

Fire extinguishing installations and equipment on premises —

Part 6: Foam systems —

Section 6.2 Specification for medium and high expansion foam systems

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Foreword

This Section of BS 5306 has been prepared under the direction of the Fire Standards Policy Committee.

The other Parts of BS 5306 in preparation or published are as follows:

- *Part 0: Guide for the selection of installed systems and other fire equipment;*
- *Part 1: Hydrant systems, hose reels and foam inlets;*
- *Part 2: Sprinkler systems;*
- *Part 3: Code of practice for selection, installation and maintenance of portable fire extinguishers;*
- *Part 4: Specification for carbon dioxide systems;*
- *Part 5: Halon systems;*
- *Section 5.1: Halon 1301 total flooding systems;*
- *Section 5.2: Halon 1211 total flooding systems;*
- *Part 6: Foam systems;*
- *Section 6.1: Specification for low expansion foam systems;*
- *Part 7: Specification for powder systems.*

Medium and high expansion foam systems are designed to provide a supply of foam for the extinction of fire.

The requirements and recommendations of this Section of BS 5306 are made in the light of the best technical data known to the committee at the time of writing, but since a wide field is covered it has been impracticable to consider every possible factor or circumstance that might affect implementation of these recommendations.

To comply with this standard, the user has to comply with all its requirements. He may depart from recommendations, but this would be on his own responsibility and he would be expected to have good reason for doing so.

It has been assumed in the preparation of this standard that the execution of its provisions is entrusted to people appropriately qualified and experienced in the specification, design, installation, testing, approval, inspection, operation and maintenance of foam systems and equipment, for whose guidance it has been prepared.

A classification of foam concentrates is given in Appendix A.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

0 Introduction

It is important that the fire protection of a building or plant should be considered as a whole. Foam systems can form only a part, though an important part, of the available facilities, but it should not be assumed that their provision necessarily removes the need to consider other measures, such as the provision of portable fire extinguishers or other mobile appliances for first aid or emergency use, or to deal with special hazards.

Foams have for many years been recognized effective media for the extinction of fires. In particular, medium expansion foams have been developed for the extinction of both flammable liquid and solid fuel fires, and high expansion foam for use against solid fuel fires and to a lesser extent flammable liquid fires. In the planning of a comprehensive fire protection scheme, it should not be forgotten that there may be hazards for which foams are *not* suitable or there may be dangers in their use which require special precautions.

Advice on these matters can be obtained from the appropriate fire authority, the Health and Safety Executive or other enforcing authority under the Health and Safety at Work etc. Act 1974, and the insurers. In addition, reference should be made to BS 5306-0 and as necessary to other Parts of this standard.

It is essential that fire extinguishing equipment should be carefully maintained to ensure instant readiness when required. This routine is liable to be overlooked or given insufficient attention by supervisors. It is, however, neglected at peril to the lives of occupants of the premises and at the risk of crippling financial loss. The importance of maintenance cannot be too highly emphasized.

1 Scope

This Section of BS 5306 specifies requirements and gives recommendations for the design, installation and maintenance of fixed and semi-fixed systems; ancillary portable or transportable equipment provided as part of a pre-planned scheme for applying medium and high expansion foam to fires in buildings, industrial plant and storage facilities.

Application rates are specified for medium expansion foam to flammable liquid fires, and for high expansion foam to flammable liquid fires and combustible solid fires.

NOTE 1 Unless otherwise specified in this standard all pressures are gauge pressures and are expressed in bars
 $1 \text{ bar} = 10^5 \text{ N/m}^2 = 10^2 \text{ kPa}$.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Section of BS 5306, the definitions given in BS 4422-4 apply together with the following.

2.1

competent person

a person capable of carrying out the inspection and maintenance procedures of clause 11, by reason of experience and access to the requisite information, tools and equipment

2.2

concentration

the ratio of foam concentrate in the foam solution usually expressed as a percentage by volume

2.3

expansion (expansion ratio)

the ratio of the volume of aerated foam to the volume of foam solution from which it was made

2.4

high expansion foam generator

a foam-making component in which air is forced through a gauze screen that is sprayed with foam solution to make the foam

2.5

medium expansion foam branchpipe

a hand-held self-aspirating foam-making component that produces foam with an expansion in the range 21 to 200

2.6

medium expansion foam monitor

a self-aspirating foam-making component that produces foam with an expansion in the range 21 to 200, at a rate of substantially greater than that of a hand-held branchpipe

NOTE A monitor is usually supported on a swivel mounting which is either connected to fixed pipework or may be mounted on a mobile wheeled or skid unit.

2.7

self-aspirating foam-making component

foam-making component in which air is induced by the discharge of foam solution from a nozzle or nozzles within the equipment. The induced air is mixed intimately with the foam solution within the equipment to produce the foam

2.8

user

the person(s) responsible for or having effective control over the fire safety provisions in or appropriate to the premises or building

3 Characteristics of medium and high expansion foam

3.1 General

Foam systems shall produce foam as an aggregate of gas filled bubbles from an aqueous solution of a foam concentrate.

COMMENTARY AND RECOMMENDATIONS ON 3.1. *The gas is usually air.*

3.2 Uses

The requirements of this standard apply to medium and high expansion foams suitable for extinguishing fires in combustible solids, flammable liquids, or combinations of both.

COMMENTARY AND RECOMMENDATIONS ON 3.2.

Medium expansion foam may be used on combustible solids up to a height of about 3 m, either by direct application to the solid surfaces or by total submersion. It operates by excluding air from the combustibles, and by wetting down the burning surfaces. It is useful in outdoor conditions, for example on bund fires, provided the wind speed is not greater than about 10 m/s and is not gusty. The foam may be laid gently upon the surface of a fire, or can be projected as a stream, according to the design of the application equipment.

Medium expansion foam is effective on hydrocarbon liquid fires but, except for the alcohol resistant type, is generally not suitable for use on foam destructive liquids which cause rapid breakdown of the foam.

High expansion foam is used most effectively in indoor spaces where it can be used to submerge a combustible solid or flammable liquid fire and exclude the air needed for combustion. Because it has a relatively low water content per unit volume it does not have a great cooling effect, e.g. on solid surfaces, and the extinction process therefore depends mostly on smothering the fire. It is capable of extinguishing fires of considerable vertical extent, e.g. in high-racked storages up to at least 10 m, provided that the foam can be applied from above the fire site and horizontal transit to the site is minimized. Some destruction of the foam by the fire will occur which can be compensated by an increased application rate. A solid fuel fire submerged in high expansion foam is not necessarily extinguished quickly, but can smoulder beneath the foam surface for a considerable time until the drainage of water from the foam cools the combustible surfaces to below ignition temperature. High expansion foam is most valuable in total flooding of places where it is inadvisable for personnel to go during firefighting, e.g. in underground storage facilities or basements.

3.3 Expansion

3.3.1 Medium expansion foam. Medium expansion foam shall have an expansion between 21 and 200.

3.3.2 High expansion foam. High expansion foam shall have an expansion between 201 and 1 000.

COMMENTARY AND RECOMMENDATIONS ON 3.3. *Foams are arbitrarily subdivided into three ranges of expansion.*

Low expansion foam (LX): expansion up to 20

Medium expansion foam (MX): expansion 21 to 200

High expansion foam (HX): expansion 201 to 1 000

3.4 Application method

3.4.1 Medium expansion. Medium expansion foams shall be applied:

- a) gently to the surface of a flammable liquid or solid combustible fire; or
- b) by means of a medium expansion foam branchpipe or monitor.

COMMENTARY AND RECOMMENDATIONS ON 3.4.1. *The first method is suitable for fixed systems where the location, size and shape of the hazard is known, and the system can be designed to meet this requirement. The second method is more appropriate where the size and location of the hazard may vary with circumstance, and needs to be dealt with by a more flexible approach.*

3.4.2 High expansion. High expansion foams shall be applied:

- a) by filling the volume in which the fire occurs; or
- b) by guiding a wall of foam in the direction of a localized fire, in order to submerge and suppress it.

The foam may be introduced directly, or through flexible ducting.

COMMENTARY AND RECOMMENDATIONS ON 3.4.2. *High expansion foam, by its nature, can only be applied gently to fires. Method a) is generally preferable as the water content of the foam needs to be retained as far as possible to ensure heat resistance at the fire. Horizontal movement at floor level promotes water drainage and degrades the foam quality. To make high expansion foam effective in large compartments and up to heights of 10 m, flexible barriers may be used to retain the foam in the required area and to permit its fast build up to the required height. Wherever possible foam should be applied at a high level, i.e. above the level of foam in the fire space.*

3.5 Potential hazards

Foam systems shall include provision to minimize the danger when foam is applied to liquids above 100 °C, energized electrical equipment or reactive materials.

COMMENTARY AND RECOMMENDATIONS ON 3.5. *Since all foams are aqueous solutions, their application to burning flammable liquids in depth, where the temperature of the liquid exceeds 100 °C, may be accompanied by the danger of frothing or slop-over of the burning liquid, due to the boiling of the water draining from the foam, as it passes through the hot layers of liquid. This danger will apply to medium expansion foam as well as to low expansion foam (see BS 5306-6.1), but it is probable that in these circumstances, the lower water content of the medium expansion foam may be largely evaporated on contact with the flammable liquid surface, reducing the danger significantly. High expansion foam is not used in this type of application.*

Because foams are made from aqueous solutions, they may be dangerous to use on materials which react violently with water, such as sodium or potassium, and should not be used when these are present. A similar danger is presented by other metals, such as zirconium or magnesium, only when they are burning.

Medium and high expansion foams are electrically conductive, and should not be used on energized electrical equipment, where this would be a danger to personnel (see 19.6).

Personnel should not enter spaces filled with high expansion foam see 19.6).

3.6 Compatibility with other extinguishing media

The foam produced by the system shall be compatible with any media provided for application at or about the same time as foam.

COMMENTARY AND RECOMMENDATIONS ON 3.6. *Certain wetting agents and some extinguishing powders may be incompatible with foams, causing a rapid breakdown of the latter. Only media that are substantially compatible with a particular foam should be used in conjunction with it.*

Water jets or sprays may adversely affect a foam blanket, but the simultaneous application of water from sprinklers can be beneficial provided that allowance is made for the increased breakdown of foam (see commentary and recommendations on 19.4).

3.7 Compatibility of foam concentrates

Foam concentrate (or solution) added or put into a system shall be suitable for use and compatible with any concentrate (or solution) already present in the system.

COMMENTARY AND RECOMMENDATIONS ON 3.7. *Foam concentrates, and foam solutions, even of the same class, are not necessarily compatible, and it is essential that compatibility be checked before mixing two concentrates or premixed solutions.*

4 Classification of flammable liquids

4.1 Flashpoint

For the purposes of this standard flammable hydrocarbon liquids are classified into those with:

- a) flash points up to and including 40 °C;
- b) flash points above 40 °C.

when determined in accordance with BS 2000-34.

COMMENTARY AND RECOMMENDATIONS ON 4.1. *It is important to note that other classifications may use different methods of flash point determination and divide the classes at other temperatures.*

Tanks containing liquids with flash points much above 60 °C are not normally protected by fixed foam systems unless these liquids are heated above ambient temperature.

4.2 Foam destructiveness

For the purposes of this standard when considering foam destructiveness, flammable liquids are considered as falling into two groups:

- a) hydrocarbons, and those non-hydrocarbon liquids which are not more foam destructive than hydrocarbons;
- b) foam destructive liquids, which are generally water soluble and which are much more foam destructive than hydrocarbons.

COMMENTARY AND RECOMMENDATIONS ON 4.2. *Special types of concentrate are used for foam destructive liquids. Higher rates of application are specified for foam destructive liquids than for hydrocarbons and it is usually essential to use gentle application methods.*

The degree of foam destructiveness varies however, and isopropyl alcohol, butyl alcohol and isobutyl methyl ketone, methyl methacrylate monomer and mixtures of water-miscible liquids in general may require higher application rates.¹⁾ Protection of products such as amines and anhydrides which are particularly foam destructive require special consideration.

¹⁾ The preferred names for isopropyl alcohol, butyl alcohol and isobutyl methyl ketone are propan-2-ol, butan-1-ol and 4-methylpentane-2-one respectively.

5 Types of system

5.1 General

For the purposes of this standard foam systems are considered as being of the fixed, semi-fixed, portable or transportable type and shall comply with 5.2 to 5.5 as appropriate.

COMMENTARY AND RECOMMENDATIONS ON 5.1. *A foam system consists of a water supply, a supply of foam liquid concentrate, a device to proportion correctly the water and foam concentrate, and pipework or hose connected to equipment to make and to distribute foam over the hazard.*

Self-contained systems are those in which all components and water and foam concentrate, separately or as premixed solution, are contained within the system. Such systems usually use compressed gas to provide pressurization at the time of operation.

5.2 Fixed systems

Fixed systems shall have permanent pipework connecting the water supply via the fire water pump (if fitted) and foam liquid proportioning device to the foam maker(s) which protect the hazard.

5.3 Semi-fixed systems

Semi-fixed systems shall have permanent pipework from the foam maker(s) which protect the hazard to an area, adjacent to the hazard, where it is considered safe for personnel to conduct fire fighting operations.

COMMENTARY AND RECOMMENDATIONS ON 5.3. *This pipework may include the proportioning device. The water supply to the pipework is via hoses and is usually pumped by mobile fire appliances. The area adjacent to the hazard should be outside any bunded area and at least one tank diameter or 15 m, whichever is the greater, from any tank. The inlet to the fixed pipework should be fitted with corrosion resistant metal connections provided with plugs or caps and should be marked by a notice reading "Foam inlet — for firefighting use only".*

5.4 Portable systems

Portable systems shall have foam producing equipment that can be carried by one or more men and connected via fire hose to a pressurized water or premixed solution supply.

5.5 Transportable systems

Transportable systems shall have foam producing equipment mounted on wheels or skids.

COMMENTARY AND RECOMMENDATIONS ON 5.5. *These may be self-propelled, towed by a vehicle or pushed by hand. These units are for connection via hoses to a water or foam solution supply.*

6 Planning

Where a foam extinguishing system is being considered for new or existing buildings or plant the following shall be consulted:

- a) the fire authority;
- b) other appropriate public authorities;
- c) the insurers.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 6. *The authorities mentioned above should be informed as early as possible of the type of foam system to be installed and the system design engineers should be fully informed of the protection required in any area. There may be statutory or local bye-law requirements and other requirements of these authorities which should be co-ordinated in the planning stages of the contract.*

Section 2. Contract arrangements

7 Contract drawings

Prior to installation, contract drawings and specifications shall be prepared and submitted to the relevant authority for approval. These shall be to scale or be fully dimensioned with sufficient detail to define clearly both the hazard and the proposed system. Details of the hazards shall be included to show the materials present, the location and/or limits of the hazard and any other materials that are likely to become exposed to the hazard in the event of a fire.

The following details of the proposed system shall be included on the contract drawings:

- a) the purpose and function of the system;
- b) the application rate and the duration of discharge of the system, and the appropriate minimum values of this standard;
- c) hydraulic calculations;
- d) the pipework including support details;
- e) the detection system layout (if specified) and method of operation;
- f) the type, location and spacing of foam discharge devices;
- g) the type and location of foam proportioning devices;
- h) the source of water and quantity needed;
- i) the quantity and type of foam concentrate, its design concentration, the method of storage and the quantity to be held in reserve.

8 Extensions and alterations

Any extension or alteration to an existing system complying with this standard shall also comply with the appropriate requirements of this standard.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 8.
Any extension or alteration to the foam installation should be carried out by the installer or his agent. The organization that services the system and the relevant authorities should be notified promptly of any alteration.

The effect on available water supply and minimum required quantity of foam concentrate should be considered at the design stage of extension or alteration to a system, and full hydraulic calculations should be carried out on the new system layout prior to commissioning.

9 Commissioning and acceptance tests

9.1 General

The installer of the system or his supervising supplier shall arrange for the completed system to be inspected and tested to determine that it is properly installed and that it will function as designed to the satisfaction of the user and the relevant authorities. A commissioning test programme shall be submitted by the installer to the user.

9.2 Inspection

A visual inspection shall be conducted to ensure that the system has been installed correctly. All normally dry horizontal pipework shall be inspected for drainage pitch (see 16.2.4).

COMMENTARY AND RECOMMENDATIONS ON 9.2.

Inspection should check for conformity with design drawings and specifications, continuity of pipework, removal of temporary blinds, accessibility of valves, controls and gauges and proper installation of foam makers, vapour seals and proportioning devices. All equipment should be checked for correct identification and operating instructions.

Water supply pipework, both underground and above ground, should be flushed thoroughly at the maximum practicable rate of flow, before connection is made to system piping, in order to remove foreign materials which may have entered during installation or which may have accumulated in the mains systems at lower rates of flow. The minimum rate of flow for flushing should be not less than the water demand rate of the system.

Foam concentrates have a lower surface tension than water, and they may cause internal pipe scale or sediment to loosen with the risk of blockage of sprayers, proportioning equipment, etc. Pipes and fittings should be carefully cleaned before assembly and any loose jointing material should be removed.

All foam system piping should be flushed after installation, using its normal water supply without foam concentrate or solution, unless the hazard cannot be subjected to water flow. The flow should be continued for a sufficient time to ensure thorough cleaning. Flushing water should be disposed of outside the system. Where flushing cannot be accomplished, pipe interiors should be carefully examined for cleanliness during installation.

9.3 Pressure tests

Except where the user agrees otherwise, all pipework shall be subjected to a hydrostatic pressure test at 1.5 times the maximum pressure anticipated for a period of 1 h. There shall be no permanent distortion or rupture.