BRITISH STANDARD

BS 5306-7: 1988

Fire extinguishing installations and equipment on premises —

Part 7: Specification for powder systems

UDC 621.844:621.844.1

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Fire Standards Committee (FSM/-) to Technical Committee FSM/13, upon which the following bodies were represented:

Association of Metropolitan Authorities
British Automatic Sprinkler Association
British Fire Protection Systems Association Ltd.
British Fire Services' Association
British Gas plc
British Nuclear Fuels Limited
Chief and Assistant Chief Fire Officers' Association
Confederation of British Industry
Convention of Scottish Local Authorities
Department of Health and Social Security
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
Fire Brigades Union
Fire Extinguishing Trades Association
Fire Insurers Research and Testing Organisation (FIRTO)
Fire Offices Committee
Fire Protection Association
Health and Safety Executive
Hevac Association
Home Office
Incorporated Association of Architects and Surveyors
Institution of Fire Engineers
Institution of Gas Engineers
Ministry of Defence
Royal Institute of British Architects
Society of Fire Protection Engineers
Society of Motor Manufacturers and Traders Limited
United Kingdom Atomic Energy Authority

This British Standard, having been prepared under the direction of the Fire Standards Committee, was published under the authority of the Board of BSI and comes into effect on
31 October 1988

The following BSI references relate to the work on this standard:
Committee reference FSM/13
Draft for comment 87/40893 DC

ISBN 0 580 16828 X

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

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 systems*[1)].

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.

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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/m^2 = 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 occuring 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 bicarbonate[2] is less effective than potassium bicarbonate[3] 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 phosphate[4] 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:

a) total flooding systems;

b) local application systems;

c) manual hose reel systems;

d) 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:

a) the fire authority;

b) other appropriate public authorities;

c) 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-surging 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 mm^2 *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.

a) *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 ± 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 2 *R balance four nozzles each discharging at a rate of R and one nozzle discharging at a rate of* 4 *R balances four nozzles each discharging at a rate of R.*

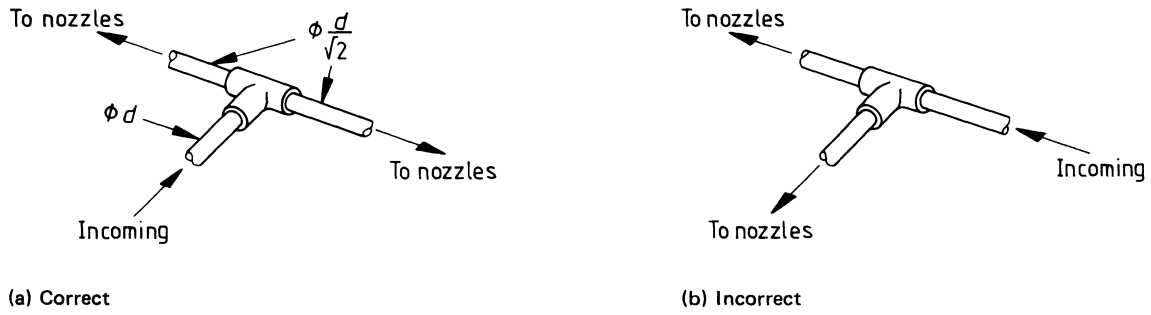
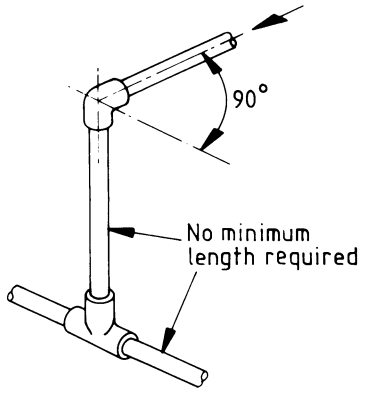
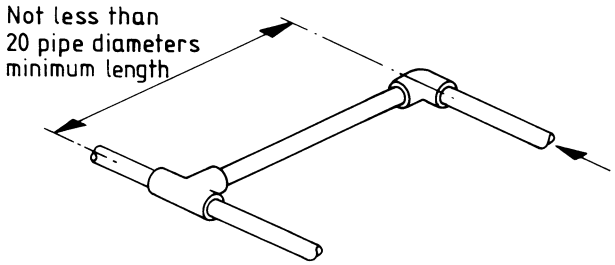


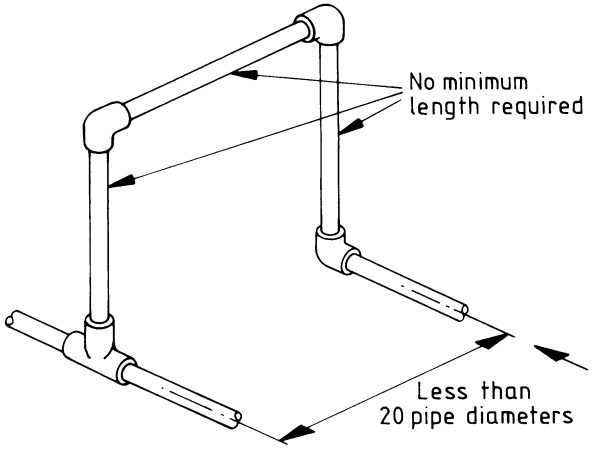
Figure 1 — Direction of flow through tees (see **7.1**)



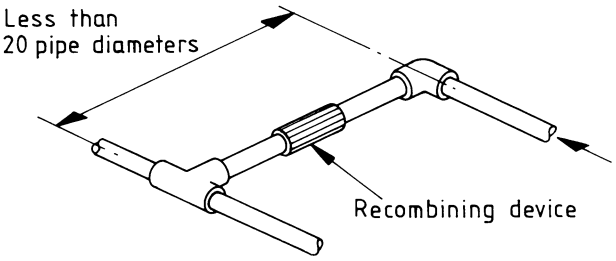
(a) Division not in plane of elbow



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



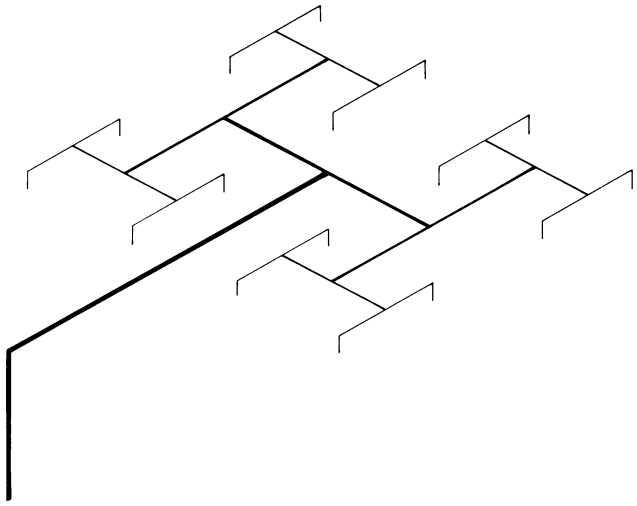
(c) Use of extra elbows



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

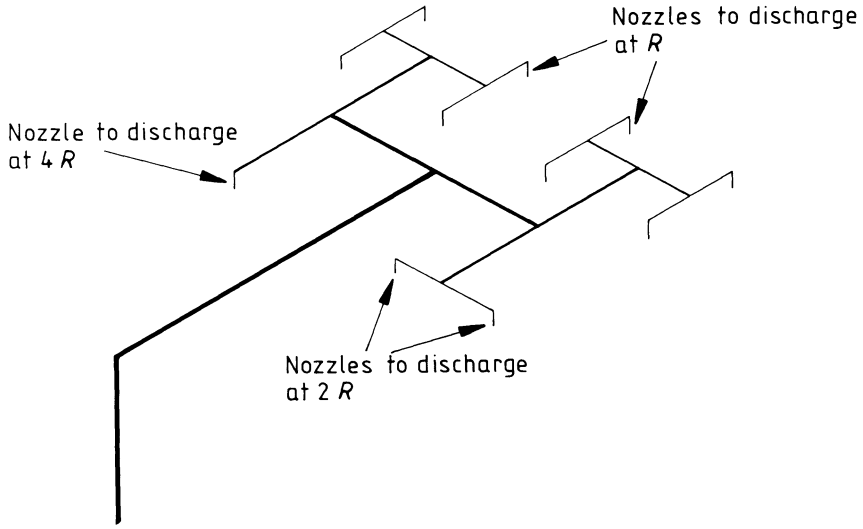
NOTE Where the distance between parallel pipes is less than 20 pipe diameters, arrangement (b) should not be used; to avoid separation of flow arrangement (c) or (d) should be used.

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**)

Section 2. Contract arrangements

8 Contract drawings

Prior to installation, system layout drawings shall be prepared. These shall be to scale or 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 involved, 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. Where a total flooding system is to be installed the plans shall show the means of egress from the protected area, and the number of persons likely to be present.

The location and sizes of piping and nozzles shall be clearly indicated, together with the location of the powder supply, fire detection devices, manual controls and all auxiliary equipment. Features such as dampers, conveyors and doors related to the operation of the system shall also be shown, together with details of all calculations used in assessing the quantity and discharge rate of powder (see examples in clause **15** and **19**). Further information shall be given separately indicating the equivalent lengths of pipe and fittings, flow rates and pressure drops throughout the system.

9 Commissioning and acceptance tests

9.1 General

The installer of the equipment or his supervising supplier shall arrange tests of the completed installation to the satisfaction of the user and the relevant authority to show that it complies with this Part of BS 5306 and functions as designed.

COMMENTARY AND RECOMMENDATIONS ON **9.1**. *Unless requested by the user or required by an authority it is not usual to test discharge powder systems, other than monitor and hose reel systems, during training because of the consequent expense of cleaning up the powder covered area.*

WARNING. Powder systems should not be test discharged into areas where the atmosphere is explosive. Electrostatic effects can induce sparking which may cause ignition of any flammable vapours or gases which may be present.

9.2 Commissioning test programme

The installer shall submit to the user a test programme which shall include instructions to:

a) check that all components of the system are installed according to the contract drawings and documents and in the correct manner;

b) check that all nuts, bolts and fittings are correctly tightened and that all pipework supports are correctly fitted;

c) check that all electrical connections are safe and in working order;

d) check that all pipework and nozzles are the correct size;

e) check that all detection equipment functions correctly;

f) operate manual release devices to confirm correct functioning;

g) check operation of all alarm devices;

h) check correct operation of all safety devices;

i) carry out a test discharge of propellant gas to check:

1) that the distribution valves, when shut, hold pressure;

2) that feed pipes lead to the correct protected space;

3) that no leaks occur at joints or fittings;

4) that pressure operated devices function correctly and the items they control, such as shutters and alarms, function correctly;

5) that piping is continuous, and nozzles are not blocked;

j) train all personnel who will be authorized to use monitor and hose reel systems, and to review the training at intervals of 6 months.

9.3 System restoration

After completion of the commissioning and acceptance tests (see **9.1** and **9.2**) the system shall be restored to operational condition and all containers checked for correct fill. The pipework shall be blown down to remove any residual powder deposits.

9.4 Completion certificate and documentation

When the system has been completed, tested and restored the user shall be provided with two copies of a completion certificate, a complete set of instructions and drawings showing the system as installed, and a statement that the system complies with all appropriate requirements of this Part of BS 5306 and giving details of any departure from appropriate recommendations.

10 Extensions and alterations

Any addition, extension, alteration or repair to a powder system complying with this Part of BS 5306 shall be carried out following the requirements of this Part of BS 5306, so that after completion of the work the restored system complies with this Part of BS 5306.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **10**. *The consultation procedures specified in clause **6** apply.*

Section 3. Periodic inspection, testing, maintenance and replenishment after use

11 Inspection

11.1 General

The user shall carry out a programme of inspection and arrange a service and maintenance schedule, and keep records of the inspections and servicing.

COMMENTARY AND RECOMMENDATIONS ON **11.1**. *The continued capability for effective performance of a powder system depends on fully adequate maintenance procedures with, where possible, periodic testing.*

Installers should provide the user with a logbook, in which inspection and maintenance records can be entered.

11.2 User's programme of inspection

The installer shall provide the user with an inspection programme for the system and components. The programme shall include instruction on the action to be taken in respect of faults.

COMMENTARY AND RECOMMENDATIONS ON **11.2**. *The user's inspection programme is intended to detect faults at an early stage to allow rectification before the system may have to operate. A suitable programme is as follows.*

a) *Weekly. Carry out a visual check that there is no obvious damage to pipework and that all operating controls are properly set and components are undamaged. Check that any protective seals on the nozzles are in place, operative and free from build up of contamination. Check pressure gauges on stored powder containers and gas propellant containers [except carbon dioxide containers, see item b) 6) in the commentary and recommendations on clause **12**]. Replace or rectify, as recommended by the manufacturer, any container showing a pressure loss (adjusted for temperature) of more than* 10 %.

b) *Monthly. Check that all personnel who may have to operate the equipment or system are properly trained and authorized to do so, and in particular that new employees have been instructed in its use.*

12 Testing and maintenance schedule

In addition to any periodical inspection test and maintenance of propellant gas containers specified in the appropriate Part of BS 5430, a service and maintenance schedule for the system shall be established.

The schedule shall be carried out by a competent person who shall provide to the user a signed, dated report of the inspection and advising any rectification carried out or needed.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **12**. *A suitable schedule is as follows.*

a) *Every three months. Test and service all electrical fire detection and alarm systems as recommended in BS 5839-1.*

b) *Every six months.*

1) *Pipework. Externally examine pipework to determine its condition. Pressure test pipework when visual inspection indicates questionable strength due to corrosion or mechanical damage. It is essential that pipework be dried after any hydrostatic test.*

2) *Nozzles. Inspect and clean discharge nozzles and check for correct alignment. This is essential after use of the system and after any discharge test.*

3) *Valves. Check all control valves for correct manual function and automatic valves additionally for correct automatic operation.*

4) *Containers. Externally inspect powder and propellant containers.*

5) *Detection devices. Check and replace as recommended by the manufacturer. This is particularly important in the case of fusible links on cooking ranges where grease and carbon can build up.*

6) *Carbon dioxide propellant containers. Weigh the container or use a liquid level indicator if appropriate, to verify correct content of carbon dioxide. Replace, or refill, any showing a loss of more than* 5 %.

c) *Every twelve months. For gas container systems only, check the powder for caking or lumping. The powder container should be opened and the powder examined to a depth of approximately* 150 mm *by a tactile means. Replace all the powder by a fresh charge if it shows any signs of caking or lumping. The removal of caked or lumpy material from powder by sieving or by machines designed for the purpose is not recommended. Such a procedure removes the symptoms temporarily but, since the basic cause has not been rectified, further caking or lumping is likely to occur. The use of sieves or machines to remove foreign bodies is also not recommended since their use for any purpose will involve considerable exposure to atmospheric humidity, increasing the risk of caking, and the procedure itself has a contamination risk.*

d) *As required by statutory regulations, but otherwise when convenient. Internally inspect powder containers.*

e) *At intervals recommended by the powder manufacturer. For stored pressure systems only, check the powder for caking or lumping.*

More frequent inspections and checks may be appropriate in particular circumstances.

13 Replenishment of the system after use

Powder and propellant used to replenish the system after use shall be of the type and specification for which the system is designed.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **13**. *Sufficient powder and propellant, as spare filled containers if appropriate, should be held on the premises, or should be available for delivery within* 24 h. *Powder refill charges should be stored in a dry environment in suitable containers.*

Section 4. Total flooding systems

14 Use of total flooding systems

The design methods of this section shall be used only for fixed nozzle systems where there is a permanent enclosure about the hazard (see clause **16**).

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **14**. *Fires that can be extinguished by total flooding are surface fires involving flammable liquids and solids.*

15 Design conditions

15.1 General

The quantity of powder discharged and the rate of application shall be sufficient to build up and maintain the specified concentration throughout the enclosure with an adequate margin of safety to compensate for any uncloseable openings, and for any ventilation system which is not shut down or closed off on operation of the system.

COMMENTARY AND RECOMMENDATIONS ON **15.1**. *Loss of powder from the enclosure generally reduces effectiveness and should in most cases be minimized by closing openings and shutting off ventilation systems; however where extraction ductwork forms part of the hazard, it may be preferable to leave the ventilation system running to facilitate extinction in the ductwork.*

15.2 Minimum quantity

The minimum quantity needed M (in kg) shall be assessed on the basis that:

$$M = M_1 + M_2 + M_3 + M_4$$

where

M_1 is the basic quantity (in kg) directly related to enclosure volume;

M_2 is an additional quantity (in kg) to compensate for openings, each less than 5 % of the bounding area, where the aggregate area of all such openings exceeds 1 % of the bounding area;

M_3 is an additional quantity (in kg) to compensate for openings each of area not less than 5 % of the bounding area;

M_4 is an additional quantity (in kg) to compensate for any ventilation system which is not shut or closed down, determined as an addition to the volume enclosure equal to the volume of the air entering or removed from the enclosure during the discharge.

The quantities M_1 and M_2 shall be evenly distributed throughout the enclosure; the quantity M_3 shall be applied across the whole area of each relevant opening in proportion to its area; the quantity M_4 shall be applied at the points of air entry into the enclosure.

COMMENTARY AND RECOMMENDATIONS ON **15.2**. *Special venting may be necessary to avoid excessive pressure build-up resulting from the amount of propellant discharged.*

The basis for determining design conditions is given in Appendix A. The powder manufacturer should be consulted for the appropriate design criteria. For good quality sodium bicarbonate based powder the following may be used:

M_1 (in kg) = 0.65 × enclosure volume (in m^3);

M_2 (in kg) = 2.5 × area of openings (in m^2) (each less than 5 %);

M_3 (in kg) = 5.0 × area of opening (in m^2) (each not less than 5 %);

M_4 (in kg) = 0.65 × ventilation rate (in m^3/s) × discharge time of system (in s).

Example 1

An enclosure 5 m × 10 m × 3 m *is to be protected by a sodium bicarbonate powder total flooding system. There is no ventilation system and the aggregate area of uncloseable openings is* 1.5 m^2.

Enclosure volume $5 \times 10 \times 3 = 150$ m^3

Bounding area $2\,(5 \times 10) + 2\,(3 \times 10) + 2\,(3 \times 5) = 190$ m^2

The area of uncloseable openings is less than 1 % *of the bounding area, so no compensatory powder (M_2 or M_3) is needed. The minimum quantity needed M is*

$$M = M_1 = 0.65 \times 150 = 97.5 \text{ kg}$$

Example 2

The enclosure described in example 1 is fitted with a ventilation system discharging 15 m^3/min *that is not shut down when the system operates. The additional quantity M_4 needed, if the discharge time is to be* 25 s, *is*

$$M_4 = 0.65 \times 15 \times \frac{25}{60} = 4.1 \text{ kg}$$

This is to be applied at the point of air entry.

Example 3

The enclosure described in example 1 has two uncloseable openings:

a) 2 m × 5 m = 10 m^2; *and*

b) 2 m × 1 m = 2 m^2.

Since opening a) exceeds 5 % *of the bounding area, additional powder* M_3*, to be applied at the opening is*

$M_3 = 5 \times 10 = 50$ kg

Since opening b) exceeds 1 % *of the bounding area, but is less than* 5 % *additional powder* M_2*, to be applied with* M_1*, is*

$M_2 = 2.5 \times 2 = 5.0$ kg

15.3 Minimum rate

The minimum rate of discharge R (in kg/s) shall be not less than that given by the equation

$R = M/30$

where M is the quantity discharged (in kg).

COMMENTARY AND RECOMMENDATIONS ON **15.3**.
Where no additional quantities (M_2*,* M_3 *or* M_4*) are to be provided the minimum rate corresponds to a rate of 0.022 times the enclosure volume (in* m^3*) for a good quality sodium bicarbonate powder.*

16 Enclosure

The volume used in calculation shall be the gross volume of the enclosure, less only the volume of any permanent, impermeable, non-combustible building elements within the enclosure.

The protected volume shall be enclosed by rigid elements of construction having a fire resistance of not less than 30 min when tested in accordance with BS 476-21 or BS 476-22 as appropriate and classified as non-combustible when tested in accordance with BS 476-4. The area of these elements shall be not less than 55 % of the bounding area of the enclosure.

Where openings can be closed, these shall be arranged to close before or at the start of discharge. The area of any drop curtains used in the enclosure shall not exceed 30 % of the bounding area.

The aggregate area of uncloseable openings, whether in the sides, bottom or top, shall not exceed 15 % of the bounding area.

17 Nozzle selection and distribution

The nozzles shall be positioned to provide the extinguishing concentration of powder throughout the entire hazard during discharge, and to cover any uncloseable openings of area not less than 5 % of the bounding area.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **17**. *The type of nozzle selected and the disposition of the individual nozzles should be such that the discharge will not splash flammable liquids, dislodge fittings such as ceiling tiles or create dust clouds that might extend the fire or create an explosion.*

Section 5. Local application systems

18 Use of local application systems

The design methods of this section shall be used for fixed nozzle systems where the hazard is not enclosed, as specified in section 4 for total flooding systems, or where the enclosure is large.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **18**. *Fire that can be extinguished or controlled by local extinguishing systems are surface fires involving flammable liquids and solids.*

Examples of hazards that may be protected by local application systems are:

a) *dip tanks;*

b) *quench tanks;*

c) *textile machinery;*

d) *spray booths;*

e) *process machinery;*

f) *deep fat fryers;*

g) *vent stacks;*

h) *pressure relief vents;*

i) *vehicle fuelling areas.*

19 Design conditions

The quantity, discharge rate, and time of application of powder shall provide an extinguishing concentration around the hazard for a time sufficient to extinguish the fire with an adequate margin of safety.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **19**. *Local application systems may be of the overhead type with nozzles above the hazard, or of the tankside type where the nozzles are positioned to discharge across the surface of the hazard, or a combination of the two arrangements. Different conditions apply for indoor and outdoor use. The basis for determining design conditions is given in Appendix A.*

Powder systems are most effective in still air conditions. Wind affects overhead nozzles more than tankside nozzles. The design methods of this specification apply for more or less still air conditions for overhead nozzles and for wind speeds up to 10 m/s *for tankside nozzles. The use of screens, or the application of powder to an area larger than the hazard, should be considered where wind speeds may be higher.*

The powder manufacturer should be consulted for appropriate design criteria, but for good quality sodium bicarbonate or potassium bicarbonate based powders, the appropriate minimum quantity discharged, rate and discharge time given in Figure 5 to Figure 12 may be used (see examples). Note that these apply to overhead, or tankside, nozzles solely; data for combinations of the two are not given.

Example 1

A rectangular area 5 m × 10 m, *indoors, is to be protected by a local application system. It is decided to use sodium bicarbonate powder with overhead nozzles. From Figure 9 for the hazard area of* 50 m^2 *the design conditions are:*

minimum quantity	480 kg;
minimum discharge rate	16.0 kg/s;
minimum discharge time	20 s.

After considering the possible nozzle sizes and configurations that might be used to cover the area of the hazard it is decided, although an arrangement of 12 nozzles would probably suffice, to use 16 nozzles to give a balanced system. Typically it might also be decided to use a 500 kg *powder container, at the working pressure usually used for systems of this particular manufacture. After designing the pipework layout the reference data (see* ***7.1*** *are used to determine the discharge rate, and if for example this was* 20 kg/s *(*1.25 kg/s *at each nozzle) then the discharge time will be* 500/200 = 25 s *and the system would be above the minimum design conditions.*

Example 2

If the hazard described in example 1 is to be protected using tankside nozzles then Figure 5 gives the design conditions as:

minimum quantity	270 kg/s;
minimum discharge rate	11.8 kg/s;
minimum discharge time	15.5 s.

The nozzles initially selected have a semi-circular discharge pattern with an effective range of 3 m, *then the area can be covered by eight nozzles so that the system can be balanced, three at each side, one at each end, and it is decided to use* 300 kg *of powder. However, the discharge rate, calculated from the reference data, is* 10 kg/s *(*1.25 kg/s *at each nozzle). This is less than the minimum given in Figure 5. The system is redesigned using larger nozzles, but the calculation now shows a discharge time of* 20 kg/s *(*2.5 kg/s *at each nozzle). This gives a discharge time of* 15 s *which is less than the minimum time from Figure 5. Further changes in the design are needed to bring the system above the minimum design conditions. Nozzles slightly smaller than those last considered would extend the discharge time, or the quantity of powder could be increased, or the working pressure reduced, or a different configuration of nozzles might be preferred. Whatever solution is adopted, the design criteria are met only when all three minima (quantity, discharge rate and discharge time) are exceeded.*

20 Nozzle selection and distribution

Sufficient nozzles shall be placed so as to provide an extinguishing concentration of powder over the entire area to be protected.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **20**. *The type of nozzle selected and the disposition of the individual nozzles should be such that the discharge will not splash flammable liquids, dislodge ceiling tiles or create dust clouds that might extend the fire or create an explosion.*

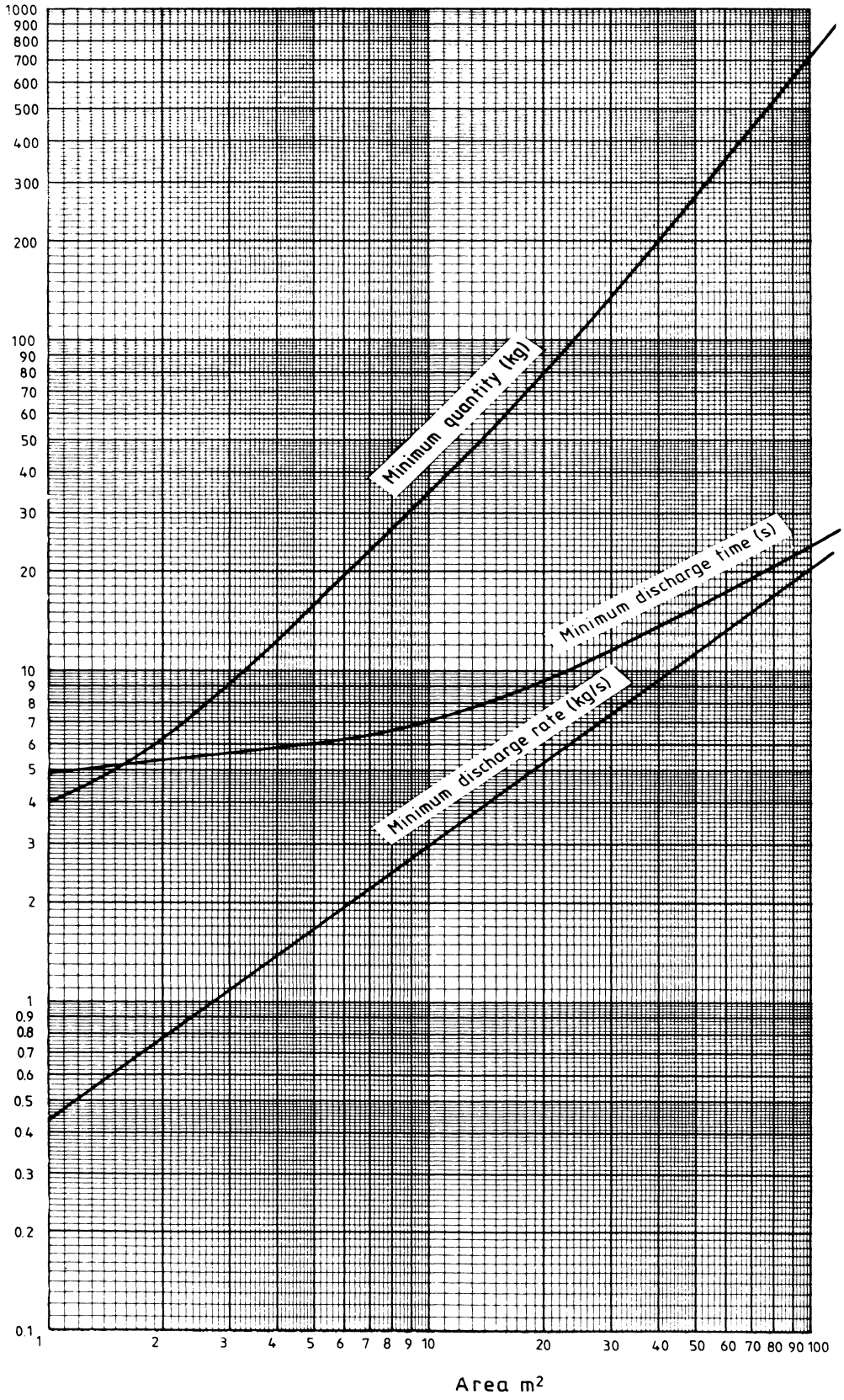


Figure 5 — Local application minimum design conditions for tankside nozzles with sodium bicarbonate; indoors (see clause **19**)

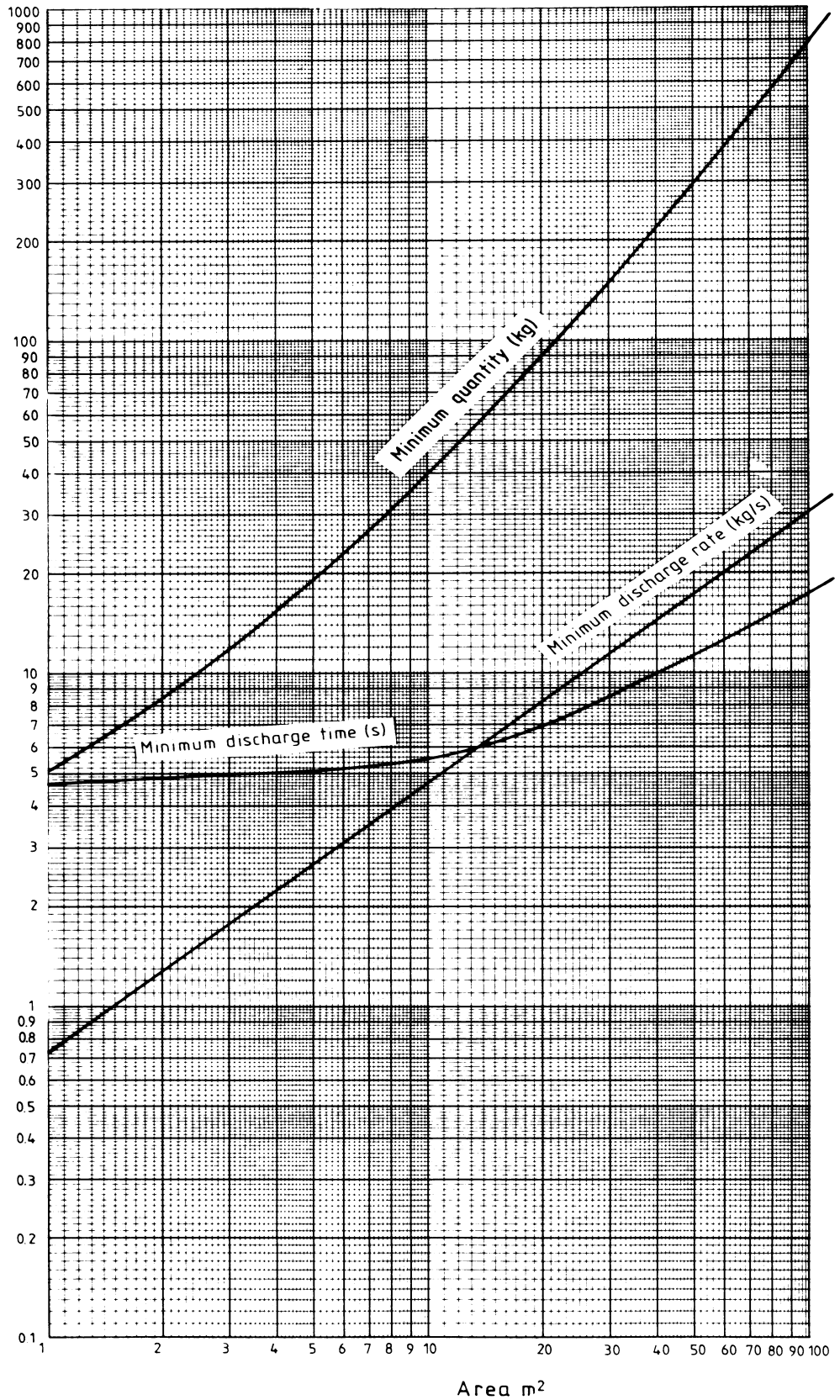


Figure 6 — Local application minimum design conditions for tankside nozzles with sodium bicarbonate; outdoors (see clause **19**)

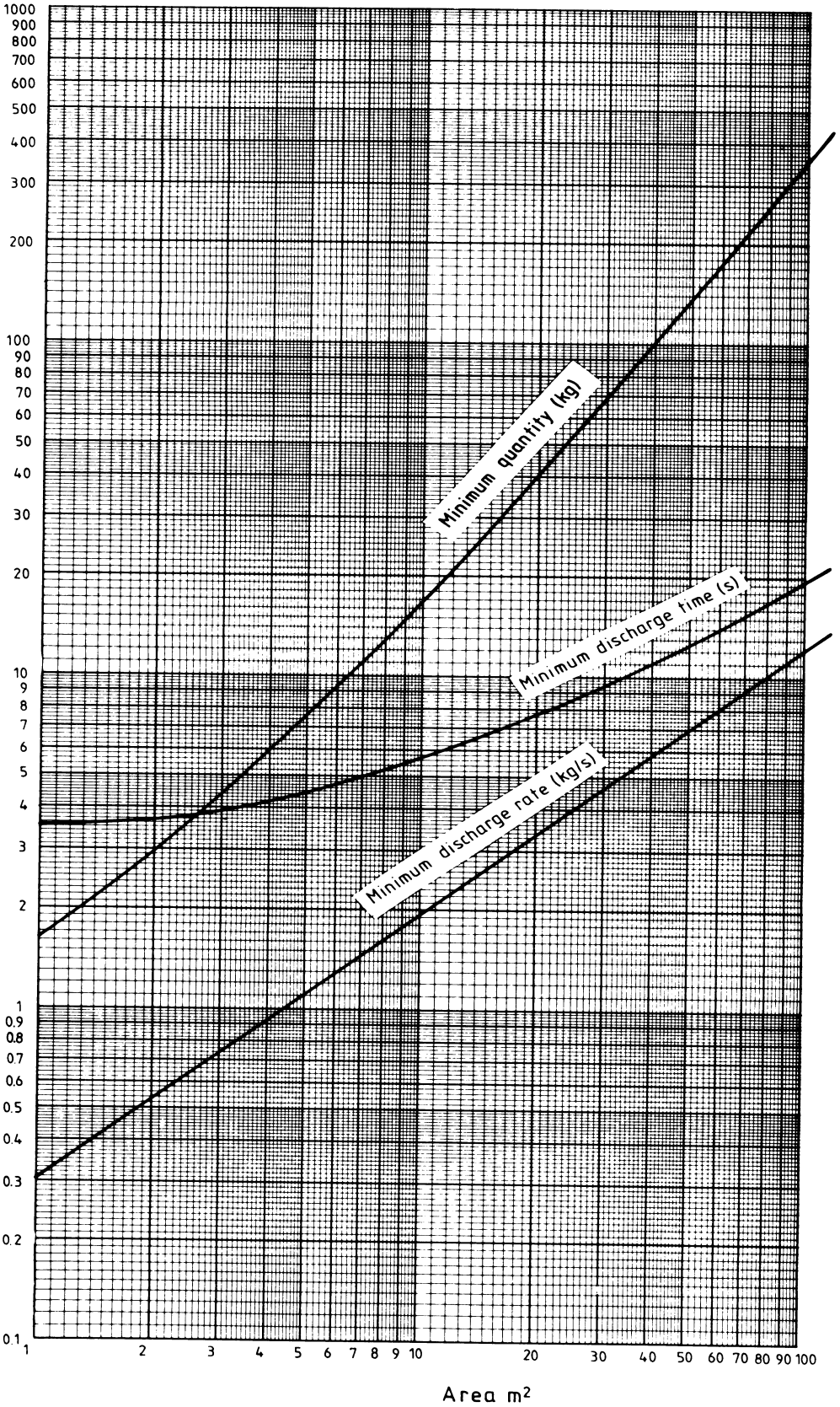


Figure 7 — Local application minimum design conditions for tankside nozzles with potassium bicarbonate; indoors (see clause **19**)

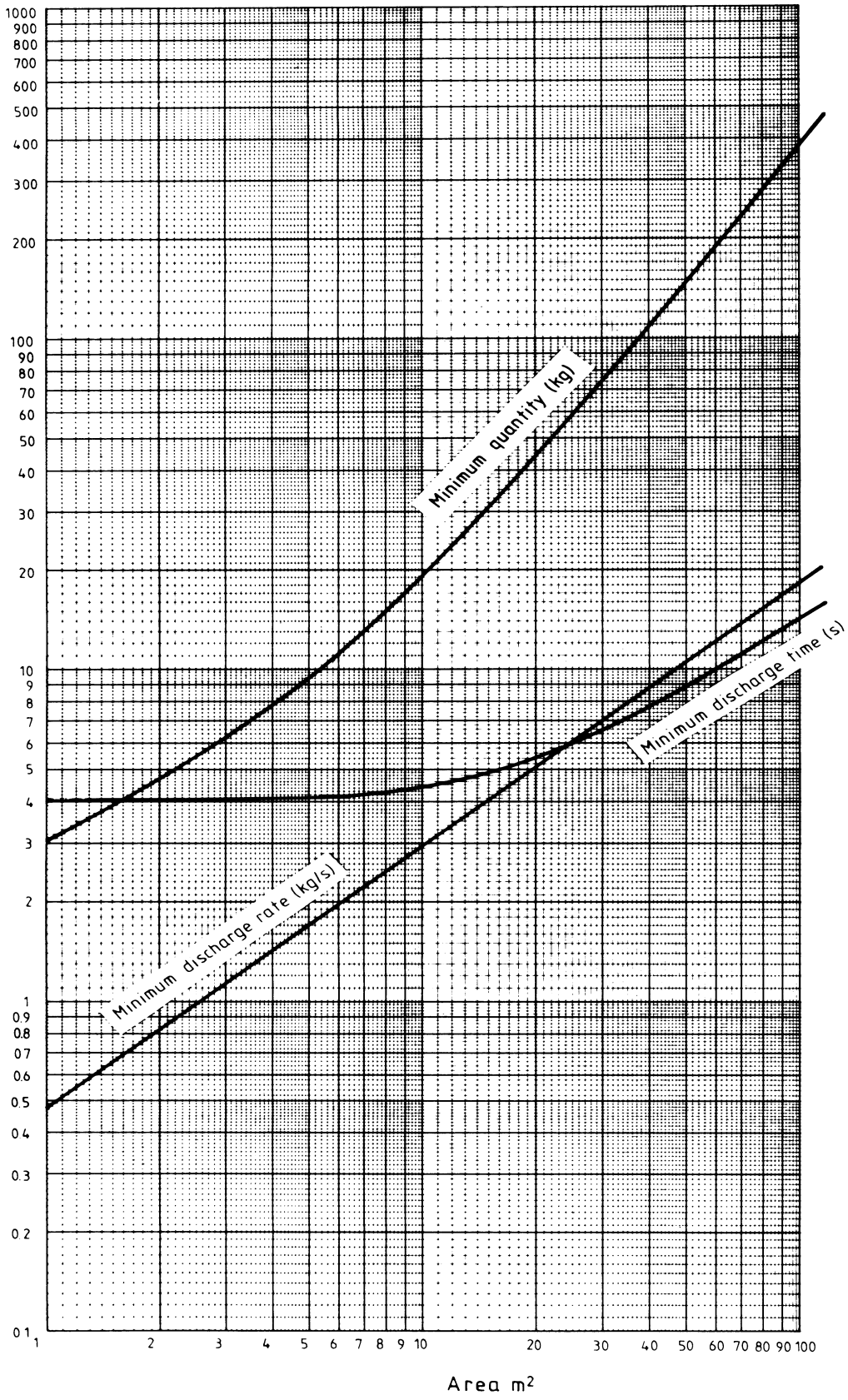


Figure 8 — Local application minimum design conditions for tankside nozzles with potassium bicarbonate; outdoors (see clause **19**)

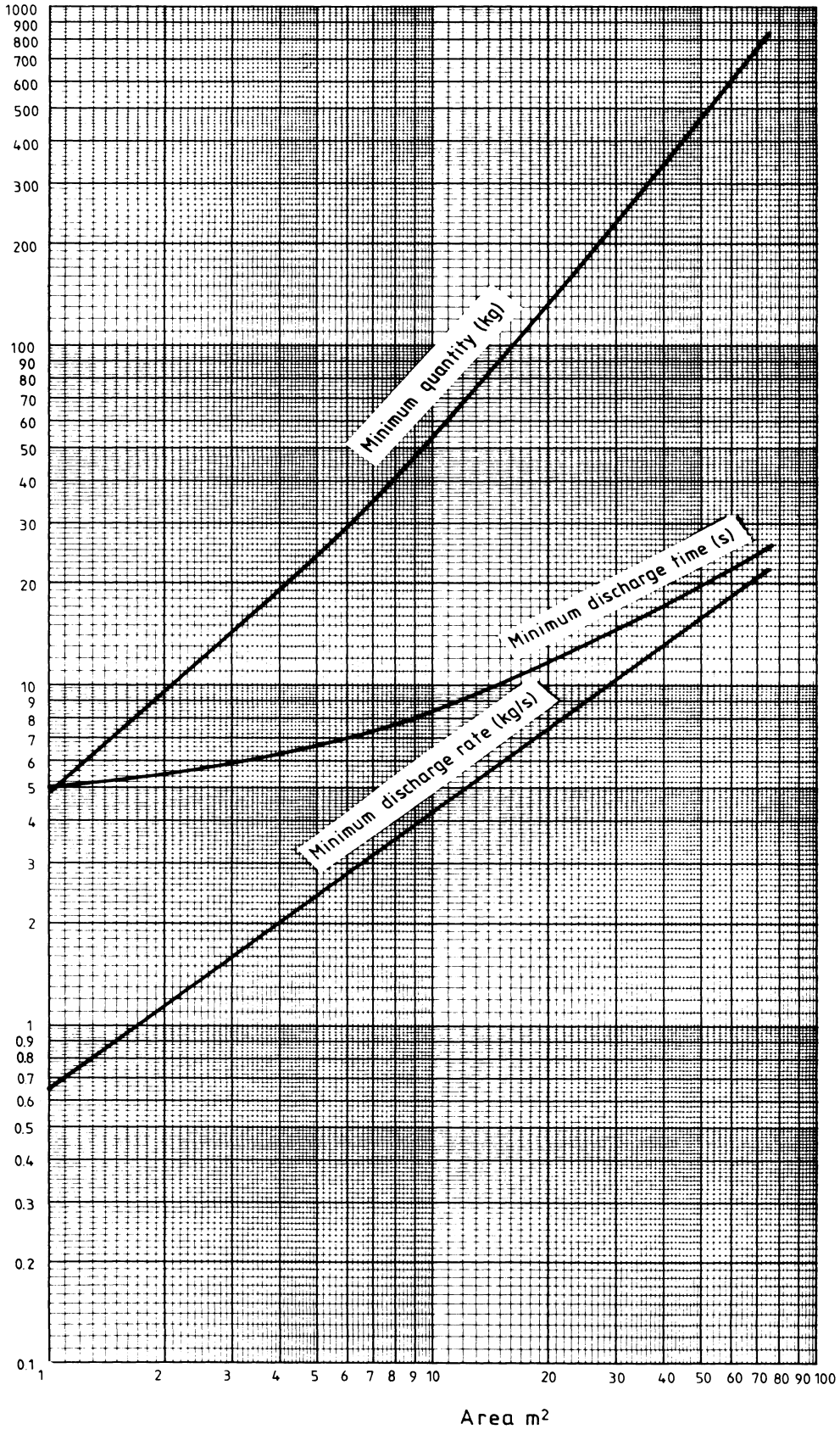


Figure 9 — Local application minimum design conditions for overhead nozzles with sodium bicarbonate; indoors (see clause **19**)

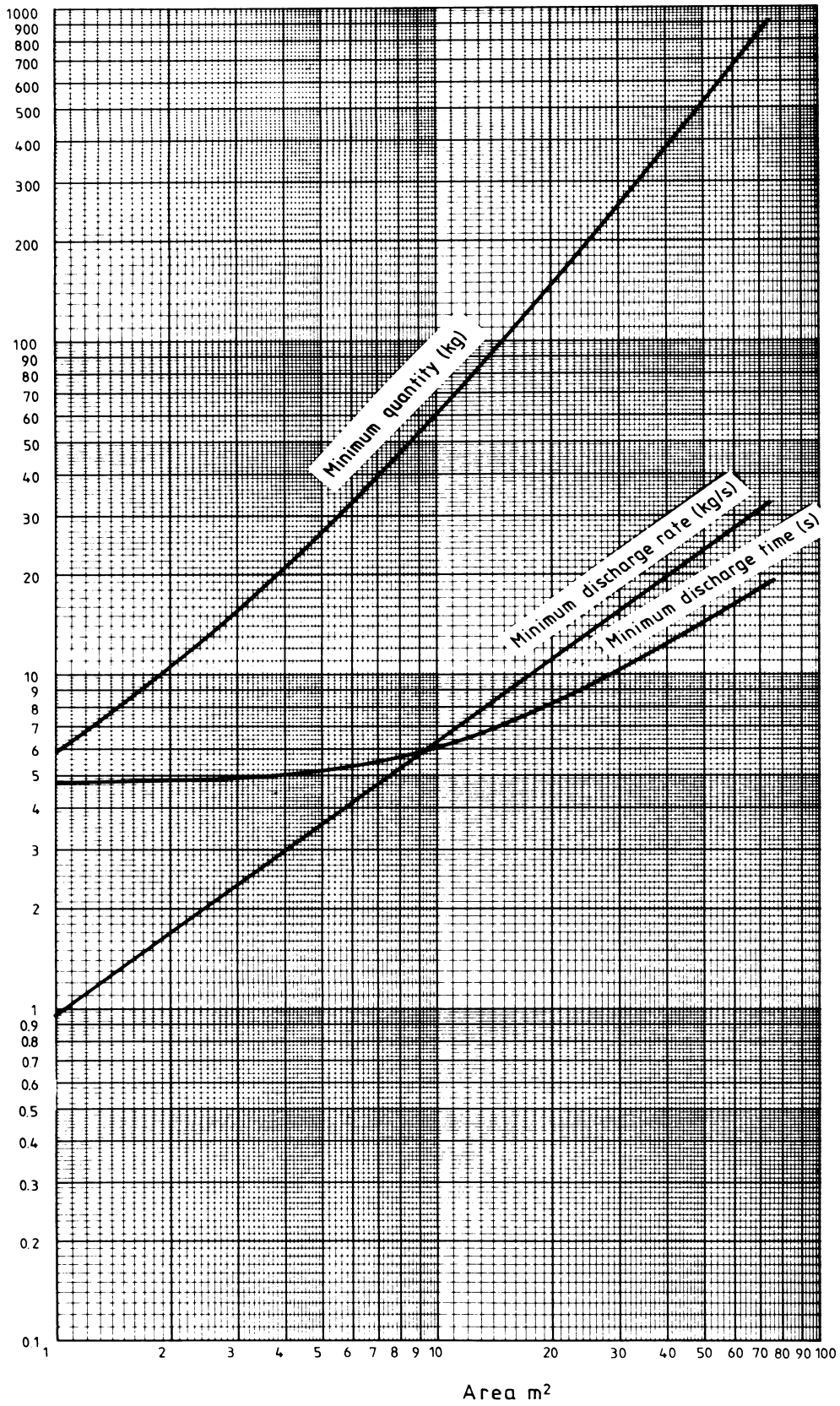


Figure 10 — Local application minimum design conditions for overhead nozzles with sodium bicarbonate; outdoors (see clause **19**)

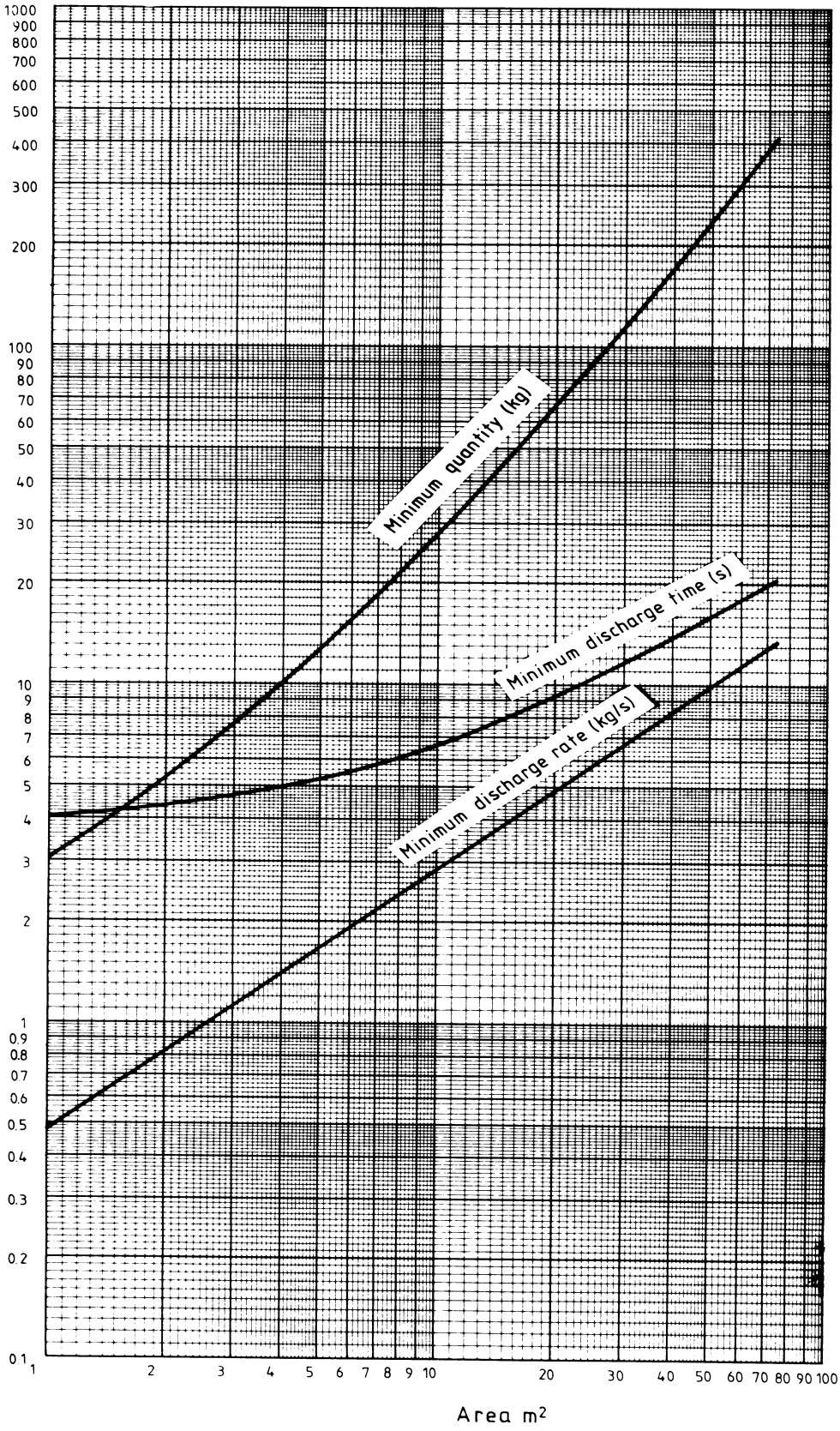


Figure 11 — Local application minimum design conditions for overhead nozzles with potassium bicarbonate; indoors (see clause **19**)

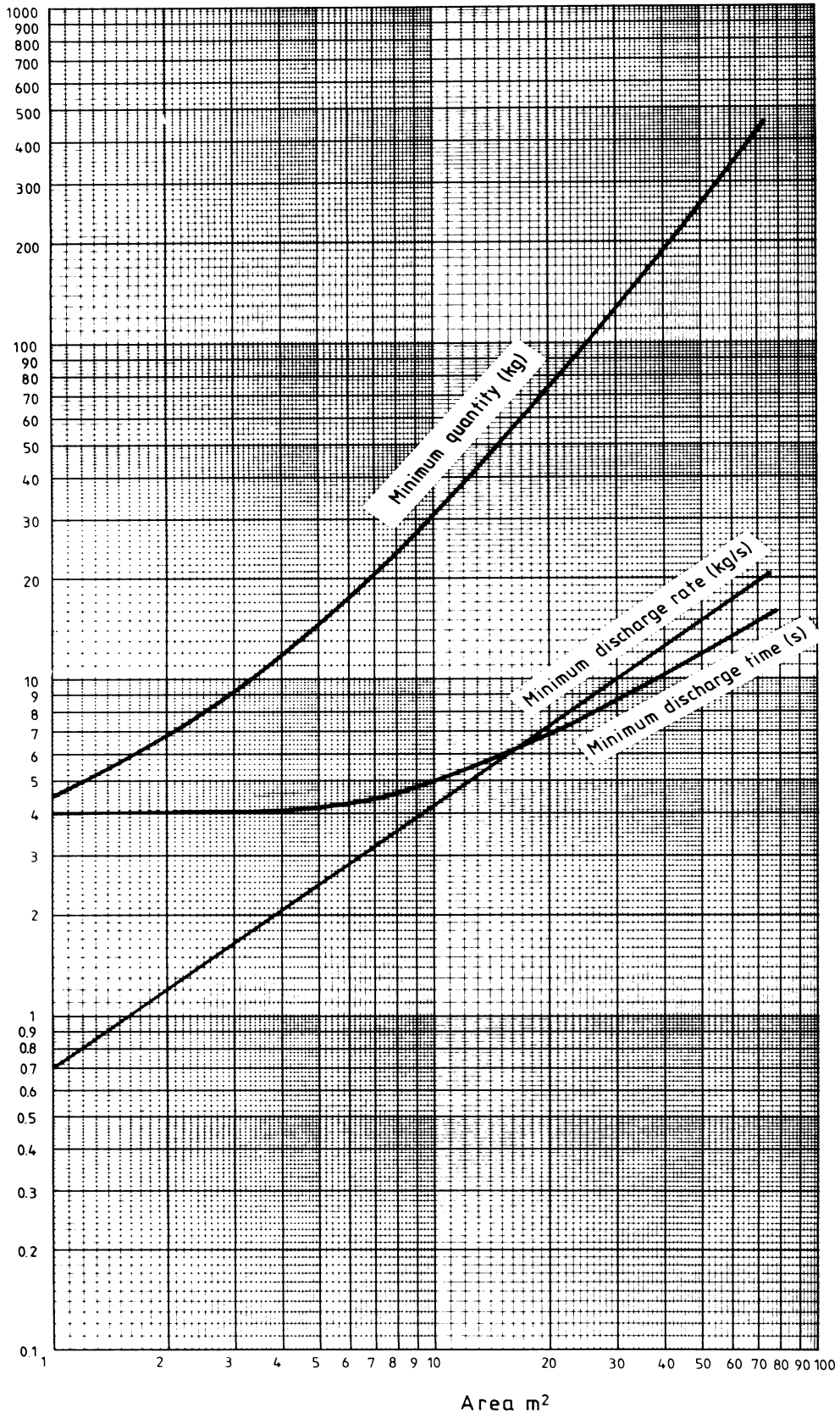


Figure 12 — Local application minimum design conditions for overhead nozzles with potassium bicarbonate; outdoors (see clause **19**)

Section 6. Monitor and hose reel systems

21 Use of monitor and hose reel systems

The design methods of this section shall be used for systems in which the nozzles are movable and each can be directed manually by one person.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **21**. *Monitor and hose reel systems may be used to supplement fixed fire protection systems or portable fire extinguishers for the protection of specific hazards for which extinguishing powder is suitable.*

Wherever possible, powder hose reels should be sited adjacent to the powder container.

Where powder monitors or hose reels are installed in addition to fixed systems, the powder supply for the monitors and/or hose reel should be separate from that for the fixed systems.

*All personnel authorized by the user to use manual hose reels should be trained in their operation and in the fire-fighting techniques applicable to them. Initial personnel training, including system discharge, should be carried out by the equipment supplier immediately after installation. Further training should be carried out every 6 months by competent supervisors [see **9.2** j)].*

22 Location and spacing of monitors and hose reels

Monitors and hose reels shall be so located that their use is not impeded by a fire in the protected area.

All parts of the protected area shall be covered by one or more monitors or hose reels.

23 Rate of discharge

The rate of discharge of a hose reel shall be not less than 1.5 kg/s.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE **23**. *Typical monitors have discharge rates up to* 10 kg/s.

Discharge rates up to 3 kg/s *are used for typical manual hose reel nozzles. At high discharge rates or high pressures, reaction forces make it difficult to control the hose and nozzle. Hose reels discharging at rates above* 3 kg/s *should only be used where essential because of the size and nature of the hazard, and where fixed nozzle and monitor systems cannot be used.*

24 Minimum quantity

The powder content of a monitor or hose reel system shall be sufficient for 30 s continuous operation at the maximum discharge rate of the maximum number of monitors or hose reels that may be used simultaneously.

25 Hose reel design

25.1 Pressure regulation

Where the powder container pressure may exceed 20 bar at any temperature within the operating range, the system shall incorporate a device which limits the inlet pressure to the hose to not more than 20 bar.

25.2 Controls

All controls for actuating the hose reel shall be immediately adjacent to it.

25.3 Hose

The hose shall be non-collapsible and non-kinking and permanently connected to the powder container. It shall be possible to run out the hose when fully pressurized. It shall be suitable for a working pressure of not less than 20 bar.

COMMENTARY AND RECOMMENDATIONS ON **25.3**. *Type B hose complying with BS 3169, or hose complying with BS 4586, is suitable.*

25.4 Discharge nozzle

The discharge nozzle shall be suitable for use by one person without assistance. It shall incorporate a quick opening shut-off valve. Handles shall be insulated to eliminate the possibility of electrostatic shock.

25.5 Signs

A sign with the wording

> "Powder hose reel, for use by authorized personnel only"

shall be mounted on or adjacent to the reel. The sign shall comply with the requirements for fire equipment signs in BS 5499-1. It shall be rectangular, the wording shall be in white and the background red. The letters shall be lower case except the initial "P" which shall be upper case. The letter height shall be not less than 50 mm.

26 Monitor design

Monitors shall be suitable for operation by one person, directly or from a remote location.

Section 7. System engineering design

27 Alarms

Total flooding and local application systems shall give an audible and a visible alarm on operation, and where the premises are provided with a main fire alarm system shall operate that alarm system. See also **29.1.4**.

28 System operation

28.1 Manual operation

The design of the manual control point shall be such that it cannot be confused with a fire alarm manual call point.

In the event of the manual control point becoming inoperative, emergency manual operation of individual system components shall be possible.

Each manual control shall be prominently labelled to identify the hazard protected.

Manual release push buttons or pull handles shall be housed in a box and protected by a quick access front.

Manual controls shall not require a pull of more than 150 N or a movement of more than 300 mm to effect operation.

COMMENTARY AND RECOMMENDATIONS ON **28.1**. *The design of fire alarm manual call points is specified in BS 5839-2.*

Consideration should be given to the incorporation of a time delay and pre-discharge alarm between actuation of the manual control and the commencement of system discharge, to allow time for personnel to leave the hazard area. Emergency manual operation of individual system components is usually by direct manual operation of the device to be operated.

*The label identifying the hazard is additional to that recommended in **29.1.5**. The manual control point or points should be located outside the hazard area so as to be conveniently and easily accessible at all times, including the time of fire. It may be a mechanical, or electromechanical device.*

If the housing box is protected by a frangible glass front this should be of a type which when broken does not leave jagged or sharp edges which might cause injury when the manual release is operated.

28.2 Automatic operation

Automatic systems shall be controlled by automatic fire detection and release devices suitable for the system and hazard, and shall also be provided with a means of manual operation.

Electrically operated fire detection systems shall comply with BS 5839-1.

The power supply shall be independent of the supply for the hazard area or, where this is not practicable, fluidic or mechanical devices shall be used, or the system shall be provided with emergency secondary power supplies with automatic changeover in case the primary supply fails.

Where two or more rapid response fire detectors are used, such as those for detecting smoke or flame, the system shall operate only after signals from two detectors have been received.

Provision shall be made for manual operation (see **28.1**) of the fire extinguishing system by means of a control situated outside the protected space or adjacent to the main exit from the space.

28.3 Additional means of operation

All systems shall be provided with a mechanical device for direct operation of the system. This shall be outside the protected area and incorporate a double action or other safety device to restrict accidental operation. The device shall be provided with a means of preventing operation during maintenance of the system.

29 Safety precautions

29.1 All systems

29.1.1 *General*. Suitable provision shall be made to safeguard persons in areas where the atmosphere may be made hazardous by the discharge, either planned or accidental, of the fire extinguishing system.

29.1.2 *System blow-down*. The system shall have a facility to allow residual powder to be blown out of the pipework after system discharge.

29.1.3 *Discharge prevention during maintenance*. The system shall have a device to prevent discharge during system inspection and servicing, which can then be carried out in safety, and also during times when the protected area is undergoing alterations or extensive maintenance.

29.1.4 *Visual indicators of system status*. At each entrance to:

a) an enclosure protected by a total flooding system;

and

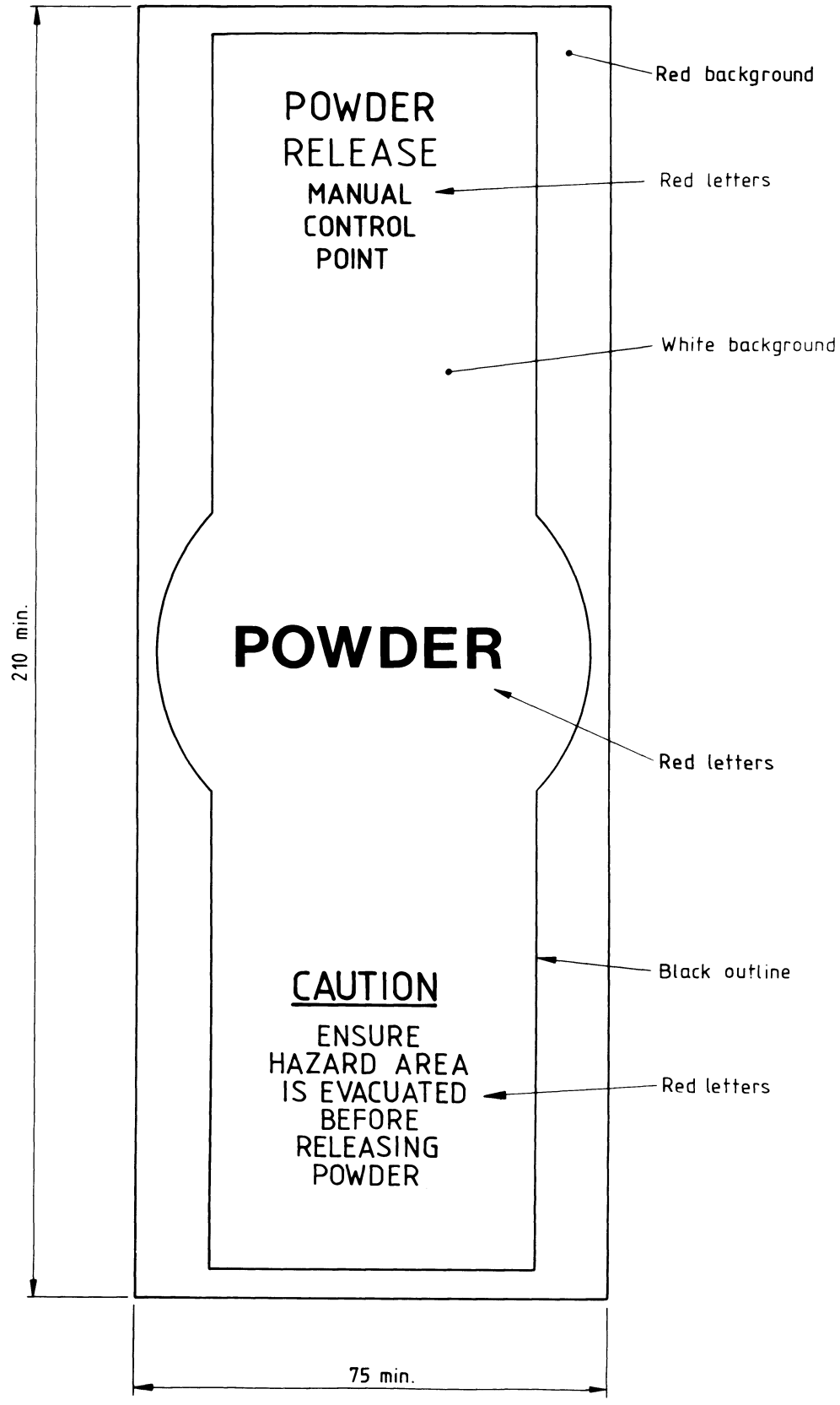
b) an area, in which personnel are normally present, protected by or adjacent to a local application system;

there shall be a system status lamp unit having the following indications:

1) red lamp: system discharged;

2) green lamp: manual control;

3) amber lamp: automatic and manual control.



All dimensions are in millimetres.

Figure 13 — Label for display at manual control (see **29.1.5**)

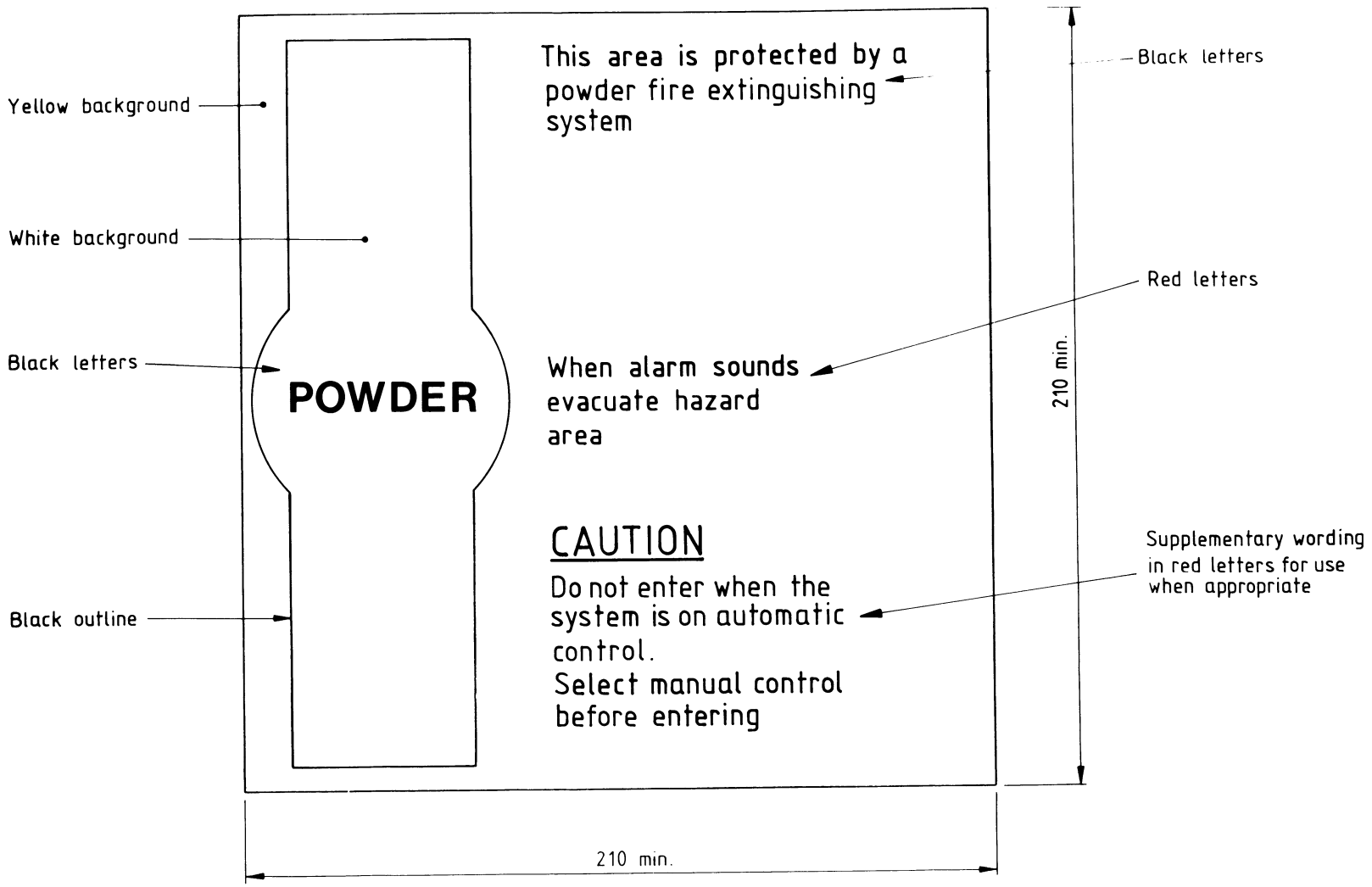


Figure 14 — Label for display at entrance to hazard (see **29.1.5**)

29.1.5 *Warning signs*. Appropriate and suitable signs shall be prominently displayed at each point of entry to a protected space, and at each manual control point.

COMMENTARY AND RECOMMENDATIONS ON **29.1.5**.
The signs shown in Figure 13 and Figure 14 are recommended for these purposes.

29.1.6 *Exits*. Adequate means of egress from a protected space shall be provided. Doors at exits shall open outwards and shall be self-closing. All exit doors shall open readily from the inside and any that have to be secured shall be fitted with panic bolts or latches.

COMMENTARY AND RECOMMENDATIONS ON **29.1.6**.
These requirements are in addition to any imposed under the Fire Precautions Act 1971 and other relevant legislation.

The means of egress from a protected space should be kept clear at all times.

BS 5725-1 gives requirements for panic bolts and latches operated by a horizontal push-bar.

29.1.7 *Venting indication*. Systems with closed pipework which is not normally pressurized shall be fitted with a device which will indicate the accidental release of propellant or powder into the closed pipework.

29.1.8 *Electrical earthing*. All exposed metalwork in systems that are housed near, or in buildings or premises with, electrical installations shall be efficiently earthed to prevent the metalwork becoming electrically charged.

COMMENTARY AND RECOMMENDATIONS ON **29.1.8**.
Where the electrical installation is covered by the Regulations for Electrical Installations (Wiring Regulations), the powder system metalwork should be efficiently connected to the main earthing terminal of the electrical installation, as required by the Wiring Regulations (15th edition).

Adequate earthing of systems, wherever located, will minimize the risk of electrostatic discharge.
BS 5958-1 gives basic information on earthing practice.

29.1.9 *Electrical hazards*. Where exposed electrical conductors are present, clearances no smaller than those given in Table 2 shall be provided, where practicable, between the electrical conductors and all parts of the system that may be approached during maintenance. Where these clearance distances cannot be achieved, warning notices shall be provided and a safe system of maintenance work shall be adopted.

COMMENTARY AND RECOMMENDATIONS ON **29.1.9**.
The system should be so arranged that all normal operations can be carried out with safety to the operator.

Where systems are to be installed in substations or switchrooms, reference should be made to BS 162.

29.2 Total flooding systems

29.2.1 *Areas normally occupied*. The system shall be provided with a device which may be used to prevent automatic discharge of the system, while retaining the detection and alarm facilities.

COMMENTARY AND RECOMMENDATIONS ON **29.2.1**.
Entry into a protected space or adjacent area that could be rendered hazardous by discharging of the system should normally only be made when the total flooding system has been placed under manual control.

The system should be returned to fully automatic control only when all persons have left the space.

Table 2 — Safety clearances to enable operation, inspection, cleaning, repairs, painting and normal maintenance work to be carried out

Rated voltage	Minimum clearance from any point on or about the permanent equipment where a person may be required to stand (measured from position of the feet)	
	To the nearest unscreened live conductor in air (section clearance)	To the nearest part not at earth potential of an insulator[a] supporting a live conductor (ground clearance)
kV	m	m
Up to 11		
15	2.59	
22		
33	2.74	
44	2.89	
66	3.05	
88	3.20	2.44
110	3.35	
132	3.50	
165	3.81	
220	4.27	
275	4.57	

NOTE See notes to definitions 30 and 31 and to clause **34** of BS 162:1961 from which this table is derived.

[a] The term insulator includes all forms of insulating supports, such as pedestal and suspension insulators, bushings, cable sealing ends and the insulating supports of certain types of circuit breaker.

29.2.2 *Areas not normally occupied but which may be entered*. Systems shall be provided with a device which may be used to prevent automatic discharge of the system, while retaining the manual operation, detection and alarm facilities.

COMMENTARY AND RECOMMENDATIONS ON **29.2.2**. *During periods of entry, the automatic discharge should be prevented. The system should be returned to automatic control as soon as all persons have left the space.*

29.3 Local application systems

Any device provided which may be used to prevent automatic discharge of the system shall retain the manual operation, detection and alarm facilities.

COMMENTARY AND RECOMMENDATIONS ON **29.3**. *A local application system normally presents a lower risk to personnel than a total flooding system; however when unusual circumstances make it difficult for personnel to leave the protected space when the system discharges, e.g. during difficult maintenance work, the system should be provided with a device which may be used to prevent automatic discharge of the system.*

The system may normally be on automatic control if, after considering the geometry of the area in which a local application system is used, it can be established that there is not a foreseeable risk of a hazardous discharge in any occupied part.

In assessing the degree of risk to personnel of automatically controlled systems, the need to approach close to the point of discharge or to work within the confines of the protected area should be considered. If it is necessary for personnel to work within an area that is likely to be quickly enveloped with powder, consideration should be given to providing a pre-discharge alarm that gives sufficient warning to allow personnel to move away from the protected area before the system is discharged.

30 Containers

30.1 Powder containers

Powder containers shall comply with either BS 5500 or, if the gross mass of the charged container does not exceed 23 kg, the relevant requirements of BS 5423. Where more than one powder container is used in a system, each container shall be provided with a dedicated nozzle or nozzles.

COMMENTARY AND RECOMMENDATIONS ON **30.1**. *The capacity of containers should be sufficient to hold the full charge of powder without compaction.*

Dedicated nozzles are provided so that there is no pipework common to more than one container, an arrangement which gives unreliable discharge.

30.2 Propellant gas containers

Propellant gas containers shall comply with one of the following:

a) BS 5045-1;

b) BS 5045-2;

c) BS 5045-3;

d) BS 5045-5;

e) BS 5045-6.

In systems using more than one gas container each shall be connected to the manifold via a non-return valve.

Gas containers shall be secured against reaction to prevent movement when the gas is discharged.

COMMENTARY AND RECOMMENDATIONS ON **30.2**. *The provision of non-return valves enables individual containers to be removed from the system without interruption of the general protection.*

30.3 Location and storage conditions

Arrangements shall be made to maintain powder and propellant containers within the recommended temperature range.

COMMENTARY AND RECOMMENDATIONS ON **30.3**. *External heating or cooling may be used to keep the temperature within the range. The recommended limits are*:

a) *for systems not using carbon dioxide: not more than* 55 °C *and not less than* – 30 °C;

b) *for systems using carbon dioxide: not more than* 55 °C *and not less than* 0 °C.

Containers and accessories should be so located and arranged that inspection, testing, recharging and other maintenance is facilitated and interruption to protection is kept to a minimum.

Containers should be located as near as possible to the hazard or hazards they protect, but preferably outside the hazard area, and they should not be exposed to fire in a manner that is likely to impair system performance.

Containers should be located so as to be protected from severe weather conditions or the risk of mechanical, or other damage. Suitable guards or enclosures should be provided where necessary.

Containers should be protected from direct sunlight and from interference by unauthorized persons. The area should be dry and ventilated.

30.4 Colour and marking of powder and gas containers

Where no confusion may arise with any colour coding scheme in use on the premises, containers shall be coloured and marked as given in Table 3.

30.5 Indication of correct content

Carbon dioxide propellant containers shall be marked with the design mass, i.e. the tare plus the mass of carbon dioxide when correctly filled.

Table 3 — Colour and marking of powder and gas containers

Container	Colour	Marking
Powder container	Signal red complying with reference 537 of BS 381C	Type and quantity of powder and working pressure
Propellant containers used exclusively for fire extinguishing purposes	Signal red complying with reference 537 of BS 381C	Identification and quantity of propellant and working pressure
Propellant containers containing an industrial gas and which are not made or supplied exclusively for fire extinguishing purposes	As specified in BS 349	As specified in **30.5** and in BS 349 and BS 5045

Propellant containers (except carbon dioxide containers) and powder containers shall be fitted with a pressure gauge suitable for indicating the pressure through the service temperature range.

31 Pipework design

31.1 General

Pipework shall be non-combustible and shall be able to withstand the expected pressures and temperatures without damage. It shall be suitably protected against both internal and external corrosion.

COMMENTARY AND RECOMMENDATIONS ON **31.1**. *In stored pressure systems the expected pressure should be taken as the system working pressure at* 55 °C.

In gas container systems two levels of expected pressure need to be considered:

a) *the propellant container working pressure at* 55 °C, *applicable to pipework between the propellant containers and the pressure reducing valve; and*

b) *the system working pressure at* 55 °C, *applicable to pipework downstream of the pressure reducing valve.*

Black carbon steel pipework may be used in clean and dry environments where no corrosive elements are present.

31.2 Pipe

Carbon steel pipe shall comply with either BS 1387 for heavyweight grade tubes or BS 3601 for schedule 40 wall thickness tubes.

Stainless steel pipe shall comply with BS 3605.

Copper alloy pipe shall comply with BS 2871-2.

COMMENTARY AND RECOMMENDATIONS ON **31.2**. *The grade of stainless steel or copper alloy to be used should be chosen in consultation with the supplier to suit the environmental conditions in which it is to be installed.*

31.3 Flanges

Flanges shall comply with BS 4504 and shall be of a rating suitable for the expected pressures and temperatures.

31.4 Flange jointing

Bolts, studs and nuts shall comply with BS 4882. Washers shall comply with BS 4320 or BS 3410, as appropriate. Gaskets shall comply with BS 2815.

31.5 Fittings

Pipe fittings shall be either screwed or welded and shall be of a rating suitable for the expected pressures and rating.

Malleable iron screwed fittings shall comply with BS 143 & BS 1256 for fittings with taper threads complying with BS 21.

Wrought steel screwed fittings shall comply with BS 1740.

Butt-welded fittings shall comply with grades WPA or WPB of BS 1640-3.

COMMENTARY AND RECOMMENDATIONS ON **31.5**. *The choice of screwed or welded fittings will depend on location and circumstances.*

32 Installation of pipework

32.1 General

Before final assembly, pipe and fittings shall be dry and shall be inspected visually to ensure that no foreign matter is inside and the full bore is clean. After assembly the system shall be thoroughly blown through.

Where pipes and associated fittings are to be concealed, provision shall be made for access to them at all times.

COMMENTARY AND RECOMMENDATIONS ON **32.1**. *The following guidelines should be followed to help to ensure a workable piped system:*

a) *do not use reducing bushings;*

b) *use right angle tees of suitable size for all pipe splits;*

c) *ensure a minimum five thread engagement of pipe in fittings;*

d) *use thread compound sparingly and only on male threads.*

Figure 1 and Figure 2 show acceptable and non-acceptable methods respectively of connecting piping.

32.2 Pipework supports

The maximum distance between supports to take into account the total mass of pipe and powder shall be as given in Table 4.

Table 4 — Maximum pipework spans

Pipe size	Maximum pipework span
mm	m
12	1.2
15	1.5
20	1.8
25	2.1
32	2.4
40	2.7
50	3.4
80	3.7
100	4.3

COMMENTARY AND RECOMMENDATIONS ON **32.2**. *It is important to ensure that pipework is securely supported, making due allowance for expansion and contraction.*

Additional supports should be provided where there are extra loads such as valves. If the pipework is located in a potentially explosive risk area, the piping system should be hung from supports that are least likely to be displaced.

32.3 Welding of pipework

Welding shall comply with BS 2633 or BS 4677 for metal arc welding or with BS 1821 for oxy-acetylene welding.

COMMENTARY AND RECOMMENDATIONS ON **32.3**. *Seats and seals that can be damaged by heat should be removed during welding operations on adjacent pipework.*

32.4 Distribution valves

If several hazards are protected separately but connected to one powder supply source, a distribution valve shall be provided for each hazard. Valves shall be provided with a manual means of opening.

All valves shall be suitable for the intended use, particularly in respect of flow capacity and operation.

Valves used shall be suitable for use at the working pressure of the powder container at 55 °C.

32.5 Discharge nozzles

Discharge nozzles shall be of corrosion resistant material and shall be of adequate strength to withstand expected working temperatures and pressures.

Discharge nozzles shall be permanently marked with the equivalent single orifice diameter. The markings shall be readily discernible after installation.

Discharge nozzles shall be provided with frangible discs or blow-out caps where clogging by foreign materials is likely. These devices shall provide an unobstructed system operation.

COMMENTARY AND RECOMMENDATIONS ON **32.5**. *Nozzles should be installed in elbows turned vertically down, unless otherwise specified by the nozzle supplier.*

32.6 Marking of pipework

All powder distribution pipework shall be painted signal red in accordance with reference 537 of BS 381C (equivalent to 04 E 53 of BS 4800).

Appendix A Basis for design

A.1 Total flooding method

A curve of the limiting conditions for extinction, of the type shown in Figure 15, can be experimentally determined for a powder. For total flooding systems extinction is dependent on the achievement of a sufficient concentration of powder throughout the enclosure. The curve is bounded by the minimum quantity required at high application rates, and by the critical rate when large quantities of powder are required.

To give safe design conditions factors of safety are applied as follows:

minimum design quantity = twice the experimental minimum quantity;

minimum design rate = twice the experimental critical rate.

These safe design conditions are shown in Figure 15.

The design conditions are usually presented in the form:

minimum quantity = constant × volume of enclosure;

minimum rate = constant × volume of enclosure.

Additional allowance is made for loss of powder through openings and by ventilation.

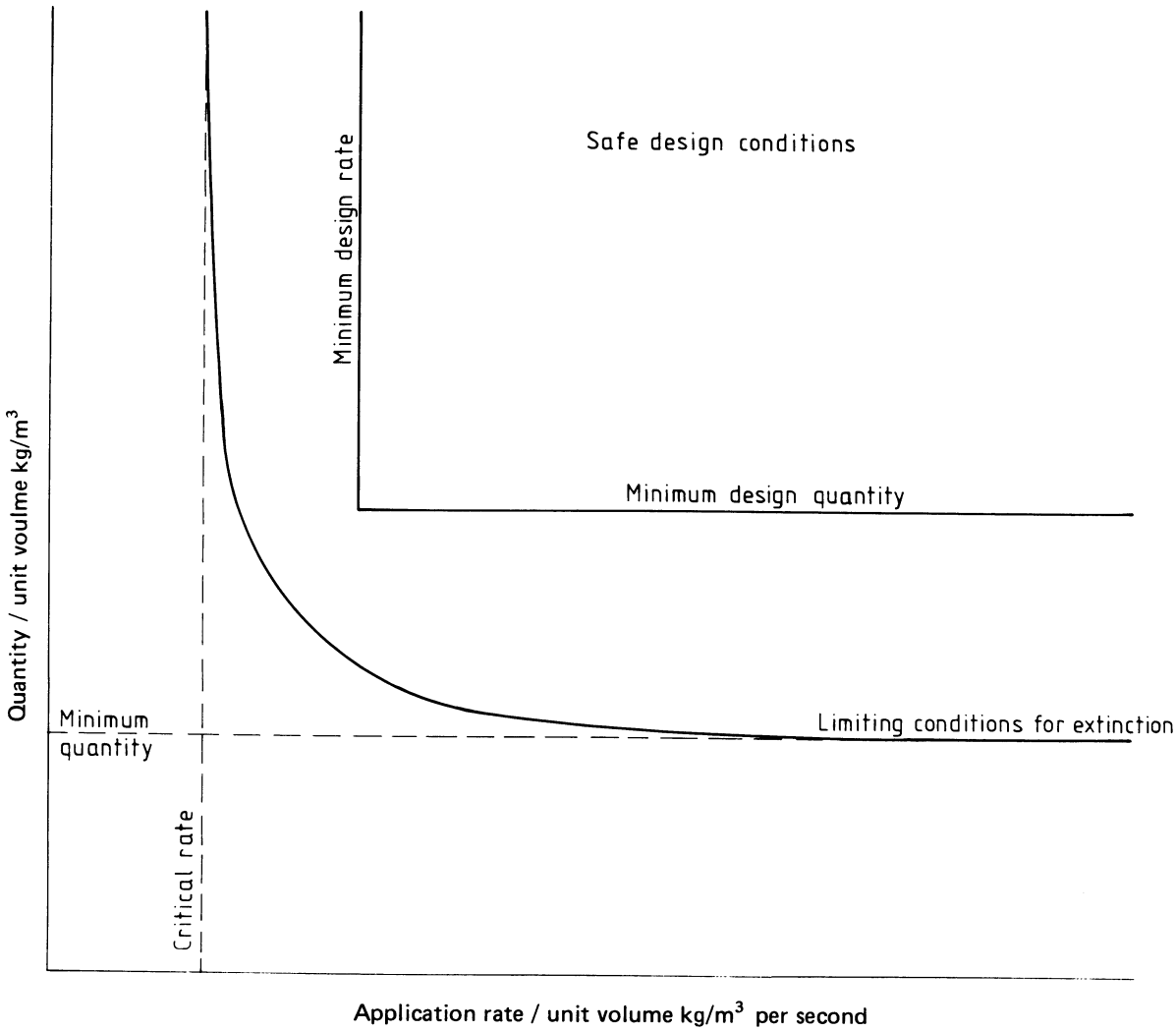


Figure 15 — Extinction conditions for total flooding

A.2 Local application method

Extinction is dependent on the achievement of a sufficient concentration of powder across the area of the fire for a minimum time. In Figure 16 the curve shows the limiting conditions for extinction of a particular area of fire when using a particular powder. The curve is bounded by:

a) the minimum quantity required at the optimum application rate;

b) by the critical rate (when large quantities of powder are required);

c) by a line showing the increased quantities required as the rate increases above the optimum.

Condition c) arises because there is a minimum discharge time, related to the time needed to establish the extinguishing concentration of powder across the fire and the time for which it needs to be maintained, below which extinction is not achieved.

To give safe design conditions factors of safety are applied so that:

minimum design quantity	=	twice minimum quantity experimentally determined;
minimum design rate	=	twice minimum rate, experimentally determined, for the minimum design quantity;
maximum design rate (at minimum design quantity)	=	1.5 times minimum design rate;

This corresponds to:

minimum discharge time	=	0.67 times discharge time at minimum design quantity and minimum design rate.

The fixed minimum discharge time for a given area gives a maximum design rate which increases in proportion to the design quantity, and which is approximately half the experimental limiting maximum value.

These safe design conditions are represented in Figure 16.

The limiting conditions for extinction depend on the method of application (overhead or tankside nozzles), whether the fire is indoors or outdoors, as well as the type of powder and the area of fire. Considerable experimental work may be necessary to establish the safe design conditions for a particular powder. Design conditions are conveniently presented in the form of graphs showing the minimum quantity, minimum rate, and minimum discharge time, plotted against the area of fire, as in Figure 5 to Figure 12.

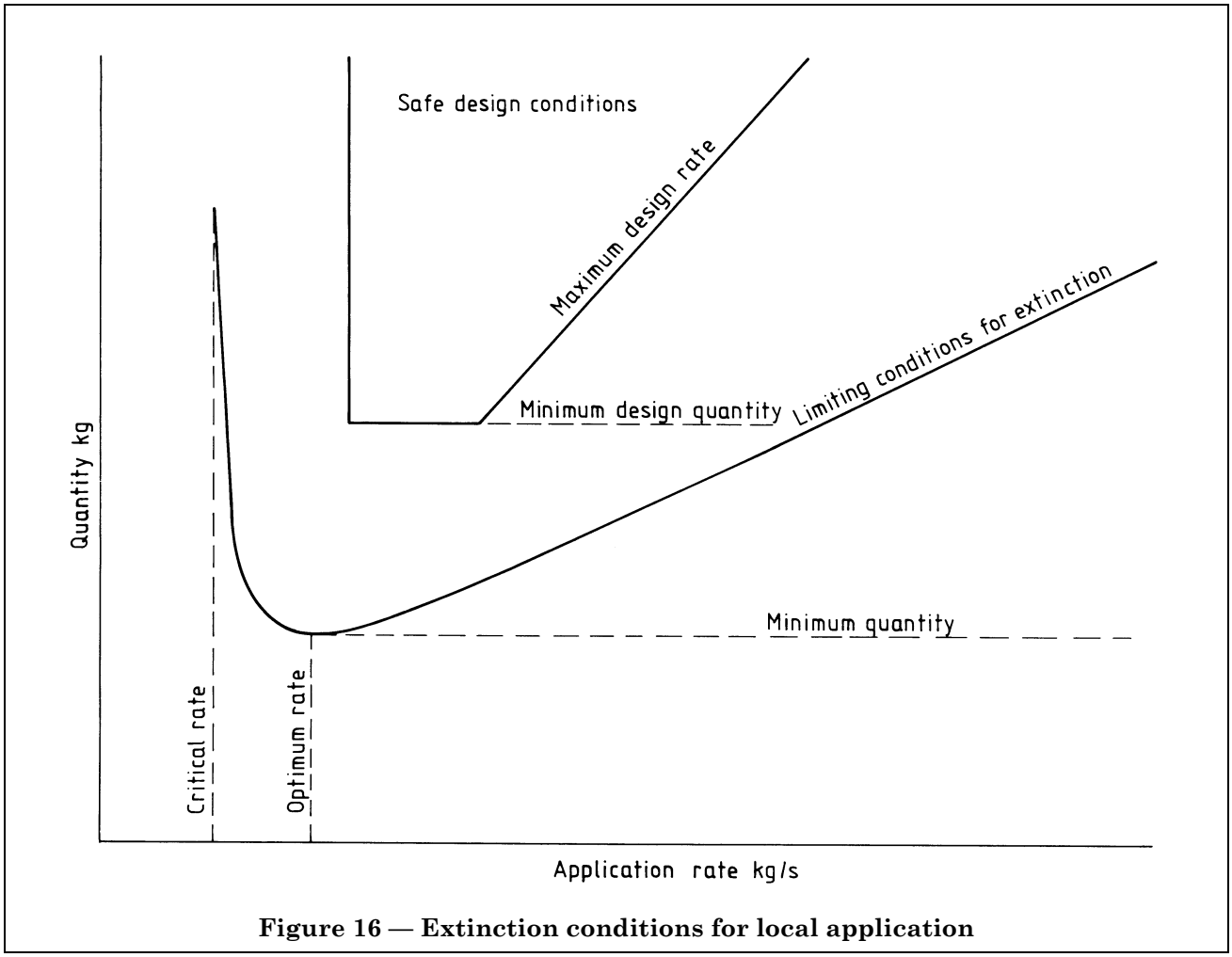


Figure 16 — Extinction conditions for local application

Publications referred to

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).*

BS 143 & BS 1256, *Specification for malleable cast iron and cast copper alloy threaded pipe fittings.*

BS 162, *Specification for electric power switchgear and associated apparatus.*

BS 349, *Specification for identification of the contents of industrial gas containers.*

BS 381C, *Specification for colours for identification, coding and special purposes.*

BS 476, *Fire tests on building materials and structures.*

BS 476-4, *Non-combustibility test for materials.*

BS 476-21, *Methods for determination of the fire resistance of loadbearing elements of construction.*

BS 476-22, *Methods for determination of the fire resistance of non-loadbearing elements of construction.*

BS 1387, *Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.*

BS 1640, *Specification for steel butt-welding pipe fittings for the petroleum industry.*

BS 1640-3, *Wrought carbon and ferritic alloy steel fittings. Metric units.*

BS 1740, *Specification for wrought steel pipe fittings (screwed BS 21 R-series thread).*

BS 1821, *Specification for class 1 oxy-acetylene welding of ferritic steel pipework for carrying fluids.*

BS 2633, *Specification for class 1 arc welding of ferritic steel pipework for carrying fluids.*

BS 2815, *Specification for compressed asbestos fibre jointing.*

BS 2871, *Specification for copper and copper alloys. Tubes.*

BS 2871-2, *Tubes for general purposes.*

BS 3169, *Specification for first aid reel hoses for fire-fighting purposes.*

BS 3410, *Specification for metal washers for general engineering purposes.*

BS 3601, *Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes.*

BS 3605, *Specification for seamless and welded austenitic stainless steel pipes and tubes for pressure purposes.*

BS 4320, *Specification for metal washers for general engineering purposes. Metric series.*

BS 4422, *Glossary of terms associated with fire.*

BS 4422-4, *Fire protection equipment.*

BS 4504, *Specification for flanges and bolting for pipes, valves and fittings. Metric series.*

BS 4547, *Classification of fires.*

BS 4586, *Specification for spiral wire reinforced rubber covered hydraulic hoses and hose assemblies.*

BS 4677, *Specification for arc welding of austenitic stainless steel pipework for carrying fluids.*

BS 4800, *Specification for paint colours for building purposes.*

BS 4882, *Specification for bolting for flanges and pressure containing purposes.*

BS 5045, *Transportable gas containers.*

BS 5045-1, *Specification for seamless steel gas containers above 0.5 litre water capacity.*

BS 5045-2, *Steel containers up to 130 litres water capacity with welded seams.*

BS 5045-3, *Specification for seamless aluminium alloy gas containers above 0.5 litre water capacity and up to 300 bar charged pressure at 15 °C .*

BS 5045-5, *Specification for aluminium alloy containers above 0.5 litre up to 130 litres water capacity with welded seams.*

BS 5045-6, *Specification for seamless containers of up to and including 0.5 litre water capacity.*

BS 5306, *Fire extinguishing installations and equipment on premises.*

BS 5306-3, *Code of practice for selection, installation and maintenance of portable fire extinguishers.*

BS 5423, *Specification for portable fire extinguishers.*

BS 5430, *Specification for periodic inspection, testing and maintenance of transportable gas containers (excluding dissolved acetylene containers).*

BS 5430-1, *Seamless steel containers.*
BS 5430-2, *Welded steel containers of water capacity 1 litre up to 130 litres.*
BS 5430-3, *Seamless aluminium alloy containers.*
BS 5499, *Fire safety signs, notices and graphic symbols.*
BS 5499-1, *Specification for fire safety signs.*
BS 5500, *Specification for unfired fusion welded pressure vessels.*
BS 5725, *Emergency exit devices.*
BS 5725-1, *Specification for panic bolts and panic latches mechanically operated by a horizontal push-bar.*
BS 5839, *Fire detection and alarm systems for buildings.*
BS 5839-1, *Code of practice for system design installation and servicing.*
BS 5839-2, *Specification for manual call points.*
BS 5958, *Code of practice for control of undesirable static electricity.*
BS 5958-1, *General considerations.*
BS 6535, *Fire extinguishing media.*
BS 6535-1, *Specification for carbon dioxide.*
BS 6535-3, *Specification for fire extinguishing powders*[5)].
PD 6501, *The preparation of British Standards for building and civil engineering*[6)].
PD 6501-1, *Guide to the types of British Standard, their aims, relationship, content and application.*
Regulations for Electrical Installations (Wiring Regulations), 15th edition, Institution of Electrical Engineers, Publications Sales Department, Station House, Nightingale Road, Hitchin, Herts. SG5 1RJ.

[5)] In preparation.
[6)] Referred to in the foreword only.

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