

Code of practice

Gaseous fire fighting systems

Committees responsible for this Draft for Development

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- Association of Metropolitan Authorities
- British Fire Protection Systems' Association
- British Fire Services' Association
- Chief and Assistant Fire Officers' Association
- Convention of Scottish Local Authorities
- Fire Brigades' Union
- Fire Extinguishing Trades' Association
- Home Office
- Institution of Fire Engineers
- Loss Prevention Council
- Trades Union Congress

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National foreword

This Draft for Development contains the general requirements for total flooding gaseous fire fighting systems, intended as replacements for halon 1301, 1211 and 2402. It specifies requirements and gives recommendations for the design, installation, testing and maintenance and safety of gaseous fire fighting systems in buildings or other construction works, and the characteristics of the various extinguishants and types of fire for which they are suitable extinguishing mediums.

This publication is not to be regarded as a British Standard.

It was prepared by the British Fire Protection Systems Association (BFPSA) and given to BSI to form the basis of a British Standard. It is being issued in the Draft for Development series of publication and is of a provisional nature because of related developments taking place in ISO Technical Committee 21 and CEN Technical Committee 191 regarding the preparation of International and European Standards for gaseous fire fighting systems. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

A review of this Draft for Development will be carried out when the draft International/European Standards are issued for comment and not later than 2 years after its publication. Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development, will be made in an announcement in the appropriate issue of *BSI News*.

According to the replies received, the responsible BSI Committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

Observations which it is felt should receive attention before the official call for comments will be welcomed. These should be sent to the Secretary of BSI Technical Committee FSH/18 at BSI, 389 Chiswick High Road, London, W4 4AL. These observations will form the basis of any UK comments on the International drafts.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to viii, pages 1 to 116 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.

Foreword

This Code of Practice has been prepared under the direction of the BFPSA Working Group Gases.

This Code of Practice comprises the following parts and sections:

- *Part 1: General Requirements;*
- *Part 2.1: Physical Properties and System Design for HFC227ea extinguishant*;*
- *Part 2.2: Physical Properties and System Design for HFC23 extinguishant*;*
- *Part 2.3: Physical Properties and System Design for IG-541 extinguishant*;*
- *Part 2.4: Physical Properties and System Design for IG-55 extinguishant*;*
- *Part 2.5: Physical Properties and System Design for IG-01 extinguishant*;*
- *Part 2.6: Physical Properties and System Design for FC-3-1-10 extinguishant*;*
- *Part 2.7: Physical Properties and System Design for FIC-13I1 extinguishant;*
- *Part 2.8: Physical Properties and System Design for HCFC/A extinguishant;*

*

- *Part 3 Integrity of Enclosures.*

Fire fighting systems covered in this document are designed to provide a supply of gaseous extinguishing medium for the extinction of fire.

Several different methods of supplying extinguishant to, and applying it at, the required point 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 Code of Practice has been prepared to meet this need.

Requirements and recommendations are given on the design, installation, maintenance and efficient operation of systems.

In particular, new requirements and recommendations to eliminate the need to release extinguishants during testing and commissioning procedures have been included. These are linked to the inclusion of enclosure integrity testing.

The requirements and recommendations of this Code of Practice are made in the light of the best technical data known to the working group 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.

**NOTE Other extinguishants will be added dependent on availability of data.*

*Where indicated by an * these extinguishants are included in the report of the Halon Alternatives Group (HAG) February 1995 for potential use in manned areas.*

It has been assumed in the preparation of this Code of Practice that the execution of its provisions is entrusted to people appropriately qualified and experienced in the specification, design, installation, testing, approval, inspection, operation and maintenance of systems and equipment, for whose guidance it has been prepared, and who can be expected to exercise a duty of care to avoid unnecessary release of extinguishant.

Attention is drawn to the Montreal Protocol on Substances that deplete the ozone layer.

To comply with this Code of Practice, users have to comply with all of its requirements. They may depart from recommendations, but this would be on their own responsibility and they would be expected to have good reason for doing so.

Introduction

It is important that the fire protection of a building or plant should be considered as a whole. Gaseous extinguishant 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.

Gaseous extinguishants have for many years been a recognised effective medium for the extinction of flammable liquid fires and fires in the presence of electrical hazards, but it should not be forgotten, in the planning of the comprehensive schemes, that there may be hazards for which these mediums are not suitable, or that in certain circumstances or situations there may be dangers in their use, requiring special precautions. It is the responsibility of the designer of an extinguishing system to ensure that the extinguishant selected is fit for purpose and meets the requirements of the appropriate regulatory authority.

Advice on these matters can be obtained from the appropriate manufacturer of the extinguishant or the extinguishing system. For use in the UK guidance may be obtained from the report of the Halon Alternatives Group (HAG) February 1995. Information may also be sought from the appropriate fire authority, the Health and Safety Executive and insurers. In addition, reference should be made as necessary to other Parts of National/European standards and statutory regulations of the particular country.

It is essential that fire fighting equipment should be carefully maintained to ensure instant readiness when required. This routine is liable to be overlooked or given insufficient attention by the owner of the system. 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.

Section 1. Scope

1.1 This Code of Practice contains the general requirements for total flooding gaseous fire fighting systems. It does not cover fire fighting systems that use carbon dioxide, Halon 1301, Halon 1211, Halon 2402, or water, some of which are addressed by other documents listed in Appendix B.

1.2 This Code of Practice is prepared for the use and guidance of those charged with specifying, designing, installing, testing, approving, inspecting, operating and maintaining engineered or pre-engineered fire fighting systems, so that such equipment will function as intended throughout its life. Nothing in this Code of Practice is intended to restrict new technologies or alternate arrangements provided that the level of safety prescribed by this Code of Practice is not lowered.

1.3 This Code of Practice specifies requirements and gives recommendations for the design, installation, testing, maintenance and safety of gaseous fire fighting systems in building or other construction works, and the characteristics of the various extinguishants and types of fire for which they are a suitable extinguishing medium.

1.4 This Code of Practice does not cover explosion suppression systems, systems in which gaseous extinguishant is discharged to pre-inert a flammable or explosive gas mixture, or small fixed fire extinguishers which are covered by other standards.

1.5 Total flood systems are also widely used on ships and in aircraft, and while the requirements of this Code of Practice may apply in general for such applications, additional requirements may be necessary, and reference made to the appropriate standards.

Section 2. Definitions and Units

2.1 Definitions

For purpose of clarification, the following general terms used with special, technical meanings in this Code of Practice are defined:

2.1.1

approved

acceptable to a relevant authority

NOTE In determining the acceptability of installations or procedures, equipment or materials, the authority may base acceptance on compliance with the appropriate standards.

2.1.2

authority

the authority is the organisation, office or individual responsible for approving equipment, installations or procedures

2.1.3

extinguishant

electrically nonconducting gaseous fire extinguishant that does not leave a residue upon evaporation

2.1.4

clearance

the air distance between equipment, including piping and nozzles and unenclosed or uninsulated live electrical components at other than ground potential

2.1.5

design concentration

concentration of extinguishant necessary to extinguish a fire of a particular fuel as defined in **2.1.9** including a safety factor

2.1.6

design pressure

equilibrium pressure within a container at the maximum working temperature. For liquefiable gases this may include superpressurization

2.1.7

engineered systems

a system in which the supply of extinguishant stored centrally is discharged through a system of pipe and nozzles in which the size of each section of pipe and nozzle orifice has been calculated in accordance with relevant parts of this Code of Practice. The design flow rates from nozzles may vary according to the design requirements of the hazard

2.1.8

fill density

the mass of extinguishant per unit volume of container (kg/l)

2.1.9

fire extinguishing concentration

minimum concentration of extinguishant required to extinguish the flame of a particular fuel under defined experimental conditions excluding any safety factor

2.1.10

flooding quantity

mass or volume of extinguishant required to achieve the design concentration within the protected volume

2.1.11

gross volume

volume enclosed by the building elements around the protected enclosure, less the volume of any permanent impermeable building elements within the enclosure

2.1.12**hold time**

period of time during which a concentration of extinguishant greater than the fire extinguishing concentration surrounds the hazard

2.1.13**lowest observable adverse effect level (LOAEL)**

the lowest concentration at which an adverse toxicological or physiological effect has been observed

2.1.14**modular system**

a modular fire fighting system consists of distributed storage containers, usually of the Pre-engineered type, in which each unit is designed to protect a given volume which is within its permitted limitations and which in total provide cover for the whole hazard

2.1.15**no observable adverse effect level (NOAEL)**

the highest concentration at which no adverse toxicological or physiological effect has been observed

2.1.16**normally unoccupied area**

area not occupied by people during working hours, that may be entered occasionally for brief periods

2.1.17**pre-engineered systems**

a fire fighting system consisting of a supply of extinguishant of specified capacity coupled to pipework with a balanced nozzle arrangement up to a maximum permitted design. No deviation is permitted from the limits specified by the manufacturer or authority

2.1.18**shall**

indicates a mandatory requirement

2.1.19**should**

indicates a recommendation or that which is advised but not required (see Foreword)

2.1.20**superpressurization**

the addition of a gas to the extinguishant container where necessary, to achieve the required pressure for proper system operation

2.1.21**total flooding system**

a fire fighting system arranged to discharge extinguishant into an enclosed space to achieve the appropriate design concentration

2.2 Units

2.2.1. Metric units of measurement in are in accordance with the modernised metric system known as the International System of Units (SI). Two units (litre and bar), outside of but recognised by SI, are commonly used in international fire protection.

Section 3. General characteristics**3.1 Extinguishants**

3.1.1 The extinguishants referred to in this Code of Practice are electrically non-conductive media.

3.1.2 The extinguishants and specialised system parameters are each covered individually in Part 2 of this Code of Practice.

3.2 Use and Limitations

3.2.1 The design, installation, service and maintenance of the fire fighting systems shall be performed by those competent in fire extinguishing system technology.

3.2.2 The hazards that can be protected by these systems and any limitations on their use shall be contained in the suppliers system design manual.

3.2.3 Total flooding fire fighting systems are used primarily to protect hazards that are in enclosures that will retain the extinguishant for the duration specified in Clause 6.7.

3.2.4 Total flooding fire extinguishing systems are used primarily to protect hazards that are in enclosures or equipment that, in itself, includes an enclosure to contain the extinguishant. Some typical hazards that may be suitable include, but are not limited to, the following:

- a) Electrical and electronic hazards.
- b) Telecommunications facilities.
- c) Flammable and combustible liquids and gases.
- d) Other high value assets.

3.2.5 The extinguishants referred to in this Code of Practice shall not be used on fires involving the following materials, unless they have been tested to the satisfaction of the authority:

- a) Chemicals containing their own supply of oxygen, such as cellulose nitrate;
 - b) Mixtures containing oxidizing agents, such as sodium chlorate or sodium nitrate;
 - c) Chemicals capable of undergoing autothermal decomposition, such as some organic peroxides.
 - d) Reactive metals (such as sodium, potassium, magnesium, titanium and zirconium), reactive hydrides, or metal amides, some of which may react violently with some gaseous extinguishants.
 - e) Solid materials in which fires quickly become deep seated where there may be an extended period of contact with fire conditions.(1)
 - f) Hazards associated with permanently hot surfaces where there is a possibility of re-ignition or production of breakdown products.(2)
- (1)(2) In both of these types of hazard (e, f) some extinguishants break down forming acid halides and other compounds which are much more toxic than the extinguishant itself.

3.2.6 Electrostatic charging of non-grounded conductors may occur during the discharge of liquefied gases. These conductors may discharge to other objects, causing an electric arc of sufficient energy to initiate the ignition of a flammable gas.

3.2.7 An enclosure shall not be protected by a total flooding system using more than one of the extinguishants referred to in Part 2 of this Code of Practice.

3.2.8 In enclosures at low temperatures of less than the boiling point of the extinguishant the total flooding characteristics may be affected and advice should be sought from the manufacturer. Similarly, the maximum temperature may exceed 50 °C and advice should be sought from the manufacturer.

3.2.9 All components shall be capable of adequate performance in temperatures of minus 20 °C to 50 °C.

Section 4. Safety

4.1 Hazard to Personnel

Any hazard to personnel created by the discharge of gaseous extinguishants shall be considered in the design of the system, reference should be made for hazards associated with particular extinguishants in Part 2 of this Code of Practice.

Adherence to this Code of Practice does not remove the users statutory responsibility to comply with the Health and Safety at Work Act, Control of Substances Hazardous to Health (COSHH) and Pressure Systems Regulations or any applicable National/European Standards.

4.2 Exits

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

The means of egress from the protected enclosure shall be kept clear at all times. In addition to the various precautions specified or recommended elsewhere in this Code of Practice, provision should be made for the prompt discovery and rescue of any persons rendered unconscious. Regard shall be given to safeguard persons who may be in the protected enclosure during or immediately after the discharge, in any planned or accidental discharge, of the system.

4.3 System Isolation

4.3.1 General

To enable system inspection and maintenance to be carried out in safety, means shall be provided to prevent the discharge from the storage container(s).

For systems using electrical actuation the means to prevent discharge shall isolate the electrical actuation circuit from the power source, alternatively each actuator may be removed from the storage container.

Attention is drawn to the possibility, with systems employing pyrotechnic actuators of induced currents from nearby electrical cables providing sufficient electrical energy to initiate the actuator.

A suitable system of work shall be established to ensure that the system is returned to its operational condition following inspection or maintenance work.

4.3.2 Audible and Visual Alarms

Alarms shall be provided within the protected area to indicate, where applicable:

- a) operation of the fire detection system indicated by audible and visual alarm; and
- b) commencement of time-delay period indicated by change in the audible alarm.

The alarms shall be easily distinguishable from the house fire alarms. Additional visual alarms, and signs may be appropriate where there is a high level of background noise. Visual indication of system operation shall be provided outside the protected area of all entrances, and the indicator should be identified with the wording "SYSTEM DISCHARGED". Consideration shall be given to providing such alarms in adjacent areas where hazardous atmospheres may result from the discharge of the extinguishant.

Reference should be made to relevant part of BS 7273 for further guidance.

4.4 Warning Signs

4.4.1 Manual Control Points

The sign illustrated in Figure 1 shall be prominently displayed at each manual control point.

4.4.2 Entrances

4.4.2.1 The sign illustrated in Figure 2 or Figure 3 shall be prominently displayed at each entrance to an area protected by a gaseous system which develops an achieved concentration not greater than the NOAEL.

4.4.2.2 The sign illustrated in Figure 3 shall be prominently displayed at each entrance to an area protected by a gaseous system which develops an achieved concentration greater than NOAEL.

4.4.3 Marking

The sign shall indicate as a minimum the chemical name of the extinguishant.

4.5 Ventilation After Discharge

The protected enclosure shall be provided with a normally closed means of ventilation with extraction arrangements which will discharge directly to the open air.

This requirement allows for ventilation of extinguishant and the post-fire atmosphere in the enclosure, away from other parts of the building.

Any mechanical ventilation provided should not form part of the normal ventilation system.

Where liquefiable gases are used, in particular those having a high boiling point, consideration should be given to providing the ventilation at low level.

Any controls for the ventilation system should be outside the protected enclosure, preferably at the system central control panel, and should be provided with a notice bearing the wording "Fire brigade extinguishant extraction switch". Preference should be given to key operated systems. Normally closed means of ventilation may be provided by doors or windows.

4.6 Electrical Hazard

Where exposed electrical conductors are present and, where practicable, clearances no smaller than those given in Table 1 shall be provided, 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.

The system should be so arranged that all normal operations can be carried out with safety to the operator.

4.7 Electrical earthing

Systems within electrical substations or switchrooms shall be efficiently earthed to prevent the metalwork becoming electrically charged.

The extinguishing system metalwork should be efficiently connected to the main earthing terminal of the electrical installation, where this is required by the Regulations for Electrical Installations (Wiring Regulations) (16th edition). BS 7671 (IEC 364) or National/European Standards.

4.8 Electrostatic Discharge

Adequate earthing of systems will minimize the risk of electrostatic discharge. BS 5958-1 gives basic information on earthing practice. BS 5958-2 gives recommendations for particular industrial applications.

Table 1 — Safety clearances to enable operation, inspection, cleaning, repairs, painting and normal maintenance work to be carried out

Maximum rated voltage	Minimum clearance from any point on or about the permanent equipment where a person may be required to stand (measure 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 (see note 2) supporting a live conductor (ground clearance)
kV	m	m
15	2.6	2.5
33	2.75	
44	2.90	
66	3.10	
88	3.20	
110	3.35	
132	3.50	
165	3.80	
220	4.30	
275	4.60	
NOTE 1 This table is based on Table 10 of BS 162:1961, which has been withdrawn.		
NOTE 2 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.		

Section 5. Components

5.1 Extinguishant Supply

5.1.1 Quantity

5.1.1.1 The amount of extinguishant in the system shall be at least sufficient for the largest single hazard protected or group of hazards that are to be protected simultaneously.

5.1.1.2 Where required, the reserve quantity shall be as many multiples of the primary supply as the authority considers necessary.

5.1.1.3 Where uninterrupted protection is required, both main and reserve supply shall be permanently connected to the distribution piping and arranged for easy changeover.

5.1.2 Quality

The extinguishant media shall comply with the relevant part of this Code of Practice.

5.1.3 Container Arrangement

5.1.3.1 Arrangements shall be made for container and valve assemblies and accessories to be accessible for inspection, testing and other maintenance when required.

5.1.3.2 Containers shall be adequately mounted and suitably supported according to the systems installation manual so as to provide for convenient individual servicing of the container and its contents.

5.1.3.3 Containers should be located as near as possible to the hazard or hazards they protect, but should not be sited so as to be exposed to a fire in a manner that is likely to impair system performance and give rise to danger.

5.1.3.4 Storage containers shall not be located so as to be subject to severe weather conditions or to potential damage due to mechanical, chemical, or other causes. Where potentially damaging exposures or unauthorised interference are likely, suitable enclosures or guards should be provided.

5.1.3.5 Where containers are stored in an enclosed area provision shall be made for adequate ventilation and means of exit by outward opening doors. Containers shall be sited as not to obstruct passageways.

Inadvertent discharge may result in high concentrations within the area necessitating a quick exit by personnel and subsequent venting.

5.1.4 Storage Containers

5.1.4.1 Containers shall be designed to hold the specific extinguishant. Containers shall not be charged to a fill density greater than specified in Part 2 of this Code of Practice.

5.1.4.2 The containers used in these systems shall be designed to meet the requirements of the relevant National/European standard. The design pressure shall be suitable for the maximum pressure developed at 50 °C or at the maximum shade temperature defined by BS 5355 or by the statutory regulations of the particular country.

Containers for fire fighting purposes should be painted signal red to the relevant National/European standard.

5.1.4.3 Marking

Container assemblies shall be marked with the nominal working pressure, type of specific extinguishant and for liquefiable gases the extinguishant mass.

These markings are additional to those markings provided to meet statutory requirements or those specified in relevant National/European standards.

5.1.4.4 Manifolded Containers

Automatic means, such as a check valve, shall be provided to prevent extinguishant loss from the manifold if the system is operated when any containers are removed for maintenance.

5.1.4.4.1 Liquefied Gases

Containers connected to a common manifold in a system shall be as follows:

- a) of the same form and capacity;
- b) filled with the same mass of extinguishant; and
- c) pressurised to the same nominal working pressure.

5.1.4.4.2 Non-liquefied gases

Containers connected to a common manifold in a system shall be pressurized to the same nominal working pressure and may be of mixed size. These systems may also incorporate an orifice plate of an area not to exceed that of the total nozzle area.

5.1.5 Pressure gauge

A pressure gauge shall be fitted to each container and valve assembly. A means to show the relationship between internal pressure and temperature shall be provided.

5.1.6 Pressure relief device

The container and valve assembly shall be fitted with a bursting disc complying with BS 2915 or equivalent National/European standard.

5.1.7 Storage temperatures

Storage temperatures should not exceed 50 °C nor be less than minus 20 °C for total flooding systems. External heating or cooling shall be used to keep the temperature of the storage container within desired range unless the system is designed for proper operation with storage temperatures outside this range.

5.2 Distribution

5.2.1 Piping

5.2.1.1 Piping shall be of noncombustible material having physical and chemical characteristics such that its integrity under stress can be predicted with reliability. Special corrosion-resistant materials or coatings shall be used in corrosive atmospheres. The thickness of the pipe wall shall be calculated in accordance with relevant National/European standard. The design pressure for this calculation shall be the developed pressure at a maximum storage temperature of not less than 50 °C. If higher storage temperatures are approved for a given system, the design pressure shall be adjusted to the developed pressure at maximum temperature. In performing this calculation, all joint factors and threading, grooving or welding allowances, shall be taken into account.

5.2.1.2 Cast iron pipe, or non-metallic pipe shall not be used.

5.2.1.3 Flexible tubing or hoses (including connections) shall be of approved materials and pressure ratings suitable for the particular extinguishant.

5.2.1.4 Before final assembly, pipe and fittings shall be inspected visually to ensure they are clean and free of burrs, spelter, rust and that no foreign matter is inside and the full bore is clear. After assembly the system shall be thoroughly blown through with air or other compressed gas.

Provision should be made for access to concealed pipes and fittings.

5.2.1.5 In sections where valve arrangements introduce sections of closed piping, such sections shall be equipped with pressure relief devices or the valves shall be designed to prevent entrapment of agent. In systems using pressure operated container valves, automatic means shall be provided to vent any container leakage that could build up pressure in the pilot system and cause unwanted opening of the container valve. The means of pressure venting shall not prevent operation of the container valve.

Pressure relief devices should be so fitted that the discharge, in the event of operation, will not injure or endanger personnel and, if necessary, the discharge should be piped to an area where it will not become a hazard to personnel.

Reference shall be made to the relevant Part 2 of this Code of Practice for specific requirements.

5.2.1.6 Protective finish

Adequate external protection shall be given to pipes, fittings or support brackets and steelwork that are likely to be affected by corrosion due to atmospheric or local chemical conditions.

5.2.1.7 Marking

Pipework shall be identified to show that it is part of a fire fighting system as defined in BS 1710 or equivalent National/European standard.

5.2.2 Fittings

5.2.2.1 Fittings including pipe joints shall have a minimum rated working pressure equal to or greater than the design pressure specified for system pipe work in the relevant Part 2 of this Code of Practice and suitable for the initial shock loading on discharge. Fittings of cast iron shall not be used.

5.2.2.2 All threads used in joints and fittings shall conform to National/European standards. Joint compound, tape, or thread sealant shall be applied only to the male threads of the joint.

5.2.2.3 Welding and brazing alloys shall have a melting point above 500 °C.

5.2.2.4 Welding shall be performed in accordance with relevant national standards.

5.2.2.5 Compression fittings in systems are not recommended, however, where copper, stainless steel, or other suitable tubing is jointed with these fittings, the manufacturer's pressure/temperature ratings of the fitting shall not be exceeded and care shall be taken to ensure integrity of assembly.

5.2.2.6 Pipe and valve supports

Pipe and valve supports shall be suitable for the expected temperature and be able to withstand the dynamic and static forces involved. Due allowance shall be made for the stresses induced in the pipe work by temperature variations. Adequate environmental protection shall be given to supports and associated steelwork. The distance between pipe supports shall be as in Table 2. All nozzles shall be adequately supported against the force of discharge.

Movement of pipework caused by temperature fluctuations arising from environment or the discharge of extinguishant may be considerable particularly over long lengths and should be considered in the support fixing methods.

Table 2 — Maximum distance between pipework supports

Pipe Size	Maximum distance between supports
mm	m
15	1.5
20	1.8
25	2.1
32	2.4
40	2.7
50	3.4
80	3.7
100	4.3
150	5.2
200	5.8

5.2.3 Valves

5.2.3.1 All valves, gaskets, o-rings, sealants and other valve components shall be constructed of materials that are compatible with the extinguishant and shall be suitable for the envisaged pressures and temperatures.

5.2.3.2 Valves shall be protected against mechanical, chemical or other damage.

5.2.3.3 Special corrosion resistant materials or coatings shall be used in severely corrosive atmospheres.

5.2.4 Discharge Nozzles

5.2.4.1 Performance

The manufacturer shall state the flow rate and maximum area coverage from each nozzle type and whether it is of a central location type (360°) or wall mounted type (180°). The maximum and minimum height, as determined by the original independent tests and approvals, will also be specified. The nozzle shall develop a uniform concentration throughout the specified volume to a given concentration within the specified time of commencement of the discharge from the nozzle.

Due consideration should be given to the positioning of the nozzle to achieve rapid mixing/distribution of extinguishant, and such that the discharge will not unduly splash flammable liquids or create dust clouds that might extend the fire, create an explosion, or otherwise adversely affect the integrity of the enclosure.

5.2.4.2 Corrosion

Special corrosion-resistant materials or coatings shall be used in severely corrosive atmospheres.

5.2.4.3 Marking

Discharge nozzles shall be permanently marked to identify the manufacturer and size of the orifice.

5.2.4.4 External Protection

Where clogging by external foreign materials is likely, discharge nozzles shall be provided with frangible discs, blow off caps, or other suitable devices. These devices shall provide an unobstructed opening upon system operation and shall be located so they will not injure personnel.

5.2.4.5 Filter

The inlet of any nozzle assembly which contains an orifice of area less than 7 mm² shall be provided with an internal filter to prevent obstruction.

5.3 Detection, Actuation, and Control Systems

5.3.1 General

5.3.1.1 Detection, actuation, alarm, and control systems shall be installed, tested and maintained in accordance with appropriate National/European standards.

5.3.1.2 Automatic detection and automatic actuation shall be used.

Exception: Manual only actuation may be permitted if acceptable to the authority.

5.3.2 Automatic Detection

5.3.2.1 Automatic detection shall be by any method or device, acceptable to the authority, capable of detecting and indicating heat, flame, smoke, combustible vapours, or an abnormal condition in the hazard that is likely to produce fire.

Detectors installed at the maximum approved spacing for fire alarm use may result in excessive delay in extinguishant release, especially where more than one detection device is required to be in alarm before automatic actuation results.

5.3.2.2 Adequate and reliable primary and 24-hour minimum standby sources of energy shall be used to provide for operation of the detection, signalling, control and actuation requirements of the system.

5.3.3 Operating Devices

5.3.3.1 Automatic Operation

Automatic systems shall be controlled by automatic fire detection and actuation systems 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 or equivalent National/European standard. The electric power supply shall be independent of the supply for the hazard area with an emergency secondary power supply with automatic changeover in case the primary supply fails.

When 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 **5.3.3.2**) of the fire fighting system by means of a control situated outside the protected space or adjacent to the main exit from the space.

The use of a single rapid response detector to initiate release of extinguishant is not recommended.

5.3.3.2 Manual Operation

In addition to any means of automatic operation, the system shall be provided with the following:

- a) one or more means, remote from the containers, of manual operation; and
- b) a mechanical device for direct operation of the system.

The manual device shall be outside the protected area and shall 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.

The choice of the means of operation will depend upon the nature of the hazard to be protected. Automatic fire detection and alarm equipment will normally be provided on a manual system to indicate the presence of a fire.

5.3.3.2.1 Manual Release Devices

The operation of a manual release device should initiate the discharge procedure without delay and should require two separate actions in order to prevent accidental operation.

The manual release housing should be predominantly yellow in colour and marked with operating instructions. Housings that require the breaking of a glazed cover in order to reach the operating device should be avoided because of the potential hazard to the operator.

Manual release devices should be sited for easy access and the safety of personnel whilst avoiding the possibility of malicious operation, and should be visually differentiated from manual call points provided for operation of the fire alarm system.

In all cases the mechanical device shall override the hold function and time delay.

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.

5.3.4 Control Equipment

5.3.4.1 The control of electrically operated actuation systems shall comply with BS 7273-1 or equivalent National/European standard. The control of mechanically operated actuation systems shall comply with BS 7273-2 or equivalent National/European standard.

5.3.4.2 Electric Control Equipment

The control equipment shall supervise the electrical actuating devices and associated wiring and, as required, cause actuation. The control equipment shall be capable of operation for the number and type of actuating devices utilized.

5.3.4.3 Pneumatic Control Equipment

Where pneumatic control equipment is used, the lines shall be protected against crimping and mechanical damage. Where installations could be exposed to conditions that could lead to loss of integrity of the pneumatic lines, special precautions shall be taken to ensure that no loss of integrity will occur.

5.3.5 Actuators

The minimum requirement for actuators is specified as those in Appendix F. Reference should be made to the relevant National/European standard for complete performance details.

5.3.6 Operating Alarms and Indicators

5.3.6.1 Alarms or indicators or both shall be used to indicate the operation of the system, hazards to personnel, or failure of any supervised device. The type (audible, visual or olfactory), number, and location of the devices shall be such that their purpose is satisfactorily accomplished. The extent and type of alarms or indicator equipment or both shall be approved.

5.3.6.2 Audible and highly visible pre-discharge alarms shall be provided within the protected area to give positive warning of impending discharge. The operation of the warning devices shall be continued after agent discharge, until positive action has been taken to acknowledge the alarm and proceed with appropriate action.

5.3.6.3 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.

5.3.7 Hold Switches

Hold switches, where provided, shall be located within the protected area and shall be located near the means of egress for the area. The hold switch shall be a type that requires constant manual pressure to inhibit system operation. Operation of the hold function shall result in both audible and distinct visual indication of system impairment. The hold switch shall be clearly recognizable for the purpose intended. Upon release of the switch, and provided the system remains in the alarm state, the time delay should restart from the beginning.

5.3.8 Time Delays

5.3.8.1 For applications where a discharge delay does not significantly increase the threat to life or property, automatic fire fighting systems shall incorporate a pre-discharge alarm with a time delay sufficient to allow personnel evacuation prior to discharge.

5.3.8.2 Time delays shall be used only for personnel evacuation or to prepare the hazard area for discharge.

5.3.9 Unwanted System Operation

Care shall be taken to thoroughly evaluate and correct any factors that are likely to result in unwanted discharges (refer to BS 7273).

Section 6. Design

6.1 Specifications, Plans and Approvals

6.1.1 Specifications

Specifications for gaseous fire extinguishing systems shall be prepared under the supervision of a person fully experienced in the design of gaseous extinguishing systems and where appropriate with the advice of the authority. The specifications shall include all pertinent items necessary for the proper design of the system such as the designation of the authority, variances from the standard to be permitted by the authority, design criteria, system sequence of operations, the type and extent of the approval testing to be performed after installation of the system and owner training requirements.

6.1.2 Working Documents

6.1.2.1 Layout and system proposal documents shall be submitted for approval to the authority before installation or modification begins. These documents shall be prepared only by persons fully experienced in the design of extinguishing systems. Deviation from these documents shall require permission of the authority.

6.1.2.2 Working documents should include the following items:

- a) Drawings to an indicated scale of extinguishant distribution system including containers, piping and nozzles, pipe hanger spacing;
- b) Name of owner and occupant;
- c) Location of building in which hazard is located;
- d) Location and construction of protected enclosure walls and partitions;
- e) Enclosure cross section, full height or schematic diagram, including raised access floor and suspended ceiling;
- f) Type of extinguishant being used;
- g) Design extinguishing or post inerting concentration;
- h) Description of occupancies and hazards being protected;
- i) Specification of containers used, including capacity, storage pressure and mass including extinguishant;
- j) Description of nozzle(s) used including inlet size, orifice port configuration, and orifice size/code;
- k) Description of pipe and fittings used including material specifications, grade, and pressure rating;
- l) Equipment schedule or bill of materials for each piece of equipment or device showing device name, manufacturer, model or part number, quantity and description;
- m) Isometric view of agent distribution system showing the length and diameter of each pipe segment; node reference numbers relating to the flow calculations;

6.1.2.3 The detail on the system shall include:

- a) information and calculations on the amount of extinguishant;
- b) container storage pressure;
- c) internal volume of the container;
- d) the location, type, and flow rate of each nozzle including equivalent orifice area;
- e) the location, size, and equivalent lengths of pipe, fittings, and hose; Pipe size reduction and orientation of tees shall be clearly indicated.
- f) the location and size of the storage facility.

Information shall be submitted pertaining to the location and function of the detection devices, operating devices, auxiliary equipment, and electrical circuitry, if used. Apparatus and devices shall be identified. Any special features shall be adequately explained. The version of the flow calculation program shall be identified on the computer calculation printout.

Exception: For pre-engineered systems the internal volume of the container, nozzle flow rates, equivalent lengths of pipe and fitting and hose, or flow calculations, do not require specifying when used within the limitations of the manufacturers system design manual.

6.2 System Flow Calculations

6.2.1 System flow calculations shall be performed using methods acceptable to the authority. Reference should be made to the appropriate part of this Code of Practice for any particular extinguishant.

Exception: Pre-engineered systems do not require a flow calculation when used within its listed limitations.

6.2.2 Valves and fittings shall be rated for equivalent length in terms of pipe or tubing sizes with which they will be used. The equivalent length of the container valves shall be listed and shall include syphon tube (where fitted), valve, discharge head and flexible connector.

6.2.3 The piping lengths, nozzle and fitting orientation shall be in accordance with the supplier's system design manual to ensure proper system performance.

6.2.4 If the final installation varies from the prepared drawings and calculations, new drawings and calculations representing the "as fitted" installation shall be prepared.

6.2.5 Liquefiable Gases — Specific Requirements

6.2.5.1 Allowance shall be made for changes in elevation as specified in the relevant section of the appropriate part of this Code of Practice.

6.2.5.2 Any imbalance of flow division at a tee shall not exceed that specified by the manufacturers system design manual.

There is a tendency for phase separation to occur at a tee, which can cause incorrect division of flow particularly where the flow division is unequal.

Incorrect division of flow is more likely where the flow is divided vertically. Horizontal division is therefore preferred. Figure 4 shows acceptable and unacceptable arrangements for division of flow.

Correct division of flow is particularly important when extinguishant is to be discharged into two or more separate enclosures, to ensure that the appropriate quantity is discharged into each within a specified time. A distance of 15 times pipe diameter is commonly used as a distance between fittings.

6.2.5.3 The minimum design rate for liquefiable extinguishants shall be sufficient to maintain the velocity required for turbulent flow to prevent separation.

If turbulent flow is not maintained, separation of the liquid and gaseous phases will occur, which can lead to incorrect division of flow at junctions.

6.2.5.4 Flow calculations shall be submitted, if required, to the authority along with the working plans.

6.2.6 Non Liquefiable Gases — Specific Requirements

6.2.6.1 There are no critical requirements for non liquefiable gases with respect to elevation, flow imbalance and flow rate; refer to relevant Part 2 of this Code of Practice for detailed requirements for a particular gas.

6.3 Enclosure

6.3.1 The protected enclosure shall be bounded by rigid elements of building construction having a fire resistance of not less than 30 minutes when tested in accordance with the relevant standard. It is recommended the hazard should not be closer than 0.5 m below the ceiling to allow adequate distribution of extinguishant.

6.3.2 To prevent loss of extinguishant through openings to adjacent hazards or work areas openings shall be permanently sealed or equipped with automatic closures. Where reasonable confinement of agents is not practicable, protection shall be extended to include the adjacent connected hazards or work areas.

6.3.3 In confined spaces, eg shallow voids, sufficient nozzles should be installed to ensure an even distribution of the extinguishant.

6.3.4 Forced-air ventilating systems shall be shut down or closed automatically where their continued operation would adversely affect the performance of the fire extinguishing system or result in propagation of the fire. Completely self-contained recirculating ventilation systems are not required to shut down. The volume of the system and associated ductwork shall be considered as part of the total hazard volume when determining agent quantities.

Exception: Ventilation systems necessary to ensure safety are not required to be shut down upon system activation. An extended agent discharge shall be provided to maintain the design concentration for the required duration of protection.

6.4 Extinguishant Concentration Requirements

6.4.1 Flame Extinguishment

6.4.1.1 The minimum design concentrations for all fires shall be the extinguishing concentration determined by test plus a 20 percent safety factor.

6.4.1.2 For combinations of fuels the minimum design concentration shall be that for flame extinguishment requiring the greatest concentration, unless tests are made on the actual mixture plus a 20 percent factor of safety.

6.4.1.3 For the purpose of this specification, fires in electronic data processing installations shall be regarded as Class A fires and the minimum design concentration shall be the extinguishing concentration plus a 20 percent safety factor.

Most class A fires burn initially at the surface and at this stage are rapidly and efficiently extinguished by gaseous extinguishants with minimum breakdown. However, many class A materials in later stages of combustion produce significant amounts of glowing embers and may not be totally extinguished by the extinguishant at the concentrations normally employed. Such fires are said to be deep-seated, and whilst gaseous extinguishants will extinguish the flames, smouldering may continue with the production of considerable quantities of breakdown products and tar, which can cause corrosion damage and may reignite upon introduction of air when the extinguishant has dissipated. Gaseous extinguishants are therefore not suitable for this type of fire.

Fires involving materials such as cloth, rags, cardboard and shredded or crumpled paper can rapidly become deep-seated.

Materials such as baled cotton, in which fires can start spontaneously from inside a bulk, are similarly deep-seated and gaseous extinguishants are not recommended for use on these.

6.4.2 Inerting

6.4.2.1 The inerting concentrations shall only be used where conditions for subsequent reflash or explosion could exist. These conditions are when both:

- a) The quantity of fuel permitted in the enclosure is sufficient to develop a concentration equal to or greater than one-half of the lower flammable limit throughout the enclosure; and
- b) The volatility of the fuel before the fire is sufficient to reach the lower flammable limit in air (maximum ambient temperature or fuel temperature exceeds the close cup flash point temperature) or the system response is not rapid enough to detect and extinguish the fire before the volatility of the fuel is increased to a dangerous level as a result of the fire.

CAUTION: Under certain conditions, it may be dangerous to extinguish a burning gas jet. As a first measure, the gas supply should be shut off.

Gaseous systems should be discharged only in the presence of a fire and because of the possible generation of static electricity during the discharge, they should not be used for inerting a potentially explosive atmosphere where a spark caused by static electricity would add to the hazard. An explosion could occur if a spark ignited the fuel/air mixture before the system had completely discharged, ie before the extinguishant concentration had reached the inerting value.

6.5 Total Flooding Quantity

6.5.1 Liquefiable Extinguishant

The amount of liquefiable extinguishant required to achieve the design concentration shall be calculated from the following formula:

$$W = V/S [C/(100-C)] \quad (1)$$

$$S = k_1 + k_2 (T) \quad (2)$$

where:

T = minimum anticipated temperature of the protected volume (see 3.2.9).

k₁ and k₂ = constants specific to the extinguishant being used. See Table in relevant standard applicable to the particular gas for values of k₁ and k₂.

C = extinguishant concentration, % by volume

- V = net volume of hazard, m³ (enclosed volume minus fixed structures impervious to clean agent)
- S = $k_1 + k_2 (T)$ is a linear equation determined by least squares curve fit techniques from data supplied by the extinguishant manufacturers and is the specific volume of superheated vapour at one atmosphere of pressure. The zero intercept is k_1 and the slope is k_2 .
- W = Mass of extinguishant.

NOTE This calculation includes an allowance for the normal leakage from a "tight" enclosure due to agent expansion.

6.5.2 Non Liquefiable Extinguishant

The amount of non-liquefiable gas required to achieve the design concentration shall be calculated from the following formula:

$$W = \frac{V}{\bar{S}} \ln [100/(100-C)] \quad (1)$$

$$S = k_1 + k_2 (T) \quad (2)$$

where:

- T = minimum anticipated temperature of the protected volume
- k_1 and k_2 = constants specific to the extinguishant being used. See table in the relevant standard applicable for the particular gas for values of k_1 and k_2 .
- C = extinguishant concentration, % by volume
- V = net volume of hazard, m³ (enclosed volume minus fixed structures)
- S = $k_1 + k_2 (T)$ is a linear equation determined by least squares curve fit techniques from data supplied by the extinguishant manufacturer.
The zero intercept is k_1 and slope is k_2 .
- W = Mass of inert gas.
To express W in terms of gas volume X the formula becomes
 $X = \frac{V}{\bar{S}} \ln [100/(100-C)] V_s$
- V_s = Specific density at T °C
and is dependent on the molecular weight of the gas or the average molecular weight (in the case of a gas mixture) shown in the relevant part 2 of this Code of Practice and the molar volume 22.41 m³/k mol at one atmosphere and 0 °C.
eg $V_s = \frac{\text{molar volume}}{\text{molecular weight}}$

NOTE Formula for W or X may also be of the form

$$W = 2.3026 \frac{V}{\bar{S}} \log_{10} [100/(100-C)]$$

$$X = 2.3026 \frac{V}{\bar{S}} \log_{10} [100/(100-C)] V_s$$

6.5.3 In addition to the concentration requirements, additional quantities of agent are required to compensate for any special conditions that would adversely affect the extinguishing efficiency.

The calculation of concentration assumes total vapourisation of the extinguishant, which in the case of liquefiable gases will only apply at temperatures above its boiling point. As the extinguishant vapourises heat is extracted from the enclosure environment to reduce the temperature possibly below that required for effective vaporization. At temperatures below the boiling point of the extinguishant vaporization is less effective such that nozzle performance with respect to droplet size is important to achieve good distribution of the extinguishant within the enclosure.

6.6 Altitude Adjustment

The design quantity of the extinguishant shall be adjusted to compensate for ambient pressures that vary more than 11 percent (equivalent to approximately 1 000 m of elevation change) from standard sea level pressures (760 mm Hg at 20 °C). The ambient pressure is affected by changes in altitude, pressurization or depressurization of the protected enclosure, and weather related barometric pressure changes. The agent quantity is determined by multiplying the quantity determined in 6.5.1 by the ratio of average ambient enclosure pressure to standard sea level pressure. These correction factors are shown in Table 3.

Table 3 — Correction Factors

Equivalent Altitude metres	Correction Factor
– 1 000	1.130
0	1.000
1 000	0.885
1 500	0.830
2 000	0.785
2 500	0.735
3 000	0.690
3 500	0.650
4 000	0.610
4 500	0.565

6.7 Duration of Protection

6.7.1 It is important that an effective extinguishant concentration not only be achieved, but shall be maintained for a sufficient period of time to allow effective emergency action by trained personnel. This is equally important in all classes of fires since a persistent ignition source (eg an arc, heat source, oxyacetylene torch, or “deep-seated” fire) can lead to resurgence of the initial event once the extinguishant has dissipated.

6.7.2 It is essential to determine the likely period during which the extinguishing concentration will be maintained about the hazard. This is known as the hold time. The predicted hold time shall be determined by the method of Part 3 of this Code of Practice or equivalent, or a full discharge test, using the assumptions that at the start of the hold time the concentration throughout the enclosure is the design concentration and the following:

6.7.3 At the end of the hold time the extinguishant concentration at the height of the tallest hazard in the enclosure is not less than the extinguishing concentration.

The hold time is necessary to ensure extinction and/or prevent reignition. For most applications 10 minutes is sufficient but for some applications this may need to be adjusted as specified by the authority.

Hold time is dependant on the integrity of the enclosure; one method of testing is in this Code of Practice.

6.8 System Performance

6.8.1 Discharge Time

6.8.1.1 The liquefiable extinguishant discharge shall be completed as quickly as possible to suppress the fire and limit the formation of decomposition products. In no case shall the discharge time exceed 10 seconds, or as otherwise required by the authority.

6.8.1.2 The discharge time period is defined as the time required to discharge from the nozzles 95 percent of the agent mass required for the minimum design concentration at 21 °C. For liquefiable agents, this can be approximated as the interval between the first appearance of liquid at the nozzle and the time when the discharge becomes predominately gaseous. This point may be indicated by a change in both the sound and the appearance of the discharge.

6.8.1.3 For inert gases/non-liquefiable extinguishant the discharge time may be extended to 1 minute.

6.8.2 Extended Discharge

When an extended discharge is necessary, the rate shall be sufficient to maintain the desired concentration for the required hold time.

6.9 Verification of System

6.9.1 The system design manual and any computer program used in the design of either pre-engineered or engineered extinguishing systems shall have been validated by an accredited approval authority by appropriate tests as described in Appendix E.

Section 7. Commissioning and acceptance

7.1 Tests

The completed system shall be reviewed and tested by qualified personnel to meet the approval of the authority. Only equipment and devices designed to national standards shall be used in the systems. To determine that the system has been properly installed and will function as specified, the following tests shall be performed:-

7.1.1 Enclosure Check

- a) It shall be determined that the protected enclosure is in general conformance with the construction documents.

7.1.2 Review Mechanical Components

- a) The piping distribution system shall be inspected to determine that it is in compliance with the design and installation documents.
- b) Nozzles and pipe size shall be in accordance with system drawings. Means of pipe size reduction and attitudes of tees shall be checked for conformance to the design.
- c) Piping joints, discharge nozzles, and piping supports shall be securely fastened to prevent unacceptable vertical or lateral movement during discharge. Discharge nozzles shall be installed in such a manner that piping cannot become detached during discharge.
- d) During assembly, the piping distribution system shall be inspected internally to detect the possibility of any oil or particulate matter soiling the hazard area or affecting the extinguishant distribution due to a reduction in the effective nozzle orifice area.
- e) The discharge nozzle shall be oriented in such a manner that optimum extinguishant dispersal can be effected.
- f) If nozzle deflectors are installed, they shall be positioned to obtain maximum benefit.
- g) The discharge nozzles, piping, and mounting brackets shall be installed in such a manner that they will not potentially cause injury to personnel. Extinguishant shall not directly impinge on areas where personnel may be found in the normal work area. Extinguishant shall not directly impinge on any loose objects or shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles.
- h) All extinguishant storage containers shall be properly located in accordance with an approved set of system drawings.
- i) All containers and mounting brackets shall be securely fastened in accordance with the manufacturer's requirements.
- j) A discharge test is generally not recommended; however, if a discharge test is to be conducted, the filling of the containers for the extinguishant shall be by weighing or other approved methods. Concentration measurements should be made at a minimum of three points, one at the highest hazard level.
- k) The actual room volumes shall be checked against those indicated on the system drawings to ensure the proper quantity of extinguishant. Fan rundown and damper closure time shall be taken into consideration.
- l) Where required by contract all piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 3 bar. At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure. Closed sections of piping shall be tested to pressures as defined for manifolds in the relevant Part 2 of this Code of Practice.
- m) A test using nitrogen, or suitable alternative, shall be performed on the piping network to verify that flow is continuous, and that the piping and nozzles are unobstructed.

CAUTION: Pneumatic pressure testing creates a potential risk of injury to personnel in the area, as a result of airborne projectiles if rupture of the piping system occurs. Prior to conducting the pneumatic pressure test, the protected area shall be evacuated and appropriate safeguards shall be provided for test personnel.

7.1.3 Review Enclosure Integrity

All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified extinguishant concentration level for the specified holding period. The preferred method is specified in Part 3 of this Code of Practice.

7.1.4 Review Electrical Components

- a) All wiring systems shall be properly installed in compliance with BS 7671 (IEC 364/or equivalent National/European standard and the system drawings. AC and DC wiring shall not be combined in a common conduit unless properly shielded and earthed.
- b) All field circuitry shall be measured for ground fault and short circuit condition. When measuring field circuitry, all electronic components (such as smoke and flame detectors or special electronic equipment for other detectors or their mounting bases) shall be removed and jumpers properly installed to prevent the possibility of damage within these devices. Replace components after measuring.
- c) Adequate and reliable primary and 24-hour minimum standby sources of energy shall be used to provide for operation of the detection, signalling, control and actuation requirements of the system.
- d) All auxiliary functions such as alarm sounding or displaying devices, remote annunciators, air handling shutdown, power shutdown, and so on shall be checked for proper operation in accordance with system requirements and design specifications. If possible, all air-handling and power cut-off controls shall be of the type that once interrupted require manual restart to restore power.
- e) Silencing of alarms (if desirable) shall not affect other auxiliary functions such as air handling or power cut-off if required in the design specification.
- f) The detection devices shall be checked for proper type and location as specified on the system drawings.
- g) Detectors shall not be located near obstructions or air ventilation and cooling equipment that would appreciably affect their response characteristics. Where applicable, air changes for the protected area shall be taken into consideration. Refer to the manufacturer's recommended guidelines.
- h) The detectors shall have been installed in accordance with supplier's system design manual.
- i) Manual release devices shall be properly installed, readily accessible, accurately identified, and properly protected to prevent damage.
- j) All manual release devices used to release agents shall require two separate and distinct actions for operation. They shall be properly identified. Particular care shall be taken where manual release devices for more than one system are in close proximity and could be confused or the wrong system actuated. Manual release devices in this instance shall be clearly identified as to which zone they protect.
- k) For systems with a main/reserve capability, the main/reserve switch shall be properly installed, readily accessible, and clearly identified.
- l) For systems using hold switches, the switches shall be of the deadman type requiring constant manual pressure, be readily accessible within the hazard area, and clearly identified. It should be noted that mechanical manual operation will override hold switches.
- m) The control equipment shall be properly installed and readily accessible.

7.1.5 Functional Testing

7.1.5.1 Preliminary Functional Tests

The following preliminary functional tests shall be provided:

- a) If the system is connected to a remote control alarm station, the station shall be notified that the fire system test is to be conducted and that an emergency response by the fire department or alarm station personnel is not desired. All concerned personnel at the end-user's facility shall be notified that a test is to be conducted and instructed as to the sequence of operation.

b) Disable each extinguishant storage container release mechanism so that activation of the release circuit will not release extinguishant. Reconnect the release circuit with a functional device in lieu of each extinguishant storage container release mechanism. For electrically actuated release mechanisms, these devices may include suitable lamps, flash bulbs, or circuit breakers. Pneumatically actuated release mechanisms may include pressure gauges. Refer to the manufacturer's recommendations in all cases.

Where non-resettable devices are used in a system these should be disconnected to avoid system malfunction.

- c) Check each detector for proper response.
- d) Check that polarity has been observed on all polarized alarm devices and auxiliary relays.
- e) Check that all end-of-line devices have been installed across the detection and alarm bell circuits where required.
- f) All supervised circuits shall be checked for proper fault response.

7.1.5.2 System Functional Operational Test

The following system functional operational tests shall be performed:

- a) Operate detection initiating circuit(s). All alarm functions shall occur according to the design specification.
- b) Operate the necessary circuit to initiate a second alarm circuit if present. Verify all second alarm functions occur according to design specifications.
- c) Operate manual release device. Verify that manual release functions occur according to design specifications.
- d) If supplied, operate hold switch. Verify that functions occur according to design specifications. Confirm that visual and audible supervisory signals are received at the control panel.
- e) All automatic valves shall be checked without the release of extinguishant or damage to the valve (destructive testing).
- f) Where required, pneumatic equipment shall be checked for integrity to assure proper operation.

7.1.5.3 Remote Monitoring Operations

The following testing of remote monitoring operations, if applicable, shall be performed:

- a) Disconnect main power supply and operate one of each type of input device while on standby power. Verify that an alarm signal is received at remote panel after device is operated. Reconnect main power supply.
- b) Operate each alarm condition and verify receipt of signal at the remote station.

7.1.5.4 Control Panel Primary Power Source

The following testing of the control panel primary power source shall be performed:

- a) Verify that the control panel is connected to a dedicated circuit and labelled properly. This panel shall be readily accessible, yet restricted to unauthorized personnel.
- b) A primary power failure shall be tested in accordance with the manufacturer's specification with the system fully operated on standby power.

7.1.5.5 Completion Functional Test

When all functional tests are complete, reconnect each storage container so that activation of the release circuit will release the extinguishant. The system shall be returned to its fully operational design condition. The central alarm station and all concerned personnel at the end-user's facility shall be notified that the fire system test is complete and that the system has been returned to full service condition.

7.2 Completion Certificate and Documentation

The installer shall provide to the user a completion certificate, a complete set of instructions, calculations and drawings showing the system as installed, and a statement that the system complies with all the appropriate requirements of this Code of Practice, and giving details of any departure from appropriate recommendations. The certificate shall give the design and achievable maximum concentration, the report of the fan test (see Part 3 of this Code of Practice) and if appropriate the actions necessary to comply with the publications listed in Appendix B.

The user may also require certificates or letters of conformity for pressure vessels, in order to meet obligations under the Pressure Systems and Transportable Gas Container Regulations 1989 or other National/European standards.

The maximum achievable concentration occurs at conditions of nett enclosure volume and maximum temperature and is a guide with respect to the NOAEL/LOAEL values for the appropriate extinguishant.

Section 8. Inspection, maintenance, testing and training

8.1 Requirements

8.1.1 At least every 6 months, all systems shall be thoroughly inspected and tested for proper operation by competent personnel. Discharge tests are not required.

8.1.2 The inspection report with recommendations shall be filed with the owner.

8.1.3 At least every 6 months, the container contents shall be checked. If a container shows a loss in extinguishant quantity of more than 5 percent or a loss in pressure for superpressurized liquefiable gases (adjusted for temperature) of more than 10 percent, it shall be refilled or replaced. When the amount of extinguishant in the container is determined by special measuring devices, these devices shall be listed.

8.1.4 All extinguishant removed from containers during service or maintenance procedures shall be collected and recycled or disposed of in an environmentally sound manner and in accordance with existing laws and regulations.

Exception: Inert gas mixtures based on those gases normally found in the earth's atmosphere are exempted from this requirement.

8.1.5 The date of inspection, person performing the inspection shall be recorded on a tag attached to the container.

8.2 Container Test

8.2.1 Containers shall be subjected to periodical tests as required by BS 5430 or National/European standard

8.3 Hose Test

8.3.1 All system hoses shall be examined annually for damage. If visual examination shows any deficiency, the hose shall be replaced.

8.4 Enclosure Inspection

At least every twelve months, the enclosure protected by the gaseous extinguishant shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect extinguishant leakage or change volume of hazard or both. Where the inspection indicates that conditions that could result in inability to maintain the extinguishant concentration, they shall be corrected or the system redesigned to provide the original degree of protection. If uncertainty still exists, the enclosures shall be re-tested for integrity in accordance with Part 3 of this Code of Practice or equivalent National/European standard..

Consideration should be given to annual testing of the enclosure integrity.

Exception: An enclosure inspection is not required every twelve months if a documented administrative control program exists that addresses barrier integrity.

Consideration should be given to any change of enclosure usage/contents that may affect the risk of fire from that originally assessed.

8.5 Maintenance

8.5.1 General

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

The continued capability for effective performance of a fire fighting system depends on fully adequate service procedures with, where possible, periodic testing.

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

8.5.2 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.

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 follow:

- a) *Weekly: Visually check the hazard and the integrity of enclosure for changes which might reduce the efficiency of the system. Carry out a visual check that there is no obvious damage to pipework and that all operating controls and components are properly set and undamaged. Check pressure gauges for correct reading. Report any containers showing a loss of more than 10 % for liquefiable gases and 5 % for non-liquefiable gases after temperature correction.*
- b) *Monthly: Check that all personnel who may have to operate the equipment or system are properly trained and authorised to do so; and in particular that new employees have been instructed in its use.*

8.5.3 Service Schedule

A service schedule shall include all appropriate requirements for periodic inspection and test given in BS 5430 for pressurized containers or equivalent National/European standards.

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

During servicing every care and precaution should be taken to avoid release of extinguishant. When containers are emptied for internal inspection, the extinguishant should not be discharged to atmosphere, but should be recovered.

Exception: Inert gas mixtures based on those gases normally found in the Earth's atmosphere are exempted from this requirement.

A suitable schedule is as follows:

- a) *Every 3 months. Test and service all electrical detection and alarm systems as recommended in BS 5839/BS 6266 or equivalent National/European standards.*
- b) *Every 6 months. Perform the following checks and inspections.*
 - 1) *Externally examine pipework to determine its condition. Replace or pressure test and repair as necessary pipework showing corrosion or mechanical damage.*
 - 2) *Check all control valves for correct manual function and automatic valves additionally for correct automatic function.*
 - 3) *Externally inspect containers.*
 - 4) *Check pressure gauges, liquefiable should be within 10 % and non-liquefiable within 5 %.*
 - 5) *Check weigh (only applicable to liquefiable systems) or use a liquid level indicator, to verify correct content of containers. Replace or refill any showing a loss of more than 5 %.*
- c) *Every 12 months. Carry out a check of enclosure integrity using the method given in Part 3 of this Code of Practice. If the measured aggregate area of leakage has increased from that measured during installation which would adversely affect system performance, carry out work to reduce the leakage.*
- d) *As required by statutory regulations, but otherwise when convenient, internally inspect containers.*
- e) *Externally examine containers for signs of damage or unauthorised modification, and for damage to system hoses.*

8.6 Training

8.6.1 All persons who may be expected to inspect, test, maintain, or operate fire extinguishing systems shall be trained and kept adequately trained in the functions they are expected to perform.

8.6.2 Personnel working in an enclosure protected by a gaseous extinguishant shall receive training in the operation and use of the system, and regarding safety issues.

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this document, but is included for information purposes only.

Personnel Safety

A.1 The discharge of gaseous extinguishant to extinguish a fire may create a hazard to personnel from the extinguishant itself and from the products of decomposition that result from exposure of the extinguishant to the fire or other hot surfaces at temperatures above the thermal decomposition temperature. Exposure to extinguishant is generally of less concern than is exposure to the decomposition or combustion products. However, unnecessary exposure of personnel to either the extinguishant or to the decomposition or combustion products should be avoided.

A.2 The following steps and safeguards should be considered by the user and designer to ensure personnel safety in areas where the atmosphere will become hazardous by the discharge or of thermal decomposition of extinguishants:

- a) provision of warning notices and appropriate instruction signs at entrances to and inside protected enclosures that a gaseous system is installed. Such signs should comply with Figure 1, Figure 2 and Figure 3.
- b) instruction and training of all personnel within or near protected enclosures, including maintenance or construction personnel who may be brought into the area, in correct action when gaseous extinguishant equipment operates.
- c) a time delay to enable evacuation of personnel before the commencement of discharge.
- d) continuous alarms within entrances to protected enclosures until the atmosphere has been restored to normal.
- e) adequate aisles and routes of exit which should be clear at all times.
- f) emergency lighting and directional signs as necessary to ensure quick, safe evacuation.
- g) outward opening self-closing doors at exits from protected enclosures. Where such doors are latched, provision of panic hardware.
- h) provision of means for post discharge ventilation of protected enclosures. Forced ventilation will often be necessary. Care should be taken to dissipate hazardous atmospheres and not merely move them to another location. Particular attention should be made to underfloor areas.
- i) provision for prompt discovery and rescue of persons incapacitated in protected enclosures by trained persons equipped with proper breathing equipment. Self-contained breathing equipment and personnel trained in its use and in rescue practices, including artificial respiration, should be readily available.
- j) monitored means to lock off or disarm the system during periods of system inspection, maintenance or modification.
- k) controls which are used to discharge the system shall be clearly identified with both function and area of risk they effect.

A.3 Other potential hazards are:

- a) discharge of a system can cause noise loud enough to be startling but insufficient to cause injury. The force of the extinguishant may be sufficient to move objects in close proximity to the discharge nozzles.
- b) direct skin contact with the vapourizing liquid from a gaseous system can cause frostbite and will have a strong chilling effect on objects. The liquid phase vaporizes rapidly when mixed with air and thus limits the hazard to the immediate vicinity of the discharge point.
- c) in humid atmospheres, reduction in visibility will occur due to condensation of water vapour.
- d) electrostatic charging of non-grounded conductors may occur during the discharge of liquefied gases. These conductors may discharge to other objects causing an electrical arc which may be capable of igniting a flammable atmosphere.

Appendix B Publications Referred to

The following documents or portions thereof are referenced within and shall be considered part of the requirements of this document. The latest version shall be used.

BS 5045, *Transportable gas containers.*

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

BS 5355, *Specification for filling ratios and developed pressures for liquefiable and permanent gases.*

BS 5430, *Specification for periodic inspection, testing and maintenance of transportable gas containers.*

BS 5490, *Classification of degrees of protection provided by enclosures.*

BS 5839, *Fire detection and alarm systems for buildings.*

BS 5958, *Code of practice for control of undesirable static electricity.*

BS 6266, *Code of practice for fire protection for electronic data processing installations.*

BS 7273, *Code of practice for the operation of fire protection measures.*

BS 7671, *16th edition of wiring regulations for electrical installations.*

SI 2169, *The pressure systems and transportable gas container regulations 1989.*

Appendix C Code of Practice Responsibility

The preparation of this Code of Practice was entrusted by the British Fire Protection Systems Association to the Committee Working Group Gases upon which the following were represented:

Chubb Fire Products and Systems
Ginge-Kerr Limited
Hygood Limited
Kidde Fire Protection Limited
Preussag Fire Protection Limited
Thorn Security Limited
Wormald Ansul Limited

This Code of Practice has been prepared with a high degree of care, however, the British Fire Protection Systems Association, its members of those participating in its activities do not accept any liability resulting from compliance, or non-compliance, with the information in this document, any restrictions on materials or processes or for the completeness of the text.

Appendix D Determination of extinguishing and inerting concentration

D.1 Extinguishing concentration

D.1.1 Principle

The cup burner apparatus is used to determine flame extinguishing concentrations for liquids and gases.

D.1.2 Apparatus

D.1.2.1 Cup burner, as shown in Figure 5 or as modified by D.1.4.1.

D.1.3 Procedure for flammable liquids

D.1.3.1 Place a flammable liquid sample in the fuel reservoir.

D.1.3.2 Adjust the adjustable stand under the fuel reservoir to bring the fuel in the cup to within 1 mm of the top of the cup.

D.1.3.3 Adjust the electric control circuitry to the cup heating element to bring the fuel temperature to 25 °C to 5 °C above the open cup flash point of the fuel, whichever is the higher.

D.1.3.4 Ignite the fuel by suitable means preferably electrical.

NOTE It is essential that the means of ignition should not contaminate the fuel under test.

D.1.3.5 Adjust the air flow rate to 40 l/min.

D.1.3.6 Start the flow of the extinguishant and increase it slowly until the flame is extinguished. Record the flow of the extinguishant.

D.1.3.7 Remove approximately 10 ml to 20 ml of fuel from the surface of the cup with a pipette.

D.1.3.8 Repeat the procedure given in **D.1.3.4** to **D.1.3.6** and average the results.

D.1.3.9 Calculate the percentage flame extinguishing concentration c_{ext} from the following equation:

$$c_{\text{ext}} = \frac{Q_F}{40 + Q_F} \times 100$$

where Q_F is the extinguishant flow (in litres/min).

D.1.3.10 Increase the fuel temperature to 5 °C below the boiling point of the fuel, or to 200 °C, whichever is the lower.

D.1.3.11 Repeat the procedure given in **D.1.3.2** and **D.1.3.4** to **D.1.3.9**.

D.1.3.12 Take the flame extinguishing concentration to be the higher of the two values obtained at the two fuel temperatures.

D.1.4 Procedure for flammable gases

D.1.4.1 Modify the apparatus by filling the cup with glass wool and inserting a rotameter calibrated for the fuel in place of the fuel reservoir of Figure 17. Connect the rotameter to a source of fuel through an appropriate pressure regulator.

D.1.4.2 Adjust the fuel flow to produce a linear velocity within the cup of 130 mm/s.

D.1.4.3 Follow the procedure given in **D.1.3.3** to **D.1.3.9**.

D.1.4.4 Increase the fuel temperature to 150 °C.

D.1.4.5 Repeat the procedure given in **D.1.3.4** to **D.1.3.9**.

D.1.4.6 Take the flame extinguishing concentration to be the higher of the two values obtained at the two fuel temperatures.

D.1.4.7 If the concentration requirement at the higher temperature exceeds that at the lower temperature, classify the fuel as “temperature-sensitive”. Determine the flame extinguishing concentration for temperature-sensitive fuels at the maximum ambient temperature existing in the specific protected area.

Appendix E System Performance Verification

E.1 Engineered Systems

The system design manual and any computer program used in the design of extinguishing systems shall be validated by an accredited approval authority.

E.1.1 An engineered extinguishing system shall be tested as specified in the following paragraphs to determine that the manufacturer’s calculation method accurately predicts the discharge time, nozzle pressure and distribution of the extinguishing agent. If the manufacturer’s calculation method is capable of predicting the discharge time, nozzle pressure and distribution of the extinguishing agent at temperatures of other than 20 °C verification tests are to be conducted throughout the temperature range specified for the manufacturer’s calculation method.

E.1.2 A minimum of three enclosures of varying volumes are to be constructed so that all limitations of the calculation method can be tested. A minimum of five different piping arrangements are to be installed and tested to determine the accuracy of the calculation method. The following factors regarding the calculation method limitations and design considerations are to be included in establishing the piping arrangements:

- a) The percentage of extinguishant in the piping is to be as large as possible for the piping arrangement and at least one test is to be conducted using the piping arrangement that permits the greatest percentage of agent in the piping.
- b) Minimum and maximum discharge time.
- c) Minimum and maximum container fill density.
- d) Minimum pipeline flow rates.
- e) Variance of piping volume to each nozzle.
- f) Maximum variance in nozzle pressures within a piping arrangement.
- g) Maximum orifice area of nozzle relative to inlet pipe area.
- h) Arrangement most likely to exhibit a vapour time-imbalance condition at the nozzle.
- i) All types of tee splits, such as side-through tees, bullhead tees, and the like.

j) Minimum and maximum flow split for each type of tee split.

E.1.3 The container is to be filled to the intended weight and the pressure is to be allowed to stabilise. The pressure container, piping and enclosure are to be maintained at a temperature of 20 °C if possible. If not possible to maintain these items at a temperature of 20 °C, the test may be conducted at a temperature other than 20 °C, with appropriate temperature correction calculations, if agreeable to all concerned. The extinguishing system unit is then to be discharged. During discharge, pressure measurements are to be taken at the container and nozzle(s), utilising a calibrated pressure transducer or equivalent pressure measuring device attached to a recorder. The discharge time is to be measured by a stopwatch and verified by pressure chart recorders. One minute after the completion of extinguisher discharge, concentration measurements are to be taken in each enclosure with a calibrated concentration metering device and the weight of the discharged extinguishant is to be calculated.

E.1.4 As an alternative to measurement of extinguishant concentrations, the extinguishant may be collected from each of the nozzles in the system and weighed to directly obtain quantity discharged.

This method of measurement is only suitable for liquefiable gases where the extinguishant can be cooled and compressed to collect the vapour phase.

E.1.5 The measured discharge time, nozzle pressure (as defined by the manufacturer's calculation method) and calculated extinguishant weight shall not deviate from the predicted values by more than the following:

- a) Discharge time: +/- 10 percent.
- b) Nozzle pressure: +/- 10 percent.
- c) Weight of extinguishant discharged: minus 5, plus 10 percent.

E.2 Pre-engineered System

E.2.1 A pre-engineered type extinguishing system unit is to be assembled using its maximum piping limitations with respect to number of fittings maximum positive elevation and length of pipe that results in the minimum nozzle design pressure at 20 °C. The system shall be discharged. During the discharge the nozzle pressure shall be measured. The measured discharge time and nozzle pressure shall not deviate from specified values by more than 10 %. The container is to be filled to its maximum capacity.

E.3 Nozzle Test

E.3.1 Nozzles for engineered or pre-engineered extinguishing systems shall mix and distribute extinguishing agent and shall totally flood an enclosure when tested in accordance with the following paragraphs under the maximum design limitations and most severe installation limitations.

E.3.2 The distribution of extinguishant shall achieve the concentration required for flame extinguishant (cup burner) within 1 minute after the end of system discharge.

E.3.3 An enclosure(s) is to be constructed having (1) the maximum area and volume (if applicable) coverage for the extinguishing system unit, and (2) the minimum and maximum protected area height limitations.

Exception: The test enclosure(s) need not have the minimum and maximum height if the height limitation is not less than 0.6 m nor more than 9.1 m.

The enclosure for the tests is to be constructed of either indoor or outdoor grade minimum 9.5 mm thick plywood or equivalent material.

E.3.4 Nozzles shall be supplied with extinguishant at the minimum nozzle design pressure at 20 °C. The extinguishing agent design concentration in the test enclosure is to be that recommended for flame extinction at the ambient temperature of the enclosure. The container is to be filled to its maximum capacity and to be conditioned after filling for at least 16 hours at the minimum storage temperature prior to the test.

E.3.5 Receptacles of 75–80 mm diameter cans at least 100 mm high, and containing either heptane or heptane and water, are to be placed within 50 mm of the corners of the test enclosure(s) and directly behind the baffle (see below), and located vertically within 300 mm of the top or bottom of the enclosure, or both top and bottom if the enclosure permits such placement. If the cans contain heptane and water, the heptane is to be at least 50 mm deep. In addition, to simulate floor to ceiling partitions, a baffle is to be installed between the floor and ceiling in the centre of the enclosure. The baffle is to be perpendicular to the direction of nozzle discharge, and be 20 percent of the length or width of the enclosure, whichever is applicable with respect to nozzle location. The heptane is to be ignited and allowed to burn for 30 seconds, after which the extinguishing system is to be manually actuated and flame extinction achieved within 60 s.

E.3.6 The heptane is to be commercial grade having the following characteristics:

Distillation —	
Initial boiling point	90 °C
50 percent	93 °C
Dry point	96.5 °C
Specific gravity	
15.6 °C/15.6 °C	0.719
Reid vapour pressure	0.137 bar
Research octane rating	60
Motor octane rating	50

E.3.7 As an alternate to extinguishment of the heptane fires, extinguishant concentration at the most remote corners of the test enclosure during and immediately following system discharge may be measured with a calibrated concentration metering device. The extinguishant concentrations measured in the test enclosure shall be at least that for flame extinction within 60 seconds.

Appendix F Actuators

F.1 General

Actuators for use in combination shall comply with the appropriate individual requirements of this clause when tested as a combined assembly.

F.2 Solenoid Operated Types

F.2.1 The degree of protection for enclosures shall conform to the requirements BS 5490 or equivalent National/European standard.

F.3 Pneumatic Types

F.3.1 General

The stored capacity of the pilot containers shall be at least two times the capacity required under the most adverse conditions to operate the largest pneumatic control system specified by the manufacturer.

Pilot containers other than CO₂ shall be fitted with a pressure gauge and pressure switch as a means of checking for leakage.

Carbon dioxide pilot containers shall be duplicated or monitored continuously by weighing.

F.4 Mechanical Types

The manufacturer shall state the force required to operate the recommended maximum number of containers under the most severe operating conditions.

Falling weights and/or springs acting as the prime mover in the release device shall be free to complete their full travel without impedence. When tested at the manufacturer's specified limiting conditions, the device shall operate the valves when the falling weight provides half the specified force and/or the springs are of the same stroke but half the rate.

F.5 Pyrotechnic Types

Data shall be provided by the pyrotechnic device manufacturer to show that the failure rate of the device in the energy transfer path does not exceed 1 in 10,000 at the recommended firing current.

The power output of the actuator at the end of its service life as recommended by the manufacturer shall be not less than three times that required to operate the system at the most disadvantageous operating conditions.

Attention is drawn to inadvertent operation by induced currents Section 4.3

F.6 Manual Types

The force required to operate a manual release device shall not exceed:

- a) 150 N for hand operated controls; or
- b) 50 N for finger pull operated controls; or
- c) 10 N for finger push operated controls;

and/or the control shall require a movement of not more than 300 mm to achieve actuation.

Appendix G Extinguishant trade names and chemical references

Extinguishant	Trade name	Company name
HFC 227ea	FM200	Great lakes Limited
HFC 23	FE-13	Dupont Limited
IG-541	Inergen	Wormald Ansul Limited
IG-55	Argonite	Ginge-Kerr Limited
IG-01	Argon	Preussag Fire Protection Limited
HCFC blend A	NAF S-111	North American Fire Guardian
FIC-13I1	Triodide	Scientific Pacific
FC 3-1-0	CEA 410	3M Company

