BRITISH STANDARD

BS 5345-4:
1977

Code of practice for

Selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture) —

Part 4: Installation and maintenance requirements for electrical apparatus with type of protection "i" — Intrinsically safe electrical apparatus and systems

UDC 696.6:621.3 – 7:614.825:614.83

Cooperating organizations

The General Electrotechnical Engineering Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices Technical Committee*
British Approvals Service for Electric Cables Ltd
British Electrical and Allied Manufacturers' Association (BEAMA)*
British Radio Equipment Manufacturers' Association
British Steel Corporation
Department of Energy (Electricity)
Electric Cable Makers' Confederation*
Electrical Contractors' Association*
Electrical Contractors' Association of Scotland
Electrical, Electronic, Telecommunications and Plumbing Union (TUC)
Electrical Research Association*
Electricity Supply Industry in England and Wales
Electronic Components Board
Electronic Engineering Association
Engineering Equipment Users' Association*
Health and Safety Executive*
Home Office
Institution of Electrical Engineers*
Ministry of Defence*
National Coal Board*
Oil Companies Materials Association*
Post Office*
Radio and Electronic Components Manufacturers' Federation*
Telecommunication Engineering and Manufacturing Association (TEMA)

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

British Electrical Systems' Association (BEAMA)
British Gas Corporation
British Industrial Measuring and Control Apparatus Manufacturers' Association
CBMPE
Chief and Assistant Chief Fire Officers' Association
Council for Electrical Equipment for Flammable Atmospheres (BEAMA)
Department of Energy — Petroleum (OIL)
Department of the Environment — Building Research Establishment (Fire Research Station)
Department of Trade (Marine Division)
Fire Offices Committee
General Council of British Shipping
Institute of Petroleum
Institution of Gas Engineers
Lighting Industry Federation Ltd.

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Contents

Foreword

Many gases, vapours, mists and dusts encountered in industry are flammable. When ignited they may burn readily and with considerable explosive force if mixed with air in the appropriate proportions. It is often necessary to use electrical apparatus in locations where such flammable materials may be present, and appropriate precautions should therefore be taken to ensure that all such apparatus is adequately protected so as to reduce the likelihood of ignition of any external explosive atmosphere. When using electrical apparatus, potential ignition sources include electrical arcs and sparks, hot surfaces and, in certain circumstances, frictional sparks.

In general electrical safety is ensured by implementing one of two considerations. Either the electrical apparatus should be located, whenever practicable, outside hazardous areas; or the electrical apparatus should be designed, installed and maintained in accordance with measures recommended for the area in which the apparatus is located.

Several techniques are available for the protection of electrical apparatus in hazardous areas. Some of these techniques (or "types of protection" as they are known) have been used for many years and have come to be regarded as traditional. Other types of protection have been introduced only recently.

This code of practice describes the basic safety features of these types of protection, full details of which are given in the relevant standards, and recommends the selection, installation and maintenance procedures that should be adopted to ensure the safe use of electrical apparatus in hazardous areas. This code takes account therefore of the significant developments that have taken place in area classification and in the design, manufacture and use of electrical apparatus for hazardous areas since the preparation of the earlier code of practice CP 1003.

For ease of reference Part 1 of this code has been divided into a number of sections, each dealing with a particular aspect of the safe use of electrical apparatus in hazardous areas.

This code of practice represents a standard of good practice and takes the form of recommendations. Compliance with it does not confer immunity from relevant statutory and legal requirements.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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0 Introduction

This document is Part 4 of code of practice BS 5345. The code offers guidance in the selection, installation and maintenance of electrical apparatus for use in areas where flammable materials are generated, processed, handled or stored, and which are therefore potentially hazardous.

In common with the earlier code of practice for the use of electrical apparatus in hazardous areas, CP 1003-1:1964, CP 1003-2:1966 and CP 1003-3:1967, the present code is divided into a number of Parts. Each Part deals with the installation and maintenance requirements appropriate to one of the types of protection which may be used to achieve electrical safety, or with basic requirements and considerations which are fundamental to the use of electrical apparatus in hazardous areas, and which therefore provide the basis for the other Parts of the code.

The full list of Parts is as follows:

— *Part 1: Basic requirements for all Parts of the code;*

— *Part 2: Classification of hazardous areas*[1)]*;*

— *Part 3: Installation and maintenance requirements for electrical apparatus with type of protection "d". Flameproof enclosure*[1)]*;*

— *Part 4: Installation and maintenance requirements for electrical apparatus with type of protection "i". Intrinsically safe apparatus and systems;*

— *Part 5: Installation and maintenance requirements for electrical apparatus with type of protection "p". Pressurisation and continuous dilution*[1)]*;*

— *Part 6: Installation and maintenance requirements for electrical apparatus with type of protection "e". Increased safety*[1)]*;*

— *Part 7: Installation and maintenance requirements for electrical apparatus with type of protection N*[1)]*;*

— *Part 8: Installation and maintenance requirements for electrical apparatus with type of protection "s". Special protection*[1)]*;*

— *Part 9: Installation and maintenance requirements for electrical apparatus with type of protection "o". Oil-immersed apparatus and with type of protection "q". Sand filled apparatus*[1)]*;*

— *Part 10: Installation and maintenance requirements for electrical apparatus for use with combustible dusts*[1)]*;*

— *Part 11: Specific industry applications*[1)]*;*

— *Part 12: The use of gas detectors*[1)].

This Part of the code should be read in conjunction with the other Parts, and in conjunction particularly with Parts 1 and 2 which, taken together, describe the fundamental considerations which affect the selection, installation and maintenance of all electrical apparatus used in hazardous areas.

The code of practice is based on the concept, which is accepted internationally, of dealing with the risk of fire and explosion by area classification. This concept recognizes the differing degrees of probability with which explosive (flammable) concentrations of combustible gas or vapour may arise in installations in terms of both the frequency of occurrence and the probable duration of existence on each occasion.

The detailed considerations which are to be taken into account are described in Part 2 of the code. For completeness, and for the convenience of readers, the definitions appropriate to area classification are repeated here. It should be noted that whereas formerly classified areas were known as Divisions, they are now called Zones. Three sets of conditions are recognized, viz:

Zone 0 In which an explosive gas-air mixture is continuously present or present for long periods.

Zone 1 In which an explosive gas-air mixture is likely to occur in normal operation.

Zone 2 In which an explosive gas-air mixture is not likely to occur in normal operation, and if it occurs it will exist only for a short time.

It should be noted that this concept of area classification deals only with risks due to flammable gases and vapours and, by implication, mists. It does not deal with combustible dusts which may lie quiescent for long periods of time until disturbed into suspension by a suitable mechanism. An area classification concept is being developed for dusts.

By implication, an area which is not classified as Zone 0, 1 or 2 is deemed to be a non-hazardous or safe area. If doubt exists as to the classification of an area which is judged to be hazardous or potentially hazardous, guidance should be sought at an early stage from the authority having jurisdiction in the industry or area concerned (see Parts 1 and 2 of the code).

[1)] In course of preparation.

Electrical apparatus used in each of the classified Zones should be suitably protected by design and manufacture, and should also be installed and maintained so as to ensure its safe use. The code of practice BS 5345, in offering guidance in the selection, installation and maintenance of suitably protected apparatus, should be used for all new installations. It should also be used for changes to existing installations, though it is recognized that minor changes only to certain existing installations may need to be made in accordance with the recommendations of the earlier code. It is intended however, that CP 1003-1, CP 1003-2 and CP 1003-3 will eventually be withdrawn from use.

Notwithstanding application of the installation recommendations of the code to new installations and changes to existing installations, the recommendations for maintenance should be applied to all electrical apparatus and installations, irrespective of age and date of installation. It should also be noted that the installation and maintenance recommendations described in the code are supplementary to and not alternative to any regulations which would apply to installations in non-hazardous areas (see also Part 1 of the code).

Section 1. General

1 Scope

This Part of BS 5345 considers the concept of ensuring electrical safety in hazardous areas by means of type of protection "i": intrinsic safety, and offers guidance on the installation and maintenance of electrical apparatus and systems, which are protected in accordance with this type of protection, in hazardous areas.

Only explosion risks due to the presence of flammable gases and vapours are considered in this Part of the code. Combustible dusts are excluded from this Part and are dealt with in Part 10.

NOTE Expert advice on the application of intrinsic safety may be obtained through the organizations listed in Appendix A.

2 References

The titles of the publications referred to in this code are listed on the inside back cover.

3 Definitions and explanation of terms

The definitions and explanations of terms given in Part 1 of this code of practice apply equally to this Part. The definitions and explanations of terms which apply particularly to the concept of type of protection "i" are as follows:

3.1
intrinsic safety

a protection technique based upon the restriction of electrical energy within apparatus and of interconnecting wiring, exposed to a potentially explosive atmosphere, to a level below that which can cause ignition by either sparking or heating effects. Because of the method by which intrinsic safety is achieved it is necessary to ensure that not only the electrical apparatus exposed to the potentially explosive atmosphere but also other electrical apparatus with which it is interconnected is suitably constructed

3.2
intrinsically safe circuit

a circuit in which no spark nor any thermal effect produced under prescribed test conditions (which include normal operation and specified fault conditions) is capable of causing ignition of a given explosive atmosphere

3.3
electrical apparatus

an electrical apparatus is an assembly of electrical components, circuits and/or parts of circuits, usually within a single enclosure

NOTE The term "usually" has been introduced to indicate that an apparatus may occasionally be in more than one enclosure (for example, a telephone instrument or a portable radio transceiver with a hand microphone).

3.4
intrinsically safe electrical apparatus

electrical apparatus in which all the circuits are intrinsically safe

3.5
associated electrical apparatus

electrical apparatus in which the circuits are not all intrinsically safe but which contains circuits that can affect the safety of intrinsically safe circuits connected to it

NOTE Associated electrical apparatus may be either:
a) electrical apparatus which has an alternative standard type of protection suitable for its use in the appropriate potentially explosive atmosphere, or
b) electrical apparatus not so protected which cannot therefore be used within a potentially explosive atmosphere.
Example: A recorder which is not in a potentially explosive atmosphere, but which is connected to a thermocouple situated within a potentially explosive atmosphere where only the recorder input circuit is intrinsically safe.

3.6
intrinsically safe system

two or more items of electrical apparatus and interconnecting wiring in which any circuits intended for use in a potentially explosive atmosphere are intrinsically safe circuits

3.7
normal operation

intrinsically safe electrical apparatus or associated electrical apparatus is in normal operation when it complies electrically and mechanically with the requirements of its design specification and is used within the limits specified by the manufacturer

3.8
fault

a defect of any component, or a defective connection between components, upon which the intrinsic safety of a circuit depends

NOTE If a fault can lead to a subsequent fault or faults, the primary and subsequent failures are considered to be a single fault.

3.9
self-revealing fault

a fault which would cause some malfunction of electrical apparatus necessitating correction before proceeding with further operation of this, and which may be indicated, for example, by an audible or visual signal

3.10
non-self-revealing fault

a fault which would not be evident to the user in the normal operation of an electrical apparatus

4 Permissible zones of use

The technique of intrinsic safety may be applied to all zones of use. There are, however, differing categories of intrinsically safe electrical apparatus, associated electrical apparatus and intrinsically safe systems, and for a given zone of risk electrical apparatus and systems should be selected in accordance with clause **8**.

5 Relevant specifications

NOTE The titles of the publications referred to in this clause are given on the inside back cover.

The present construction and test requirements for this protection concept are embodied in Certification Standard SFA 3012:1972 issued by the British Approvals Service for Electrical Equipment for Flammable Atmospheres (BASEEFA). These requirements were based upon a draft standard produced by Subcommittee 31G of the International Electrotechnical Commission (IEC). The IEC standard resulting from this draft is published as IEC Standard 79.11. The European Committee for Electrical Standards (CENELEC) will also shortly publish a standard EN 50.020.

The requirements of the aforementioned three documents will be essentially the same and, therefore, electrical apparatus and systems complying with any one of them is acceptable for installation under this code.

Prior to the introduction of SFA 3012 electrical apparatus and systems were certified as complying with the requirements of BS 1259:1958. Since this standard did not include certain present requirements (e.g. temperature classification) electrical apparatus and systems certified only to BS 1259 may not be suitable for installation under this code and expert advice should be sought.

6 Certification of electrical apparatus and systems

6.1 General. An intrinsically safe installation normally consists of an intrinsically safe system (for typical examples see Appendix B). Although, in some cases, the entire intrinsically safe system may be installed in a hazardous area, normally part of such a system will be installed in a non-hazardous area. In either case the safety of the intrinsically safe system depends upon all pieces of apparatus which form it and upon the interconnecting wiring.

Use of electrical apparatus and systems should generally comply with the requirements of **6.2** and **6.3**.

6.2 Self-contained electrical apparatus. This type of apparatus should normally be certified as intrinsically safe electrical apparatus and subsequently installed and used in accordance with the requirements of its certificate.

6.3 Intrinsically safe systems. Intrinsically safe systems should be certified unless they can be shown to be safe in accordance with **6.3.1**, **6.3.2** and **6.3.3**.

6.3.1 *Simple systems*. Simple systems, in which all the electrical apparatus is certified intrinsically safe or certified associated electrical apparatus, do not require to be certified provided it is completely clear from the information given on the electrical apparatus certification documents that the system is intrinsically safe. Simple systems may also contain uncertified apparatus and components as specified in **6.3.3**.

6.3.2 *Modifications*. Where certified pieces of electrical apparatus form part of a certified intrinsically safe system, such items of electrical apparatus may be replaced by alternative items of certified electrical apparatus provided that the parameters quoted for the replacement electrical apparatus are within those quoted on the certification documents for the original electrical apparatus.

6.3.3 *Simple electrical apparatus and components*. Simple electrical apparatus and components (e.g. thermocouples, photocells, junction boxes) may be used in intrinsically safe systems without certification provided that they do not generate or store more than 1.2 V, 0.1 A, 20 μJ and 25 mW in the intrinsically safe system in the normal or fault conditions of the system prescribed in the standards referred to in clause **5** and, also, if no components located in the hazardous area can dissipate more than 1.3 W in such conditions. Simple electrical apparatus and components should also meet the insulation, creepage and clearance and enclosure requirements of one of the standards described in clause **5**.

The temperature classification awarded to simple electrical apparatus and components complying with these requirements should generally be T4 (135 °C). Junction boxes and switches, however, may be awarded T6 (85 °C) because, by their nature, they do not contain heat dissipating components.

Section 2. Selection of electrical apparatus and systems

7 General

The general factors affecting the selection of electrical apparatus and systems for hazardous areas are described in detail in section 2 of Part 1 of this code of practice. The specific factors which need to be taken into account when selecting electrical apparatus and systems with type of protection "i" are described in the remaining clauses of this section.

8 Permissible zones of use

Certification documents for self-contained intrinsically safe electrical apparatus will specify the appropriate categorization for the apparatus (e.g. "ia" or "ib"). Such apparatus awarded category "ia" is suitable for all hazardous areas but that awarded category "ib" is suitable for Zones 1 and less hazardous areas only (but see also **26.1** of Part 1 of this code of practice).

Certification documents for intrinsically safe systems or parts of such systems will specify the appropriate categorization for such systems or parts of systems (e.g. "ia" or "ib"). Intrinsically safe systems or parts of systems awarded category "ia" are suitable for all hazardous areas but systems or parts of systems awarded category "ib" are suitable for use in Zones 1 and less hazardous areas only.

Simple intrinsically safe systems, as described in clause **6**, will be awarded category "ia" if all items of certified electrical apparatus in such systems have been awarded category "ia" and category "ib" if some or all of the items of certified apparatus in such systems have been awarded category "ib".

Simple apparatus and components not subject to certification (see clause **6**) will normally adopt the categorization awarded to the intrinsically safe system or part of a system in which they are installed. Switches and other devices of this type with normally sparking contacts may not normally be installed in category "ia" intrinsically safe systems or parts of systems unless they are afforded the additional protection required by one of the standards specified in clause **5**.

Associated apparatus should be installed only in non-hazardous areas unless it is protected and installed in accordance with one of the other Parts of the code of practice.

9 Temperature classification

Certification documents for intrinsically safe systems or self-contained intrinsically safe electrical apparatus will give temperature classifications for the items of electrical apparatus intended for use in hazardous areas.

The temperature classification of simple electrical apparatus and components which are not subject to certification should be in accordance with clause **6** or one of the standards referred to in clause **5**.

The maximum temperature appropriate to the temperature classification awarded to any item of electrical apparatus should not exceed the minimum ignition temperature of any gas, vapour or mist which may be present at the intended location of that apparatus. For more detail on temperature classification refer to Part 1 of this code of practice.

10 Grouping of intrinsically safe electrical apparatus and systems

Certification documents for self contained intrinsically safe electrical apparatus will specify the appropriate subgroup for the apparatus (e.g. IIA, IIB, IIC). For further information on the permissible use of such apparatus refer to Part 1 of this code of practice.

Certification documents for intrinsically safe systems will specify the appropriate grouping for the system, or part of a system if differing parts are awarded different groupings. The grouping awarded to any intrinsically safe system or part of a system applies not only to the pieces of electrical apparatus therein but also to all interconnecting cables within that system or part of a system.

Simple systems referred to in clause **6** will be awarded a grouping which will be the same as the most restrictive awarded to any of the items of certified electrical apparatus forming that system.

Simple apparatus and components not subject to certification (see clause **6**) will adopt the grouping awarded to the intrinsically safe system, or part thereof, in which they are installed.

11 Certification of electrical apparatus and systems

See clauses **5** and **6** and Part 1 of this code of practice.

12 Environmental conditions

Electrical apparatus and interconnecting cables should be chosen taking account of the environmental conditions existing at their proposed installation sites (see **12.4** of Part 1:1976 of this code of practice).

Section 3. Installation requirements

13 General

Electrical apparatus and systems complying with the requirements of type of protection "i" should be installed in accordance with the general installation requirements described in Part 1 of this code of practice.

The specific factors which need to be taken into account when installing electrical apparatus and systems with type of protection "i" are described in clauses **14** to **17**.

14 Assurance of safety

It is necessary to ensure that any installation complies with the requirements of the appropriate certification documents, this code of practice and any other requirements specific to the plant on which installation takes place. To achieve this result it is recommended that the following information should be made available prior to installation and, subsequently, remain available to installation and maintenance staff and those having responsibility for the safe operation of the plant.

a) The zonal classification of the areas in which each item of electrical apparatus and any interconnecting cables are to be installed.

b) Relevant certificate numbers for certified intrinsically safe systems.

c) Detailed reference to any item of uncertified apparatus including its type number, the name of its manufacturer and the justification upon which its use is based.

NOTE This requirement is intended to ensure that adequate justification for the use of simple electrical apparatus and components (see clause **6**) is always available.

d) For the simple systems described in clause **6**, the certificate numbers for the individual items of certified electrical apparatus and the justification for the safety of the installation.

e) For self-contained intrinsically safe electrical apparatus, the apparatus certificate number.

f) Details of the specific types of cable which may be used with cross reference to any cable requirements contained in certification documentation.

NOTE The object of this is to allow cables to be selected on-site without the necessity of measuring their parameters and, also, to draw attention to any special requirement which may exist (e.g. possible special requirements for multicore cables containing more than one intrinsically safe circuit).

g) Reference to any special requirements listed in the certification documentation and the detailed methods by which such requirements are met in the particular installation.

h) The physical location on the plant of each item of electrical apparatus and the proposed routing of any interconnecting cables.

i) Categorization and grouping of such intrinsically safe system or part thereof or of each item of self-contained intrinsically safe electrical apparatus.

j) Inspection check lists against which commissioning and routine inspections should be carried out.

k) Details of any electrical testing permitted or required as part of the commissioning and routine inspections.

l) A record of any modifications to electrical apparatus or systems together with the justification for such modifications.

It is considered to be the responsibility of the occupier to ensure that the above information is produced but it is recognized that he may delegate such work to other bodies such as consultants, constructors, etc. (see Appendix C).

15 Specific requirements

15.1 Interconnecting cables. The general requirements which apply to the interconnecting cables used in intrinsically safe systems are given in this subclause. Such cables should also comply with any special requirements given in the certification documentation.

15.1.1 *Minimum conductor sizes*. The conductors of interconnecting cables should not exceed the maximum temperature permitted by the temperature classification awarded to the system or part of a system in which they are used, when carrying the maximum current which can occur in the fault conditions specified in one of the standards referred to in clause **5**. For copper conductors and temperature classes T1 to T4 this requirement is met if the conductor sizes are chosen by reference to Table 1.

Table 1 — Minimum conductor sizes

Maximum current (A)	1.0	1.65	3.3	5	6.6	8.3
Cross-sectional area (mm^2)	0.017	0.03	0.09	0.19	0.28	0.44

The cross-sectional area for stranded conductors is the total cross-sectional area of all the strands of the conductor.

15.1.2 *Insulation*. The conductors of interconnecting cables should be insulated with thermoplastics or elastomeric material of minimum thickness 0.3 mm or be mineral insulated.

Completed thermoplastics or elastomeric cable should be capable of withstanding, between any core and all other cores and any screen, a voltage test at 500 V r.m.s., without breakdown of the insulation. A suitable method of test is given in **15.3** of BS 5308-1:1975.

Mineral insulated copper sheathed cables with copper conductors should comply with the requirements of BS 6207-1:1969.

Where interconnecting cables incorporate individually screened groups of conductors, such screens should be insulated from other screens in such a manner that the insulation resistance between screens is not less than 1 MΩ/km when measured at 500 V d.c. and 20 °C after steady electrification for 1 min at 500 V d.c.

Where thermoplastics or elastomeric cables have an overall screen, this screen should be insulated from any conducting material external to the cable (e.g. cable tray etc.). This insulation may be provided by an overall thermoplastics or elastomeric sheath having a thickness compatible with the cable diameter and which is capable of passing the appropriate spark test described in **4.1.2** of BS 5099:1974.

15.1.3 *Mechanical protection*. To protect the cores of interconnecting cables from the possibility of faults to the cores of other cables and earth faults and to ensure the preservation of cable parameters (e.g. inductance and capacity) interconnecting cables should have an overall sheath. For cables with overall screens this sheath may provide the insulation required in **15.1.2**.

This Part of the code of practice does not require that cables be screened or armoured for mechanical protection (but see **15.1.7**).

15.1.4 *Screening and armouring or metal sheaths*. Where an interconnecting cable is fitted with a screen this should be earthed at one point only and where the intrinsically safe circuit contained within the screen is earthed the screen should be earthed at the same point as the circuit.

Where an interconnecting cable is armoured or has a metal sheath the armouring or metal sheath should be solidly earthed.

15.1.5 *Invasion*. Interconnecting cables containing intrinsically safe circuits may be run in the same ducting or tray as other cables, provided that either the intrinsically safe cables or other cables are armoured or metal sheathed. Armouring or metal sheathing is not, however, required in locations where the risk of mechanical damage is slight (e.g. in ducting in a control room) but in such cases both types of cables should be insulated and sheathed.

15.1.6 *Induction*. Induction into interconnecting cables at a level which could lead to a significant reduction in safety has been shown to be extremely unlikely in most practical situations. Significant induction could, however, occur if interconnecting cables are sited parallel to and close to overhead power distribution lines or heavy current carrying single core cables. Accordingly, care should be taken to avoid siting of interconnecting cables containing intrinsically safe circuits close to such cables and lines.

15.1.7 *Multicore cables*. Intrinsically safe circuits should not be run in the same cables as other types of circuit.

Where intrinsically safe systems or parts of systems are used in Zone 0 interconnecting cables containing more than one intrinsically safe circuit should not be used in any part of the intrinsically safe system unless it can be shown that no combination of faults between the intrinsically safe circuits within the cable can lead to an unsafe condition.

Other intrinsically safe circuits or parts of circuits may be run in multicore cables containing more than one intrinsically safe circuit without consideration of faults between circuits provided that the cables used meet the following conditions.

a) The cable should be run, if possible, where the risk of mechanical damage is low or, alternatively, where the risk of mechanical damage is high given additional protection.

b) The cable should be firmly fixed throughout its length.

c) Each intrinsically safe circuit contained in the cable should occupy adjacent cores throughout the length of the cable.

d) No intrinsically safe circuit, contained within the cable, should operate, in normal conditions or the fault conditions specified in one of the standards referred to in clause **5**, at more than 60 V peak.

Where the conductors of each intrinsically safe circuit are contained within a screen, which is insulated in accordance with **15.1.2** and earthed in accordance with **15.1.4**, the requirements of **15.1.7** concerning apparatus siting and cable installation do not apply.

15.2 Cable entries. The method of cable entry to apparatus should be such as to minimize the risk of mechanical damage to the cable (e.g. if the cable enters through a hole, a grommet or cable gland should be fitted).

The cable should be firmly fixed at, or near to, its point of entry to apparatus to prevent any stress on conductor terminations.

The method of cable entry to apparatus should be such as to preserve the degree of protection required by the certification documents and that necessary for the intended location of the apparatus, whichever is greater.

15.3 Conductor terminations. The method of termination should be such as to avoid reduction of the clearances achieved by the terminal blocks or connectors associated with the apparatus.
To achieve this, insulation of conductors should be continued as close to the point of connection as possible, care should be taken to ensure that all strands of stranded conductors are terminated (e.g. by the use of a ferrule) and the length of conductors from which the outer cable sheath has been removed should be kept to a minimum.

15.4 Junction boxes and terminal units. This clause deals with the minimum requirements for junction boxes and terminal units used in intrinsically safe systems.

15.4.1 *Creepage and clearance distances*. To reduce the risk of interconnection between separate intrinsically safe circuits or an intrinsically safe circuit and earth the point of connection of terminals associated with an intrinsically safe circuit should be separated from all other terminals and any other metalwork by the distances quoted in Table 2.

Table 2 — Minimum clearance distances

Peak voltage	Minimum clearance in air between terminals of separate circuits	Minimum clearance in air between terminals and earth
V	mm	mm
0 to 90	6	4
90 to 375	6	6

The peak voltage referred to in Table 2 is the maximum which can occur in normal operation or the conditions of fault specified in one of the standards referred to in clause **5**.

Where terminals of intrinsically safe and non-intrinsically safe circuits are adjacent, their points of connection shall be separated by a distance in air of 50 mm, or by an insulating barrier or earthed metal barrier which extends to at least the height of the terminals being protected and to within 1.5 mm of the inside surfaces of the enclosure. Alternatively, the clearance in and around such barriers should be 50 mm.

All other metal parts of terminals should comply with the creepage and clearance requirements specified in one of the standards referred to in clause **5**.

15.4.2 *Protection against damage.* Terminals associated with intrinsically safe circuits require protection against damage and, therefore, in any other than a well controlled environment, the terminals should be provided with an enclosure giving a degree of protection appropriate to the conditions at the site of installation with a minimum of IP 20 (see Appendix A of Part 1:1976 of this code of practice).

15.4.3 *Connection facilities*. The connection facilities provided by terminals should be in accordance with the requirements specified in one of the standards referred to in clause **5**.

A permanent means of readily identifying each terminal should be provided if the conductors to be terminated are not, themselves, identified.

16 Earthing of intrinsically safe systems

Any connection to earth, either directly or via a resistor or similar device should only be made in accordance with the system documentation. Direct connections to earth should also comply with the requirements given in **16.1** to **16.3**.

16.1 Earth connections required for intrinsic safety. Where earth connections are necessary to preserve the integrity of an intrinsically safe system (e.g. a diode safety barrier earth, a transformer screen earth, a barrier relay frame earth) such connections should be made to a high integrity earth in such a way as to ensure that the impedance from the point of connection to the main power system earth point is less than 1 Ω. This may be achieved by connection to a switch room or similar earth bar or by the use of separate earth rods. The conductor used for the connection should be equivalent to a copper conductor of 4 mm^2 minimum cross-sectional area.

Where the earth connection is made via junction boxes, plugs and sockets, etc., care should be taken to ensure that its integrity is not reduced (e.g. by the inadvertent removal of a plug).

The conductor used for the earth connection should be insulated to prevent invasion of the earth by fault currents which might flow in metallic parts with which the conductor could otherwise come into contact (e.g. control panel frames etc). It should also be given mechanical protection in places where the risk of damage is high.

16.2 Other connections to earth. Where other connections to earth are permitted by the system documentation these need not comply with the requirements of **16.1** but care should be taken, when making such connections, to minimize the risk of invasion of the intrinsically safe system by any currents or voltages from the point of connection to earth. This normally requires careful choice of the earth to be used and insulation of the interconnecting conductor.

16.3 Bonding conductors. Intrinsically safe circuits are, normally, insulated from earth or earthed at one point only. Some circuits may, however, be earthed at more than one point. Such circuits will have galvanic isolation elements between the points connected to earth or the system documentation will specify the use of a bonding conductor between the earths used.

Where a bonding conductor is specified this should be an insulated conductor equivalent to a copper conductor of 4 mm^2 minimum cross-sectional area. It should be permanently fixed between the points of connection to earth and terminations within a hazardous area should comply with the requirements of BS 4683-4:1973. It is also advisable that terminations in a non-hazardous area comply with the requirements of BS 4683-4:1973 but they should, in any event, be of high integrity and not rely on any plug and socket arrangement.

Where bonding conductors are used, care should be taken to avoid invasion of other intrinsically safe systems, which do not utilize bonding conductors, by elevation caused by any currents which may flow in the common earthing system due to the presence of the bonding conductor (e.g. where a system utilizing barrier devices is fitted with a bonding conductor, the bar on which the barrier devices are fitted should contain only barrier devices associated with bonded systems and it should be earthed separately from other barrier bars).

17 Diode safety barriers

Diode safety barriers are devices which are widely used to minimize the requirements for apparatus associated with intrinsically safe systems, which is mounted in non-hazardous areas, by limiting the power and energy which it is possible to transmit to the hazardous area on failure of such apparatus.

17.1 Use of barrier devices. A wide range of diode safety barriers is manufactured offering a wide variation in current and voltage capability. As most of these devices are superficially similar, care should be taken to ensure that a barrier device fitted in an intrinsically safe system is that specified in the system documentation as the use of one of differing characteristics can lead to a situation where power and energy available in a hazardous area is incendive.

17.1.1 *Restrictions on hazardous area apparatus*. The only apparatus which may be connected to the "hazardous area" terminals of a diode safety barrier is that which is specified in the system documentation.

17.1.2 *Restrictions on non-hazardous area apparatus*. The only restrictions placed upon apparatus connected to the "non-hazardous area" terminals of a diode safety barrier are that such apparatus should not be fed from or contain a supply of greater voltage or prospective short circuit current than that specified in the system documentation and that if it is fed from a mains supply it should be fed through a suitably fused, double wound transformer.

17.2 Location and protection of diode safety barriers

Wherever a diode safety barrier is used the location should be permanently marked to show the correct type of replacement barrier for that location.

NOTE This is necessary because of the variations in characteristics of diode safety barriers referred to in **17.1**.

Diode safety barriers should, normally, be mounted on copper busbars of minimum cross section 25 × 3 mm which are earthed in accordance with **16.1**.

Diode safety barriers are normally mounted in non-hazardous areas but should be mounted at the nearest convenient point to that at which the intrinsically safe circuits enter the hazardous area.

To protect diode safety barriers from unauthorized interference they should normally be mounted in enclosures offering a degree of protection of at least IP 20 (see Appendix A of Part 1:1976 of this code of practice). Alternative methods of mounting may be used if they offer similar integrity against interference (e.g. diode safety barriers mounted on open racks in a normally locked switch room).

Diode safety barriers may be mounted in Zones 1 or 2 provided that they are afforded protection appropriate to those zones (e.g. diode safety barriers may be mounted in Zone 1 within a flameproof enclosure or in Zone 2 if their mounting complies with the requirements of BS 4683-3:1972). Barrier devices must **NOT** be mounted in Zones 0.

Section 4. Inspection and test of intrinsically safe systems and self-contained intrinsically safe apparatus

18 General

Regular inspection procedures, by properly trained personnel, should be established to minimize the risk of an intrinsically safe system or self-contained intrinsically safe apparatus acting as a source of ignition due to accidental damage or unauthorized interference.

After any repair to, or modification of, a piece of apparatus it should be inspected to ensure that it complies with system documentation before it is reinstalled. It is recommended that this inspection is carried out by a person other than the one who carried out the repair or modification.

The inspections recommended in this Part of the code of practice are for the preservation of intrinsic safety only and should be considered as additional to any which may be required for other reasons.

Where intrinsically safe systems enter Zones 0, special care should be exercised when carrying out the inspections and any testing required by this Part of the code of practice in view of the increased risk associated with such zones.

19 Initial inspection

19.1 General. After installation and before commissioning, any intrinsically safe system should be inspected to ensure that it is suitable for the hazardous area in which it is installed, that it complies with its relevant system documentation and that no obvious damage has occurred during installation. It is not considered necessary to carry out detailed examination of the construction of items of apparatus to ensure that they comply with system documentation as this should have been carried out before delivery.

Any change in area classification or process changes on a plant should be immediately followed by an initial inspection of all affected systems to ensure that they remain suitable and any modification to or repair of a system should be followed by an initial inspection to ensure the continued suitability of that system.

It is recommended that the initial inspection should cover the points dealt with in **19.2** to **19.15**.

19.2 Area classification. The documentation for the system or self-contained intrinsically safe apparatus should show the following information:

Area classification	System or apparatus requirements
Zone 0	System should be category "ia". Self-contained intrinsically safe apparatus should be category "ia".
Zone 1	System should be category "ia" or "lb". Self-contained intrinsically safe apparatus should be category "ia" or "lb".
Zone 2	As for Zone 1.

19.3 Grouping. The grouping shown on the documentation for the system or self-contained intrinsically safe apparatus should be appropriate to the grouping associated with the flammable atmospheres shown on the appropriate area classification drawing (e.g. for a flammable material associated with Group IIB, systems or apparatus of Groups IIb or IIC may be used but not those of Group IIA).

19.4 Surface temperature classification. The surface temperature classification shown in the documentation for any apparatus should be appropriate to the minimum ignition temperature of the flammable materials shown on the appropriate area classification drawing (e.g. for a flammable material with an ignition temperature of 150 °C apparatus with a temperature classification of T4, T5 or T6 is appropriate but not that with a temperature classification T1, T2 or T3).

19.5 Compliance with documentation. The installation should be inspected to ensure that it complies with the requirements of the relevant documentation and, particularly, that any special installation conditions have been adhered to.

19.6 Labelling. All labels should be inspected to ensure that they are legible and comply with the requirements laid down in the appropriate documentation to ensure that the apparatus actually fitted is that specified.

19.7 Damage. All installations should be inspected to ensure that there is no obvious damage caused by careless installation, vibration or other adverse environmental factors.

19.8 Lamps. All lamps on intrinsically safe apparatus which can easily be replaced (e.g. those mounted on the outer enclosure which are replaceable without removal of the enclosure) should be inspected to ensure that they are of the type specified in the appropriate documentation.

19.9 Fuses. All fuses in intrinsically safe systems or self-contained intrinsically safe apparatus which can easily be replaced (see **19.8**) should be inspected to ensure that they are of the type and rating specified in the appropriate documentation.

19.10 Earthing. All installations should be inspected to ensure that the only connections to earth are those specified in the system documentation and that all such earths have been made in accordance with clause **16**.

NOTE The requirements for electrical testing are contained in clause **21**.

19.11 Cable screens. All installations should be inspected to ensure that any cable screens are earthed in accordance with the appropriate documentation, **15.1.4** and clause **16**. Particular attention should be paid to installations utilizing multicore cables which contain more than one intrinsically safe system.

NOTE The requirements for electrical testing are contained in clause **21**.

19.12 Diode safety barriers. All diode safety barrier installations should be inspected to ensure that the correct types of barriers have been used and that all such devices are firmly fixed to the barrier earth bar in a way which gives good earth continuity.

Because of the importance of the main barrier earth bar connection particular attention must be paid to inspection of this in accordance with **19.10**.

NOTE The requirements for electrical testing are contained in clause **21**.

19.13 Diode safety barrier boxes and junction boxes. Boxes containing diode safety barriers and junction boxes should be inspected to ensure that they contain no wiring not specified in the documentation appropriate to any system passing through them.

19.14 Cabling. All installations should be inspected to ensure that the cables used comply with the system documentation and **15.1**. Particular attention should be paid to the possibility of unauthorized circuits in multicore cables containing more than one intrinsically safe system and to the protection afforded where cables containing intrinsically safe systems and other cables are run in the same pipe, duct or cable tray.

19.15 Relays and similar devices. All installations should be inspected to ensure that relays and similar devices which act as safety barriers between circuits have not become damaged by repeated operation or vibration in a way which reduces the segregation afforded.

20 Routine inspections

20.1 General. All installed intrinsically safe systems and self-contained intrinsically safe apparatus should be regularly inspected to ensure that they continue to comply with the appropriate documentation. It is recommended that the maximum period between routine inspections should be 2 years but an increase in frequency is advisable for installations in particularly arduous environmental conditions.

It is recommended that the routine inspection should cover the points dealt with in **20.2** to **20.10**.

20.2 Labelling. All labels should be inspected to ensure that they are legible and comply with the requirements laid down in the appropriate documentation to ensure that the apparatus actually fitted is that specified.

20.3 Damage. All installations should be inspected to ensure that there is no obvious damage caused by vibration or other adverse environmental factors.

20.4 Lamps. All lamps on intrinsically safe apparatus which can easily be replaced (e.g. those mounted on the outer enclosure which are replaceable without removal of the enclosure) should be inspected to ensure that they are of the type specified in the appropriate documentation.

20.5 Fuses. All fuses in intrinsically safe systems and self-contained intrinsically safe apparatus which can easily be replaced (see **20.4**) should be inspected to ensure that they are of the type and rating specified in the appropriate documentation.

20.6 Earthing. All installations should be inspected to ensure that the earth connections specified in the system documentation are in accordance with clause **16**.

NOTE The requirements for electrical testing are contained in clause **21**.

20.7 Cable screens. All installations should be inspected to ensure that any cable screens are earthed in accordance with the appropriate documentation, **15.1** and clause **16**. Particular attention should be paid to multicore cables which contain more than one intrinsically safe circuit.

NOTE The requirements for electrical testing are contained in clause **21**.

20.8 Diode safety barriers. All diode safety barrier installations should be inspected to ensure that the correct types of barriers have been fitted and that they remain firmly fixed to the barrier earth bar.

Because of the importance of the main barrier earth bar connection particular attention must be paid to its continued integrity.

NOTE The requirements for electrical testing are contained in clause **21**.

20.9 Diode safety barrier boxes and junction boxes. Boxes containing diode safety barriers and junction boxes should be inspected to ensure that they contain no wiring not specified in the documentation for any intrinsically safe system which passes through them.

20.10 Relays and similar devices. All installations should be inspected to ensure that relays and similar devices which act as safety barriers between circuits have not become damaged by repeated operation or vibration in a way which reduces the segregation afforded.

21 On-site electrical testing

Where compliance with the appropriate documentation cannot be demonstrated by physical inspection, electrical testing should be carried out in accordance with **21.1** and **21.2**. Other electrical testing should only be carried out in accordance with the requirements of the appropriate documentation as the voltages and currents associated with some test instruments could lead to an unsafe condition either directly or by damage to safety components.

21.1 Insulation testing. In order to ensure that only the earth connections specified on the appropriate documentation are present the intrinsically safe system or self-contained intrinsically safe apparatus should first be isolated from its normal source of power and its intended earth, and then, insulation testing should be carried out as described in **21.1.1** to **21.1.3**.

21.1.1 *Insulation testing with non-certified test instruments*. Because of the possibility of high voltage test instruments causing incendive sparking and the possibility of breakover of the test voltage from one system to another, it is not normally possible to test with such instruments except when the entire plant can be shown to be free of flammable atmospheres (e.g. on a completely new plant prior to the introduction of any flammable material) and only when specifically permitted by the relevant documentation.

21.1.2 *Insulation testing with an intrinsically safe insulation tester*. Insulation testing with a certified insulation tester, whose maximum output parameters do not exceed 1.2 V, 0.1 A and 25 mW and whose energy storage capability does not exceed 20 μJ, may be carried out on intrinsically safe apparatus and system regardless of the possible presence of flammable atmospheres.

21.1.3 *Insulation testing frequency*. It is recommended that insulation testing in accordance with **21.1** be carried out on all installations as part of the initial inspection procedure.

Routine insulation testing should also be carried out in accordance with **21.1**, as part of the routine inspection procedure but it is only considered necessary to carry out such testing on a sample basis. The sample used should, in general, be 10 % of the installations chosen at random but precautions should be taken to ensure that subsequent routine tests are carried out on different installations to ensure that all installations are ultimately tested.

If the results of such tests show that certain installations are more prone to faults than others then the percentage sample should be increased and care taken to ensure that the less reliable systems are checked more frequently than others.

21.2 Earth continuity testing. In order to ensure that earth connections specified in the appropriate documentation are reliable it may be necessary to carry out earth continuity tests. In order to carry out such tests the installation should first be isolated from its source of supply and then tested as follows.

21.2.1 *Earth continuity testing with high current continuity testers*. Tests using high current continuity testers are only permissible in the conditions specified in **21.1.1**. Where such a test is carried out the test used should be that specified in Appendix 6 of IEE Regulations for the electrical equipment of buildings (14th edition) and the resistance measured should not exceed that specified on the system documentation.

21.2.2 *Earth continuity testing using intrinsically safe continuity testers*. Earth continuity testing with a certified continuity tester, whose maximum output parameters do not exceed 1.2 V, 0.1 A and 25 mW and whose energy storage capability does not exceed 20 μJ, may be carried out on intrinsically safe apparatus and systems regardless of the possible presence of flammable atmospheres.

21.2.3 *Earth continuity testing frequency*. It is recommended that earth continuity testing in accordance with **21.2** be carried out on all installations as part of the initial inspection procedure.

Routine earth continuity testing should also be carried out, in accordance with **21.2**, as part of the routine inspection procedure but it is only considered necessary to carry out such testing on a sample basis. The samples tested should be chosen in accordance with **21.1.3**.

22 Records

A means should be established to record, for all intrinsically safe systems and self-contained intrinsically safe electrical apparatus, the results of inspections and tests and, in addition, to record any action taken to correct defects found during inspections. These records should be kept with the information required by clause **14**.

Section 5. Maintenance

23 General

In order to ensure that maintenance work does not reduce the level of safety achieved by intrinsically safe systems and self-contained intrinsically safe electrical apparatus the precautions detailed in clauses **24** to **27** should be observed when maintenance is carried out.

Careless maintenance (e.g. careless use of tools such as screwdrivers), including that of certified apparatus, can lead to an unsafe condition, either directly or by damage to safety components, wiring or clearances. Therefore, it is considered essential that such maintenance is only carried out by competent personnel.

24 Removal of electrical apparatus

Where electrical apparatus is removed for maintenance, any exposed conductors which remain should be mechanically and electrically secured in an appropriate manner so as to prevent the occurrence of an unsafe condition.

25 Maintenance work on installed intrinsically safe systems and self-contained intrinsically safe electrical apparatus

Maintenance work may be carried out with the intrinsically safe system or self-contained intrinsically safe apparatus energized subject to the conditions detailed in **25.1** and **25.2**.

25.1 Maintenance work in hazardous areas. Any maintenance work should be restricted to the following:

a) disconnection of and removal or replacement of items of electrical apparatus and cabling;

b) adjustment of any controls which is necessary for the calibration of the electrical apparatus or system;

c) removal and replacement of any plug in components or assemblies;

d) use of any test instruments specified in the relevant documentation;

e) any other maintenance activity specifically permitted by the relevant documentation.

It is considered necessary that the person carrying out any of the functions described above should carefully ensure that the intrinsically safe system or self-contained intrinsically safe apparatus meets the requirements of the relevant documentation after completion of any of those functions.

25.2 Maintenance work in non-hazardous areas. Maintenance of associated electrical apparatus and parts of intrinsically safe systems located in non-hazardous areas should be restricted to that described in **25.1** whilst such electrical apparatus or parts of systems remain interconnected with parts of intrinsically safe systems located in potentially explosive atmospheres.

Other maintenance work on associated apparatus or parts of an intrinsically safe system mounted in a non-hazardous area should be carried out only if the electrical apparatus or part of a system is disconnected from the part of the system located in a potentially explosive atmosphere. Also an inspection in accordance with clause **18** should be carried out after any such maintenance work to ensure continued compliance with the relevant documentation.

26 Maintenance in a workshop

In the design of intrinsically safe and associated electrical apparatus and intrinsically safe systems, factors taken into account in order to ensure safety include the choice of components of specific types and ratings, physical separation of and electrical insulation of components and wiring and the types of enclosure used. It is considered essential for safety that all of these factors remain unaltered and, therefore, an inspection should be carried out after maintenance work, in accordance with clause **18**, to ensure that these factors remain unchanged.

27 Shunt diode safety barriers

If it is known or suspected that a shunt diode safety barrier has been subjected to an excessive voltage or current, it should be removed from service and tested in accordance with the tests specified in the manufacturer's documentation for the device.

Appendix A Organizations through which advice on intrinsic safety applications may be obtained

Expert advice on the application of intrinsic safety may be obtained through the following organizations.

Health and Safety Executive:	
Safety and General Division	SGA4
HM Factory Inspectorate	F15
HM Inspectorate of Mines and Quarries	MQI
British Approvals Service for Electrical Equipment in Flammable Atmospheres	BASEEFA
Safety in Mines Research Establishment	SMRE
National organizations:	
British Standards Institution	BSI
British Industrial Measuring and Control Apparatus Manufacturers' Association	BIMCAM
British Electrical and Allied Manufacturers Association	BEAMA
Engineering Equipment Users' Association	EEUA
Institution of Electrical Engineers	IEE
Electrical Research Association	ERA
Oil Companies Materials Association	OCMA
Institute of Petroleum	IP
Council of British Manufacturers of Petroleum Equipment	CBMPE
Scientific Instrument Manufacturers Association	SIMA
The Sira Institute Limited	SIRA

Appendix B Illustrations of typical intrinsically safe installations

Figure 1 to Figure 6 are linked with the installations discussed in Appendix C and should be used in conjunction with this Part of the code of practice.

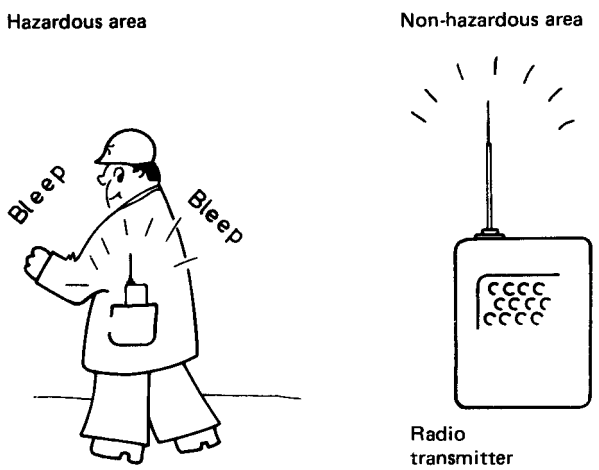


Figure 1 — Self-contained apparatus (6.2): paging system

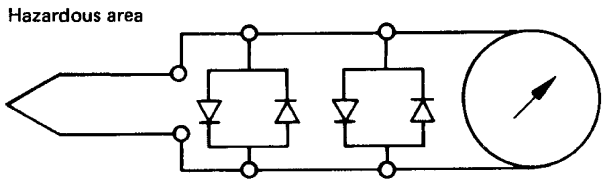


Figure 2 — Simple apparatus (6.3.3): thermocouple with direct deflection indicator

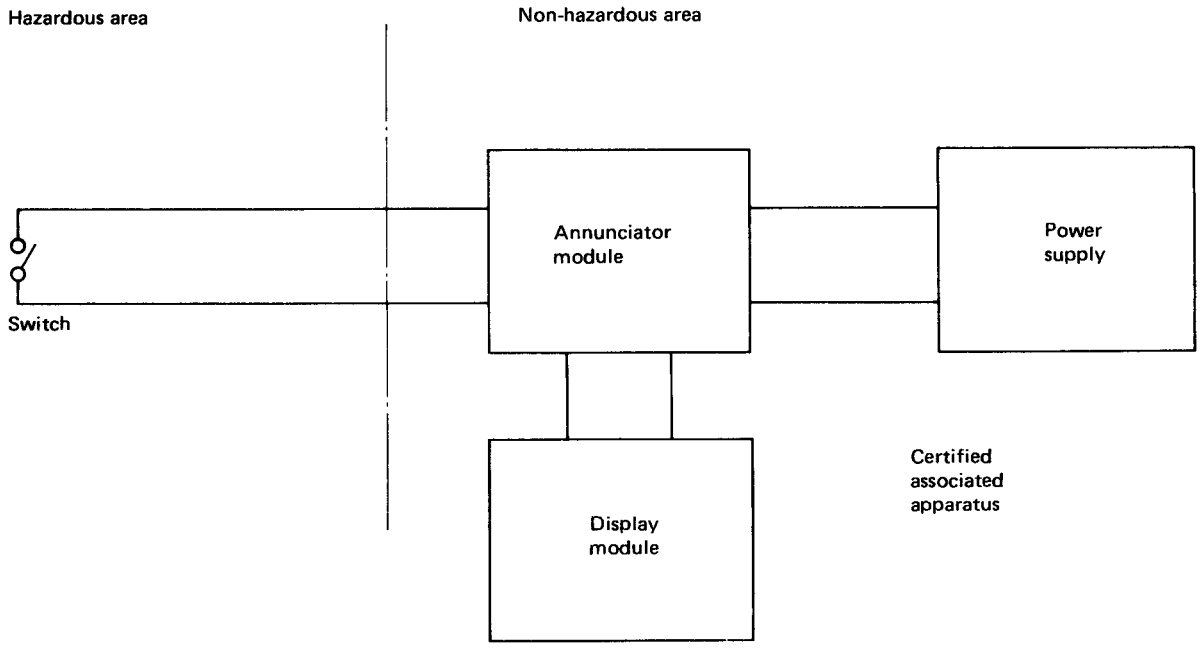
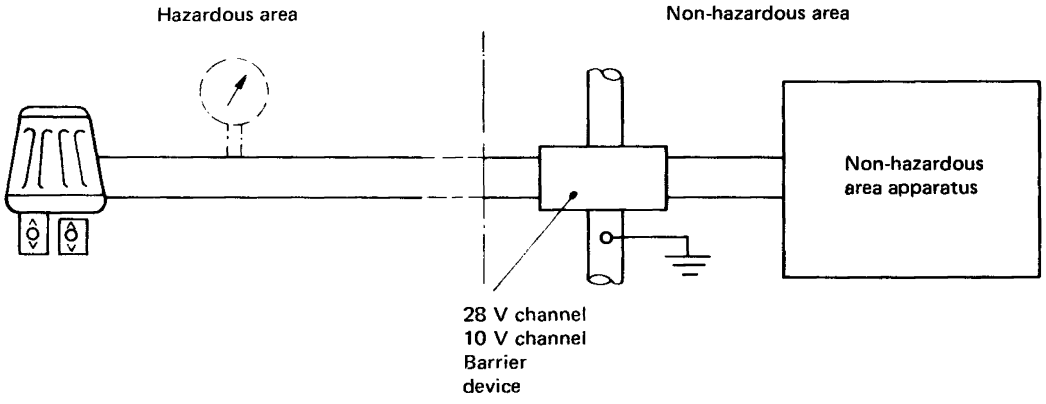
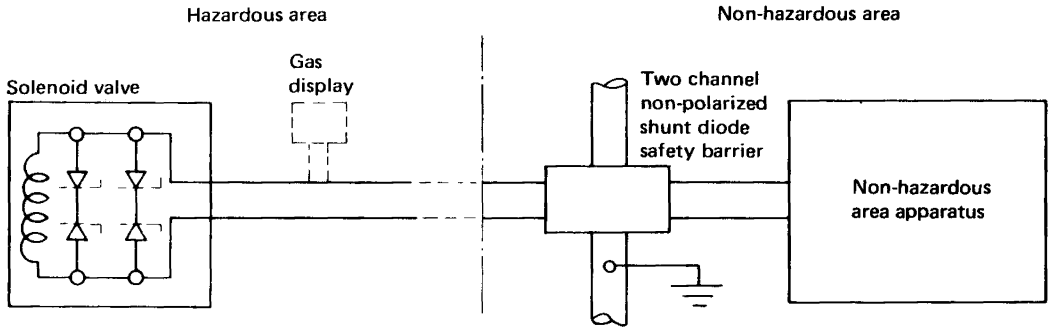


Figure 3 — Certified associated apparatus



NOTE Transmitter with certified effective input capacitance, and inductance, and maximum permitted supply volts matched to barrier with certified maximum fault voltage and permitted hazardous area parameters.
Moving coil meter may be added as simple apparatus (**6.3.3** and clause **8**).

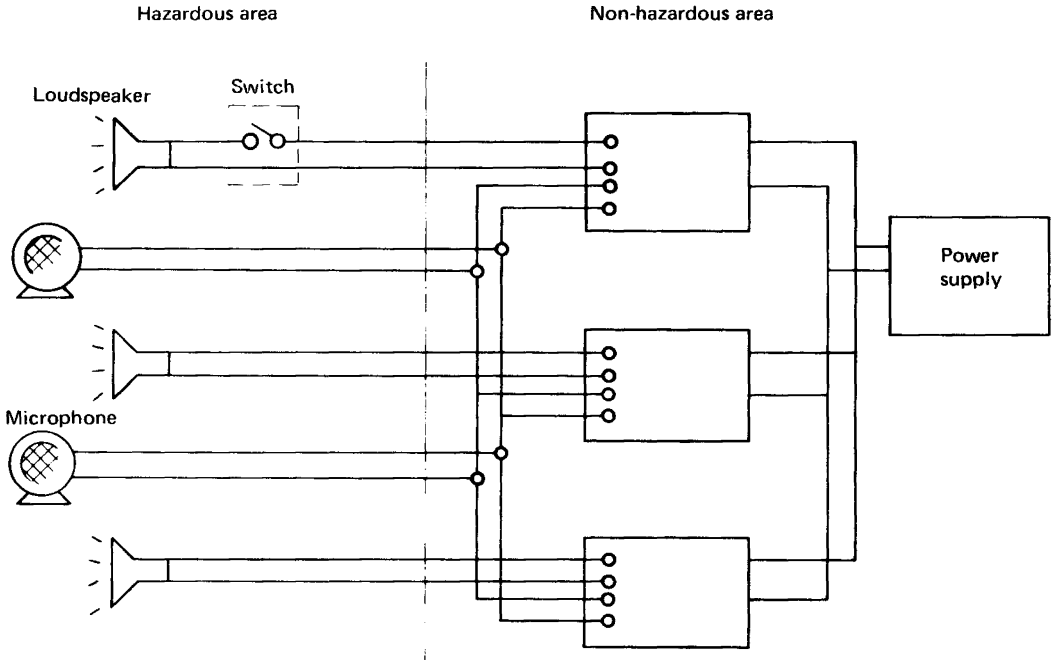
Figure 4 — Certified apparatus (6.3.1) with compatible parameters



NOTE Compatibility of the two units is not readily demonstrated because of the complex characteristic of the partially suppressed solenoid. Hence system should be considered by a national authority.

Non-energy storing gallium arsenide display of drive current magnitude could be added without further consideration by national certifying authority.

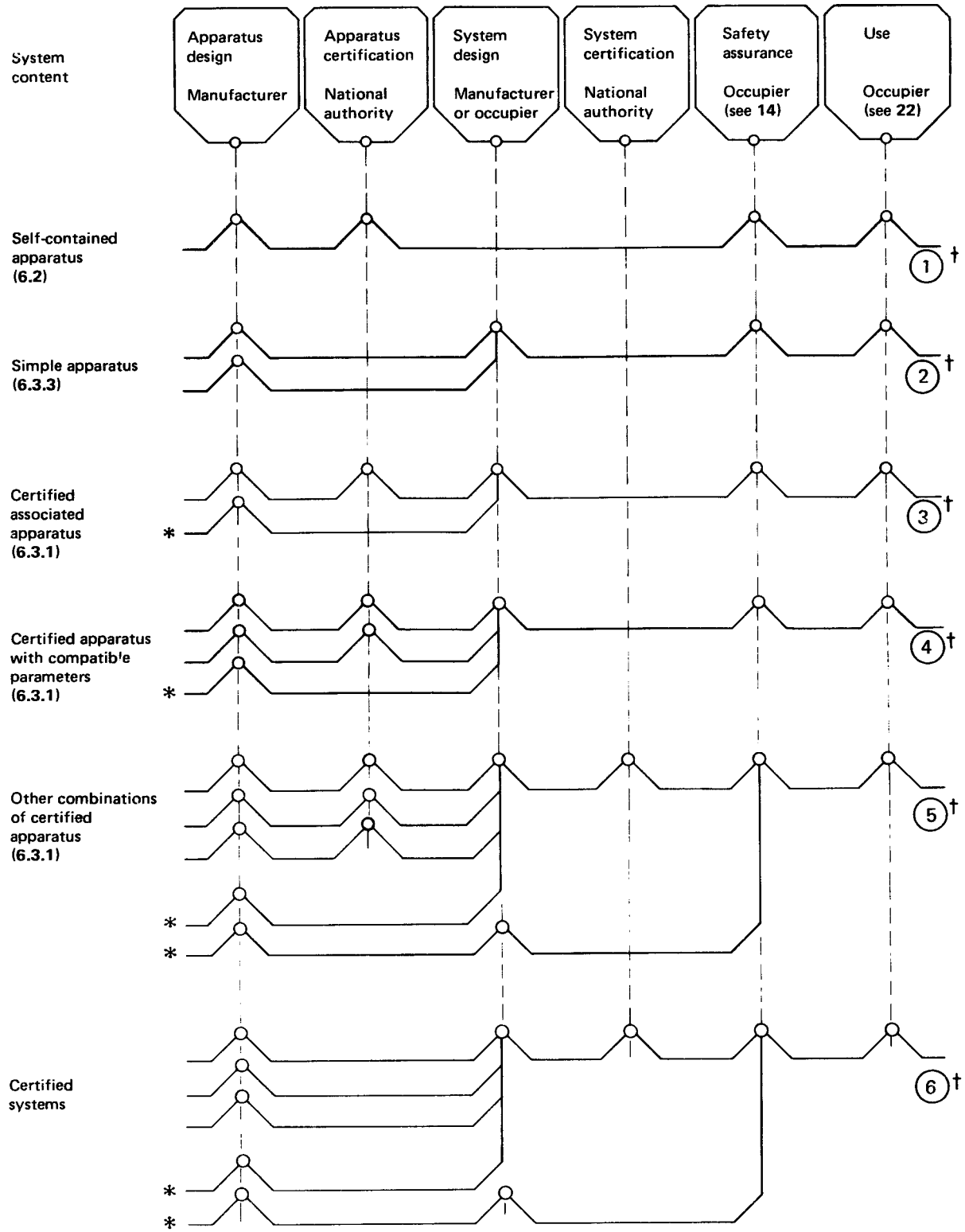
Figure 5 — Other combinations of certified apparatus: solenoid valve with barrier



NOTE Where a specific combination is always used together, the whole may be certified to make best use of the system fault count. Switch to isolate a particular loudspeaker could be added as simple apparatus later (but see clause **8**).

Figure 6 — Certified systems: microphone and loudspeaker system

Appendix C Typical procedural stages for intrinsically safe installations



* Denotes "simple apparatus" (**6.3.3**) which may be added to any system without reference to certifying authority.
† Numbers refer to figures in Appendix B

blank

Publications referred to

BS 1259, *Intrinsically safe electrical apparatus and circuits for use in explosive atmospheres.*

BS 4683, *Electrical apparatus for explosive atmospheres.*

BS 4683-3, *Type of protection N.*

BS 4683-4, *Type of protection "e".*

BS 5099, *Spark testing of electric cables.*

BS 5308, *Instrumentation cables intended for intrinsically safe systems.*

BS 5308-1, *Polyethylene insulated cables.*

BS 5345, *Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture).*

BS 5345-1, *Basic requirements for all Parts of the code.*

BS 6207, *Mineral-insulated cables.*

BS 6207-1, *Copper-sheathed cables with copper conductors.*

CP 1003, *Electrical apparatus and associated equipment for use in explosive atmospheres of gas or vapour other than mining applications.*

CP 1003-1, *Choice, installation and maintenance of flameproof and intrinsically-safe apparatus.*

CP 1003-2, *Methods of meeting the explosion hazard other than by the use of flameproof or intrinsically-safe electrical equipment.*

CP 1003-3, *Division 2 areas.*

IEC 79, *Electrical apparatus for explosive gas atmospheres.*

IEC 79-11, *Construction and test of intrinsically safe and associated apparatus.*

EN 50.020, *Electrical apparatus for potentially explosive atmospheres — intrinsic safety "i".*

SFA 3012, *Intrinsic safety (BASEEFA certification standard).*

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