Fire protection services

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Principle causes of fires in buildings

The three basic essentials required before any fire can start are:

a. Fuel, i.e., something to burn
b. Air, i.e., oxygen to sustain combustion
c. Heat.

The process of combustion or burning can be likened to a triangle as shown in Figure 1.

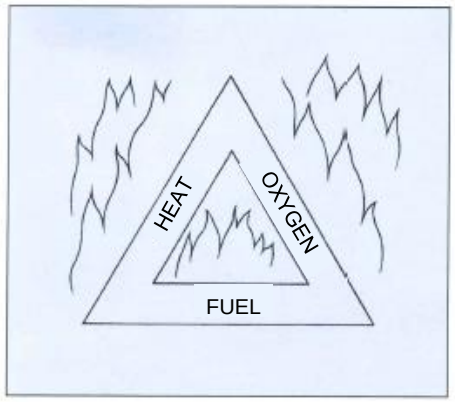


Figure 1 Fire triangle

Removal of any one of the sides of that triangle will result in extinguishment of the fire and this is the principle on which all forms of fire extinguishment are based.

Classification of fire risks

Fires are divided into three categories, A, B and C. Details of these together with the methods of extinguishment and extinguishing agents are shown in Table 1.

Table 1 Classification of fire risks

Class	Risk involved	Method of extinguishant	Extinguishing agent
A	Wood Textiles Paper All goods manufactured from above	Cooling	Water
B	Inflammable liquids	Smothering	Dry powder CO_2 gas Foam
C	Electrical equipment	Smothering with a non-conductive agent	Dry powder CO_2 gas

Residential/ domestic fire sprinkler systems

A residential fire sprinkler system for life safety purposes is designed to fight fires at an early stage in their development, thus controlling the fire and enabling occupants to reach safety. The sprinkler system will consist of pipework that is constantly charged with water, connected to a suitable water supply, with a number of sprinkler heads that discharge water. In the event of a fire, it is the heat generated which will cause a sprinkler head to operate. Thus, the closest sprinkler head to the fire is most likely to operate, and may be the only head to operate. Once a flow of water is detected in the pipework an alarm is triggered which operates a visual and audible alarm.

Sprinkler protection for residential and domestic properties are described in DD251, a Draft for Development published in 2000, issued by BSI. DD251 gives recommendations for the water supplies, system components such as the sprinkler heads and valves, and for the design, installation, commissioning, and maintenance of the system. The Draft for Development is open to public comment and changes to the recommendations contained within it may be made during the document's lifetime. The public comment period will usually last for 2 - 3 years after which time BSI will consider whether a full British Standard is required.

It is recommended that installers of residential/domestic systems be familiar with the content of DD251. Installation of residential sprinkler systems should only be undertaken by certificated sprinkler contractors, i.e., those contractors who have undertaken and passed a recognised course of training specific to sprinkler system installation.

The properties covered by DD251 include 'Residential occupancies', such as: apartments, residential homes, HMOs, blocks of flats, boarding houses, aged persons homes, nursing homes, residential rehabilitation accommodation and dormitories, and 'Domestic occupancies', such as individual dwelling houses, individual flats, maisonettes and transportable homes.

Where a sprinkler system is being considered it is necessary to consult the fire authority, the water supplier, the building control body and the insurer(s) of the dwelling and dwelling contents.

Feasibility

Before installation work can begin, the service pipe water supply should be tested to ensure that, when at its lowest hydraulic characteristic, the required flow rate and pressure requirement can be achieved. If the required pressure and flow rate is not achieved the installation should not proceed and the designer of the system should be consulted.

The installation requirements of BS 6700 (Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages) and the Water Regulations apply.

Water supplies

Sprinkler systems should ideally be connected to a town main but may also be connected to one of the following water supplies:

a. Pressure tank or vessel
b. Automatic pump drawing from a stored water facility
c. Automatic booster pump drawing water from a town main or an elevated storage tank
d. Gravity fed stored water system.

Most installations will be mains connected with either a dedicated sprinkler supply or a demand valve to divert all available incoming water to the sprinkler system. Where the water supply is shared with the domestic services and there is no priority demand valve an additional flow rate is required in all calculations, reference should be made to DD251.

Components

Sprinkler heads

A sprinkler head is a device that allows water to discharge in a predetermined pattern; different types of sprinkler head produce different patterns. The sprinkler head is operated by temperature, i.e., when a critical temperature is reached the water will flow through the sprinkler.

This critical temperature is known as the 'temperature rating' of the sprinkler and for normal conditions in the United Kingdom will be 57°C or 68°C. In any case the temperature rating of the sprinklers should be the closest to but at least 30°C greater than the highest anticipated ambient temperature of the location. If sprinklers are installed under glazed roofs the sprinkler temperature rating should be within the range of 79°C to 100°C.

Sprinklers should be installed in accordance with their approval listing specification and supplier/ manufacturer's instructions. Only new equipment should be used. Any sprinkler head removed from a system should be discarded. Sprinkler heads should only be fitted by qualified installers.

When using residential/domestic sprinkler heads the system should be capable of providing flow rates in accordance with the manufacturer's recommendations, based on the result of the component performance test, or the flow rates required for conventional sprinkler heads, see DD251.

If conventional sprinkler heads are to be used the flow rate at the sprinkler head should be not less than 60l/min for single head operation and 42 l/min for each of two heads operating simultaneously in domestic properties and for each of four heads operating simultaneously in residential properties.

Sprinklers should be positioned such that they are not more than 4m apart nor are they more than 2m from any wall or partition. The distance between sprinklers within a room should not be less than 2m. DD251 recommends that the maximum area protected by a single sprinkler be 15m^2.

Sprinklers should be positioned so that:

a. They are in accordance with the manufacturer's instructions identified in the approval listing.

b. Their sensitivity and discharge pattern are not adversely affected by obstructions such as constructional beams or light fittings or other sprinkler heads.

c. The potential for a shielded fire to develop is considered.

d. The heat sensitive elements are within 25 to 100mm below the ceiling for ceiling mounted sprinklers.

e. The heat sensitive elements are within 100 to 150mm below the ceiling for wall mounted sprinklers.

f. The whole of the floor area and the walls from the floor up to 0.7m below the ceiling are wetted when the sprinklers are operated.

NOTE concealed sprinklers may be considered with the approval of the authority having jurisdiction.

The minimum operating pressure at any sprinkler should not be less than 0.5 bar.

Sprinklers should be threaded suitable for use with fittings threaded in accordance with ISO 7-1:1982 and ISO 65: 1981 and BS 21.

The nominal size of sprinklers should be one of those shown in Table 2.

Table 2 Sprinkler head orifice and pipe thread sizes

Nominal diameter of orifice (mm)	Nominal pipe thread size (inch)
10	$^3/_8$
15 and 20	$^1/_2$
20	$^3/_4$

Valves and alarm devices

Valves and alarm devices suitable for residential and domestic systems should be installed in accordance with manufacturers' instructions and should be manufactured to the appropriate British Standards, where applicable.

The sprinkler system should have:

a. A backflow prevention valve to prevent mains water contamination.

b. A stop valve, of the full-bore lever type to isolate sprinkler pipework from mains water supply. The valve should be locked in the open position to prevent accidental interruption of the water supply to the sprinkler system.

c. And, where appropriate, a priority demand valve.

d. An alarm test valve: a test facility should be provided at the end of the hydraulically most remote range pipe on the system consisting of not less than a 22mm nominal diameter pipe and quick acting test valve with an outlet nozzle equivalent in size to the smallest sprinkler in the system.

e. A drain and test valve should be fitted at the lowest point of the sprinkler pipework to allow testing and the complete draining of the sprinkler system, consisting of not less than a 22mm nominal diameter pipe and quick acting test valve with an outlet nozzle equivalent in size to the smallest sprinkler in the system.

f. An air bleed valve fitted to the highest point/s of the sprinkler system to allow the purging of air from the system.

g. A water flow alarm for detecting water flow into the system and sounding an alarm.

h. A mechanically driven alarm or an electrically operated flow switch which, when triggered by the flow of water in the sprinkler system, will operate an audio-visual alarm.

Pipework installation

Pipework

All pipework should be installed in the same way as other water services, as described in BS 6700.

Pipes and fittings should either comply with the appropriate standards of Table 3 or for plastic and other pipe and fittings suitable for residential and domestic sprinkler systems, be installed in accordance with the manufacturers' instructions and the approval and listing requirements of an independent third-party certification body.

Pipework support

Only metallic pipe fixings should be used. Batons and lock type clips should be fitted in close proximity to the sprinkler heads to ensure no movement is allowed which may recoil heads into the ceiling or loft voids. Sprinkler system pipework should be supported at the intervals given in Tables 4, 5, and 6.

Pipe sizing (Hydraulic calculations)

All pipework downstream of the alarm valve should be sized by hydraulic calculation; calculation of pressure losses throughout the system.

The difference in static pressure between two connected points in a sprinkler system is given by the following formula:

Static pressure difference, p = 0.1 h (bar) where *h* is the vertical distance between the two points (in m).

The pressure loss due to pipe friction should be calculated from the Hazen-Williams formula.

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

where p = pressure loss in pipe (bar)

Q= flow rate through pipe (litres/min)

d = mean bore of pipe (mm)

L = equivalent length of straight pipe, bends and fittings (m)

C- a constant for pipe material (see Table 7)

For flow rates of 60 l/min the following tables give the appropriate pressure losses per metre of pipe.

Table 3 Pipe and pipe fittings specifications

Location	Pipe	Fittings
Below ground	BS EN 1057 NOTE 1	BS EN 1254 Part 2 NOTE 1
	BS 1387	BS 1740 Part 1
	BS 3505	BS 4346
	BS 3506	BS 4346
	BS 6572	BS EN 1254 Part 3
Above ground	BS EN 1057	BS EN 1254 Part 1 NOTE 2
	BS 1387	BS 1740 Part 1
	BS 7291 Part 4	BS 7291 Part 4

1. *Copper tube to BS EN 1057 used in underground locations should be R220 (annealed), thick walled, factory plastic coated tube. In this case, fittings should be manipulative Type B. Brass fittings in underground locations should be immune to de-zincification.*
2. *Capillary fittings to be jointed by soldering or brazing with alloys with a melting point of not less than 230°C as specified in BS EN 29453.*

Table 4 Maximum spacing of fixings for copper and stainless-steel pipework

Nominal diameter (mm)	Horizontal run (m)	Vertical run (m)
22	1.8	2.4
28	1.8	2.4
35	2.4	3.0
42	2.4	3.0
54	2.7	3.0

Table 5 Maximum spacing of fixings for steel pipework

Nominal diameter (mm)	Horizontal run (m)	Vertical run (m)
15	1.8	2.4
20	2.4	3.0
25	2.4	3.0
32	2.7	3.0
40	3.0	3.6
50	3.0	3.6

Table 6 Maximum spacing of fixings for CPVC pipework

Nominal diameter (mm)	Horizontal run (m)	Vertical run (m)
12 ($^3/_8$")	0.6	1.2
15 ($^1/_2$")	0.8	1.6
22 ($^3/_4$")	0.8	1.6
28 (1")	0.9	1.8
32 (1$^1/_4$")	1.0	2.0
40 (1$^1/_2$")	1.05	2.1
50 (2")	1.2	2.4

Table 7 Values of C for steel, copper and CPVC

Material	C
Steel	120
Copper	140
CPVC	150

Table 8 Pressure loss in 1m of copper pipe for a water flow rate of 60 litres/min

Tube size (mm)	Mean size (mm)	Pressure loss (bar)
22	20.2	0.0554
28	26.2	0.0156
35	32.6	0.0054
42	39.6	0.0021
54	51.6	0.0006

Table 9 Pressure loss in 1m of CPVC pipe for a water flow rate of 60 litres/min

Tube size (mm)	Mean size (mm)	Pressure loss (bar)
20	20	0.0512
25	25	0.0173
32	32	0.0052
40	40	0.0018
50	50	0.0006

Table 10 Pressure loss in 1m of steel pipe for a water flow rate of 60 litres/min

Tube size (mm)	Mean size (mm)	Pressure loss (bar)
20	21.63	0.0529
25	27.31	0.0170
32	35.97	0.0044
40	41.86	0.0021
50	52.98	0.0007

Equivalent lengths of pipe for pulled bends in copper tube (in m of pipe)

Frictional pressure loss in copper pipework bends where the direction of water flow is changed through 45° or more should be calculated using the following equation.

Equivalent length

$$= 7.65 \times 10^{-3}\, Q^{0.15}\, d^{0.87}$$

where Q= the water flow rate (litres/min)

d = the tube bore (mm)

The equivalent length of pipe for the pressure loss due to the bend for a water flow rate of 60 litres/min is as given in Table 11.

Table 11 The equivalent length of copper pipe for the pressure loss due to the bend for a water flow rate of 60 litres/min

Tube size (mm)	Mean size (mm)	Equivalent length (m)
22	20.2	0.1932
28	26.2	0.2423
35	32.6	0.2930
42	39.6	0.3470
54	51.6	0.4369

Frost protection

It is essential that any water filled pipework which may be subjected to low temperatures should be protected against freezing at all times. Note: the use of electrical trace heating and/or lagging or antifreeze solutions, or subsidiary alternate systems may be considered.

Extent of sprinkler protection

Sprinkler protection should be provided in all habitable parts of the dwelling. There are several areas that can be exempt from protection including:

a. Bathrooms with a floor area of less than 5m^2

b. Cupboards and pantries with floor areas of less than 2m^2 and where the least dimension does not exceed 1m and the walls and ceilings are covered with non-combustible or limited-combustible materials

c. And crawl spaces.

Non-communicating parts of the property e.g., attached garages, boiler houses, etc., can also be exempted if the separation from the habitable areas has a 30-minute fire resistance.

Table 12 Copper - equivalent lengths of pipe for fittings (in m of pipe)

Fitting	Nominal diameter (mm)				
	22	28	35	42	54
Tee run	0.068	0.10	0.13	0.16	0.22
Tee branch	1.00	1.40	1.80	2.30	3.10
90° capillary elbow	0.49	0.68	0.91	1.10	1.70
90° compression elbow	0.74	1.00	1.30	1.50	2.10

Table 13 Steel - equivalent lengths of pipe for fittings (in m of pipe)

Fitting	Nominal diameter (mm)					
	20	25	32	40	50	65
90° screwed elbow	0.63	0.77	1.04	1.22	1.46	1.89
90° welded elbow	0.30	0.36	0.49	0.56	0.69	0.88
45° screwed elbow	0.34	0.40	0.55	0.66	0.76	1.02
Standard screwed tee or cross	1.25	1.54	2.13	2.44	2.91	3.81

Table 14 CPVC - equivalent lengths of pipe for fittings (in m of pipe)

Fitting	Nominal diameter (mm)						
	20	25	32	40	50	65	80
Tee run	0.30	0.30	0.30	0.30	0.30	0.60	0.60
Tee branch	0.90	1.50	1.80	2.40	3.00	3.60	4.50
90° elbow	2.10	2.10	2.40	2.70	3.30	3.60	3.90
45° elbow	0.30	0.30	0.60	0.60	0.60	0.90	1.20
Coupling	0.30	0.30	0.30	0.30	0.30	0.60	0.60

Commissioning

On completion of the installation the pipework needs to be tested; leakage and hydraulic tests need to be carried out. A small quantity of air should be left in the system at the end of the purging process.

With the pipework filled with water at the normal working pressure for the system any leaks should be found and repaired. The water supply to the system should then be isolated and the system should be tested to a minimum of 1.5 times working pressure for one hour. If the system fails to maintain pressure the leak should be found and corrected and this test repeated.

The sprinkler system should be tested to ensure that at least the required flow rate can be achieved at the required pressure at the alarm test valve. If this flow rate at the required pressure cannot be achieved, the system should not be approved for use until the system has been corrected and the test specified in this clause has been passed. The installer and the designer should be responsible for correcting the system.

The alarm (and/or repeaters) should be heard in all habitable rooms in the premises protected by sprinklers coupled to the alarm device being tested. The stated audibility should be achieved when there is a water flow of not more than 60 litres/minute through the alarm device under test.

When all the commissioning tests have been passed the installer should sign a Certificate to indicate that the system has been designed and installed following the guidance set out in DD251.

Documentation

For new and extended systems all drawings and documents should bear:

a. The address and location of the premises

b. The name and address of the installer

c. The name of the designer

d. *The* date of installation.

On completion of the installation, the installer should provide the following information to the owner or occupier:

a. Details of the authorities consulted and any response to consultation.

b. A general specification of the system and a statement of compliance with the guidance given in DD251.

c. A layout of the sprinklered premises showing the extent of the installation.

d. Details of the water supplies which, if a town main, should include pressure/flow rate data at a specified location for the commissioned installation, with the time and date of the test.

e. An inspection and routine checking program for the system. The program should include instructions on the actions to be taken in respect of operation of the system, faults, etc.

f. A list of components used, identifying manufacturer's name and parts reference number.

g. A 24-hour emergency telephone number which can be used to obtain assistance.

h. A Logbook containing inspection, checking and maintenance documents, detailing a regular program to be undertaken by an approved contractor.

i. Essential information for the user e.g., 'do not paint, cover or in any way impede the operation of a sprinkler head'.

It is recommended that a number of spare sprinkler heads be left at the site of the installation to replace activated, or damaged, sprinkler heads. Heads should only be replaced by qualified installers.

Logbook

A logbook should be handed over on completion of the system commissioning. This logbook should give details of:

a. The date of inspection

b. Details of all tests conducted and their results

c. Details of any remedial action taken

d. Confirmation or otherwise of the sprinkler systems operational status

e. Confirmation or otherwise of the alarm systems operational status

f. Details of any recommendations or comments.

Maintenance

It is the property owner's responsibility to ensure that a regular inspection and testing program is in place. The person carrying out the inspection should complete and sign the logbook accordingly.

The sprinkler system should be subject to an annual inspection and test by a qualified installer to ensure that the sprinklers' heat sensing capacity and their spray pattern is not impeded; the minimum flow rates are achieved at the drain and test valve; the alarm is effective, and that the system has not been modified, unless by a qualified designer/installer.

The person carrying out the inspection should test the system by visually inspecting for leaks wherever possible.

Should a leak be suspected the pipework should be pressure tested to 1.5 times working pressure for 1 hour. The alarms should be activated so that their satisfactory operation can be audibly verified. The sprinkler system should be flow tested for 1 minute at the drain and test valve, or the highest test point of the installation pipework, to ensure that the system flow rate requirements are met. Stop valves should be exercised to ensure free movement. Where trace heating is installed, its effective operation should be checked.

Hose reel installations

A hose reel consists basically of a steel drum or reel on which is rolled a length of suitable rubber hose with a shut-off nozzle at the end; the whole unit being connected to a suitable water supply. They are installed to provide the occupants of a building with first aid means of fighting a fire whilst awaiting the arrival of the local fire brigade. The fire service personnel do not normally use them unless the fire happens to be a small localised one, as the amount of water discharged by each reel, approximately 23 litres/min is not sufficient to extinguish a large fire.

Positioning of hose reels

As hose reels are intended for use by the building occupants, it is of vital importance that they are placed in readily accessible positions so that they can be used without exposing the personnel to danger. This means that they must as a general rule be fixed along escape routes or adjacent to fire exits so that personnel escaping from an outbreak of fire will pass them on their way to safety and can thus use them without having their means of escape cut off.

In office blocks especially the multi-storey type, the hose reels must be fitted inside the actual office accommodation which as a rule means that they are fitted adjacent to the fire exit doors into the lift or stair lobbies. This enables the hose reel to be used without opening the smoke stop doors thus preventing the lobby from being filled with smoke. In industrial premises, it is not always possible to site hose reels adjacent to the fire exits because the width of the building would prevent the hose from reaching a fire in the centre. In these circumstances it is necessary to position the hose reels in the centre of the building usually on the columns or stanchions, but care must be taken to ensure that they can be used safely in the event of fire.

Types of hose reel

There are two basic types of hose reel, fixed or swinging. The fixed type of reel should normally have its centre line at least 1,5m above the floor. A swinging type of hose reel can be swung through 180° and be mounted at any convenient height, the average being 900mm to 1.05m above the floor.

Hose reels are normally fitted with 20mm diameter reinforced non-kink rubber hose, but hose reels fitted with 25mm dia. are available if required. The usual lengths of hose are 23m, 30m, 36m and 45m.

Each reel is also fitted with a 5mm lever operated shut off nozzle at the end of the hose.

In determining the length of hose to be used the critical factor is the requirement that all areas of the building must be covered, and no part must be more than 6m from the hose reel nozzle when the hose is uncoiled.

Manually operated hose reels are fitted with a wheel head type isolating valve on the inlet to the reel which is closed when the reel is not in use to prevent the hose from being continuously subject to water pressure. Before running out the hose, it is necessary to turn on the isolating valve and a warning notice to this effect must be positioned adjacent to the reel.

Automatic hose reels are fitted with a valve which is opened or closed by the revolving action of the reel when the hose is pulled out or rewound and with this type it is only necessary to pull out the hose and open the shut off nozzle at the end to allow water to be discharged.

It is, however, normal practice to fit a lock shield type isolating valve on the feed pipe so that individual reels can be shut down for maintenance purposes without isolating the whole system.

Discharge from jets

Quantity Q= velocity x area

q = Cd x V x A x 1000

Putting C_d = 0.96 – cc – efficient of discharge

H in m

d in mm

V in m/s = $\sqrt{2gH}$

q in litres/sec

$$q = 0.96 \times \sqrt{2gH} \times \frac{\pi}{4} \times \frac{d^2}{10^6} \times 10^3$$

This reduces the formula:

$$q = \frac{3.35d^2}{1000} \times \sqrt{H}$$

Example

when d = 8mm

H = 9m

$$q = \frac{3.35 \times 8^2 \times \sqrt{9}}{1000}$$

$$= \frac{3.35 \times 64 \times 3}{1000}$$

$$= \frac{10.05 \times 6.4}{1000}$$

q= 0.64l /sec

Pipework

Hose reel systems are classed by the water authorities as domestic cold water services because water can be freely drawn off through the reels.

All hose reels must be fitted with a union between the isolating stop valve on the feed pipe and the inlet to the reel. This enables individual reels to be shut off and dismantled for maintenance and overhaul without shutting down the entire system.

Table 15 Height of jet (max) in metres

Head on jet in metres	Diameter of orifice in millimetres						
	3.2	6.3	9.5	12.7	16.8	19.0	25.4
3.0	2.67	2.86	2.93	2.97	2.99	3.00	
6.0	4.57	5.33	5.59	5.72	5.79	5.85	5.91
9.0	5.79	7.44	8.00	8.29	8.46	8.63	8.72
12.0	6.10	9.14	10.15	10.67	10.97	11.28	11.43
15.2	-	10.49	12.07	12.86	13.41	13.72	14.05
18.3	-	11.43	13.72	14.84	15.54	15.83	16.50
21.3	-	12.19	16.15	18.29	19.51	20.42	21.34
24.4	-	12.19	16.15	18.29	19.51	20.42	21.34
27.4	-	-	17.07	19.81	21.34	22.25	23.47
30.4	-	-	17.68	21.03	23.86	24.08	25.60

Table 16 Discharge from jets in litres per second

Head on jet in metres	Diameter of orifice in millimetres										
	3.2	4.8	6.3	8.0	9.5	11.5	12.7	16.8	19.0	22.0	25.4
1.5	0.04	0.09	0.16	0.25	0.36	0.49	0.65	1.00	1.46	1.99	2.60
3.0	0.06	0.12	0.23	0.36	0.52	0.70	0.92	1.43	2.07	2.81	3.67
4.5	0.07	0.16	0.28	0.44	0.63	0.86	1.12	1.76	2.53	3.45	4.50
6.0	0.08	0.18	0.32	0.51	0.73	0.98	1.30	2.03	2.70	3.99	5.20
7.6	0.09	0.20	0.36	0.57	0.82	1.11	1.45	2.27	3.27	4.46	5.82
9.0	0.10	0.22	0.40	0.62	0.89	1.22	1.59	2.44	3.58	4.88	6.37
10.6	0.11	0.24	0.43	0.67	0.97	1.32	1.72	2.69	3.87	5.27	6.89
12.0	0.12	0.26	0.46	0.72	1.03	1.41	1.87	2.87	4.14	5.63	7.36
13.7	0.125	0.27	0.49	0.77	1.10	1.53	1.95	3.05	4.39	6.11	7.80
15.2	0.13	0.29	0.51	0.80	1.15	1.61	2.05	3.21	4.63	6.43	8,26
18.3	0.14	0.31	0.56	0.88	1.27	1.73	2.25	3.52	5.07	6.90	9.02
21.3	0.15	0.34	0.60	0.95	1.37	1.86	2.43	3.80	5.48	7.46	9.77
24.4	0.16	0.36	0.65	1.02	1.46	1.99	2.60	4.06	5.85	7.96	10.38
27.4	0.17	0.39	0.69	1.08	1.55	2.05	2.76	4.24	6.21	8.41	10.99
30.4	0.18	0.40	0.73	1.14	1.64	2.23	2.91	4.55	6.55	8.86	11.59

The drop pipe to the hose reel from the distribution main is normally 25mm diameter with a 25mm by 20mm reducing elbow at the bottom, the feed pipe to the reel being 20mm diameter.

Care should be exercised in positioning hose reels on drinking water systems that a sufficient flow of water passes along the pipework (oversized to meet the hose reel requirements) to ensure fresh wholesome water at all drinking and culinary terminal fittings.

Water supplies

The following water systems are acceptable for hose reel installations and are the ones most commonly used.

a. Direct connection from town's main (or mains)

b. Connection from sprinkler installation trunk main

c. Pump supply (usually with suction break tank)

d. Connection from boosted domestic water service

e. Connection from hydrant main or wet fire riser.

A normal requirement for a hose reel system water supply is that it should be capable of providing a flow rate of at least 2.27 l/s at a running pressure of 2 bar at the level of the top hose reel in the system.

With a pressure drop of approximately 0.5 bar through the reel this is sufficient to produce a 6m jet of water to comply with requirements. The flow rate of 2.27 l/s will permit up to six reels to operate efficiently (0.38 l/s per reel), although if a fire has reached a size requiring this number of hose reels to be brought into action, it is unlikely to be extinguished solely by their use.

Special provision in respect of pump supplies

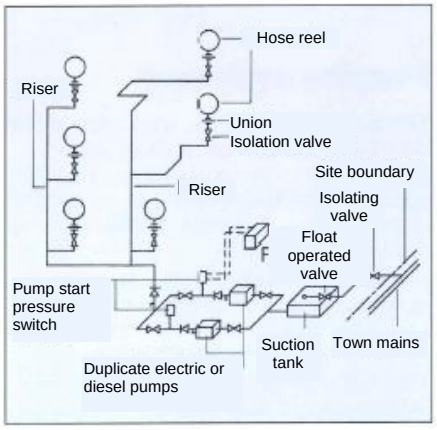


Figure 2 Typical arrangement of hose reel system.

A typical pump supply is shown in Figure 2.

As most water companies do not permit direct connections from their mains to be boosted, it is often necessary to provide a suction break tank supplied from the town's main via a suitable float operated valve. The required capacity of the break tank varies. As a general guide a capacity of 1250 litres or 1,2m^3 is a common requirement, but the local water company should be contacted to establish their requirements.

Duplicate pumps

Duplicate pumps are normally provided, and these may be controlled as follows:

As automatic 'On' and manual 'Off'

This system of control is identical to that used for sprinkler system pumps in that the pump is started automatically by a pressure switch and stopped manually by a stop/reset push button on the starter.

In addition, an electrical alarm bell is provided to run all the time the pump is running and thus provide a remote warning of system operation.

Automatic 'On' and 'Off'

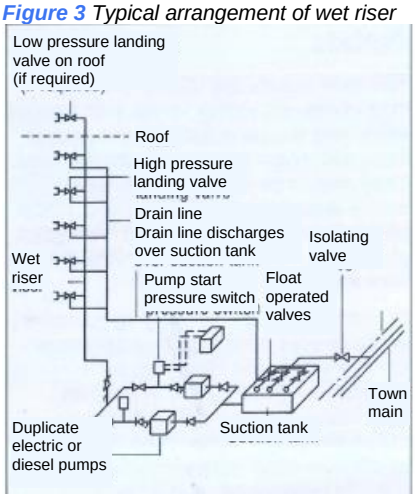
With this system the pumps are started by a pressure switch, but a flow switch is also provided in the pump delivery line to ensure that the pump continues to run all the time there is a flow of water through the system.

Testing and approval

Completed installations are normally required to be tested in the presence and to the satisfaction of the local fire authority and to be approved by both the local fire authority and water company.

Wet risers

Figure 3 Typical arrangement of wet riser



Statutory regulations

There are no insurance requirements relating to wet risers. Also, as they are only installed in buildings exceeding 61m in height and as there are very few standard requirements, it is advisable to obtain the local authority requirements in each instance.

Size and positioning

A wet rising main should be positioned either in the ventilated lobby approach staircase or within the stair enclosure itself.

The riser should be 100mm diameter normally with outlets on all floors. Normally only one outlet per floor would be required, but where two are necessary the second riser should be provided at the opposite end of the building.

Water supplies

Generally, a wet riser supply system should be capable of maintaining a minimum running pressure at the top outlet at roof level of 4 bar at a flow rate of 22.7 l/s. The maximum running pressure permitted with only one outlet in operation is 5 bar.

To maintain the above pressure and flow rates it is necessary to employ pumping equipment, usually duplicate electric and diesel fire pumps. In view of the very high pressures involved (up to 16.5 bar at the pump delivery) direct boosting of the town's mains is not permitted and therefore it is necessary for the pumps to be supplied from a suction break tank which must have a minimum actual capacity of 45.45m^3. An automatic inflow from a town's main having a flow rate of at least 7.6 l/s must be provided to refill the tank.

Outlets

Wet riser outlets are 65mm diameter high pressure landing valves with flanged inlets and female instantaneous outlets fitted with plugs secured by short chains. They should be mounted with their centre lines between 910mm and 1.06m above finished floor level and one outlet should be provided for every 929m^2 of floor area.

In order to reduce the running pressure in the canvas hose line, high pressure landing valves are fitted with an adjustable butterfly valve in the inlet which acts in a similar manner to an orifice plate and reduces the pressure under flow conditions when the valve is open between 4 bar and 5 bar.

The butterfly can be adjusted by means of a nut on the outside of the landing valve body and by use of a special test pipe and gauge, can be altered to give the correct running pressure when the landing valve is fitted in position.

It is also necessary to limit the static pressure in the canvas hose to a maximum of 6.6 bar if water is shut off by closing the branch pipe nozzle at the end of the hose. This is achieved by means of a spring-loaded pressure relief valve incorporated in the outlet from the landing valve. The discharge from the relief valve is piped via a 50mm dia. connection into a 100mm dia. drainpipe running vertically down the building alongside the main riser and discharging over the suction tank. In early wet riser installations, a lot of trouble was experienced through inadequate drainage facilities and it is important to ensure that the drain pipework is short and direct with the minimum number of bends.

Pumping equipment

The arrangement of the duplicate electric and diesel fire pumps, starters and suction tank is identical to that used for sprinkler installations except for the method of control. In a similar way to hose reel systems, the electric pump can be either 'Auto On' and 'Manual Off or 'Auto On' and 'Auto Off but in both cases the diesel pump (which is on standby) is 'Auto On' and 'Manual Off.

The 'Auto Off facility is provided by incorporating a flow switch in the electric pump delivery line.

Installation

The requirements for installation during construction of a building are the same as from a dry riser. If when the riser is initially installed it is impossible to commission the pumping equipment, then it must be fitted out as temporary dry riser with a temporary breaching inlet in a suitable position at ground level.

It is necessary to efficiently earth wet risers to prevent damage from lightning.

Testing and approval

Completed installations are normally required to be tested in the presence, and to the satisfaction, of the Local Fire Authority and be approved by both the Local Fire Authorities and Water Companies.

Dry risers

A dry riser consists of an empty or dry pipe rising vertically up a building with hydrant valve outlets on each floor and at roof level. An inlet (Breeching Piece) is provided at ground level in an external wall to enable the Fire Brigade to pump water into the riser from the nearest suitable hydrant.

Dry risers are provided solely for use by the Fire Brigade personnel, and they are not intended as first aid firefighting equipment for use by the building occupants in the same way as a hose reel system. Use of a dry riser in the event of fire avoids the necessity of running long lengths of canvas hose up the staircase of a building and thus enables the Fire Brigade to tackle the blaze much more effectively and in the case of very tall buildings much more quickly (see Figure 4).

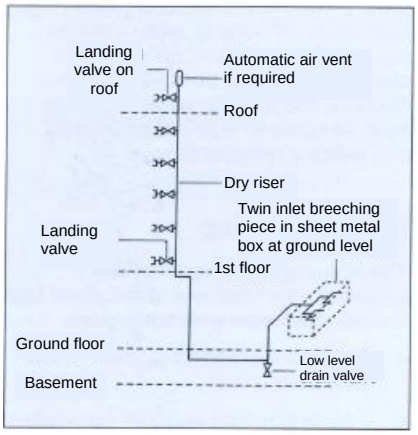


Figure 4 Typical arrangement of dry riser.

Statutory regulations

Dry risers are normally installed when they are a requirement of the Local Water Company. Most local Fire Brigades publish a standard for dry risers installed in their area. They are normally only installed in buildings up to 61m high; wet risers being required in buildings exceeding this height.

Size and positioning of risers

Risers should be 100mm diameter where only one hydrant valve outlet is provided on each floor. When two outlets are provided on a floor fed from the same riser then the diameter should be 150mm.

Dry risers should normally be positioned in the ventilated lobby approach staircase or within a staircase enclosure. This enables Fire Service personnel to couple up their hose to the riser outlet in a smoke-free area and it is not necessary to open the smoke stop doors until the last moment when the water is turned on.

Inlets

A 100mm riser should be fitted with twin inlets and a 150mm riser should have four inlets. Each inlet consists of a 65mm diameter male instantaneous coupling to BS 336 with a non-return valve and a blank cap secured with a short length of chain. The inlets are normally grouped together in a single casting called a “breeching pipe” or “inlet breeching” which has a single flanged or screwed outlet. The “inlet breeching” must be mounted in an external wall with its centre line not more than 762mm above pavement level. When positioning inlets due regard must be paid to accessibility, the positions of adjacent street hydrants and danger from falling glass, etc, in the event of a fire.

Inlet breechings are normally contained in sheet metal inlet boxes with wired glass doors in accordance with BS 3980. The doors are secured with spring locks so that they can be opened from inside by smashing the glass and releasing the catch on the lock.

Outlets

Dry riser outlets are 65mm diameter gunmetal gate pattern landing valves with flanged inlets and female instantaneous outlets fitted with plugs secured by short chains. They should be mounted with their centre lines between 910mm and 1.06m above finished floor level.

Outlets should be provided for every 929m^2 of floor area on every floor from first floor level to the roof. An exception to this requirement is made in the case of blocks of flats where outlets are normally only required on every other floor from first floor to roof.

Automatic Air Relief Vents are sometimes required by the Local Fire Authority to be fitted at the top of the riser.

Because dry risers project above the roof level of buildings it is necessary for them to be efficiently earthed to prevent damage from lightning.

Installation

Dry risers should be installed progressively as a building is constructed to provide protection during the building operations. In buildings over 30.48m in height the riser must be installed when the building exceeds 18.28m in height.

Testing and approval

Completed installations are normally required to be tested in the presence, and to the satisfaction, of the Local Fire Authority and be approved by both the Local Fire and Water Companies.

Foam systems

Foam is a frothy product, similar in appearance to soap suds and it is so light that it will float on the surface of a liquid. The properties desired in foam are that it should be tough, tenacious, long lasting and flow freely. It should also resist heat, wind and rain, and retain its water content for a long time.

Foam has three constituents; foam, water and air, and its production takes place in two stages. First the liquid foam compound is induced into the water stream and the aeration takes place. The two stages (induction and aeration) are sometimes carried out in one apparatus, but often separate units are employed, in which case the mixture of foam compound and water is pumped through a pipe or hose to the foam maker (sometimes known as an aerator box or aspirator box).

Application

Foam may be used for extinguishing fires of oils, spirits, paints, molten fats and similar liquids. Foam may also be used for items of plant or complete buildings.

To appreciate the value of foam when used to fight fires involving liquids, it must be remembered that the liquid itself does not burn. It is the mixture of air and the vapour given off from the liquid that burns. Combustion does not occur actually at the surface of the liquid because the proportion of vapour to air is too great to form a combustible mixture. The fire occurs slightly above the surface of the liquid.

Liquid stored in open or closed tanks is dealt with by applying foam to the surface of the liquid, in such quantities as to cover the entire surface of the burning liquid. This blanket of foam excludes air and prevents the formation and possible re-ignition of further vapour.

Foam should not be used on live electrical equipment because it is a conductor of electricity.

Types of system

Portable extinguishers

Extinguishers generally have a nominal capacity of up to approximately 17kg and should be capable of expelling a continuous discharge of foam in the form of a jet until the whole of the contents have been discharged.

Mobile foam units

MFU-s may be used in situations where the quantity of foam likely to be required is greater than could be provided by portable extinguishers, foam trailers, tenders or engines. These units have the disadvantage in that they are always ready for immediate use, but as they cannot be refilled quickly, their use is limited to the time taken to discharge the original contents.

Fixed foam installations

Where large quantities of foam are required such as oil storage tanks, boiler houses, etc, it is normal practice to install a system of pipework to deliver the foam to the particular risk.

The oil storage tank is a risk commonly protected by the application of foam and the installation would be designed to provide a blanket of foam to the burning oil surface within the storage tank. Assuming an adequate supply of water at the required pressure is available from an underground main, a typical installation would comprise a valid connection from the water main via an induction unit or venturi to the oil storage tank.

Foam branch pipes

These are generally carried on Fire Brigade appliances and comprise a specially designed branch pipe for use with a 65mm hose. A small tank of foam compound (sometimes in the form of a knapsack) is connected by a flexible pipe to the branch pipe. The flow of water through the branch pipe induces the foam compound into the water stream, aeration takes place within the branch pipe and a jet of foam capable of a range of 9m from water pressure of 3.3 bar up to 30m from water pressure 8 bar.

Foam inlets

Rooms which contain oil fired boilers, oil storage tanks, oil filled electrical equipment or other materials or apparatus for which foam is a suitable extinguishing medium may be fitted with pourers so placed that a foam blanket can be formed over the equipment and floor of the room. Pipework from the pourers would be connected back to a convenient point in the open (generally in an outside wall), the fire brigade can then connect a foam making branch pipe by means of an adapter and pump foam into the room or basement area to deal with the fire.

Design data

Minimum recommendations for foam systems have been established by the National Fire Protection Association (NFPA). Application rates higher than these will be beneficial and reduce extinguishing time but as a general rule the NFPA standard is accepted as a good basis for design purposes.

High expansion foam

Foam has an expansion ratio of between 6 and 8 to 1. High expansion foam has an expansion rate of between 600 and 1000 to 1. The method of generating high expansion foam differs from the method employed with ordinary foam systems in that a fan is incorporated to provide the large quantity of air necessary for making high expansion foam.

High expansion foam units may be installed as a permanent system with manual operation, automatic operation or both. They may also be carried as part of a fire brigade's equipment.