

Code of practice for

**Selection, installation and  
maintenance of intrinsically  
safe electrical equipment in  
coal mines**

Confirmed  
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# Committees responsible for this British Standard

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- Association of British Mining Equipment Companies
- British Aggregate Construction Materials Industries
- British Iron and Steel Producers' Association
- Confederation of United Kingdom Coal Producers
- Health and Safety Executive
- Transmission and Distribution Association (BEAMA)

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## Foreword

This revision of BS 6704 has been prepared by Subcommittee MRE/3/3 and reflects changes in legislation since the first edition was published in 1987. This standard provides guidance on the correct selection, installation and maintenance of intrinsically safe electrical equipment for use in potentially explosive atmospheres in coal mines. This standard supersedes BS 6704 : 1987 which is withdrawn.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Attention is drawn to the Health and Safety at Work etc. Act 1974 [1] and the Mines and Quarries Act 1954 [2], the Regulations made under these Acts and also any other appropriate statutory requirements or Bye-laws. These place responsibility for complying with specific safety requirements on the manufacturer and the user. The addresses of the recognized certification test houses appointed by the Secretary of State for Employment under the Electrical Equipment for Explosive Atmospheres (Certification) Regulations 1990 [3] are:

Health and Safety Executive,  
Electrical Equipment Certification Service (EECS),  
Harpur Hill,  
Buxton,  
Derbyshire,  
SK17 9JN.

SIRA Certification Service, (SCS)  
Saighton Lane,  
Saighton,  
Chester,  
CH3 6EG.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

## Section 1. General

### 1.1 Scope

This British Standard describes the concept of ensuring electrical safety in hazardous atmospheres in coal mines by means of the type of protection 'i' (intrinsic safety), provides background information and gives recommendations on the selection, installation, inspection and testing, and maintenance and repair of intrinsically safe electrical apparatus, systems and networks.

Electrical safety of apparatus installed outside the hazardous atmosphere, or which is safeguarded by a type of protection other than intrinsic safety, is also considered in so far as the selection, installation and maintenance of such apparatus could affect intrinsically safe circuits. Only explosion risks due to the presence of flammable gases and vapours are considered. Combustible dusts are excluded except for coal dust layers which could be ignited by elevated surface temperatures.

Design or performance aspects of intrinsically safe apparatus pertinent to operational safety are not considered.

### 1.2 References

#### 1.2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 18. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

#### 1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed page 18, but reference should be made to the latest editions.

### 1.3 Definitions

For the purposes of this British Standard the following definitions apply.

#### 1.3.1 intrinsic safety

A protection technique based upon the restriction of electrical energy within both apparatus and interconnecting wiring, exposed to a potentially explosive atmosphere, to a level below that which can cause ignition by either sparking or heating effects.

NOTE. 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.

#### 1.3.2 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.

#### 1.3.3 electrical apparatus

An assembly of electrical components and circuits or parts of circuits, usually contained within a single enclosure.

NOTE. An apparatus may occasionally be in more than one enclosure, e.g. a telephone instrument or a portable radio transceiver with a hand microphone.

#### 1.3.4 intrinsically safe electrical apparatus

Electrical apparatus in which all the circuits are intrinsically safe.

#### 1.3.5 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 that has an alternative standard type of protection suitable for its use in the appropriate potentially explosive atmosphere, e.g. a flameproof enclosure containing an intrinsically safe power supply; or
- b) electrical apparatus not protected for use in a potentially explosive atmosphere, e.g. a recorder that is installed in a safe area on the surface, connected to an intrinsically safe transducer situated within a potentially explosive atmosphere underground and where only the recorder input circuit is intrinsically safe.

#### 1.3.6 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.

#### 1.3.7 intrinsically safe network

Two or more intrinsically safe systems that are interconnected in a defined manner.

#### 1.3.8 intrinsically safe equipment

A term embracing intrinsically safe apparatus, systems and networks.

#### 1.3.9 normal operation

The operation of intrinsically safe electrical apparatus or associated electrical apparatus when it conforms electrically and mechanically to its design specification and is used within the limits specified by the manufacturer.

#### 1.3.10 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.

### 1.3.11 safety coupler

A device that is used to limit the transfer of electrical energy between intrinsically safe circuits.

### 1.3.12 safety barrier

A device that is used to limit the transfer of electrical energy from a non-intrinsically safe to an intrinsically safe circuit.

## 1.4 Information on legislation

### 1.4.1 Legislation affecting the use of electricity in British mines

**1.4.1.1** The Electricity at Work Regulations 1989 [4] supported by the Health and Safety Executive (HSE) approved code of practice, *The use of electricity in mines* [5], govern the use of electricity in all mines. Additional requirements for coal mines are also contained in the Coal and Other Mines (Locomotives) Regulations 1956 [6], the Coal and Other Mines (Safety Lamps and Lighting) Regulations 1956 [7], the Coal and Other Safety-Lamp Mines (Explosives) Regulations 1993 [8], the Coal and Other Mines (Ventilation) Regulations 1956 [9], and the Management and Administration of Safety and Health at Mines Regulations 1993 [10].

**1.4.1.2** The principal statutory safeguards against the risk of a firedamp ignition by electricity can be summarized as follows.

- a) In potentially 'gassy' parts of a mine the use of electrical equipment which is capable of producing incendive sparking in normal working is not permitted. See Regulation 19 of the Electricity at Work Regulations 1989 [4] and **1.4.1.3**.
- b) Regular periodic testing of the mine environment using gas detectors and methanometers is required by the Coal and Other Mines (Ventilation) Regulations 1956 [9] and the Management and Administration of Safety and Health at Mines Regulations 1993 [10], and where the amount of flammable gas in the general body of the mine air exceeds 1.25 % by volume the supply of electricity has to be cut off. Signals, telephones, caplamps, gas detectors and other similar essential safety equipment are excluded from the requirement providing they are of a type approved by the Health and Safety Executive (Mines Inspectorate) as being suitable to remain energized when flammable gas concentrations exceed the stipulated limit.
- c) Under the Management and Administration of Safety and Health at Mines Regulations 1993 [10], the mine manager is required to ensure that all plant and equipment is safely installed and commissioned and to provide and implement a scheme to ensure the proper inspection, examination, testing and maintenance of all electrical equipment and to appoint a sufficient number of suitably qualified and competent persons to direct and manage, supervise and undertake all the above activities.

**1.4.1.3** Regulation 19 of the Electricity at Work Regulations 1989 [4] prohibits the use of certain electrical equipment at safety-lamp mines in zones below ground in which firedamp is likely to occur in a quantity sufficient to indicate danger.

The manager of the mine is responsible for deciding which parts of the mine can be considered free from flammable gas and, using his discretion, he has to identify the zones where Regulation 19 of the Electricity at Work Regulations 1989 [4] applies and show them on a plan of the mine. There are no absolute rules governing the identification of such zones since circumstances and conditions may vary greatly from mine to mine, but guidance is given in the Coal and Other Mines (Ventilation) Regulations 1956 [9] on the method to be used in order to declare a roadway free from flammable gas. However, in general all places within 300 m of a working face and all places ventilated by auxiliary ventilation should, in the absence of evidence to the contrary, be considered hazardous zones.

**1.4.1.4** It is generally accepted that electrical equipment certified by a European notified body (see **1.5.1**) as conforming to the appropriate standards for flameproof or intrinsically safe electrical equipment for use in group I atmospheres (class 1 in earlier standards), is acceptable for use in hazardous zones in coal mines.

**1.4.1.5** Regulation 20 of the Electricity at Work Regulations 1989 [4] contains the requirement for the supply to all electrical apparatus, with the exception of approved signalling, telephone, gas detection or other equipment required for the safety of persons, to be switched off if the amount of flammable gas in the general body of air at the place in question exceeds 1.25 % by volume. The aim is to ensure that only apparatus essential for safety remains energized in an explosive atmosphere. Such approved apparatus is normally certified as intrinsically safe in accordance with either BS 1259 or category 'ia' of BS 5501 : Part 7 : 1977.

NOTE. The types of electrical equipment approved by the Health and Safety Executive (HSE) for the purpose of Regulation 20 of the Electricity at Work Regulations 1989 [4] are mentioned in **1.4.1.2b**. The HSE also approves other equipment for the purposes of other Regulations. For example shot firing equipment and locomotives should not be confused with the Regulation 20 equipment, as they are neither intrinsically safe equipment, nor allowed to remain energized when flammable gas concentrations exceed 1.25 %.

### 1.4.2 European legislation

#### 1.4.2.1 EU article 100 directives

Within the European Union under Article 100 of the Treaty of Rome, provision is made for the removal of technical barriers to trade by the issue of Directives. The Council of the European Communities has issued several such Directives and one, Directive 82/130 EEC of 15 February 1982 [11], commonly known as the 'Gassy Mines' Directive, concerns electrical equipment for use in potentially explosive atmospheres in mines susceptible to firedamp. This Directive requires that

member states shall not prohibit the sale, free movement, or use for its proper purpose of such equipment which has been certified as conforming to harmonized standards and which may be marked with the distinctive community mark, as shown in figure 1.

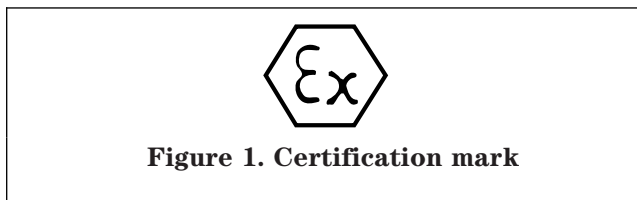


Figure 1. Certification mark

#### 1.4.2.2 EU article 100A Directives

A new article 100A Directive was written and published on 23 March 1994 as Directive 9/94/EC [12], commonly known as the 'ATEX' Directive. This applies to all kinds of apparatus, electrical and non-electrical and, as of 1 March 1996, runs concurrently with the old Article 100 Directives until the year 2003, at which time the old Article 100 Directives will be withdrawn.

The ATEX Directive [12] also introduced the concept of aligning apparatus with its usage by describing the requirements for mining apparatus in usage category M1 and usage category M2. These align closely with the existing legal requirements for British mines, with category M2 being the apparatus used in normal circumstances and M1 being that apparatus which can remain energized when firedamp concentrations exceed 1.25 % by volume (normally only that meeting the requirements of intrinsic safety category ia and needing to remain energized for safety reasons).

### 1.5 Information on certification

#### 1.5.1 British mining certification authorities

Certification of electrical apparatus for mines has been carried out since 1911 in conjunction with HM Mines Inspectorate. The Electrical Equipment Certification Service (EECS) has certified virtually all explosion-protected electrical equipment used in British mines. It has two divisions, MECS (Mining Equipment Certification Service) and for non-mining industries BASEEFA (British Approvals Service for Electrical Equipment in Flammable Atmospheres).

In 1992, by way of an amending Commission Directive, article 8 of Directive 82/130/EEC [11] (the 'Gassy Mines' Directive) harmonized the protection concept standards listed in table 1 and requires certificates to be issued only by an approved body. Article 14 of Directive 82/130/EEC [11] requires each member state to notify the European Commission of its approved bodies.

Certification by a notified body consists of attesting formally that a specified type of apparatus or system conforms to a recognized standard such as BS 1259 or BS 5501 : Part 7.

The certificate issued can be one of the following.

- a) *Certificate of conformity*, attesting conformity to standards harmonized under European Union Directives.
- b) *Supplementary certificate*, resulting from an application for a variation to a previously certified electrical apparatus or system.
- c) *Certificate of assurance*, attesting conformity to non-harmonized standards.
- d) *Inspection certificate*, referring to electrical equipment which, although not conforming to European harmonized standards, is of an equivalent degree of safety.
- e) *Component certificate*, referring to component parts assessed as suitable for use with appropriately certified electrical apparatus.

#### 1.5.2 Certification to European standards

The harmonized standards referred to in Directives 82/130/EEC [11] and 94/9/EC [12] are European standards (ENs) produced by the European Committee for Electrotechnical Standardization (CENELEC). The European Standards dealing with the design, construction and testing of electrical apparatus for use in hazardous atmospheres and the corresponding British Standards are as shown in table 1.

NOTE. EN 50039 is not yet a harmonized standard for Group I. Until it is harmonized, certificates of conformity may be issued where designs conform to the requirements of appendix 3 to annex B of EEC Directive 82/130/EEC [11].

#### 1.5.3 Certification to British Standards

The construction and test requirements for type 'i' protection (intrinsic safety) are embodied in BS 1259 : 1958, BS 5501 : Part 7 : 1977 and BS 5501 : Part 9 : 1982. To enable interfacing, BS 6709 lays down construction and test requirements for apparatus conforming to these standards. Electrical equipment conforming to any one of these standards is acceptable for installation in accordance with this British Standard. Other British Standards specify electrical input and output characteristics of various types of intrinsically safe equipment necessary to ensure operational compatibility when such equipment is interconnected. These standards, which may also simplify the assessment of intrinsic safety, are BS 5754, BS 6182, BS 6353, BS 6556 and BS 6705.

### 1.6 Information on certification of electrical apparatus and systems

#### 1.6.1 Intrinsically safe electrical apparatus

Intrinsically safe apparatus which has been certified to BS 1259 or BS 5501 : Part 7 normally falls into one of the following three categories:

- a) completely self-contained apparatus which has no electrical connection to other electrical apparatus;
- b) apparatus which is self-contained apart from its power supply. Permitted type(s) of power supply are specified in the certification documentation issued for the apparatus;

**Table 1. Standards dealing with the design, construction and testing of electrical apparatus for use in hazardous atmospheres**

| EN              | BS EN              | Part of BS 5501             |
|-----------------|--------------------|-----------------------------|
| EN 50014 : 1992 | BS EN 50014 : 1993 | Part 1 : 1977 <sup>1)</sup> |
| EN 50015 : 1994 | BS EN 50015 : 1994 | Part 2 : 1977 <sup>2)</sup> |
| EN 50016 : 1977 | —                  | Part 3 : 1977               |
| EN 50017 : 1994 | BS EN 50017 : 1994 | Part 4 : 1977 <sup>3)</sup> |
| EN 50018 : 1994 | BS EN 50018 : 1995 | Part 5 : 1977 <sup>4)</sup> |
| EN 50019 : 1994 | BS EN 50019 : 1994 | Part 6 : 1977 <sup>5)</sup> |
| EN 50020 : 1994 | BS EN 50020 : 1995 | Part 7 : 1977 <sup>6)</sup> |
| EN 50028 : 1988 | —                  | Part 8 : 1988               |
| EN 50033 : 1991 | BS EN 50033 : 1991 | —                           |
| EN 50039 : 1980 | —                  | Part 9 : 1982               |

<sup>1)</sup> Partially replaced by BS EN 50014 : 1993.

<sup>2)</sup> Replaced by BS EN 50015 : 1994, but remains current.

<sup>3)</sup> Replaced by BS EN 50017 : 1994, but remains current.

<sup>4)</sup> Replaced by BS EN 50018 : 1995, but remains current.

<sup>5)</sup> Replaced by BS EN 50019 : 1994, but remains current.

<sup>6)</sup> Replaced by BS EN 50020 : 1995, but remains current.

c) apparatus which is capable of being assessed, tested and certified separately, but which cannot be used except as a component part of a system. Conditions of use are defined in the certification documentation issued for the apparatus.

## 1.6.2 Intrinsically safe electrical systems

### 1.6.2.1 General

Apart from simple intrinsically safe systems built up from separate items of apparatus as described in 1.6.1b, intrinsically safe systems have generally been certified to BS 1259 which is now an obsolescent standard and new intrinsically safe systems will be certified to BS 5501 : Part 7 and BS 5501 : Part 9. Where it is necessary to interconnect to existing installations certified to BS 1259, the newly formed system will be certified to BS 1259. (See also the note to 1.5.2.)

### 1.6.2.2 Permitted variations in system layout

The certification documentation for an intrinsically safe system in accordance with BS 1259 specifies the items of apparatus, either by type or electrical characteristics, that may be connected and the manner by which such connections may be made. In this way a degree of flexibility is provided which permits variations to suit particular site requirements. The standards listed in 1.5.3 provide further flexibility.

NOTE. Notwithstanding these provisions a need may arise to vary the system layout in a manner not covered by the certification documentation, or to include additional items of apparatus. In such cases the certificate holder needs to obtain supplementary certification before the changes are implemented.

## 1.6.3 Intrinsically safe electrical networks

Intrinsically safe electrical networks can be formed by interconnecting separately certified intrinsically safe systems in a manner permitted by the certification documentation.

Electrical networks so constructed are suitable for use in hazardous areas in coal mines provided all conditions specified in the certification documentation for all the systems involved are met. Such a network may be regarded as an 'uncertified system' in the sense that the specific arrangement and interconnection of all equipment contained therein has not been assessed as a whole nor has a single certificate of intrinsic safety for the enlarged system been issued.

## 1.6.4 Intrinsically safe categories

**1.6.4.1** BS 5501 : Part 7 specifies two categories of intrinsic safety, 'ia' and 'ib'. Category 'ia' apparatus is intended for use in areas of high risk and is incapable of causing ignition in normal operation and with any combination of two faults applied; whereas category 'ib' apparatus takes only one fault into account.

**1.6.4.2** Self-contained apparatus or systems certified to BS 5501 : Part 7 or BS 5501 : Part 9 is either category 'ia' or 'ib' and this is specified in the certification documentation and also marked on the apparatus.

**1.6.4.3** Apparatus which is approved under mining legislation (see 1.4) and which can be left energized when the content of firedamp in the general body of air exceeds 1.25 % by volume has to satisfy the requirements for category 'ia'.