

ENGINEERING STANDARD

FOR

DRY CHEMICAL FIRE EXTINGUISHING

SYSTEMS

CONTENTS :

PAGE No.

0. INTRODUCTION	3
1. SCOPE	4
2. SOURCES AND REFERENCES	4
3. DEFINITIONS AND TERMINOLOGY	4
4. UNITS	6
5. GENERAL INFORMATION AND REQUIREMENTS.....	6
6. POWDER.....	7
6.1 General	7
6.2 Classification	7
6.3 Chemical Composition	8
6.4 Particle Size	9
7. DRY CHEMICAL AND EXPELLANT GAS SUPPLY.....	9
7.1 Quantity	9
7.2 Quality	9
7.3 Reserve Supply	10
7.4 Storage	10
7.5 Container	10
7.6 Propellant	10
8. GENERAL DESIGN PRINCIPLES.....	10
8.1 Steady Flow	10
8.2 Flow Distribution.....	12
8.3 Calculation and Design	14
8.4 Hazards to Personnel	14
8.5 Contamination.....	14
9. TYPES OF SYSTEM.....	15
9.1 Systems Protecting One or More Hazards.....	15
9.2 Hose Reel.....	15
10. TOTAL FLOODING SYSTEMS.....	15
10.1 Use of Total Flooding Systems.....	15
10.2 Design Conditions	15
10.3 Enclosure	18
10.4 Nozzle Selection and Distribution.....	18
10.5 Leakage and Ventilation	19

11. LOCAL APPLICATION SYSTEMS.....	19
11.1 Use of Local Application Systems.....	19
11.2 Design Conditions	19
11.3 Nozzle Selection and Distribution.....	22
12. MONITOR AND HOSE REEL SYSTEMS.....	22
12.1 Use of Monitor and Hose Reel Systems.....	22
12.2 Location and Spacing of Monitors and Hose Reels.....	22
12.3 Rate of Discharge.....	22
12.4 Minimum Quantity.....	22
12.5 Hose Reel Design.....	23
12.6 Monitor Design.....	23
12.7 Jetty Deck	23
13. ALARMS AND INDICATORS	23
14. SAFETY PRECAUTIONS.....	24

APPENDICES :

APPENDIX A	26
APPENDIX B	30

0. INTRODUCTION

"Fire Fighting and Fire Protection Systems" are broad and contain variable subjects of paramount importance therefore, a group of engineering standards are prepared to cover the subject.

This group includes the following standards:

STANDARD CODE	STANDARD TITLE
IPS-E-SF-120	"Off-Shore Installations Fire Fighting & Fire Protection"
IPS-E-SF-140	"Foam Generating and Proportionating Systems"
IPS-E-SF-160	"CO ₂ Gas Fire Extinguishing Systems"
IPS-E-SF-180	"Dry Chemical Fire Extinguishing Systems"
IPS-E-SF-200	"Fire Fighting Sprinkler Systems"
IPS-E-SF-220	"Fire Water Distribution and Storage Facilities"
IPS-E-SF-240	"Fire Water Pump Systems"
IPS-E-SF-260	"Automatic Detectors and Fire Alarm Systems"
IPS-E-SF-280	"Telecommunication for Fire Fighting Systems"
IPS-E-SF-300	"Application of Breathing Apparatus in Safety and Fire Fighting"
IPS-E-SF-320	"Tugs, Fire-Fighters and other Off-Shore Harbour Vessels"
IPS-E-SF-340	"Fire Fighting Hose Houses"

This Standard covers:

"Dry Chemical Fire Extinguishing Systems"

1. SCOPE

This Standard specifies the minimum requirements for powder fire extinguishing systems which discharge powder 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 contained systems, with maximum working pressures not exceeding 25 bar at maximum ambient temperature.

This Standard does not deal with powder portable fire extinguishers.

2. SOURCES AND REFERENCES

2.1 Sources

In preparation of this Standard, in addition to the Referenced Codes and Standards mentioned in 2.2, the following standards and publications have also been considered:

BSI (BRITISH STANDARDS INSTITUTION)

BS 5306 pt 7 "Specification for Powder Systems"

NFC (NFPA) (NATIONAL FIRE CODES)

Volume 1 section 17 "Dry Chemical Extinguishing Systems"

Volume 7 code 480 "Dry Powder for Magnesium"

3. DEFINITIONS AND TERMINOLOGY

Auxiliary Equipment

Listed equipment used in conjunction with the dry chemical systems, i.e. to shut down powder, fuel or ventilation to the hazard being protected or to initiate signaling devices.

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.

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.

Caking

A phenomenon that occurs when moisture chemically reacts with a dry chemical fire extinguishing agent. This reaction results in materials that, being hydrated by moisture, stick together to form a large agglomerate, or what is more commonly referred to as lumps. For the purpose of this standard, lumps are defined as those that do not crumble into particles when dropped from a height of (101 mm) onto a hard surface.

Calculation and Design

The process of computing with the use of equations, graphs, or tables, the system characteristics such as flow rate, pipe size, area or volume protected by each nozzle, nozzle pressure, and pressure drop. This information is not required for listed pre-engineered systems since these systems must be installed in accordance with their pretested limitations described in the manufacturer's installation manual.

Deep-seated Fire

A fire involving solids subject to smoldering.

Dry Chemical

A powder composed of very small particles, usually of sodium bicarbonate, potassium bicarbonate, urea-potassium based bicarbonate, potassium chloride, or mono ammonium phosphate with added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption (caking) and the proper flow capabilities.

Dry Chemical System

A supply of dry chemical which can be automatically or manually activated to discharge through a distribution system onto or into the protected hazard. The system can also include auxiliary equipment.

Engineered System

Those requiring individual calculation and design to determine the flow rates, nozzle pressures pipe size, area or volume protected by each nozzle, quantities of dry chemicals, and the number and types of nozzles and their placement in a specific system.

Gas Container System

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

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.

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.

Manual System

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

Monitor System

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

Stored Pressure System

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

Surface Fire

A fire involving flammable liquids, gases or solids not subject to smoldering.

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.

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.

4. UNITS

International System of Units (SI) in accordance with IPS-E-GN-100 shall be used.

5. GENERAL INFORMATION AND REQUIREMENTS**5.1 Dry Chemical**

The type of dry chemical used in the system shall not be changed unless proved to be changeable by a testing laboratory, recommended by the manufacturer of the equipment, and approved by the IPI authorities. Systems are designed on the basis of the flow and extinguishing characteristics of a specific make and type of dry chemical.

Caution:

Types of dry chemical shall not be mixed. Mixtures of certain dry chemicals will generate dangerous pressures and will form lumps.

5.2 Use and Limitations**5.2.1 Use**

Types of hazards and equipment which can be protected using dry chemical extinguishing systems include the following:

- a) flammable or combustible liquids and combustible gases.

Caution:

Extinguishment of uncontrolled discharge of flammable liquids or combustible gases can result in a subsequent explosion hazard.

- b) combustible solids having burning characteristics similar to naphthalene and pitch, which melt when involved in fire;

- c) electrical hazards such as transformers or oil circuit breakers
- d) ordinary combustibles such as wood, paper, or cloth using multipurpose dry chemical when it can reach all surfaces involved in combustion;
- e) restaurant and commercial hoods, ducts and associated cooking appliance hazards such as deep fat fryers;
- f) some plastics, depending upon the type of material and its configuration of hazard. For more specific information, consult the manufacturer of the equipment.

5.2.2 Limitations

Dry chemical extinguishing systems shall not be considered satisfactory protection for the following:

- a) Chemicals containing their own oxygen supply, such as cellulose nitrate.
- b) Combustible metals such as sodium, potassium, magnesium, titanium, and zirconium.
- c) Deep-seated or burrowing fires in ordinary combustibles where the dry chemical cannot reach the point of combustion.

5.2.2.1 Before dry chemical extinguishing equipment is considered for use to protect electronic equipment or delicate electrical relays, the effect of residual deposits of dry chemical on the performance of this equipment shall be evaluated.

5.2.2.2 Multipurpose dry chemical shall not be considered satisfactory for use on machinery such as delicate electrical equipment because, upon exposure to temperatures in excess of (121°C) or relative humidity in excess of 50 percent, deposits will be formed which will be corrosive, conductive and difficult to remove.

5.2.2.3 Dry chemical, when discharged, will drift from the immediate discharge area and settle on surrounding surfaces. Prompt cleanup will minimize possible staining or corrosion of certain materials which may take place in the presence of moisture.

5.3 Pre-engineered Systems

Those having predetermined flow rates, nozzle pressures, and quantities of dry chemical. These systems have the specific pipe size, maximum and minimum pipe lengths, flexible hose specifications, number of fittings and number and types of nozzles prescribed by a testing laboratory. The hazards protected by these systems are specifically limited as to type and size by a testing laboratory based upon actual fire tests.

Limitations on hazards which can be protected by these systems are contained in the manufacturer's installation manual which is referenced as part of the listing.

6. POWDER

6.1 General

Powder used for the initial supply shall be suitable for the system and for the intended use.

6.2 Classification

6.2.1 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 shall also be effective on surface fires of class A materials.

D Powders : suitable for use on class D fires.

The classes of fires are defined 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 or materials in contact with energized electrical power.

Class D: fires involving metals.

This Part of standard is concerned only with class B fires involving most liquids including gasoline (but excluding liquids of low fire point such as carbon disulfide) 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.

Dry powder chemical may contribute to damage the electrical equipment and should not be used on fires involving computers or delicate instrumentation.

6.2.2 A supply of extinguishing powder which require special engineering consideration and when approved for use on magnesium fire shall be kept within easy reach of each operator performing a machining, grinding, or other operation on magnesium. The powder shall be kept in suitable containers with easily removable covers and a hand scoop shall be provided at each container for application of the powder. Approved portable extinguishers designed for use with these powders shall replace the scoop and container.

6.2.3 The amount of extinguishing powder to be provided will depend on the amount of chips or turnings involved. Where conditions permit the development of a fire requiring a large quantity of powder, that quantity shall be provided and long handled shovels provided for its application. Heat-resistant gloves and face guards shall be available for protection of the personnel applying the powder.

6.2.4 Containers of extinguishing powder shall be plainly labeled.

6.2.5 Extinguishing powder shall be applied by making a ring around the fire with the powder and then spreading the powder evenly over the surface of the fire to a depth sufficient to smother it. Care shall be taken to avoid scattering the burning metal. If smoking continues in spots, more powder should be added as required. Where burning magnesium is on a combustible surface, a (25 to 50 mm) layer of powder shall be spread out nearby, after the fire has been covered as described above, and the burning metal shoveled onto this layer, with additional powder added as required.

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

6.3 Chemical Composition

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

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⁽¹⁾ is less effective than potassium bicarbonate⁽²⁾ but because sodium salts are less expensive they are generally prove cost effective, or is preferred for use on deep fat fryers where a surface layer of powder and saponified fat is produced which

reduces the possibility of reignition. Carbonate powders, which are mixtures or compounds of urea and bicarbonate, are more effective than the simple bicarbonates.

Mono ammonium phosphate⁽³⁾ 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.

Notes:

- 1) The preferred name for sodium bicarbonate is sodium hydrogen carbonate.
- 2) The preferred name for potassium bicarbonate is potassium hydrogen carbonate.
- 3) The preferred name for mono ammonium phosphate is ammonium dihydrogen orthophosphate.

For further information see data sheets in Appendices A and B.

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 powders 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.

6.4 Particle Size

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

7. DRY CHEMICAL AND EXPELLANT GAS SUPPLY

7.1 Quantity

The amount of dry chemical in the system shall be at least sufficient for the largest single hazard protected, or for the group of hazards which are to be protected simultaneously.

7.2 Quality

The dry chemical used in the system shall be supplied by the manufacturer of the equipment. The characteristics of the system are dependent upon the composition of the dry chemical and the type of expellant gas, as well as upon other factors, and, therefore, it is imperative to use the dry chemical provided by the manufacturer of the system and the type of expellant gas specified by the manufacturer of the system.

7.2.1 Where carbon dioxide or nitrogen is used as the expellant gas, it shall be of good commercial grade, free of water and other contaminants that might cause container corrosion.

7.3 Reserve Supply

Where a dry chemical system protects multiple hazards by means of selector valves, sufficient dry chemical and expellant gas shall be kept on hand for one complete recharge of the system. For single hazard systems, a similar supply shall be kept on hand if the importance of the hazard is such that it cannot be shut down until recharges can be procured.

7.4 Storage

Storage of charging supplies of dry chemical shall be in a constantly dry area, and the dry chemical shall be contained in metal drums or other containers which will prevent the entrance of moisture even in small quantities. Prior to charging the dry chemical chamber, the dry chemical shall be carefully checked to determine that it is in a flowing condition.

7.5 Container

The dry chemical container and expellant gas assemblies shall be located near the hazard or hazards protected, but not where they will be exposed to a fire or explosion in these hazards.

7.5.1 The dry chemical container and expellant gas assemblies shall be located so as not to be subjected to severe weather conditions, or to mechanical, chemical, or other damage. When excessive climatic or mechanical exposures are expected, suitable enclosures or guards shall be provided.

7.5.2 The dry chemical container and expellant gas assemblies utilizing nitrogen shall be located where the ambient temperature is normally, between (-40°C and 48.9°C). Assemblies utilizing carbon dioxide shall be located where the ambient temperature is normally between (0°C and 48.9°C). If temperatures are outside these limits, the equipment shall be listed for such temperatures, or methods shall be provided for maintaining the temperatures within the ambient ranges given.

7.5.3 The dry chemical container and expellant gas assemblies shall be located where they will be easy to inspect, maintain and service.

7.6 Propellant

The propellant shall be one, or more, of the gases listed in Table 1.

Carbon dioxide shall comply with IPS-E-SF-160.

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

8. GENERAL DESIGN PRINCIPLES

8.1 Steady Flow

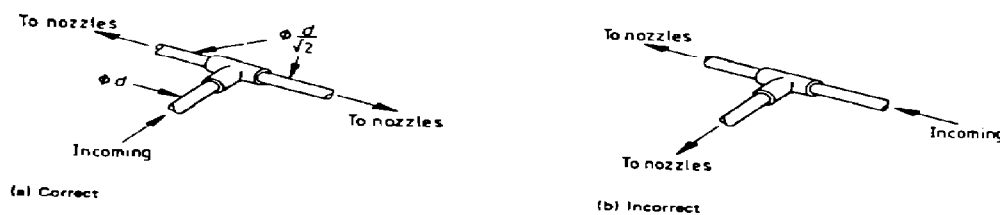
Systems shall maintain non-surfing two phase flow of powder and propellant, without separation.

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 at constant pipe diameter). 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 Fig. 1(a)).

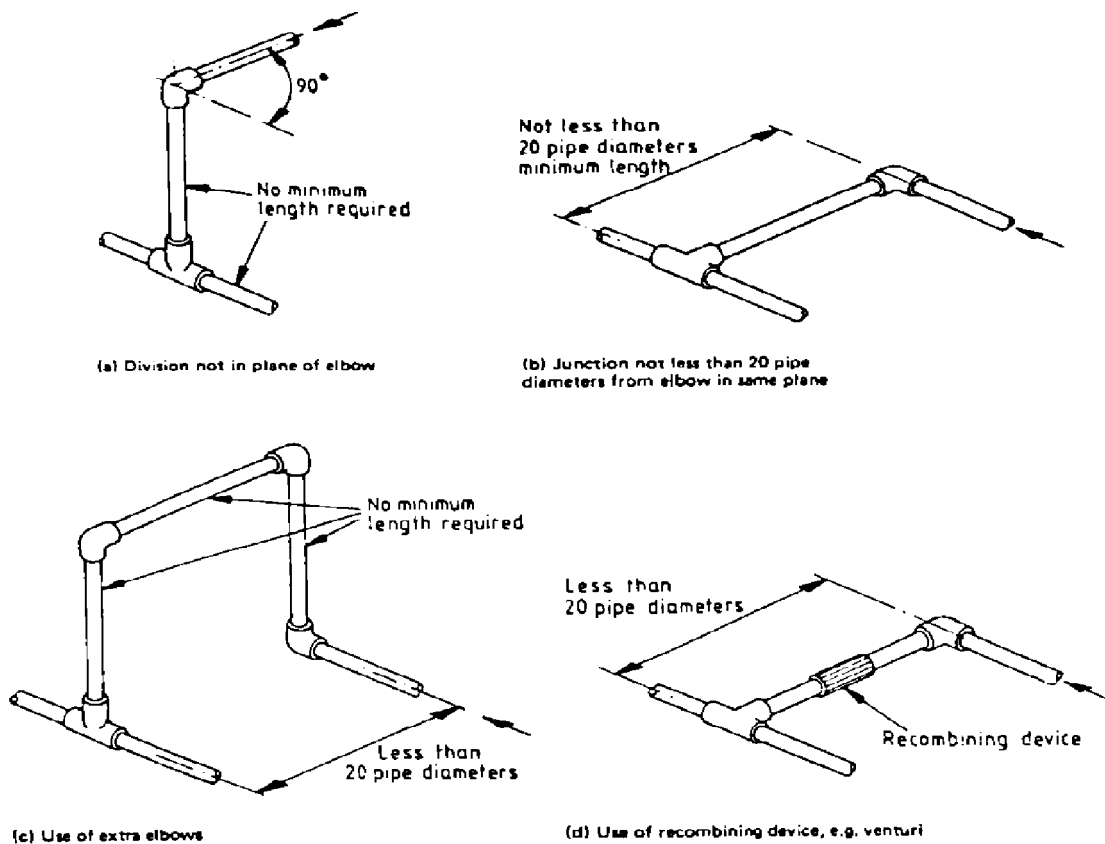
Separation will occur at points where the direction of flow changes and the following principles should be observed to minimize and compensate for this effect.

- 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 Fig. 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 shall 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 shall occur. Fig. 2 shows the correct arrangements to avoid this.
- d) Nozzles should be mounted in elbows on the pipe.



DIRECTION OF FLOW THROUGH TEES (SEE 8.1)

Fig. 1



CORRECTION FOR SEPARATION AT ELBOWS (SEE 8.2)

Fig. 2

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.

8.2 Flow Distribution

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

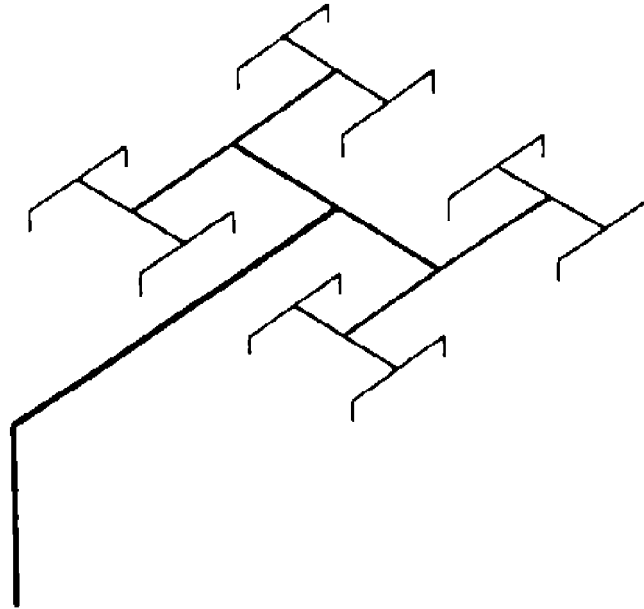
Even distribution of flow is more easily achieved in balanced systems. Unbalanced systems are more difficult to design, are more likely to have variable and unpredictable performance and are more likely to have fluctuating rates of discharge from the nozzles.

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 Fig. 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.

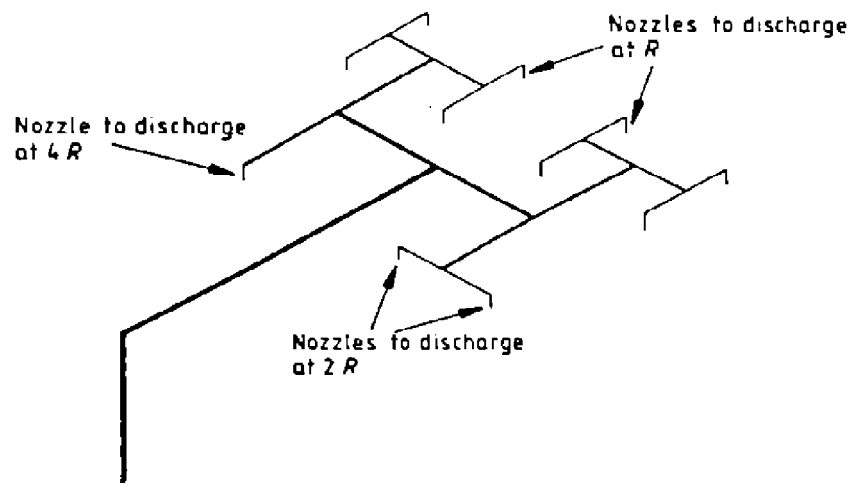
Where nozzles of differing discharge rates are used the system will be non-symmetrical. Such a system can be balanced by selecting the larger nozzles to discharge at 2, 4, 8, etc. times the rate r of the smallest. The orifice diameters will be less than 2, 4, 8, etc. times that of the smallest nozzle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



NOTE. All nozzles discharge at the same rate R .

SYMMETRICAL BALANCED SYSTEM (SEE 8.2)

Fig. 3



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

NON-SYMMETRICAL BALANCED SYSTEM (SEE 8.2)

Fig. 4

8.3 Calculation and Design

The process of computing with the use of equations, graphs, or tables, the system characteristics such as flow rate, pipe size, area or volume protected by each nozzle, nozzle pressure, and pressure drop, is not required for listed pre-engineered systems since these systems must be installed in accordance with their pretested limitations described in the manufacturer's installation manual.

8.4 Hazards to Personnel

Powders shall not present a toxic hazard. 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 will 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.

8.5 Contamination

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

The powder discharged from a system will cover all exposed surface 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.

9. TYPES OF SYSTEM

For the purposes of this Part of standard 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.

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.

9.1 Systems Protecting One or More Hazards

If more than one hazard is involved simultaneously in fire by reason of their proximity, the hazards shall be protected by individual systems installed to operate simultaneously, or by a single system designed to protect all hazards that may be simultaneously involved. Any hazard which will allow fire propagation from one area to another shall constitute a single fire hazard.

9.2 Hose Reel

Where manual hose reel system is used on a hazard that is also protected by a fixed system, separate dry chemical supplies shall be provided.

Exception:

If a single dry chemical supply is used for both a hose reel system and a fixed nozzle system, the hazards protected by the two systems shall be separated so that the hose reel cannot be simultaneously used on the hazard protected by the fixed monitor system.

10. TOTAL FLOODING SYSTEMS

10.1 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 9.3).

Fires that can be extinguished by total flooding are surface fires involving flammable liquids and solids.

10.2 Design Conditions

10.2.1 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.

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.

10.2.2 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.

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 Fig. 5. The powder manufacturer should be consulted for the appropriate design criteria. For good quality sodium bicarbonate based powder the following may be used:

$$\begin{aligned} M_1 \text{ (in kg)} &= 0.65 \times \text{enclosure volume (in m}^3\text{)}; \\ M_2 \text{ (in kg)} &= 2.5 \times \text{area of openings (in m}^2\text{) (each less than 5\%)}; \\ M_3 \text{ (in kg)} &= 5.0 \times \text{area of opening (in m}^2\text{) (each not less than 5\%)}; \\ M_4 \text{ (in kg)} &= 0.65 \times \text{ventilation rate (in m}^3\text{/s)} \times \text{discharge time of system (in s)}. \end{aligned}$$

Example 1:

An enclosure $5 \text{ m} \times 10 \text{ m} \times 3 \text{ m}$ 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 .

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

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

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 $15 \text{ m}^3/\text{min}$. 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:

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

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

Example 3:

The enclosure described in example 1 has two unclosable openings:

- a) $2 \text{ m} \times 5 \text{ m} = 10 \text{ m}^2$; and
- b) $2 \text{ m} \times 1 \text{ m} = 2 \text{ m}^2$.

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

$$M_3 = 5 \times 10 = 50 \text{ kg}$$

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:

$$M_2 = 2.5 \times 2 = 5.0 \text{ kg}$$

10.2.3 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).

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.

A curve of the limiting conditions for extinction, of the type shown in Fig. 5 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:

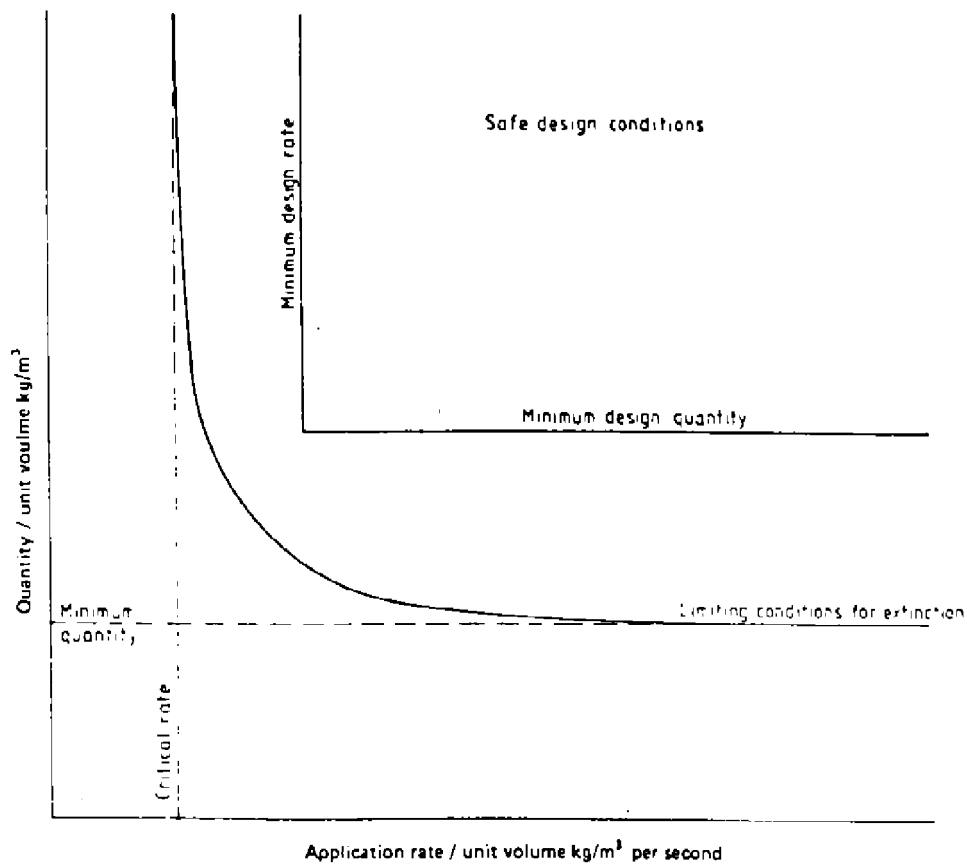
- minimum design quantity = twice the experimental minimum quantity;
- minimum design rate = twice the experimental critical rate.

These safe design conditions are shown in Fig. 5.

The design conditions are usually presented in the form:

- minimum quantity = constant \times volume of enclosure;
- minimum rate = constant \times volume of enclosure.

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



EXTINCTION CONDITIONS FOR TOTAL FLOODING
Fig. 5

10.3 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 and classified as non-combustible. The area of these elements shall be not less than 55% of the bounding area of the enclosure. Fire resistance test shall be in accordance with BS 476 pt 21.

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.

10.4 Nozzle Selection and Distribution

The nozzle 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.

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.

10.5 Leakage and Ventilation

10.5.1 The leakage of dry chemical from the protected space shall be minimized since the effectiveness of the flooding system depends upon obtaining an extinguishing concentration of dry chemical.

10.5.2 Where possible, openings such as doorways, windows, etc., shall be arranged to close before, or simultaneously with, the start of the dry chemical discharge, or 10.2.2 shall be followed.

10.5.3 Where forced-air ventilating systems are involved, they shall either be shut down and/or closed before, or simultaneously with the start of the dry chemical discharge.

11. LOCAL APPLICATION SYSTEMS

11.1 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 10 for total flooding systems, or where the enclosure is large.

Fire that can be extinguished or controlled by local extinguishing systems are surface fires involving flammable liquids and solids.

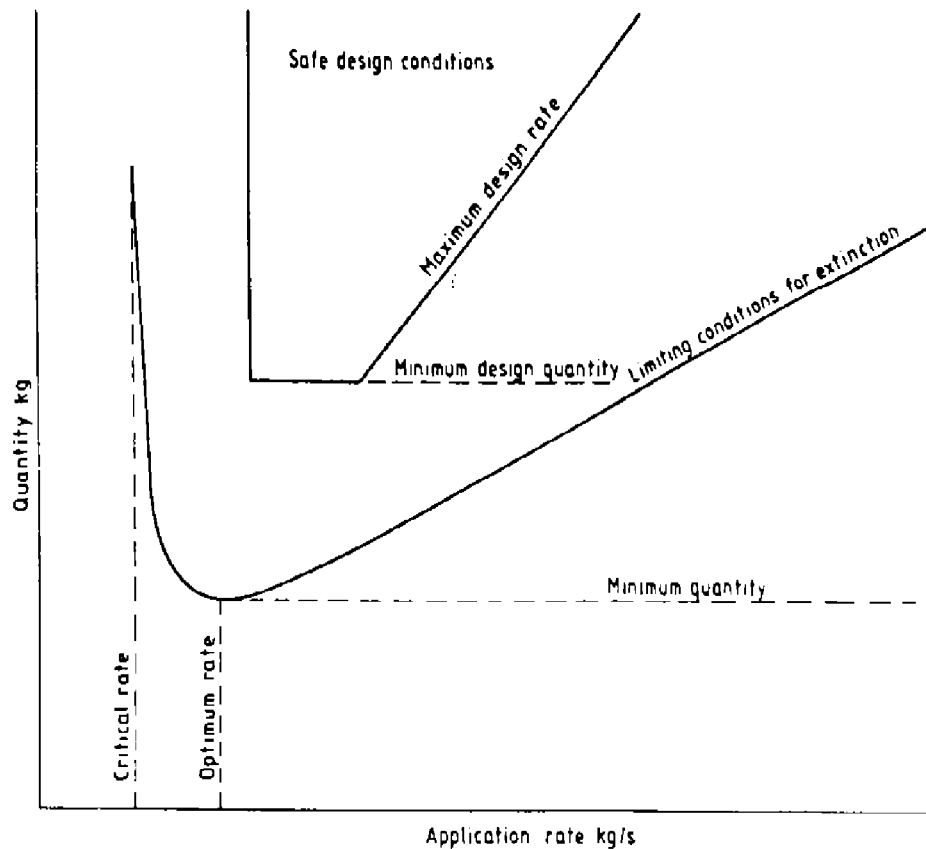
Examples of hazards that can be protected by local application systems are:

- a) dip tanks;
- b) quench tanks;
- c) spray booths;
- d) process machinery;
- e) deep fat fryers;
- f) vent stacks;
- g) pressure relief vents;
- h) vehicle fuelling areas.

11.2 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.

Local application systems shall 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 Fig. 6.



EXTINCTION CONDITIONS FOR LOCAL APPLICATION
Fig. 6

Extinction is dependent on the achievement of a sufficient concentration of powder across the area of the fire for a minimum time. In Fig. 6 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 = 1.5 times minimum design rate;
- (at minimum design quantity)

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 Fig. 6.

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 Figs. 7 to 14 in the appendices.

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 discharge rate and discharge time given in figures 7 to 14 shall 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 11 for the hazard area of 50 m 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 is 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 shall 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 10.2) 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 500/20 = 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 Fig. 7 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 Fig. 7. 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 Fig. 7. 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 minimal (quantity, discharge rate and discharge time) are exceeded.

11.3 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.

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.

12. MONITOR AND HOSE REEL SYSTEMS

12.1 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.

Monitor and hose reel systems shall 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.

12.2 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 monitor(s) or hose reel(s).

12.3 Rate of Discharge

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

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.

12.4 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.

12.5 Hose Reel Design

12.5.1 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.

12.6 Monitor Design

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

12.7 Jetty Deck

One or two fixed installed dry chemical powder package units for each berth shall be installed on the jetty deck. The dry powder monitor of the units shall be located to cover the ships manifold and the loading/unloading facilities. The capacity of each unit shall be 1500 kg to supply a monitor having a discharge rate of 20-50 kg/s and a throw of 30-50 m, and two hose reels with nozzles having a discharge rate of 2.5 kg/s and a throw of 15 m.

13. ALARMS AND INDICATORS

13.1 An alarm or indicator shall be provided to show the system has operated, that personnel response may be needed, and that the system is in need of recharge.

The extinguishing system shall be connected to the alarm system, if provided, in accordance with the requirements of the appropriate signaling system standard so that actuation of the dry chemical system will sound the fire alarm as well as provide the function of the extinguishing system.

Two sources of electrical power shall be provided. These shall consist of a primary (main) supply and a secondary (standby) supply. The primary (main) power supply shall have a high degree of reliability, adequate capacity for the intended service, and shall consist of one of the following:

- a) light and power service;
- b) engine-driven generator or equivalent.

Secondary (Standby) Power Supply Capacity and Sources. The secondary (standby) supply shall be provided to supply the energy to the system under the maximum normal load for 24 hours and then be capable of receiving one fire alarm signal persisting for five minutes in the event of a total power failure or low voltage condition (less than 85 percent of the nameplate voltages) of the primary (main) power supply.

The secondary (standby) power supply shall automatically transfer to operate the system within 30 seconds of the loss of the primary (main) power supply. The secondary (standby) power supply shall consist of one of the following:

- a) a storage battery with 24 hours capacity;
- b) an engine-driven generator;
- c) multiple automatic-starting engine-driven generators capable of supplying the energy required with the largest generator out of service.

Secondary (standby) power shall not be required to operate the evacuation alarm-indicating appliances or other supplemental functions not essential to the receipt of signals at the main control unit.

These systems shall be electrically supervised so the occurrence of a single open or single ground fault condition of its installation wiring which prevents the normal operation of the system or failure of the primary electric power supply will be indicated by a distinctive trouble signal.

13.2 Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinctive from alarms indicating operation or hazardous conditions.

13.3 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.

14. SAFETY PRECAUTIONS

14.1 All Systems

14.1.1 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.

14.1.2 System blow-down

The system shall have a facility to allow residual powder to be blown out of the pipework after system discharge.

14.1.3 Suitable safeguards shall be provided to ensure prompt evacuation of contaminated locations, and also to provide means for prompt rescue of any trapped personnel. Safety items to be considered shall include, but not be limited to personnel training, warning signs, discharge alarms, predischARGE alarms and respiratory protection.

14.1.4 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.

14.1.5 When dry chemical pressure containers are not attached to piping or hand hose lines the discharge outlet shall be provided with a protective diffusing safety cap to protect personnel from recoil and high flow discharge in case of accidental actuation. Such protective caps shall also be used on empty pressure containers to protect threads. These caps shall be provided by the manufacturer of the equipment.

14.1.6 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:

- a) red lamp: system discharged;
- b) green lamp: manual control;
- c) amber lamp: automatic and manual control.

14.1.7 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.

14.1.8 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.

14.1.9 Electrical hazards

Where exposed electrical conductors are present, clearances shall be provided, where practicable, between the electrical conductors and all parts of the system that will 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.

14.2 Areas not Normally Occupied but which Are to be Entered

Systems shall be provided with a device which is used to prevent automatic discharge of the system, while retaining the manual operation, detection and alarm facilities.

14.3 Hazards to Personnel

The discharge of large amounts of dry chemical will create hazards to personnel such as reduced visibility and temporary breathing difficulty.

APPENDICES

APPENDIX A

Various types of Dry Chemical Powder (D.C.P.) manufactured by different producers are used by NIOC Northern districts at the present time have the following chemical properties. These are based on requirements of ISO-7202 and 9002, DIN-PL 12/78 and PL 7/58, BS 6535 Part 3, BS 5750 pt 2.

1A - SODIUM HYDROGEN CARBONATE BASE

SPECIFICATION	
FIRE CLASSES	B AND C
COLOR	WHITE
MAIN COMPONENTS	SODIUM HYDROGEN CARBONATE
BULK DENSITY (g/l)	1000 ±50
COMPRESSED DENSITY (g/l)	1400
SPECIFIC SURFACE (cm ² /g)	3300 ±300
PARTICLE DISTRIBUTION	
mesh size (μm)	AMOUNT PASSED THROUGH (%)
<20	42 - 52
<40	75 - 82
<100	96 - 100
MOISTURE CONTENT (%)	<0.2
TEMPERATURE STABILITY RANGE (°C)	-60 TO +65

(to be continued)

APPENDIX A (continued)

DRY CHEMICAL POWDER BC-NOVO TROXIN

Physico-Chemical Properties

Density (g/cm ³)	:2,3
Apparent Density (g/100 ml)	:100 - 125
Specific Surface (cm ² /g) (according to Blaine)	:2000 - 300
Volume by Compactness (cm ³ /100 g)	:74 - 76
Flowability (g/sec.)	:75 - 100
Sintering-Point(°C)	:60
Amount of Propellant Required for one kilo of Powder (Normal Liter CO ₂)	:11 - 15
Efficiency	:average
Max. Particle Size (mm)	:0,16
Particles Smaller than 40 µm (%)	:min. 75
Particles Smaller than 63 µm (%)	:90 - 99.9
Packed Density Test Residue (%)	:<8
Comportment at 80% Relative Moisture	:stable
Stability in the Temperature Range from (°C)	: -80/+

This leaflet and the technical informations are for guidance only.

All data contained therein are given without any liability.

They are subject to modifications for the purpose of technical improvements.

TECHNICAL INFORMATION - FIRE EXTINGUISHING POWDER

FC Standard Dry Fire-Fighting Powder

Suitable for BC Risks:	Foam compatible
Color:	Yellow
Bulk Density:	(av) 0.98 g/ml
Particle Size:	% retained on 40 micron sieve (av) 22.5%
(nir-jet sieve)	% retained on 63 micron sieve (av) 10.0%
	% retained on 125 micron sieve (av) 0.6%
Chemical content:	approx. 96% sodium bicarbonate
Remainder:	flow-prompting agents
	Anticaking agents
	Water repellency additives
Moisture content:	Not greater than 0.20%
	av= 0.06%
Foam compatibility:	Compatible with all types of foam
Fire test performance:	3 kg 89B
Resistance to low temperature:	Passes BS 6535 Pt3 Clause 12 and ISO 7202 Clause 9
Electrical insulation value:	9.1 kV breakdown voltage

(to be continued)

APPENDIX A (continued)

Specific Surface Area:	(av) 3100 cm ² /g
(Blaine) (Canadian standard 28-GP-20M)	

pH (French Standard NF 560-204): Approx. 8.6
Storage Temperature Range: - 40°C to 60°C

All tests carried out as described in BS 6535: Part 3:1989 unless otherwise indicated.

Manufacture and quality control system approved to BS 5750 Part 2 and ISO 9002.

DRY CHEMICAL POWDER BCE-STANDARD

Physico-Chemical Properties:

Density (g/cm ³)	2,3
Apparent Density (g/100 ml)	100-125
Specific Surface (cm ² /g) (according to Blaine)	2000-3000
Volume by Compactness (cm ³ /100g)	74-76
Flowability (g/sec.)	75-100
Sintering-Point(°C)	60
Amount of Propellant Required for one kilo of Powder (Normal Liter CO ₂)	11-15
Degree of Efficiency*)	IV
Max. Particle Size (mm)	0,16
Particles Smaller than 40 µm (%)	min. 75
Particles Smaller than 63 µm (%)	90-99,9
Packed Density Test Residue (%)	<8

*) Degree of Efficiency:

I maximum efficiency
II high efficiency
III efficiency above the average
IV average efficiency

Comportment at 80% Relative Moisture	stable
Stability in the Temperature	-80
Range from (°C)	+60

This leaflet and the technical informations are for guidance only. All data contained therein are given without any liability. They are subject to modifications for the purpose of technical improvements.

TECHNICAL SPECIFICATION

Composition
Appearance

ISOCOMP BC

Sodium Bicarbonate
White free flowing powder

(to be continued)

APPENDIX A (continued)

Bulk Density gm/cc	1.05-1.15
Tap Density gm/cc	1.35-1.45
Specific Surface sq. cm/gm (using Fisher apparatus)	2500-3200

Particle size

Retained on 40 μm sieve % 30-35
 Retained on 63 μm sieve % 8-12
 Maximum μm sieve % 300

Water repellency

Greater than 4 hours

(as per ISO 7202)

Moisture Content %

Less than 0.1

Moisture sensitivity mm

Greater than 15

(ISO 7202 penetrometer)

Discharge %

Greater than 85

Temperature stability °C

-60 to +55

All ISOCOMP BC powders are non-toxic and non-corrosive

2A - POTASSIUM CARBONATE BASE

APPEARANCE	FINE WHITE POWDER
COMPOSITION	POTASSIUM CARBONATE
MEAN PARTICLE SIZE	60 MICRONS
FLUIDITY	90 MINIMO G/SEC., ACCORDING TO TEST STANDARDS
SPECIFIC SURFACE	5500÷6600 cm^2/g
COMPATIBILITY WITH FOAM CONCENTRATES	70% RESIDUAL FOAM (ACCORDING TO STANDARDS)
DIELECTRICAL RESISTANCE	EXTINGUISHERS LOADED WITH MONNEX POWDER SATISFY ELECTRICAL FIRE CLASSIFICATION

CHEMICAL-PHYSICAL PROPERTIES:

FIRE CLASSES	B & C
COLOR	GREEN
MAIN COMPONENTS	POTASSIUM-AMMONIUM-CARBONATE
SPECIFIC GRAVITY AT (G/L)	2.20
BULK DENSITY (G/L)	950 \pm 50
COMPRESSED DENSITY (G/L)	1200
SPECIFIC SURFACE (cm^2/G)	5000 \pm 300
PARTICLE DISTRIBUTION	
LESS THAN 20 $\mu\text{m}\%$	40 - 50
LESS THAN 40 $\mu\text{m}\%$	75 - 85
LESS THAN 100 $\mu\text{m}\%$	95 - 100
MOISTURE CONTENT %	0.2
FLOW VALUE G/S	90
TEMPERATURE STABILITY RANGE °C	-60 TO +80

APPENDIX B

Various types of dry chemical powder (D.C.P.) manufactured by different producers are used by NIOC Southern Districts (Fields area) at the present time have the following chemical properties.

These are based on requirements of UL, DIN PL-9/83, PL-12/78 AND PL-7/58.

1B - POTASSIUM BICARBONATE AND UREA BASE

Typical Values for certain physical properties are listed below, together with the test method or specification:

1. Apparent density : 0.64 kg/dm³ : DEF 1420
2. Tap density : 0.95 kg/dm³ : DEF 1420
3. Moisture content : Less than 0.2% w/w. Typically 0.1% w/w
4. Specific surface : 6500 cm²/gram : BS.4359 : 1971: ai permability by RIGDEN Method
5. Particle size distribution by sieve analysis

40%	45 micron
20%	45 63 micron
15%	63 90 micron
15%	90 125 micron
10%	125 250 micron

6. Foam compatibility

Monnex is foam compatible when tested by the methods of DEF 1420 and the American UL.

PHYSICO-CHEMICAL CHARACTERISTICS

APPEARANCE COMPOSITION MEAN PARTICLE SIZE FLUIDITY SPECIFIC SURFACE COMPATIBILITY WITH FOAM CONCENTRATES	FINE WHITE POWDER POTASSIUM CARBONATE 60 MICRONS 90 MINIMO G/SEC., (ACCORDING TO TEST STANDARDS) 5500÷6600 cm ² /G 70% RESIDUAL FOAM (ACCORDING TO STANDARDS)
DIELECTRICAL RESISTANCE	EXTINGUISHERS LOADED WITH MONNEX POWDER SATISFY ELECTRICAL FIRE CLASSIFICATION

(to be continued)

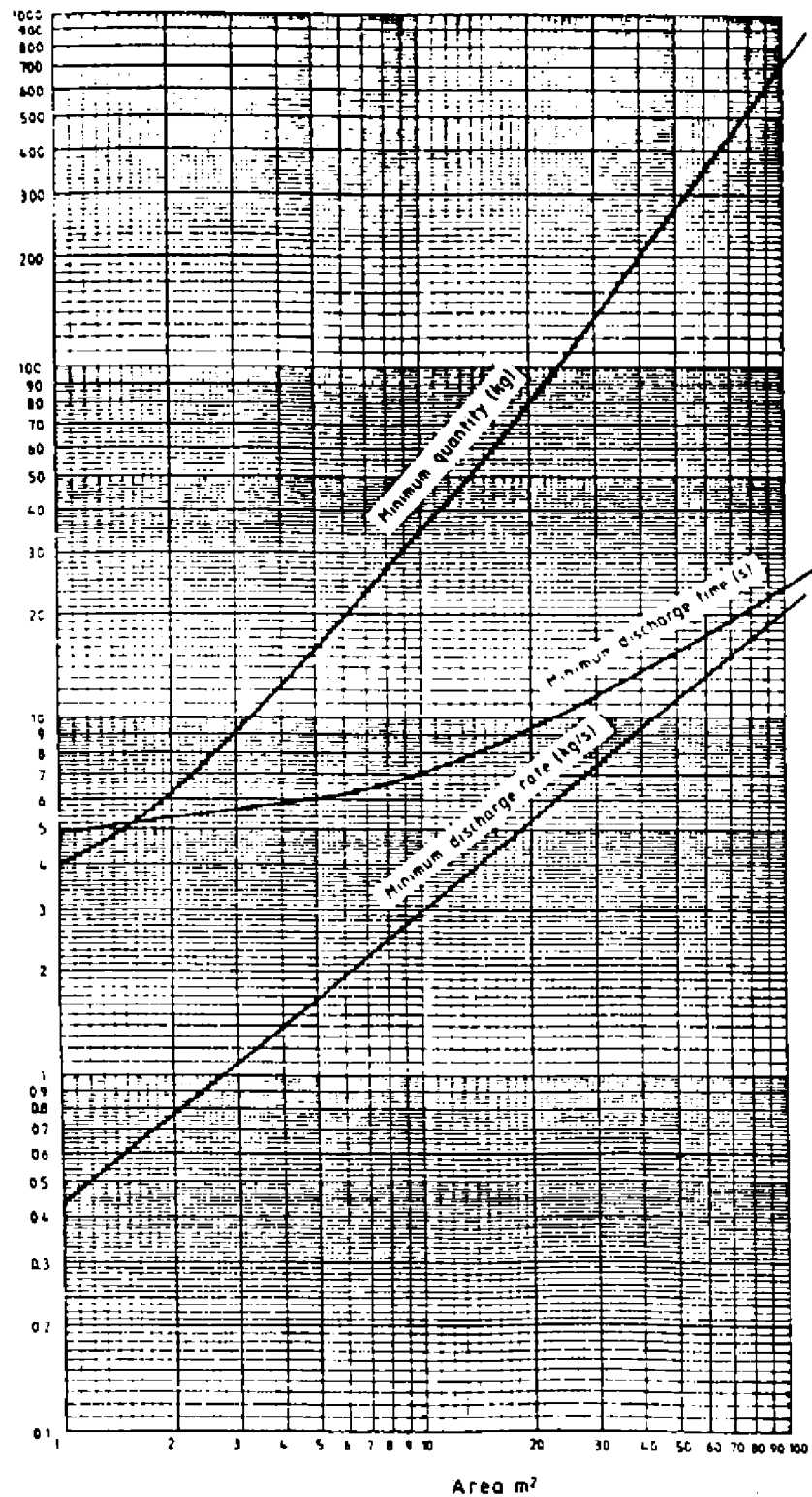
APPENDIX B (continued)

SUPERIOR EFFICIENCY OF MONNEX POWDER COMPARED WITH POTASSIUM BICARBONATE ON STANDARDIZED FIRES			
SURFACE OF FIRE IN m ²	18.6	37.1	111
QUANTITY OF MONNEX IN EXTINGUISHER (kg)	4.1	11.8	79.5
UL FIRE INTENSITY CLASSIFICATION	80 BC TEST TYPE	160 BC	320 BC
MINIMUM QUANTITY OF POTASSIUM BICARBONATE IN EXTINGUISHER, HAVING SAME UL CLASSIFICATION (kg) REQUIRED TO OBTAIN THE SAME RESULTS	12.23	56.62	136.3

2B - POTASSIUM-AMMONIUM CARBONATE BASE

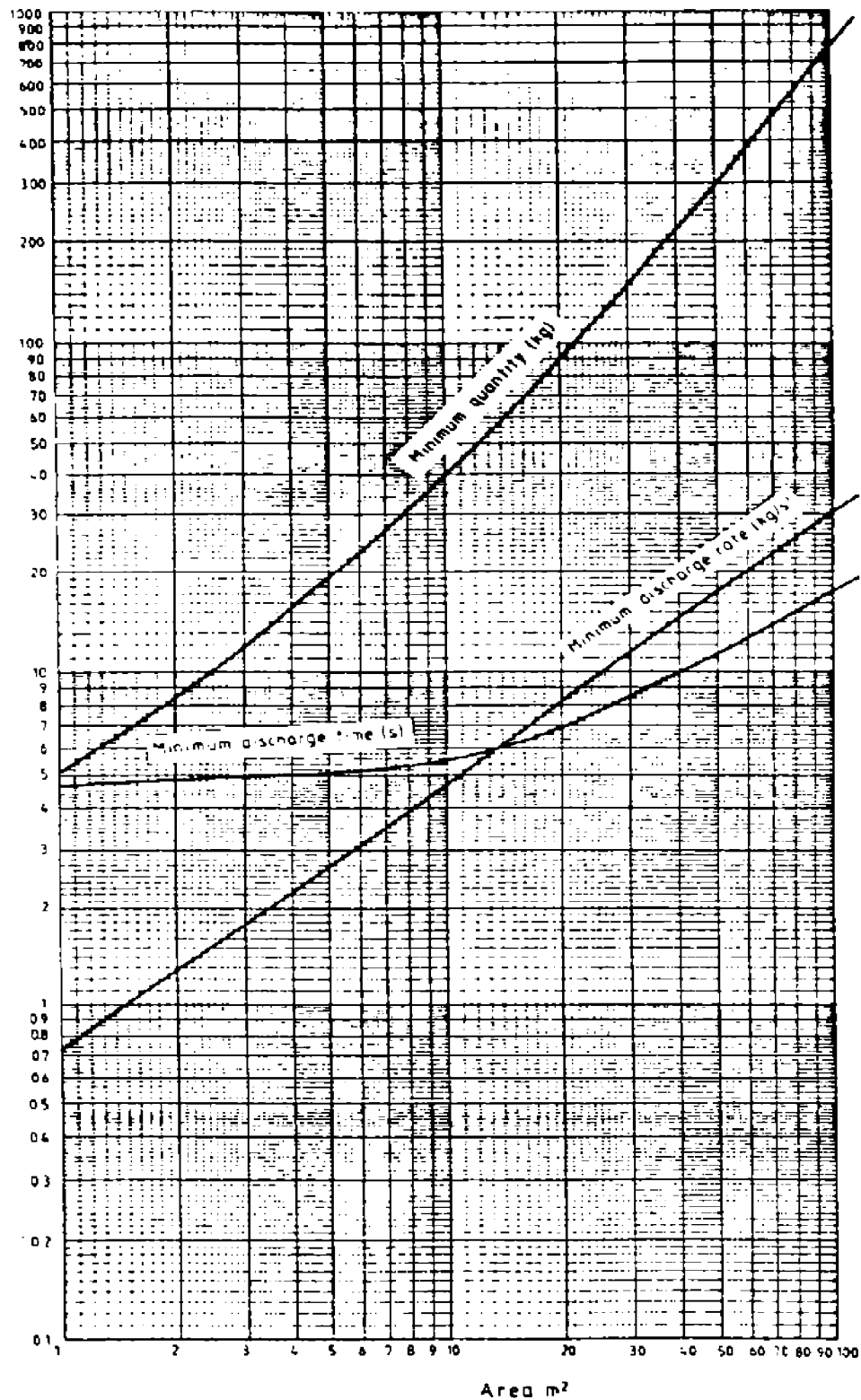
CHEMICAL-PHYSICAL PROPERTIES:

FIRE CLASSES	B & C
COLOR	GREEN
MAIN COMPONENTS	POTASSIUM-AMMONIUM-CARBONATE
SPECIFIC GRAVITY AT (G/L)	2.20
BULK DENSITY (G/L)	950 ±50
COMPRESSED DENSITY (G/L)	1200
SPECIFIC SURFACE (cm ² /G)	5000 ±300
PARTICLE DISTRIBUTION	
LESS THAN 20 µm%	40 - 50
LESS THAN 40 µm%	75 - 85
LESS THAN 100 µm%	95 - 100
MOISTURE CONTENT %	0.2
FLOW VALUE G/S	90
TEMPERATURE STABILITY RANGE °C	-60 TO +80



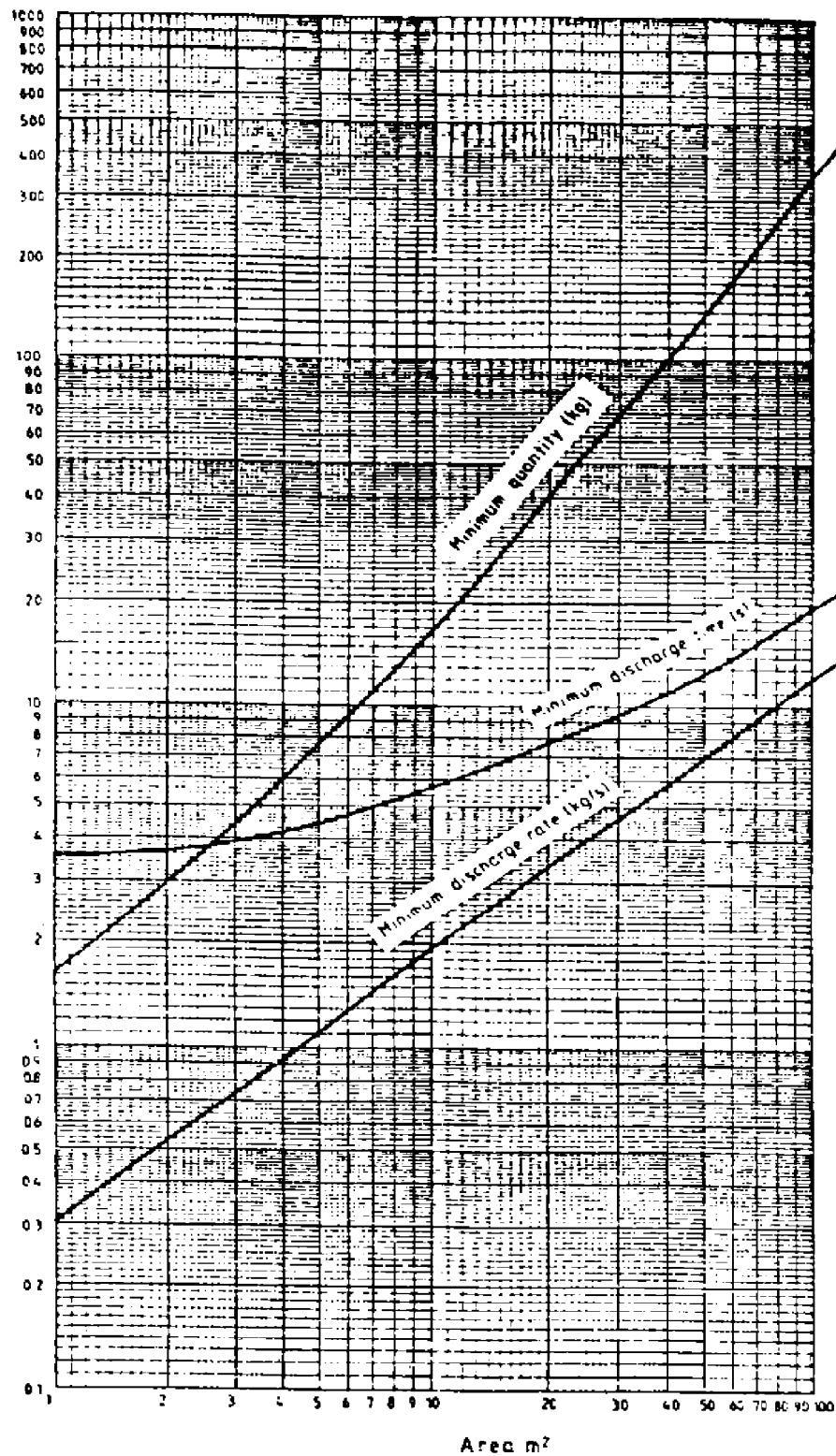
LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR TANKSIDE NOZZLES WITH SODIUM BICARBONATE; INDOORS (SEE CLAUSE 11-2)

Fig. 7



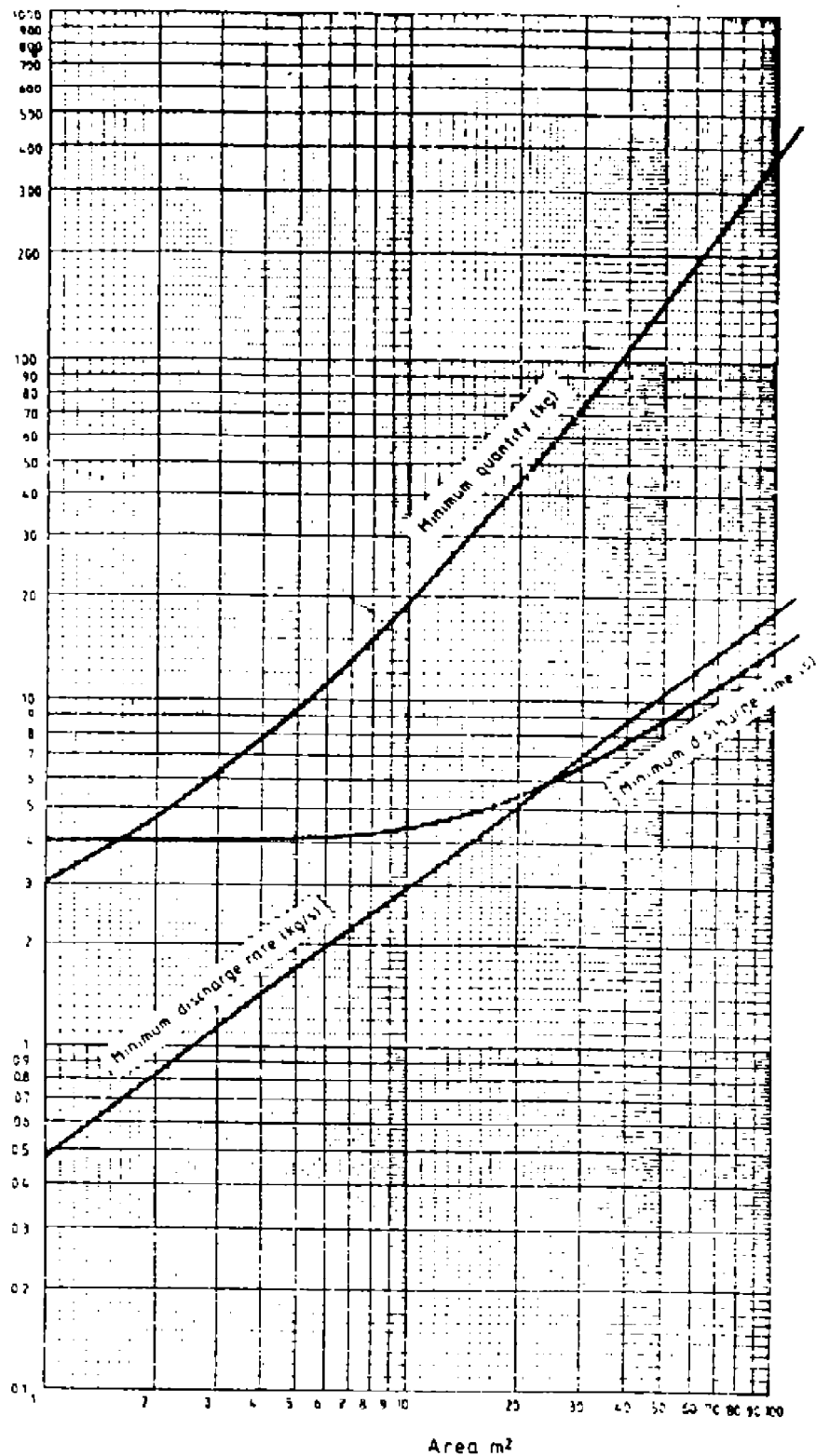
LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR TANKSIDE NOZZLES WITH SODIUM BICARBONATE; OUTDOORS (SEE CLAUSE 11-2)

Fig. 8



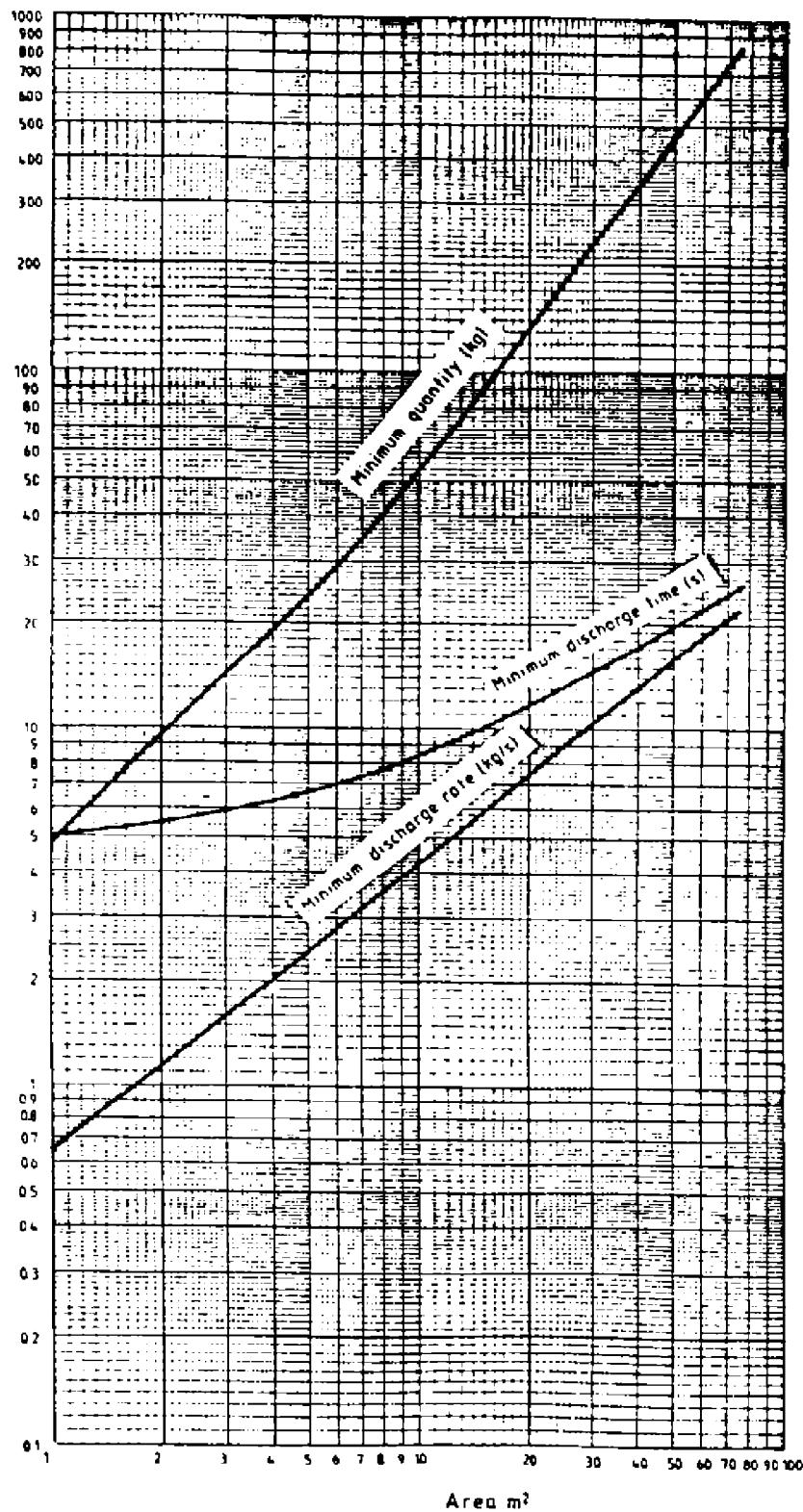
LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR TANKSIDE NOZZLES WITH POTASSIUM BICARBONATE; INDOORS (SEE CLAUSE 11-2)

Fig. 9



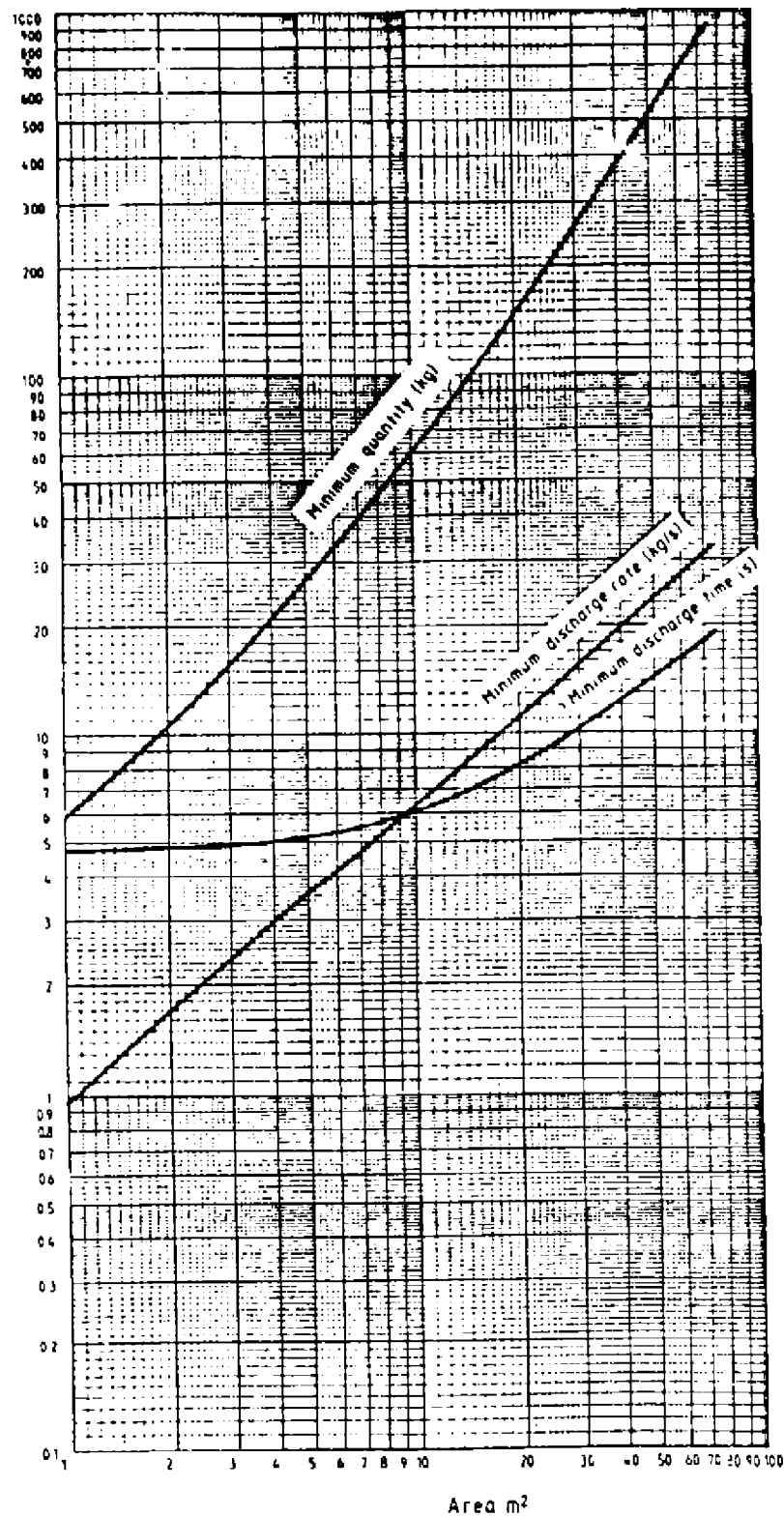
LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR TANKSIDE NOZZLES WITH POTASSIUM BICARBONATE; OUTDOORS (SEE CLAUSE 11-2)

Fig. 10



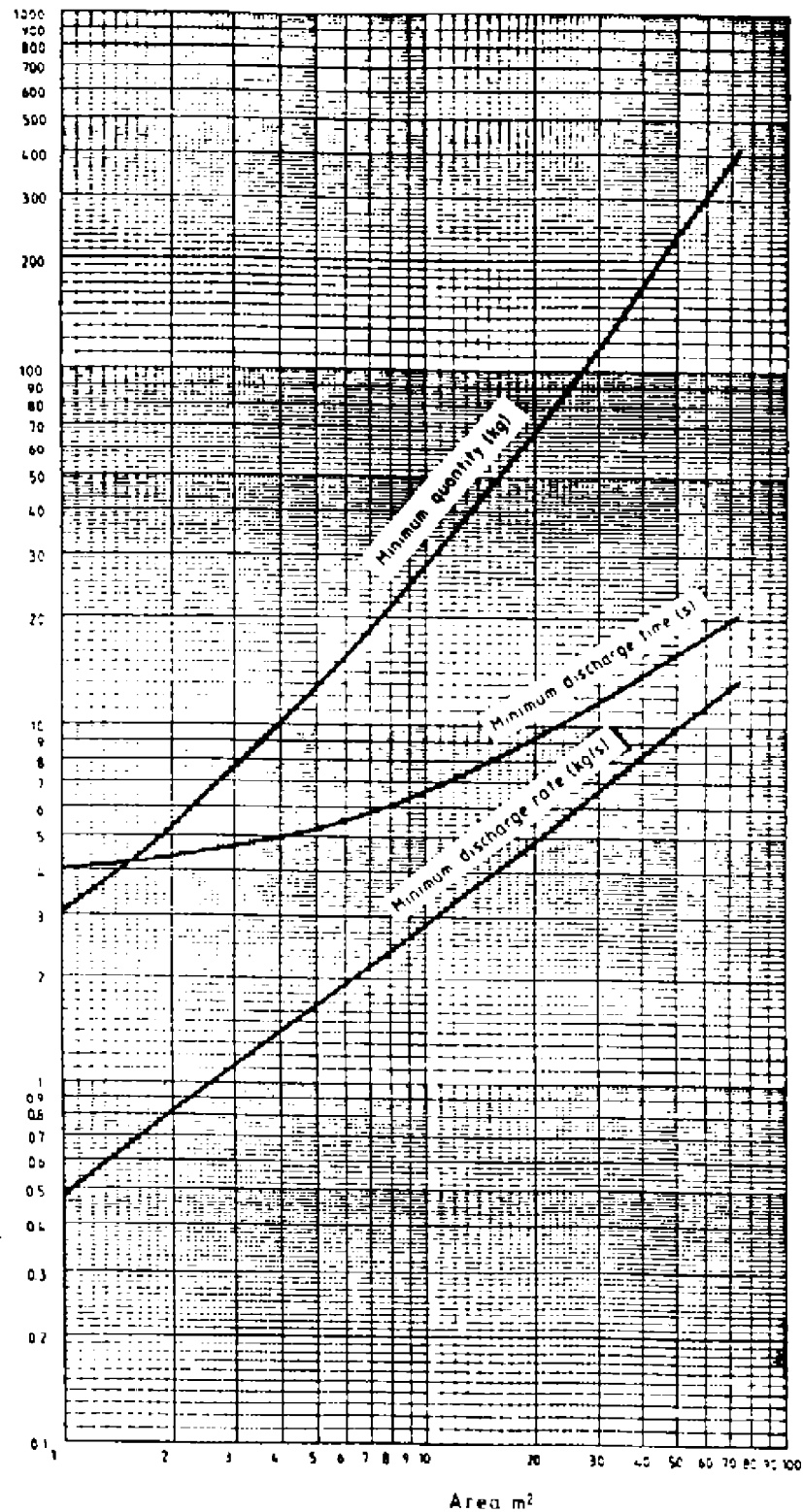
LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR OVERHEAD NOZZLES WITH SODIUM BICARBONATE; INDOORS (SEE CLAUSE 11-2)

Fig. 11



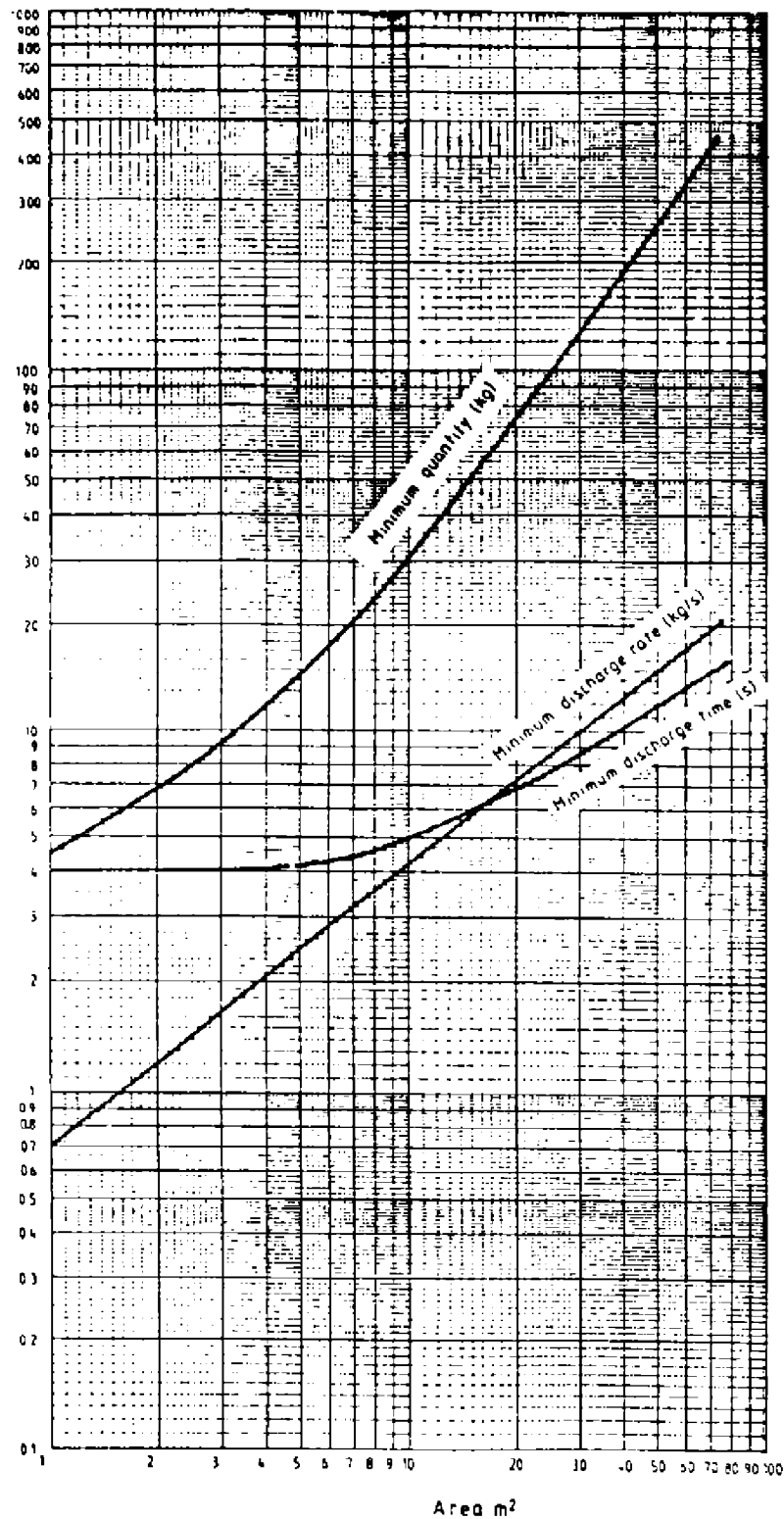
LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR OVERHEAD NOZZLES WITH SODIUM BICARBONATE; OUTDOORS (SEE CLAUSE 11-2)

Fig. 12



LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR OVERHEAD NOZZLES WITH POTASSIUM BICARBONATE; INDOORS (SEE CLAUSE 11-2)

Fig. 13



LOCAL APPLICATION MINIMUM DESIGN CONDITIONS FOR OVERHEAD NOZZLES WITH POTASSIUM BICARBONATE; INDOORS (SEE CLAUSE 11-2)

Fig. 14