BRITISH STANDARD

BS 7924:1999

Code of practice for

The repair and overhaul of certified electrical apparatus intended for use in mines susceptible to firedamp

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Committees responsible for this British Standard

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Association of British Mining Equipment Companies
Health and Safety Executive
Transmission and Distribution Association (BEAMA Ltd.)

The following bodies were also represented in the drafting of the standard, through a panel:

Association of Electrical Machinery Trades
Confederation of United Kingdom Coal Producers
Institution of Electrical Engineers
Rotating Electrical Machines Association (BEAMA Ltd.)
Co-opted members

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Foreword

This British Standard has been prepared by Subcommittee MRE/3/2.

Attention is drawn to the Health and Safety at Work etc. Act 1974, the Mines and Quarries Act 1954 and the Regulations made under these Acts, and also to any other appropriate statutory requirements or bylaws. These place responsibility for complying with certain specific requirements on the manufacturer, user and persons performing overhaul or repair of apparatus, to ensure that it is safe for use and that any relevant information relating to its safe use is available to the user.

Three certification test houses are currently recognized by the Secretary of State for Employment under the Electrical Equipment For Explosive Atmospheres (Certification) Regulations 1990. Their addresses are as follows:

1. The Electrical Equipment Certification Service (EECS)
   [Mining Equipment Certification Service (MECS)]
   Harpur Hill
   BUXTON
   SK17 9JN

2. SIRA Test & Certification Service Ltd.
   Saighton Lane
   Saighton
   CHESTER
   CH3 6EG

3. ERA Technology
   Cleeve Road
   Leatherhead
   Surrey
   KT22 7SA

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Summary of pages

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0 Introduction

0.1 The legal requirements for zoning and explosion protection in mines

The Electricity at Work Regulations 1989 [1] require the manager of every British mine to assess the risk of flammable gas occurring in the mine workings and to indicate these places on a plan.

Such places are defined as zones in which firedamp, whether or not normally present, is likely to occur in a quantity sufficient to indicate danger.

NOTE The same regulations define firedamp as a mixture of flammable gases naturally occurring in mines.

Having designated the zones on a plan, the manager must ensure that these places are identifiable underground so that workers know where the zones start and finish. The manager must also ensure that mine workers are made aware of the fact that any electrical apparatus is not energized inside a zone unless it is protected in such a way as to prevent it from being an igniting source for an explosive firedamp/air atmosphere.

The Electricity at Work Regulations 1989 [1] contain a list of the various types of apparatus which may be energized in the zones and, with the exception of mining type cables and certain apparatus which is constantly supervised under Manager's Operating Rules, the majority of electrical apparatus is expected to be of a type which is certified by a third-party test house, i.e. having a certificate testifying that the design conforms with a recognized published standard relating to the protection of electrical apparatus intended for use in a potentially explosive atmosphere.

Such certificates are usually issued to the manufacturer of the apparatus (or to an agent) by one of the recognized European test houses.

0.2 Nature and limits of the explosion protection

The nature of the explosion protection applied to the apparatus will vary depending upon the type of apparatus and its intended duty. Other factors such as its physical size, electrical rating and the amount of energy it can release will also influence the protective measures adopted. With the exception of one form of explosion protection known as intrinsically safe, or type "i" (which attempts to protect apparatus both during normal working and during faults), it is universally recognized in European Directives, such as 82/130/EEC (commonly called the "Gassy Mines Directive") [2] and 94/9/EC (commonly called the "ATEX Directive") [3], that the explosion protection can only be considered to be effective during normal working of the apparatus.

0.3 Second line of defence

Because a single fault in the explosion protective measures could cause the majority of explosion-protected apparatus to become unsafe in respect of firedamp ignition, British law incorporates a second line of defence. This requires all electrical apparatus, other than that given approval by the Health and Safety Executive, to be either isolated or made safe if firedamp concentrations in the general body of mine air exceed 1.25 %.

0.4 Standards and special certificates

The majority of explosion-protected electrical apparatus is constructed in accordance with recognized national standards (e.g. British Standards) or, more recently, with CENELEC European Standards. Exceptions include rare items of apparatus allowed by special certificates (type "s") or inspection certificates.

0.5 Test houses (notified bodies)

In Britain, a government-owned mining certification service was set up in 1931 to issue certificates for explosion-protected apparatus intended for use in mines. This service has continued to the present day, being joined in 1991 by a privately owned UK test house. Both test houses have been approved by the Secretary of State for Employment as notified bodies under the Electrical Equipment for Explosive Atmospheres (Certification) Regulations 1990 [4], and are able to issue European Certificates of Conformity to the European Standards in the series EN 50014 to EN 50039, until 2003. After that date, only certificates indicating conformity with Directive 94/9/EC [3] (see **0.6**) may be issued.

Until the 1960s, only two types of concept protection certificates were issued for mining apparatus in the UK, these being for flameproof apparatus (FLP) and intrinsically safe apparatus (IS). In 1977 the British Standards for flameproof apparatus (i.e. BS 229 and BS 4683) and intrinsically safe apparatus (i.e. BS 1259) were joined by, and coexisted with, the BS 5501 series of standards, the latter being identical with the first editions of CENELEC European Standards in the series EN 50014 to EN 50039. This resulted in small quantities of other types of explosion-protected apparatus entering British mines, in particular, apparatus known as increased safety (type "e") and moulded/encapsulated (type "m").

When the second editions of the CENELEC standards replaced the first editions in 1994/95, they were published in the UK by BSI as BS EN standards with European numbering. Thus, the second edition of the European Standard EN 50014 was published as BS EN 50014.

A list of the various types of explosion protection, suitable for use in mines susceptible to firedamp, can be found in Appendix 1 of the HSE Code of Practice *The Use of Electricity in Mines* [5]. This code of practice is approved under section 16 of the Health and Safety at Work etc. Act 1974 [6], and accompanies the Electricity at Work Regulations [1].

The list in the HSE Code of Practice includes the earlier types of protection defined in British Standards BS 1259, BS 4683 series and BS 5501 series, and also the types of protection given in the European Standard EN 50014, with the exception of oil-filled apparatus (type "o") defined and described in EN 50015 (BS 5501-2). Restrictions are placed upon the use of oil-filled apparatus in British mines because of the risk of atmospheric pollution of the mine ventilation system should the oil catch fire.

0.6 Effects of Directive 94/9/EC

On 23 March 1994, a new Article 100A Directive, 94/9/EC, concerning equipment and protective systems intended for use in potentially explosive atmospheres [3] was published in the Official Journal of the European Communities. The Directive applied from 1 March 1996 and includes both electrical and mechanical equipment. The Directive is implemented in Britain by the Equipment and Protective Systems for use in Potentially Explosive Atmospheres Regulations 1996 [7].

In the case of apparatus intended for use in gassy mines susceptible to firedamp, the Regulations/Directive do not apply to apparatus placed on the market or put into service for the first time before 1 March 1996. After that date, and up to 30 June 2003, apparatus may be placed on the market or put into service for the first time if it conforms to either the Regulations/Directive or the UK statutory requirements/certification arrangements in place on 23 March 1994.

After 30 June 2003, apparatus may not be placed on the market or put into service for the first time unless it conforms to category M1 or M2 of the Directive 94/9/EC [3]. Apparatus which is legally in service on 30 June 2003, but which does not conform to 94/9/EC, may be repaired or overhauled and put back into service after 30 June 2003 without the need to conform to 94/9/EC, provided that no modifications are made affecting the design.

0.7 The objective of this standard

The duties of manufacturers and users of explosion-protected equipment in British mines are more clearly detailed in mining law than those involved in the repair and reclamation of such apparatus after it has been used. The objective of this standard is therefore not to specify procedures for the construction of explosion-protected apparatus by the original manufacturer, nor its selection for use in mines, but to set down recommendations for overhaul and repair of apparatus which has already been in use at a mine and is intended to be put back into service following such overhaul or repair. The recommendations are especially relevant if the work involves alterations or modifications which affect the type of explosion protection afforded. Companies undertaking repair work should establish and maintain a quality assurance system such as that described in BS EN ISO 9002, and any statutory duties and obligations should be transferred or apportioned to the appropriate responsible party.

This standard is supplementary to the existing explosion protection concept (construction) standards recognized in Britain. These include BS 229, BS 4683 parts 2 and 4, BS 1259, BS 5501 parts 1 to 9, and the EN 50014 to EN 50039 series.

1 Scope

This British Standard gives recommendations for the repair, overhaul, reclamation and modification of certified electrical apparatus intended for use in mines susceptible to firedamp (defined as "Group I" apparatus in the explosion protection concept standard BS EN 50014:1998).

Maintenance is not covered, other than where this cannot be dissociated from repair and overhaul. It does not give advice on the use of electrical apparatus or the prevention of any hazards other than ignition of an explosive atmosphere. Similarly, it does not give advice on cable entry systems which may require renewal when the apparatus is re-installed.

NOTE 1 Recommendations regarding routine maintenance, and the selection and installation of intrinsically safe electrical apparatus for use in potentially explosive atmospheres in mines, are given in BS 6704.

NOTE 2 The contract between the user and the repairer will need to address other safety-related matters beyond the scope of this document, e.g. prevention of electric shock, electrical protection (overload, short circuit, earth leakage) and electrical/mechanical interlocking.

Clauses **4** to **9** give general recommendations applicable to persons involved in the repair and/or overhaul of electrical apparatus intended for use in potentially explosive atmospheres found in coal mines. They also identify certain specific responsibilities under the Health and Safety at Work etc. Act 1974 [6] as applicable to those who are likely to be concerned with the repair of certified apparatus.

Clauses **10** to **15** cover those aspects of repair and overhaul which are common to all explosion protected apparatus.

Clauses **16** to **18** give recommendations applicable to specific types of explosion protected apparatus.

This standard excludes apparatus having the following forms of protection, which is generally considered irreparable: oil immersion "o"; pressurized "p"; powder filling "q"; and encapsulation "m".

NOTE 3 Apparatus which contains oil is installed in British mines, but such equipment should be repaired in accordance with this standard and that to which it was certified.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 229:1957, *Specification. Flameproof enclosure of electrical apparatus*.

BS 1259:1958, *Intrinsically safe electrical apparatus and circuits for use in explosive atmospheres*.

BS 4683-2:1971, *Specification for electrical apparatus for explosive atmospheres — Part 2: The construction and testing of flameproof enclosures of electrical apparatus*.

BS 4683-4:1973, *Specification for electrical apparatus for explosive atmospheres — Part 4: Type of protection "e"*.

BS 5501-5:1977, *Electrical apparatus for potentially explosive atmospheres — Part 5: Flameproof enclosure "d"*.

BS 5501-6:1977, *Electrical apparatus for potentially explosive atmospheres — Part 6: Increased safety "e"*.

BS 5501-7:1977, *Electrical apparatus for potentially explosive atmospheres — Part 7: Intrinsic safety "i"*.

BS EN 50014:1998, *Electrical apparatus for potentially explosive atmospheres — General requirements*.

BS EN 50018:1995, *Electrical apparatus for potentially explosive atmospheres — Flameproof enclosures "d"*.

BS EN 50019:1994, *Electrical apparatus for potentially explosive atmospheres — Increased safety "e"*.

BS EN 50020:1995, *Electrical apparatus for potentially explosive atmospheres — Intrinsic safety "i"*.

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1

flameproof apparatus (type "d")

apparatus conforming to BS 229:1957, BS 4683-2:1971, BS 5501-5:1977 (EN 50018:1977) and/or BS EN 50018:1995

3.2

intrinsically safe (IS) apparatus (type "i")

apparatus conforming to BS 1259:1958, BS 5501-7:1977 (EN 50020:1977) and/or BS EN 50020:1995

3.3

increased safety apparatus (type "e")

apparatus conforming to BS 4683-4:1973, BS 5501-6:1977 (EN 50019:1977) and/or BS EN 50019:1994

3.4

serviceable condition

state of the apparatus such that it is fit for use and is in accordance with the explosion protection concept standard to which the apparatus was originally certified

3.5

overhaul

action intended to restore apparatus to its serviceable condition, where inspection has established that the apparatus is neither faulty nor damaged, which does not involve the replacement of any part that can affect the explosion protection

3.6

repair

action intended to restore apparatus to its serviceable condition, where inspection has established that the apparatus is either faulty or damaged, which involves the replacement or reclamation of a part that can affect the explosion protection

3.7

repairer

person or organization performing repair or overhaul

NOTE A repairer can be the manufacturer, the user or a third party (e.g. a repair agency).

3.8

manufacturer

maker of the apparatus in whose name any certification of the apparatus was originally registered

NOTE The manufacturer can also be the supplier, the importer or the agent.

3.9

reclamation

means of repair involving the removal or addition of material and/or the replacement of components not supplied by the manufacturer as user-replaceable parts, which affects the explosion protection afforded to the apparatus

NOTE The term "recovery" is sometimes used as a synonym for "reclamation".

3.10

certification

issuing of a document by a notified body testifying that a type of apparatus or a type of component conforms to a published national or international standard

3.11

approval

issuing of a document by the Health and Safety Executive's Mines Inspectorate, to meet a legal obligation, testifying that a type of apparatus or a type of component conforms to the requirements of an Act of Parliament or statutory instrument

3.12

copy winding

total or partial replacement of a winding by another, the characteristics and properties of which are at least as good as those of the original

3.13

modification

change to the design of the apparatus which affects material, fit, form or function

3.14

module

part of the apparatus which is intended to be detached and repaired in its own right, and which is not unique to the apparatus

4 General

4.1 Repairs should be carried out using good engineering practice. Apparatus should only:

a) be repaired using manufacturer's specified parts or parts specified in the certification documentation; or

b) be repaired or modified in accordance with certification documentation; or

c) be repaired in accordance with the relevant explosion protection concept standard.

Options a) and b) should be taken whenever possible. Before option c) is taken, the repairer should seek the written permission of the user.

NOTE 1 Where repairs are carried out in accordance with c), the user and repairer assume total responsibility for ensuring that the apparatus conforms to the explosion protection concept standard and that it is not likely to be a source of ignition of an explosive atmosphere when it is returned to service.

NOTE 2 Any repairs not in accordance with a), b) or c) are excluded from this standard and the apparatus is not suitable for re-use in a potentially explosive atmosphere.

4.2 Before any repair is made to explosion-protected apparatus the repairer should check the certification documentation to see if the repair falls within the scope of the certification. If this documentation is not available, or the repairer is unsure about any aspect of the repair, the manufacturer of the apparatus should be consulted. If neither the documentation nor the manufacturer is accessible, then the repairer should seek permission from the user of the apparatus to carry out repairs in accordance with the explosion protection concept standard.

NOTE This may involve discussion with the certifying authority.

4.3 Before any repair involving a modification is performed, it should be discussed with the original manufacturer and agreement gained in writing that supplementary certification has been obtained from the certifying authority.

5 Statutory requirements

The relevant statutory requirements are the Health and Safety at Work etc. Act 1974 [6] and the Mines and Quarries Act 1954 [8], Regulations made under these Acts, the Provision and Use of Work Equipment Regulations 1992 [9], the Supply of Machinery (Safety) Regulations 1992 [10], and the Equipment and Protective Systems for use in Potentially Explosive Atmospheres Regulations 1996 [7]. See also annex A.

6 Responsibilities of the manufacturer

The Supply of Machinery (Safety) Regulations 1992 [10] require that the manufacturer's documentation include:

— technical specification;
— performance and conditions of use;
— dismantling and assembly instructions;
— certification limitations where specified;
— marking (including specification marking);
— recommended methods of repair/overhaul for the apparatus;
— spare parts list.

7 Responsibilities of the user

7.1 The user should keep records of previous overhauls, repairs and modifications and make them available to the repairer if required.

7.2 The user should inform the repairer of any special requirements stipulated in the user's specifications and which are supplementary to the various standards.

8 Responsibilities of the repairer

8.1 General

8.1.1 The repairer should own, have available and use as necessary an up-to-date copy of the relevant explosion protection concept standard for the apparatus to be repaired (and an up-to-date copy of the general requirements standard, if it is separate from the concept standard).

8.1.2 The repairer should appoint a competent person, within the management of the organization, to accept responsibility for ensuring that the repaired equipment remains safe and within the limits/tolerances allowed by the explosion protection concept standard. The person so appointed should have a working knowledge of the explosion protection concept standard and an understanding of BS 7924:1999.

8.1.3 If the repair is to be performed in accordance with a) and/or b) of **4.1**, the repairer should have available sufficient documentation to demonstrate an adequate working knowledge of the type of apparatus to be repaired and the materials/components used in its construction. This may be achieved by either being able to produce copies of the documents listed below, or by demonstrating an accurate knowledge of their contents. The relevant documents are as follows:

— the certificate of conformity with the explosion protection concept standard;

— any supplementary certificates or letters issued with regard to the certificate allowing alternative arrangements or modifications;

— certification drawings and/or specifications associated with the above;

— manuals for operation and maintenance.

8.1.4 If the repair is performed in accordance with c) of **4.1**, the repairer should be able to demonstrate to the user that the apparatus still conforms to the explosion protection concept standard to which it was originally certified.

8.1.5 If apparatus is received by the repairer with no certification label attached, then no repair/overhaul should be attempted unless the certification status of the apparatus can be positively established and a replacement certification label fitted.

8.1.6 The repairer should retain a record of his repairs/overhauls performed on a particular item of apparatus, including its serial number, identification number, the date of repair/overhaul and details of the work needed to restore the apparatus to serviceable condition. Such records should be maintained for at least 5 years after the date of repair/overhaul.

8.1.7 Following the repair or overhaul of a particular item of apparatus, the repairer should provide the apparatus user with sufficient detail of the work undertaken, to allow the user's record (see **7.1**) to be maintained and passed on to the next repairer. This should include, as necessary:

— details of any overhaul work done;

— details of any fault detected;

— details of any repairs, including replaced and reclaimed parts;

— details of the method of reclamation (if relevant);

— the results of any tests performed to check conformity to the certification drawings or the explosion protection concept standard;

— a declaration as in **16.5.5** and/or **16.5.6**.

8.2 Use of spare parts

8.2.1 Whenever possible, new parts should be obtained from the original equipment manufacturer. These spare parts may be specified by the manufacturer, the apparatus standard or the relevant certification documentation.

8.2.2 The following components or parts of apparatus are not considered to be reclaimable, and should only be replaced:

— components or parts made of glass or plastics;

— components or parts made of any material which is not dimensionally stable (e.g. rubber);

— fasteners;

— encapsulated or potted assemblies which have been stated by the manufacturer to be unreclaimable.

8.3 Competence of repairer's employees

8.3.1 The repairer should ensure that employees involved in repairs or overhaul on behalf of the company are competent, have been purpose-trained, have sufficient understanding of their duties and have received written instructions.

Training should include:

— general principles of the explosion protection and marking;

— an outline of certification, test houses and the concept standards;

— those aspects of the apparatus construction which affect the explosion protection;

— identification of user-replaceable parts which are authorized by the manufacturer;

— particular techniques employed in the repair or overhaul of apparatus (see clauses **10** to **18**).

8.3.2 In the case of overhaul, the written instruction should restrict the employee's duties solely to general dismantling, cleaning and the fitting of the manufacturer's spare parts.

8.3.3 Appropriate refresher training should be given, at intervals not exceeding 3 years.

8.4 Workshop facilities

The repairer should have a workshop containing machinery, tools, and inspection and test equipment which are suitable for performing acceptable repairs on the apparatus and for testing it (following repair) to ensure that it remains in accordance with the certification drawings and/or the explosion protection concept standard.

8.5 Quality assurance

The repairer should operate a scheme to ensure that the quality of repair/overhaul work is controlled.

NOTE *Assessed capability*. Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series (e.g. BS EN ISO 9002) by an accredited third-party certification body.

9 Identification of repaired and overhauled apparatus

9.1 Apparatus which has been either repaired or overhauled should be marked to identify that a repair or overhaul has been performed.

NOTE Apparatus which is subject to routine maintenance by the user does not require a label.

9.2 Marking should be legible and durable, taking into account the possibility of chemical corrosion, and should be located as near as practicable to the original certification plate.

9.3 Each repaired or overhauled module should be individually marked.

9.4 The marking on repaired or overhauled apparatus or modules should include:

a) the relevant symbol (see **9.7**);

b) the name of the repairer or his registered trade mark;

c) the repairer's reference number relating to the repair or overhaul;

d) the date.

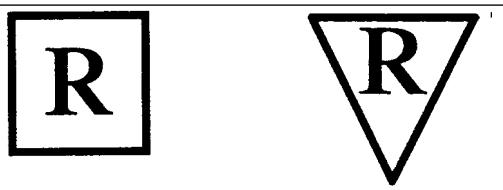
9.5 The marking should be on a label securely attached to the repaired or overhauled apparatus or module without adversely affecting the explosion protection. The materials used for the label should conform to BS EN 50014:1998, **8.1**.

9.6 If the apparatus or module has been previously repaired or overhauled, the earlier label detailing those repairs/overhauls should be removed. A record should be made of all the markings on the earlier label, and this record should be passed to the user.

9.7 To identify the status of repair or overhaul, symbols should be used on the labels as follows:

a) the letter "R" in a square (see Figure 1a) when the repaired or overhauled apparatus conforms to the certification documents relating to it; or

b) the letter "R" in an inverted equilateral triangle (see Figure 1b) when the repaired or overhauled apparatus conforms to the explosion protection concept standard, but not necessarily to the certification documents relating to it.



a) b)

(See **9.7**)

Figure 1 — Symbols indicating status of repair/overhaul

9.8 If an earlier label removed (see **9.6**) had the triangular symbol as shown in Figure 1b, then the symbol on subsequent labels should also be triangular unless the repairer restores the whole apparatus to full conformity with the certification documents.

9.9 Apparatus which, after repair or overhaul, conforms neither to the certification documents nor to the explosion protection concept standard should have its original manufacturer's certification label removed until a supplementary certificate is obtained by the manufacturer to cover the repair or overhaul. If the apparatus is returned to its owner before such supplementary certification is obtained, the record described in **8.1.7** should indicate that the apparatus is not in serviceable condition and is not to be used in a place where flammable gas is likely to occur.

10 Reclamation

10.1 General

10.1.1 Any reclamation process which results in changes to the dimensions affecting the explosion protection should only be permissible if:

— the changed dimensions are still within the limits allowed by the relevant explosion protection concept standard; and

— the verification tests agreed between the user and the repairer have been performed to satisfy both parties that the apparatus complies with the standard.

A record of such tests should be given to the user of the apparatus.

10.1.2 It should be the responsibility of the repairer to satisfy himself, on the completion of reclamation, that the apparatus is in a serviceable condition.

10.2 Metal spraying

10.2.1 Metal spraying should be used only if agreed between the user and the repairer, and only where the materials are metallurgically compatible and the parent metal is free from cracks and similar defects.

10.2.2 Metal spraying should not be used to increase the dimensions of any part of the apparatus which has been weakened beyond its safe operating limit. In determining this limit, the assessment should take account of wear, damage and any machining needed to prepare the part for metal spraying. The sprayed metal (although adding material to the dimension of the component part) should not be considered as improving its strength.

NOTE Details of procedures for metal spraying are given in BS 4761.

10.3 Electroplating

10.3.1 Electroplating for the purposes of reclamation should be used only by agreement between the user and the repairer, and only where the materials are metallurgically compatible and the metal to be plated is free from cracks and similar defects.

10.3.2 Electroplating should not be used to increase the dimensions of any part of the apparatus which has been weakened beyond its safe operating limit. In determining this limit, the assessment should take account of wear, damage and any machining needed to prepare the part for electroplating. The plated metal (although adding material to the dimension of the component part) should not be considered as improving its strength.

10.4 Sleeving

Sleeving should not be used to increase the dimensions of any part of the apparatus which has been weakened beyond its safe operating limit. In determining this limit, the assessment should take account of wear, damage and any machining needed to prepare the part for sleeving. The sleeving (although adding material to the dimension of the component part) should not be considered as improving its strength.

10.5 Brazing or welding

NOTE Welding applies to both metallic and non-metallic enclosures.

10.5.1 Brazing or welding should not be performed in a reclamation process unless good penetration and continuous fusion with the parent material (without blow holes etc.) can be ensured.

10.5.2 Brazing or welding should not be performed in a reclamation process if it introduces abnormal stress into the apparatus or will damage other components which can affect the explosion protection (e.g. by thermal effects).

10.6 Metal stitching

The cold reclamation of a fractured casting, e.g. using nickel alloy stitches and a sealant, should not be used on any part of the apparatus on which the explosion protection relies.

10.7 Reclamation of rotating machine stator or rotor cores

The maximum permissible air gap between the rotor and stator of rotating machines should not be exceeded as a result of any skimming operation performed on them. Damaged stator or rotor cores should not therefore be skimmed without reference to the manufacturer, or, if the manufacturer is not available, the certifying authority.

10.8 Threaded holes for fasteners

Repairs involving threaded holes, which have been damaged such that their integrity can no longer be guaranteed, should be performed using one of the following methods:

— oversize drilling, re-tapping and the fitting of a proprietary thread insert;

— oversize drilling, plugging, re-drilling and re-tapping;

— plug welding, re-drilling and tapping.

10.9 Re-machining of surfaces

Surfaces which are critical to the explosion protection, as specified in the concept standard, should be re-machined only if the enclosure/component is not weakened beyond its safe operating limit and its integrity is maintained. The surface finish stipulated by the manufacturer on the certification drawing, or specified in the explosion protection concept standard, should be maintained.

11 Removal of damaged windings

The use of solvents or heat to assist in the removal of damaged windings should be performed so as not to adversely affect the insulation between the laminations of the magnetic parts or core.

NOTE 1 This is to prevent an increase in surface temperature due to increased core losses.

NOTE 2 The manufacturer may need to be contacted to establish the composition/characteristics of the material used for the inter-lamination insulation, and the recommended method of removing windings without affecting this insulation.

12 Encapsulated parts

Encapsulated parts forming part of the explosion protection should only be repaired if the design and certification documents allow for such repair (e.g. the removal and replacement of soft-setting compound), and if agreed with the user.

13 Light-transmitting parts

No attempt should be made to re-cement or repair light-transmitting parts that affect the explosion protection. Only complete replacement assemblies, as supplied or specified by the apparatus manufacturer, should be used.

14 Temporary repairs

Temporary repairs that affect the explosion protection should not be undertaken.

15 Cleaning agents and finishes

15.1 Parts of enclosures made of plastics material should not be cleaned with solvents or any cleaning agent likely to degrade the explosion protection of the part/enclosure.

NOTE Household detergents are normally acceptable as cleaning agents.

15.2 Any finish (e.g. paint, varnish or other coating material) applied to the surface of an enclosure should not adversely affect or degrade the material used for the enclosure or its heat dissipation properties.

16 Repair of flameproof apparatus (type "d")

NOTE Group I flameproof apparatus (type "d") enclosures are capable of withstanding an internal explosion of firedamp without damage that affects the explosion protection. They also resist the transmission of incendive flames from the interior of the enclosure to the outside atmosphere during a firedamp–air explosion. The type testing of such apparatus therefore usually involves exploding a firedamp–air mixture inside a fully assembled enclosure to demonstrate non-transmission of flame and to obtain a reference pressure to work to. The apparatus is then routinely tested (usually by hydraulic means) to demonstrate a pressure-withstand safety factor (normally 1.5 times the explosion reference pressure). Some apparatus having a small internal volume and obvious mechanical strength (e.g. a casting for a small stop/start switch) may be exempted, by the certification authority, from routine pressure testing. As the integrity of the enclosure involves tests which require special facilities and trained operators, it is easier and preferable that repairers replace damaged enclosures by new ones obtained from the original manufacturer, rather than attempt reclamation.

16.1 Principles and objectives

When repair or overhaul of flameproof apparatus is undertaken, the objective should be to preserve the original explosion protection. This should be achieved by ensuring that:

— the enclosure is correctly assembled;

— the enclosure's ability to withstand an internal explosion of firedamp has not been reduced[1)];

— flamepaths have not been reduced or painted with a hard-setting paint or compound[2)];

— flamepath joint gaps have not been enlarged beyond the limits stipulated in the relevant standard for Group I apparatus;

— surface finishes conform to the relevant flameproof protection concept standard and, where appropriate, to the certification documents/drawings;

— seals or gaskets fitted in flameproof joints have been replaced by the correct type, made of the same material and having the same dimensions;

— any alloys that have been introduced into the external parts of the enclosure conform to BS EN 50014:1998, **8.1**;

— the operating temperature of external parts does not exceed the declared temperature classification;

— all cable entries, glands, plugs and sockets, and blanking plugs are of a type certified for use with the apparatus.

16.2 The flameproof enclosure

16.2.1 Holes should not be drilled into a flameproof enclosure unless the certification documents allow for such holes. Where holes are drilled in the wall of an enclosure, the repairer should be able to demonstrate that an unintended flamepath has not been formed and, where necessary, that the minimum thickness of material stipulated in the concept standard has been left at the bottom of the hole and around the hole.

16.2.2 Water cooling jackets forming part of a flameproof enclosure should be pressure tested to the manufacturer's design pressure (normally 50 bar with no decay over a 30 min period) and the values for flow of coolant stipulated on the certification documents should be confirmed. The volume of coolant contained within the cooling jacket should be measured to ensure that no blockages exist.

16.2.3 Ventilation holes should be cleared of any blockage, and cooling-fan clearances should be checked to ensure that they conform to any values specified in the explosion protection concept standard. Replacement fans should be of the same material and design as the original, so that they introduce no electrostatic charging hazard.

16.3 Internal parts

16.3.1 *General*

The explosion protection of flameproof apparatus depends mainly upon the construction of the enclosure, but some internal parts can influence its integrity. Where such parts are replaced or reclaimed, that integrity should not be compromised.

NOTE In some cases the requirements of the flameproof protection concept standard for Group I apparatus (i.e. mining) differ from those for Group II apparatus (non-mining). For example, BS EN 50018:1995, **12.6** specifies a comparative tracking index (CTI) of at least CTI 400 M (as defined in BS 5901:1980) for insulating materials in certain apparatus (e.g. switchgear) within flameproof enclosures of Group I.

16.3.2 *Terminations*

Repairs to terminations should not reduce the creepage and clearance distances. Insulation material with a lower CTI should not be used (see note to **16.3.1**).

16.3.3 *Insulating materials used in windings*

Repaired or replaced insulation material should not be inferior to that originally used. For example, a winding insulated with class E material should be repaired with class E or class F material.

[1)] Hydraulic pressure testing may be required to confirm this.

[2)] Soft grease or non-setting compounds may be used to protect the flamepaths.

16.3.4 ***Replacement of windings in flameproof apparatus***

Faulty or damaged windings should be replaced by identically constructed windings having characteristics identical to those of the original. This should be achieved using data obtained from the original manufacturer, or alternatively, if such data is not available, using copy winding techniques.

16.3.5 ***Repair of rotating machine rotors***

16.3.5.1 Faulty die-cast aluminium rotor cages should be replaced by new rotors supplied by the machine manufacturer. Bar-wound cage rotors may be re-wound using materials of identical specification.

16.3.5.2 The repairer should ensure that replaced conductors in a cage rotor are tight in the slots. This should be achieved by adopting the same method of securing them as that employed by the machine manufacturer.

16.3.6 ***Testing of windings***

16.3.6.1 The resistance of repaired windings should be measured at ambient temperature and recorded (see **8.1.7**) and should conform to the manufacturer's data when available. In the case of multi-phase windings, the resistances of the phases and between the lines should be balanced to within 5 % of each other.

16.3.6.2 The insulation resistance should be measured between windings (including any auxiliary windings) and to earth (or to the casing, framework or similar zero-voltage reference if the apparatus is not earthed in normal operation), using a minimum test voltage of 500 V d.c. The results should not be inferior to those given in Table 1 and should be recorded (see **8.1.7**).

Table 1 — Resistance of insulation on windings

Item	Minimum resistance of insulation MΩ
New windings	100
Overhauled windings on a.c. motors	50
Other windings, e.g. d.c. motors, solenoids and control coils	Value to be agreed between the repairer and the user

16.3.6.3 A dielectric test should be carried out in accordance with the relevant product standard. No breakdown of insulation should occur. The results should be recorded (see **8.1.7**).

16.3.6.4 In the case of transformers and similar apparatus, the no-load supply current and secondary voltage should be measured when the primary winding is energized at normal working voltage. The measured values should not deviate significantly from those of the original apparatus (as stated by the manufacturer). In multi-phase systems, the current in all phases should be balanced as far as is practicable. The results should be recorded (see **8.1.7**).

16.3.7 ***Testing of rotating machines***

16.3.7.1 Rotating machines should be run at full speed. Any abnormal or untoward noise, out-of-balance movement or vibration should be investigated and corrected. The results should be recorded (see **8.1.7**).

16.3.7.2 In order to check the integrity of windings and joints in motors, either a full-load test or a locked rotor test should be performed. The results should be recorded (see **8.1.7**).

NOTE Further guidance on the testing of rotating machines is given in BS 4999-143.

16.3.8 ***Incorporated temperature sensors***

If temperature sensing devices are incorporated to monitor winding temperatures or prevent over-temperature, they should replaced only with devices whose characteristic is identical to that of the original. If they are embedded in the windings, they should be fitted before varnishing and curing.

16.3.9 ***Intrinsically safe circuits***

Where a flameproof enclosure contains an intrinsically safe circuit, the repairer should ensure that the requirements of the relevant explosion protection concept standard are preserved; see clause **17**.

16.3.10 ***Cells or batteries***

Cells or batteries are rarely used in flameproof apparatus because electrolytic gases (e.g. hydrogen and oxygen) created inside the enclosure can affect its flame transmission properties. Where cells or batteries are used, they should be replaced only with cells or batteries of a type specified by the apparatus manufacturer.

16.3.11 ***Lamps/lampholders/ballasts***

16.3.11.1 Only types of lamp specified by the manufacturer of the apparatus should be used as replacements, and the maximum wattage specified should not be exceeded.

16.3.11.2 Only replacement lampholders listed by the manufacturer should be used.

16.3.11.3 Ballast chokes or capacitors should be replaced only by the manufacturer's listed spare parts.

16.3.12 ***Switchgear and control gear***

Parts critical to the operation of the making, carrying and breaking of short-circuit currents, such as arcing contacts and mechanism springs, should be replaced only with manufacturers' recommended parts. If this is not possible, then the replacement components should be type-tested in accordance with the original apparatus specification and component specifications.

16.4 Reclamation of flameproof enclosures

16.4.1 ***General***

Flameproof enclosures which have reclaimed components or parts should not be considered as being in serviceable condition unless they either pass the over-pressure test outlined in the relevant flameproof protection concept standard, or the repairer can guarantee (see note) that the strength of the enclosure has not been reduced.

NOTE It may not always be necessary to perform the over-pressure test on reclaimed parts if it can be demonstrated by alternative means that the mechanical strength of the flameproof enclosure has not been reduced. For example, this could apply to reclamation of the flameproof path of a motor drive shaft where the flameproof enclosure is the motor casing.

Damaged components which neither form an integral part of the enclosure nor form part of the explosion protection, e.g. fixing lugs, may be repaired by welding or metal stitching, but care should be taken to ensure that the integrity and stability of the flameproof apparatus is not impaired. It is particularly important to check that any cracks being repaired do not extend into the flameproof enclosure, thereby reducing its ability to withstand and contain the internal pressures and flames developed during a firedamp explosion inside it.

16.4.2 ***Flameproof joints (flamepaths)***

16.4.2.1 Reclamation of damaged or corroded flameproof flanges, joint faces and flamepaths (including spigot joints) should be performed only if the resultant gap, flange dimensions (flamepath) and surface finish are maintained within the limits specified in the relevant flameproof protection concept standard and, where appropriate, in the certification documents/drawings.

NOTE Machining of a spigot-type motor end shield may affect the concentricity between rotor and stator.

16.4.2.2 Metal spraying should not be used for the reclamation of flameproof flanged joints that form part of the explosion protection.

NOTE See the limitations stated in clause **10** concerning reclamation by electroplating, welding and remachining.

16.4.3 ***Threaded flameproof joints***

16.4.3.1 Male threaded parts of cable entries and other similar entry joints (e.g. adaptors), should not be reclaimed. New components should be used to replace damaged ones. Female threaded parts of flameproof joints (flamepaths) should only be reclaimed if the required fit and correct number of engaged threads can be ensured following the repair.

16.4.3.2 Screwed/threaded covers forming part of a flameproof enclosure should not be reclaimed.

NOTE See **10.8** for permissible methods of reclaiming threaded holes for fasteners.

16.4.4 ***Sleeve bearings/journals***

The journals of sleeve bearings should be reclaimed only by electroplating or metal spraying.

16.4.5 ***Rotors and stators***

16.4.5.1 Rotors and stators should not be skimmed to remove eccentricities or surface damage if the resultant increase in the air gap between the rotor and stator will cause a change in the pressure piling characteristics or a change in the external temperature of the apparatus such that it no longer conforms to its surface temperature classification (i.e. for machines conforming to BS 4683) or to its maximum permissible surface temperature (i.e. 150 °C for machines conforming to BS 5501-1 and BS 5501-5 or to EN 50014 and EN 50018). The repairer should seek advice from the manufacturer before this procedure is adopted.

16.4.5.2 Reclaimed stator cores should be submitted to a flux test to ensure that there are no hot spots which infringe the temperature classification or maximum permissible temperature (see **16.4.5.1**), or which will damage the stator windings.

16.4.6 ***Pressure barriers***

Internal barriers which are provided to minimize the effects of pressure piling should be renewed in an identical form.

16.5 Modifications to flameproof apparatus

16.5.1 No modification affecting the explosion protection should be carried out on any part of a flameproof enclosure without advice from the original manufacturer, certificate holder or the certifying authority.

16.5.2 No additional cable entries should be constructed, or any existing indirect cable entry converted to a direct cable entry, without advice from the original manufacturer, certificate holder or certifying authority.

16.5.3 No conductor termination assembly incorporating a flameproof joint (declared flamepath) or bushing should be modified (e.g. terminals with insulated bushings between a terminal box and the main enclosure).

16.5.4 Termination assemblies not incorporating a flameproof joint or declared flamepath should only be replaced by alternatives which have the same characteristics (i.e. the same current-carrying capacity and insulator CTI), and which maintain the original creepage and clearance distances.

16.5.5 Apparatus should not be rewound for an operating voltage other than that shown on the certification documentation without advice from the original manufacturer, certificate holder or certifying authority. Where agreement has been obtained for a change of operating voltage, a declaration should be given to the apparatus user that the magnetic loading, current/flux densities and losses are not increased so as to impair the explosion protection and that the creepage and clearance distances are suitable for the increased voltage. Following such modification, a new rating plate should be obtained from the manufacturer to show the new operating parameters, and the user informed in accordance with **8.1.7**.

16.5.6 Rotating machines should not be rewound for a different speed without advice from the original manufacturer, certificate holder or certifying authority. Following such modifications, the rating plate should be changed to show the new operating parameters, and the user informed in accordance with **8.1.7**.

16.5.7 Additional auxiliary apparatus (e.g. anti-condensation heaters, temperature sensors) should not be fitted inside flameproof enclosures without consulting the original manufacturer, certificate holder or certifying authority.

17 Repair of intrinsically safe (IS) apparatus (type "i")

NOTE Group I intrinsically safe apparatus and systems (type "i") are constructed so that no exposed part of the circuit exceeds the ignition temperature of coal dust (or firedamp if coal dust is prevented from forming a layer) and so that any electrical sparks produced during normal working or faulty working have insufficient energy to ignite a firedamp air mixture. This is normally achieved by limiting the current in the circuit to very low values, thereby restricting its heating effects and arcing energy. The acceptable values of current vary according to the metals used in the arcing contacts and the degree of resistance, inductance and capacitance in the circuit. See BS EN 50020:1995, Figures A.1, A.2, A.4 and A.5. (The values shown in these figures are also used for apparatus which conforms to BS 1259).

For safety reasons, certain IS apparatus and systems need to continue to operate and remain energized while in explosive concentrations of flammable gas (e.g. gas monitoring systems, telephone systems). Apparatus and systems of this type, are certified to the "ia" category by a certifying authority, and also have to be approved by the HSE Mines Inspectorate under Regulation 20 of the Electricity at Work Regulations 1989 [1]. Although overhaul and repair of such approved apparatus and systems do not normally need to be covered by a variation approval, modifications need to be discussed with HSE Mines Inspectorate, whether or not supplementary certification is obtained from the certifying authority.

17.1 General

Interpretation of intrinsically safe circuit parameters needs special training and experience, because the circuit not only has to be assessed for normal working but also for fault conditions. Repair work should only be performed by competent persons, able to assess the risks associated with circuit repairs, however minor. As a general rule, only identical components and wiring should be used to replace faulty parts and an assessment should be made to establish why the original part became faulty (e.g. if a resistor is "open circuit", was it caused by an overload fault elsewhere on the circuit?).

If one part of the circuit is in the hazardous zone and the other part is in a gas-free place (e.g. a computer at the mine surface monitoring gas levels at the coal face), care should be taken to ensure that the correct isolating barrier devices or coupling units are in place to segregate the circuits and prevent non-IS power supplies from the gas-free place being conveyed into the hazardous zone (e.g. during faults on the mine's electrical system, or lightning strikes on overhead power lines). Such barrier devices (e.g. comprising components such as zener diodes, fuses and limiting resistors) should not be repaired, because some of the components upon which safety depends may have been damaged by over-stress.

17.2 Principles and objectives

Where repair of intrinsically safe apparatus and systems is undertaken, the objective should be to preserve the original explosion protection. It is particularly important to ensure that:

— the degree of ingress protection (IP code) provided by enclosures (and cable entries) containing intrinsically safe circuits has not been reduced;

NOTE IP codes are defined in BS EN 60529:1992.

— the values and characteristics of safety-critical components (e.g. current-limiting resistors, zener diodes) have not been changed;

— the inductance or capacitance of the circuit has not been changed;

— the wattage or rating of components has not been changed, nor heat sinks removed (which could allow components to get hotter than originally intended by the manufacturer);

— creepage and clearance distances have not been reduced (especially on printed circuit boards on which new components have been soldered in place);

— varnishes and other coatings have been renewed according to the original specification;

— any alloys that have been introduced to the external parts of the apparatus conform to BS EN 50014:1998, **8.1**.

17.3 Enclosures

Repairs to the enclosures of intrinsically safe apparatus should not result in a lesser degree of protection against the ingress of dust and water (IP code) than that originally provided.

NOTE The majority of Group I (mining) intrinsically safe apparatus enclosures have an ingress protection rating (IP code) of IP54, as defined in BS EN 60529:1992. If a more stringent degree of protection has been applied by the manufacturer, this may have been provided to cater for unusual environmental conditions specified by the user. In such cases the repairer should discuss the IP code with the apparatus owner before the repair is made.

17.4 Terminations

17.4.1 *General*

Repairs to terminations should not change the layout of the connections, remove earthed or insulating screens/barriers provided between connections, or decrease the creepage and clearance distances shown in the relevant explosion protection concept standard or the certification drawings.

17.4.2 *Soldered connections*

Repairs involving soldered connections should maintain the integrity of the original apparatus.

NOTE The requirements of the explosion protection concept standards (see **3.2**) relating to redundancy for connections, differ according to whether the connections are hand-soldered or machine-soldered. Similarly, the requirements for creepage and clearance distances depend upon whether or not a connection is coated after soldering.

17.5 Fuses

If a fuse is found to have ruptured, an investigation should be performed to ensure that no other components have failed or been over-stressed. Any replacement fuse should have the same rating and rupturing capacity as that specified in the certification documents. Where a fuse is encapsulated to exclude hazardous atmospheres, only an identical fuse assembly should be used as a replacement.

17.6 Relays

Replacement relays should be obtained from the original relay manufacturer or from the apparatus manufacturer, and should be identical to those originally fitted.

17.7 Safety barriers

17.7.1 Modular or encapsulated safety barrier devices should not be repaired.

17.7.2 Replacement safety barrier devices should be in accordance with the certification documents.

17.8 Printed circuit boards (PCBs)

As creepage and clearance distances between individual tracks on PCBs are usually close to the limits allowed in the explosion protection concept standard, repairers should ensure that these distances are not reduced by any repair to the board or by the positioning and fixing of components on to it.

Where the certification documents require a PCB to be varnished after repair, then the varnish should be of the type prescribed by the manufacturer of the apparatus and should be applied using the technique adopted for the original (e.g. dipping, brushing).

NOTE Two independent coats are normally required.

17.9 Opto-couplers

Opto-couplers should only be replaced by those having identical characteristics, rating, internal geometry and creepage and clearance distances between their input and output circuits.

17.10 Electrical components

Electrical components in IS circuits should be replaced only with identical items, which may be obtained from any supplier. Where the apparatus manufacturer has indicated that a particular item (e.g. a zener diode) has been chosen by a select-on-test method, the replacement should either be obtained from the apparatus manufacturer or selected using the same test method. Where a select-on-test method has been used by the repairer, the parameters should be recorded in accordance with **8.1.7**.

17.11 Cells and batteries

17.11.1 Only cells and batteries listed in the apparatus manufacturer's documentation should be used as replacements.

17.11.2 Where cells and batteries are encapsulated, the whole assembly should be replaced.

17.11.3 If IS apparatus or an IS system is normally supplied from an HSE-approved power supply, a non-approved power supply should not be substituted without the agreement of the apparatus user.

NOTE An HSE-approved power supply is normally an IS battery power supply used for apparatus essential for the safety of persons in a mine. They are approved as separate entities by the Health and Safety Executive, under Regulation 20 of the Electricity at Work Regulations 1989 [1]. This allows them to continue in operation when explosive concentrations of flammable gas are present in the atmosphere.

17.12 Internal wiring

Disturbed or replaced IS wiring should be configured and located in the same position as the original wiring. Particular attention should be paid to the refitting of any screens or barriers, and of extra outer sheathing or double insulation, and the same methods of fixing and colour coding should be adopted.

17.13 Transformers

Replacement transformers for IS circuits should be obtained from the IS apparatus manufacturer. No attempt should be made to repair or replace an embedded or encapsulated thermal trip device within a transformer.

17.14 Non-electrical parts

Non-electrical parts, e.g. fittings or windows, which do not affect the intrinsic safety of the apparatus or system should only be replaced by parts providing equivalent ingress protection against dust and water (IP code). Non-metallic parts should meet the requirements of the protection concept standard for the prevention of electrostatic charge.

17.15 Testing of repaired IS apparatus

After completion of repairs to an IS circuit, the insulation between the IS circuit and its enclosure should be tested to ensure that it conforms to BS EN 50020:1995, **6.4.12**.

17.16 Reclamation of IS apparatus and systems

Components upon which intrinsic safety depends should not be reclaimed.

17.17 Modifications to IS apparatus and systems

Modifications which affect the intrinsic safety of the apparatus or system should not be performed without consulting the apparatus manufacturer, certificate holder or certifying authority.

18 Repair of increased safety apparatus (type "e")

NOTE Group I increased safety apparatus (type "e") is constructed so that no part of it produces an arc or spark in normal operation, and no part exceeds a temperature of 150 °C where coal dust can form a layer, or 450 °C where coal dust is prevented from forming a layer. To achieve this protection, switches, contacts and other possible arc sources are excluded from the apparatus; terminals have to be of a special type which cannot loosen in service; and detailed attention is paid to the quality of insulating materials, to maintaining enhanced creepage and clearance distances, and to preventing the ingress of contaminants which might lead to tracking between terminals.

The use of type "e" apparatus in British mines has, to date, been limited to various types of junction box, solenoid valve assemblies and large traction batteries used to power mining locomotives or free-steered vehicles. Clause **18** therefore deals mainly with this type of apparatus.

18.1 Principles and objectives

Where the repair of increased safety apparatus is undertaken, the objective should be to preserve the explosion protection. It is particularly important to ensure that:

— the degree of ingress protection (IP code) provided by enclosures (and cable entries) has not been reduced;

— terminals are replaced by identical types having over-generous current-carrying capacity and non-loosening properties;

— the quality of replacement insulating material is at least as good as the originals;

— creepage and clearance distances have not been reduced below the values specified in the explosion protection concept standard;

— any alloys that have been introduced to the external parts of the apparatus conform to BS EN 50014:1998, **8.1**;

— the operating temperature of external parts does not exceed 150 °C, or 450 °C where coal dust is prevented from forming a layer;

— cells of the correct type have been used to form any type "e" battery, and ventilation slots (provided to disperse electrolytic gas) have not been blocked or impeded.

18.2 Enclosures

18.2.1 Repairs to the enclosures of increased safety apparatus should not result in a lesser degree of protection against the ingress of dust and water (IP code) than that originally provided.

NOTE The majority of Group I (mining) increased safety apparatus enclosures have an ingress protection rating (IP code) of IP54, as defined in BS EN 60529:1992. However, type "e" vehicle traction battery containers usually have a rating of IP23, as defined in BS EN 60529:1992, because of the need to compromise between dispersion of electrolytic gases (i.e. provide ventilation slots) and prevent the ingress of dust and dripping mine water. If a more stringent degree of protection has been applied by the manufacturer, this may have been provided to cater for certain unusual environmental conditions specified by the user. In such cases the repairer should discuss the IP code with the apparatus owner before the repair is made.

18.2.2 Repairs to increased safety apparatus enclosures should not result in a lesser degree of impact resistance than that originally provided. The repairer should ensure that the repaired apparatus can successfully withstand the same impact test as that performed on the original apparatus.

NOTE Table 4 of the explosion protection concept standard BS EN 50014:1993 specifies two levels of impact energy for the impact resistance tests, corresponding to the risk of mechanical danger. Because of the arduous conditions normally associated with the coal face, some apparatus, such as increased safety coal-face lights, is subjected to the higher of these two energy levels (i.e. 20 J).

18.2.3 Replacement cable entries need not be of an identical type, but should preserve the ingress protection (IP code) stipulated on the certification documents, or the IP code of the original enclosure, whichever is the more stringent.

18.3 Internal parts

18.3.1 *Terminations and internal connections*

Replacement terminations should preferably be identical to those originally fitted, or they may be of an alternative type specified in the certification documentation. The manufacturer, certificate holder or certifying authority should be consulted if the proposed replacement is of any other type.

NOTE Terminations and internal connections used in increased safety apparatus are of a special type, capable of carrying the load without overheating, loosening or arcing in service. They are usually specified in detail on the certification drawings/documentation. The fitting of unspecified terminations invalidates the certification of increased safety apparatus (type "e").

18.3.2 ***Insulation***

Replacement insulation should not be inferior to that specified in the certification documentation.

18.3.3 ***Windings***

NOTE The windings of solenoids, motors and similar magnetic circuits for increased safety apparatus are constructed to prevent overheating, hot spots and other adverse thermal effects which may ignite coal dust or firedamp. They are usually specified in detail on the certification drawings/documentation.

It is preferable that windings on increased safety components be replaced by identical types obtained from the original apparatus manufacturer.

When it is not possible to obtain a replacement winding from the manufacturer and repairs are to be attempted, the repairer should obtain sufficient constructional data from the manufacturer, certificate holder or certifying authority to allow faithful reproduction of the original and restoration to a serviceable condition. This data should include:

— the type of winding (e.g. single layer, double layer, etc.);

— a winding diagram;

— constructional details of the bobbin or core on which the winding is to be wound/fitted;

— the number of conductors per slot and parallel paths per phase;

— the method of securing the winding in position;

— interphase connections;

— the conductor size;

— the insulation system used (including the specification for varnishing/coating, etc.);

— the electrical resistance of a phase winding, or the electrical resistance between two terminals;

— details of any embedded temperature monitoring devices.

18.3.4 ***Testing of windings***

Repaired windings should conform to **16.3.6.**

18.3.5 ***Increased safety cells or batteries***

NOTE As the use of type "e" batteries in coal mines has been limited to locomotive and free-steered vehicle traction batteries having a capacity greater than 25 A·h, the recommendations in **18.3.5** relate primarily to such apparatus.

18.3.5.1 Cells or batteries inside increased safety enclosures should be replaced only with identical cells or batteries, or with alternatives listed on the certification drawings/documents.

18.3.5.2 Sweated or soldered inter-cell connections should be replaced by crimped type connections on not more that 6 % of the number of cells in a traction battery.

18.3.5.3 Bolted inter-cell connectors should be tightened to the torque value specified by their manufacturers.

18.3.6 ***Lamps/lampholders/ballasts***

18.3.6.1 Only types of lamp specified by the manufacturer of the apparatus should be used as replacements, and the maximum wattage specified should not be exceeded.

18.3.6.2 Only replacement lampholders specified by the manufacturer should be used. If the wiring to the lampholder is factory-made, then repair should not be undertaken unless the repairer has the necessary facilities, tools and equipment to make wiring to the same specification.

NOTE Lampholders for increased-safety luminaires are invariably of a special type (e.g. with a single pin for tubular fluorescent lamps or a screw cap for tungsten filament lamps).

18.3.6.3 Ballast chokes or capacitors should be replaced only by the manufacturer's listed spare parts.

18.4 Reclamation of increased safety apparatus

18.4.1 Increased safety enclosures may be reclaimed by any of the techniques described in clause **10** provided that the original mechanical protection, ingress protection (IP code) and impact resistance are preserved.

18.4.2 Ventilation arrangements (e.g. in traction battery enclosures) should not be covered, blocked or changed in any way which might impair their effectiveness.

18.5 Modifications to increased safety apparatus

Modifications which affect the increased safety concept should not be performed without consulting either the apparatus manufacturer, certificate holder or certifying authority. Such modifications include:

— changes to the enclosure which affect its IP code, mechanical strength or impact resistance;

— changes to terminals which may affect their current carrying capacity or anti-loosening properties;

— changes to ventilation openings;

— changes which may affect the temperature of the apparatus or its components (e.g. cause hot spots);

— changes which may cause open sparking;

— changes to the operating parameters, e.g. voltage, speed.

Annex A (informative)
Statutory duties

A.1 Manufacturer's duties

A.1.1 The manufacturer's responsibilities under the Health and Safety at Work etc. Act 1974 [6] are stated in Section 6 of the Act. In particular, Section 6(1)(c) states:

"to take such steps as are necessary to secure that there will be available in connection with the use of an article at work adequate information about the use for which it is designed and has been tested, and about any conditions necessary to ensure that, when put to that use, it will be safe and without risks to health."

A.1.2 It is therefore not acceptable merely to assume that adequate information is or can be so widely circulated that it is always available where and when it is needed. Specific steps must be taken to make it available. Sources of adequate information are users, manufacturers or, under certain circumstances, the certifying authorities.

A.1.3 The manufacturer also needs to take into account The Supply of Machinery (Safety) Regulations 1992 [10], The Equipment and Protective Systems for use in Potentially Explosive Atmospheres Regulations 1996 [7] (which implement Directive 94/9/EC [3]).

A.2 User's duties

A.2.1 Apart from the need to comply with Section 2 of the Health and Safety at Work etc. Act 1974 [6] (regarding safe maintenance of plant and systems by the employer), the user is also required to pay due regard to Section 6 of the Act should he wish to undertake the repair or overhaul of the equipment himself.

A.2.2 The Provision and Use of Work Equipment Regulations 1992 [9] amplify and make more explicit the general duties on employers, the self-employed and persons in control to provide safe plant and equipment. In particular, Regulation 7 states:

"Where the use of work equipment is likely to involve a specific risk to health or safety, every employer shall ensure that repairs, modifications, maintenance or servicing of that work equipment is restricted to those persons who have been specifically designated to perform operations of that description (whether or not also authorized to perform other operations).

The employer shall ensure that the persons designated for the purposes of the above paragraph have received adequate training related to any operations in respect of which they have been so designated."

A.2.3 The user therefore needs to ascertain that any repair organization is competent to perform the repairs. This may be achieved by ensuring that the repairer complies with the relevant recommendations of BS 7924, with particular reference to quality control, quality assurance, workshop equipment and the competence of the persons directly involved in the repair and/or overhaul.

A.2.4 The user also has the responsibility of checking that, in the case of a repair to a component part of an apparatus, the whole apparatus is safe before it is put to use.

A.2.5 The user needs to be aware of any changes in responsibility for health and safety if refurbishment and/or re-installation is to be carried out by a third party.

A.2.6 The user also needs to take into account The Electricity at Work Regulations 1989 [1] and associated Approved Code of Practice relating to the Use of Electricity in Mines [5], The Supply of Machinery (Safety) Regulations 1992 [10] and the regulations which implement Directive 94/9/EC [3].

A.3 Repairer's duties

A.3.1 The repairer's legal responsibility is outlined in the generality of Section 36 of the Health and Safety at Work etc. Act 1974 [6], which states:

"Where the commission by any person of an offence under any of the relevant statutory provisions is due to the act or default of some other person, that other person shall be guilty of the offence, and a person may be charged with and convicted of the offence by virtue of this subsection whether or not proceedings are taken against the first-mentioned person."

A.3.2 The repair organization therefore needs to have adequate repair and overhaul facilities, to utilize appropriate equipment and to employ competent persons to carry out the necessary repairs, checks and tests, taking into account the specific type of protection. Any failure in this respect could constitute an offence under Section 36 of the Act.

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