
British Standard Code of practice for

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

Code de bonne pratique pour le choix, l'installation et la maintenance des appareils électriques à sécurité intrinsèque utilisés dans les mines de charbon

Leitfaden zur Auswahl, Montage und Wartung von eigensicheren elektrischen Anlagen in Kohlenbergwerken

Foreword

This code of practice has been prepared under the direction of the Mining and Quarrying Requisites Standards Committee to provide guidance on the correct selection, installation and maintenance of intrinsically safe electrical equipment for use in potentially explosive atmospheres in coal mines.

NOTE. It had been anticipated that a code of practice might be published covering several methods of protection, of which type 'i' (intrinsic safety) would form one part. That has not as yet materialized and the committee for intrinsic safety in coal mines which is responsible for this standard decided that this subject should not be delayed.

Compliance with a British Standard does not of itself confer immunity from legal obligations. Attention is drawn to the Health and Safety at Work etc. Act 1974, the Factories Act 1961, the Mines and Quarries Act 1954, the Regulations made under these Acts, and also any other appropriate statutory requirements or bye-laws. These place responsibility for complying with certain specific safety requirements on the manufacturer and the user. The address of the recognized certification authority in the UK for Group I (coal mining) apparatus for intrinsic safety purposes is as follows:

Health and Safety Executive
HSE (M) Certification Support Unit
Harpur Hill
Buxton
Derbyshire SK17 9JN

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Section one. General

1 Scope

This code of practice describes the concept of ensuring electrical safety in hazardous atmospheres in coal mines by means of the type of protection 'i' (intrinsic safety) and gives recommendations on the selection, installation and maintenance of electrical apparatus, systems and networks which are so protected.

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 may be ignited by elevated surface temperatures.

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

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

2 Definitions

For the purposes of this standard the following definitions apply.

2.1 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.

2.2 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.

2.3 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.

2.4 intrinsically safe electrical apparatus. Electrical apparatus in which all the circuits are intrinsically safe.

2.5 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.

2.6 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.

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

2.8 intrinsically safe equipment. A term embracing intrinsically safe apparatus, systems and networks.

2.9 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.

2.10 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.

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

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

3 Mining legislation affecting the use of electricity*

NOTE. For references keyed by numbers in brackets see appendix A.

3.1 The Coal and Other Mines (Electricity) Regulations 1956, as amended [1], govern the use of electricity in coal mines but additional requirements are contained in regulations for firedamp drainage plants [2], for locomotives [3], for lighting [4] and for the installation and maintenance of electrical plant [5].

* The need for revision of the existing Electricity Regulations to take account of technological developments has long been recognized. Draft electricity regulations have been circulated to interested parties for informal consultation. The draft is based on the Health and Safety Commission and the Health and Safety Executive philosophy for legislation that:

- (a) regulations should simply but clearly identify the safety objectives to be achieved; and
- (b) the manner in which the specified safety objectives might be achieved should be contained in an HSE-approved code of practice or some other appropriate guidance document, but other means could be used if they were shown to be no less safe.

When new electricity regulations are established, this clause on legislation will be amended.

3.2 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 22 of [1] and **3.3**.

(b) Regular periodic testing of the mine environment using gas detectors and methanometers is required 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. Signalling, telephone and gas detection equipment are exempted from this requirement but they have to be of a type approved by the Health and Safety Executive (Mines and Quarries Inspectorate) for use in mines. See Regulation 6, Regulation 20 and Regulation 21A of [1].

(c) The mine manager is required to provide and implement a scheme to ensure the proper installation, examination, testing and maintenance of all electrical equipment and to appoint an electrical engineer and sufficient competent staff to operate the scheme. The electrical engineer and the supervisory members of his staff have to hold appropriate certificates issued by the Mining Qualifications Board. See [5].

3.3 Regulation 22(1) of [1] * states:

'In any part of a mine below ground in which inflammable gas although not normally present is likely to occur in a quantity sufficient to indicate danger, no electrical apparatus shall be used if there is in the normal working thereof a risk of incendive sparking therefrom.'

The manager of the mine is responsible for deciding which parts of the mine can be considered free from flammable gas and in using his discretion can identify 'safe' and 'hazardous' areas underground. There are no absolute rules governing the identification of such areas since circumstances and conditions may vary greatly from mine to mine but guidance is given in [6] 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' areas.

3.4 It is generally accepted that electrical equipment which has been certified by HSE(M), the recognized certification and approval authority for mining electrical equipment in the UK, or by its predecessors, as flameproof or intrinsically safe is acceptable for use in 'hazardous' areas.

3.5 Regulation 6 of [1] states the requirement for the supply to all electrical apparatus, with the exception of

approved signalling, telephone and gas detection equipment, to be switched off if the amount of flammable gas in the general body of air at that place 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.

3.6 Other types of electrical equipment that are required to be approved by HSE under present law include safety lamps; some types of lighting equipment; storage battery and diesel locomotives and shot firing exploders. Testing memoranda specifying the technical and test requirements which approved equipment have to meet are issued by HSE(M). Memoranda are available for methanometers [7], safety lamps [8], shot firing exploders [9] and locomotives [10].

4 British mining certification authority

Although officers of the Safety in Mines Research Establishment, and HM Mines and Quarries Inspectorate and their predecessors, together with associated administration branches of various government departments, have provided a service for the testing and certification of electrical equipment to be used in potentially explosive atmospheres in mines since 1930, it was not until 1981 that the service was clearly identified by name. It is known as HSE(M)† and is the British national testing, certification and approval authority for electrical equipment for use in potentially explosive atmospheres in mines. Together with the British Approvals Service for Electrical Equipment in Flammable Atmospheres (BASEEFA), the certification authority for non-mining industries, HSE(M) is administered by the Health and Safety Executive with the Director of the Explosion and Flame Laboratory of the Research and Laboratory Service Division (RLSD) of HSE as head.

All mining certification and testing is carried out at Buxton where a common certification support unit services both HSE(M) and BASEEFA.

An Electrical Equipment Certification Management Board (EECMB) has executive responsibility for providing efficient mining and non-mining certification services. Advice to the EECMB on all technical matters affecting the operation of the mining service is given by an advisory committee, the Certification of Electrical Equipment Mining Advisory Council (CEEMAC). Both EECMB and CEEMAC include appointees from major organizations involved in the manufacture, use and certification of mining electrical equipment.

Details of the services provided and guidance to applicants seeking certification are contained in the SHE Electrical Equipment Certification Guide.‡

* 'inflammable' is a deprecated term but is used in the Regulations. It is synonymous with 'flammable'.

† HSE(M) is notified to the Commission of the European Communities as the national approved body for the purposes of Article 14 of the Directive 82/130/EEC of 15 February 1982.

‡ Obtainable from HSE Electrical Certification Service, Harpur Hill, Buxton, Derbyshire SK17 9JN.

Certification by HSE(M) consists of attesting formally that a specified type of apparatus or system conforms to a recognized standard such as those mentioned in 3.5. The certificate issued can be one of the following:

- (a) *Prime certificate* resulting from a new application made for the certification of electrical apparatus, or component or system.
- (b) *Supplementary certificate* resulting from an application for a variation to previously certified electrical apparatus, or component or system.
- (c) *Certificate of conformity* referring to electrical apparatus or component or a system complying with standards harmonized under European Directives.
- (d) *Inspection certificate* referring to electrical apparatus 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.

5 Certification standards and other relevant specifications

5.1 European and international standards

Within the European Economic Community, 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, no. 82/130/EEC of 15 February 1982, 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 complying with harmonized standards and marked with the distinctive community mark:



The harmonized standards referred to in this Directive are European standards (EN) produced by the European Committee for Electrotechnical Standardization (CENELEC). This organization comprises the standards organizations of EEC member states and other European countries.

CENELEC is headed by a General Assembly with a Technical Board and General Secretariat based in Brussels. Its main objective is the removal of technical barriers to trade by producing harmonized standards acceptable to all its members.

Once a European standard has been agreed by CENELEC, member countries are required to publish identical standards and to withdraw any conflicting standards after

an agreed period. 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 follows:

EN 50 014	BS 5501 : Part 1
EN 50 015	BS 5501 : Part 2
EN 50 016	BS 5501 : Part 3
EN 50 017	BS 5501 : Part 4
EN 50 018	BS 5501 : Part 5
EN 50 019	BS 5501 : Part 6
EN 50 020	BS 5501 : Part 7
EN 50 039	BS 5501 : Part 9

NOTE. EN 50 028 'Encapsulation 'm'' and EN 50 033 'Cap lamps for mines susceptible to firedamp' are in preparation.

CENELEC has a general remit to base, as far as possible, its harmonization work on established documents produced by the International Electrotechnical Commission (IEC), which is the official body responsible for international standardization in the electrotechnical field. The IEC is the electrotechnical counterpart of the International Organization for Standardization (ISO) and comprises the national electrotechnical committees of more than forty countries. It shares, with ISO, central offices in Geneva, and publishes many standards and other documents on various electrotechnical products, including IEC 79 relating to electrical apparatus for use in explosive gas atmospheres.

5.2 British Standards

The British Standards Institution is the national body in the UK for the preparation of standards in all fields, and also represents British interests in all matters concerned with international standards, including representation in CENELEC and IEC. It is an independent association incorporated by Royal Charter and supported by industry, commerce and government.

British Standards are drawn up by Technical Committees consisting of experts and interested parties drawn from, for example, trade organizations, manufacturing organizations, engineering institutions, research institutions, trade unions, users, certification and testing authorities and regulating bodies.

The construction and test requirements for type 'i' protection (intrinsic safety) are embodied in BS 1259 : 1958, BS 5501 : Part 7 : 1977 (EN 50 020) and BS 5501 : Part 9 : 1982 (EN 50 039). To enable interfacing, BS 6709 lays down construction and test requirements for apparatus complying with these standards. Electrical equipment complying with any one of these standards is acceptable for installation in accordance with this code. Recently other British Standards have been published, and others are in preparation, which 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 3101, BS 5754, BS 6182, BS 6353 and BS 6556.

6 Certification of electrical apparatus and systems

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 self-contained apart from its power supply. Permitted type(s) of power supply are specified in the certification documentation issued for the apparatus.
- (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.

6.2 Intrinsically safe electrical systems

6.2.1 General. Apart from simple intrinsically safe systems built up from separate items of apparatus as described in 6.1(b), intrinsically safe systems have generally been certified to BS 1259 or BS 5501 : Part 9.

6.2.2 Permitted variations in system layout. The certification documentation for an intrinsically safe system 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 5.2 provide further flexibility. For example, appropriately certified transducers and signal measuring circuits complying with BS 5754 may be safely interconnected without the need for further certification.

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 should obtain supplementary certification before the changes are implemented.

6.3 Intrinsically safe electrical networks

Intrinsically safe networks can be formed by inter-connecting separately certified intrinsically safe systems in a manner permitted by the certification documentation. The standards listed in 5.2 simplify such interconnections but the network as a whole may not be covered by a single certificate of intrinsic safety.

6.4 Multicore cables

In general different intrinsically safe circuits should not be carried in the same multicore cable. Certification may however permit an intrinsically safe circuit to be carried in a multicore cable, containing other circuits, provided that each circuit:

- (a) is connected to the multicore cable through a specified safety coupler; or

- (b) has a factor of safety of at least four times that required by BS 1259 or BS 5501 : Part 7; or
- (c) is separated from other circuits in the cable by an earthed metallic conducting screen.

6.5 Intrinsically safe categories

BS 5501 : Part 7 specifies two categories of intrinsic safety, 'ia' and 'ib'. Category 'ia' apparatus 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. Category 'ia' apparatus is intended for use in areas of higher risk (see 7.4).

6.6 Surface temperature

Where an apparatus has been certified to BS 5501 : Part 7, the maximum surface temperature that any internal circuit component can attain under fault conditions will have been assessed. Where coal dust can form a layer the maximum allowed surface temperature is 150 °C. Where internal parts are so protected that coal dust is unlikely to form a layer, the maximum allowed surface temperature is 450 °C. This latter value is based on the igniting temperature of methane by a hot surface.

NOTE. In accordance with UK mining practice, to reduce the risk of skin burns the maximum permissible exterior surface temperature of apparatus when used underground is 90 °C unless appropriate safeguards are taken to minimize the risk of accidental bodily contact.

6.7 Conditions of use

Certificates of intrinsic safety for both electrical apparatus and systems may specify conditions of use necessary to ensure that intrinsic safety is maintained. These conditions are included in the certificate and may be defined on the certification drawings.

6.8 Special conditions of use

For apparatus certified to BS 5501 : Part 7, the letter 'X' after the certificate reference number indicates that special conditions are necessary for its safe use. Where legislation requires that apparatus be approved, additional conditions of use may also be included in the approval documentation.

6.9 Special requirements

Some types of intrinsically safe apparatus may have to meet special requirements. For example, apparatus used by rescue personnel may have to be tested for intrinsic safety in the presence of hydrogen, and apparatus for detecting or measuring the quantity of firedamp in the general body of air has to meet statutory performance requirements (see 7.8).

6.10 Cells and batteries

6.10.1 A special feature of cells and batteries is that they cannot be de-energized in the same manner as an electrical circuit can be isolated. The requirements for cells and batteries used in intrinsically safe apparatus are given in

BS 5501 : Part 7 but requirements affecting use may appear on certificate documents or in the HSE(M) Electrical Equipment Certification Guide.

NOTE. HSE(M) presently permit only sealed batteries of the primary or secondary type and having a capacity not exceeding 10 A h to be used in intrinsically safe circuits. Batteries exceeding this capacity should be provided with 'special' protection, and it is expected that HSE(M) will publish a document setting out the requirements for Special Protection (Mining). This document is intended to facilitate the certification of electrical apparatus designed for use in gassy mines and which, while not using a type of protection covered by established standards, is nevertheless assessed by HSE(M) as possessing a satisfactory level of safety against the ignition hazard.

6.10.2 Any cell or battery used in intrinsically safe apparatus and which requires a current limiting device for safety purposes is normally encapsulated or enclosed with its current limiting device in such a way that only the intrinsically safe terminals of the assembly or any terminal intended for recharging are accessible. Rechargeable types are provided with some form of protection against the withdrawal of current from the charging terminals, e.g. by including series blocking diodes. A cell or battery intended to be changed underground (or in a hazardous area on the surface) is constructed so that it forms a complete replaceable unit with its current limiting device. A battery

power pack is marked with a type designation and with information relating to the apparatus with which it is associated. To prevent inadvertent withdrawal of power from a battery power pack any output socket or terminal exposed when not in use may be provided with a blanking cover or cap. Similarly a portable battery power supply unit may incorporate a switch in its output circuit which can be locked off during transportation of the power supply unit.

6.10.3 When a cell or battery is not intended to be changed underground it may be housed with its current limiting device in a compartment having covers secured by fasteners designed to prevent unauthorized entry. The compartment carries a label giving warning that it should not be opened underground.

NOTE. Certification documentation of apparatus incorporating primary batteries has often identified the particular battery to be used by the type designation allocated by the battery manufacturer and the apparatus carries a label giving the permissible battery replacement type; for example, a particular brand and designation to be used. This method of control can lead to difficulties in continuing usage if the battery manufacturer introduces new batteries as replacements for existing types. To overcome this problem, it is proposed that wherever possible use will be made of standard internationally agreed battery type designations specified in BS 397.