

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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## Contents

Foreword *iii*

### Section 1. General 1

- 1 Scope 1
- 2 Normative references 1
- 3 Terms and definitions 2
- 4 Range of information 6

### Section 2. Relation to other fire safety measures 7

- 5 General 7

### Section 3. Fire-fighting media 8

- 6 General 8
- 7 Water 8
- 8 Gaseous media 9
- 9 Foams 10
- 10 Powders 12

### Section 4. Effects of fire-fighting media on people, property and the environment 14

- 11 General 14
- 12 Water 14
- 13 Gaseous media 15
- 14 Foams 17
- 15 Powders 18

### Section 5. Fixed systems and other fire-fighting equipment 19

- 16 General 19
- 17 Hydrant systems, hose reels (water) and foam inlets 19
- 18 Automatic water systems 20
- 19 Portable fire extinguishers 26
- 20 Inert gas and halocarbon agent systems 27
- 21 Carbon dioxide systems 30
- 22 Halon systems 32
- 23 Foam systems 32
- 24 Powder systems 36

### Section 6. Dual use of media and systems 37

- 25 General 37
- 26 Examples of dual use of media and systems 37

### Section 7. Control of fixed fire-fighting systems 38

- 27 General 38
- 28 Water systems 38
- 29 Gaseous systems 39
- 30 Foam systems 40
- 31 Powder systems 41

### Section 8. Characteristics of fire hazard 42

- 32 General 42
- 33 Risk assessment 42
- 34 Information and advice 42

### Section 9. Selecting the system to suit the fire hazard 43

- 35 General 43
- 36 Effect of system discharge on neighbouring occupancies 43
- 37 Effect of changing occupancies or building redundancy 44

**Section 10. Installation, inspection and testing of systems and equipment 46**

- 38** General 46
- 39** Installation 46
- 40** Acceptance testing 46

**Section 11. Servicing and maintenance of systems 48**

- 41** General 48
- 42** Hydrant systems, hose reels and foam inlets 48
- 43** Sprinkler, water spray and watermist systems 48
- 44** Gaseous systems 49
- 45** Foam systems 49
- 46** Powder systems 50

**Section 12. Responsibility for fire-fighting equipment and systems on premises 51**

- 47** Contract arrangements 51

**Annexes**

- Annex A (informative) Typical applications of fire-fighting systems 52
- Annex B (informative) Halon 60

**Bibliography 62****List of figures**

- Figure 1 – Typical hydrant system hose reel and foam inlet installed in building 20
- Figure 2 – Typical automatic sprinkler system 22
- Figure 3 – Typical water spray system for limited area of risk 24
- Figure 4 – Gaseous system – example Single zone system 28
- Figure 5 – Gaseous system – example Multi-zone system 29
- Figure 6 – Carbon dioxide total flooding system protecting a turbo-generator with initial and delayed discharge over the whole volume 31
- Figure 7 – Carbon dioxide local application system protecting quench tank 32
- Figure 8 – Typical pre-mixed foam system protecting a specific hazard 33
- Figure 9 – Typical low expansion foam deluge system using open foam nozzles or aspirating foam sprinklers 34
- Figure 10 – Typical high expansion foam system for total flooding of a warehouse or storage 36

**List of tables**

- Table 1 – Limits for inert gas and halocarbon agent concentrations 16
- Table 2 – Environmental rating of commonly used gaseous media 17
- Table 3 – Classes of sprinkler system for different hazard classifications 23
- Table A.1 – Typical applications for gaseous systems 56

**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<sup>1)</sup>*  
(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*).

<sup>1)</sup> 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*<sup>2)</sup>.

### 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<sup>3)</sup>. Water discharge densities are expressed as rainfall at floor level, in mm/min (1 mm/min = 0.02 gal per ft<sup>2</sup> per min = 1 L per m<sup>2</sup> 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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<sup>2)</sup> In preparation.

<sup>3)</sup> 1 bar = 10<sup>5</sup> N/m<sup>2</sup> = 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, banded 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 | LOAEL |
|---------------------------------------------------|-------|-------|
|                                                   | %     | %     |
| 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 |
| <i>NOTE Values taken from the HAG report [2].</i> |       |       |

#### 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.