BS 5306-0:2011

BSI Standards Publication

# Fire protection installations and equipment on premises

## Part 0: Guide for selection of installed systems and other fire equipment

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## Publishing and copyright information



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# Contents

**Summary of pages**
This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 64, an inside back cover and a back cover.

# Foreword

## Publishing information

This part of BS 5306-0 is published by BSI and came into effect on 31 January 2011. It was prepared by Subcommittee FSH/18/6, *Gaseous extinguishing media and systems*, under the authority of Technical Committee FSH/18, *Fixed fire fighting systems*. A list of organizations represented on this committee can be obtained on request to its secretary.

## Supersession

This part of BS 5306 supersedes BS 5306-0:1986+A2:1991, which is withdrawn.

## Relationship with other publications

This part of BS 5306 serves to introduce the subsequent parts of BS 5306, each of which gives requirements or recommendations for the application of a particular type of fire-fighting system, discharging a particular fire-fighting medium. Taken together, the various parts of BS 5306 and other British Standards are intended to cover all the main types of fire-fighting medium and system in current use, and therefore form a comprehensive guide to all aspects of the subject.

The subsequent parts of BS 5306 are as follows:

- *Part 1: Hose reels and foam inlets*;
- *Part 3: Commissioning and maintenance of portable fire extinguishers – Code of practice*;
- *Part 4: Specification for carbon dioxide systems*;
- *Part 5: Halon systems*;
  - — *Section 5.1: Specification for halon 1301 total flooding systems*;
  - — *Section 5.2: Halon 1211 total flooding systems*;
- *Part 8: Selection and installation of portable fire extinguishers – Code of practice*.

The following parts of BS 5306 have been superseded:

- *Part 2: Specification for sprinkler systems* [1)]

  (Superseded by BS EN 12845+A2, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*);
- Part 6: *Foam systems*;
  - — *Section 6.1: Specification for low expansion foam systems;*
  - — *Section 6.2: Specification for medium and high expansion foam systems*

  (Superseded by BS EN 13565-2, *Fixed firefighting systems – Foam systems – Part 2: Design, construction and maintenance*);
- *Part 7: Specification for powder systems*

  (Superseded by BS EN 12416-2, *Fixed firefighting systems – Powder systems – Part 2: Design, construction and maintenance*).

1) BS 5306-2 is current but obsolescent, meaning that it is no longer being maintained by the committee. As such, BS EN 12845+A2 should be used instead.

Other related British Standards and Drafts for Development are as follows:

- BS 9251 *Sprinkler systems for residential and domestic occupancies – Code of practice*;
- BS 9990, *Code of practice for non-automatic fire-fighting systems in buildings*;
- BS EN 671 (all parts), *Fixed firefighting systems – Hose systems*;
- BS EN 12416 (all parts), *Fixed firefighting systems – Powder systems*;
- BS EN 12845+A2, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*;
- BS EN 13565 (all parts), *Fixed firefighting systems – Foam systems*;
- BS EN 15004 (all parts), *Fixed firefighting systems – Gas extinguishing systems*;
- DD 8458 (all parts), *Fixed fire protection systems – Residential and domestic watermist systems*;
- DD 8489 (all parts), *Fixed fire protection systems –Industrial and commercial watermist systems*[2].

## Information about this document

The aim of this part of BS 5306 is to aid selection of the fire-fighting medium and type of system or equipment by describing the characteristics and most suitable applications of each.

Consideration has been given to other aspects of fire-fighting media including toxicity to people, effect of discharge on visibility, danger of use on electrical equipment etc., in addition to other considerations such as monitoring, testing, maintenance and user responsibility.

More detailed consideration of systems and equipment, including safety precautions, is given in the subsequent parts of BS 5306 and other British Standards.

None of the recommendations or guidance in this standard should be taken as precluding the provision of manual means of fighting fire or as obviating the necessity to notify the fire and rescue service in the event of a fire.

This standard is written in SI units, except that pressures are expressed in bars[3]. Water discharge densities are expressed as rainfall at floor level, in mm/min (1 mm/min = 0.02 gal per $ft^2$ per min = 1 L per $m^2$ per min).

## Use of this document

As a guide, this part of BS 5306 takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

## Contractual and legal considerations

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

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

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2) In preparation.

3) 1 bar = $10^5$ $N/m^2$ = 100 kPa.

# Section 1. General

## 1 Scope

This part of BS 5306 gives guidance on the selection, use and application of automatic water sprinkler, water spray, watermist, gaseous, foam and powder fire-fighting systems and hypoxic air fire-prevention systems. It also gives guidance on installed equipment for fire and rescue service use, and on the application of portable fire extinguishers. It complements the more detailed information given in the specialized parts of this standard and other relevant standards.

This part of BS 5306 does not cover fire-fighting systems for use on ships, in aircraft, on vehicles and mobile fire appliances or for below ground systems in the mining industry.

It also does not cover powdered aerosol extinguishing agents.

## 2 Normative references

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

BS 4422, *Fire – Vocabulary*

BS 5306-1, *Code of practice for fire extinguishing installations and equipment on premises – Part 1: Hose reels and foam inlets*

BS 5306-3, *Fire extinguishing installations and equipment on premises – Part 3: Commissioning and maintenance of portable fire extinguishers – Code of practice*

BS 5306-4, *Fire extinguishing installations and equipment on premises – Part 4: Specification for carbon dioxide systems*

BS 5306-5.1, *Fire extinguishing installations and equipment on premises – Part 5: Halon systems – Section 5.1: Specification for halon 1301 total flooding systems*

BS 5306-5.2, *Code of practice for fire extinguishing installations and equipment on premises – Part 5: Halon systems – Section 5.2: Halon 1211 total flooding systems*

BS 7273-1, *Code of practice for the operation of fire protection measures – Part 1: Electrical actuation of gaseous total flooding extinguishing systems*

BS 7273-2, *Code of practice for the operation of fire protection measures – Part 2: Mechanical actuation of gaseous total flooding and local application extinguishing systems*

BS EN 12845+A2, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*

# 3 Terms and definitions

For the purposes of this part of BS 5306, the terms and definitions given in BS 5306-1, BS 5306-3, BS 5306-4 and BS 5306-5, BS 4422 and the following apply.

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

[BS EN 12845+A2]

*NOTE This is sometimes referred to as the "assumed maximum area of operation".*

**3.2 class A fire**
fire involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers

[BS 4422]

**3.3 class B fire**
fire involving liquids or liquefiable solids

[BS 4422]

**3.4 class C fire**
fire involving gases

[BS 4422]

**3.5 class D fire**
fire involving metals

[BS 4422]

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

[BS EN 12845+A2]

*NOTE The valve nearest the supply is termed the mains shut-off valve and serves to cut off the supply when the system is undergoing maintenance or modification. At all times when the system is operative, it is open and is strapped in this position to prevent inadvertent closure. The valve immediately downstream of the mains shut-off valve is termed the alarm valve and serves to separate the water supply from the system. The alarm valve opens automatically when a sprinkler operates in response to the hot gases rising from a fire.*

**3.7 deluge system**
water spray system, usually with separate detection system, incorporating open nozzles which discharge over a prescribed area

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

**3.9 extinguishing concentration**
concentration of a gaseous extinguishing medium necessary to ensure extinction of flaming combustion of a particular material

[BS EN 15004]

**3.10 fire-fighting medium**

substance contained in a fire-fighting system that, when discharged on to the fire, is intended to produce extinction, suppression or control depending upon the objective of the system

**3.11 fire mains**

**3.11.1 dry fire main**

water supply pipe installed in a building for fire-fighting purposes, fitted with inlet connections at fire and rescue service access level and landing valves at specified points, which is normally dry but is capable of being charged with water, usually by pumping from fire and rescue service appliances

[BS 9990]

**3.11.2 wet fire main**

water supply pipe installed in a building for fire-fighting purposes and permanently charged with water from a pressurized supply, and fitted with landing valves at specified points

[BS 9990]

**3.12 foam branch**

similar device to the foam-making branchpipe except that it does not induce air, the foam being made further upstream at an in-line generator, and reaches the branch as expanded foam

**3.13 foam inlet**

fixed equipment consisting of an inlet connection, fixed piping and a discharge assembly, enabling the fire and rescue service to introduce foam into an enclosed compartment

[BS 5306-1 (modified)]

**3.14 foam-making branchpipe**

hand-held foam generating and discharge device in which the foam solution is aerated, expanded and discharged as a jet or spray

**3.15 foam monitor**

similar device in principle to the foam branch or foam branchpipe, but mounted on a swivelling base, so that its greater output can be discharged without reaction on the operator. The base unit may be fixed at one place, or may be trolley-mounted or vehicle-mounted

**3.16 fluorinated surfactant**

particular type of surfactant that gives greater reduction of surface tension

**3.17 halon**

halogenated hydrocarbon used as an extinguishing medium

**3.18 fire hazard**

particular area or activity in which a risk of fire can occur, and the consequences of that fire

*NOTE A hazard might be, for example, a data centre, telecoms switching centre, paint spraying plant, printing press, industrial fryer or heat-treatment bath. In fire sprinkler standards, "hazard" indicates the rate of growth of a fire in the early stages.*

**3.19 high-racked storage**
storage in which goods are held on high racking so that they are accessible for loading and withdrawal, usually by mechanical means

**3.20 hose reel (water)**
fire-fighting equipment, consisting of a length of tubing fitted with a shut-off nozzle and attached to a reel, with a permanent connection to a pressurized water supply

[BS 5306-1]

**3.21 hypoxic air**
air containing a constant reduced oxygen concentration relative to that at atmospheric pressure at sea level

**3.22 inerting concentration**
concentration of a gaseous extinguishing medium necessary to prevent ignition of a particular material

[BS 4422 (modified)]

*NOTE The inerting concentration is usually higher than the recommended extinguishing concentration.*

**3.23 landing valve**
assembly comprising a valve and outlet to enable connection of fire-fighting hose to a fire main

[BS 9990]

**3.24 liquefied natural gas (LNG)**
gas comprising naturally occurring light hydrocarbons at normal atmospheric temperature and pressure

*NOTE These hydrocarbons are often associated with crude oil deposits. They are stored and handled as deeply refrigerated liquids at substantially atmospheric pressure.*

**3.25 liquefied petroleum gas (LPG)**
gas comprising light hydrocarbons, which at normal atmospheric temperature and pressure exist as gases but which are readily liquefied by the application of moderate pressure

*NOTE These hydrocarbons can be stored and handled as liquids under pressure at ambient temperature or as refrigerated liquids at substantially atmospheric pressure. The term is used to include commercial butane, commercial propane and mixtures thereof.*

**3.26 local application system**
automatic or manual fire-fighting system in which a fixed supply of a fire-fighting medium is permanently connected to fixed piping with nozzles arranged to discharge the fire-fighting medium directly to a fire occurring in a defined area that has no enclosure surrounding it, or is only partially enclosed, and that does not produce an extinguishing concentration throughout the entire volume containing the protected hazard

[BS 5306-4 (modified)]

**3.27 lowest observed adverse effect level (LOAEL)**
lowest concentration at which an adverse toxicological or physiological effect has been observed

[BS 4422]

**3.28 manual hose-reel (gaseous) system**
fire-fighting system consisting of a hose, stowed on a reel or rack, with a manually operated discharge assembly, all connected by a fixed pipe to a supply of carbon dioxide (see also **3.21**)

**3.29 no observed adverse effect level (NOAEL)**
highest concentration at which no adverse toxicological or physiological effect has been observed

[BS 4422]

**3.30 slop over**
condition that occurs when a water spray (or foam) is applied to the surface of a burning liquid that has developed a hot zone beneath the surface at a temperature in excess of 100 °C; on passing through this zone, the water boils and expands suddenly, causing some of the flammable liquid to pour over the rim of the tank

[BS 4422]

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

[BS EN 12845+A2]

**3.32 sprinkler installation**
part of sprinkler system comprising a control valve set, the associated downstream pipes and sprinklers

[BS EN 12845+A2]

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

[BS EN 12845+A2]

**3.34 storage hazard**
general dangers of storage of goods, with regard to their fire grading, flammability, method of packing, storage, etc.

**3.35 surfactant**
surface-active agent, i.e. a chemical that reduces the surface tension of water

**3.36 total flooding system**
automatic or manual fire-extinguishing system in which a fixed supply of extinguishing medium is permanently connected to fixed piping with nozzles arranged to discharge the extinguishing medium into an enclosed space in order to produce a concentration sufficient to extinguish fire throughout the entire volume of the enclosed space

[BS 5306-4 (modified)]

**3.37 watermist system**
distribution system connected to a water supply, with atomizing media where required, that is fitted with one or more nozzles capable of delivering watermist intended to control, suppress or extinguish fire

*NOTE Watermist systems can discharge water or a mixture of water and some other agent or agents, i.e. inert gases or additives.*

**3.38 water spray system**

system, similar in principle to a sprinkler system, that is designed to extinguish, suppress or control flammable liquid fires, or to provide cooling to an exposed area likely to be subjected to intense heat radiation from a neighbouring fire

[BS 4422 (modified)]

*NOTE Spray systems range in size from very small to very large, as described in Section **5**.*

# 4 Range of information

A range of information needs to be considered by the specifier or designer of a fire-fighting system to ensure that the most suitable medium and type of system is selected for a given application. The decision-making process is informed by carrying out an assessment of the nature of the fire hazard and the degree of risk. This is a fundamental element and, in addition to consideration of the likelihood of a fire, it needs to take into account the consequences in terms of, for example, life safety, property protection, business/service interruption, consequential losses and damage to the environment. Defining the characteristics of the fire hazard is discussed in Section **8**.

The information necessary for successfully selecting a fire-fighting system is given in Sections **2** to **12**. More detailed information is given in the subsequent specialized parts of BS 5306 and other British Standards.

Annex A gives examples of risks and occupancies for which particular systems are suitable.

It is noted that fire-fighting systems are usually, though not invariably, made from a series of standardized, approved components. The variation between risks generally requires that each system, while constructed from the standardized components, is nevertheless designed to meet the application in hand. This is a task for the expertise of the designer and manufacturer.

# Section 2. Relation to other fire safety measures

## 5 General

An installed automatic fire-fighting system can be a highly effective element in the fire protection strategy because it is immediately available and designed specifically to meet the defined fire hazard. The extent of the fire strategy is defined by a range of elements, one of which is the installed fire-fighting system. While each element is independent of the others, they are mutually supportive and should be regarded as a whole. The fire protection elements may include the following:

a) first-aid fire-fighting measures, e.g. fire extinguishers, hose reels and fire blankets;

b) the installed fire-fighting system;

c) action by the fire and rescue service (including use of their own equipment and installed equipment such as hydrants, fire mains and foam inlets);

d) structural fire protection measures for the building and its contents, e.g. fire-protective coatings, structural fire resistance and fire compartmentation;

e) the fire detection and alarm system.

*NOTE 1 For a full description of fire strategy, see BS 9999:2008,* ***0.2****.*

*NOTE 2 Gaseous fires require special consideration because, if the flow of gas is not quickly stopped after extinguishing the fire, a serious danger of explosion could arise. The primary consideration in gaseous fires is to isolate the leak and if necessary protect adjacent hazards.*

The degree of importance of each element, and the extent of interdependency, varies with the type of installed system and the characteristics of the hazard. The need for a particular element might be reduced or eliminated by the success of others, but in some cases all the elements might be required.

# Section 3. Fire-fighting media

## 6 General

The fire-fighting media available are:

a) water (see Clause **7**);

b) gaseous media, including inert gases, halocarbon agents and carbon dioxide (see Clause **8**);

*NOTE Reduced oxygen (hypoxic air) systems use an inert gas, nitrogen, to continually maintain a lower level of oxygen.*

c) foams (see Clause **9**);

d) powders (see Clause **10**).

## 7 Water

Water, which is applied for wetting and surface cooling, is the most widely used fire-fighting medium and is likely to remain so because of the following properties.

a) It is inexpensive and usually readily available.

b) It has a high heat capacity absorbing large amounts of heat as a liquid and even greater amounts by its conversion to steam. Therefore, it is an effective medium:

  1) in jet, spray (e.g. sprinklers) or mist form, for suppressing class A fires, even when these fires are deep-seated. It is also capable of extinguishing class A fires;

  *NOTE 1 As fires in these materials represent the majority of fire hazards, the applications of water in jet, spray or mist form are profuse.*

  2) in spray or mist form, for use against class B fires, particularly those of a high flash point (around 65 °C and above), e.g. diesel oil, transformer oil and lubricating oil;

  3) in mist form, for use against fires involving petrol and alcohols;

  4) in jet, spray or mist form, for achieving cooling. It is particularly effective:

    i) as a spray in cooling exposed building elements or process equipment, such as doors and windows, subject to radiant heat from an adjacent fire, or fuel storage tanks which are adjacent to a fire;

    ii) as a mist in cooling the fire and its surroundings as well as blocking radiant heat transfer.

Water can be applied to fires indoors, or just as readily outdoors in circumstances where a fixed system can be used. When water is delivered as a mist, often at low water delivery rates, the increased surface area of the water droplets means it can provide effective protection. The use of watermist should be limited to applications supported by fire testing.

*NOTE 2 Examples of circumstances where water might be applied indoors include the protection of large storage buildings and hangars. Examples of outdoor use include the protection of oil-cooled transformers or cooling of tanks in tank farms.*

For certain types of fuels, the effectiveness of water-based systems can be increased by the use of additives, e.g. foam (see Clause **9**).

When using water, other considerations include:

1) the possibility of electrical conductivity. This is particularly relevant to water when applied as a jet;

   *NOTE 3 Fixed high velocity water spray systems designed and installed by specialized contractors have been used extensively and successfully for the protection of oil-filled electrical plant in electricity-generating and sub-stations.*

2) the effect of low temperatures;
3) consequential water damage;

   *NOTE 4 This can be minimized when water is applied in a fixed automatic water based system.*

# 8 Gaseous media

## 8.1 General

The gaseous media available for fire extinction include inert gases (see **8.2**), halocarbon agents (see **8.3**) and carbon dioxide (see **8.4**). These media have a number of characteristics, as follows.

a) They are clean agents, i.e. they do not adversely affect the materials against which they are discharged. However, there is a need to vent the area after discharge to remove the remaining gas, any decomposition products and products of combustion (see **13.2**).
b) They are particularly useful in extinguishing fires in enclosed equipment within the protected room where other media, e.g. foam, powders and water sprays, might not be able to penetrate effectively. They are best used in those enclosed spaces with controllable ventilation where the extinguishing concentration can be built up quickly and maintained to ensure cooling of the fire zone.
c) They are highly effective in penetrating electrical equipment. If the extinction is rapid, the equipment can be saved from unnecessary damage from the fire and there is very little cleaning up after extinction. Since they are not electrically conductive, they are safe to use in this way, even against high voltage equipment.
d) In closely controlled environments, they (principally nitrogen) can be used to reduce the oxygen concentration to below that necessary for combustion (hypoxic air systems). Reduced oxygen concentrations can suppress flaming combustion, thus creating conditions in which fires cannot readily ignite and develop. At sufficiently low oxygen concentrations, fires can be extinguished.

## 8.2 Inert gases

The inert gas agents are colourless, odourless, electrically non-conductive gases, which are used either as blends of nitrogen, argon and carbon dioxide, or, in the case of nitrogen, argon and carbon dioxide (see **8.4**), as single component agents, these are stored as gases under pressure. The following are some of the inert gas agents commonly used:

- IG-01: 100% Argon;
- IG-100: 100% Nitrogen;
- IG-55: 50% Nitrogen, 50% Argon;
- IG-541: 50% Nitrogen, 42% Argon, 8% Carbon Dioxide.

### 8.3 Halocarbon agents

The halocarbon agents are colourless, essentially odourless, electrically non-conductive gases, stored as liquids under pressure (all of which are super-pressurized, except HFC-23). The following are some of the halocarbon agents commonly used:

- HFC-23: Trifluoromethane;
- HFC-125: Pentafluoroethane;
- HFC-227ea: Heptafluoropropane;
- FK-5-1-12: Dodecafluoro-2-methylpentan-2-one.

Halons (1301 and 1211) are now not used except for a limited number of critical applications defined in EC Regulation No. 1005/2009 [1] (see Annex B).

### 8.4 Carbon dioxide

Carbon dioxide is a colourless, odourless, electrically non-conductive gas, stored as a liquid under pressure. Under some conditions it is possible for electrostatic discharges to be produced during the release of carbon dioxide. The effect can be minimized in systems by bonding and earthing the pipework.

## 9 Foams

### 9.1 General

Foams consist essentially of a bubble structure formed by aerating and agitating a solution of a foam concentrate in water.

Protein foams are made from concentrates based on proteinaceous products alone and with the addition of fluorinated additives to give fluoroprotein foams. Hydrocarbon and fluorinated surfactant materials can also be mixed with stabilizers to form aqueous film-forming foam (AFFF) type concentrates. These are used for the extinction of fires in hydrocarbons and other water-immiscible flammable liquids.

Modifications of fluoroprotein and AFFF foams have been developed that are suitable for use on fires in water-miscible flammable liquids, e.g. alcohols and ketones. These are the alcohol-resistant (AR) foams or general purpose foams.

Other types of foam currently used are:

- film-forming fluoroprotein foam (FFFP), which is a fluoroprotein foam concentrate with the ability to form an aqueous film on the surface of some hydrocarbons;
- fluorine free foam (F3), which does not contain fluorinated surfactants;
- class F foam for use on oil and grease bearing kitchen equipment.

Foams are classified by their expansion ratio (expansion), the ratio of the volume of the made foam to the volume of the solution from which it is made, as follows:

a) low expansion foams, with expansions between 1 and 20 (see **9.2**);

b) medium expansion foams, with expansions between 21 and 200 (see **9.3**);

c) high expansion foams, with expansions between 201 and 1 000 (see **9.4**).

## 9.2 Low expansion foams

Low expansion foams are intended primarily for application to the surface of flammable liquid fires.

However, there is no reason why they cannot be applied to solid fuels, provided adequate coverage can be obtained to exclude air as much as possible. In practice, low expansion foams can be applied either:

a) to the surface of a burning liquid (surface application); or

b) beneath the surface so that the foam stream floats to the surface and spreads to form a protective layer or blanket upon it (sub-surface application).

The first method is the more common, and can be used against spill fires and fires in, for example, bunded areas and fuel tanks, using the appropriate equipment.

## 9.3 Medium expansion foams

Medium expansion foams can be made from low expansion foam concentrates, but it is more usual to make them from a surfactant concentrate based on ammonium lauryl ether sulfate.

These foams are intended for surface application or for application to fires which require a certain depth of foam to obtain coverage, e.g. up to depths of 4 m.

Medium expansion foams are generally applied to the surface of flammable liquid fires, either by hand-held foam-making branches, or from fixed foam makers. This medium can also be used effectively on solid fuel fires, or “mixed” fires of solid and liquid combustibles.

*NOTE Examples of where medium expansion foams might be applied include a fire in a gas turbine driven generating set, a fuel fire in the engine room of a ship, heat-treatment baths, or places where fuel spillages can occur, e.g. in pit areas, in garages or in overhaul shops.*

### 9.4 High expansion foams

As with medium expansion varieties, high expansion foams are made from a surfactant concentrate based on ammonium lauryl ether sulfate.

These foams are intended for filling enclosures, within which a number of fires might be burning, at different levels.

High expansion foams are similar in action to medium expansion foams, but they require generators in which high volumes of air are supplied, often by means of a fan, in order to achieve the rate of flow necessary for their production. They work by blanketing or smothering a fire, but the degree of cooling available is much less than for medium expansion foams, due to their lower water content. They can, however, produce much greater foam depths and can therefore smother a fire in goods stored on high racks. For this, the depth of the foam needs to increase rapidly in order to match, or overtake, the upward rate of development of the fire.

High expansion foam systems can be effective in fighting fires in confined spaces, such as cable tunnels and joint chambers, provided that the problems of back pressure are taken into account during the design stage.

## 10 Powders

### 10.1 General

Powders are finely divided chemicals with a controlled range of particle size, which are used in the extinction of fires in flammable liquids, gases and solids. They are manufactured in the following four main types:

a) BC powders (see **10.2**);

b) BC (foam compatible) powders (see **10.2**);

c) ABC powders (see **10.3**);

d) D powders (see **10.4**).

### 10.2 BC powders and BC (foam compatible) powders

BC powders and BC (foam compatible) powders are suitable for use on flammable liquids and flammable gases only. The latter are also suitable for use in conjunction with fire-fighting foams without adverse effects on the foam.

They are usually the bicarbonates of sodium or potassium, with a siliconized additive to promote flow and non-caking qualities. There is also a proprietary powder based upon an intimate mixture of potassium bicarbonate and other materials that decrepitates in the fire zone and produces a fine powder of high performance.

*NOTE A flammable liquid fire reflashes when application of powder ceases if an ignition source (including hot metal) is present.*

### 10.3 ABC powders

ABC powders are suitable for use generally on flammable liquids, gases and solids (excepting flammable metals).

They are based on ammonium phosphates with a siliconized additive. On impact with the surface of a burning solid, the powder melts and forms a coating that inhibits further combustion. Solid fuel fires against which ABC powder is used re-ignite slowly if application stops before extinction.

## 10.4 D powders

D powders are suitable for use on flammable metals. These powders might be subdivided into those suitable for radioactive metals and those for use on general industrial metals.

They are usually formulated with a specific range of metals in mind, and hence they vary widely in their characteristics.

# Section 4. Effects of fire-fighting media on people, property and the environment

## 11 General

This section reviews the problems and issues that can arise in the use of the various fire-fighting media in systems relating to:

a) people;

b) property;

c) the environment.

It is assumed that personnel leave any area covered by a fixed fire-fighting system involved in fire to limit their exposure to products of combustion.

It is noted that the environmental considerations in **13.3**, **14.3** and **15.3** address the fire-fighting media themselves, but do not analyse the considerable impact of fire on the environment and this should not be ignored.

## 12 Water

### 12.1 Effects on people

Water is non-toxic to humans unless it has been contaminated by toxic substances, e.g. radioactive or toxic chemicals wrongfully disposed of, brackish or other sediments and sewage. The source of water supplies should be tested periodically to ensure that the water used does not present a toxic hazard.

Water is not normally a danger to respiration unless it is discharged directly into the face or contains bacteria and/or is inhaled in aerosol form.

Water supplies, with their dissolved natural salts, conduct electricity to a degree dependent upon the specific conductance of the solution. (Some watermist systems use demineralized water to minimize this effect.)

Care should always be exercised when water is used against electrical equipment, where manual methods of application are used. Experience has shown that for fixed systems this is less of a concern.

### 12.2 Effects on property

Water with its dissolved salts can be corrosive, particularly to iron and steel, although other metals, such as brass, bronze and aluminium, are not affected, especially if dried off after exposure.

Automatic sprinkler heads and automatic watermist nozzles operate individually and only the heads immediately in the vicinity of the fire operate. Consequently the identified disadvantages associated with water discharge are usually confined to areas local to the fire.

# 13 Gaseous media

## 13.1 Effects on people

### 13.1.1 General

The precautions to be taken when using the gaseous media are considered in detail in the subsequent parts of BS 5306, BS EN 15004, and the Halon Alternatives Group (HAG) report [2], as appropriate.

The gaseous media do not conduct electricity and do not present a danger of shock if they are discharged against high voltage equipment, provided that the recommended system component clearance gaps are observed. However, discharge of these media can sometimes be accompanied by a loud noise and also in some circumstances brief obscuration of vision.

Protected spaces can be occupied while the system is in automatic mode, depending upon the achieved concentration of gas being within safe limits. Where this is not the case, such systems might need to be in the manual mode and, in some circumstances, fitted with a lock-off device. In all cases, there should be an audible and visible warning that a discharge is about to take place. There should be a delay to facilitate evacuation prior to discharge, which should be not more than 30 s. In some circumstances, a hold-off device that allows personnel to manually delay the discharge should be fitted. Guidance on the electrical control and actuation of gaseous extinguishing systems can be found in BS 7273-1.

### 13.1.2 Inert gases and halocarbon agents

The inert gas agents extinguish most fires by reducing the ambient oxygen concentration from 21% to between 12% and 14%. The halocarbon agents generally extinguish fires by heat absorption and, in the process, thermally decompose at high temperatures. The amount of agent that can be expected to decompose in extinguishing a fire depends to a large extent on the size of the fire, the particular agent, the concentration of the agent, and the length of time the agent is in contact with the flame or heated surface. If there is a rapid build-up of concentration to the critical value, the fire is extinguished quickly and the decomposition is limited to the minimum possible with that agent.

Systems of both types designed to create concentrations lower than the NOAEL can be used in occupied areas with the system in automatic mode. Those creating concentrations between the NOAEL and the LOAEL require some additional safety features when used in normally occupied areas. Those creating concentrations above the LOAEL are not considered safe for use in normally occupied areas.

*NOTE See Table 1 for the NOAEL and LOAEL of inert gases and commonly used halocarbon agents.*

### 13.1.3 Reduced oxygen (hypoxic air)

These systems create environments with reduced oxygen levels. Prolonged occupation by people should be subject to a risk assessment and requires screening of the workforce to identify those who might suffer adverse health effects at such concentrations. This risk assessment should take into account the nature of work carried out as a person's performance in carrying out certain tasks can be impaired in low oxygen environments.

Table 1 **Limits for inert gas and halocarbon agent concentrations**

| Gas | NOAEL<br>% | LOAEL<br>% |
|---|---|---|
| All inert gases | 43 | 52 |
| HFC-23 | 30 | 40 |
| HFC-125 | 7.5 | 10.0 |
| HFC-227ea | 9.0 | 10.5 |
| FK-5-1-12 | 10.0 | >10.0 |

*NOTE Values taken from the HAG report [2].*

### 13.1.4 Carbon dioxide

Carbon dioxide is normally present in the atmosphere at a concentration of 0.03% (*V*/*V*).

Fire-extinguishing concentrations create a lethal atmosphere and it is thus confined to normally unoccupied areas. In the event that it is used in a normally occupied area it should be fitted with a lock-off device.

*NOTE At concentrations in the range 5% (V/V) to 10% (V/V), breathing becomes increasingly laboured, and a 10% (V/V) concentration might be regarded as the danger level for most people. A concentration of 10% (V/V) is sufficient to cause unconsciousness and if not removed the subject could die.*

## 13.2 Effects on property

The gaseous media do not adversely affect materials provided they are discharged in a manner that does not cause sudden cooling of sensitive electronic and other equipment. As they are "clean" (see BS EN 15004), they do not leave any residual deposits that require cleaning up after extinction.

Halocarbon agents can decompose when coming into contact with high temperatures. Of particular concern would be hazards where hot surfaces might be present such as furnaces, ovens, etc. When and where decomposition products occur, they are corrosive. The main decomposition product is hydrogen fluoride (HF) and prompt venting of the space after discharge can reduce the likelihood of corrosive action on materials. This is also relevant to gases that do not produce decomposition products as the fire itself produces by-products which, given the force of a discharge, are distributed widely throughout the protected space, and might therefore cause corrosion if not removed.

Discharge of gaseous agents causes some pressure changes which vary according to the particular agent, discharge time, environmental conditions, natural leakage, etc. Pressure relief devices might be required to avoid damage caused by such pressurization.

### 13.3 Effects on the environment

The gaseous media (with the exception of the halons – see Annex B) do not have an ozone depletion potential (ODP). Inert gases are naturally occurring and do not have any global warming potential (GWP). Halocarbon agents have varying GWPs and atmospheric lifetimes (ATL) and the use of certain agents is managed by existing legislation, as outlined in Annex B. Carbon dioxide used as a fire-extinguishing agent is not subject to any environmental controls.

*NOTE Table 2 gives values for the ODP, GWP and ATL of the commonly used inert gases and halocarbon agents.*

Table 2 **Environmental rating of commonly used gaseous media**

| Gas | ODP | GWP A) | ATL years |
|---|---|---|---|
| IG-01 | 0 | 0 | n/a |
| IG-100 | 0 | 0 | n/a |
| IG-55 | 0 | 0 | n/a |
| IG-541 | 0 | 0 | n/a |
| HFC-23 | 0 | 14800 | 250 |
| HFC-125 | 0 | 3500 | 32 |
| HFC-227ea | 0 | 3220 | 36.5 |
| FK-5-1-12 | 0 | 1 | 0.014 |
| Carbon dioxide | 0 | 1 | n/a |

A) IPCC 4th Assessment Report [3].

## 14 Foams

### 14.1 Effects on people

The commonly used foaming solutions are not toxic to humans, nor are they likely to be a danger to respiration when applied as a surface layer or foam spray.

There is one situation, however, where high expansion foams can be a danger. This occurs where the foam is being applied to fill an enclosure or volume so as to provide a fire-fighting facility over a substantial depth. In such circumstances, personnel can strike hidden objects when moving towards exits and, where the depth extends above their heads, they can lose vision and hearing and become disorientated.

Where the foam layer extends to a significant level above the head it is difficult to prevent foam causing asphyxia. It is imperative, therefore, that in total flooding systems, warning is given to personnel to evacuate an enclosure before discharge occurs, and that adequate time is given for them to do so.

Foam solutions conduct electricity in the same way as water with dissolved salts does. The specific electrical resistance of the solution should be checked to determine the degree of risk. Aerated foam is less conductive than the foam solution, the specific resistance increasing linearly with the expansion.

### 14.2 Effects on materials

Most foam solutions can cause corrosion, even if only by removing the grease layer from a metal. Some of the low expansion foam concentrates are corrosive to specific materials. It is therefore necessary to establish that the foam concentrate selected does not have an adverse effect on the system in which it is used. This is best achieved by reference to the foam manufacturer, who can carry out check tests where necessary. Valuable equipment wetted by foam in the course of fire-fighting needs to be carefully cleaned afterwards, particularly if its subsequent corrosion is likely to affect its life or operation.

### 14.3 Effects on the environment

The Groundwater Regulations 1998 [4] state that fire-fighting foams cannot be discharged to groundwater. Discharged foam needs to be contained, collected and disposed of safely, either via a foul sewer (subject to agreement with the local water undertaking) or by incineration.

## 15 Powders

### 15.1 Effects on people

Whilst the commonly used powders for class A, B or C fires are not toxic to humans, they are extremely unpleasant to inhale and might cause irritation to the respiratory tract and lungs and temporary breathlessness. When powders are discharged from a total flooding system, it is desirable that the personnel present either leave the enclosure or take precautions against inhalation of the powder. Powder discharge markedly reduces visibility, so that evacuation should take place before discharge of the powder.

Powders specifically designed to be used against class D fires (particularly those for radioactive metals) are intended to be used under controlled conditions where they are not be inhaled. Some of them are toxic, and all should be treated with caution. It is strongly recommended that personnel in affected areas wear appropriate respiratory protection.

### 15.2 Effects on materials

Powders discharged on to equipment cling to decorated surfaces, metals, glass, ceramics, grease films, etc., and in combining with the moisture of the atmosphere (or fire-fighting water) can form an acidic layer which can "bake on" and is corrosive. Many powders have the effect of removing painted layers. ABC powders melt on to hot surfaces and, after cooling, the hardened coating might be difficult to remove. Equipment and spaces contaminated with powder need to be cleaned as soon as possible. However, it should be noted that powder hangs suspended in the air for some time and contaminated areas could require cleaning more than once.

### 15.3 Effects on the environment

All powders are classed as hazardous waste.

# Section 5. Fixed systems and other fire-fighting equipment

## 16 General

This section describes installed fire-fighting systems and equipment dealt with in the subsequent parts of BS 5306 and other British Standards. In addition, it addresses some types of systems and equipment which are not dealt with in a standard at present. In the latter case, accepted good practice is described.

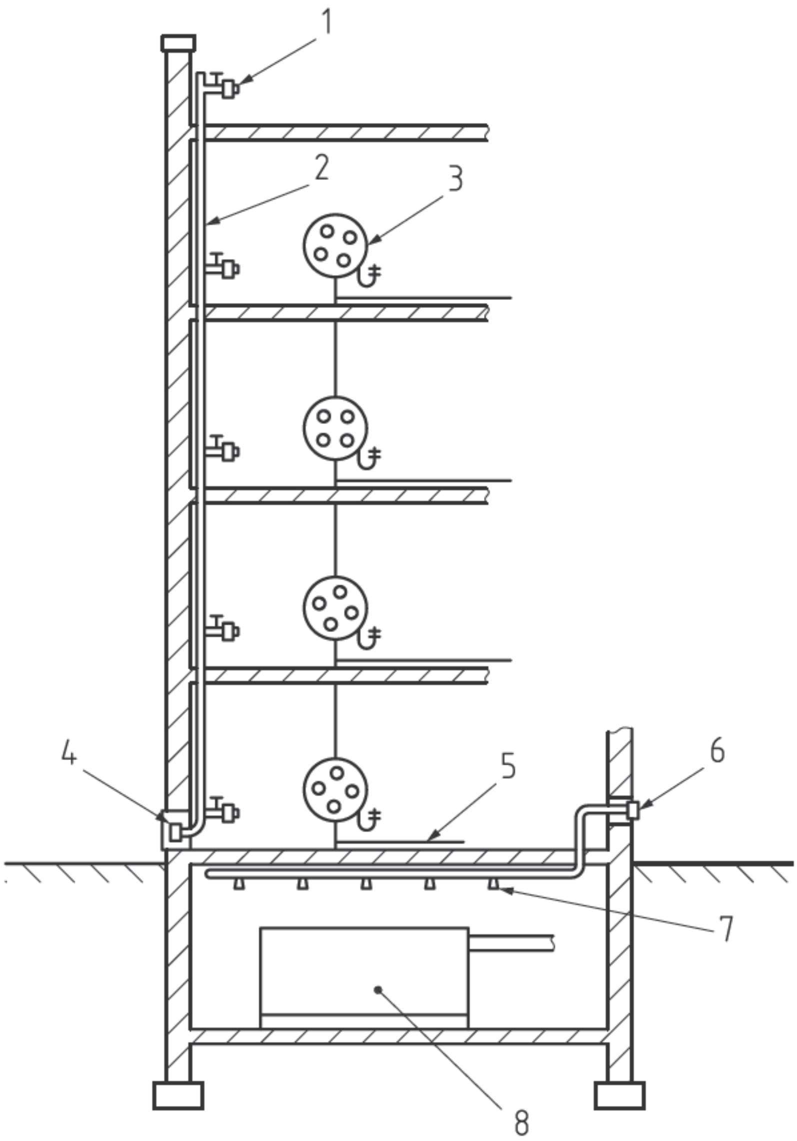
## 17 Hydrant systems, hose reels (water) and foam inlets

Hydrant systems, hose reels (water) and foam inlets are classified as installed equipment and, while not responding automatically to a fire, they are available at strategic points for use by suitably trained occupants or the fire and rescue service. They convey the water or foam to hose points without the need for laborious laying-out of hoses over large heights and distances. Water supplies are available from installed fire mains or, in the case of dry fire mains, can be pumped in from fire and rescue service equipment. Foam supplies are usually served from fire and rescue service equipment or, in the case of tank farms and other oil complexes, from centralized foam-generating and pumping units.

BS 5306-1 and BS 9990 deal with the provision of hydrant systems, hose reels and foam inlets and are essential for use when planning the main services to a building as this concerns the water undertaking, the fire and rescue authority, and the insurers in addition to the architect and advisers. They recommend the numbers and location of fire hydrants, wet and dry fire mains, landing valves, hose reels, fire mains, pumps and all associated equipment. BS 5306-1 also gives recommendations for foam inlets and outlets and makes reference to all related standards appropriate to the subject. It covers testing and test records, maintenance and the rectification of defects.

*NOTE Figure 1 shows a building fitted with the three types of equipment. The water supply to the dry fire main inlet, or foam to the foam inlet is provided via a fire and rescue service vehicle and a mains hydrant outside the building.*

Figure 1 **Typical hydrant system hose reel and foam inlet installed in building**




**Key**

| | | | |
|---|---|---|---|
| 1 | Landing valve | 5 | Connected to building water supply |
| 2 | Dry fire main | 6 | Foam inlet |
| 3 | Hose reel | 7 | Foam nozzle |
| 4 | Dry fire main inlet | 8 | Oil-fired heating appliance |

# 18 Automatic water systems

## 18.1 Sprinkler systems

BS EN 12845+A2 deals with industrial and commercial sprinkler systems, design, installation and maintenance and are the most widely used of all fire protection systems. BS 9251 deals with domestic and residential sprinkler protection design and installation.

Sprinkler systems have been particularly successful in safeguarding the lives of both occupants and the fire and rescue service in fire situations. They are the means by which insurers seek to minimize fire losses in many types of occupancies. Similarly, they have been called for by Building Regulations authorities and by fire and rescue services to meet their requirements. Under certain circumstances the installation of a sprinkler system can result in the relaxation of other Building Regulations [5] requirements.

Sprinkler systems have been used successfully for many years in a wide range of applications. A wealth of knowledge has been obtained on the performance of sprinklers in relation to a wide range of fire hazards. As a consequence, mature, well established design criteria exist and these are incorporated in British Standards.

Traditionally, sprinklers have been installed to protect property. In recent years there has been recognition of the value of sprinklers for their use in life safety applications.

Sprinkler systems consist of an array of heat-sensitive closed nozzles (sprinkler heads), mounted on pipework beneath the ceilings of the protected buildings, designed, installed and maintained in accordance with BS EN 12845+A2 or an equivalent standard.

*NOTE 1 UK insurers often require protection in accordance with Loss Prevention Council (LPC) rules for sprinkler systems [6] incorporating BS EN 12845+A2.*

Each sprinkler is capable of opening individually in response to the heat from a fire and of discharging a spray of water onto the fire below, whilst also initiating an alarm. In response to the development of high bay warehouses, sprinkler systems have been developed to suppress fires in these high hazard environments either by roof or ceiling sprinklers alone or a combination of roof and ceiling sprinklers with in-rack sprinkler protection. Whichever solution is appropriate only small numbers of sprinklers operate in the event of a fire, limiting fire and water damage to the immediate fire site and surroundings, but these are still only used on those areas where this is required for fire suppression.

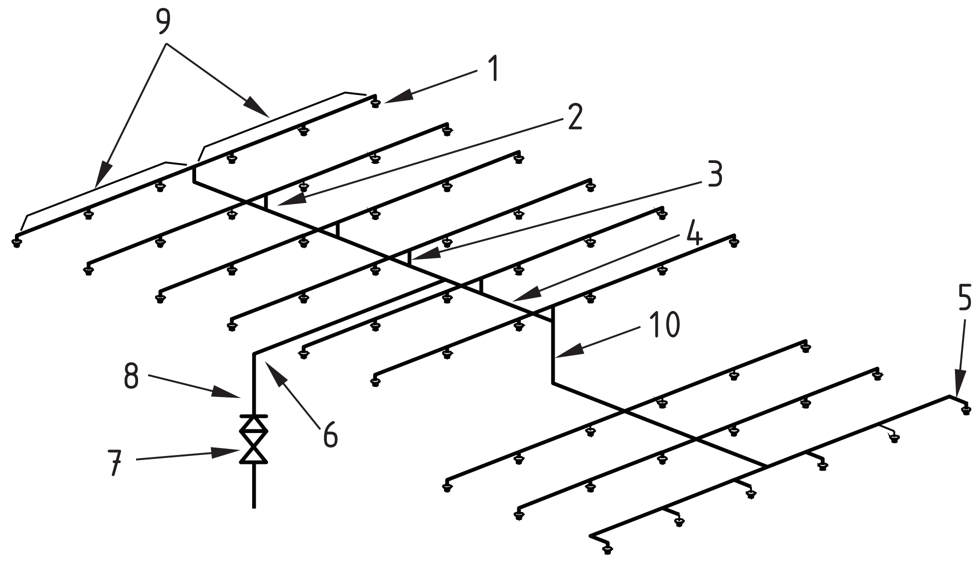
For some warehouse storages systems involving plastic storage tote boxes or plastic pallets foam enhanced sprinkler protection can be the most effective form of fire protection. For these hazards, relatively low concentrations of foam additive are used and although the run-off should be contained and disposed of safely, no depth of foam is created within the area of discharge.

Sprinklers were intended primarily to suppress and contain class A fires. In many instances they not only extinguish this class of fire but can also be adapted to deal with class B fires, either within general sprinkler systems or by the addition of the special water spray systems described in **18.2**.

In a typical sprinkler system, each sprinkler head has a temperature rating and water discharge capacity which is appropriate to the fire load within the protected compartment. The spacing between each sprinkler head is also determined by the compartment's fire load.

*NOTE 2 Figure 2 shows a building fitted with an automatic sprinkler system.*

Figure 2 **Typical automatic sprinkler system**




**Key**

| | | | |
|---|---|---|---|
| 1 | Sprinkler head | 6 | Main distribution pipe |
| 2 | Riser | 7 | Control valve set |
| 3 | Design point | 8 | Riser |
| 4 | Distribution pipe spur | 9 | Range pipes |
| 5 | Arm pipe | 10 | Drop |

In 1968, the Fire Offices' Committee (FOC) introduced the 29th edition of its *Rules for the Installation of Automatic Sprinkler Systems* [7] [4]. When BS 5306-2 was published in 1990, it was largely based on these Rules and was then used as a basis for the preparation of the current standard, BS EN 12845+A2.

In BS EN 12845+A2 sprinkler protection is designed and installed in accordance with a hazard classification system which identifies an appropriate level of protection for the occupancy, the quantity of combustible material constituting the fire load, the configuration of the fire load, the fire load burning characteristics and the necessary water flux rates (referred to as density in mm/min) to control and suppress burning.

In BS EN 12845+A2, risks are divided into three main classes and seven subclasses, as follows:

a) LH – light hazard;

b) OH – ordinary hazard (divided into group 1, group 2, group 3 and group 4);

c) HH – high hazard (divided into process risks and storage risks).

*NOTE 3 The word "hazard" in sprinkler standards is used to define the expected rate of growth of a fire in the early stages, based on long experience. "Hazard" is a critical dimension in fixed fire-fighting system design as it is essential that fires are detected and suppressed in the early stages.*

[4] This publication is now obsolete.

Each class and subclass is linked to a design density, and an area over which the design density is achieved, as given in Table 3.

Table 3 **Classes of sprinkler system for different hazard classifications**

| **Class** | **Design density** mm/min | **Assumed maximum area of coverage** $m^2$ |
|---|---|---|
| LH | 2.25 | 84 |
| OH | | |
| Group 1 | 5.0 | 72 |
| Group 2 | 5.0 | 144 |
| Group 3 | 5.0 | 216 |
| Group 4 | 5.0 | 360 |
| HH | | |
| Process (HHP1,2,3&4) | 7.5 to 12.5 | 260 |
| Storage (ST1,2,3,4,5&6) | 7.5 to 30.0 | 260 to 300 |

*NOTE Typical examples of risks falling within each class and subclass are given in* ***A.1****.*

BS EN 12845+A2 specifies four main types of system as follows.

1) Wet – suitable for locations where freezing temperatures do not occur. The pipes are permanently charged with water.
2) Dry – suitable for locations where freezing temperatures occur. The pipes are normally charged with air.
3) Alternate – arranged to be either 1) or 2) to suit ambient temperature conditions.
4) Pre-action – suitable for locations where water should only be admitted into the distribution piping, once a fire has been detected. The pipes are normally charged with air and fill with water when a fire operates a separate detection system. For water to be discharged it is also necessary for the sprinkler heads to operate in the normal manner.

BS EN 12845+A2 also deals with:

i) water supplies and their required pressure, quality and flow rate;
ii) basic principles of system design;
iii) pumps, tanks and other components;
iv) materials and workmanship;
v) inspection, testing and approval;
vi) maintenance and repair procedures.

## 18.2 Water spray systems and deluge systems

Water spray systems and deluge systems are not covered by BS EN 12845+A2 and, because they are generally tailored in their design to a specific process hazard, water spray systems are generally considered project specific and are covered by DD CEN/TS 14816.

Such systems are specified in various guidance documents and national standards and in technical specifications published by CEN (DD CEN/TS 14816). They can be zoned, so that only selected areas are activated according to the location of the fire. They are usually detector-operated, and are designed to discharge water and/or foam.

Water spray systems are intended primarily for use against flammable liquid (class B) fires. They might form an extension to a sprinkler system, e.g. for small flammable liquid fires in factories or storages, or they might be complete systems in their own right.

Like a sprinkler system, they can consist of either:

a) a number of spray heads, each operated individually on actuation by hot gases from a fire; or

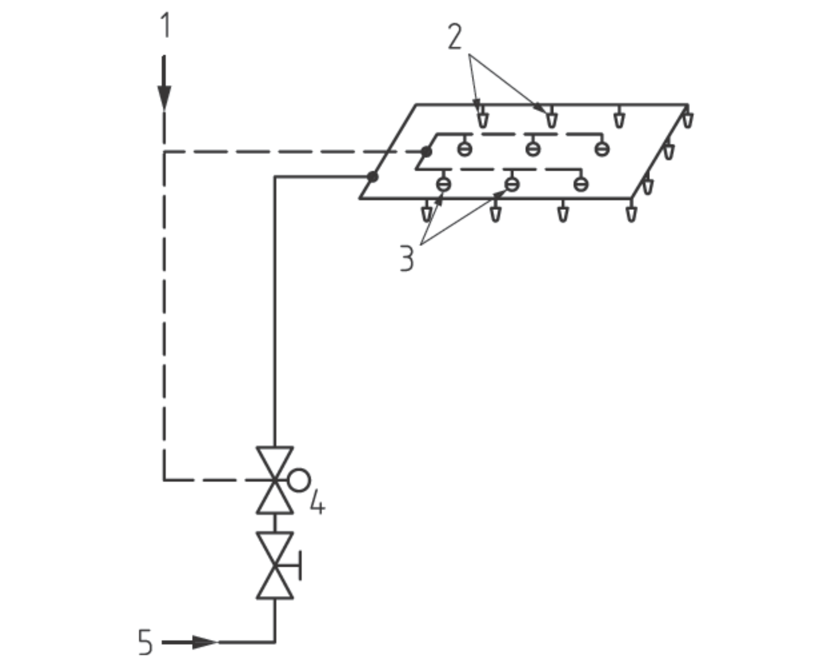
b) a series of open heads fed with water simultaneously on operation of a control valve.

The latter is more common since flammable liquid fires generally reach their full intensity rapidly, and it is more effective to simultaneously release all the heads covering a particular area (see Figure 3).

Actuation of such systems is normally enabled by the use of heat-sensitive devices, often sprinkler heads fitted to a separate set of air-pressurized pipes ("the detection line"), installed in parallel with the water discharge pipes around the object or area to be protected. While conventional heat detection can be used to operate water spray or deluge systems, the detection line approach is popular because of its inherent simplicity, reliability and ruggedness for use outdoors.

*NOTE 1 For applications where there is no risk of freezing, a watercharged detection line could be used.*

Figure 3 **Typical water spray system for limited area of risk**




**Key**

1 Compressed air supply
2 Spray nozzles
3 Detectors
4 Automatic deluge valve
5 Water supply

Typical water spray systems are of five main types as follows:

1) high velocity water spray systems for the extinction of fire in flammable liquids having fire points greater than around 65 °C. These have proved to be very effective and have been used extensively in electricity-generating stations and substations;

   *NOTE 2 An example would be a system of open nozzles protecting an oil-cooled transformer in which the coolant has burst from a broken tube or tubes, and is burning on the outside of the tubes or oil escaping from the lubrication system of a turbo-alternator and discharging onto hot surfaces. Rapid response and speedy fire extinguishment are required.*

2) medium velocity water spray systems for use against fires in water-immiscible liquids of low fire points, or in fires in water-miscible liquids, e.g. alcohols;

3) deluge systems sometimes using an early limited discharge of foam, for large flammable liquid spillages, e.g. in aircraft hangars and tanker refuelling bays. Medium velocity nozzles are used to cover all parts of the fire hazard or a specific zone of the hazard in which the fire is occurring;

4) deluge systems to protect fuel storage tanks against heat radiation from an adjacent fire. These can employ medium velocity spray nozzles, or nozzles specially selected to give a uniform distribution over the protected surface;

5) deluge systems, or water spray systems, used to protect apertures in fire-resisting compartment walls. Such apertures might be small, e.g. a hole for electrical conduits, or very large, e.g. connecting doorways between different areas of a factory or storage, capable of being closed by sliding or folding shutter doors but kept open for transit of goods during working hours.

## 18.3 Watermist systems

DD 8458 covers domestic and residential watermist systems. DD 8489 covers watermist systems for commercial and industrial applications [5)].

*NOTE The National Fire Protection Association code, NFPA 750 [8] also covers the use of watermist systems.*

There are two main types of operating system used in watermist applications for hazards involving materials associated with Class A fires, i.e. automatic nozzle systems and open nozzle systems and these fall into one of the following three categories:

a) low pressure (<12 bar);

b) intermediate pressure (12–50 bar); and

c) high pressure (>50 bar).

Automatic nozzle includes thermal release, frangible glass bulb, elements. Where the water in these systems can be maintained at ambient temperatures above freezing, the pipework is permanently charged with water. Where water temperatures might be below freezing, the pipework is empty of water until the control valve is actuated. In automatic nozzle systems, only the nozzles in the immediate vicinity of the fire are expected to operate to control and suppress a fire.

5) In preparation.

Open nozzle systems are designed so that watermist discharges from all nozzles when the system control valve is actuated. These systems can be deployed to protect complete enclosures and/or to provide "local application" protection for designated equipment within an enclosure.

For both types of watermist system, designs are based upon the results from representative fire tests which establish the type and quantities of nozzles needed to control, suppress and extinguish fire. Factors of safety (which are given in the appropriate DD) are then applied to these results to establish the design basis. All results are unique and specific to each supplier of nozzles.

Automatic nozzle systems have been tested and validated for hotels and similar accommodation hazards, offices, some retail applications. Open nozzle systems have been tested for a variety of hazards involving flammable liquids, such as turbines, engines and fuel/lube oil hazards.

As watermist systems discharge small quantities of water through small orifice nozzles, system hygiene is important and therefore stainless steel, copper and, in some applications, fire resistant plastic pipes are used together with appropriate water supply filters. This is to prevent clogging of nozzles which would hinder discharge.

The water supplies for watermist systems can be provided by either pumps with dedicated water storage tanks, or from containers where the water is propelled by gas under pressure. For hazards involving materials associated with Class A fires, a 30-min water supply duration is required, whereas for some hazards involving flammable liquids the supply duration could be as little as 10 min because rapid fire extinguishment and post-fire cooling is achieved. The available water supply should provide for a minimum of a 10-min discharge.

## 19 Portable fire extinguishers

While portable fire extinguishers are not automatic systems, they nevertheless represent the highly important first phase in the control of an outbreak of fire. If they are of the appropriate type and are selected and located correctly to suit the hazard, there is always the possibility that the operation of the fixed fire-fighting system might be rendered unnecessary by the control of the fire in its very early stages.

Portable fire extinguishers are specified in BS EN 3 (all parts), which includes requirements for type, quality and fire-fighting performance.

BS 5306-3 and BS 5306-8 deal with the selection and maintenance of portable fire extinguishers in buildings and for other hazards. BS 5306-3 covers:

a) inspection, maintenance and testing of the various types of extinguisher on a monthly and annual basis;

b) periodic special test and discharge;

c) examination at the manufacturer's works after a number of testing cycles; and

d) recharging and remedial action.

It also provides guidance on the competence and training of servicing engineers giving guidance on syllabus and examinations.

BS 5306-8 gives general guidance on the types of extinguisher available, and suitability for use in the different classes of fire. It stresses the importance of considering fire extinguishers in the whole concept of fire protection, as they form the important first step in the control of fire. Consultation with the fire and rescue service, the insurers and the Health and Safety Executive (HSE) is strongly recommended, together with the training of skilled operators on a regular basis, the avoidance of a multiplicity of types of extinguisher, and the location of extinguishers in a prominent position, close to the hazards they cover.

BS 5306-8 explains the test fire rating scheme for extinguishers as defined in BS EN 3 (all parts), and shows how the ratings achieved are used to decide the number of extinguishers of various types for a particular hazard. It introduces the concept of a maximum acceptable travel distance between extinguisher and fire hazard. The standard gives specific advice for class A and B fire hazards, and explains how extinguishers with a mixed rating might contribute to meeting the class A and B requirements simultaneously.

## 20 Inert gas and halocarbon agent systems

### 20.1 General

Components for gas systems are covered by the BS EN 12094 series.

The BS EN 15004 series specifies requirements and gives recommendations for the installation of inert gas and halocarbon agent systems. These systems are suitable for total flooding and consist essentially of a source where the gas is stored under pressure in containers, and a piping system by which it is conveyed from the source to the points of discharge (see Figure 4 and Figure 5).

*NOTE 1 BS EN 15004-1 specifies general system requirements while individual agents are covered in Parts 2 to 10.*

BS EN 15004-1 gives guidance on:

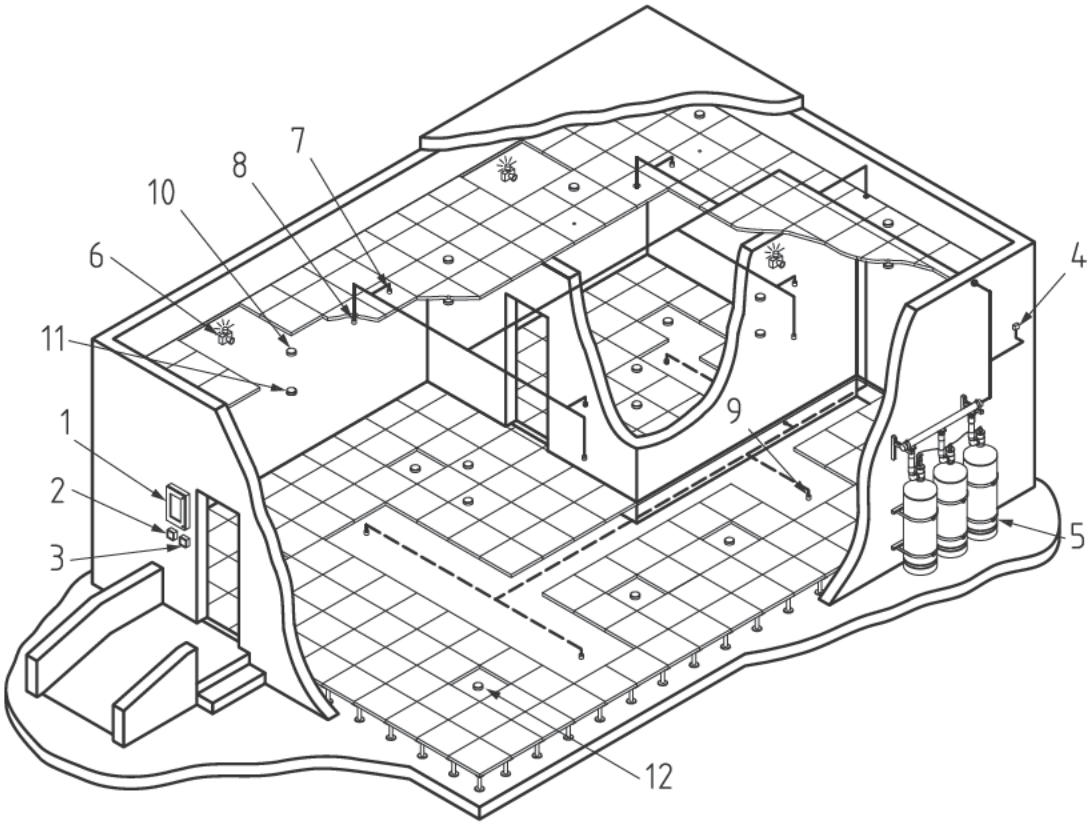
a) the design of systems including valves and manifolds, pipework, earthing, calculation of flow through nozzles, pressure drops, balanced and unbalanced systems, audible and visual alarms, etc.;
b) appropriate inspection and maintenance schedules and safety precautions to be taken during maintenance;
c) methods of actuating the system (see Section **7**);
d) the discharge times;
e) the integrity of the enclosed volume and the need for venting;
f) how the extinguishing concentrations are determined via cup burner and room fire tests;
g) contract arrangements.

*NOTE 2 BS EN 15004-1 confirms the need to seek advice in the planning of a gaseous system.*

BS EN 15004, Parts 2 to 10, give guidance on:

1) the physical characteristics of the agents;
2) the use of the agents, by way of tables detailing the measured extinguishing concentration and the minimum recommended design concentration to extinguish flames, for a range of fuels;
3) the total flooding quantity of agents at a range of temperatures;
4) storage containers characteristics and super-pressurization, where applicable.

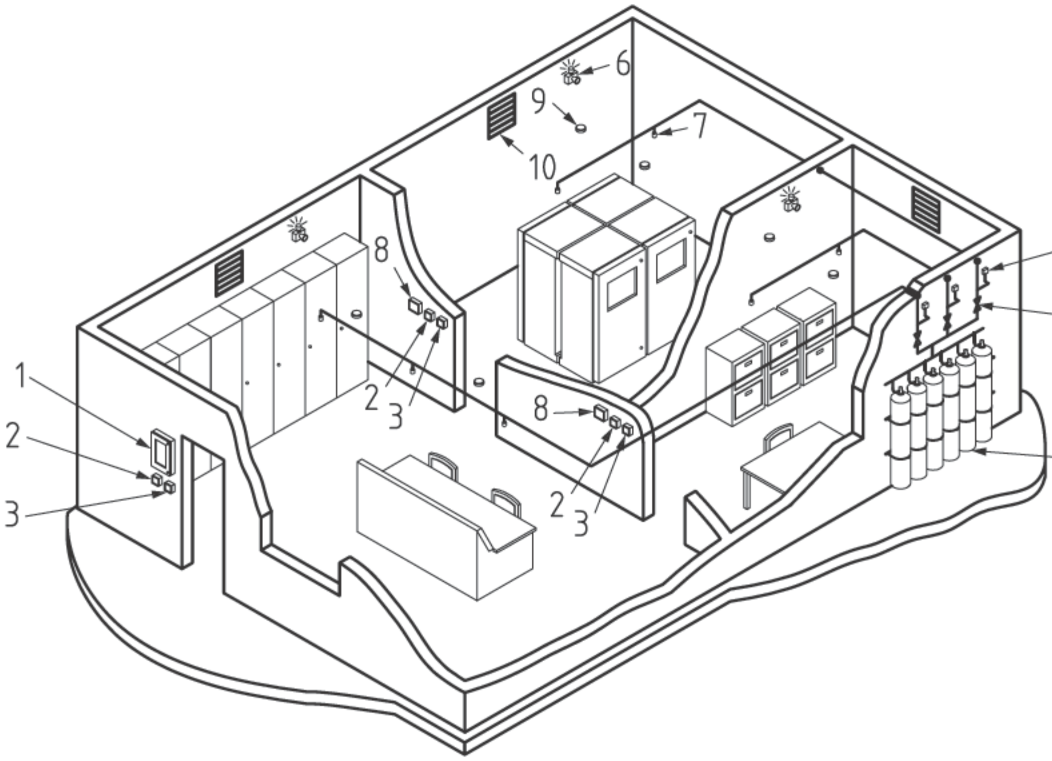
Figure 4 **Gaseous system – example Single zone system**




**Key**

| | | | |
|---|---|---|---|
| 1 | Main control panel | 7 | Discharge nozzle – ceiling void |
| 2 | Manual release | 8 | Discharge nozzle – room |
| 3 | Hold-off button (normally inside) | 9 | Discharge nozzle – floor void |
| 4 | Discharge pressure switch | 10 | Detector – ceiling void |
| 5 | Agent containers | 11 | Detector – room |
| 6 | Audio/visual pre-discharge alarm | 12 | Detector – floor void |

Figure 5 **Gaseous system – example Multi-zone system**




**Key**

1 Main control panel
2 Manual release
3 Hold-off button (normally inside)
4 Discharge pressure switch
5 Agent containers
6 Audio/visual pre-discharge alarm
7 Discharge nozzle
8 System state indicator c/w auto/manual changeover switch
9 Detector
10 Pressure relief vent (as required)
11 Selector valve

## 20.2 Reduced oxygen (hypoxic air) systems

Currently, there are no standards giving provisions for the design, installation, commissioning and maintenance of reduced oxygen (hypoxic air) systems.

These systems are designed to deliver either pure nitrogen, or air with a pre-mixed composition with increased nitrogen, into a controlled space in order to continuously maintain an oxygen concentration of between 13% and 16%. When the oxygen concentration is reduced to around 13%, conditions are similar to the atmosphere created after the discharge of nitrogen gas by a system intended to extinguish surface class A fires.

For fire prevention, oxygen concentrations of 15% to 16% are quoted by manufacturers of these systems. An environment continuously maintained at these levels of oxygen usually suppresses the development of flaming combustion in materials that give rise to class A fires. Lower concentrations could be needed for some materials, particularly if there is a risk of "deep-seated" combustion (considerably lower concentrations are normally required to extinguish such fires) and for fuels that give rise to class B fires.

Although flaming combustion is likely to be suppressed under these circumstances, the presence of a heat source still gives rise to pyrolysis. The potential for smouldering and/or the generation of products of incomplete combustion under vitiated conditions should be considered.

## 21 Carbon dioxide systems

BS 5306-4 specifies requirements and gives recommendations for carbon dioxide systems. These systems consist essentially of a central source where the gas is stored under pressure, and a piping system by which it is conveyed from the source to the points of discharge.

The central source can be either a low pressure (21 bar) tank within which the carbon dioxide is kept refrigerated at a temperature of –18 °C, or a single high pressure (58 bar) container, or bank of containers, stored at ambient temperature.

Tanks and high pressure containers are often kept within special storage rooms or compounds in order to protect them from severe weather conditions, chemical or mechanical damage, or interference by unauthorized persons. The ambient conditions recommended in BS 5306-4 are:

a) for total flooding systems, not more than 46 °C nor less than –18 °C;

b) for local application systems, not more than 46 °C nor less than 0 °C.

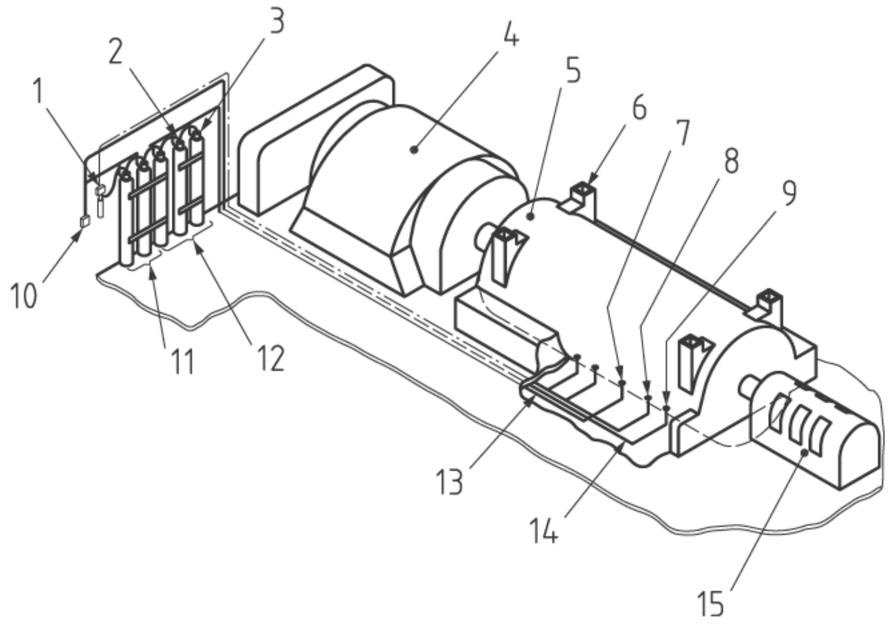
Carbon dioxide systems are classed as total flooding, local application or manual hose-reel systems. The first two can be operated manually or automatically, the last only manually. A total flooding system (see Figure 6) is intended to provide an extinguishing concentration of gas throughout the enclosure into which it discharges. A local application system (see Figure 7) provides an extinguishing concentration at the local points of risk at which it discharges. A manual hose-reel system is intended to provide a local extinguishing concentration at any point where the discharge nozzle is directed.

BS 5306-4 gives guidance on specifying, designing, accepting and testing total flooding systems. It includes procedures for periodic inspection, servicing and maintenance, and notes the use of service contracts for this purpose.

It also gives guidance on the uses and general design of local application systems and manual hose-reel systems. It includes techniques for estimating the total carbon dioxide to be stored, calculated by the surface area method and the volume method.

Finally, it gives guidance on detail design, safety precautions including methods for checking container content, specifications for pipework and fittings, and inspection, testing and commissioning procedures.

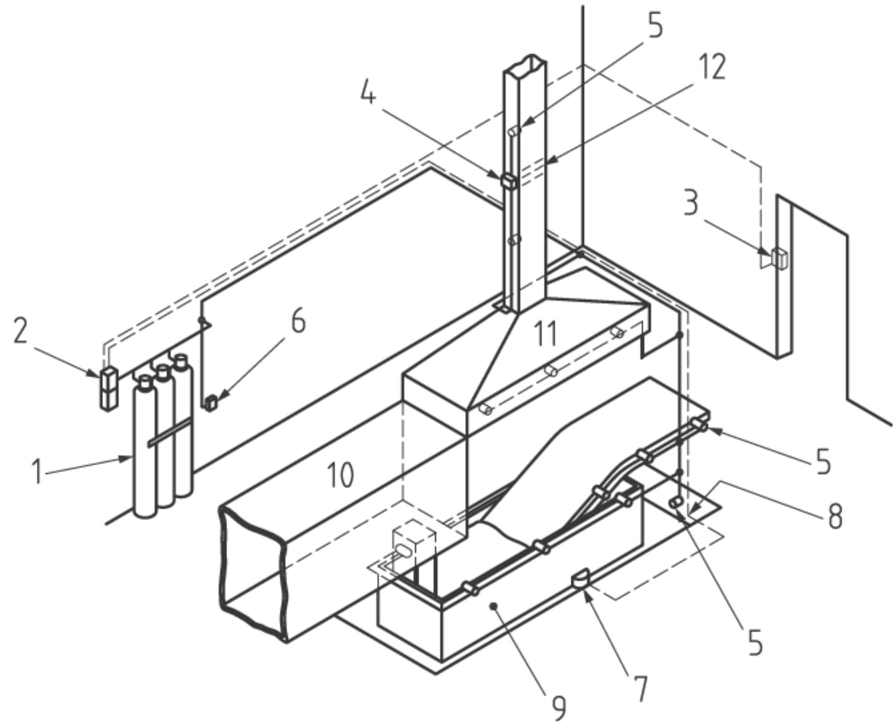
Figure 6 **Carbon dioxide total flooding system protecting a turbo-generator with initial and delayed discharge over the whole volume**




**Key**

1 System actuator (electrical)
2 Pilot loop
3 Container valve and actuator
4 Turbine
5 Generator
6 Vertical cooler (horizontal type similarly protected)
7 Extended discharge nozzle
8 Heat detector
9 Initial discharge nozzle
10 Discharge pressure switch
11 Initial discharge containers
12 Extended discharge containers
13 Extended discharge feed pipe
14 Initial discharge feed pipe
15 Exciter

Figure 7 **Carbon dioxide local application system protecting quench tank**




**Key**

| | | | |
|---|---|---|---|
| 1 | $CO_2$ container | 7 | Heat actuated detector |
| 2 | System controller | 8 | Pit |
| 3 | Manual release | 9 | Quench tank |
| 4 | Pressure trip | 10 | Oven |
| 5 | Local application nozzles | 11 | Hood |
| 6 | Pressure switch | 12 | Damper |

# 22 Halon systems

See Annex B.

# 23 Foam systems

## 23.1 Low expansion foam systems

### 23.1.1 General

There is a wider range of methods used for applying low expansion foams than for any other medium. This is because the properties at risk often vary enormously in size and complexity. The range of methods is described in **23.1.2** to **23.1.7**.

*NOTE A basic system might consist of a simple pressure vessel containing foam solution under gas pressure, and discharging when a fire on, for example, a dip tank causes a heat-sensitive sprinkler to operate. An example of a complex system would be a fully fledged automatic foam-generating system feeding a foam deluge system in an aircraft hangar.*

BS EN 13565-1+A1 specifies components for foam systems.

BS 13565-2 describes methods for assessing the quality of foam produced by a system, the rate of discharge of the foam, and its distribution over the area or volume to be protected. It also covers the periodic inspection, testing and maintenance of foam systems.

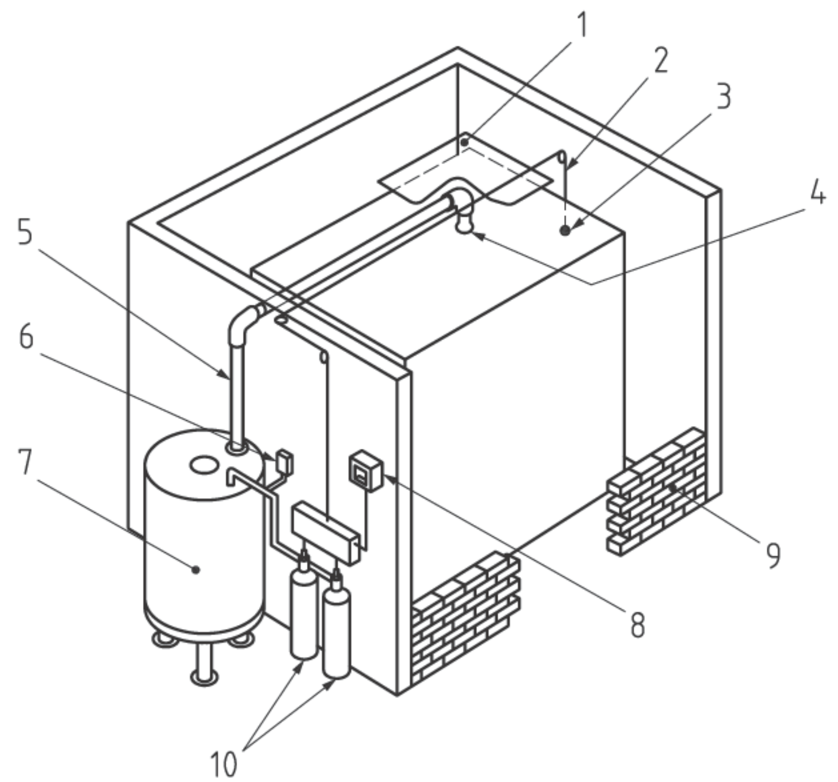
### 23.1.2 Monitors and branch pipe systems

Monitors and branch pipe systems are used to provide primary protection for flammable liquid spills, bunded areas and storage tanks. They can include either portable or mobile equipment fed from the water supply fire main, in order to give the greatest flexibility of use. They are also used for the protection of harbours, jetties and oil-producing and handling plant in refineries.

### 23.1.3 Aspirating fixed foam sprays

Aspirating fixed foam sprays, which produce foam by intimately mixing air and foam solution, are used to protect defined areas where fuel spillage fires might occur, e.g. loading racks, horizontal tanks, pump rooms, large dip tanks and aircraft in hangars, on aprons or on landing pads. A pre-mixed foam system is shown in Figure 8 and a large pumped system is shown in Figure 9.

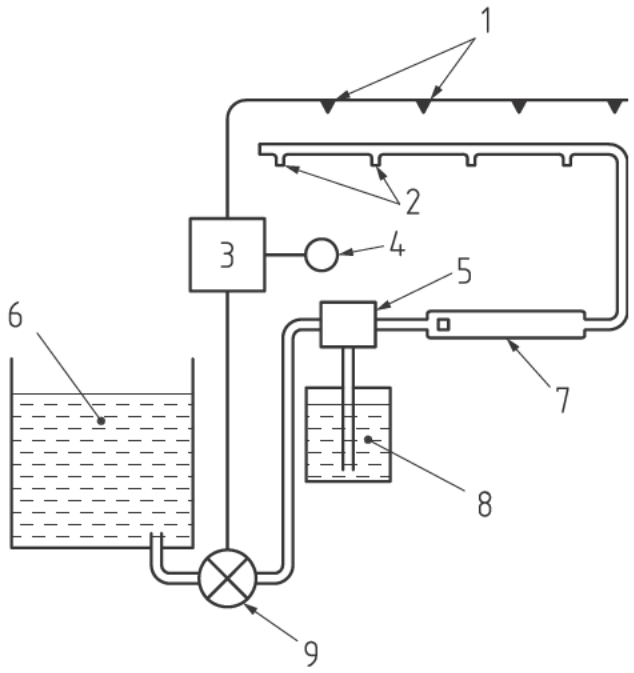
Figure 8 **Typical pre-mixed foam system protecting a specific hazard**




**Key**

1 Heat retaining plate
2 Heat detector
3 Link line anchor
4 Foam sprinkler
5 Discharge pipe
6 Pressure switch to alarm bell
7 Tank for premixed foam solution
8 Manual discharge control
9 Bund wall
10 Twin cylinders of carbon dioxide or nitrogen

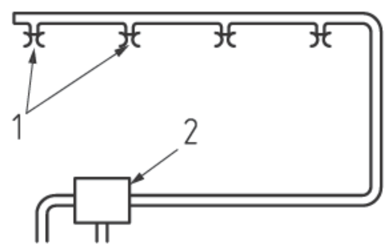
Figure 9 **Typical low expansion foam deluge system using open foam nozzles or aspirating foam sprinklers**




a) Open foam nozzles

**Key**

1 Heat detectors
2 Open foam nozzles
3 Control box
4 Alarm
5 Foam proportioner
6 Water
7 In-line foam generator
8 Foam liquid
9 Pump




b) Aspirating foam sprinklers

**Key**

1 Self-aspirating foam sprinklers
2 Proportioner

### 23.1.4 Non-aspirating fixed foam sprays

Non-aspirating foam sprays, which produce a spray of foam solution with little or no mixing of air, are used where water sprays alone might not be fully effective, but the addition of an AFFF, FFFP or AFFF/AR concentrate, as appropriate, would provide an effective fire-fighting performance. The nozzles used can also produce good spray with water alone.

Foam enhanced sprinkler protection is sometimes employed where flammable liquid fires might be encountered in a sprinklered building. Typical examples are bulk storage of flammable liquids and storages involving plastic tote boxes or pallets.

### 23.1.5 Fixed foam pourer systems

Fixed foam pourer systems are used for the protection of fixed roof fuel storage tanks, with or without floating roofs. They operate by pouring the foam on to the free surface of the fuel, or on to the rim seal area around the floating roof.

### 23.1.6 Sub-surface and semi-sub-surface foam systems

Sub-surface foam systems operate by injecting the foam beneath the surface of the fuel in a fixed-roof tank, and allowing it to float to the surface to form a sealing layer or blanket. Not all foams (typically those without fluorinated surfactants) are sufficiently resistant to breakdown by the fuel and thus suitable for this application.

Semi-sub-surface systems are similar, but the foam is fed to the surface via a protecting sleeve which prevents its contamination by the fuel. The methods are only suitable for water-immiscible liquids.

### 23.1.7 Supplementary and bund protection system

Supplementary and bund protection systems form an adjunct to the systems described in **23.1.2** to **23.1.6**.

## 23.2 Medium expansion foam systems

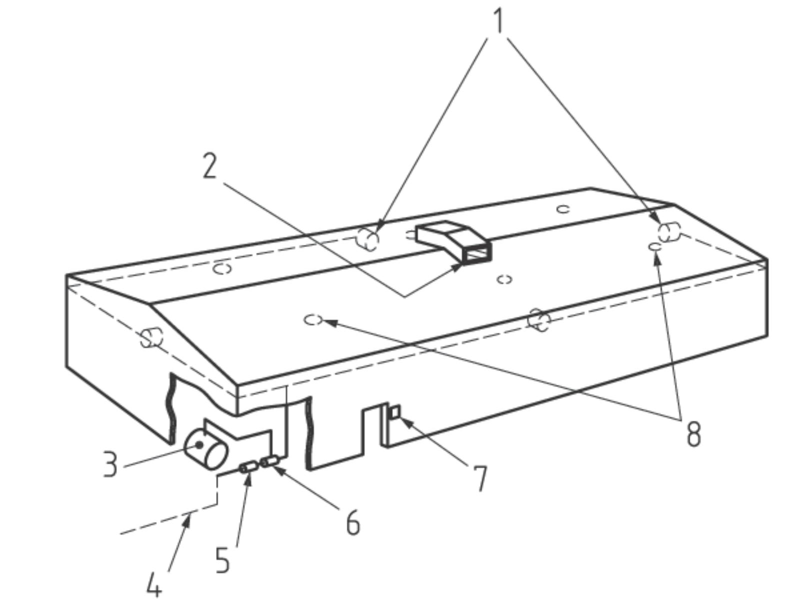
Medium expansion foam systems are intended to provide protection, either indoors or outdoors, against spills of flammable liquids where the foam can be applied gently close to the hazard, to build up rapidly and to give good vapour suppression.

## 23.3 High expansion foam systems

High expansion foam systems (see Figure 10) dispense foam from a number of high expansion foam generators to fill the volume within which fires (either class A or class B) might exist at various levels.

They are suitable for large volumes, cable tunnels, refrigerated rooms, basement areas, etc. While predominantly suitable for indoor use, high expansion foam can be used in outdoor areas where it is sheltered from the effects of the wind.

Figure 10 **Typical high expansion foam system for total flooding of a warehouse or storage**




**Key**

| | | | |
|---|---|---|---|
| 1 | Foam generators | 5 | Automatic valve |
| 2 | Automatic vent | 6 | Proportioner |
| 3 | Foam liquid storage tank | 7 | Control panel |
| 4 | Water line | 8 | Heat actuated devices |

## 24 Powder systems

BS EN 12416, which is published in two parts, deals with powder systems. Part 1 covers the design, construction and testing of components, e.g. powder containers, actuators and nozzles. Part 2 covers the design, construction and maintenance of the entire system. Information about condensed aerosols is provided in PD CEN/TR 15276-1 and PD CEN/TR 15276-2.

# Section 6. Dual use of media and systems

## 25 General

There are many examples where the use of one medium alone might not be successful in extinguishing a fire. In such cases, it is often effective to use two, the first to provide major fire control and the second to complete the extinction. They can be applied simultaneously or sequentially. The development of dual systems, or the dual use of individual systems, is therefore necessary. The circumstances of each case need to be judged on their merits in order to determine the best procedure. The principles are illustrated by the examples in Clause **26**.

## 26 Examples of dual use of media and systems

### 26.1 Sequential dual use

Carbon dioxide systems are often installed to protect rolling mills in conjunction with water-based systems.

### 26.2 Simultaneous dual use

Powder and foam can be used simultaneously on flammable liquids of low flash point, to benefit from the rapid knock down of powder and the sealing action of foam.

# Section 7. Control of fixed fire-fighting systems

## 27 General

This section sets out the general principles and practices involved in the control of fixed fire-fighting systems. It describes the control methods for various types of system, and their suitability for different applications.

In automatic systems, operation is initiated directly by a suitable method of fire detection, which also initiates a warning locally and usually at a centrally manned point(s), and in some cases, via an alarm receiving station to the fire and rescue services. Some systems, other than sprinkler system, are usually equipped with a selector switch to provide for either manual or automatic operation, particularly where the discharge of the agent could be hazardous to personnel in the area affected by the discharge. Some method of inhibiting operation when the system is undergoing maintenance may also be provided. The details of these facilities vary from system to system.

Where separate fire detection, control and actuation systems are used, they can be mechanical, pneumatic or electrical. Recommendations relating to these systems can be found in BS 7273 (all parts). Specific additional provisions are set out in BS 6266 covering electronic equipment installations.

## 28 Water systems

### 28.1 Sprinkler systems

Sprinkler systems have closed heads, i.e. the valve in the head is kept closed by a thermally sensitive bulb or strut which fractures when heated by a fire, allowing the valve to open and water to be discharged. The sprinkler head therefore acts as a fire detector and a water distributor. The discharge of water from the affected sprinklers causes the main alarm valve on the system to open and permits a continuous flow of water through the opened heads.

A variant of the sprinkler system is the pre-action system in which an automatic fire detection system triggers the main valve, allowing water to flow to the closed heads, from whence it is discharged as soon as the heads open. Where sprinklers are used to give a controlled discharge over a selected area, they are fed from a multiple jet control (MJC), which is an in-line valve opened by the operation of a bulb or soldered strut. The sprinkler heads fed from the MJC are of the open type.

All sprinkler systems can be manually shut off for maintenance or alterations by closing the main stop valve.

Sprinkler systems are normally supplied with a local mechanical (water powered) alarm but are easily connected to an existing fire detection system control panel using a pressure or flow switch. Thus, they can be connected to an alarm receiving centre which can transmit alarms directly to the fire and rescue service in accordance with BS 7273-3.

### 28.2 Water spray systems

Water spray systems have some similarities to sprinkler systems but spray nozzles (or projectors) are usually of the open type grouped under the control of an MJC or valve similar to a sprinkler valve (see **28.1**) of the most common type of water spray system, sometimes referred to as deluge system, that usually covers a much larger area and is typically under the control of a separate fire detection system that is sensitive enough to give a rapid response to fire conditions, but not so sensitive as to give false operation under non-fire conditions. Actuation of the detection system, usually based on an airline system fitted with sprinkler heads, actuates the deluge valve allowing water to flow to all the open nozzles that it supplies.

As with sprinkler systems, all water spray systems can be manually shut-off for maintenance or alterations by closing the main stop valve.

Spray systems can be connected to a fire detection control panel via a flow switch.

### 28.3 Watermist systems

Watermist systems fitted with automatic nozzles operate in a manner identical to sprinklers.

Where open nozzle systems are in place, the system's control valve/s are actuated by a dedicated fire detection system tailored to the nature of the fire risk.

All watermist systems can be manually isolated for maintenance and alterations by closing the stop valve at the system control valve.

They can also be arranged to provide signals of "fire" and "system operation" to an alarm receiving centre, which can be connected to the fire and rescue service if required.

## 29 Gaseous systems

Gaseous systems include "total flooding" and "local application" and manual hose-reel systems for carbon dioxide.

Automatically operated gaseous systems can be triggered by a number of types of automatic detection systems. In order to prevent false operation under non-fire conditions, systems are generally arranged to respond to a minimum of two detectors, each on different zones of the detection circuits. This is termed coincidence operation. Following coincidence operation, a preset time delay (generally not exceeding 30 s) is normally initiated prior to the release of the gaseous media to allow for evacuation. A "hold" switch can also be included in the protected area to delay operation of the system until the switch is released. Some carbon dioxide systems are designed to give a primary discharge to extinguish the initial fire, followed by a secondary discharge to maintain the extinguishing concentration within the enclosure. The detection and control systems should be in accordance with BS 7273-1 and BS 7273-2.

All gaseous systems are equipped with a means of preventing discharge when the system is being serviced or maintained.

*NOTE Further information is provided in BS 5306-4 and BS EN 15004.*

Reduced oxygen (hypoxic air) systems employ oxygen sensors to monitor the oxygen level in the protected space. Although not required to actuate the system, separate fire detection systems would normally be provided to warn of the presence of pyrolysis and smouldering combustion.

## 30 Foam systems

Foam systems encompass a wider variety of types of equipment and some have features in common with water systems. Therefore, experience of the latter has played a major part in the development of control of foam systems.

The simplest type of foam discharge system comprises a cylinder or tank of foam solution retained under pressure by means of a closed sprinkler or sprayer. On operation of the heat-sensitive bulb or link, the sprinkler valve opens and the foam solution is discharged on to the area of the fire as foam.

*NOTE 1 Such systems can be used for small oil filled transformers, heat treatment baths, and similar applications to small areas.*

Foam enhanced sprinkler protection operates on similar principles to low expansion foam systems where a complete sprinkler system, sprinkler installation or part of an installation may include foam enhancement.

A common type of low expansion foam system, larger than the simple type described, is similar in its control to a sprinkler system. When one or more of the heat-sensitive closed spray heads is opened by the heat from the fire, the ensuing drop of pressure in the trunk main causes a pressure-sensitive switch to switch in the pump. This then forces the water to flow through a suitable type of proportioning device where the foam concentrate is injected, and thence to the now-open spray heads.

*NOTE 2 Where a pre-mixed foam solution is used, the proportioning device is not required.*

Another type of full-scale automatic foam system includes a fire detection system which relays a signal to a control and annunciation panel. This panel gives audible and visual alarms and also sends a signal to start a water pump that supplies water and opens the foam system control valve. The flow of water induces another flow of foam concentrate in the correct proportion, and the two streams mix to form a foam solution. The foam solution is delivered through hydraulically designed pipework to a series of open nozzles, from which it is discharged.

Other types of foam system, e.g. protection of storage tanks by fixed pourers or monitors or by sub-surface application, are usually operated manually on receipt of an alarm given by a heat-sensitive or other form of fire detection system.

Medium and high expansion foam systems can be operated by point or linear system fire detection devices suitable for the fire and hazard being addressed. The detection and control panel also have a manual/automatic selector switch and a time delay facility to allow personnel to leave the area after the warning is given. The time delay can be up to 30 s.

## 31 Powder systems

Small systems typically containing less than 20 kg of powder are normally used to protect a specific fire hazard, e.g. a heat-treatment bath or a carding machine, where fires could occur frequently. Such a system could be discharged by heat actuated devices. Larger modular systems, typically up to approximately 100 kg, could be operated by similar equipment and would be used to protect larger hazards in places where personnel would not normally go during the time at which a fire is most likely, e.g. engine test bays.

Systems above 100 kg may be operated by full-scale detection systems with manual/automatic selection, coincidence connection and time delay as appropriate, in a similar manner to gaseous systems.

# Section 8. Characteristics of fire hazard

## 32 General

The selection of equipment and fire-fighting media is determined largely by the characteristics of the fire hazard that is to be managed. Guidance on the selection of the fire protection systems can be found in BS 9999 and the specific systems standards.

## 33 Risk assessment

In order to decide the most suitable type of fixed fire-fighting system for a given hazard, a risk assessment of the characteristics of the fire hazard should first be made. This might entail the consideration of a complete commercial or industrial building, in which many complex and interdependent operations take place. Alternatively, the risk assessment might be a straightforward matter, e.g. consideration of a self-contained hazard such as a spray booth or electronic data processing (EDP) equipment in its own protection enclosure.

The risk assessment should always focus on safety so that the possibility of the fire going beyond the expected limits is taken into account.

## 34 Information and advice

It is recommended that a list be prepared of all individuals and organizations whose views, recommendations or published requirements might need to be considered. This list is likely to include some or all of the following, as appropriate:

a) the client and/or his architect;

b) the fire and rescue authority;

c) the fire insurer;

d) the fire protection consultant;

e) the HSE;

f) the local authority;

g) the manufacturer or his approved installer; and

h) any other authority concerned with the particular type of hazard.

# Section 9. Selecting the system to suit the fire hazard

## 35 General

The analysis of Section **8** gives guidance on the problem of managing a particular fire hazard, in relation to the fire-fighting media and types of system available (see Sections **3** to **5**). Annex A gives examples of hazards and occupancies for which particular systems are suitable.

Particular consideration should be given to:

a) the possible effects of an installed system on a neighbouring occupancy, within or adjacent to the building within which the system is discharged (see Clause **36**);

b) the need for modifying or replacing an installed system when the occupancy of a building changes (see Clause **37**).

The maintenance needs of the system, its operational life expectancy and its whole life costs (i.e. the possible costs of replacing gas, powder or foam after actuation) should also be taken into account.

## 36 Effect of system discharge on neighbouring occupancies

### 36.1 General

It is essential that a system discharged within one occupancy does not adversely affect the interests, livelihood or safety of persons within an adjacent occupancy, and this should always be taken into account when selecting the fire-fighting system to meet a particular fire hazard. A summary of possible adverse effects, which need to be avoided, is given in **36.2** to **36.5**.

### 36.2 Water

#### 36.2.1 Sprinkler and spray systems

Sprinkler systems provide proven protection against fire damage, which means that adjacent properties are likely to remain unaffected by the effects of fire, heat and smoke. Where appropriate, drainage or retention (in a suitable catchment pond) of water from sprinklered buildings should be provided.

#### 36.2.2 Watermist systems

Watermist systems also provide significant cooling of the fire and combustion gases and block radiant heat transfer. Adjacent properties are likely to remain unaffected by the effect of the fire, heat or smoke. Some minor water clean up might be required.

### 36.3 Gaseous systems

All the fire-fighting gases (except nitrogen) are denser than air, and on discharge tend to sink to the lowest possible level. In venting from a protected enclosure, therefore, it is essential that the discharge of gas and any products of combustion do not create a hazardous atmosphere in adjacent spaces. The venting arrangements have to be carefully designed to ensure that the discharge vents outside the building.

*NOTE A typical example is the use of a gas for extinguishing a fire in a discrete records store or part of a library on one of the upper floors of a building, a task for which these agents are eminently suitable due to the lack of damage to the contents.*

### 36.4 Foam systems

Most foam systems are designed to discharge within areas in which flammable liquid hazards exist, and the likelihood of their affecting neighbouring occupancies is small, since the methods of discharge are such that foam is not applied outside the affected area. However, the foam might drain away from the area of application and cause effluent disposal problems or pollute local water sources. All foams and fire effluent run-off should therefore be contained.

### 36.5 Powder systems

Powder systems are likely to be a nuisance rather than a danger, since a normal door or window holds back the bulk of the powder discharged into an enclosure. The very finest particles might penetrate, but only in small quantities.

However, there are two possible exceptions, as shown in the following examples.

a) The process of clearing up the discharged powder might affect the production of a neighbouring occupancy involved in the manufacture of fine electronic equipment, or similar, unless stringent efforts are made to contain it.

b) Where a metal finishing plant uses a special powder to extinguish fires in the outlet duct from a finishing and burnishing plant, the residues could be a severe impediment to a paint spray plant in a neighbouring occupancy, unless the metal plant outlet duct is fitted with very efficient filters.

## 37 Effect of changing occupancies or building redundancy

It is imperative when changing occupancy or use that the fire-fighting system already installed is carefully assessed to determine whether it is suitable for its new duties or whether it needs to be modified or changed altogether. Possible effects on neighbouring occupancies should also be considered (see Clause **36**).

If the system is not suitable, an analysis of the hazards and requirements should be made (see Section **8**), to provide the design parameters of the new system. Where a new system is considered on changing occupancies or locations, the question of fire-fighting agent and power supplies has to be carefully studied to ensure that they are adequate for the revised loading. In all these cases, the appropriate authorities should be consulted so that they can provide advice, and ultimately approval, for the change.

In the event that a building or part of a building becomes redundant and is to be vacated, refurbished or demolished, consideration should be given to the safe removal and disposal of the fire-fighting system. This is particularly important where pressure vessels form part of the fire-fighting system. However, given that empty buildings are at considerable risk from deliberately set fires, consideration should be given to leaving fire protection in service; especially where these systems are supplied with water direct from the service mains.

# Section 10. Installation, inspection and testing of systems and equipment

## 38 General

Guidance on the installation, inspection and acceptance testing of each type of system or equipment is given in the relevant British Standard (see Section **5**). There is a common approach to these topics in the different standards, but there are also some differences.

## 39 Installation

The British Standards outlined in Section **5** give guidance on the quality, corrosion protection and siting of the components of the system or equipment, and list other applicable British Standards, industry standards and codes.

BS 9990 (hydrants and fire mains), BS 5306-1 (hose reels and foam inlets) and BS EN 12845+A2 (sprinkler systems) all cover similar issues, including the numbers and locations of the relevant items to ensure that they cover the fire hazard adequately and are in the most favourable position for fire and rescue service use. They also cover design features to ensure compatibility with fire and rescue service equipment, and also with the quality and quantity of water supplies and pumps, and other matters to ensure reliability and efficiency.

*NOTE BS EN 12845+A2 also gives details regarding the choice of most suitable type of system, valves, water supplies, tanks, alarms, corrosion protection, welding precautions, maintenance, etc.*

BS 5306-8 covers the suitability, siting and distribution of portable fire extinguishers on premises, using the test fire rating system of BS EN 3-7 as the means of determining the recommended distribution.

BS 5306-4 and BS EN 15004-1 (gaseous media) cover the design and quality of component parts and their location in relation to the fire hazard to ensure effectiveness yet to avoid mechanical or chemical damage. The quality of pipework and fittings, including supports, is dealt with, as are the issues of electrical earthing, the fitting of drain taps and testing for leakage before lagging.

BS EN 13565-2 covers foam systems and BS EN 12416-1 and BS EN 12416-2 cover powder systems.

DD 8489 and DD 8458 cover watermist systems.

## 40 Acceptance testing

Although the details of acceptance testing systems for approval purposes differ across the various British Standards, the general practice is the same, as follows.

The date and programme of acceptance tests is first notified to all parties involved, and a joint inspection of the system is then made. The agreed test programme is then carried through and might comprise the following items:

a) the date and time of inspection/test;

b) the responsible persons carrying out/witnessing tests;

c) the test programme including fan integrity testing for gaseous systems, and discharge testing for waterspray, foam and gaseous systems (where applicable);

d) the test results and conclusions;

e) any external factors significantly affecting the test;

f) subsequent action agreed as necessary;

g) the work carried out as a result of e) and f) and the result of retests, if any;

h) the final test report.

# Section 11. Servicing and maintenance of systems

## 41 General

Guidance on the servicing and maintenance of each type of system or equipment is given in the relevant British Standard (see Section **5**). As with installation, inspection and testing, there is much common ground in the approach to this subject but there are some detail differences to suit the different types. Each standard notes, however, that a regular programme of servicing and maintenance is essential, and if possible it should be formally entered into by means of an inspection and service schedule between the user and the installer, his agent or an accredited servicing organization. The details of the servicing agreement vary between the types of system.

## 42 Hydrant systems, hose reels and foam inlets

It is recommended that the following maintenance instructions are provided to the owners or occupiers of the building.

a) All fire hydrants should be inspected at least once a year by a competent person to ensure that pressure and flow are satisfactory, that there are no obstructions and that all isolating valves are locked in the open position.

b) All dry fire mains should be checked every six months to ensure that all valves are fully serviceable, and a wet pressure test should be carried out annually to ensure that there is no leakage.

c) Wet fire mains should be similarly checked and, in addition, the water storage tanks and booster pumps should be checked for operational serviceability.

d) Hose reels should be checked regularly to ensure that there are no leaks, the valves operate satisfactorily, the nozzle outlet is not choked and the nozzle can be moved from "jet" to "spray" position and vice versa without difficulty. The hose should be run out fully at least once a year, and subjected to operational water pressure. At the same time, the booster pumps may be checked and the flow rate of each hose reel measured to check that it is not less than the minimum recommended in BS 5306-1.

Defects in equipment should be rectified as soon as possible by a competent person and if delay ensues, the fire and rescue service should be warned, and warning notices should be posted in the building at the appropriate place. The fire and rescue service should be informed as soon as the equipment is serviceable again.

## 43 Sprinkler, water spray and watermist systems

The maintenance of sprinkler systems should be carried out in accordance with BS EN 12845+A2 and, especially in respect of hazard review, any insurers' requirements.

BS EN 12845+A2, BS 9251, DD 8489 and DD 8458 recommend that regular tests be made to ensure that the alarm is working, that the stop valves are secured fully open and that the water supply is in order. Weekly inspections are specified to see that correct water and air pressures (where applicable) are maintained, that the water level in pressure tanks is satisfactory, and that the alarm operates. Each quarter, a full inspection and test of the system should be made to ensure that the water supplies are satisfactory, the sprinkler/water spray/watermist nozzles are in good order and have not been painted since the last inspection, and that there is no leakage or corrosion of the sprinkler/water spray/watermist nozzles or pipes. During this examination, any changes in the fire hazard or its conditions of operation should be noted, e.g. changes in structure, occupancy, heating or lighting. These checks should also verify that goods are not stored less than 500 mm below sprinkler heads and that the nature of the goods stored has not changed.

Maintenance, repair and any changes in a sprinkler, water spray or watermist system should be carried out by a competent person familiar with the testing and maintenance of systems. If a system has to be shut down for maintenance, additional hand fire-fighting equipment should be made available in the affected area and any hazardous activity involving hot work should be discontinued. As an additional precaution, the insurers[6] and fire and rescue service should be informed, especially if there is a direct alarm link between the premises and a central alarm receiving station for onward transmission to the fire and rescue service. If a fire occurs, and the fire and rescue service is called, the action of closing down the installation after the fire should be taken only by the fire and rescue service.

## 44 Gaseous systems

Gaseous systems should be subject to a planned inspection at least every six months, whilst it is also recommended that a weekly programme of visual inspection is carried out by the system user to ensure that the system is free of faults and that all pressure gauges, where applicable, indicate the correct pressure. The servicing and maintenance provisions for all systems state that the permissible loss should be not more than 5% of the extinguishant mass and, in the case of super-pressurized systems, more than 10% loss in pressure, adjusted for temperature. This should also include an inspection of the pipework and nozzles to ensure that they are not obstructed, and remain in the designed position, and to ensure that all operating controls are properly set and that components have not been damaged.

It is essential that the system be kept in good working order at all times with this responsibility being in no way diminished by any periodic or regular servicing carried out.

Room integrity, and thus gas retention/hold time should be revalidated annually.

## 45 Foam systems

The periodic inspection, testing and maintenance of foam systems are detailed in BS EN 13565-2. While recognizing the variation in types of system, the user has overall responsibility for correct servicing and maintenance of the system, so that it remains in good working order at all times. There are likely to be two parts to the inspection

[6] Most insurance policies require such notification as a warranty and failure to inform insurers that a fire protection system is impaired could result in the policy being voided.

schedule, one to be carried out by the user, and the other by the servicing organization with whom it is recommended the user enters into a contract. The servicing organization could be the installer, the installer's agent or an approved servicing organization.

It is envisaged that the user's programme is a weekly visual programme to ensure that there are no leaks, no damage to pipework or components, that all the controls are properly set and that the water (and foam concentrate) supplies are operative and at the right pressure.

The following maintenance guidance should be provided to the user. Such guidance should provide recommendations for:

a) a monthly check to ensure that all operators are familiar with the equipment or system, and that new operators have been trained fully in its use;
b) a check every three months to ensure that all associated detection and other electrical systems have been inspected and serviced and that a report has been received from the responsible servicing organization;
c) a check every six months to ensure that a full inspection has been made of the foam fire-fighting system and that a report has been received;
d) an annual check to ensure that the foam concentrate, foam solution, and foam proportioning has been tested, and a report received.

The servicing organizations' programme is that each three months, all electrical detection and alarm systems are thoroughly tested and serviced.

Every six months, similar action should be taken in relation to foam-producing equipment, pipework, strainers, valves, and a visual inspection of all foam concentrate and solution tanks for evidence of deterioration. Annually, samples of foam concentrate and foam solution should be tested and analysed for changes in constitution and physical properties. Sedimentation should be carefully measured. All these tests should be the subject of a report to the owner or his representative.

## 46 Powder systems

BS EN 12416 follows in principle those for gaseous systems, plus physical and chemical tests of the stored powder at periodic intervals.

# Section 12. Responsibility for fire-fighting equipment and systems on premises

## 47 Contract arrangements

### 47.1 General

The responsibility for producing an effective and efficient fixed-fighting system is divided between the manufacturer/installer and the user or owner of the premises.

### 47.2 Specification and design stages

It is usual for the user or owner (or their representative) to state their requirements, giving as full a description of the occupancy and the fire hazard as possible, in order that the manufacturer/installer can prepare their proposals. At this stage, it is the concern of both parties to supply information that is as complete as possible in order that a suitable specification and design might be prepared by the manufacturer/installer.

### 47.3 Completed installation

When the equipment and system are installed, acceptance tested and approved, the user, who is usually the user or owner of the building, is expected to accept responsibility for the systems and, at this stage, the user usually becomes responsible for maintaining the equipment and system in full working order.

*NOTE The maintenance of any fire protection systems or equipment provided for the safety of life is legally mandated in all parts of the UK and failure to ensure that such systems are subject to a suitable system of maintenance and are maintained in an efficient state, in efficient working order and in good repair could result in the prosecution of the person/s responsible for the premises.*

# Annex A (informative) Typical applications of fire-fighting systems

## A.1 Sprinkler systems

### A.1.1 General

Applications are classified in terms of the hazard rating of the occupancy as detailed in **A.1.2** to **A.1.4**. As hazard classification is a critical characteristic in selecting and designing fire-fighting equipment, attention is also drawn to the classifications given in BS EN 12845+A2.

It is noted that, in areas where there is a high-racked storage of stock, extra high-hazard protection is recommended.

### A.1.2 Light-hazard occupancies

Light-hazard occupancies include:

- hospitals (certain areas);
- hotels (certain areas);
- prisons (certain areas);
- libraries not large book storage areas/stacks or archives;
- museums;
- nursing homes;
- office buildings (certain areas);
- schools and colleges (certain areas).

### A.1.3 Ordinary hazard occupancies

#### A.1.3.1 Group 1

Group 1 occupancies include:

- abrasive wheel and powder manufacturers;
- butcheries;
- slaughterhouses;
- breweries (special conditions affect certain areas);
- cement works;
- creameries and wholesale dairies;
- jewellers;
- factories;
- restaurants and cafes.

#### A.1.3.2 Group 2

Group 2 occupancies[7)] include:

- bakeries and biscuit manufacturers;
- chemical works (ordinary);
- confectionery manufacturers;
- engineering works, including light metal works;
- laundries;
- motor garages, including public and private car parks;
- motor vehicle manufacturing and assembly plants;
- potteries;
- retail shops (medium size, employing generally not more than 50 assistants);
- sauce, pickle and preserved food manufacturers;
- smallware manufacturers;
- tobacco manufacturers.

#### A.1.3.3 Group 3

Group 3 occupancies include:

- aircraft factories (excluding hangars);
- bleach, dye and print works;
- boot and shoe manufacturers;
- broadcasting studios and transmitters;
- brush factories;
- carpet manufacturers;
- clothing factories;
- corn, flour and provender mills;
- cotton mills (excluding preparatory processes);
- department stores and retail shops (employing generally more than 50 assistants);
- flax, jute and hemp mills (excluding preparatory processes);
- glass factories;
- hosiery and lace factories;
- paper mills and paper goods manufacturers;
- plastics manufacturers and plastics goods manufacturers (excluding foam plastics);
- printers and allied trades;
- radio and television, etc. manufacturers;
- rubber and rubber goods manufacturers (excluding foam rubber);
- saw mills and woodworkers (including furniture manufacturers);
- shirt factories;

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7) Excluding woodworking, painting and any other high fire load areas which are to be treated as ordinary hazard group 3.

- soap and candle manufacturers;
- sugar refineries;
- tanneries;
- wallpaper manufacturers;
- woollen and worsted mills;
- warehouses generally (except for high storages, where extra high-hazard protection is required).

#### A.1.3.4 Group 4

Group 4 occupancies include:

- cotton mills (processes preparatory to spinning);
- distilleries (still houses);
- film and television studios;
- flax, jute and hemp mills (processes preparatory to spinning);
- flax and hemp scutch mills;
- match factories;
- oil mills[8)].

### A.1.4 High-hazard occupancies

#### A.1.4.1 High-hazard process risks

High-hazard process risks include:

- aircraft hangars;
- celluloid manufacturers;
- fire lighter manufacturers[9)];
- firework manufacturers;
- foam plastics and foam rubber manufacturers;
- foam plastics and foam rubber goods manufacturers (excluding areas requiring a higher design density);
- floor cloth and linoleum manufacturers;
- paint, colour and varnish manufacturers[8)];
- resin, lamp black and turpentine works[8)];
- rubber substitute manufacturers[8)];
- tar distillers[8)];
- wood wool manufacturers.

#### A.1.4.2 High-hazard high-piled storage risks

Details of this application are given in BS EN 12845+A2.

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8) In areas where flammable solvents are involved, supplementary protection by means of medium velocity sprayers ought to be used for tank cooling.

9) Supplementary protection of high or medium velocity sprayers (as appropriate) ought to be used for these risks in areas where solvents or other flammable liquids are stored or handled.

## A.2 Water spray systems

### A.2.1 High velocity sprays (projectors)

High velocity sprays are used for the following:

a) extinction of fires in flammable liquids with fire points above about 65 °C, by direct impingement on liquid surface, e.g. transformer oil, diesel oil, quench oil and lubricating oil;

b) cooling and extinguishing fires in oil-filled transformers, heat-treatment baths, etc. Ullage has to be sufficient to avoid overspill, and surface temperature has to be less than 100 °C;

c) cooling surfaces of exposures where spray needs direction and reach, as opposed to general cooling of area, e.g. top surface of fixed roof tanks. Special nozzles can be designed to meet specific requirements;

d) where the penetration of the spray can be valuable in reaching hidden fire areas, e.g. in stacks of timber.

### A.2.2 Medium velocity sprays (sprayers)

Medium velocity sprays are used for the following:

a) suppression and control of fires in flammable liquids with fire points below about 65 °C, e.g. petrol, and for water-miscible fuels, such as alcohols, which can be extinguished by dilution;

b) cooling of plant producing or handling flammable liquids, e.g. process plant in oil refineries, tanker loading bays and storage tanks;

c) protecting exposures such as storage tanks for flammable liquids and gases, e.g. LPG and LNG;

d) protecting steelwork in industrial and chemical plant;

e) protecting hazard areas such as oil-fired boiler rooms, drum stores, tankages and pumps and valve assemblies handling flammable liquids;

f) protecting any other hazards where a general spray protection delivered in a specified area or volume of hazard where flammable liquids are involved;

g) hangars and similar hazards where flammable liquid could be spilled. If the fire area is likely to be 40 $m^2$ and above, a spray system is recommended. For even larger areas, the area can be divided into zones, each protected by a separate deluge system under the control of an automatic detection system operated by a deluge valve.

## A.3 Watermist systems

### A.3.1 Automatic nozzle systems

Automatic nozzles are used for the following:

- accommodation;
- hospitals;
- public areas, e.g. restaurants;

- computer rooms;
- schools;
- car parks;
- retail areas;
- offices.

### A.3.2 Open nozzle systems

Open nozzles are used for the following:

- turbines;
- diesel engines/generators;
- pump rooms;
- incinerators;
- machinery spaces;
- hydraulic oil systems;
- cable tunnels.

## A.4 Gaseous systems

Typical applications for gaseous systems are given in Table A.1.

Table A.1 **Typical applications for gaseous systems**

| Hazard | Inert gases total flood protection | Halocarbon agents total flood surface protection | Carbon dioxide local application | Carbon dioxide total flood protection | |
|---|---|---|---|---|---|
| | | | | Surface protection | Deep-seated protection |
| Archive | ✓ | ✓ | | | ✓ |
| Drawing store | ✓ | ✓ | | | ✓ |
| Carbonizing furnace | | | ✓ | | |
| Chemical store | ✓ | ✓ | | ✓ | |
| Coal pulverizer | | | | | ✓ |
| Coating machine | | | ✓ | | |
| Coffee roaster | | | | | ✓ |
| Compressor room | ✓ | ✓ | | ✓ | |
| Computer rooms | ✓ | ✓ | | | |
| Control rooms | ✓ | ✓ | | | |
| Curing oven | | | | ✓ | |
| Deed store | ✓ | ✓ | | | ✓ |
| Dip tank | | | ✓ | | |
| Drum store | ✓ | ✓ | | ✓ | |
| Drying oven | | | | ✓ | |

Table A.1 **Typical applications for gaseous systems** *(continued)*

| Hazard | Inert gases total flood protection | Halocarbon agents total flood surface protection | Carbon dioxide local application | Carbon dioxide total flood protection | |
|---|---|---|---|---|---|
| | | | | Surface protection | Deep-seated protection |
| Dust collector | | | | | ✓ |
| EDP rooms | ✓ | ✓ | | | |
| Engine enclosure | ✓ | ✓ | | ✓ | |
| Extruder | | | ✓ | | |
| Flammable liquid store | ✓ | ✓ | | ✓ | |
| Flight simulator | ✓ | ✓ | | | |
| Flow coater | | | ✓ | | |
| Fluff bin | | | | | ✓ |
| Fume exhaust duct | | | | ✓ | |
| Gas turbine enclosure | ✓ | ✓ | | ✓ | |
| Generator | ✓ | | | | ✓ |
| Grinding machine | | | ✓ | | |
| Honing machine | | | ✓ | | |
| Hydraulic press | | | ✓ | | |
| Laboratory hood | | | ✓ | | |
| Library | ✓ | ✓ | | | ✓ |
| Negatives file | ✓ | ✓ | | | ✓ |
| Oil store | ✓ | ✓ | | ✓ | |
| Oil quench | | | ✓ | | |
| Paint dip | | | ✓ | | |
| Printing press | | | ✓ | | |
| Relay rooms | ✓ | ✓ | | | ✓ |
| Rolling mill | | | ✓ | | |
| Service voids | ✓ | ✓ | | | ✓ |
| Solvent cleaning | | | ✓ | | |
| Solvent store | ✓ | ✓ | | ✓ | |
| Spray booth | | | ✓ | | |
| Switch rooms | ✓ | ✓ | | ✓ | |
| Telecoms rooms | ✓ | ✓ | | | |
| Transformer rooms | ✓ | ✓ | | ✓ | |

*NOTE ✓ indicates recommended system.*

## A.5 Foam systems

### A.5.1 Low expansion foam systems

Low expansion foam systems can be used as follows.

a) Monitors and foam-making branchpipe systems are used to give primary protection against flammable liquid spills in bund areas, jetties and other fuel handling areas, and for fixed roof storage tanks up to 20 m diameter. Portable foam-making branchpipes are suitable for extinguishing rim fires on floating roof tanks.

b) Aspirating fixed foam spray systems are used to cover a specific area of risk in which flammable liquids might be spilled, e.g. loading racks, horizontal tanks, pump rooms, dip tanks and aircraft in hangars or on aprons or landing pads. In aircraft hangars they are sometimes used in conjunction with fixed or oscillating foam monitors that give under-wing protection.

c) Non-aspirating fixed foam systems are used on indoor or outdoor hazards of specific area, in which water sprays alone would be marginally effective, but where the addition of an AFFF or AFFF/AR foam concentrate would provide an effective performance.

d) Foam pourer systems are intended to apply foam to flammable liquids contained in fixed roof tanks, or covered floating roof tanks or bunded areas in tank farms, refineries and chemical plant. There are also systems available to apply foam to the rim seal area of floating roof tanks of the open type.

e) Sub-surface (base injection) systems are used for the protection of tanks containing water-immiscible fuels, especially those having a relatively low fire point (below about 65 °C). The method can be used against higher flash point fuels, but if these are hot-zone forming, special precautions might need to be taken to avoid slop-over or boil-over. It is not suitable for water-miscible fuels.

f) Semi-sub-surface application systems fulfil a similar role to sub-surface systems, and have the advantage of reducing fuel contamination of the foam.

### A.5.2 Medium expansion foam systems

Medium expansion foam systems are intended to give protection against spills of flammable, toxic or cryogenic liquids where rapid vapour suppression is essential. They are also effective against class A fire hazards, and are suitable for the total flooding of small enclosures, e.g. engine test cells and turbo-generator cells, where the depth of foam required is up to about 3 m. Medium expansion foam is effective both indoors and outdoors.

### A.5.3 High expansion foam systems

High expansion foam systems are used to apply foam in locations where rapid suppression of fire at different levels might be required, e.g. warehouses, furniture depositories and other similar large volumes. They can be used effectively in locations where personnel cannot readily be sent, e.g. refrigerated rooms, mine shafts and cable tunnels. As noted in **23.3**, high expansion foam is most effective indoors, but can be used outdoors if the location is sheltered from wind.

 

High expansion foam (500:1) is also used for fire control and vapour suppression of LNG releases, indoors and outdoors. The small quantities of water within the foam blanket limit heating of the cryogenic LNG whilst enabling the foam to suppress the release of flammable vapours and to separate the fuel from the air it needs to burn.

## A.6 Powder systems

### A.6.1 General

Powder systems can be used in the applications detailed in **A.6.2** and **A.6.3**.

*NOTE Care should be taken to ensure that the unwanted side effects of powder on occupants, especially in confined spaces, are properly considered.*

### A.6.2 Modular systems

Modular systems can be used as follows.

a) In any area, indoors or outdoors, BC and ABC powder systems can be used where a flammable liquid fire could occur from a known hazard, and the powder residues are not objectionable, e.g. deep-fat frying ranges and engine test bays where spillage of liquid fuel over a limited area might occur.

b) Similarly for solid fuel fires, ABC powder systems can be used to suppress fires in cotton and wool picking machinery, danger areas in belt conveyor systems, and other process machinery where a fire of limited area can occur at a specific point of hazard. However, sprinklers are likely to be more effective on such class A materials.

c) D powder systems can also be used to extinguish fires in the processing of flammable metals, either radioactive or non-radioactive, provided that adequate protection of personnel is given, e.g. glove boxes, machining processes for magnesium alloys and metal finishing processes.

d) Powders can be used in the presence of live electrical equipment without danger of shock, but the residual effects on the equipment (cleaning up, corrosion, etc.) should be considered carefully before deciding to do so. One of the gaseous agents, specifically carbon dioxide, could be more advantageous.

e) Powders are probably the most effective agents for extinguishing leakages of flammable gases from pipes and running fuel fires. The situation should be most carefully considered to ensure that the extinction of the fire would not leave a potential risk of explosion before the leakage could be sealed [see Section **2**, Clause **5**, Note 2)].

### A.6.3 Large systems

Large systems can be used in any volume where a general fire hazard could develop, and where:

a) the particular properties of powders make them acceptable over other agents, i.e. speed/capability of extinguishing gaseous and fuel leakages and non-conductivity; and

b) their disadvantages are not a deterrent, e.g. powder residues, problems relating to cleaning and possible ultimate corrosion, and the lack of an inerting value after the powder has settled.

Typical applications are:

- offshore oil drilling platforms;
- pump stations;
- oil cellars;
- paint store rooms;
- engine rooms with multiple pipework runs, etc.;
- lumber storages where ventilation spaces are left (ABC powder).

Powders do not penetrate tightly-packed combustibles, e.g. in record libraries or fur storage vaults, which are best protected by a gaseous medium.

Powders should not be used where they might affect low voltage relays or electronic circuits. Large electric motors and generators, transformers, large switches and circuit breakers can be protected. Powders might be considered for other large fire hazards by comparison with other fire protection systems.

# Annex B (informative) Halon

## B.1 Halon manufacture

Under the 1987 Montreal Protocol on substances that deplete the ozone layer, the production of halons identified as ozone-depleting compounds was banned. This ban was implemented and enforced in the European Community through EC Regulation No. 3093/94 [9], which is enacted in the The Environmental Protection (Controls on Ozone-Depleting Substances) Regulations 2002 [10], which prohibit the production of halons, and controls their supply and use. The use of halon 1211 and 1301 is restricted to the "critical uses" listed in the Regulation [9].

## B.2 Withdrawal of halon systems and extinguishers

Amendments to the Montreal Protocol during the 1990s, along with the increased availability of technologies for replacing ozone-depleting substances, led to the introduction of control measures stricter than those imposed by EC Regulation No. 3093/94 [9]. EC Regulation No. 1005/2009 [1] prohibits the placing on the market and use of halons and of products and equipment containing halons, except for the "critical uses" listed in Annex VU of this Regulation. This was implemented in the United Kingdom by The Environmental Protection (Controls on Ozone-Depleting Substances) Regulations 2002 [10] and The Environmental Protection (Controls on Ozone-Depleting Substances) (Northern Ireland) Regulations 2003 [11]. After 31 December 2002, it became an offence to supply halons that have been recovered, recycled or reclaimed in existing extinguishers, and after 31 December 2003 it became an offence to possess a halon extinguisher, unless this is for one of the "critical uses".

The European Commission is currently reviewing Regulation No. 1005/2009 [1] and it is expected for the revised Regulation to include an annual review of the critical uses.

## B.3 Withdrawn halon systems and extinguishers

Halon extinguishers withdrawn from service are required to be emptied in such a way that the halon is recovered, either for the limited possibility of re-use or for disposal by a non-contaminating method. To this end, they have to be sent to an authorized disposal agent with the facilities and expertise required to recover or destroy the halon. The Ozone Depleting Substances (Qualifications) Regulations 2006 [12] set the minimum qualifications for anyone who handles halon. These Regulations require that any person handling halon either for disposal or critical uses is certified to show that they meet the minimum requirements.

*NOTE This includes removing halon from a customer's site.*

The Regulations list in annexes which are the acceptable qualifications and who are the recognized training and certification bodies in the United Kingdom.

Currently the only acceptable method of disposal of halon in the UK is via high temperature incineration.

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[10] See Foreword.

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## Further reading

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[16)] Repealed in 2000.

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