup factories</li> <li>sugar factories</li> </ul>	<ul style="list-style-type: none"> <li>alcohol distilleries</li> </ul>

Miscellaneous	<ul style="list-style-type: none"> <li>• hospitals</li> <li>• hotels</li> <li>• libraries (excluding book stores)</li> <li>• Restaurants</li> <li>• Schools see 5.2.1</li> <li>• Offices see 5.2.1</li> </ul>	<ul style="list-style-type: none"> <li>• Laboratories (physical)</li> <li>• Laundries</li> <li>• Car parks (excluding automatic car parks)</li> <li>• museums</li> </ul>	<ul style="list-style-type: none"> <li>• broadcasting studios (see also film (TV) studio)</li> <li>• railway stations</li> <li>• plant room</li> <li>• farms</li> </ul>	<ul style="list-style-type: none"> <li>• cinemas and theatres</li> <li>• concert halls</li> <li>• Tobacco factories</li> <li>• Film (TV) studios</li> </ul>
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**Table A.2 - Ordinary Hazard occupancies - continued**

Occupancy	Ordinary Hazard group			
	OH1	OH2	OH3	OH4
Paper			<ul style="list-style-type: none"> <li>• Book binding factories</li> <li>• cardboard factories</li> <li>• paper factories</li> </ul>	<ul style="list-style-type: none"> <li>• Waste paper processing</li> </ul>
Rubber and plastics				
Shops and offices	<ul style="list-style-type: none"> <li>• Data processing (computer room, excluding tape storage)</li> <li>• offices see 5.2.1</li> </ul>		<ul style="list-style-type: none"> <li>• department stores</li> <li>• shopping centres</li> </ul>	<ul style="list-style-type: none"> <li>• exhibition halls (4)</li> </ul>
Textiles and clothing		Leather goods factories	<ul style="list-style-type: none"> <li>• Carpet factories (excluding rubber and foam plastics)</li> <li>• Cloth and clothing factories</li> <li>• Fibre board factories</li> <li>• Footwear factories, excluding plastics and rubber</li> <li>• Knitting factories Linen factories</li> <li>• Mattress factories (excluding foam plastics)</li> <li>• Sewing factories</li> <li>• Weaving mills</li> <li>• Woollen and worsted mills</li> </ul>	<ul style="list-style-type: none"> <li>• cotton mills</li> <li>• flax preparation</li> <li>• plants hemp preparation</li> <li>• plants</li> </ul>



Timber and wood			<ul style="list-style-type: none"> <li>• woodworking factories</li> <li>• furniture factories (without foam plastics)</li> <li>• furniture showrooms upholstery (without foam plastics)</li> <li>• factories</li> </ul>	<ul style="list-style-type: none"> <li>• plywood factories</li> </ul>
<p><i>NOTE 1: Where there is painting, large amount of flammable liquids or other similar high fire load areas, they shall be treated as OH3.</i></p> <p><i>NOTE 2 : Warehouses generally and high rise buildings according to annex E in order to ensure flexibility.</i></p> <p><i>NOTE 3: If combustible insulated panels are used, consideration for a possible higher classification should be taken.</i></p>				

**Table 32: High Hazard Process occupancies (A.3)**

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 tires for cars and lorries	
rubber substitute manufacture wood wool manufacture match manufacturers	depots for buses, unladen lorries and railway carriages	manufacture of foam plastics, foam rubber and foam rubber goods	
paint application shops with solvent	candle wax and paraffin manufacturers		
refrigerator factories printing works	Paper machine halls		
cable factories for PP/PE/PS or similar burning characteristics; other OH3	carpet factories including rubber and foam plastics		
injection moulding (plastics) for PP/PE/PS or similar burning characteristics; other OH3	saw mill		
plastics factories and plastic goods (excluding foam plastics) for PP/PE/PS or similar burning characteristics; other OH3	chipboard manufacturing (1)		
rubber goods factories	paint, colour and varnish manufacture		
synthetic fibre factories (excluding acrylic)			
rope factories			
carpet factories including unexpanded plastics			
footwear factories, including plastics and rubber			
<b><u>NOTE 1 Additional object protection may be necessary</u></b>			

## Annex B

# Process for Categorising Stored Materials

### B.1 General

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.

To categorise products, this method first addresses the material involved to produce a « material factor » and then modifies this where necessary due to the configuration of the goods to determine the category. Where no modification is required, the « material factor » is the sole determinant of the Category.

### B.2 Material factor

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 expanded plastic. The storage of rubber tiers needs special consideration.

The following four material factors shall be used in determining the category:

#### B.2.1 Material Factor 1

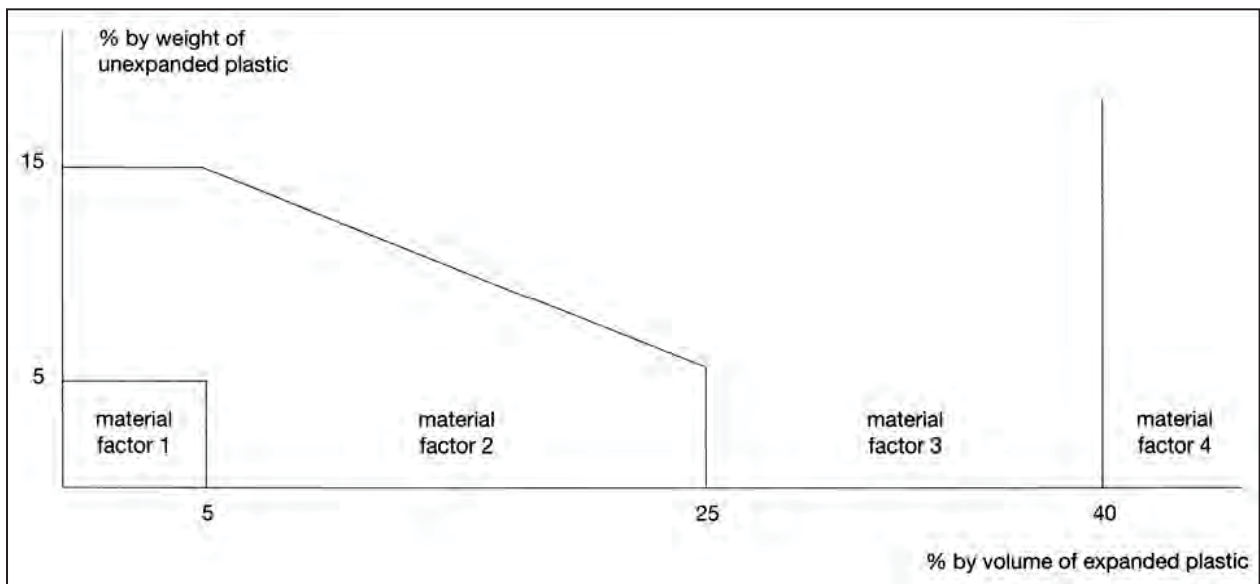
Non combustible products in combustible packaging and low or medium combustibility products in combustible/non-combustible packaging. Products having little plastic content as defined below:

- unexpanded plastic content less than 5% by weight (including the pallet);
- expanded plastic content less than 5% volume.

Examples :

- 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;
- cartoned plastic or glass bottles of non-flammable liquids;
- large electrical appliances (with little packaging).

*Figure 12- Material Factor (B1)*



#### B.2.2 Material Factor 2

Materials having a higher energy content than Material Factor 1 materials, for instance those containing plastics in greater quantities as defined in Figure B1.

Examples:

- wood or metal furniture with plastic seats;
- electrical equipment with plastic parts or packaging;
- electric cables on reels or in cartons;
- synthetic fabrics.

#### B.2.3 Material factor 3

Materials which are predominantly unexpanded plastic (see Figure B1) or materials of a similar energy content.

Examples :

- accumulators without electrolyte;
- personal computers;
- unexpanded plastic cups and cutlery.

#### B.2.4 Material factor 4

Materials which are predominantly expanded plastic (more than 40% by volume) or materials of a similar energy content (see Figures B1).

**Table 33: Categories as a function of stored materials configuration (B1)**

Storage configuration	Material Factor			
	1	2	3	4
Exposed plastic container with non-combustible content	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. II	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
<i>NOTE : See B.3.1 to B.3.7 for explanations of the storage configurations.</i>				

Examples:

- foam mattresses;
- expanded polystyrene packaging;
- foam upholstery;

### **B.3 Effect of stored materials configuration**

After determining the material factor, the stored materials configuration shall be consulted in Table B1 to determine the most appropriate Categorisation. If an appropriate category is given in Table C1 the higher of the two values shall be used.

This stored materials configurations in the table are as follows:

#### **B.3.1 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 ( $\leq 501$ ) containers with non-combustible solids;
- category III: large ( $> 501$ ) containers with non-combustible

solids; Examples:

- 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.3.2 Exposed plastic surface - unexpanded

The Category should 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.

Examples:

metal parts in PVC storage bins;

shrink wrapped tinned foods.

### B.3.3 Exposed plastic surface - expanded

Exposed expanded plastics are more severe than unexposed plastics. They should be treated as Category IV.

### B.3.4 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.

Examples:

- cardboard;
- 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.3.5 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.

Examples:

- blocks of solid rubber, vinyl floor tiles in block storage etc..

*NOTE: this configuration does not apply to blocks of expanded plastics (Category IV).*

### B.3.6 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.*

Examples:

- plastic granules used for injection moulding stored in cardboard boxes

*NOTE 2: this configuration does not apply to rack storage.*

### B.3.7 No special configuration

Goods that have none of the above characteristics e.g. cartoned goods.

## Annex C

# Alphabetical listing of stored products and categories

Table C.1 is applicable where any packaging of the goods, with or without pallets, is no more hazardous than a cardboard box or a single layer of corrugated cardboard wrapping.

**Table 34: Stored products and categories (C.1)**

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, powder	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 plastics	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
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, may be necessary
Crockery	I	
Electrical appliances	I	Predominantly metal construction with $\leq 5\%$ by mass 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	May require special measures



Fibreboard	II	
Firelighters (barbecue)	III	

*Table 35: Stored products and categories (continued (C.2))*

Product	Category	Comments
Flax	II	Special measures, such as an increased area of operation, may be necessary
Flour	II	In sacks or paper bags
Foods, tinned	I	In cardboard boxes and trays
Foodstuffs	II	In sacks
Furniture, upholstered	II	With natural fibres and materials but excluding plastics
Furniture, wooden	II	
Furs	II	Flat in boxes
Glass fibre	I	Unfabricated
Glassware	I	Empty
Grain	I	In sacks
Hemp	II	Special measures, such as an increased area of operation, may be necessary
Hides	II	
Jute	II	
Knitwear	II	See clothes
Laminated board	II	
Leather goods	II	
Linen	II	
Linoleum	III	
Matches	III	
Mattresses	IV	With expanded foam
Mattresses	II	others
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 <sup>2</sup> , (e.g. tissue paper), rolls stored horizontally
Paper	IV	Mass < 5 kg/100 m <sup>2</sup> , (e.g. tissue paper), rolls stored vertically
Paper	III	Mass < 5 kg/100 m <sup>2</sup> (e.g. newspaper), rolls stored vertically
Paper	II	Mass > 5 kg/100 m <sup>2</sup> , (e.g. newspaper), rolls stored horizontally
Paper, bitumen coated	III	
Paper, pulp	II	Rolled or baled
Paper, waste	III	Special measures may be necessary, such as an increased area of operation.
Pillows	II	Feather or down
Rags	II	Loose or baled
Resins	III	

Roof felt in rolls	III	
Rope synthetic	II	
Shoes	II	≤ 5% by mass plastic or rubber
Shoes	III	With plastic (5% or more)
Soap, water soluble	II	
Spirituous liquors, cased glass bottles (other see K)	I	≤ 20% degree of alcohol
Spirituous liquors, cased glass bottles (other see K)	III	> 20% degree of alcohol only in bottle; others see annex K

*Table 36: Stored products and categories (continued( C.3))*

Product	Category	Comments
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, unsawn	II	
Tobacco	II	Leaf and finished goods
Tyres stored horizontally	IV	Tyres stored vertically, in racks, are not covered by this standard.
Vegetable fibres	II	Special measures such as an increased area of operation may be necessary
Wax (paraffin)	IV	
Wicker work	III	
Wood		See timber
Wood, chipboard, plywood	II	Stored flat, excluding ventilated stacks
Wood pulp	II	Baled
Wood veneer sheets	III	
Wood wool	IV	Baled

## Annex D

# Requirements for Multi-Storey Buildings

### D.1 Scope

This Annex specifies requirements particular to the sprinkler protection of multi-storey buildings when zoning is adopted. It applies only to OH sprinkler installations of the wet pipe type.

*NOTE: see also Annex E for high rise systems.*

### D.2 Zoning of installations

Wet pipe Ordinary Hazard sprinkler installations may be zoned or unzoned.

The number of sprinklers to be controlled by any one wet control valve set in Ordinary Hazard may exceed 1000 (see Table 19), with the following restrictions:

- a) the installation shall be zoned in accordance with D.3;
- b) zoned installations shall not include any hazard greater than OH3;
- c) car parks and areas involving the unloading and storage of goods shall be on a separate unzoned installation;
- d) the building shall be sprinkler protected through- out on all floors;
- e) the total number of sprinklers controlled by any one control valve set shall not exceed 10 000.

### D.3 Requirements for zoned installations

#### D.3.1 Extent of zones

No zone shall:

- a) include more than 500 sprinklers;
- b) encompass more than one ownership;
- c) cover more than one floor level, which may however include a mezzanine floor no greater than 100 m<sup>2</sup>.

#### 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 not less than 20mm 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 tamperproof 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 main 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 D1). Each of the three stop valves shall be fitted with tamper proof devices to monitor their status (i.e. fully open or not fully open).

#### 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, located on the premises, where the following indications and warnings shall be given:

- a) by means of green visual indicators that each monitored stop valve is in its correct operational position;
- b) by means of audible devices and amber visual indicators that one or more control valve sets are not fully open;
- c) by means of audible devices and amber visual indicators that one or more zone subsidiary stop valves are not fully open;
- d) by means of audible devices and amber visual indicators that the static pressure in any trunk main supplying the system has fallen to a value 0,5bar or more below the normal static pressure;
- e) by means of audible devices and red visual indicators that water is flowing into the installation;
- f) by means of audible devices and red visual indicators that water is flowing into one or more zones.

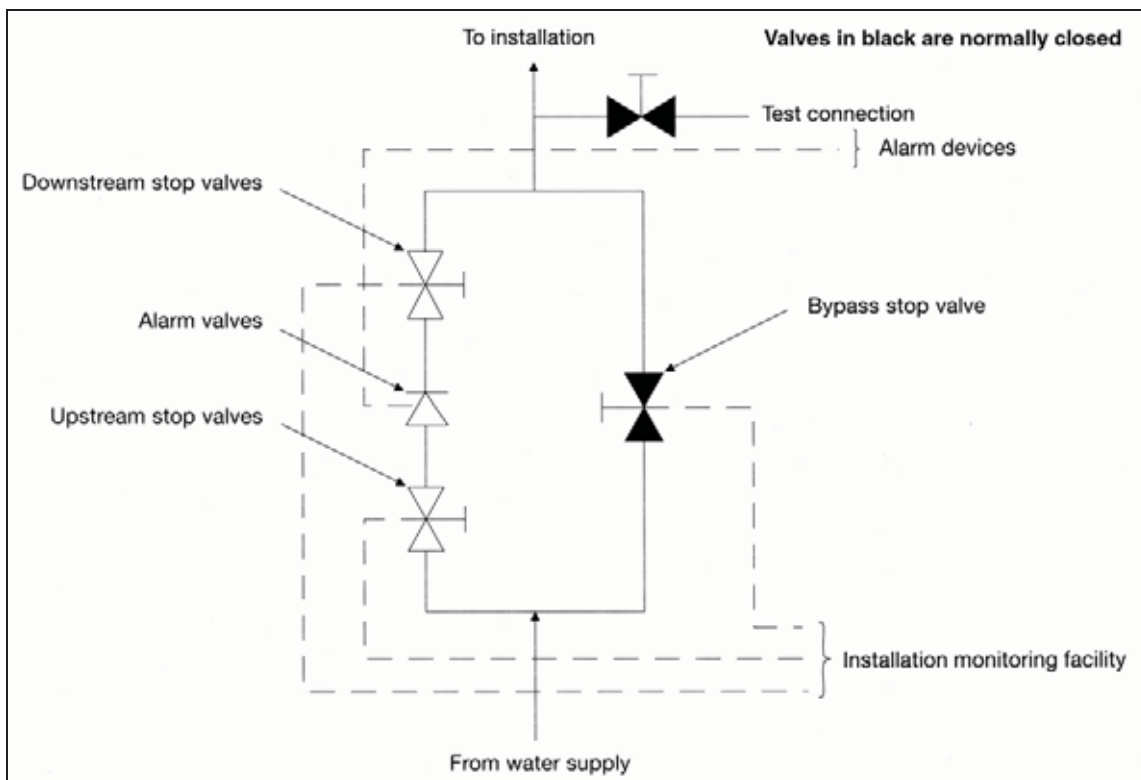
Facilities shall be provided at the indicator panel for silencing the audible alarms but the visual indicators shall continue to operate until the installation is restored to the normal standby condition.

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.

*Figure 13- Control valve bypass arrangement for zoned multi-storey building installations*



## Annex E

# Special Requirements for High Rise Systems

### E.1 Scope

This Annex specifies requirements particular to the sprinkler protection of multi-storey buildings with a height difference between the highest and lowest sprinkler exceeding 45m. The requirements are applicable to buildings intended for use with occupancies where the hazard is classified as no greater than Ordinary Hazard Group III.

*NOTE: 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 comply with 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 such that the height difference between the highest and lowest sprinkler on any one installation does not exceed 45m (see Figures E1 and E2).

#### E.2.3 Zoning

High Rise Sprinkler systems shall be zoned in accordance with Annex D.

#### E.2.4 Standing water pressures at back pressure and alarm valves

The minimum standing pressure at any back pressure 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.

Back pressure valves controlling installation flow should operate correctly with a ratio of service pressure to installation pressure not exceeding 1,16:1, as measured by valve lift and pressure equalisation upstream of the back pressure valve.

#### E.2.5 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 1 000 l/min (see G. 2.4.2).

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, may be increased by an amount equal to the difference in static head gain between the sprinklers at the level concerned and the highest sprinkler in the installation.

### E.2.6 Water pressures

Pipework, fittings, valves and other equipment shall be capable of withstanding the maximum pressure likely to be encountered.

*NOTE: to overcome the problem of pressures in excess of 12bar, hydraulic alarm gongs may be driven via a pressure reducing valve or from a secondary water supply such as a town main, controlled by a diaphragm valve connected to the main installation control valve alarm port.*

## 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 7, 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 7, 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 19.

*NOTE: Pressures are taken at the pump outlet or the relevant stage of multi-stage pumps, on the delivery side of any orifice plate.*

Figure 14 - Typical layout of high rise system with pump supply (E1)

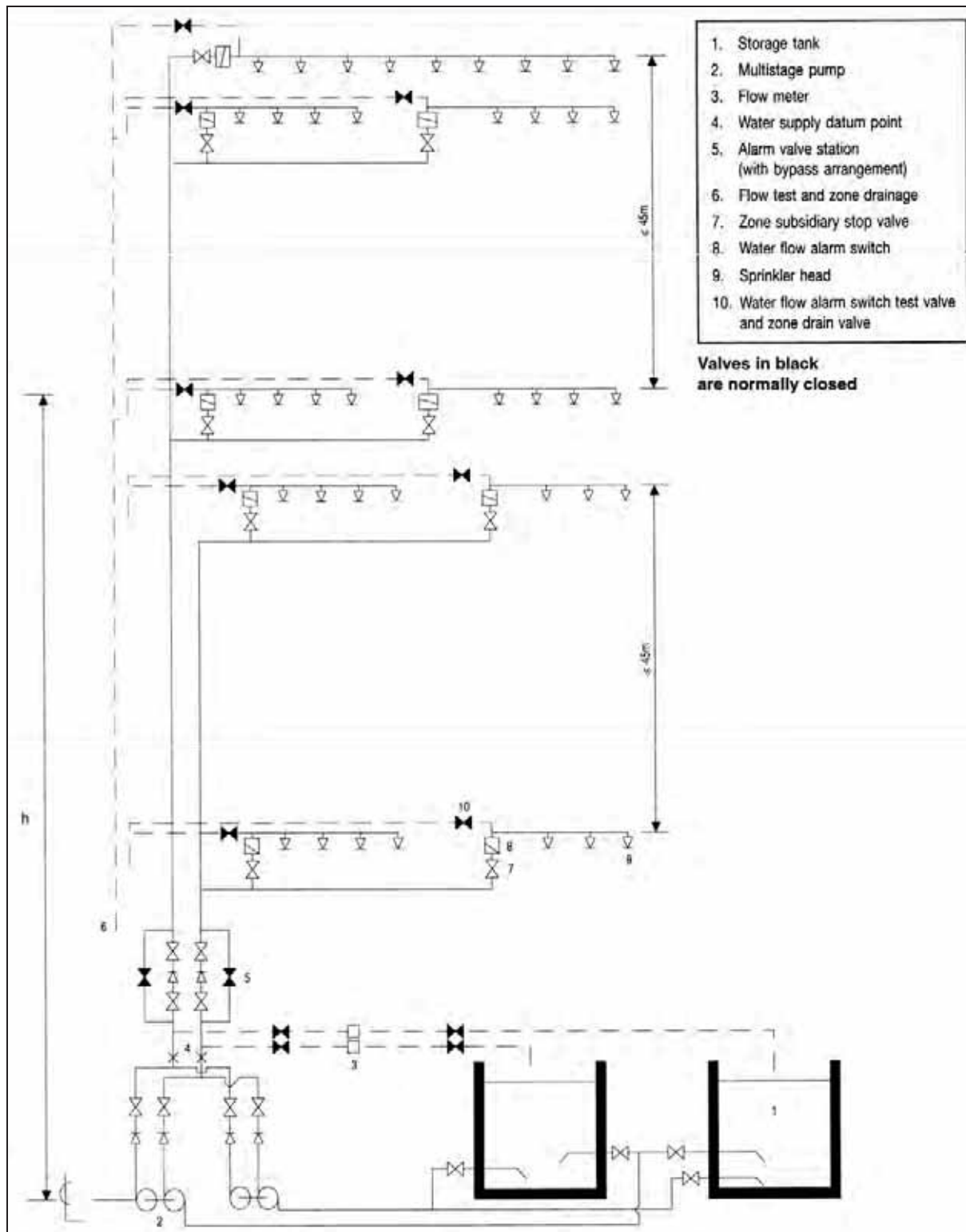
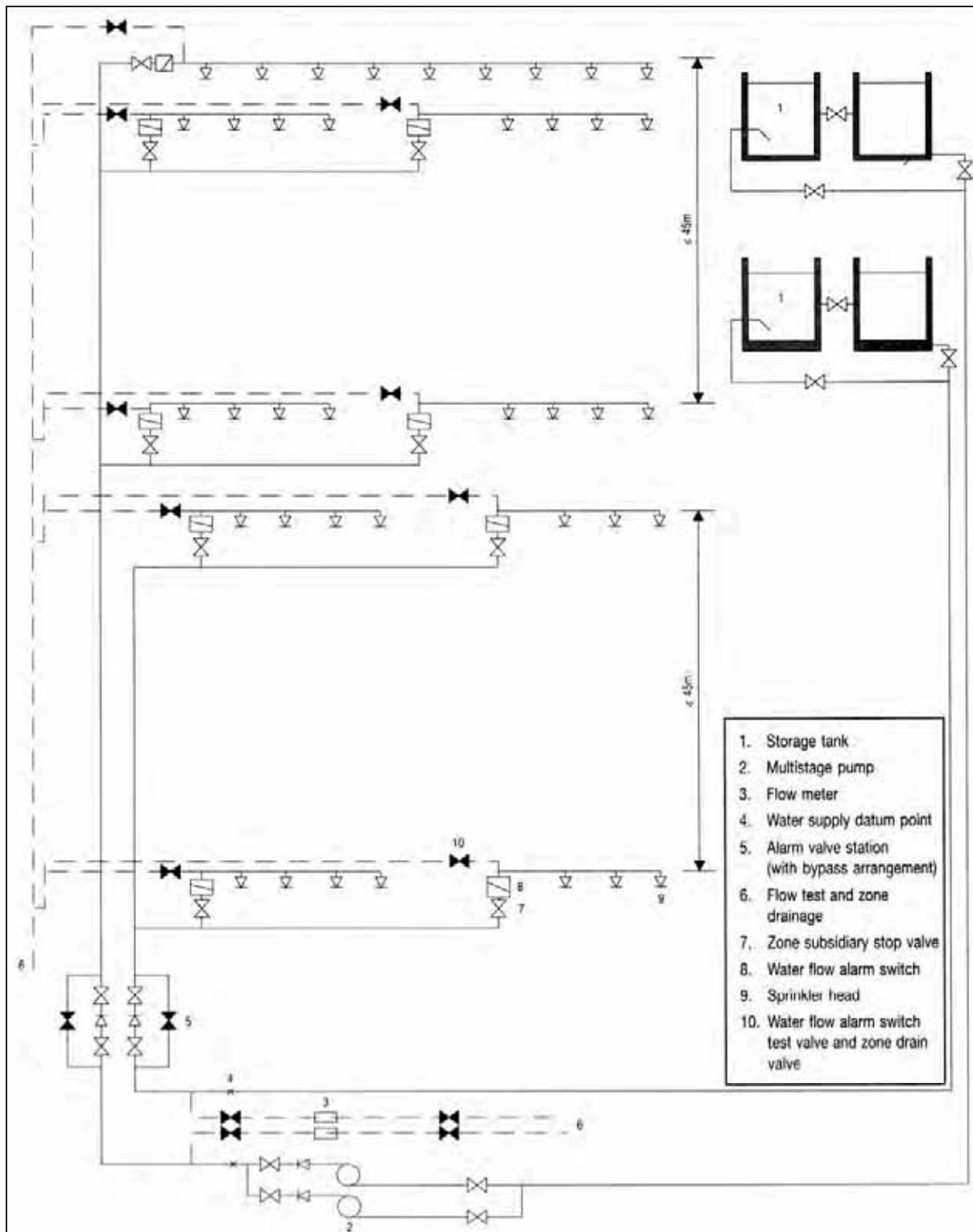




Figure 15- Typical layout of high rise system with gravity tanks and booster pumps (E2)



## Annex F

# Special Requirements for Life Safety Systems

### F.1 Subdivision into zones

Installations shall be subdivided into zones, in accordance with Annex D, with a maximum of 200 sprinklers per zone.

### F.2 Wet Pipe Installations

Sprinkler installations for life safety shall be of the wet pipe type and any subsidiary dry pipe or alternate extension shall comply with 10.5.

### F.3 Sprinkler type and sensitivity

Conventional, Spray or Sidewall sprinklers shall be used. The sensitivity shall be Quick response, except that Standard 'A' and Special response may be used in rooms not less than 500m<sup>2</sup> in area or not less than 5m in height.

### F.4 Installation Main 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.5 Water Supplies

The system shall have at least one superior single water supply.

*NOTE: in some countries duplicate supplies are required for life safety systems.*

### F.6 Theatres

National requirements shall be taken into consideration.

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 12m may be protected by sprinklers.

All workshops, dressing rooms, scenery, storerooms and spaces below the stage shall be sprinklered.

### F.7 Additional precautions for maintenance

Only one zone of a multi-zone installation shall be shut down at a time. An installation or zone shall be shut down for the minimum time necessary for maintenance.

The partial or complete shut-down of a life safety sprinkler installation shall be avoided wherever possible. Only the smallest part of the installation necessary shall be isolated.

When a zone (or zones) is charged or recharged with water after draining, the flushing valve(s) (see D.3.3) shall be used to check that water is available in the zone (or zones).

Individual alarm valves in a duplicate control valve set, where required, shall be separately serviced, provided the water supply to the installation is maintained.

The following procedure shall be followed before servicing duplicate control valve sets:

- the stop valves to the duplicate alarm valve shall be checked and if necessary opened. One of the stop valves to the alarm valve to be serviced shall be closed and an alarm test (see 18.3.2.3) 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

# Methods for sizing pipework

## G.1 Calculation of pressure losses in pipework

### G.1.1 Pipe friction loss

Frictional pressure loss in pipes shall be hydraulically calculated. The Hazen-Williams formula should be used:

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

where:

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

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

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

C is a constant for the type and condition of the pipe (see Table G1);

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

The values of C to be used in sprinkler installation and water supply calculations shall be as indicated in table G1.

**Table 37: C values for various types of pipe (G1)**

Type of pipe	Value of C
cast iron	100
ductile iron	110
mild steel	120
galvanised steel	120
spun cement	130
stainless steel	140
reinforced glass fibre	140

The pressure loss due to velocity may be ignored.

### G.1.2 Static pressure difference

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

$$p = 0,098h$$

where:

p is the static pressure difference, in bar;

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

### G.1.3 Velocity

The equilibrium water velocity shall not exceed:

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

10m/s at any other point in the system,

for the stabilised flow condition at the demand point involving an area of operation or where the system includes intermediate sprinklers the total number of sprinklers assumed to be in simultaneous operation.

### G.1.4 Fitting and valve friction losses

The pressure loss due to friction in valves, in fittings and in couplings where the direction of water flow is changed through 45° or more, shall be calculated using an equivalent length and applying the formula specified in G.1. The appropriate equivalent length to be used shall be one of following:

- a) as specified by the equipment manufacturer; tested in a laboratory which is accepted by the authorities;
- b) as taken from Table G2, provided that it is no lower than a).

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 expressed in pipe length of the smaller diameter.

### G.1.5 Accuracy of calculations

Calculations shall be carried out with the accuracy of measurements given in Table G3.

Furthermore the following degree of accuracy for calculations shall be adhered to:

- the algebraic sum of pressure loss in a loop shall equal 0mbar  $\pm$  1mbar;

**Table 38: Equivalent length of fittings and valves (G2)**

Fittings and valves	Equivalent length of steel straight pipe for a C value of 120° m											
	Nominal diameter (mm)											
	20	25	32	40	50	65	80	100	125	150	200	250
90° screwed elbow (standard)	0,63	0,77	1,04	1,22	1,46	1,89	2,37	3,04	3,67	4,30	5,67	7,42
90° welded elbow (r/d=1.5)	0,30	0,36	0,49	0,56	0,69	0,88	1,10	1,43	1,72	2,00	2,64	3,35
45° screwed elbow (standard)	0,34	0,40	0,55	0,66	0,76	1,02	1,27	1,61	1,96	2,30	3,05	3,89
Standard screwed tee or cross (flow through branch)	1,25	1,54	2,13	2,44	2,91	3,81	4,75	6,10	7,36	8,61	11,34	14,85
Gate valve - straight way	-	-	-	-	0,38	0,51	0,63	0,81	0,97	1,13	1,50	1,97
Alarm or back pressure valve (swinging type)	-	-	-	-	2,42	3,18	3,94	5,07	6,12	7,17	9,40	12,30
Alarm or back pressure valve (mushroom type)	-	-	-	-	12,08	18,91	19,71	25,46	30,67	35,88	47,27	61,85
Butterfly valve	-	-	-	-	2,19	2,86	3,55	4,56	5,47	6,38	8,62	9,90
Globe valve	-	-	-	-	16,43	21,64	26,80	34,48	41,64	48,79	64,29	84,11
These equivalent lengths can 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	0,850	1,000	1,160	1,330							

**Table 39: Accuracy of hydraulic calculations (G3)**

Quantity	Unit	Round to
Length	m	0,01
Height	m	0,01
Equivalent length	m	0,01
Flow	l/min	1,00
Pressure loss	mbar/m	1,00
Pressure	mbar	1,00
Velocity	m/s	-0,10
Area	m²	0,01
Density of water application	mm/min	0,10

- where the water flows join together at a junction, the calculation shall be balanced to within 1mbar;
- the algebraic sum of water flow at a junction shall equal 0 l/min  $\pm$  0,1 l/min.

## G.2 Pre-calculated systems

### G.2.1 General

G.2.1.1 Pipe sizes shall be determined partly from the following tables and partly from hydraulic calculations. Pipe diameters shall not increase in the direction of flow of water to any sprinkler.

G.2.1.2 Range pipe sizes and the maximum number of sprinklers fed by each size of pipe in the range shall be as specified in Tables G9 and G10, except in the case of Light Hazard, where Table G6 specifies only the pipes feeding the last three or four sprinklers on each range.

G.2.1.3 The size of all pipes upstream of each design point shall be calculated as specified in G.2.3.2 for Light Hazard and G.2.4.2 for Ordinary Hazard.

G.2.1.4 Risers or drops, connecting distribution pipes to ranges, and pipes connecting single sprinklers, other than arm pipes, shall be considered as distribution pipes and sized accordingly.

## G.2.2 Location of Design Points

G.2.2.1 The design point shall be located 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 is specified in Tables G4 and G5. The design point is located by counting from the hydraulically most remote sprinkler in the array.

G.2.2.2 In Light Hazard installations the design point shall be located downstream of the sprinkler identified in Table G4 column 3.

G.2.2.3 In Ordinary and High Hazard installations the design point shall be located downstream of the junction of distribution pipes and range pipes in accordance with Table G5 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, indicated in Table G5 column 2, the design point shall be positioned downstream of the point of connection to the distribution pipe of the range or the array hydraulically nearest to the control valve set.

**Table 40: Location of design points – LH (G4)**

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

**Table 41: Location of design points - OH, HHP and HHS (G5)**

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 <sup>th</sup> sprinkler where n is	Range layout
OH	> 16	17	two end-side
HHP and HHS	> 18	19	all except two end-side
	> 48	49	all

NOTE 1: figure H2 illustrates typical range pipe arrays.

NOTE 2: examples of pie layouts with the appropriate design points are given in Figure H3 for LH, Figure H4 for OH and Figures H5, H6 and H7 for HHP and HHS.

### G.2.3 Light Hazard LH

G.2.3.1 The size of range pipes, and terminal distribution pipes downstream of the design point shall be as given in Table G6.

**Table 42: Range pipe diameters for LH installations (G6)**

Pipes	Nominal pipe size mm	Maximum number of sprinklers on range pipes
All range pipes and terminal distribution pipes	20	1
	25	3

It is permitted to install a 25mm 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 25mm pipe shall not be installed between the 3<sup>rd</sup> and 4<sup>th</sup> sprinkler.

G.2.3.2 All pipework between the main control valve set and the design point at each extremity of an array shall be sized by hydraulic calculation using the values in Tables G7 and G8.

**Table 43: Maximum friction loss between control valve set and any design point – LH (G7)**

Number of sprinklers on a range or in a room	Maximum friction loss including changes in direction (see Note to table) bar	Range and distribution pipe loss, see :
$\leq 3$	0,9	Table G8 columns 2 and 3
$\geq 4$	0,7	Table G8 column 3
$\geq 3$ in a single line, in a narrow room or range at a roof apex	0,7	Table G8 column 3
<i>NOTE: in buildings with two or more floors, the pressure loss may be increased on each floor 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.</i>		

G.2.3.3 If there are more than 2 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 G8. 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 G8.

*NOTE: figure H3 shows an example of pipe layout in LH with design points from which the piping shall be fully calculated.*



**Table 44: Pressure loss for design flow rates in LH installations (G8)**

Nominal pipe size	Loss of pressure in pipe	
Column 1	Column 2 (100 l/min)	Column 3 (225 l/min)
25	44,00	198,00
32	12 ,00	52,00
40	5,50	25,00
50	1,70	7,80
65	0,44	2,00

#### G.2.4 Ordinary Hazard - OH

G.2.4.1 For range and distribution pipes, the dimensions given Table G9 and G10 shall be used.

**Table 45: Range pipe diameters for OH installations (G9)**

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

***Table 46: Distribution pipe diameters in OH installations (G10)***

Distribution pipes	Layout	Diameter mm	Maximum number of sprinklers fed
At extremities of system	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 G.2.4.2	

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

The use of 65mm diameter pipe between the design points and the control valve set is permitted provided that a hydraulic calculation shows this to be possible.

*NOTE: figure H4 gives an example of a pipe layout in OH with the appropriate design points from which the pipe diameters shall be fully calculated.*

G.2.4.2 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 1000l/min does not exceed 0,5bar, except modified in G.2.4.3 and G.2.4.4.

G.2.4.3 In buildings with a number of floors, or where there are a number of different levels, e.g. : platforms or lean-to's, the 0,5bar loss in pressure from the design point on each floor may be increased by an amount equivalent to the static pressure due to the height difference between the highest level and 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.

G.2.4.4 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 0,5bar may be increased by 50% of the available extra pressure, as indicated in the following example for OH3.

Example:

Pressure required at the control valve set excluding static pressure (Table 6 for OH3)	1,4bar
Pressure difference due to the difference in height between the highest sprinkler and the control valve set	1,2bar

=====

Required pressure at the control valve set	2,6bar
Pressure available at the control valve set for the flow appropriate in HH e.g.	6,0 bar
Extra pressure which may be used: 50% of (6,0-2,6)=	1,7bar
The pipework shall be dimensioned to allow for a maximum pressure loss of: $0,5+1,7 (1\ 000/1\ 350)^2 =$	1,43bar

## G.2.5 High hazard - HHP and HHS (except intermediate level sprinklers)

### G.2.5.1 The pipe sizing depends upon:

- 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 25mm.

G.2.5.2 For installations with water supplies which conform to the demands shown in Table 8 (1) and with sprinklers having a K factor of 80, the pipe sizes for range pipes and distribution pipes shown in Tables G11 and G12 shall apply.

No more than 4 sprinklers shall be installed on any range pipe. No range pipe shall be connected to a distribution pipe exceeding 150mm in diameter. 100mm diameter pipe may be installed between the design points and the control valve set if calculation shows this to be possible.

*NOTE: figure H5 gives an example of a pipe layout in accordance with Tables G11 and G12 and design points from which the pipe diameters shall be fully calculated.*

G.2.5.3 For installations with water supplies which conform to the requirements shown in Table 8 (2) and with sprinklers having a K factor of 80, the pipe sizes for range pipes and distribution pipes shall be determined from Tables G11 and G13.

No more than 4 sprinklers shall be installed on any range Pipe. No range pipe shall be connected to a distribution pipe exceeding 150mm in diameter. No distribution pipe less than 65mm diameter is permitted for 4 end-side systems. 150mm diameter pipe may be installed between the design points and the control valve set if calculation shows this to be possible.

*NOTE: figure H6 gives an example of a pipe layout in accordance with Tables G11 and G13 and design points from which the pipe diameters shall be fully calculated.*

G.2.5.4 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 8 (4) with sprinklers having a K factor of 115, the pipe sizes for range pipes and distribution pipes shown in Tables G13 and G14 shall apply.

In an end-side arrangement, no more than 6 sprinklers shall be fitted to any range pipe. In a two end-centre layout, no more than 4 sprinklers shall be fitted to any range pipe. No range pipe shall be connected to a distribution pipe exceeding 150mm in diameter. No distribution pipe less than 65mm diameter shall be used for 4 end-side systems. 150mm diameter pipe may be installed between the design points and the control valve set if calculation shows this to be possible.

NOTE: figure H7 gives an example of a pipe layout in accordance with Tables G13 and G14 and design points from which the pipe diameters shall be fully calculated.

**Table 47: Range pipe diameter for HH installations with pressure and flow characteristics as given in Table 8 (1 or 2)(G11)**

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

**Table 48: Distribution pipe diameters downstream of the design point in HH installations with pressure and flow characteristics as given in Table 8 (1) (G12)**

Distribution pipes	Diameter mm	Maximum number of sprinklers fed by distribution pipe
Pipes at extremities of system	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 G.2.5	

**Table 49: Distribution pipe diameters downstream of the design point in HH installations with pressure and flow characteristics as given in Table 8 (2,3 or 4) (G13)**

Distribution pipes	Diameter mm	Maximum number of sprinklers fed by distribution pipe
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 G.2.5	

***Table 50: Range pipe diameters of HH installations with pressure and flow characteristics as given in table 7 (3 or 4) (G14)***

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

G.2.5.5 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 8, 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.

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

### **G.3 Fully calculated systems**

#### **G.3.1 Density of discharge**

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

Where possible 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. 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 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 (see figure H8).

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.

### G.3.2 Locations of the area of operation

#### G.3.2.1 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 H9, H11 and H12).

*NOTE: proof of the correct position of the hydraulically most unfavourable area of operation in the case of gridded installations entails displacing the area of operation by one sprinkler pitch in each direction along ranges, and in the case of looped installations by one sprinkler pitch along distribution pipes.*

#### G.3.2.2 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 H10 to H12).

### G.3.3 Shape of the area of operation

#### G.3.3.1 Hydraulically most unfavourable location

The area of operation shall be as near as possible rectangular. The following shall be considered:

- 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 up-stream range row to the rectangular area (see figures H9 and H12);
- 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 1,0m 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;

The area of operation shall be as far as possible symmetrical with respect to the sprinkler layout (see figure H11).

### G.3.3.2 Hydraulically most favourable location

The area of operation shall be as near as possible square. The following shall be considered:

- 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 H10 and H12);
- 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 H11).

### G.3.4 Minimum sprinkler discharge pressure

The pressure at the hydraulically most unfavourably situated sprinkler when all the sprinklers in the area of operation are open, shall be not less than that required by G.3.1 or the following in table G15, whichever is the higher.

***Table 51: Minimum sprinkler discharge pressure and minimum sprinkler K factor (G15)***

Hazard class	K factor minimum	Minimum pressure Bar
LH	57	0,7
OH	80	0,35
HHP/HHS roof or ceiling protection	80	0,5
HHP/HHS roof or ceiling protection	115	0,5
HHP/HHS roof or ceiling protection	160	0,5
In-racks sprinkler	80	2
In-racks sprinkler	115	1

### G.3.5 Minimum pipe diameters

The minimum allowable pipe diameter is 20mm for LH and 25mm for OH, HHP and HHS.

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

For installations with range pipes fed from one end, (see figures H9 and H12) no 25mm diameter range pipe shall be fitted with more than 8 sprinklers.

For installations with ranges pipes fed from both ends, (see figure H11) no 25mm diameter range pipe shall be fitted with more than 16 sprinklers.

Upright sprinklers may not be directly connected to any pipe with a diameter greater than 65mm. Pendent sprinklers may not be directly connected to any pipe with a diameter greater than

80mm. For larger diameters an armpipe shall be fitted so that the minimum distance from the sprinkler deflector to the edge of the main pipe is 1,5 times the diameter of this pipe.



## Annex H (Informative)

### Figures with examples

*Figure 16- Typical pump curve (see 9.7) (H1)*

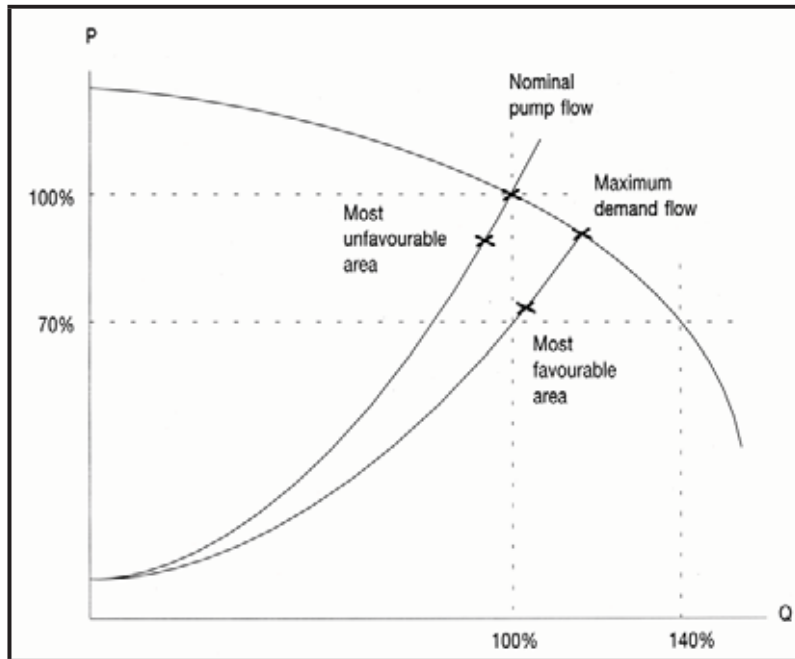


Figure 17- Examples of range pipe arrays (see G.2.2) (H2)

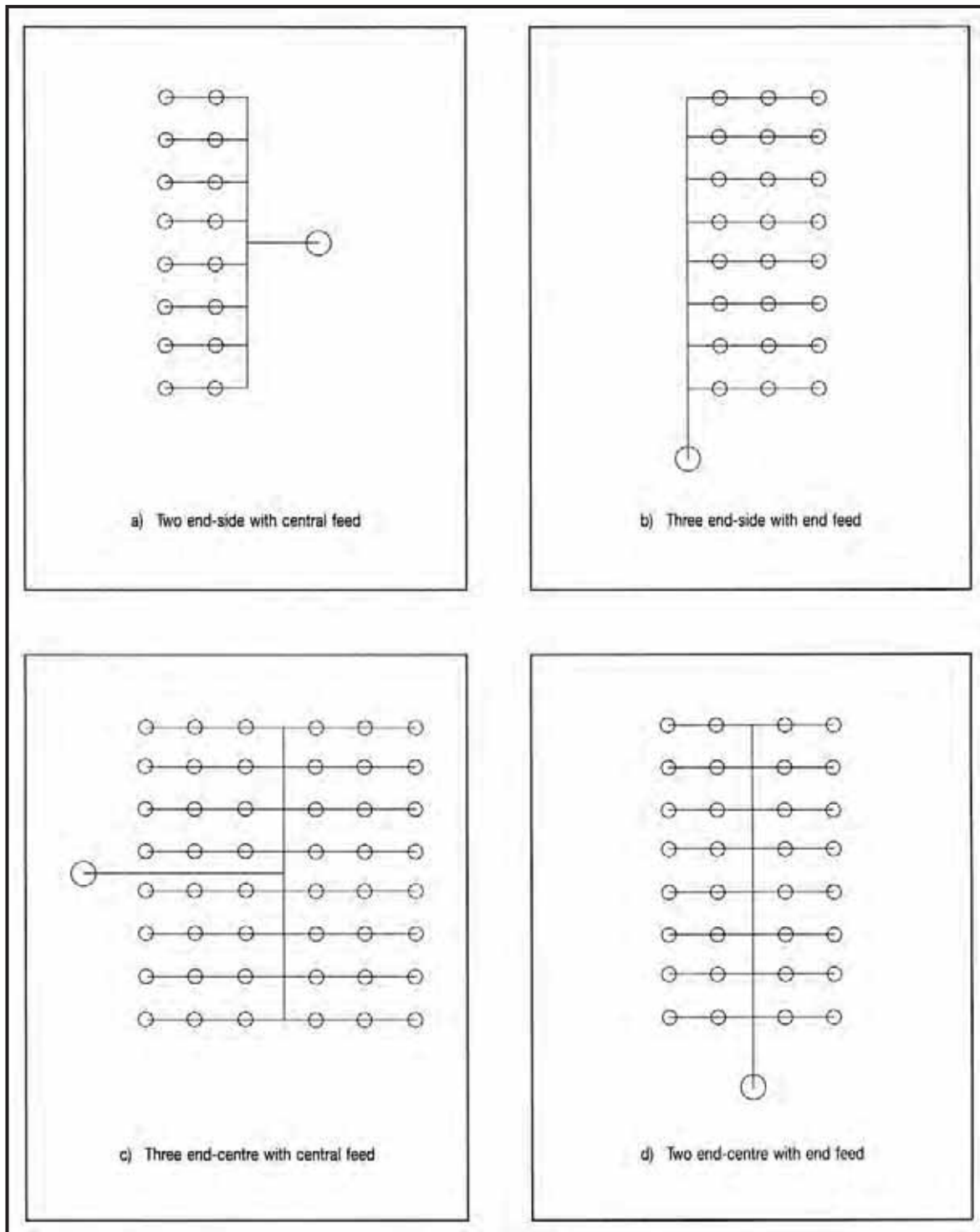


Figure 18- Example of application of design points in an LH installation (see G.2.2) (H3)

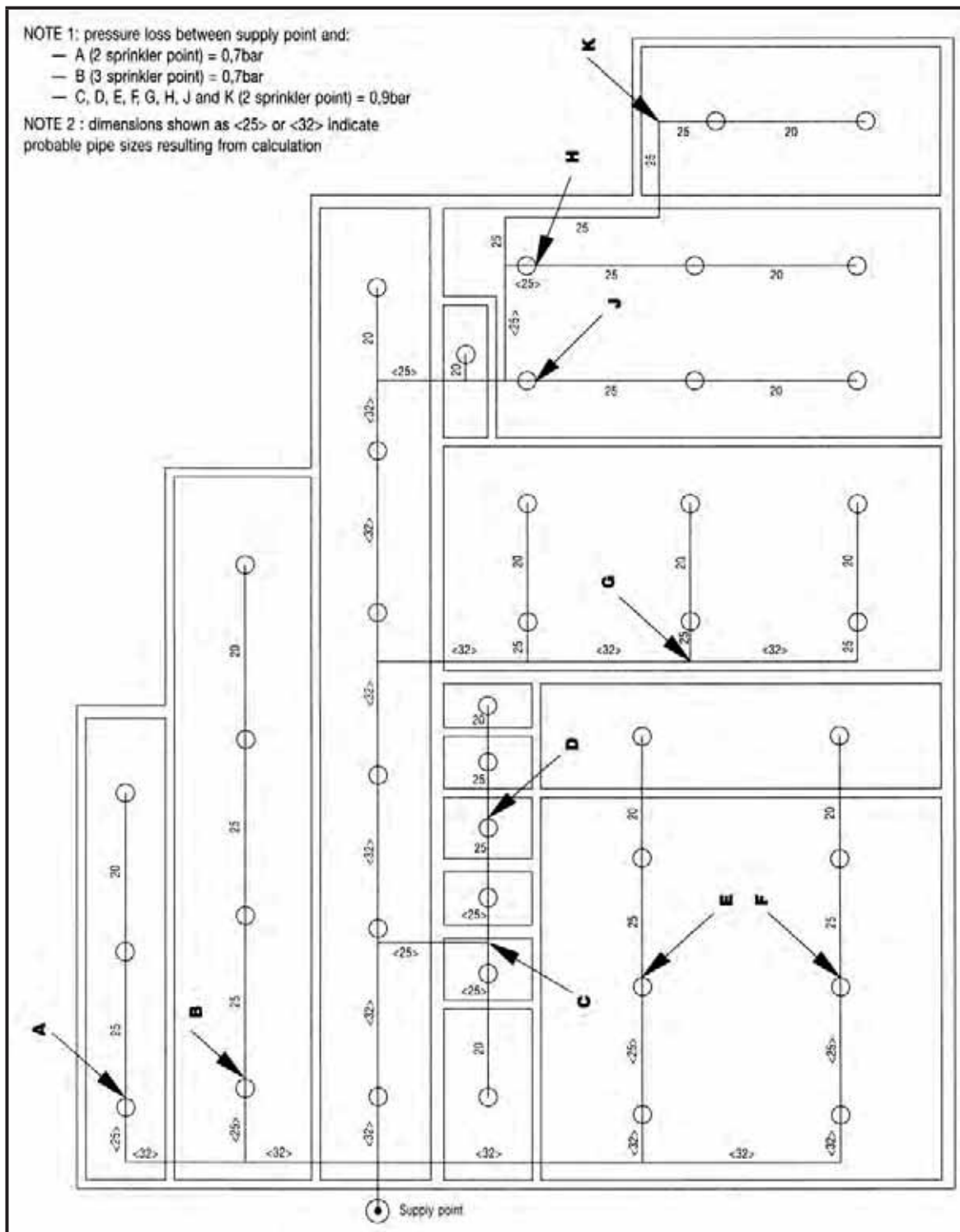
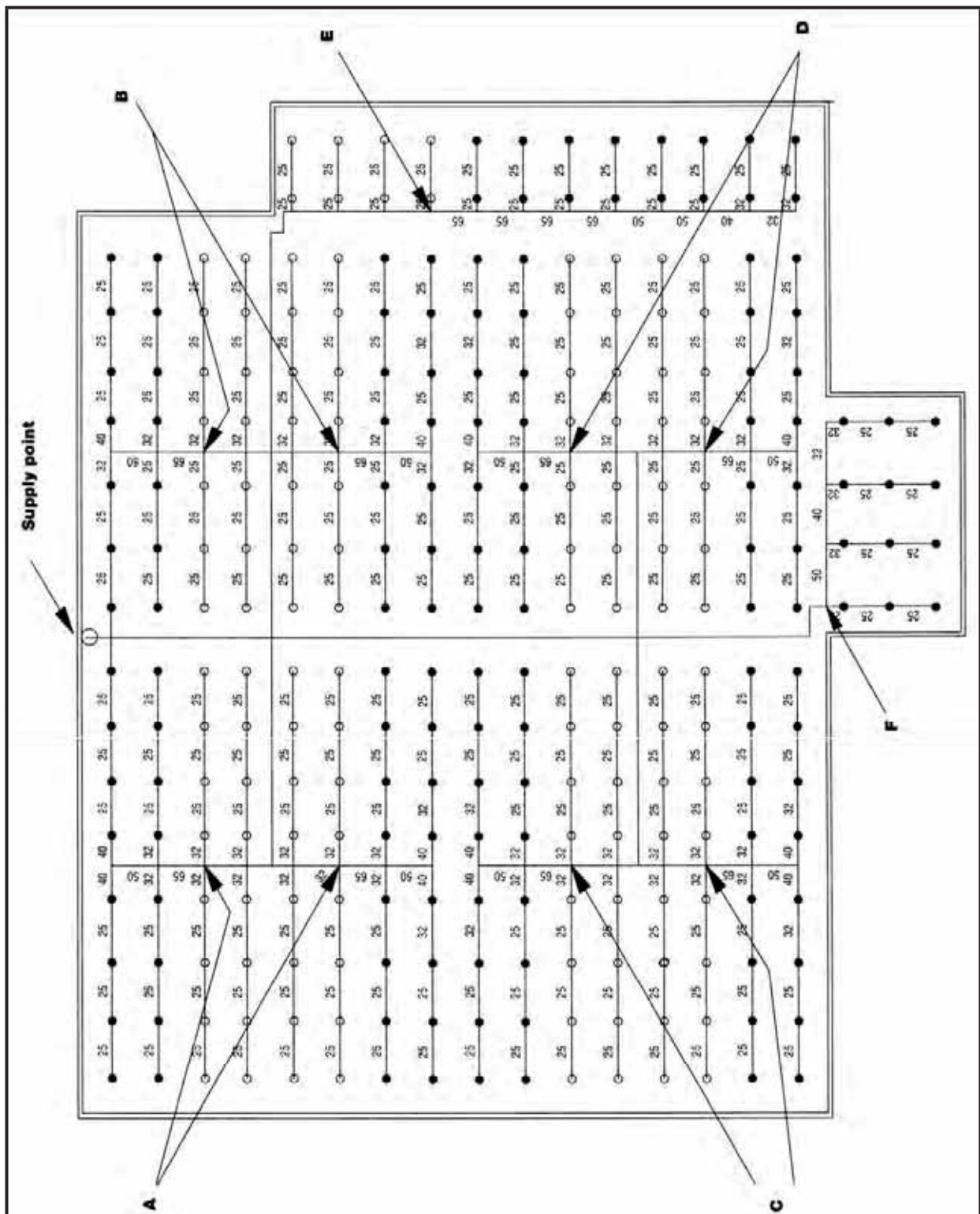
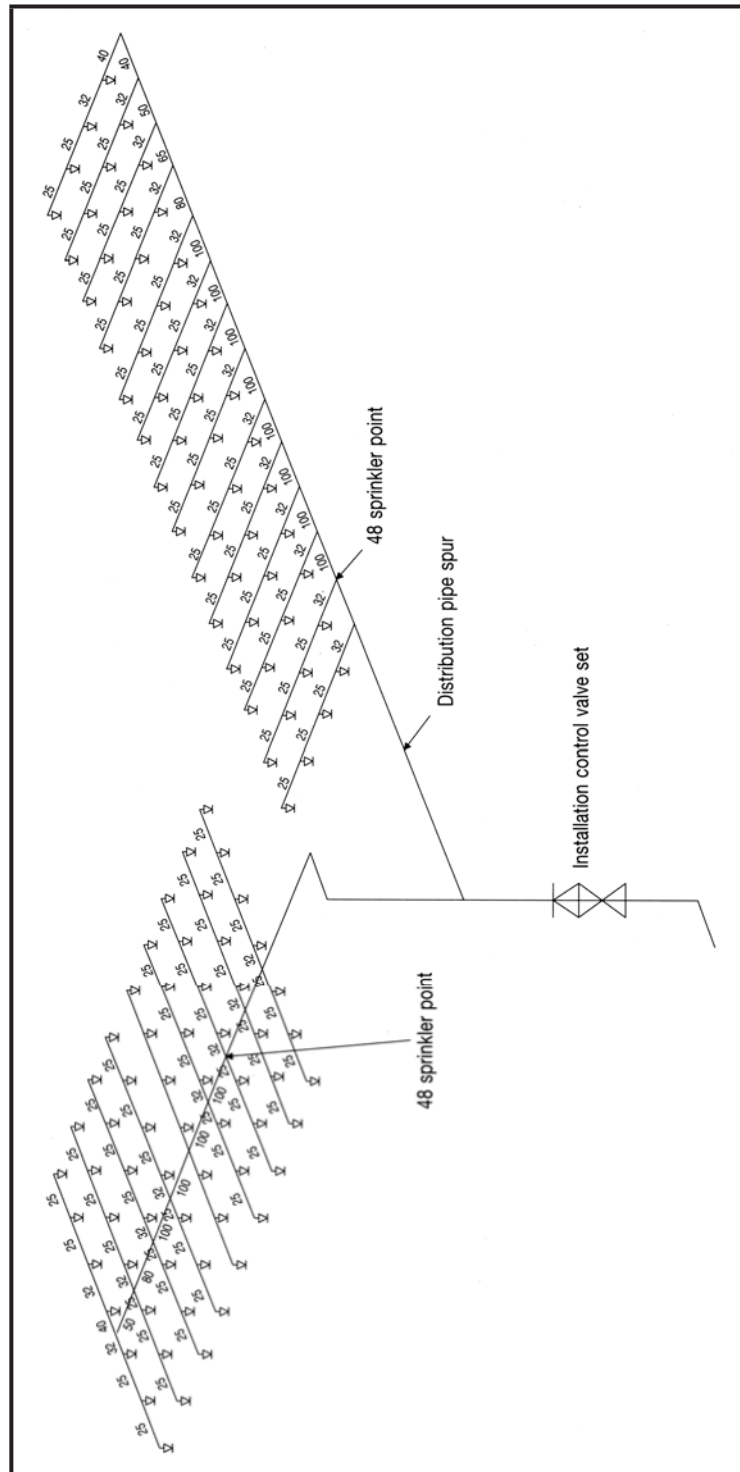


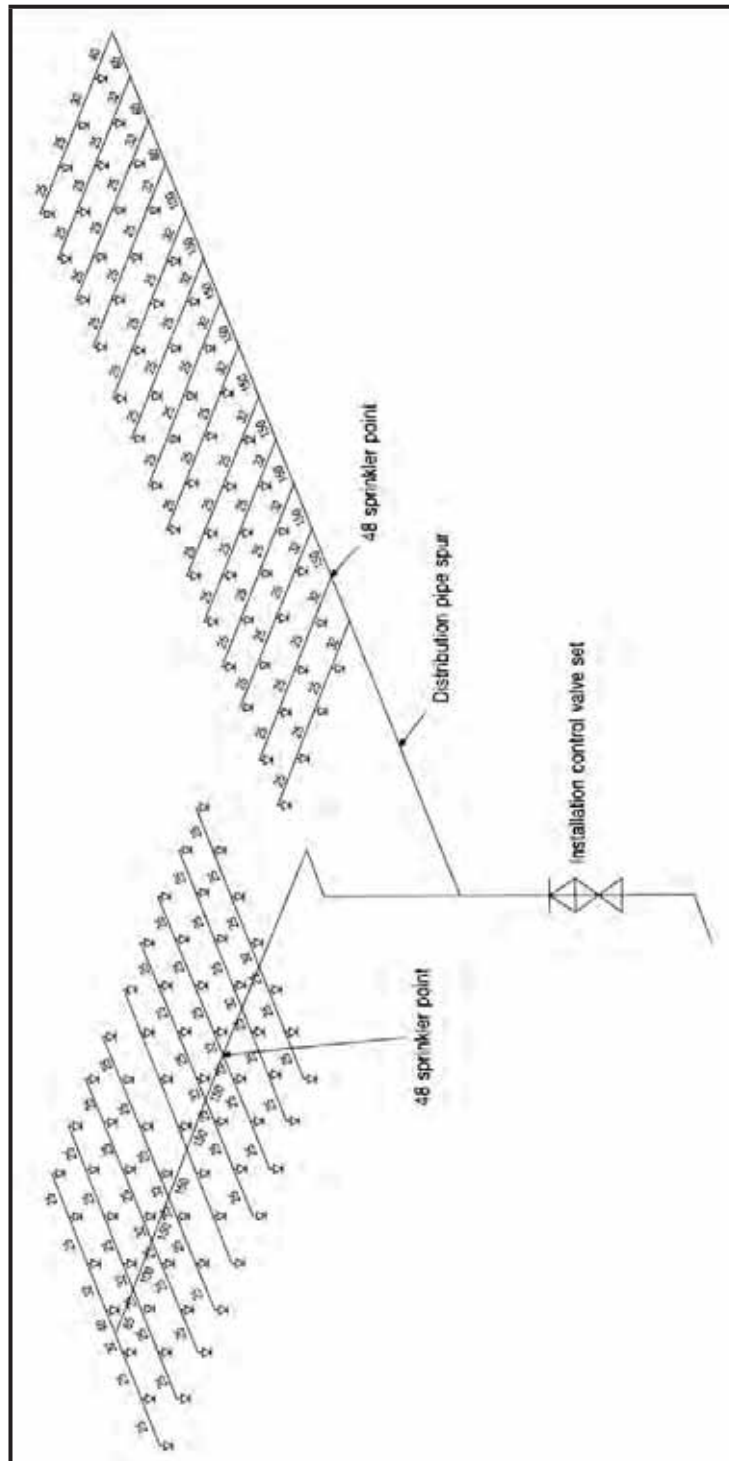
Figure 19- Example of application of design points in an OH installation (see G.2.2) (H4)



*Figure 20- Example of application of design points in an HH installation with pipework sized from tables G11 and G12 (H5)*



*Figure 21- Example of application of design points in an HH installation with pipework sized from Tables G11 and G13 (H6)*



*Figure 22- Example of application of design points in an HH installation with pipework sized from Tables G13 and G14 (H7)*

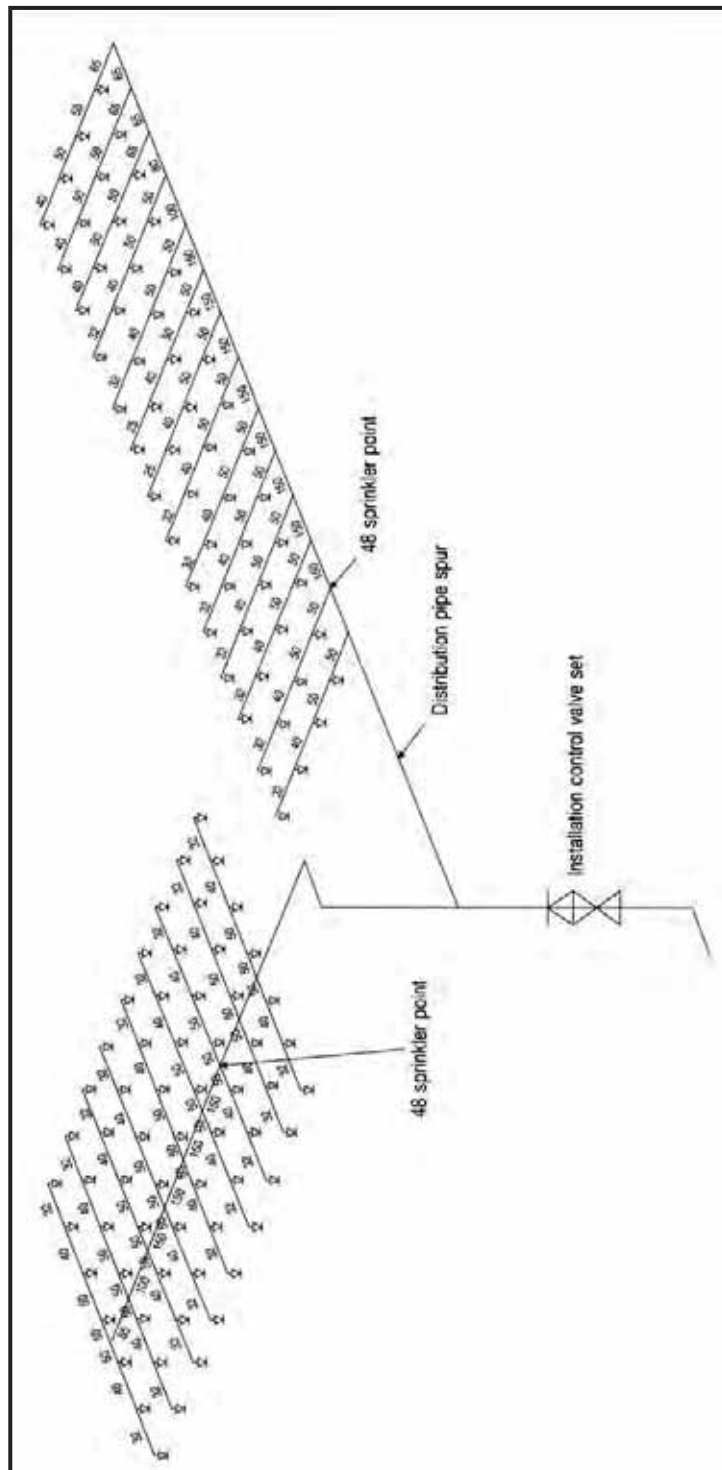


Figure 23- Determination of area covered per sprinkler (see G.3.1) (H8)

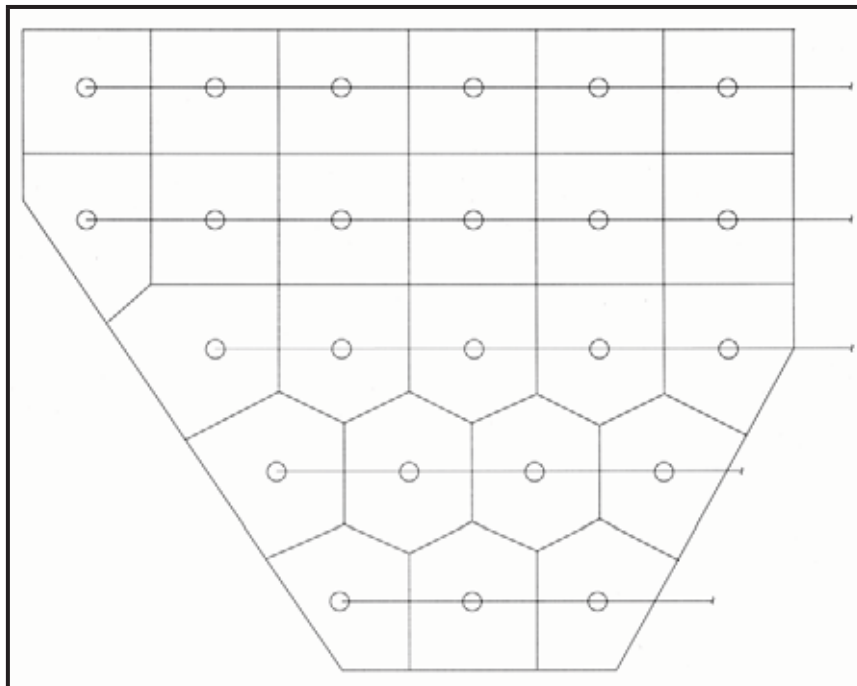
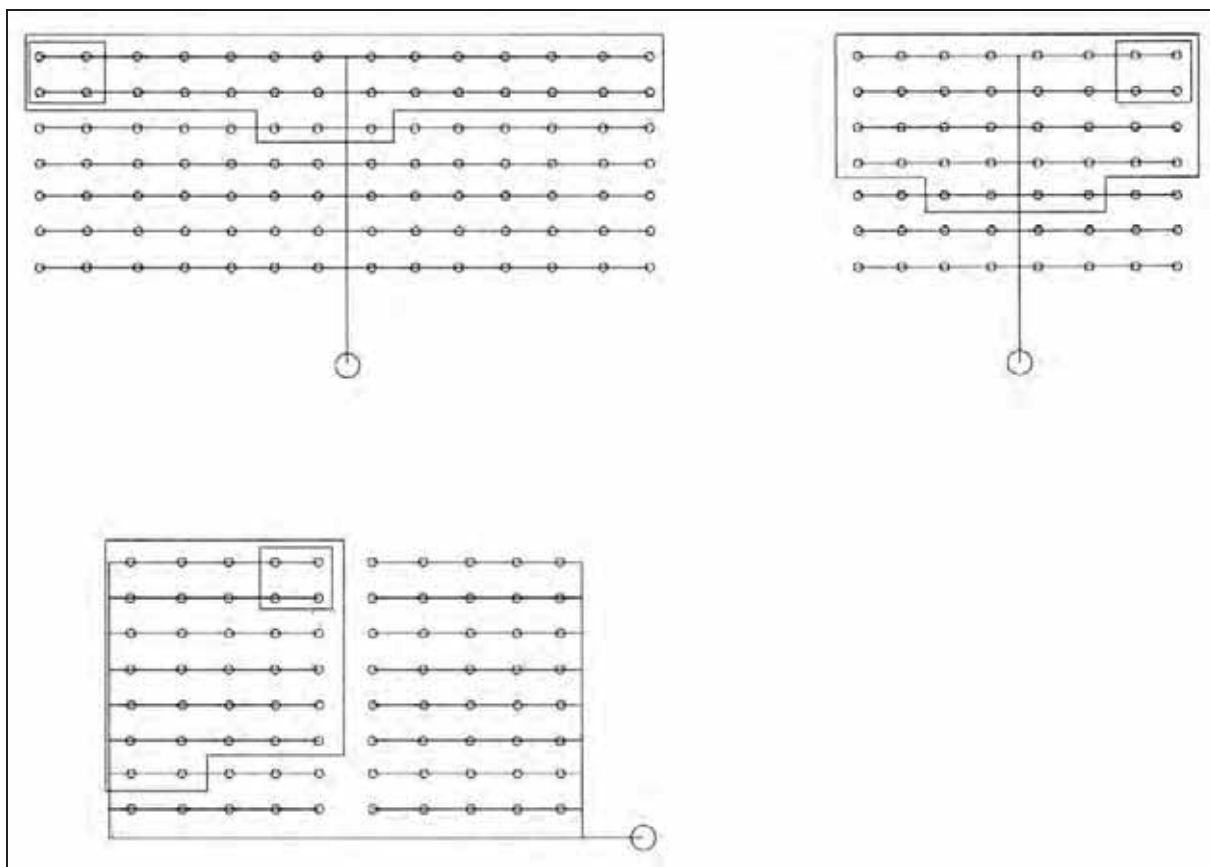
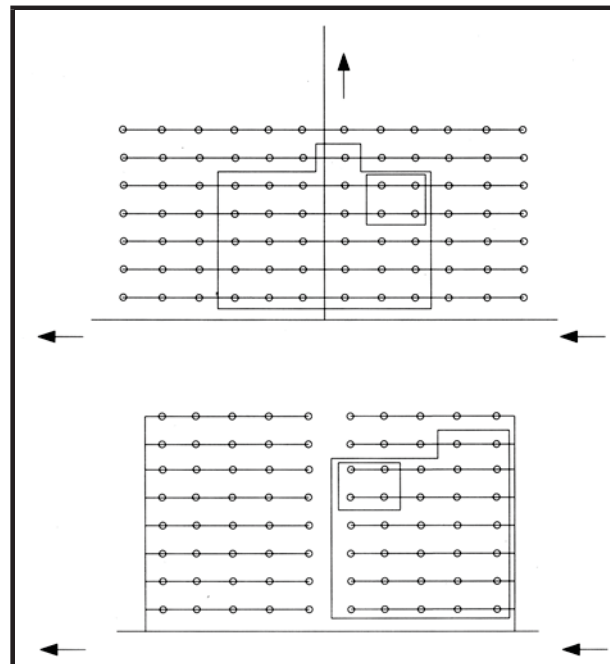


Figure 24- Most unfavourable areas of operation in one-sided and two-sided pipe layouts (see G.3.3.1) (H9)





*Figure 25- Most favourable areas of operation in one-sided and two-sided pipe layouts (see G.3.2) (H10)*



*Figure 26- Most favourable and unfavourable areas of operation in a gridded pipe layout (see G.3.2) (H11)*

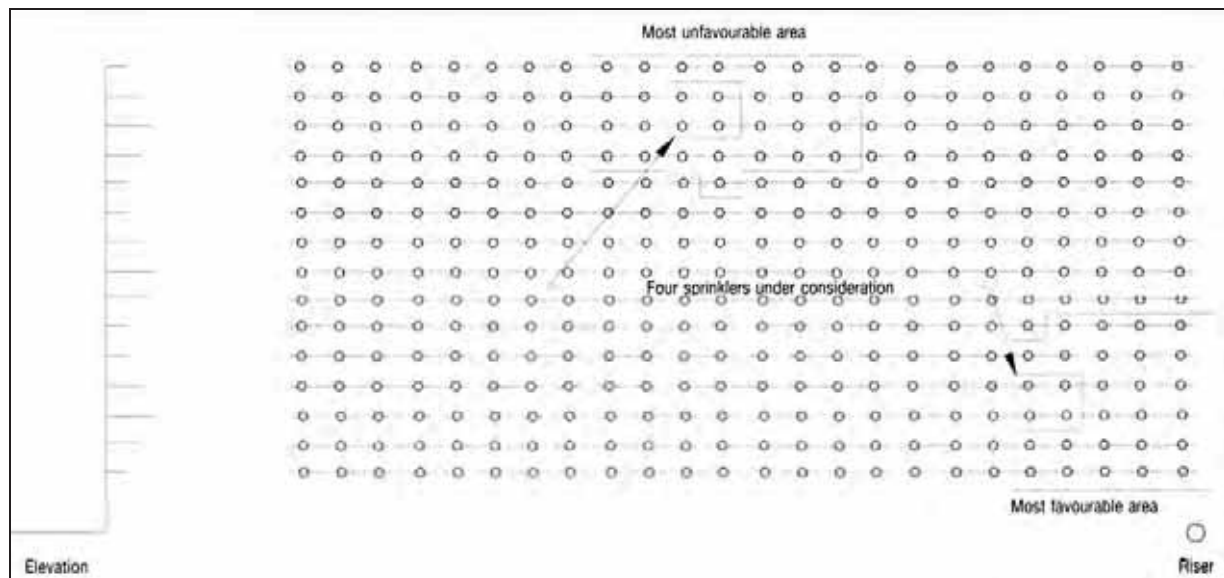
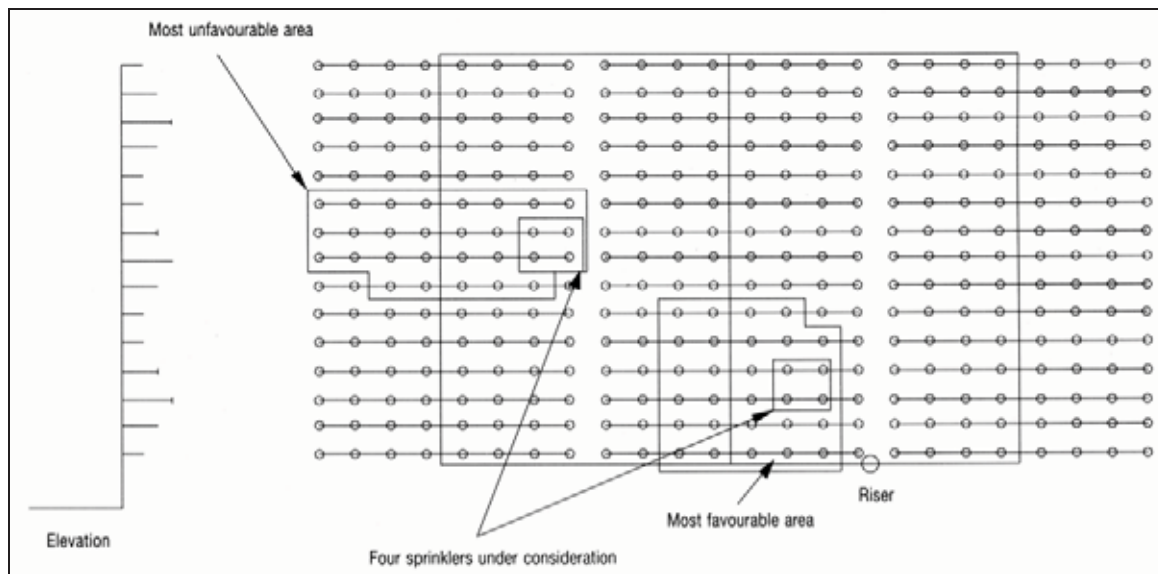


Figure 27- Most favourable and unfavourable areas of operation in a looped pipe layout (see G.3.2) (H12)



## Annex I (Informative)

# Approved components

Components subject to approval by the insurers include, but are not necessarily listed to:

- a) sprinklers;
- b) wet alarm valve assemblies;
- c) dry alarm valve assemblies;
- d) alarm motors and gongs;
- e) water flow detectors;
- f) pipe couplings;
- g) pipe hangers;
- h) pressure switches;
- i) sprinkler pumpsets;
- j) preaction alarm valve assemblies Type A;
- k) preaction alarm valve assemblies Types B.

## Annex J (Informative)

# New technology

These rules cover only the types of sprinkler specified in Table 26. During the years preceding the preparation of these rules new technologies were being developed for special applications, including in particular the following:

- early suppression fast response sprinklers (ESFR) see annex L;
- large drop sprinklers;
- residential sprinklers;
- special in-rack sprinklers.

These sprinklers should only be used in accordance with the results of large scale fire test data and where the design criteria are fully acceptable to the authorities involved.

It is intended that they will be included in future editions of these rules.

## Annex K

# Protection of Special Hazards

National requirements shall be taken into consideration. The following product examples need special consideration.

### K.1 Aerosols

Protection for aerosol storages shall be in accordance with table K 1.

Precautions shall be taken to avoid projection of aerosol containers.

The maximum area of aerosol storage and any containment shall be considered and the authorities shall be consulted.

*Table 52: Protection criteria for aerosol storage (K1)*

	Maximum storage height		Sprinkler K factor	Minimum density	Area of operation
	m			mm/min	m²
	Aerosol contents				
	alcohol based	hydrocarbon based			
STI - Free standing storage	1,5	-	115 160	12,5	260
	-	1,5	115 160	25,0	300
ST4 Palletized rack storage	Maximum vertical height between sprinkler rows m			12,5 plus in-rack sprinklers	260
	1,8	-	115/160 (1) 80/115 (2)	12,5 (3)	260
	-	1,8	115/160(1) 80/115(2)	25,0 (3)	300

*NOTE: 1 ceiling sprinkler protection.*

*NOTE: 2 intermediate level sprinkler protection.*

*NOTE: 3 intermediate level sprinkler protection shall be installed in accordance with Category III or IV layout but at the maximum vertical height separations between sprinkler rows given in columns 2 and 3.*

## K.2 Clothes in multiple garment hanging storage

### K.2.1 General

This annex describes special provisions for the protection of intensive hanging garment stores having multiple row or garment racks at two or more levels. They may have automatic or semi-automatic garment delivery, picking or transportation systems. Access to elevated garment storage levels within a warehouse is usually by walkways and ramps. A common feature of hanging garment storage is that there is no fire separation between the decks. Walkways, aisles, ramps and garment racks create a significant obstruction to ceiling level sprinkler protection. Protection of hanging garments stored in carousels or vertical blocks without aisles is beyond the scope of this annex.

### K.2.2 Categorization

This annex applies to all types of garments, irrespective of their storage category.

### K.2.3 Sprinkler protection

Each garment rack shall be limited to two rows of hanging garments (side by side) and a storage height of 3,5m between intermediate levels of sprinklers. Each rack shall be separated by an aisle of at least 0,8m width. The garment racks shall be protected by a single row of sprinklers. The spacing between the sprinkler rows shall not exceed 3,0m.

The sprinklers installed directly above the garment racks shall be stagger spaced in the vertical plane, at horizontal intervals of not more than 2,8m along the length of the rack. There shall be a sprinkler not more than 1,4m from the rack end. The clearance between the top of the garments and the sprinkler deflector shall be at least 0,15m.

Each sprinkler row protecting garment storage racks should be capped by a continuous solid horizontal baffle of at least the length and width of the garment row. The baffle should preferably be of a non-combustible material.

The upper level of sprinkler rack protection and baffle may be omitted providing the clearance between the top of the garments and the deflectors of the ceiling sprinklers does not exceed 3m height.

Sprinklers shall be installed below all access ramps, main aisles, walkways and transportation routes, with the exception of aisles, not exceeding 1,2m wide, between sprinkler protected garment storage rows.

### K.2.4 Sprinklers in operation

The number of rack sprinklers assumed to operate 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 should be assumed to operate on all protected levels.

### K.2.5 Ceiling sprinklers

Ceiling sprinklers shall be designed for a density of 7,5mm/min over an area of operation of 260m<sup>2</sup>, 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 at least of Category III goods. The stack height shall be measured from above the uppermost intermediate level sprinklers to the top of the hanging garments.

#### K.2.6 Automatic shutdown

Operation of the sprinkler system shall automatically stop all automatic distribution systems within a warehouse.

#### K.2.7 Control valve set

All installations shall be of the wet pipe type.

### K.3 Flammable liquid storage

The maximum area of flammable liquid storage and any containment shall be considered and the authorities shall be consulted.

The use of a film forming foam and wetting agent is recommended.

Flammable liquids shall be classified into four classes according to their flash point (FP), as shown in tables K2 and K3. Tables K2 and K3 shall be used for flammable liquids stored in non-pressurized metal drums with a capacity greater than 20 l but not greater than 208 l. Table K4 shall be used for flammable liquids stored in non-pressurized metal drums with a capacity less than 20 l.

**Table 53: Flammable liquids in metal drums (ST1) with a capacity > 20 l and 208 l (K2)**

Class	Properties °C	Storage methods	Permitted storage	Ceiling sprinklers	
				Density mm/min	Area of operation m <sup>2</sup>
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 < 55	on side on end	3 drums high 1 drums high	25	450
4	FP < 21	on side or on end	1 drum high	25	450

**Table 54: Flammable liquids in metal drums (ST4) with a capacity >20 l and 208 l (K3)**

Class	Properties °C	Storage methods	Intermediated sprinkler level in figure 10 (1) configuration	Ceiling sprinklers	
				Density mm/ min	Area of operation m <sup>2</sup>
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 < 55	on side on end	each 3rd tier each tier	25 10	450
4	FP < 21	on side or on end	each tier	25	450
NOTE: (1) Horizontal distance between sprinklers shall not exceed 1,9m.					
NOTE: (2) Drums shall be stored at a height of one drum per tier.					

**Table 55: Flammable liquids in metal drums (ST1,ST5,ST6) with a capacity of 20 l (K4)**

Class	Properties °C	Storage methods	Maximum storage height	Ceiling sprinklers	
				Density mm/min	Area of operation m <sup>2</sup>
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 < 55	ST1 ST5/6	1,5 2,1	12,5	450
4	FP < 21	ST1 ST5/6	1,5 2,1	12,5	450

#### K.4 Pallets - idle

Idle pallets stored in solid piles or on pallets shall be protected with ceiling sprinklers according to table



K5. Pallets stored in racks shall be protected with ceiling and in-rack sprinklers according to table K6.

***Table 56: Protection of solid piled or palletized pallets (ST1) (K5)***

Type of pallet	Maximum storage height m	Ceiling sprinkler	Special requirements
Wood and cellulose material pallets	3,8	see table 4 Category IV	
Non- expanded high density polyethylene pallets with solid deck	3,8	see table 4 Category IV, with sprinkler rated at 93°C or 100°C	Separation: 60 min. minimum fire resistant compartment
All other plastic pallets	3,3 3 2,7 2,3 2 1,6	25 mm/min over 300 m <sup>2</sup> 20 mm/min over 300 m <sup>2</sup> 17,5 mm/min over 300 m <sup>2</sup> 15 mm/min over 300 m <sup>2</sup> 12,5 mm/min over 300 m <sup>2</sup> 10 mm/min over 300 m <sup>2</sup>	Storage in 60 min. minimum fire resistant compartment.

***Table 57: Protection of rack storage of pallets (ST4) (K6)***

Type of pallet	In-rack sprinklers	Ceiling sprinkler	Special requirements
Wood and cellulose material pallets. Non-expanded high density polyethylene pallets with solid deck	Category IV configuration	As for Category IV, with sprinkler rated at 93°C or 100°C see table 5	separation: 60 min. minimum fire resistant when storage height >3,8m
All other plastic pallets	Category IV configuration, including one level of sprinklers above top level of storage, sprinklers with K=I 15 and minimum operating pressure of 3 bar	25 mm/min over 300 m <sup>2</sup>	Separation: 60 min. minimum fire resistant compartment.

## K.5 Spirituous liquors in wooden barrels

Barrels may be stored to a height not exceeding 4,6m with ceiling sprinklers only. For greater

storage heights intermediate sprinklers shall be installed in accordance with Category III/IV requirements. In both cases the ceiling sprinklers shall be installed with a density of 15 mm/min over an area of operation of 360m<sup>2</sup>.

*NOTE: drainage or bounding 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.*

## K.6 Non-woven synthetic fabric

### K.6.1 Free standing storage

Ceiling sprinklers shall be installed using the criteria shown in table K7.

*NOTE: for storage heights above 4,1m consideration may be given to the use of special technology sprinklers such as the so-called "large drop" or "ESFR" sprinklers.*

**Table 58: Non-woven synthetic fabric: design criteria with roof or ceiling protection only (K7)**

Storage methods	Maximum storage height (1)	Minimum design density mm/min	Area of operation (wet or pre-action system)(2) m <sup>2</sup>
ST1 Free standing or block stacking	1,6	10,0	260
	2,0	12,5	
	2,3	15,0	
	2,7	17,5	
	3,0	20,0	300
	3,3	22,5	
	3,6	25,0	
	3,8	27,5	
	4,1	30,0	
<i>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.</i>			
<i>NOTE 2: dry and alternate installations should be avoided.</i>			

### K.6.2 Rack storage

In-rack sprinklers should be used in accordance with Category IV requirements. Ceiling sprinklers should have a minimum design density of 12,5 mm/min over 260m<sup>2</sup>.

## K.7 Special requirements for protection of storage utilising Polypropylene (PP) and Polyethylene (PE) storage containers

### K.7.1 Storage methods ST4 – Palletised rack

Polypropylene and Polyethylene storage containers having a single wall, through which water can permeate (1) shall be classified as high hazard category III (HHS3). "Sprinklers shall have the sensitivity rating "Special" or "Quick" (see note 1 table 25)".

*NOTE 1: containers shall be assumed to be water permeable if the head of water collected in the container does not exceed 10 mm for a water discharge into the container, equivalent to 20 mm/min. ( Storage containers with 5 mm diameter drainage holes uniformly distributed at not less than 50 holes/m<sup>2</sup> of container plan area, may satisfy the above water permeability requirements). Consideration shall be given to the influence of the stored goods and any packaging materials on water permeability.*

The maximum horizontal distance of the sprinklers in intermediate levels for category HHS 4 shall not exceed 1,5 m and 2,5m for category HHS3. Sprinklers shall have the sensitivity rating "Special" at the ceiling and "Special" or "Quick" in intermediate levels. The maximum storage height for racks without intermediate sprinklers shall not exceed 2,1m for HHS 3 and 1,2 m for HHS 4.

#### K.7.2 Storage methods ST1 - free or block standing - ST2 and ST3 - post pallet storage

The maximum storage height shall not exceed 3 m.

Only non-combustible pallets with closed surface like steel pallets shall be used. The storage height on each pallet shall not exceed 1 m. The top storage containers on the pallet shall be closed with a lid.

The sprinklers shall have the sensitivity rating "Special".

Film-forming foam and wetting agents shall be added to the water of the sprinkler system.

*NOTE: if other sprinkler protection concepts are demonstrated by appropriate fire tests as adequate protection the above requirements can be adapted.*

#### **K.8 Special requirements for the protection of mobile shelving with ceiling or roof-level sprinkler only**

This annex includes mobile shelving with the top open or closed. Perforated tops are preferred.

Only Category I or II products shall be stored in mobile shelving.

The height of the mobile shelving protected by ceiling or roof-level sprinkler only shall be limited to 3m. The clearance between the top of the mobile shelving units and the sprinkler deflectors shall not be less than 0,5m.

The area of each block of closed (compressed) mobile shelving shall not exceed 150m<sup>2</sup>. There shall be aisles of at least 1,2m surrounding each block of mobile shelving in either the closed or open (uncompressed) condition.

When the mobile shelves are closed (compressed), each shelf unit shall close against hard tops, which shall maintain a space of at least 50mm between adjacent shell units.

The water density at the ceiling protection shall be in accordance with the specification (see clause 6) with a minimum of 10 mm/min.

For rooms with a floor area less than 150 m<sup>2</sup> the following density shall be applied:

Maximum room height (m)	Density (mm/min)
3	7,5
2,6	5

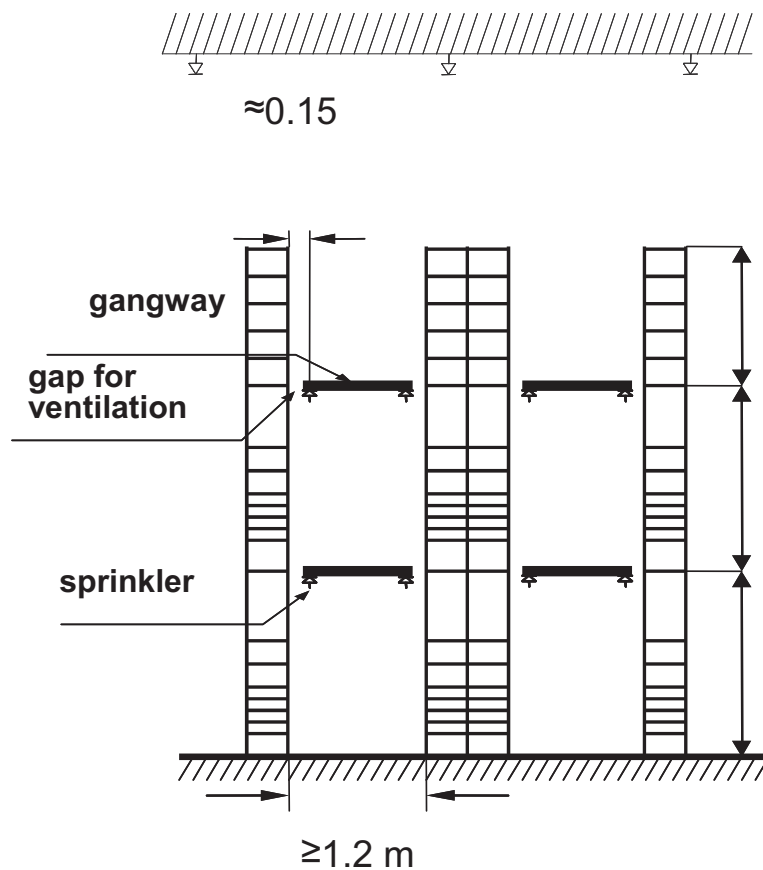
## K.9 Protection of racks with solid shelves and gangways storing plastic boxes

This section covers the protection of racks with solid shelves and gangways. The gangways shall be solid. a gap of 0.1 m is allowed between the rack and the gangway for ventilation purposes.

This concept is based on fire tests and shows one possible solution to provide adequate protection.

### K.9.1 Sprinkler arrangement in rack

Sprinklers shall be arranged under the gangways at the outside of the racks at a distance of approx. 0.15 m from the face of the racks (see figure K1). The horizontal sprinkler distance parallel to the rack and along the gangway shall be 1.8 m max. with one sprinkler min. between two rack posts. The following figure shows the sprinkler arrangement.



The sprinklers shall have the following characteristics:

- spray sprinklers
- K-factor min. 57
- RTI-value quick
- upright

Furthermore, baffles or water shields for the sprinklers shall be installed to avoid cooling (see 11.3) and to protect them against dripping plastics.

The hydraulic design of rack protection shall consider the following parameters:

- area of operation of 90 m<sup>2</sup> for each level in addition to the ceiling protection (see figure)
- 0.5 bar minimum pressure at sprinkler

#### K.9.2 Ceiling protection

The ceiling protection shall have the following characteristics:

- design: 10 mm/min over 260 m<sup>2</sup>
- K-factor min. 80
- RTI-value special or quick
- protection area per sprinkler max. 9 m<sup>2</sup>

#### K.9.3 Additional measures

Foam proportioning with AFFF foam for rack and ceiling protection shall be provided.

For limiting horizontal fire spread vertical non combustible sheet barriers shall be installed within one double rack line and at a maximum distance of every 7 m.

### K.10 Plastic Packaging Recycling Plants

#### K.10.1 General

This concept is based on fire tests and shows one possible solution to provide an adequate protection.

The different areas of plastic packaging recycling plants shall be protected by sprinkler or deluge systems according to the amount of combustible loading available. Pneumatic conveyor equipment may require additional protection by spark extinguishing systems. As the fire extinguishing of bulk and bale storage requires additional clearing and follow-up extinguishing measures, it is necessary to have direct alarm transmission to a permanently manned station.

The protection concept should be agreed with the authorities during the planning stage.

#### K.10.2 Design data of sprinkler systems for recycling plants

A sprinkler system shall be used for:

- f free pile storage
- f bale storage (compressed plastic)
- f sorting area

The following equipment should be protected by an additional water extinguishing system (sprinkler

or deluge system):

- f material storage bunker
- f comminuting systems (e.g. shredders, mills)
- f drying systems
- f silo systems

The maximum storage heights for bulk storage and bale storage are given in table K8 and the design data in table K9.

***Table 59: Maximum bulk and bale storage heights (K8)***

	Max. storage height	Max. room height
Bulk storage	5.0 m	9 m
Bale storage	4.0 m	9 m

***Table 60: Design data for sprinkler systems for bulk and bale storage (K9)***

Density of discharge	17.5 mm/min
Area of operation	260 m <sup>2</sup> wet system 325 m <sup>2</sup> dry system
Sprinkler sensitivity	'quick'
Extinguishing agent	water with film-forming foam
time of operation	
Water supply	90 min.
Foam supply	60 min.

For local protection of the equipment present in the sorting area a density of discharge of 7.5 mm/min is required. Special or quick response sprinklers shall be used.

If dry pipe systems are required for the protection of bulk and bale storage, it shall be ensured that an opening of the test fitting at the end of the pipework induces the discharge of water after 20 s at the latest.

#### K.10.3 Design data of deluge systems in recycling plants

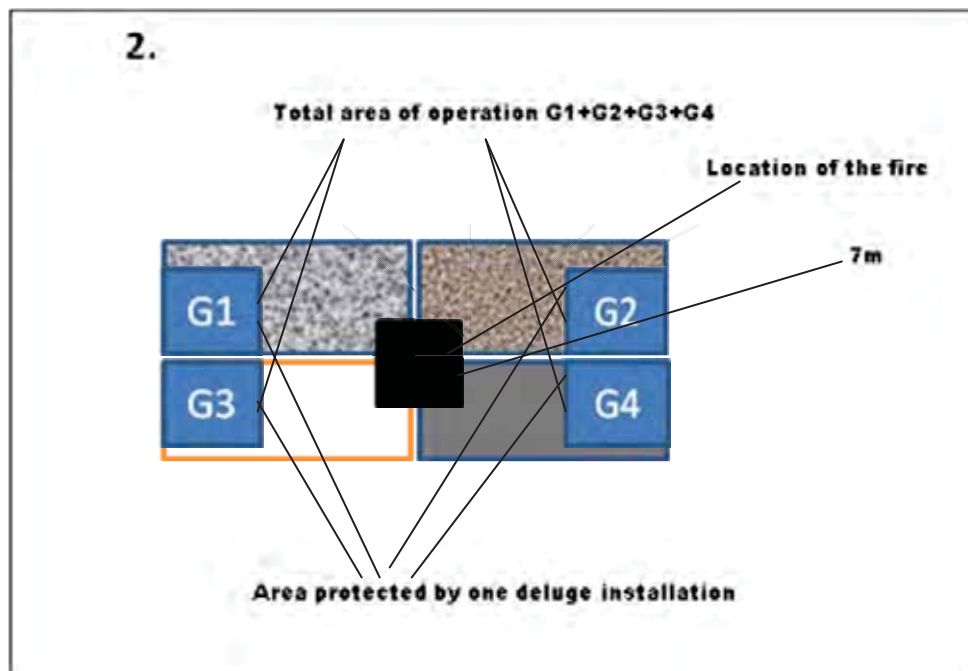
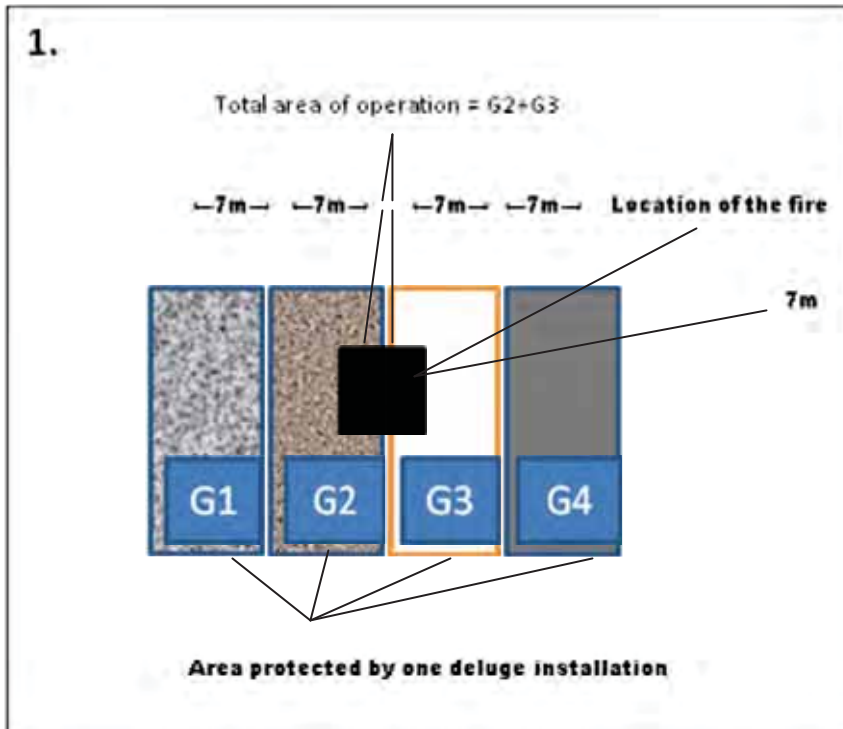
A deluge system shall be used for enclosed mechanical conveyor equipment such as long belt, chain and spiral or vibratory conveyors with a density of discharge of 7.5 mm/min.

*Note: Alternatively to sprinkler protection according to section K10.2, bulk and bale storage may be protected by a deluge system with a density of discharge of 17.5 mm/min and a proportioning of film-forming foam, provided that the storage heights are in accordance with table K9.*

##### *Area of operation for deluge systems*

*The area protected by one deluge installation shall be not less than 100 m<sup>2</sup> except rooms with an area of less than 200 m<sup>2</sup>. The water supply shall be capable to supply the total area of operation. The total area of operation shall be found by assuming a fire at the borderline between adjacent areas protected by different deluge installations. All areas are to be supplied at the same time which are touched by a radius of 7 m from the most unfavourable possible location of a fire.*

*Figure 28: Area of operation for deluge systems (K2)*



Upon triggering of the deluge system, the conveyor and screening equipment of the appropriate area shall be disabled automatically.

The water demand for the local protection equipment in the operating areas shall be hydraulically taken into account.

#### K.10.4 Monitoring of sprinkler or deluge system

The sprinkler resp. deluge systems shall be monitored for operational availability.

#### K.10.6 Spark extinguishing systems in recycling plants

A spark extinguishing system (CEA 4033) shall be used for pneumatic conveyor equipment for waste material and dust (e.g. baling presses, filter systems, air separators, press waste container station).



## Annex L

# Early suppression fast response sprinkler systems

## L.1 General

### L.1.1 Scope

This annex specifies design and installation requirements for Early Suppression Fast Response (ESFR) sprinkler systems. ESFR sprinklers are quick acting high performance sprinklers which have the capability of extinguishing fires within designated 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 may not succeed with adverse design features and non-compliances, which may 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 ESFR protection.

With the exception of the clauses identified at 1.4.1, all the requirements of the CEA prevention specification 4001 are applicable when installing ESFR sprinklers.

Preliminary agreement of the authorities is essential before selecting ESFR sprinklers to be used in a sprinkler installation.

ESFR sprinklers are mainly used if in-racks sprinkler cannot be installed for technical reasons.

*NOTE: preliminary design considerations shall be carried out to determine if the building construction is suitable for the use of ESFR sprinklers.*

### L.1.2 Definitions

**Sprinkler, ESFR pattern:** Nozzle with a thermo sensitive sealing device which opens to discharge water, distributing it in a specified pattern, with sufficient momentum, over a designated area to achieve suppression of a fire or inhibit growth when connected to the appropriate piping and water supplies.

### L.1.3 ESFR sprinklers

ESFR sprinklers shall be quick (thermal) response and have one of the following temperature ratings:

Bulbs: 68°C

93°C

Fusible element: 68 to 74°C

93 to 104°C

The higher temperature ratings shall only be used where needed because of high ambient temperature conditions.

The nominal k factor of ESFR sprinklers shall be between 200 and 360.

### L.1.4 Application

L.1.4.1 The following clauses of the CEA rules for Automatic Sprinkler Systems - Design and Installation are

not applicable for ESFR sprinkler protection: 6.1, 6.2, 6.3, 6.4.1, 8.3.2.1, 8.3.2.2, , 10.2, 10.3, 10.4, 10.5, 11.1.2, 11.2, 11.3, 11.4.1, 11.4.2, 11.4.4, 11.4.5, 11.4.6, 11.4.7, 11.4.9, 11.4.10, 11.4.12, 11.4.13, 11.5, 12.2, 12.4, 12.5, 12.6, 12.8, 12.9.

#### L1.4.2 Storage configurations

##### L1.4.2.1 Flue spaces

Storages should have longitudinal and transverse flues, which are:

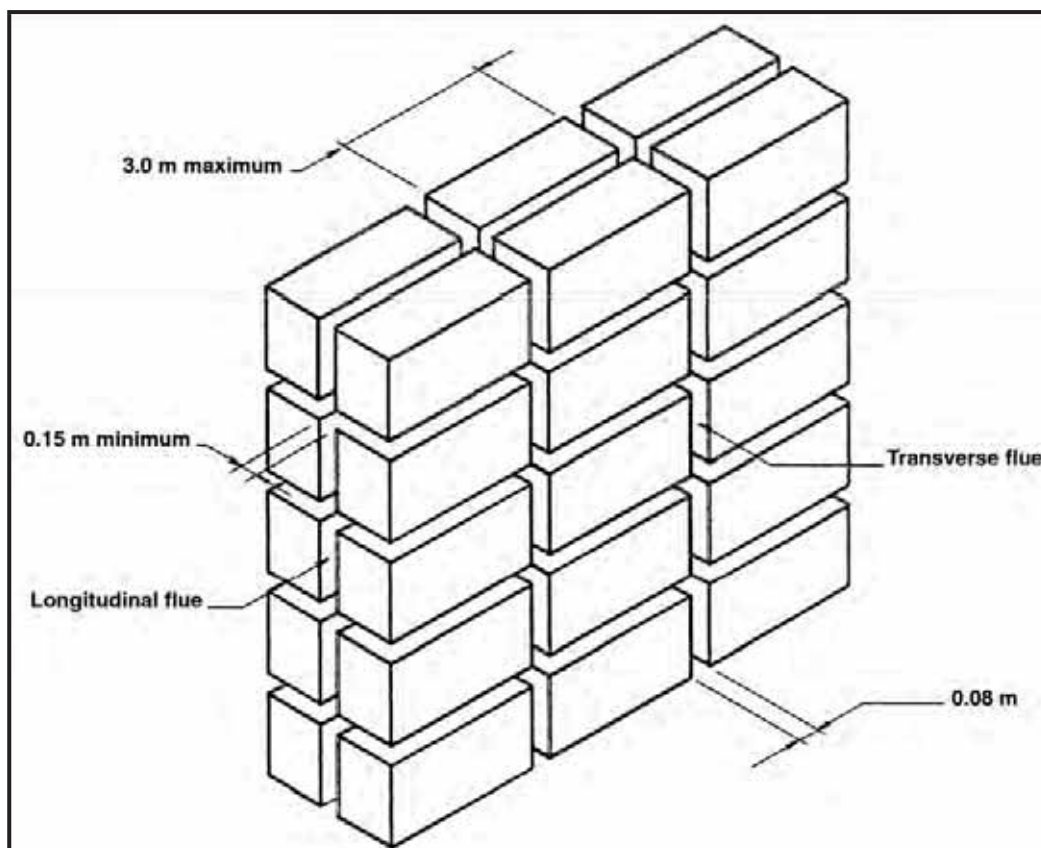
- a) continuous for the full height of each block of storage;
- b) vertically aligned;
- c) free of stored goods;

##### L1.4.2.2 Storage methods ST1 ST2 ST3 ST4 ST5 and ST6

Storage methods ST1 - ST2 - ST3 - ST4 - and ST6 shall have flue spaces regularly spaced and having dimensions as follows:

- (1) transverse flues shall be at least 0,08m width and shall be spaced at distances of not more than 3,0m (see Figure L.1); and
- (2) longitudinal flues shall be at least 0,15m width and shall be spaced at distances of not more than 3,0m

***Figure 29: Storage methods ST2, ST3 and ST4 transverse and longitudinal flues (L1)***



### L 1.4.2.3 Storage methods ST5 and ST6

Single and double-row shelved racks shall comply with one of the following:

- a) shelves having openings of less than 50% of the plan area shall not exceed 2.0m<sup>2</sup> total plan area and shall be bounded on all four edges by flue spaces of not less than 0,15m width;
- b) slatted shelves shall have shelf-open areas, uniformly interspaced of at least 50% of the shelf plan area. The distance openings shall not exceed 0,15m; or;
- c) 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 0,15m.

L.1.4.3 ESFR sprinklers shall be designed in accordance with Table L1.

***Table 61: Sprinklers design and maximum height (L1)***

Commodity (storage methods required to comply with clauses L 1.4.2.2 and L 1.4.2.3)	Maximum ceiling height: 9,1m (see note 1)			Maximum ceiling height: 9,8m (see note 1)		Maximum ceiling height: 10,6 m (see note 1)		Maximum ceiling height: 12,2m (see note 1)		
	Maximum storage height (m) see note 6	Sprinkler operating pressure (bar)		Maximum storage height (m) see note 6	Sprinkler operating pressure (bar)	Maximum storage height (m) see note 6	Sprinkler operating pressure (bar)	Maximum storage height (m) see note 6	Sprinkler operating pressure (bar)	
		K-200	K-360						K-200	K-360
Expanded plastic and foamed rubber in carton (more than 15 % in volume of the cardboard carton)	7,6	3,5	1,4	7,6	4,2	NA	NA	NA	NA	NA
Category 1, 2, 3 & 4 (see note 2 & 3)	7,6	3,5	1,4	7,6	4,2	7,6	2,1	10,6	5,2	2,8
Paper rolls stored on end (stored vertically) in open or closed arrays, banded or unbanded: heavyweight paper(see note 4 & 5)	7,6	3,5	1,4	see note 7	see note 7	see note 7	see note 7	9,1	5,2	2,8

Paper rolls stored on end (stored vertically) in open or closed arrays, banded or unbanded : Medium weight paper and plastic coated heavyweight paper ( see note 4 & 5)	6,1	3,5	1,4	see note 7	see note 7	see note 7	see note 7	6,1	5,2	2,8
Mezzanine height ≤ 4,5 m. All acceptable stored goods and storage configurations	6 operating sprinklers at 3,5 bar for K = 200 and at 1,4 bar for K = 360 (see note 6)									
Mezzanine height > 4,5 m. All acceptable stored goods and storage configurations	Pressure appropriate for stored goods and ceiling (mezzanine) height (see note 6)									

#### Note 1

The ceiling height shall be taken as the maximum vertical distance measured from the floor to the underside of the ceiling or roof deck.

#### Note 2

Authorities shall be consulted for the protection of plastic commodity.

#### Note 3

Plastic products (expanded or unexpanded) shall be contained in wooden, cardboard or non-combustible boxes. Expanded plastic and foamed rubber shall not occupy a greater volume than 15% of the capacity of the box.

#### Note 4

Excluding lightweight paper

#### Note 5

Lightweight paper - all paper with a weight of less than 50 g/m<sup>2</sup> and paper with absorbent features (such as toilet paper, paper towelling, disposable absorbent paper product) regardless of weight. Medium weight paper – non-absorbent paper with a hard or smooth finish that weighs 50 g/m<sup>2</sup> or more but less than 100 g/m<sup>2</sup> heavyweight paper – non-absorbent paper or cardboard that weighs 100 g/m<sup>2</sup> or greater.

#### Note 6:

The vertical distance from the floor to the sprinkler deflector minus 1 m or the value shown in the table, whichever is the lower.

#### Note 7

The values given for a maximum ceiling height of 12,2m shall be used.

L.1.4.4 ESFR sprinklers shall only be installed in buildings with roofs or ceilings which :

- a) have a slope not exceeding 170mm/m.;
- b) are continuous and have no permanent opening;
- c) are of non-combustible construction;
- d) withstand an upward pressure of 150 N/m<sup>2</sup>.

*NOTE 1: Where the roof or ceiling slope exceeds 170mm/m, the roof or ceiling may be underdrawn with a false ceiling complying with (a) to (d) above, with ESFR sprinklers located below the false ceiling.*

*NOTE 2: Typical ceiling materials include 10 mm gypsum board, corrugated or sheet steel and mineral tiles.*

*NOTE 3: Concealed spaces shall comply with 5.4. "*

L.1.4.5 The following example of storage or commodities are not suitable for protection by ESFR sprinklers:

- certain storages which exhibit unusual fire characteristics such as roll tissue;
- open-top combustible containers;
- unusual commodities or storage arrangements which have not been proven, by either testing or analysis, to be appropriate for ESFR sprinklers protection;
- warehouses in which the commodities or the type of storage are unpredictable;
- special risks which are described in Annex K (K1 aerosols, K3 flammable liquid storages, K5 spirituous liquors and K7 storage containers fabricated from polypropylene and polyethylene);
- rubber tyres.

## L.2 Sprinkler System Design

### L.2.1 General

L.2.1.1 Only wet-pipe systems shall be used.

L.2.1.2 ESFR protection is based on construction without roof vents or other roof opening.

If roof vents or other roof openings are unavoidable, they shall be operated manually. Any draft curtains used in conjunction with roof vents or other roof openings shall be limited in depth and located with respect to sprinklers so that distances specified in Table L3 are complied with.

Any open roof vents or other roof openings shall be closed automatically preferably before, but in no case more than 30 s after, the operation of the first sprinkler.

L.2.1.3 The clear space beneath the sprinkler deflectors shall be no less than 1m.

L.2.1.4 Skylights shall be flush to the ceiling or underdrawn at ceiling level. The skylights shall be capable of withstanding, without failure, a temperature of 300°C for at least 5min. Where powered ventilation is employed, the building shall be protected by an approved fire alarm installation. The powered ventilation shall be stopped and any dampers closed automatically in response to the fire detection system alarm of fire.

## L.2.2 Hydraulic design

L.2.2.1 ESFR sprinkler installation shall be fully hydraulically calculated in accordance with annex G1 and G3.

L.2.2.2 The design area of operation shall consist of an area with a minimum of 12 ceiling sprinklers or minimum 90 m<sup>2</sup> whichever is the greater. This design area of operation shall be the hydraulically most unfavourable area and may include up to 6 additional sprinklers within the same area (e.g. under obstructions). The minimum operating pressures are stated in Table L1.

The water supply shall be capable of providing the demand flow for at least 60 min.

L.2.2.3 For hydraulic calculation purposes, 4 sprinklers shall be assumed to operate on each of 3 range pipes. When range pipes have less than four sprinklers, all the sprinklers on the range pipe shall be assumed to operate and the number of ranges involved shall be increased until a total of 12 sprinklers are assumed operating.

L.2.2.4 Where ESFR sprinklers are installed beneath mezzanines of 4,5m height from the floor or less, at least 6 ESFR sprinklers shall be assumed to operate (three ESFR sprinklers on each of two ranges) at an operating pressure of at least 3,5 bar.

*NOTE: where standard sprinkler protection is employed beneath mezzanines of 4,5m height or less, the area of operation and design density shall comply with the appropriate requirements of Section 6 - Hydraulic design criteria.*

ESFR sprinklers shall be used beneath mezzanines which are higher than 4,5m; twelve ESFR sprinklers shall be assumed to operate (four sprinklers on each of three ranges).

L.2.2.5 Sprinklers beneath walkways, conveyors, obstructions and mezzanines shall be taken into account when designing the water supplies, in accordance with table L2.

**Table 62: Sprinklers design beneath obstruction (L2)**

Obstructions within the design area of operation	Maximum number of additional sprinklers to be added to the ceiling sprinkler water supply requirements
Obstructions less than 3m width	2 sprinklers operating at 3,5 bar (K=200) at 1,4 bar (K=360)
Obstructions greater than 3m width such as walkways and conveyors	4 sprinklers operating at 3,5 bar (K=200) at 1,4 bar (K=360)
Mezzanines (See note 1)	6 sprinklers operating at the design pressure, (see table L1).
<p><i>NOTE 1: Providing:</i></p> <p><i>a) open-fronted mezzanines are fitted vertically with screens which extend at least 1,2m below the ceiling are of non-combustible construction and fit tightly against the underside of the ceiling;</i></p> <p><i>and</i></p> <p><i>b) a clear aisle beneath the screen of at least 0,6m wide each side of the screen centre-line is maintained; additional sprinklers need not be added to the water supply requirement.</i></p>	

### L.2.3 Spacing and location of sprinklers

L.2.3.1 The area of coverage of ESFR sprinklers shall be not less than  $7,5\text{m}^2$  and not more than  $9\text{m}^2$ . The distance between sprinklers shall be in accordance with table L3.

*Table 63: Distance between sprinklers (L3)*

Maximum height ceiling m	Distance between sprinklers in m	
	min	max
9,1	2,4	3,7
12,2	2,4	3

L.2.3.2 The centre line of the sprinkler heat-sensitive element shall be between 0,1 to 0,33m below the roof or ceiling for an ESFR sprinkler with a K factor of 200.

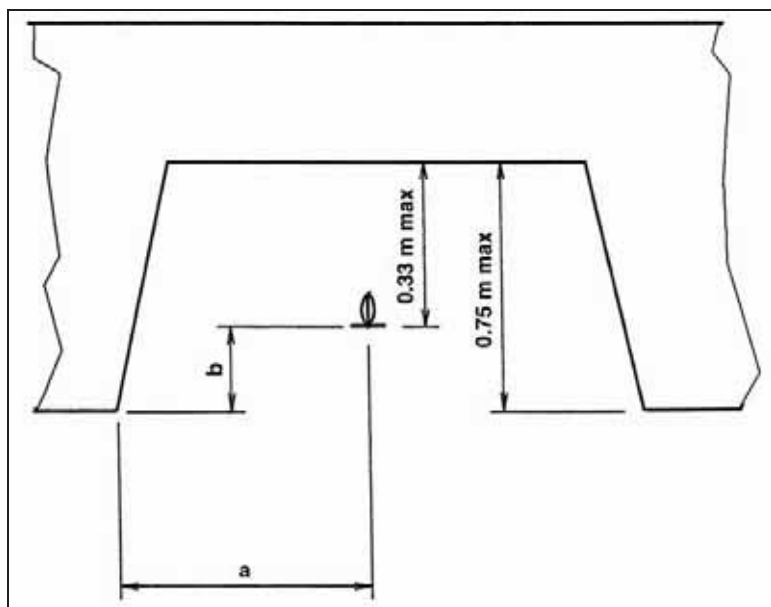
The centre line of the sprinkler heat-sensitive element shall be between 0,1 to 0,45m below the roof or ceiling for an ESFR sprinkler with a K factor of 360.

Where the roofs or ceilings are constructed using beams and girders or profiled paneling, sprinklers should be located in bays rather than under beams. Bays formed by this method of construction should not exceed 0,75m depth. Where the ceiling is profiled, the distance from the ceiling to the sprinkler shall be measured from the top of the profile, see figure L2 to L6.

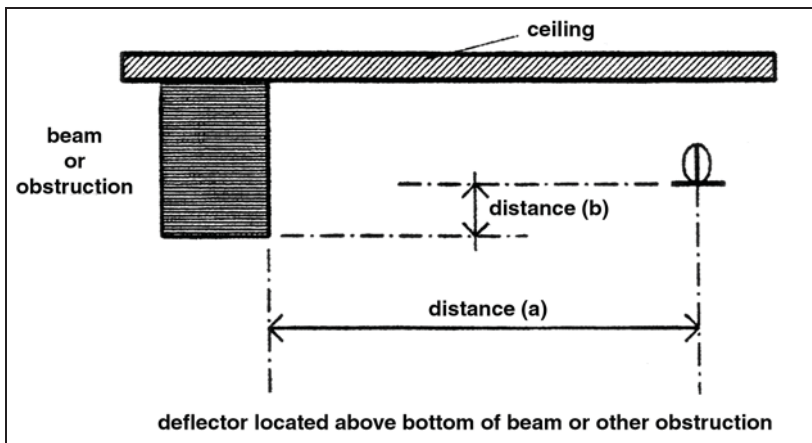
Where this is not practical, the roof or ceiling shall be underdrawn by a suspended ceiling.

*Figures L2, L3, L4, L5, L6: Sprinkler location relative to obstacles*

*Figure 30:L2*



*Figure 31:L3*



*Figure 32 :L4*

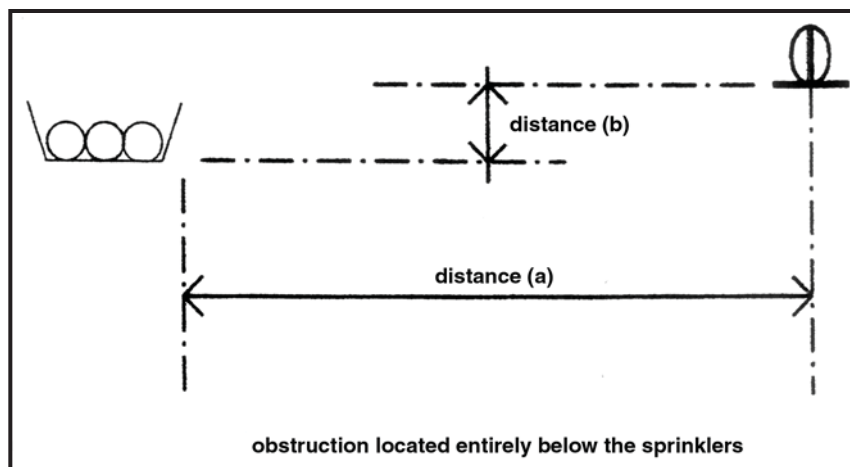
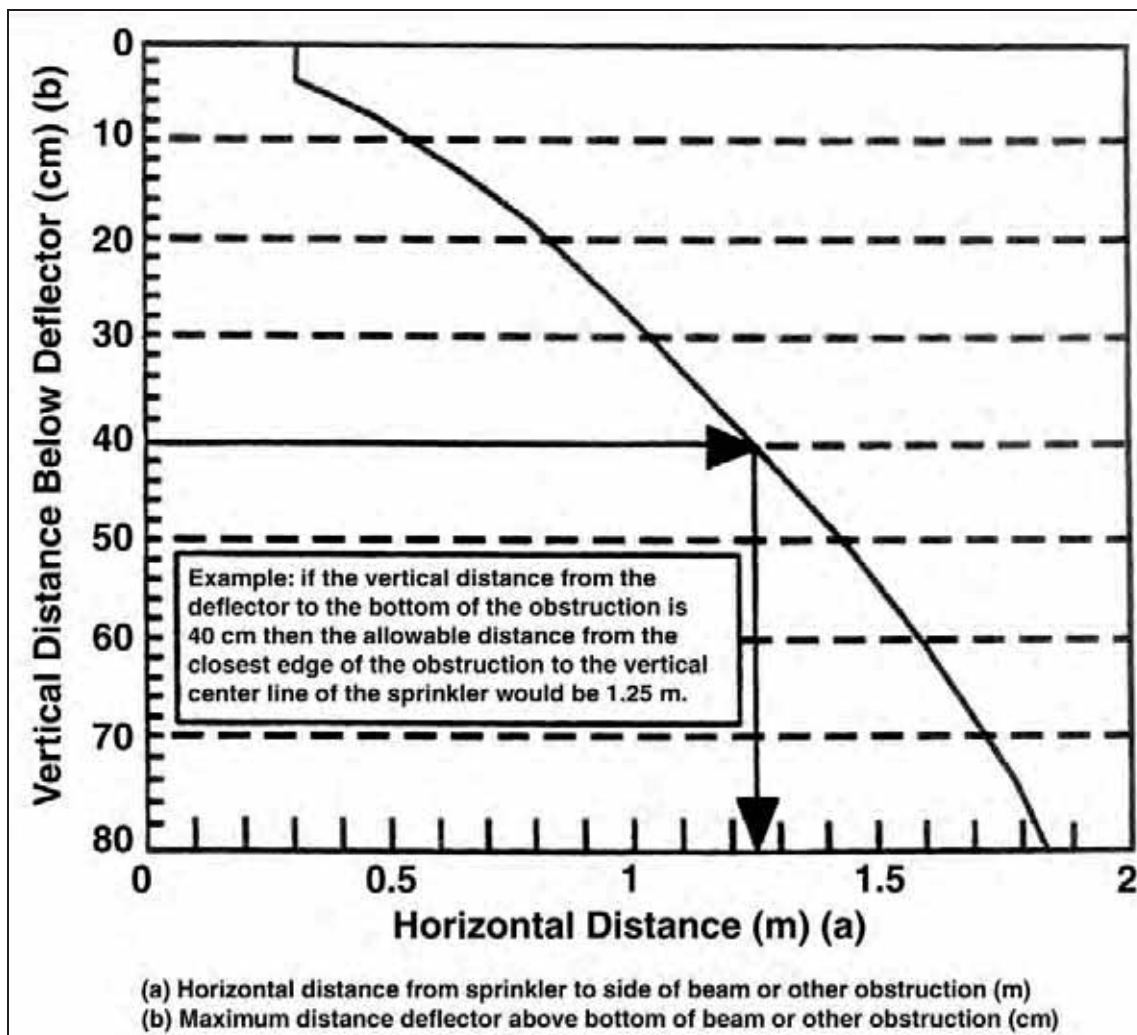




Figure 33 :L5



L.2.3.3 Where sprinkler deflectors are located above the bottom of beams, girders, ducts, fluorescent lighting fixtures or other obstructions located near the ceiling, the position of the sprinklers with respect to these obstructions shall be in accordance with figures L3, L4 and L5, as appropriate.

L.2.3.4 Continuous obstructions located below sprinklers, such as sprinkler piping, utility piping or duct work up to 0,3 m wide at a horizontal distance of at least 0,6m from the vertical centre-line of the sprinklers do not require additional sprinklers below. Additional sprinklers shall be located below wider or more closely located obstructions.

L.2.3.5 Upright sprinklers shall be positioned so that the deflector has a minimum distance of 0,180m above the top of the range pipe.

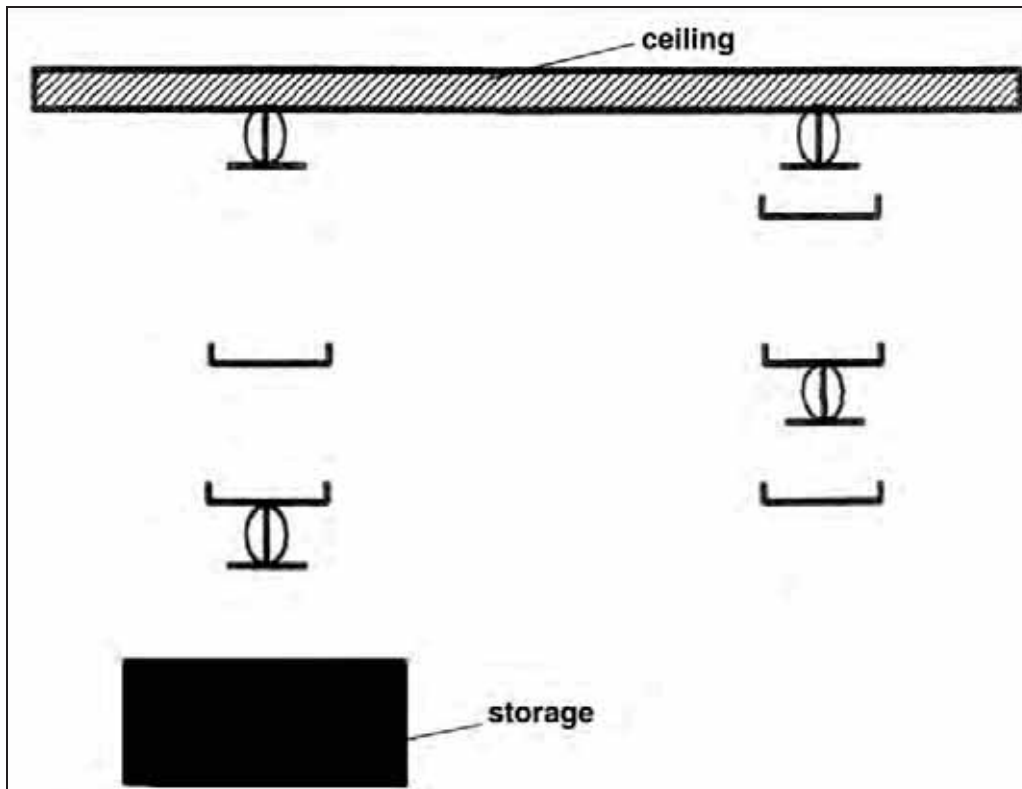
L.2.3.6 Roller-type conveyor and grated walkways with 50 % or more uniform openings are not considered as obstructions to ceiling sprinkler discharge. However, when there are more than one level above each other of conveyors or walkways 50 % or more open, a line of ESFR sprinklers shall be

installed beneath every other level starting from the second level down from the ceiling. (See figure L6).

#### L.2.4 Separation between ESFR and other sprinkler installations.

L.2.4.1 Vertical screens shall be installed between areas protected by ESFR sprinklers and areas protected by other type of sprinklers. This applies whether the roof over the two areas is at the same elevation or at different elevations. The screens shall extend at least 1,2m below the ceiling, be non-combustible and fit tightly against the underside of the roof. A clear aisle, at least 1,5m on each side of the centre-line beneath the screen, shall be maintained.

*Figure 34 :L6*



## Annex M (informative)

# Commodity classification methodology utilising calorimeter tests

## M.1 Introduction

Efficient and reliable sprinkler protection of storage risks is dependent on appropriate commodity classifications.

This European sprinkler installation specification subdivides commodities into four categories, based on experience and fire test results. Full-scale fire testing has been the preferred solution for determining commodity classifications, but is a costly procedure. The development of a purpose built Fire Products Collector (FPC) by Factory Mutual Research Corporation (FMRC) has made the classification of commodities possible using smaller amounts of materials than has hitherto been acceptable.

The FPC consists of a large capacity calorimeter hood with a water application pipework array located below the collector hood, beneath which a fuel array is burnt.

## M.2 Test principles

This classification methodology assesses the heat output of the burning goods, placed beneath the calorimeter, in a fuel array of eight pallets. The pallets are ignited in a specified manner and are allowed to burn freely until a predefined condition is achieved, at which time water is released at one of three application rates onto the burning fuel array. The convective heat release rate is measured over the duration of the test. Three tests are undertaken at different water application rates.

## M.3 Method

The method used is described in the document "NORDTEST METHOD NT FIRE 049".

The document may be obtained by:

NORDTEST P.O. Box 116  
FIN-02151 ESPOO FINLAND  
Phone: +35894554600  
Fax: +35894554272

## M.4 Evaluation of test results

A rank value is determined for each of the three test results, by means of comparing the results with those of known commodities. The ranking system, by comparison, ultimately enables the determination of a commodity classification for the goods under consideration.

## M.5 Bibliography

- a) Chicarello, P-J- Troup, J.M, "Fire products collector test procedure for the determining the commodity classification of ordinary combustible products", Factory Mutual Research Corporation, August 1990.
- b) Heskestad, G. (a fire products collector for calorimetry in the MW range", Factory Mutual Research Corporation, June 1981.
- c) "Commodity classification - A more objective and applicable methodology", Swedish National Testing Research Institute, SP Report 1993:70.
- d) "Combustible Products: commodity classification - fire test procedure", Nordtest method, NT FIRE 049.

## Annex N (informative)

Minimum water supply for all hazard classes shall be superior.  
The exceptions are given in table 30 hereunder:

Hazard Classes	Cumulated number of sprinklers per Hazard classes	Minimum type of Water supply
LH; OH1	< 1000	Single (2)
HHP	> 5000	Duplicate
HHS	> 3000 (1)	Duplicate

*Note 1: 4000 if more than 1000 in-rack sprinklers.*

*Note 2: In premises for immobile persons (e.g. hospitals, children's nurseries...), the minimum is a superior water supply.*

If the cumulated number of sprinklers connected to the same water supply is greater than 10.000 the type of water supply shall be duplicated.

Annex O (reserved)

## Annex P

# Addition of foam concentrate

The compliance with local environmental rules and regulations for the design, testing, drainage, system run off or other potential environmental requirements shall be checked.

Foam concentrate utilized in system shall be suitable for the fuel or chemical being protected. Where fuel or chemical being protected is miscible or soluble, (able to mix with water), an alcohol resistant foam concentrate shall be utilized.

Only compatible materials with the foam concentrate or foam solution shall be installed in the system. The foam concentrate manufacturer shall publish compatible materials to be utilized on the system.1  
Type of installation.

### P.1 Type of installation

Means shall be provided to allow a test of the alarm devices without injection of foam agent.

#### P.1.1 Wet Systems

For wet system the pipework shall be designed so that it takes the water maximum one minute to flow from the foam injector to the most remote sprinkler assuming that only one sprinkler is open.

#### P.1.2 Premix solution

Where pre-mix solution is maintained in the system piping, periodic sampling of the solution located in the sprinkler piping shall be tested in accordance with the foam manufacturers requirements but at least once a year.. Periodic testing will be based on need, as water quality and jobsite conditions will vary. Test samples shall be tested by an independent laboratory specializing in such testing or by the foam concentrate manufacturer. .

The sample shall be collected via special valves at the pipework at least on three points:

- the inlet of the foam agent,
- at the centre or at thermally stressed points of the ceiling pipework,
- at the end of the pipework.

Pass/fail criteria for the foam solution shall be based upon spread-ability, expansion (if applicable) and foaming / wetting ability.

Note: This may be done in accordance with the relevant parts of EN 1568.

Valves for testing foam solution shall be identified with a permanent label or sign. Label or sign shall read "Foam Solution Test Valve".

If the test result does not meet the requirement the pipework shall be emptied, flushed and filled with new premix. If pre-mix solution continually fails, a test of the water supply or investigation of contamination may be required. If contamination is present, the offending product must be replaced.

#### P1.3 Dry systems

Dry installations shall be designed in such a way, that the water- foam mixture reaches the test valve at the end of the pipework within 30 seconds of system activation. This test can be performed using water only.

## **P.2 Foam injection device**

P.2.1 The foam injection device shall be approved (GEI3).

Installer shall ensure that the foam injection device is compatible with the foam additive chosen.

Closed head sprinkler systems shall be designed so the proportioning of foam concentrate into the water stream shall occur within 4 sprinklers flowing. Proportioning rate into the water stream shall be a minimum of the foam concentrate approval e.g. 1%, 3%, 6%.

P.2.2 A foam solution test valve for foam concentration and an installation isolation valve shall be fitted downstream of the foam injection device. The installation system isolation valve shall be located as close as practical to the foam solution test valve. The foam solution test valve and installation isolation valve shall be installed in accordance with the foam injection device manufacturers recommendations.

The commissioning of the installation shall include a test of the achieved foam concentration using appropriate measuring devices. In a first test sequence water or test foam that has been designed to simulate the flow and shearing characteristics of the foam concentrate can be injected in place of foam to avoid unnecessary use of foam. At the initial system testing and commissioning, the foam concentrate utilized for the system shall be utilized in the system commissioning.

For closed head sprinkler systems, tests shall be carried out with an equivalent flow rate of four sprinklers and at the design flow rate of the system. The test at the design flow rate can be carried out by replacing foam by another liquid. The injection device shall deliver foam solution within a tolerance not less than its approval to 1.3 times its approval. A maximum of 1% point will be allowed. (Meaning 3% concentrate shall be allowed to be proportioned between 3% and 3.9 %, 6% concentrate shall be allowed to be proportioned between 6% and 7%).

Annual testing after the first year can be provided utilizing water or test foam using the comparative data from the first year. If proportioning with the required range does not occur with water or test foam, a new test with foam concentrate shall be made. Corrections to the proportioning system shall be made as required injection device.

P.2.3 If the foam injection device utilizes moving parts, means shall be provided to allow a test of the mechanical operating components. If the foam injection device utilizes electrical devices or electrical controllers, means shall be provided to test the electrical devices or electrical controllers, means of monitoring the working condition of electrical devices shall be provided. Foam injection devices shall immediately be ready for service after testing and shall restore automatically.

## **P.3 Foam injection pumps**

P.3.1 Foam injection pumps shall be selected for the special working conditions like corrosion, tightness.

The performance characteristics of the foam injection pumps shall be selected for the maximum flow rate and the viscosity of the foam agent. If foam injection proportioning devices are utilized in conjunction with a foam injection pump, the minimum pressure differential between the water injection point and the



foam injection device shall be per the foam injection device manufacturers requirements, but in no case lower than 1 bar.

P.3.2 Foam injection pumps shall not work under suction conditions.

P.3.3 Foam pumps shall be installed with a pump casing relief valve. Casing relief valve shall be set to open after pump pressure is 1 bar higher than the design limit of either the pump or the system piping network, whichever is less. The discharge of the casing relief valve shall not be piped to the suction side of the foam pump. The discharge of the casing relief valve may be piped or to the liquid level of the foam storage tank.

P.3.4 An approved pressure sustaining valve shall, if required by the injection device manufacturer, be installed in the discharge side of the foam injection pump and shall be designed to discharge below the liquid level of the foam tank. The pressure sustaining valve shall be calibrated to open where low water flow rate through the main stream of the proportioned is present and to close where large water flow rate is present during proportioning. Piping shall be adequately sized on the supply and discharge of pressure sustaining valve for full flow capacity.

P.3.5 The pipes up- and downstream the foam injection pumps shall be fitted with flushing connections. No water shall flow back in the foam tank.

P.3.6 Foam pumps shall start by automatic means. Foam pumps shall require weekly testing.

P.3.7 Suction pipes with pure foam agent shall be designed in such a way that the NPSH available is at least 1m higher than the required NPSH of the foam pump.

#### **P.4 Foam agent.**

P.4.1 Foam agents shall be approved by the authorities.

The foam agent shall be selected appropriate to the materials to be protected and the foam injection device.

P.4.2 The water shall not have any ingredients which are not compatible with the foam agent.

The quantity of the foam agent is determined at design flow rate by the operation time and the design concentration.

Unless specified elsewhere, the quantity of foam agent shall allow a continuous operation of the system for at least 30 min.

P.4.3 The quantity of foam agent may be reduced to 50 % if the premises have a recognised fire brigade and the same quantity of foam agent can be feed in the foam tank in a time not exceeding 15 min. The fulfilling of this requirement shall be approved by the authorities in the planning state of the installation.

P.4.4 Only the same type of foam agent of the manufacturer shall be used for refilling. Mixing of different foam concentrates is forbidden.

#### **P.5 Foam tank**

P.5.1 Foam tanks shall be approved by the authorities.

Depending on the type and quantity of foam agent a security pool can be necessary.

The manufacturers recommendation for the storage of the foam agent shall be observed.

#### **P.5.2 Non pressurized foam tank**

The foam tank shall be adequately designed to allow for the thermal expansion of the foam concentrate.

The foam tank shall have a venting, a level gauge and means to prevent overfilling.

Means for servicing and inspecting the inside of the tank shall be provided. Foam storage tank shall be constructed of a material that is compatible with the foam concentrate. Foam concentrate manufacturer shall be consulted for compatible materials.

Connections for filling and draining shall be fitted. The fill and suction pipes shall end above the tank bottom. The volume under the suction pipe shall not be taken account by calculating the tank volume.

The suction pipe may end at the tank bottom of tanks only if they are manufactured of reinforced glass fibre, or equivalent or corrosion resistant steel and if the foam agent is a sediment free and synthetic type.

#### **P.5.3 Pressurized foam tank**

Pressurized foam tanks (bladder tanks) shall be fitted with means for filling, draining, venting, measuring of the fill level, cleaning and controlling of the tank inside. Pressurized foam tanks shall be designed and constructed per a recognized standard for pressure vessels.

Pressurized foam tanks shall incorporate a concentrate control valve near the foam injection device.

An operation manual shall be provided. The recommendation shall be followed for all works.

Pressurized foam tanks cannot be refilled during operation of the extinguishing activity. Pressurized foam tanks shall be inspected and tested per manufacturers recommendations and the pressure equipment directive. The integrity of the bladder shall be tested for leaks on an annual basis. The quantity of foam agent may be stored in more than one pressurized foam tank. If the quantity of foam agent is stored in more than one pressurized foam tank, piping of equal pressure loss supplying the bladder tank and piping of equal pressure loss discharging from the bladder tank to the foam injection device shall be maintained.

### **P.6 Foam agent and water foam pipe-work**

**P.6.1** Components and pipes filled with foam concentrate at any time shall not influence the performance characteristics of the foam agent. Only materials compatible with the foam concentrate shall be utilized in the foam concentrate supply line to the foam injection device or system.

**P.6.2** The filling of the foam pipes upstream of the foam injection device with foam agent shall be achieved within 10 seconds or the pipes shall continuously be filled with foam agent. If the foam agent pump and the foam injection device are filled at all times with foam agent they shall be made of corrosion resistant materials that are compatible and suitable as pressurized piping.

**P.6.3** Galvanized pipes shall not be used for pipe-work filled with water foam mixture or used in foam concentrate lines unless proof of the compatibility of the foam agent with galvanized pipes is available.

**P.6.4** A filter or strainer shall be fitted upstream the foam injection device. Maintenance and cleaning of the filter shall not affect the operation of the extinguishing system (by pass around the strainer).

Filters are not necessary if a sphere with a diameter of 8mm can pass all ways of foam through pressurized tanks, foam injection devices,....

## **P.7 Calculation of the friction loss of foam agent pipes**

**P.7.1** The calculation shall be done for the lowest and highest viscosity (only highest viscosity for Newtonian liquid) of the foam agent.

This calculation shall be based on the foam demand corresponding to the sprinkler design flow.

The friction loss in the foam pipes shall be calculated with the Darcy formula

$$\Delta p = \lambda \cdot \frac{L}{d} \cdot \frac{\rho}{2} \cdot v^2 \quad (\text{Darcy - formula})$$

With:

$\Delta p$  friction loss, in N/m<sup>2</sup>

$\lambda$  friction number

$L$  pipe length, in m

$d$  pipe diameter, in m

$\rho$  fluid density, in kg/m<sup>3</sup>

$v$  flow velocity, in m/s

The friction number  $\lambda$  shall be determined depending on the Reynolds number  $Re$  using the following formula.

Reynolds number:

$$Re = d \cdot \frac{v}{\gamma}$$

With:

$\gamma$  kinematic viscosity, in m<sup>2</sup>/s

For the determining of the Reynolds number the Kinematic viscosity at the lowest temperature at the foam tank shall be used.

For  $Re < 2350$  (laminar) is:

$$\lambda = \frac{64}{\text{Re}}$$

$$\text{For } 2350 < \text{Re} < 65 \frac{d}{k}$$

with:

$k$  pipe roughness, in mm (for steel pipes:  $k = 0,5$  mm; for stainless steel pipes:  $k = 0,2$  mm) is

$$\lambda = \left[ 2 \cdot \lg \left( \text{Re} \cdot \frac{\sqrt{\lambda}}{2,51} \right) \right]^{-2}$$

$$\text{For } 65 \frac{d}{k} < \text{Re} < 1300 \frac{d}{k} \text{ is}$$

$$\lambda = \left[ -2 \cdot \lg \left( \frac{2,51}{\text{Re} \cdot \sqrt{\lambda}} + \frac{k}{3,71 \cdot d} \right) \right]^{-2}$$

$$\text{For } \text{Re} > 1300 \frac{d}{k} \text{ is}$$

$$\lambda = \left[ 2 \cdot \lg \left( 3,71 \cdot \frac{d}{k} \right) \right]^{-2}$$

P.7.2 Friction loss data must be obtained from the foam concentrate manufacturer. Friction loss data must be provided to the approval body when drawings and calculations are submitted.

## P.8 Disposal

The capacities of the necessary extinguish water collecting pools shall be determined according to the national regulation (and CEA recommendations Disposal of foam agent and water foam mixtures shall be done according to the national rules.

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