

Fire extinguishing installations and equipment on premises —

Part 6: Foam systems —

Section 6.1 Specification for low expansion foam systems

ICS 13.220.10

Committees responsible for this British Standard

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 British Fire Services' Association
 British Gas plc
 British Nuclear Fuels Limited
 Chief and Assistant Chief Fire Officers' Association
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 Department of the Environment, Building Research Establishment (Fire Research Station)
 Department of the Environment (Property Services Agency)
 Department of Transport (Marine Directorate)
 Electricity Supply Industry in England and Wales
 Engineering Equipment and Materials Users' Association
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 Fire Insurers Research and Testing Organisation (FIRTO)
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Foreword

This Section of BS 5306 has been prepared under the direction of the Fire Standards 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 6.2: Specification for medium and high expansion foam systems¹⁾;*
- *Part 7: Extinguishing powder systems¹⁾.*

Low 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 to iv, pages 1 to 32, 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.

¹⁾ In preparation.

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.

Foam has for many years been a recognized effective medium for extinction of flammable liquid fires, but it should not be forgotten, in the planning of the comprehensive schemes, that there may be hazards for which this medium is not suitable, or that in certain circumstances or situations there may be dangers in its use, requiring 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 low expansion foam to fires in buildings, industrial plant and storage facilities.

Application rates are specified for foams made from four classes, protein (P), fluoroprotein (FP), film-forming fluoroprotein (FFFP) and aqueous film forming (AFFF), of foam concentrate for use on fires of hydrocarbon liquids, and for alcohol resistant (AR) foam concentrates for use on fires of foam destructive liquids.

This standard is not applicable to low expansion foam systems using synthetic (S) foam concentrates as such systems are not in common use in the UK.

NOTE 1 Unless otherwise specified in this standard all pressures are gauge pressures and are expressed in bars

1 bar – 10^5 N/m² – 10^2 kPa.

NOTE 2 The titles of 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

self-aspirating foam-making equipment

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

2.2

concentration

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

2.3

drainage time

the time for a defined percentage, usually 25 %, of the liquid content of a foam to drain out under specified conditions

2.4

expansion (expansion ratio)

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

2.5

film forming

the characteristic of a foam or foam solution forming an aqueous film on some hydrocarbon liquids

NOTE The term may be applied to foam and foam concentrates and foam solutions.

2.6

hydrant

a fixed outlet from which water or foam solution may be dispensed from the mains supply

2.7

preburn time

the period of time between ignition of a fire and the commencement of foam application

2.8

spill fire

a flammable liquid fire having an average depth of not more than 25 mm

2.9

user

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

2.10**aspirated foam**

foam produced, by the intimate mixing of air and foam solution, within the equipment

2.11**non-aspirated foam**

foam produced, by the mixing of air and a spray of foam solution, outside the equipment

3 Characteristics and use of low expansion foam

3.1 General

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

COMMENTARY AND RECOMMENDATIONS ON **3.1.** *The gas is usually air. Foam was sometimes formerly referred to as air-foam or mechanical foam to distinguish it from chemical foam made by chemical reaction of two solutions.*

3.2 Uses

The requirements of this standard apply to low expansion foam and foam systems suitable for extinguishing fires on a generally horizontal flammable liquid surface.

COMMENTARY AND RECOMMENDATIONS ON **3.2.** *Extinction is achieved by the formation of a blanket of foam over the surface of the burning liquid. This provides a barrier between the fuel and air, reducing the rate of emission of flammable vapours to the combustion zone, and cooling the liquid.*

Low expansion foam is not generally suitable for the extinction of running fuel fires, e.g. fuel running from a leaking container or from damaged pipework or pipe joints. However, low expansion foam can control any pool fire beneath the running fire which may then be extinguished by other means.

Low expansion foam, except for the alcohol resistant type, is generally not suitable for use on foam destructive liquids which cause rapid breakdown of the foam.

Low expansion foam is not suitable for use on fires involving gases or liquefiable gases with boiling points below 0 °C, or cryogenic liquids. The advice of the manufacturer should, therefore, be sought for this application.

3.3 Expansion

Low expansion foam shall have an expansion not exceeding 20.

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

Low expansion foams shall be applied:

- gently to the surface of the burning liquid (as pourer or semi-subsurface systems); or
- forcefully to the surface of the burning liquid (as in monitor and branchpipe systems); or
- below the surface so that they float to the surface under their own buoyance (as in subsurface systems).

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, where liquid fuel temperatures exceed 100 °C they may be ineffective and, particularly where the fuel depth is considerable (e.g. tanks) may be dangerous in use. The foam and drainage of the water from the foam can cool the flammable liquid but boiling of this water may cause frothing or slop-over of the burning liquid. Boil-over, which may occur even where foam is not applied, is a more severe and hazardous event. Large scale expulsion of the burning contents of a tank is caused by the sudden and rapid boiling of water in the base of the tank or suspended in the fuel. It is caused by the eventual contact of the upper layer of liquid fuel in the tank, heated to above 100 °C by the fire, with the water layer. Particular care should be taken when applying foam to high viscosity liquids, such as burning asphalt or heavy oil, above 100 °C.*

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 where they are present. A similar danger is presented by some other metals, such as zirconium or magnesium, only when they are burning.

Low expansion foam is a conductor and should not be used on energized electrical equipment, in situations where this would be a danger to personnel.

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.

Use of water jets or sprays may adversely affect a foam blanket. They should not be used in conjunction with foam unless account is taken of any such effects.

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 or 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 Flash point

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, isobutyl methyl ketone, methyl methacrylate monomer and mixtures of water-miscible liquids in general may require higher application rates²⁾. Protection of products such as amines and anhydrides which are particularly foam destructive requires special consideration.

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 steel 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 steel 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.

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

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 hazard 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 given in 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;
- j) 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 system 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 requests otherwise, all pipework, except that carrying foam for surface application or semi-subsurface application systems, 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.

COMMENTARY AND RECOMMENDATIONS ON **9.3.** *There should be no substantial leakage during this test.*

9.4 Discharge tests

If requested by the user, a full scale discharge test shall be conducted to ensure that the system discharges at the design rate, functions in accordance with all other design requirements, and produces and maintains an even foam blanket over the surfaces to be protected.

COMMENTARY AND RECOMMENDATIONS ON **9.4.** *The tests should be carried out by competent persons.*

Discharge tests should be carried out wherever possible. Wind and obstructions such as pipework, pumps, motors, vessels, may hinder the development of an even foam blanket. Particular checks should be made during the discharge tests to ensure that these factors have been taken properly into account.

Water may be used instead of foam solution for some tests to avoid the need of extensive cleaning of the system after tests.

The inspections and tests should cover:

- a) *rate of application of foam solution;*
- b) *foam properties;*
- c) *foam distribution;*
- d) *running pressures;*
- e) *concentration of the foam solution;*
- f) *manpower requirements.*

9.5 System restoration

After completion of the acceptance tests, the pipework shall be flushed, strainers inspected and cleaned and the system restored to operational condition.

9.6 Completion certificate

The installer shall provide to the user a completion certificate stating that the system complies with all the appropriate requirements of this standard, and giving details of any departure from appropriate recommendations.