

Fire extinguishing installations and equipment on premises —

Part 7: Specification for powder systems

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- British Fire Services' Association
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Foreword

This Part 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 6.1: Specification for low expansion foam systems;*
- *Section 6.2: Specification for medium and high expansion foam systems¹⁾.*

Powder systems are designed to provide a piped supply of finely divided chemical for the extinction of fire.

Several different methods of piping supplies of powder to, and applying it at, the required points of discharge for fire extinction have been developed in recent years, and there is a need for dissemination of information on established systems and methods. This Part of BS 5306 has been prepared to meet this need.

Advice is given on the selection of the system most suited to a particular need, suitable methods of operation, and on the part these systems may play in general schemes of fire protection on premises. Requirements and recommendations are given on the design, maintenance and efficient operation of systems.

The requirements and recommendations of this Part 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 the recommendations.

In order to make it more suitable for reference in designs and specifications for actual projects, this Part of BS 5306 has been written in the form of a specification (see clause 6 of PD 6501-1:1982). To comply with this specification, 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 reasons for doing so.

It has been assumed in the preparation of this standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

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 34, 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. Powder systems form only a part, though an important part, of the available facilities but it should not be assumed that their adoption necessarily removes the need to consider supplementary 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.

Powder has, for many years, been a recognized effective medium for the extinction of flammable liquid fires and solid fires, including those in the presence of electrical hazards, but it should not be forgotten, in the planning of 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 as necessary to other Parts of BS 5306.

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 Part of BS 5306 specifies requirements and gives recommendations for powder fire extinguishing systems which discharge powder complying with BS 6535-3 from a container, or centrally grouped containers, through pipework or a hose to a nozzle or nozzles within the hazard area. It covers both stored pressure and gas container systems, with maximum working pressures not exceeding 25 bar at 20 °C.

This standard does not deal with powder portable fire extinguishers (which are covered, together with portable fire extinguishers of other types, in BS 5423 and BS 5306-3), transportable extinguishers, modular systems in which powder containers are positioned at more than one point, or with fixed extinguishers.

Powder system for explosion suppression are not covered in this Part of BS 5306.

NOTE 1 Unless otherwise stated in the text all pressures are gauge pressures and are expressed in bars.

1 bar = 10^5 N/m² = 100 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 Part of BS 5306, the definitions given in BS 4547 and BS 4422-4 apply, together with the following.

2.1 authority

an organization, office or individual responsible for approving equipment, installations or procedures

2.2 automatic system

a fire extinguishing system that, under specified conditions, functions without intervention by a human operator

2.3 balanced system

a powder fire extinguishing system, with more than one discharge nozzle, in which the powder flow divides equally at each junction in the pipework

2.4 bounding area

the area of the real or notional surface (sides, bottom and top) of an enclosure round a hazard protected by a total flooding system

2.5 competent person

a person capable of carrying out the inspection and maintenance procedures given in clause 12, by reason of experience and access to the requisite information, tools and equipment

2.6 deep-seated fire

a fire involving solids subject to smouldering

2.7 gas container system

a system in which the propellant gas is separately contained in a gas container, not in the powder container

2.8 hose reel system

a system including a hose, stowed on a reel or a rack, with a discharge nozzle which is manually directed and operated

2.9**local application system**

a system of fixed piping and nozzles arranged to discharge powder directly to a fire occurring in a defined area and that does not produce a concentration sufficient to extinguish fire throughout the entire volume containing the protected hazard

2.10**manual system**

a fire extinguishing system that, under specified conditions, functions by intervention of a human operator

2.11**monitor system**

a system of fixed piping with nozzles that can be manually directed and operated, locally and/or remotely

2.12**stored pressure system**

a system in which the propellant gas is stored within, and permanently pressurizes, the powder container(s)

2.13**surface fire**

a fire involving flammable liquids, gases or solids not subject to smouldering

2.14**total flooding system**

a system of fixed piping and nozzles arranged to discharge the powder into an enclosed space to produce a concentration sufficient to extinguish fire throughout the entire volume of the enclosed space

2.15**unbalanced system**

a powder fire extinguishing system, with more than one discharge nozzle, in which the powder flow divides unequally at one or more junctions in the pipework

2.16**user**

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

3 Powder**3.1 General**

Powder used for the initial supply shall be suitable for the system and for the intended use and shall comply with BS 6535-3.

COMMENTARY AND RECOMMENDATIONS ON 3.1.

BS 6535-3 gives methods of performance assessment and test methods for classification of powders (see 3.2).

3.2 Classification

Powders are classified according to their potential applications as follows.

ABC powders: suitable for use on class A, class B or class C fires.

BC powders: suitable for use on class B or class C fires and which may also be effective on surface fires of class A materials.

D powders: suitable for use on class D fires.

COMMENTARY AND RECOMMENDATIONS ON 3.2. The classes of fire are defined in BS 4547 as follows.

Class A: fires involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers.

Class B: fires involving liquids or liquefiable solids.

Class C: fires involving gases.

Class D: fires involving metals.

This Part of BS 5306 is concerned only with class B fires involving most liquids including petrol (but excluding liquids of low fire point such as carbon disulphide) and surface burning of class A materials which can be detected quickly enough to be extinguished by BC powders.

While powder systems are a suitable means of extinguishing class C fires, the risk of explosion should be carefully considered. Where appropriate and possible the gas flow should be isolated before, or as soon as possible after, extinction.

The use of powder for the extinction of deep-seated fires or fully developed fires in class A materials, or of class D fires, is not covered in this Part of BS 5306 and requires special engineering considerations.

Powder systems are not suitable as a means of inerting explosive atmospheres.

3.3 Chemical composition

The composition of the powder shall be suitable for the intended application.

COMMENTARY AND RECOMMENDATIONS ON 3.3.

Extinguishing powders are composed of very small particles of a solid extinguishing medium, treated with selected flow additives to give resistance to packing, moisture absorption and caking during storage and to give free-flowing qualities when discharged through pipework or hoses, and nozzles.

Most BC powders are based on alkali metal salts, usually the bicarbonate. For general use sodium bicarbonate²⁾ is less effective than potassium bicarbonate³⁾ but because sodium salts are less expensive they may generally prove cost effective, or may be preferred for use on deep fat fryers where a surface layer of powder and saponified fat is produced which reduces the possibility of reignition. Carbamate powders, which are mixtures or compounds of urea and bicarbonate, are more effective than the simple bicarbonates.

Mono ammonium phosphate⁴⁾ is the chemical most generally used for ABC powders; on BC fires it is no less effective than sodium bicarbonate, but it is not as effective as the potassium salts.

A wide range of chemicals has been used for class D fires, some for use on radioactive metals and some for use on non-radioactive metals.

WARNING. Containers used for one powder should not be refilled with a different powder. It is most important that mixing or cross-contamination of different types of powder be avoided. Some mixtures can react, sometimes after a long delay, producing water and carbon dioxide with consequent caking of the powder and, in closed containers, a pressure rise. This rise in pressure could cause sealed containers to explode.

3.4 Particle size

The particle size of the powder shall be adequate to achieve extinction and suitable for discharge by the system.

COMMENTARY AND RECOMMENDATIONS ON 3.4. The finer the particles of extinguishing medium the more effective it is in extinguishing fire. The effect is not equally marked for all powders; the carbamate powders show little increase in effectiveness with finer size, since their effectiveness depends on decrepitation within the flame. Finer powders are more difficult to discharge from the container and to project for any distance from the nozzle. They also tend to clog and pack more easily in pipework and, because the bulk density is less, less can be held in a given container or vessel.

3.5 Foam compatibility

Appropriate precautions shall be taken to prevent powder discharged from the system adversely affecting any firefighting foam which may be used at or about the same time.

COMMENTARY AND RECOMMENDATIONS ON 3.5. Not all powders can be used with fire-fighting foams without deleterious effects on the foam performance.

Since powder gives a good knock down to a flammable liquid fire and foam seals the flammable liquid surface and prevents reignition, combined use of the two media is often considered. In such cases it is essential to use a powder and a foam which are compatible.

3.6 Prevention of reignition

Appropriate precautions shall be taken to reduce possible reignition of a fire extinguished by a powder system.

COMMENTARY AND RECOMMENDATIONS ON 3.6. While powders can suppress a fire, they do not form an inerting atmosphere and rapidly settle out once application stops. Flammable liquid fires are then open to reignition, either from an external source or spontaneously in the case of liquids heated above their fire point; the latter is not usually a problem except where the fire point is exceptionally low, e.g. carbon disulphide. A solid fuel fire extinguished with an ABC powder will have been rendered safe from reignition except by large intense sources, at least for a time, by the powder remaining on the surface.

Powders may be used indoors or outdoors. Wind may cause dispersal of the powder cloud making extinction less certain and assiting reignition from any hot sources or glowing embers. Outdoors therefore the rate of application of powder may need to be increased by up to 50 %, and the discharge time of the system by up to 100 %, in order to offset this effect.

Where possible the supply of electrical power, and any gas (see 3.2) or liquid fuel, to the hazard area should be cut off when the powder system is actuated.

²⁾ The preferred name for sodium bicarbonate is sodium hydrogen carbonate.

³⁾ The preferred name for potassium bicarbonate is potassium hydrogen carbonate.

⁴⁾ The preferred name for mono ammonium phosphate is ammonium dihydrogen orthophosphate.

3.7 Hazards to personnel

Powders shall not present a toxic hazard.

COMMENTARY AND RECOMMENDATIONS ON 3.7. *In extinguishing concentrations class B powders generally available are of minimal chemical toxicity, but some types of powder, in particular class D powders, need special precautions in use. Powders are not pleasant to inhale, some may cause severe irritation, albeit temporary, particularly if breathed for a considerable period. A powder cloud in a confined space severely reduces visibility and persons within the space may suffer loss of orientation and consequent collision with obstructions within the space.*

3.8 Contamination

Precautions shall be taken to minimize the effects on other materials of contamination by powder.

COMMENTARY AND RECOMMENDATIONS ON 3.8. *The powder discharged from a system will cover all exposed surfaces in the vicinity. If this is cleaned up within a few hours there are normally no problems. Powders exposed to air absorb moisture, and prolonged contact with this damp powder may cause corrosion of some metals. Particular attention should be paid to the cleaning of open machinery and electrical equipment.*

4 Propellant

The propellant shall be one, or more, of the gases listed in Table 1. Carbon dioxide shall comply with BS 6535-1. Tracers may be added to the propellant to facilitate leakage detection, but the content shall not exceed 3 % (m/m) of the propellant content.

Table 1 — Propellants

Material	Maximum water content
	% (m/m)
Air	0.006
Argon	0.006
Carbon dioxide	0.015
Helium	0.006
Nitrogen	0.006

5 Types of system

For the purposes of this Part of BS 5306 powder systems shall be classified as one of the following types:

- total flooding systems;
- local application systems;
- manual hose reel systems;
- monitor systems.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 5. *Systems are also distinguished as either stored pressure systems, or gas container systems. Systems are sometimes elsewhere referred to as engineered, that is especially designed for a particular hazard, or pre-engineered, that is of a size and design which allows them to be installed for any hazard within certain limits of size and type.*

6 Planning

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

- the fire authority;
- other appropriate public authorities;
- the insurers.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 6. *The authorities should be informed as soon as possible of the type of powder system to be installed and system design engineers should be fully informed of the protection, whether total flooding, local application or monitor and hose reel, 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.

7 General design principles

7.1 Steady flow

Systems shall maintain non-surfing two phase flow of powder and propellant, without separation.

COMMENTARY AND RECOMMENDATIONS ON 7.1. *System manufacturers and designers have reference data for flow of a particular powder through pipework and nozzles, which take account of the general principles of two phase flow.*

Separation occurs more readily at low velocity (low flow rate). Pipe diameters should be small enough to give powder flow rates of not less than 0.05 kg per mm² cross-sectional area (equivalent to 1.5 kg/s in 25 mm pipe). More or less constant velocity is achieved in balanced systems by reducing pipe diameters by a factor of $\sqrt{2}$ at each junction [see Figure 1(a)].

Separation will occur at points where the direction of flow changes and the following principles should be observed to minimize and compensate for this effect.

- Changes of direction of pipe runs should be achieved only by the use of elbows (preferably 90°), not by the use of bends.*

b) Pipe runs should be divided only by the use of right angle tees in the configuration shown in Figure 1(a) or other equally effective means. The configuration shown in Figure 1(b) will lead to unequal division of the flow and irregular flow and should not be used.

c) Separation may occur at elbows but re-combination of the phases will take place within a length of pipework equal to 20 pipe diameters; if division of flow in the plane of the elbow occurs within this distance, flow irregularities may occur. Figure 2 shows recommended arrangements to avoid this.

d) Nozzles should be mounted in elbows on the pipe.

7.2 Flow distribution

Powder systems shall provide the intended design flow at each nozzle.

COMMENTARY AND RECOMMENDATIONS ON 7.2. Even distribution of flow is more easily achieved in balanced systems. Unbalanced systems are more difficult to design, are more likely to have variable and unpredictable performance and are more likely to have fluctuating rates of discharge from the nozzles.

Correspondingly greater care should be taken in the design of unbalanced systems; wherever possible a test discharge should be carried out to verify correct function.

The simplest form of balanced system is a symmetrical array of pipework nozzles, all of the same size and at the same elevation, as illustrated in Figure 3. The pipework from one outlet of any tee is balanced by an identical array at the other outlet with the same length of pipework and the same number and arrangement of fittings.

In practice the symmetry need not be exact. Effective balance can be achieved provided that the equivalent lengths of the various corresponding arrays are within $\pm 5\%$, which allows for some variation of the actual length of pipework, but for little difference in the number of fittings.

Where nozzles of differing discharge rates are used the system will be non-symmetrical. Such a system can be balanced by selecting the larger nozzles to discharge at 2, 4, 8, etc. times the rate r of the smallest. The orifice diameters will be less than 2, 4, 8, etc. times that of the smallest nozzle to provide additional flow resistance (pressure drop) to balance the resistance in the corresponding longer non-identical pipe array. The principle is illustrated in Figure 4 where two nozzles each discharging at a rate of $2R$ balance four nozzles each discharging at a rate of R and one nozzle discharging at a rate of $4R$ balances four nozzles each discharging at a rate of R .

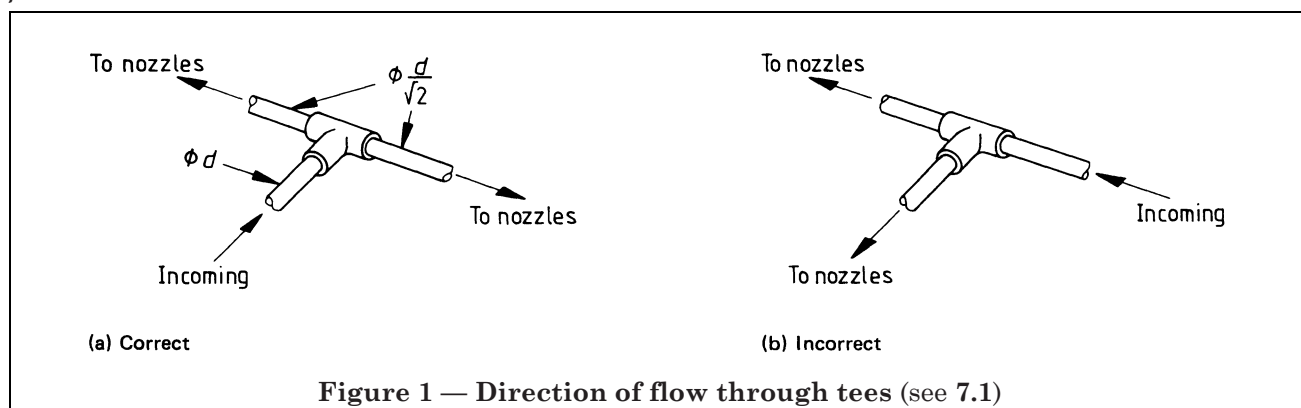
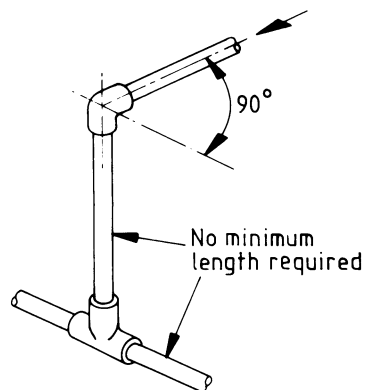
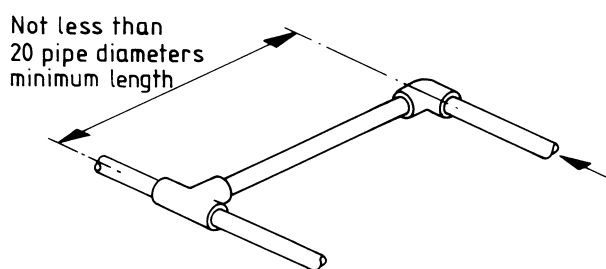


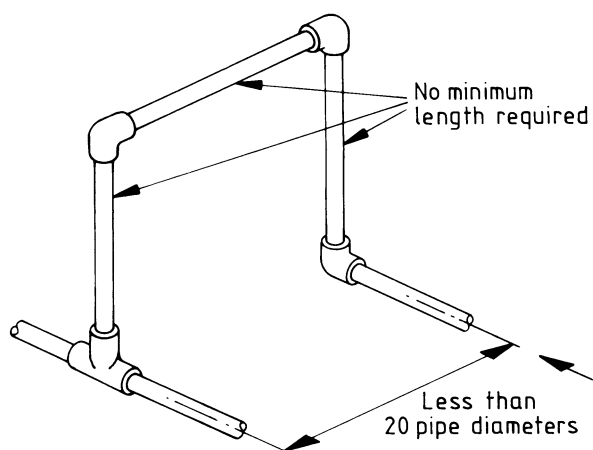
Figure 1 — Direction of flow through tees (see 7.1)



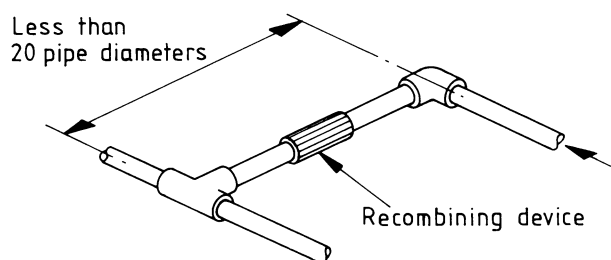
(a) Division not in plane of elbow



(b) Junction not less than 20 pipe diameters from elbow in same plane



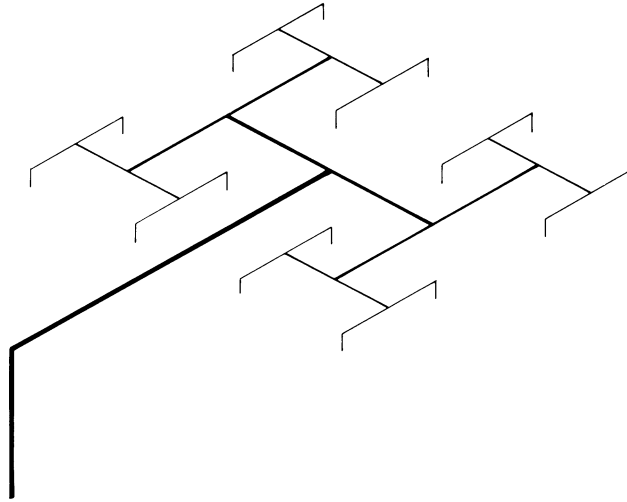
(c) Use of extra elbows



(d) Use of recombining device, e.g. venturi

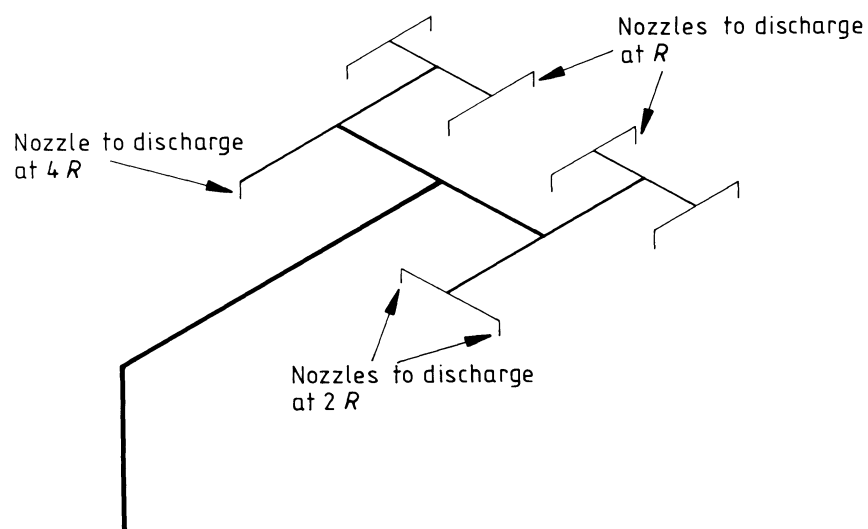
NOTE Where the distance between parallel pipes is less than 20 pipe diameters, arrangement (b) should not be used; to avoid separation of flow arrangement (c) or (d) should be used.

Figure 2 — Correction for separation at elbows (see 7.2)



NOTE All nozzles discharge at the same rate R .

Figure 3 — Symmetrical balanced system (see 7.2)



NOTE Nozzles discharge at a rate of R , $2R$ or $4R$.

Figure 4 — Non-symmetrical balanced system (see 7.2)