

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Explosive atmospheres –
Part 38: Equipment and components in explosive atmospheres in underground
mines**

**Atmosphères explosives –
Partie 38: Appareils et composants destinés à être utilisés dans les mines
souterraines grisouteuses**



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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Explosive atmospheres –

Part 38: Equipment and components in explosive atmospheres in underground mines

Atmosphères explosives –

Partie 38: Appareils et composants destinés à être utilisés dans les mines souterraines grisouteuses

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES –

Part 38: Equipment and components in explosive atmospheres in underground mines

FOREWORD

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International Standard ISO/IEC 80079-38 has been prepared by subcommittee 31M: Non-electrical equipment and protective systems for explosive atmospheres, of IEC technical committee 31: Equipment for explosive atmospheres.

It is published as a double logo standard.

The text of this standard is based on the following documents of the IEC:

FDIS	Report on voting
31M/105/FDIS	31M/111/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table. In ISO, the standard has been approved by 13 P members out of 21 having cast a vote.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

"A list of all parts in the IEC 60079 series, under the general title *Explosive atmospheres*, as well as the International Standard 80079 series, can be found on the IEC website."

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This part of ISO/IEC 80079 specifies requirements for the constructional features of equipment and components that may be an individual item or form an assembly, to enable them to be used in mines, or parts of mines, susceptible to explosive atmospheres of firedamp and/or combustible dust.

Most of the electrical equipment used on mining machinery is certified as an individual item of equipment, e.g. the motor, switchgear etc., and meets its own marking requirements. This certification, however, does not deal with the interconnection of these items of equipment by cables or the machine electrical power system as an entity. The equipment and components, including their interconnections, should be assessed, from an ignition point of view, by the manufacturer.

Both non-electrical equipment and the interconnection of electrical/non-electrical equipment require an ignition hazard assessment.

Therefore, it is necessary that not just the equipment, but all its parts, is examined by the manufacturer according to a formally documented ignition hazard assessment that establishes and lists all the possible ignition sources of the equipment including the cables and electrical supply system. The documentation shall list the measures that shall be introduced to keep possible ignition sources from becoming effective.

The need for this International Standard arises because of major operational differences between underground mining operations and those in other industries working with, or in, explosive atmospheres. Examples of these differences are:

- the product being won from the underground strata may be combustible and may continually release firedamp during the winning process;
- the ignitability of the atmosphere around equipment and components usually depends upon the amount of dilution offered by an active ventilating system;
- the atmosphere in the general body of mine air in which machinery is working may change from one that is potentially explosive to one that is explosive (for example, during an outburst of firedamp);
- persons working in the mine are usually situated within the potentially explosive atmosphere;
- there is a need to monitor constantly the mine atmosphere at strategic places to ensure that power can be disconnected from all equipment except Ma equipment which is suitable for use in a constantly explosive atmosphere;
- in gassy coal mines, an explosion of firedamp at a machine can raise a combustible dust cloud that exacerbates the explosion;
- some mining machinery, especially that associated with winning the product, contains cutting devices and drilling devices that are intended to cut into the combustible product as part of their normal operation. This introduces an ignition risk from frictional heating or frictional sparking from contact with strata containing high concentrations of quartz or iron pyrites;
- long roadways in coal mines are equipped with mineral conveying systems carrying a product that has a potential for raising a combustible dust cloud and the production of firedamp.

To decide which equipment or its component parts should merit inclusion in this International Standard, ignition data has been examined based on international experience.

When drafting this International standard, it has been assumed that equipment and components are:

- designed in accordance with good engineering practice, taking account of expected shocks, vibrations and failure modes;
- of sound mechanical and electrical construction;
- made of materials with adequate strength and of suitable quality;
- free from defects; and
- kept in good repair and working order, e.g. so that the required dimensions remain within permissible tolerance despite wear.

EXPLOSIVE ATMOSPHERES –

Part 38: Equipment and components in explosive atmospheres in underground mines

1 Scope

This part of ISO/IEC 80079 specifies the explosion protection requirements for the design, construction, assessment and information for use (maintenance, repair, marking) of equipment that may be an individual item or form an assembly.

This includes machinery and components for use in mines susceptible to explosive atmospheres of firedamp and/or combustible dust. The standard atmospheric conditions (relating to the explosion characteristics of the atmosphere) under which it may be assumed that equipment can be operated are:

- temperature -20 °C to +60 °C;
- pressure 80 kPa (0,8 bar) to 110 kPa (1,1 bar); and
- air with normal oxygen content, typically 21 % v/v.

This part of ISO/IEC 80079 applies for equipment and components according to EPL Mb to be used in explosive atmospheres containing firedamp and/or combustible dust.

NOTE 1 In some countries, there might be differences according to the classification, e.g. Mb is similar to category M2 in the European Union.

For equipment and components according to EPL Ma, the requirements of this standard and of ISO 80079-36 and IEC 60079-0 apply.

NOTE 2 A standard with additional requirements for EPL Ma is under preparation.

It is necessary to take account of external conditions to the equipment which may affect the hazard and the resultant protection measures. These measures may include ventilation, gas detection or gas drainage.

This part of ISO/IEC 80079 also deals with the prevention of ignitions of explosive atmospheres caused by burning (or smouldering) of combustible material such as fabric fibres, plastic "O"-rings, rubber seals, lubricating oils or greases used in the construction of the equipment if such items could be an ignition source. For example, the mechanical failure of rotating shaft bearings can result in frictional heating that ignites its plastic cage, plastic seal or lubricating grease.

Detailed requirements and test procedures for the fire protection of conveyer belts are not part of this part of ISO/IEC 80079.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-25, *Explosive atmospheres – Part 25: Intrinsically safe electrical systems*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60204-11, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60332-1 (all parts), *Tests on electric and optical fibre cables under fire conditions*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

ISO 340, *Conveyor belts – Laboratory scale flammability characteristics – Requirements and test method*

ISO 630-5, *Structural steels – Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

ISO 1940-1, *Mechanical vibration – Balance quality requirements for rotors in a constant (rigid) state – Part 1: Specification and verification of balance tolerances*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO 13849-1, *Safety of Machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 14916, *Thermal spraying – Determination of tensile adhesive strength*

ISO 14935, *Petroleum and related products – Determination of wick flame persistence of fire-resistant fluids*

ISO 15029-1, *Petroleum and related products – Determination of spray ignition characteristics of fire-resistant fluids – Part 1: Spray flame persistence – Hollow-cone nozzle method*

ISO/TS 15029-2, *Petroleum and related products – Determination of spray ignition characteristics of fire-resistant fluids – Part 2: Spray test – Stabilized flame heat release method*

ISO 80079-36:2016, *Explosive atmospheres – Part 36: Non-electrical equipment for explosive atmospheres – Basic method and requirements*

ISO 80079-37:2016, *Explosive atmospheres – Part 37: Non-electrical equipment for explosive atmospheres – Non-electrical type of protection constructional safety ‘c’, control of ignition sources ‘b’, liquid immersion ‘k’*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60079-0, ISO/IEC 80079-36, ISO/IEC 80079-37 and the following apply.

3.1

firedamp

flammable mixture of gases naturally occurring in a mine

Note 1 to entry: As firedamp consists mainly of methane, the terms firedamp and methane are used frequently in mining practice as synonyms.

[SOURCE: IEC 60079-0:2011, 3.34, Note modified]

3.2

protection against firedamp explosions

explosion prevention and protection in underground parts of mines and those parts of surface installations of such mines liable to be endangered by firedamp and or flammable dust

3.3

flammable substance

substance in the form of gas, vapour, liquid, solid, or mixtures of these, able to undergo an exothermic reaction with air when ignited

3.4

component

any item essential to the safe functioning of equipment and protective systems but with no autonomous function

3.5

equipment

machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection and prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy, for the processing of material, and which may be capable of causing an explosion through their own source(s) of ignition

[SOURCE: ISO/IEC 80079-36:2016, 3.10]

3.6

explosion

sudden increase of pressure and temperature, due to oxidation or other exothermic reaction

[SOURCE: IEC 60050-426:2008, 426-02-13, modified, (removal of "(of an explosive atmosphere)" from the title)]

3.7

explosive atmosphere

mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

[SOURCE: IEC 60079-0:2011, 3.30]

3.8

intended use

use of equipment, protective systems and devices in accordance with the equipment group and equipment protection level (EPL), and taking into account all the information supplied by the manufacturer which is required for the safe functioning of equipment, protective systems and devices

3.9 machinery

assembly, fitted with or intended to be fitted with a drive system consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application

Note 1 to entry: The term "machinery" also covers an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole.

[SOURCE: ISO 12100]

3.10 malfunction

equipment or components which do not perform their intended function with respect to explosion protection

Note 1 to entry: For the purposes of this standard this can happen due to a variety of reasons, including

- failure of one (or more) of the component parts of the equipment or components;
- external disturbances (e.g. shocks, vibration, electromagnetic fields);
- design error or deficiency (e.g. software errors);
- disturbance of the power supply or other services;
- loss of control by the operator (especially for hand-held machines).

[SOURCE: IEC 60079-0:2011, 3.41]

3.11 minimum ignition energy MIE

lowest stored energy which upon discharge is sufficient to effect ignition of the most ignitable atmosphere under specified test conditions

3.12 potentially explosive atmosphere

atmosphere which could become explosive due to local and operational conditions

3.13 self-ignition of dust in bulk

ignition of dusts caused by the rate of heat generation from oxidation and/or decomposition reactions of the dust being greater than the rate of heat loss to the surroundings

3.14 equipment protection level EPL

level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp and/or combustible dust

Note 1 to entry: The equipment protection level may optionally be employed as part of a complete risk assessment of an installation.

[SOURCE: IEC 60079-0:2011, 3.26, modified (addition of "combustible dust" and removal of the reference to IEC 60079-14 in the note)]

3.15 EPL Ma

equipment for installation in a mine susceptible to firedamp and/or combustible dust, having a "very high" level of protection, which has sufficient security that it is unlikely to become an

ignition source in normal operation, during expected malfunctions or during rare malfunctions, even when left energized in the presence of an outbreak of gas

[SOURCE: IEC 60079-0:2011, 3.26.1, modified by addition of “combustible dust”]

3.16

EPL Mb

equipment for installation in a mine susceptible to firedamp and/or combustible dust, having a “high” level of protection, which has sufficient security that it is unlikely to become a source of ignition in normal operation or during expected malfunctions in the time span between there being an outbreak of gas and the equipment being de-energized

[SOURCE: IEC 60079-0:2011, 3.26.2, modified by addition of “combustible dust”]

3.17

maximum surface temperature

highest temperature that can be attained in service, under the most adverse operating conditions (but within the recognised tolerance) by any part or surface of equipment, protective system or component which can produce an ignition of the surrounding explosive atmosphere

Note 1 to entry: The surface temperature which is relevant can be internal or external depending upon the type of ignition protection concerned.

Note 2 to entry: In order to avoid ignition it follows that the maximum surface temperature should be lower than the ignition temperature of the explosive atmosphere.

Note 3 to entry: For Ex equipment in an explosive dust atmosphere, this temperature occurs on the external surface of the enclosure and may include a defined dust layer condition

[SOURCE: ISO/IEC 80079-36:2016, 3.4, addition of Note 2]

3.18

non-electrical equipment

equipment which can achieve its intended function mechanically

Note 1 to entry: Equipment addressed in ISO 80079-36 can be powered by any kind of energy including electrical equipment.

[SOURCE: ISO/IEC 80079-36:2016, 3.7]

3.19

mechanical sparks

sparks, as well as showers of sparks, produced by impact or friction between two similar or dissimilar solid materials

3.20

incendive sparks

mechanical sparks with sufficient thermal energy to ignite a flammable atmosphere

3.21

hydraulic fluids

all fluids and their concentrates for hydraulic transmission and monitoring with exception of water

4 Requirements for equipment (machines) and components

4.1 General

All electrical and non-electrical equipment and components for use in an explosive atmosphere shall be designed and constructed according to good engineering practice and in conformity with requirements of EPL Mb equipment to ensure that ignition sources do not occur. Information on inspection and maintenance shall be provided in the instructions according to 7.2.2 to maintain the safe status of the equipment.

In some circumstances, particular components or sub-systems may need to be EPL Ma (e.g. methane detection /monitoring system on a machine).

The equipment shall conform with the requirements for EPL Mb according to IEC 60079-0 for electrical equipment and according to ISO 80079-36 for non-electrical equipment.

NOTE 1 To determine any local conditions of use that affect the ignition hazard assessment, negotiations often take place between the manufacturer or authorized representative, purchaser and/or user.

In particular, the following requirements apply to all machines and shall be taken into account:

- the need to restrict the maximum surface temperature according to ISO 80079-36:2016, 6.2;
- the need to meet the electrostatic requirements according to ISO 80079-36:2016, 6.7;
- the need to restrict the use of exposed light metals according to ISO 80079-36:2016, 6.4.4 and IEC 60079-0:2011. Light alloy parts of hand tools shall be protected by protective coating. They shall pass both tests according to Annex E (impact test in explosive atmospheres and adhesion test).
- the need to perform tests on non-metallic parts on which the ignition protection depends to ensure they will not deteriorate in the conditions of use in mines and cause the protection to be lost (see also Clause 6).

Exceeding the maximum surface temperature may be avoided by one, or a combination of, the following measures:

- continuous rating of the equipment so that it can easily cope with the maximum duty cycle;
- a suitable short-time rating of the equipment;
- additional cooling systems;
- shut-down devices measuring the temperature of either the surface or the cooling system;
- limitation of power transfer through the equipment, e.g. current limitation of motor supply or disengagement of mechanical power.

Where the means of limiting the surface temperature is not by continuous rating, the manufacturer has to specify the specific conditions of use in the user instructions, e.g. maximum oil temperature at which the equipment is automatically de-energized.

NOTE 2 Welding, cutting, grinding, burning and other processes involving naked flames and/or open sparking are normally prohibited in coal and other gassy mines unless special precautions are taken. Therefore, Mb equipment will be constructed so that such processes are not normally required to assemble, dismantle, maintain or repair machinery underground in a gassy mine.

In addition to the requirements for non-metallic materials specified in IEC 60079-0 and ISO 80079-36, where such materials can be an ignition source, they shall be fire-resistant (see 6.2).

4.2 Ignition hazard assessment

4.2.1 Formal analysis

All equipment and all parts of it shall be subjected to a formal documented ignition hazard assessment according to ISO 80079-36.

NOTE The following clauses are extracted from ISO 80079-36 and are specific to mining equipment.

4.2.2 Assessment for equipment-group I, EPL Mb

In the case of EPL Mb equipment, the assessment shall list all of the potential ignition sources, that are either effective or likely to become effective taking account of the need to have a high level of protection and the fact, that Mb equipment is required to be safe, in normal operation and during expected malfunction even under severe operating conditions, in particular those arising from rough handling and changing environmental conditions.

It shall also list those sources where the risk of them becoming effective remains, despite the equipment being designed to be de-energised in the event of an explosive atmosphere occurring. The assessment shall indicate the means used to minimize the likelihood of ignition. These means may either be according to this standard or to ISO 80079-36.

NOTE An example is when the concentration of flammable gas in the atmosphere (e.g. 20 % of the LEL) is detected by a methanometer (EPL Ma) and the energy source to the equipment (EPL Mb) is automatically removed.

Analysis shall include minimization of the likelihood of flame propagation, e.g. by elimination or minimizing fuel sources.

4.2.3 Establishing the maximum surface temperature

As part of the ignition hazard assessment, the maximum surface temperature of the equipment shall be established; this is the highest surface temperature, adjusted by the safety margins given in ISO 80079-36:2016, 8.2. This highest surface temperature applies to any part of the equipment that could be exposed to the explosive atmosphere, or where a dust layer could form, taking account of its size and ability to become an ignition source.

The assessment shall also take account of any integral device(s) fitted to limit the highest surface temperature (e.g. the use of a low melting point fusible drain plug in a fluid coupling). Where a temperature limiting device is used it shall fulfil the requirements for Type of Protection "b", control of ignition source. and the worst case operational state for which the equipment is designed. The maximum surface temperature shall be assessed at the maximum ambient temperature

The determination, by measurement or calculation, of the highest surface temperature shall be made with the equipment at worst case working conditions, but with those failures tolerated by the applied type of ignition protection. The measurement or determination by calculation of the highest surface temperature shall include the conditions of operation of expected malfunction for EPL Mb.

Conditions where the surface temperature increases following the machine stopping due to loss of cooling and heat dissipation shall be considered.

For some equipment or parts of equipment the worst working conditions may be continuous full load, or it may be the maximum duty cycle which includes severe overloads.

NOTE Maximum surface temperatures are stated in ISO 80079-36.

4.2.4 Dust deposits and other material in the gap of moving parts

The ignition hazard assessment shall consider the ignition risk that arises from dust or other material trapped between two moving parts or a moving part and a fixed part. If dust or other

material remains in contact with the same moving part for a long period, it can heat up and can cause a burning deposit of dust or other material which can later ignite an explosive atmosphere. Even slow moving parts can cause a large rise in temperature.

4.2.5 Ignition hazard assessment report

The ignition hazard assessment report shall be completed according to ISO 80079-36 (see examples of ignition hazard assessment reports of mining equipment in Annex A and Annex B).

4.2.6 Ignition sources

The ignition capability of the ignition source shall be compared with the ignition properties of the flammable substance.

The likelihood of occurrence of the effective ignition sources shall be assessed, taking into account those that can be introduced e.g. by maintenance and cleaning activities.

NOTE Protective measures can be used to make the ignition source non-effective.

If the likelihood of occurrence of an effective ignition source cannot be estimated, the assumption shall be made that the ignition source is present at all times.

The ignition hazard assessment for the different ignition sources shall consider the requirements of Annex C.

4.3 Non-electrical equipment and components

All non-electrical equipment and components (including parts used within the machine in order to connect them), shall comply with the requirements of ISO 80079-36 and, where necessary, one of the other Types of Protection listed in that standard, except where specific requirements exist in this International Standard, e.g. the fitting of water spray ignition protection to cutting picks.

NOTE 1 ISO 80079-36 addresses ignition protection of non-electrical equipment and components intended for use in both explosive gas atmospheres and explosive dust atmospheres, existing either separately, or combined (hybrid mixtures as defined in IEC 60079-14).

NOTE 2 Types of ignition protection are given in ISO 80079-37.

4.4 Electrical equipment and components

4.4.1 General

All electrical equipment and components shall comply with the requirements of IEC 60079-0 and at least one of the types of protection listed in that standard related to Group I.

NOTE 1 It is the intent of this document that the electrical equipment and components be designed and constructed on sound engineering principles, suitable for their intended use and be designed in a manner that will facilitate inspection, testing and maintenance.

NOTE 2 IEC 60079-0 deals with the ignition protection of electrical equipment and components intended for use in explosive gas atmospheres and explosive dust atmospheres. For gassy mines, equipment tested in an explosive gas atmosphere and protected against igniting firedamp is also adequately protected against ignition of an explosive coal dust cloud.

NOTE 3 Examples of Type of Protection standards particularly relevant to mining are:

- IEC 60079-1 (Flameproof enclosure "d");
- IEC 60079-7 (Increased safety "e");
- IEC 60079-11 (Intrinsic safety "i").

NOTE 4 The requirements of this standard supplement the applicable electrical safety requirements of the relevant industrial standards. The relevant electrical safety standards typically include IEC 60204-1 and

IEC 60204-11. It is not a requirement of this standard that compliance with the relevant industrial standards be verified.

Where protective measures depend on devices external to the machine, the manufacturer shall specify these in the instructions. For the purposes of this International Standard, the requirements below commence at the point where the electrical supply is connected to the machine (terminals, plug and socket).

NOTE 5 All terms used to describe electrical devices are as defined in IEC 60050-441.

4.4.2 Electrical equipment protection

When electrical equipment is used in a potentially explosive atmosphere, the Specific Conditions of Use specified in the certificate according to IEC 60079-0 shall be complied with.

NOTE Typical conditions for safe use might, for example, include the minimum flow of cooling water, temperature protection settings, duty cycle (short time rating).

4.4.3 Over-current protection

4.4.3.1 Overload protection

For the protection of motors and their supply cables against overloading, the requirements of IEC 60204-1 and IEC 60204-11 shall apply.

NOTE 1 In general, overload causes overheating.

NOTE 2 The objective of the overload protection is to prevent damage to electrical parts by excessive temperature. The overload protection contributes to reducing the risk of surface temperatures exceeding those specified in IEC 60079-0. Additionally, possible overloads or temperature rises can be caused by:

- a) high starting frequency;
- b) starting under load.

Motors that are likely to be overloaded shall additionally be protected by temperature monitoring devices.

Special consideration may be needed for motors with severe duty cycles including the supply cables which should be sized to match the motor duty without overheating. Voltage drop requirements may also need to be considered in sizing cables.

The setting of the overload tripping device may be above the nominal current of the motor if it is monitored by direct temperature monitoring, in accordance with the certificate of conformity to IEC 60079-0.

NOTE 3 Such direct temperature monitoring is typically achieved by locating temperature sensors in the motor stator windings, near to the bearings.

Protection against overload shall be achieved by the use of fuses, directly-operating trip relays, current-transformer-operated trip relays or thermal trip devices, etc. Depending on the system, combinations of the above might be required.

Overload protection shall not be provided if:

- a hazard is caused by its operation, e.g. the prevention of high voltages on secondary windings of current transformers, or tripping of exciter windings in generators or synchronous motors, or electrical braking circuits, and
- its exclusion is in accordance with the certificate according to IEC 60079-0.

Overload protection devices shall be installed at the beginning of each circuit and at positions where the current-carrying capacity of a conductor is reduced.

4.4.3.2 Short-circuit protection

Short-circuit protection shall be provided to protect in the event of a short-circuit occurring in any part of the circuit being protected except IS circuits (see IEC 60079-11).

Short-circuit protection may be incorporated in or external to the electrical equipment.

Facilities to avoid resetting by unauthorized persons shall be provided.

All external cables installed on a mobile machine shall be provided with short-circuit protection that will adequately protect the smallest cross section area cable that it is protecting.

Short circuit protection should also be considered to contributing to reducing the risk from arcing capable of igniting an explosive atmosphere by disconnecting the electricity supply as quickly as possible at the lowest current possible. There should be no intentional delay introduced to the operating time of short circuit protection for final load elements and it should be capable of operating well below prospective short circuit currents so that arcing faults can be detected. When possible, short circuit fault disconnecting should be displayed.

4.4.4 Earth-fault protection

The requirements of IEC 60204-1 and IEC 60204-11 shall apply insofar as they describe shock-hazard protection and include automatic disconnection of the supply if an insulation fault occurs.

The specific design depends on network configuration and should allow for connection to a disconnecting device that automatically interrupts the power supply to a machine if either the insulation of a supply cable is faulty or a fault occurs in the machine circuits. Information should be provided in the user instructions about the connection of the machine to the electrical system of the mine.

All enclosures and exposed metallic parts of electrical equipment and components capable of igniting a firedamp/air atmosphere or a coal dust/air cloud shall be electrically connected together and to a continuous protective conductor (individual external conductor or integrated into a multi-core cable).

Earth-fault protection shall be provided by either a) or b) below:

- a) the protection shall be designed such that when one phase is connected to earth (protective conductor) in a system having near infinite insulation resistance, the protection system shall operate when the earth- fault current attains a value greater than 20 % of the prospective earth-fault current, or

NOTE 1 For mines having a potentially explosive atmosphere, the connection between the protective conductor and the other conductors will usually have an earth-fault current restricting device fitted in order to limit the maximum prospective earth current in the power system to a value below that specified in local installation rules or code of practice.

- b) the insulation resistance between live conductors and the protective conductor shall be monitored. The design of the earth-fault monitoring device shall ensure that faulty components in the circuit are disconnected.

The reconnection of power to the equipment while an insulation fault persists shall be prevented.

In the case of battery-powered traction vehicles and vehicles with on-board starter batteries, the insulation level between the vehicle frame or earth or bonded metallic parts and the positive and negative poles shall be continuously monitored. Indication shall be given to the vehicle operator if the insulation level between any pole and the vehicle frame, earth or metallic parts falls to a level below a fixed value.

NOTE 2 Permissible values are stipulated in individual equipment standards or by local installation rules.

Earth fault protection should also be considered to contributing to reducing the risk from arcing capable of igniting an explosive atmosphere by disconnecting the electricity supply as quickly as possible at the lowest current possible. There should be no intentional delay introduced to the operating time of earth fault protection for final load elements.

The earth-fault protection system shall have visible means of indication and shall not be self-resetting and shall require manual reset.

Protective devices shall be provided with means to test the earth-fault protection, unless the diagnostic coverage or self-checking arrangements provide for sufficient safety integrity.

Means of restricting access, for resetting the protection, shall be provided.

Consideration should be given to the effect of d.c. and inverter systems including variable speed drives on the operation of the earth-fault relay.

4.4.5 Mechanical protection of live parts

All electrical equipment on machines, including cables and components shall be protected against damage expected in mining conditions (impact, rubbing, crushing) which could cause an ignition risk, e.g. an arc resulting from a short-circuit of live conductors or a live conductor and earth.

4.4.6 Electric cables that are part of the equipment

4.4.6.1 Machine cabling

Cables between machine enclosures shall have the following constructional features:

- a) be constructed of materials that can withstand the harsh mining environment;
- b) be constructed from materials that inhibit the propagation of fire;
- c) have constructional features that prevent the propagation of fire due to excessive voids between conductors, insulation, fillers, cradle separators, screening and sheaths;
- d) be capable of maintaining explosion protected properties of enclosures;
- e) have conductors that provide an appropriate level of flexibility;
- f) have integral protective earth conductors;
- g) be capable of withstanding foreseeable over voltages on the system (IT systems may need insulation that is rated at line voltage instead of phase voltage).

All external cables installed on a mobile machine shall be;

- a) arranged clear of moving parts;
- b) provided with short-circuit protection;
- c) protected from hot surfaces that may adversely affect the insulation of cables and moving parts;
- d) arranged so as to avoid excessive bending or twisting;
- e) clamped in place to avoid undue movement;
- f) protected from mechanical damage by being correctly positioned;
- g) protected from abrasions caused by movement of hydraulic lines;
- h) at least of the same temperature rating as the environment in which they are installed.

4.4.6.2 Cable protection hoses

Where cables are mechanically protected by cable protection hoses the hoses shall be flame resistant in accordance with 6.2 and anti-static in accordance with ISO 80079-36. Consideration shall be given to the identification of hoses and to differentiate between electrical and other applications, e.g. hydraulics.

4.4.6.3 Cables used in intrinsically safe systems

Cables used in intrinsically safe systems shall comply with the requirements of IEC 60079-25.

5 Additional requirements for specific equipment and components

5.1 Cutting and stripping equipment

5.1.1 General

Where there is a risk of the cutting picks igniting the atmosphere, they shall be designed so as to minimize the risk of frictional heat and/or sparks.

NOTE The risk of ignition by the cutting picks is usually associated with the following conditions:

- a) an ignitable concentration of firedamp may occur in the cutting zone and at the face around the picks;
- b) the coal strata or rocks that might be contacted contain quartz;
- c) the coal strata or rocks that might be contacted contain deposits of pyrites.

In selecting the type of cutting picks – to minimize frictional sparking – the instructions shall specify:

- the type of picks to be used;
- their acceptable wear limits;
- a safe method of pick replacement;
- a requirement that the user determines a checking frequency.

It is recognized that interlocks with proven reliability according to functional safety standards (IEC 62061 or ISO 13849-1) are available and may be used to demonstrate that the required reliability has been achieved but the use of such systems is not a requirement of this standard.

5.1.2 Machines with cutting picks

5.1.2.1 General

Any machine intended to be used under the conditions described in 5.1.1 shall incorporate a system that has been demonstrated to provide ignition protection. This system shall have either ventilation to the cutting zone or water sprays to the cutting picks or a combination of both. The effectiveness of the protection system shall be validated by the manufacturer and operating parameters determined and specified in the user instructions. The minimum water pressure and/or flow shall be specified by assessing the ignition risk according to 4.2.

5.1.2.2 Water spray systems

Where these systems are used, the machines shall incorporate a water spray system directed at the cutting picks. It also includes a device for monitoring the pressure and/or water flow to the spray system. An interlock shall be connected into the machine control circuit to avoid the rotating cutting tools from operating unless the minimum pressure and/or flow of water is present in the water spray system.

The above does not apply to end-ring picks of shearer loaders that cannot be sprayed.

NOTE Research has shown that the most likely ignition location within the cutting zone is at the rear of the cutting pick where hot particles or surfaces occur. Trailing sprays typically provide improved ignition control.

5.1.2.3 Air dilution systems

Where these systems are used, machines shall incorporate a means to dilute flammable gases around the cutting picks. In these cases, a disconnection device shall be provided to either continuously monitor the air flow or the equipment that produces it. An interlock shall be connected to machine monitoring circuit to avoid that the cutting picks are operated before there is a minimum amount of air in the cutting zone.

5.1.3 Stripping machines

Stripping machines, such as ploughs, shall have an interlock arranged so that they cannot be started unless a water spray system is operating. Such spray systems may be positioned either at, or on, the stripping head or applied to the particular section of the face being mined.

5.2 Rope haulages for level and inclined transport

For rope-hauled systems for level and inclined transport systems, excessive heat caused by frictional slipping between the haulage ropes and the drive pulley wheel/drum shall be avoided, for example, by maintaining the correct tension on the rope using a suitable rope tensioning device.

For endless rope systems, at least 2,5 laps of rope or a larger number of laps if specified by the manufacturer shall be maintained on the drive pulley wheel/drum.

The instructions shall include information about the correct positioning and siting of idler rollers, guide rollers and runners and any other precautions needed to avoid seizure by contamination from water, dust and dirt.

The instructions shall include information on the recommended inspection intervals necessary to detect/observe impending roller failures.

5.3 Fans

5.3.1 Ventilating fans for use in underground parts of mine

5.3.1.1 General

Ventilating fans for underground use may also be used for cooling and dust removal.

Fan casings shall be rigid and capable of withstanding without deformation the loads and impacts that might normally be encountered in mining operations. They shall be made from mild steel in accordance with ISO 630-5 and the minimum material thickness shall be at least 5 mm, so that the moving parts do not come into contact with the casing.

5.3.1 does not apply to fans for the cooling of rotating electrical machines, which comply with IEC 60079-0.

5.3.1.2 Bifurcated and centrifugal fans

Bifurcated fans with casings having a material thickness of less than 8 mm shall have additional strengthening in the form of roll bars or similar means.

Casings of mixed flow or centrifugal bifurcated or volute fans shall have a separate inlet cone which shall be adjusted to suit the impeller position, securely fixed and then locked in position by two offset spiral dowel pins.

5.3.1.3 Inlet and outlet cones

Inlet cones for mixed flow and centrifugal fans shall be rigid and constructed to a tolerance of $\pm 1,5$ mm on diameter.

5.3.1.4 Impellers and impeller rings

Impellers shall be designed and constructed to minimize locations where a build-up of combustible dust might occur.

Impellers shall be of a rigid design and shall be able to withstand a test run at a minimum of 1,15 times the maximum operational rotating speed for at least 60 seconds without causing an ignition risk and shall only produce small deformations relative to the clearance within the design temperature range.

The impeller and housing shall be of a design that will minimize dust from attaching or setting under normal conditions. Suitable facilities (e.g. easily accessible inspection doors) shall be provided so that inspection and cleaning operations can be easily carried out. Where dust is liable to form thick layers, vibration monitoring shall be fitted.

Bearings shall comply with the requirements of ISO 80079-37.

5.3.1.5 Clearance

For bifurcated and axial fans having the motor bolted into the casing with the impeller attached, the radial clearance shall be specified in the instructions.

For bifurcated and axial fans, the minimum axial clearance shall be 1,5 mm between the impeller and the casing. If materials other than those of low ignition risk are used, the clearance between rotating and static parts shall be not less than 1/250 of the casing diameter, but need not exceed 5 mm. Inlet cones may be constructed entirely from materials of low ignition risk (see Table 1).

5.3.1.6 Balancing

Impellers shall be balanced and corrections made by fixing an appropriate mass to the impeller. Before balancing, the impeller shall be in a clean condition and free of rust and scale. Once the impeller is fitted to the actual motor rotor, the rotating parts of the completed fan shall have a balance quality better than G 6,3 as described in ISO 1940-1.

If the ventilating fans will be used for dust extraction, vibration monitoring shall be fitted.

5.3.1.7 Overheating of the fan motor

At an air density of $1,4 \text{ kg/m}^3$, the power required to drive the fan at the point on the fan characteristic curve with the steepest possible impeller blade setting shall not exceed the appropriate motor power given on the rating plate.

5.3.1.8 Materials

In order to minimize the risk of ignition by sparking between impeller and fan casing, all fan casings shall be provided with static rings of low ignition risk material according to Table 1 at potential rubbing points. The clearances between the impellers and fixed parts of casings or inlet cones shall not be less than those shown in Table 1

Table 1 – Combination of materials

Material used for the rubbing track	Material used for the impeller			
	AlSi10Mg(a) EN AB 43000 ^a	AlSi12(a) EN AB 44200 ^a	Cu Zn 39 ^b	High grade steel X 5 CrNi 18 9
AlSi10Mg(a) EN AB 43000 ^a	(1)	(1)	(1)	(3)
AlSi12(a) EN AB 44200 ^a	(1)	(1)	(3)	(3)
Cu Zn 39 ^b	(1)	(1)	(3)	(2)
High grade steel X 5 CrNi 18 9	(3)	(3)	(3)	(3)
Steel S235JR ^c	(3)	(3)	(3)	(3)
Low ignition risk for: (1) Combination of materials with low ignition risk: radial clearance ≥ 1 mm or 1/1 000 of the impeller diameter, whichever is the greater. (2) Combination of materials with low ignition risk: radial clearance $\geq 1,5$ mm For both cases, the rubbing track rings shall be formed with a thickness of not less than 3 mm. (3) Combination of materials with higher ignition risk: radial clearance at least 1/250 of the impeller diameter, but need not exceed 5 mm.				
NOTE The use of these light alloys in this application reduces the risk of ignition. National legislation may restrict some of these combinations of materials.				
^a See EN 1676 (No International Standard available) ^b See EN 12163 (No International Standard available) ^c See EN 10025-2 (No International Standard available)				

5.3.2 Other fans

Fans used typically on machines for cooling and/or dust extraction shall comply with the following requirements:

- the inlet to the fan shall have ingress protection against solid objects to at least IP2X as defined in IEC 60529;
- the outlet of the fan shall have an ingress protection of at least IP1X according to IEC 60529;
- in normal operation the clearances, taking into account design tolerances, between the rotating blades and any fixed parts e.g. the hood, cowling or ventilation screens, shall be at least 1/100 of the maximum diameter of the fan. These clearances need not exceed 5 mm and may be reduced to 1 mm if the opposing parts are manufactured so as to have dimensional accuracy and stability. In no case shall the clearance be less than 1 mm;
- where plastics are used for parts of the fan, the thermal stability of the plastics material shall exceed the maximum service temperature by at least 20 K. Requirements for electrostatic charge are covered by ISO 80079-36.

5.4 Internal combustion engines

Internal combustion engines used in potentially explosive atmospheres in mines shall be explosion protected and designed in accordance with

- Group I,
- EPL Mb.

The main sources of ignition by internal combustion engines are:

- hot surfaces;
- flames and hot gases;
- mechanically generated sparks;
- electrical apparatus and systems;
- static electricity.

No ignition of the explosive atmosphere outside the enclosure by hot surfaces, hot gases, flames, sparks or electrical equipment shall occur.

NOTE 1 A new international standard on internal combustion engines for use in explosive atmospheres is under preparation in IEC/TC 31.

NOTE 2 The following standards give helpful information to ensure explosion protection:

- Europe: EN 1834-2
- Australia/New Zealand: AS/NZS 3584.2, AS/NZS 3584.3
- USA: 30 CFR 36.23, 36.25, 36.27, 36.31, 36.32, 36.48, 36.50

5.5 Air compressors

The engine or motor driving the compressor shall be automatically shut down if the temperature of any exposed part exceeds the maximum surface temperature (normally 150 °C at every stage of pressure increase). In the case of multi-stage compressors, the temperature shall be measured at every stage of pressure increase and at the discharge air outlet.

All parts of the compressor that are subject to oil residues and other deposits could be a significant ignition risk. Regular maintenance should be carried out according to the manufacturer's instructions.

The methane content of compressed air should be considered.

Where oil injection is used on a compressor, the air temperature shall be limited to 100 °C at every stage of pressure increase.

The requirements of 5.5 do not apply to water-cooled air compressors integrated in the cooling and shutdown circuit of a diesel engine.

5.6 Drilling equipment and components

Where drilling equipment and components are to be used in circumstances where there is a likelihood of there being an ignition risk between the drilling tools and the material being drilled, the manufacturer shall ensure that the drilling machine and drilling tools are not capable of creating hot surfaces or sparks. To achieve this, the following shall apply:

- a) all drilling rods, drilling bits and power transmission connections on hammer and rotary drills shall be positively engaged and driven by means other than friction so as not to be capable of producing surface temperatures that are an ignition risk;
- b) if the ignition hazard assessment according to 4.2 results in an ignition hazard, all drilling bits of the drilling equipment exceeding 3 kW drive power shall be provided with either mud flushing, water flushing or air flushing to both cool the drilling bit and remove drill cuttings from the borehole;
- c) the hardness and wear limits of the drilling tools shall be given in the instructions, based on the type of use.

5.7 Brakes

5.7.1 Brakes used only for stopping in emergency

Brakes, designed to be used only for emergency stopping of equipment, shall be constructed to allow for the maximum kinetic energy to be dissipated, neither shall the maximum surface temperature be exceeded nor shall incendive sparks be generated at any part exposed to the explosive atmosphere.

NOTE For a low likelihood of response of an emergency stopping device the hazard assessment according to 4.2 can come to the result that no further means of protection relating to EPL Mb equipment are necessary.

5.7.2 Service brakes (including friction brakes and fluid based retarders)

Service brakes shall be constructed to allow for the maximum kinetic energy to be dissipated so that neither shall the maximum surface temperature be exceeded nor shall incendive sparks be generated at any part exposed to the explosive atmosphere.

NOTE It will frequently be recommended to take other protective measures to avoid sources of ignition developing.

5.7.3 Parking brakes

Parking brakes shall be fitted with an interlock which avoids the drive power being applied if the brake is not fully released. Alternatively a control device shall be fitted.

5.8 Traction batteries, starter batteries and vehicle lighting batteries

Traction batteries, starter batteries and vehicle lighting batteries shall be equipped with a device (e.g. switch or switch-disconnector) that automatically disconnects the machine circuit from the battery if:

- a) an external short-circuit or thermal overload occurs;
- b) in the case of rigid connection (i.e. guided rigid plug and socket) between a battery and a machine the battery is removed before separating the contacts.

NOTE In deciding to fit and use batteries on machines intended for use in potentially explosive atmospheres, manufacturers and users should bear in mind that neither the internal parts of the battery cell nor their terminals can be de-energized when an explosive atmosphere occurs. Traction batteries, starter batteries and vehicle lighting batteries are normally high-energy EPL Mb equipment, ignition-protected according to IEC 60079-7 as type "e" – 'increased safety apparatus'. Because of their construction, these batteries cannot be de-energized if an explosive atmosphere occurs around them. Batteries protected by Ex e are subject to mechanical shock defined by IEC 60079-7 due to their specific application in underground parts of mine.

A switch-disconnector shall be positioned directly on the battery casing in order to de-energize the outgoing cable.

All cables shall be protected against mechanical damage to avoid short-circuits. This also applies to unprotected starter motor circuits on vehicles.

For circuits for which provision of protection against overcurrent is either impractical or undesirable for safety reasons (e.g. circuits associated with steering, braking or starting, or supply wiring before the first protection device), effective measures should be taken to minimize the risk of circuit failure.

Where batteries are fitted for starting purposes or are feeding other power circuits, the following shall apply:

- a) batteries shall be positioned and secured to avoid movement or mechanical damage that could cause the terminals to short-circuit (e.g. via the metal battery container). Housings shall be vented to release electrolytic gases and be fire-resistant;
- b) battery terminals shall be protected against inadvertent contact, e.g. by insulating covers or shrouds.

5.9 Optical fibres used on machines and electromagnetic radiation from components on machines

5.9.1 External pipes/optical fibres

5.9.1.1 The total energy, capable of being converted into an ignition capable heated surface or hot particle, delivered by any pipe or fibre intended for continued operation in an explosive atmosphere, shall be restricted to a level incapable of igniting firedamp or an explosive dust cloud in the event of its release, for example, by damage to the pipe or fibre.

5.9.1.2 In the case of optical radiation, which is, or could be directed onto coal dust particles or other particles suspended in the air, either in normal operation or as a result of damage to the conducting medium, the radiated power shall be limited to:

- a radiated power of less than 150 mW, or
- a peak radiation flux of less than 20 mW/mm²

NOTE The above values are derived from levels shown to be safe when optical radiation impinges on dust particles suspended in methane/air mixtures in the form of an explosive atmosphere.

These values do not apply if the optical radiation can impinge on a coal dust layer and cause local heating in excess of 150 °C. In such cases, the maximum radiation values will have to be determined by tests which are outside the scope of this standard dealing with atmospheres.

5.9.1.3 Where the optically radiated power is not limited by means of an infallible energy source, or by the use of an infallible limiting device, and the optically radiated power is carried in a transmission medium (e.g. an optical fibre cable) which can, if damaged, for example by guillotining, expose the optically radiated power to an explosive coal dust atmosphere, an interlock shall be provided which cuts off the radiated power at the transmitter, if either the transmission medium, or the energy received at the remote receiver becomes interrupted/lost.

5.9.2 Radio-frequency radiation from equipment

The radio-frequency radiated threshold power from equipment shall not exceed 6 W.

NOTE Local installation rules or code of practice can impose stricter limits for radiated power output for reasons other than the risk of ignition of firedamp and/or coal dust. For example the avoidance of radio frequency ignition of electro-explosive devices (commonly known as detonators) by radio transmitters.

5.10 Gas monitoring systems

Where a gas monitoring system is provided, the system shall have the following features:

- a) the trip mechanism shall isolate the energy supply to the equipment. Isolation devices shall be explosion protected;
- b) the monitor shall give a visual warning that a predetermined concentration of explosive gas has been reached;
- c) the monitor shall be configured to cease operation of parts of the equipment when the explosive gas concentration set point has been reached;
- d) a lockout mechanism that will avoid the restoration of energy to the equipment until the trip mechanism is reset shall be fitted. Following an explosive gas trip it shall not be possible to apply energy to the equipment until the explosive gas concentration has fallen to safe levels;
- e) there shall be a visual indication of the gas level;
- f) a system to override the trip mechanism may be provided to allow the safe withdrawal of the equipment for repair and maintenance;
- g) access to the override or reset mechanism shall be restricted to authorised personnel;

- h) in case of a failure of the methane monitoring system, it shall ensure the shutdown of the equipment. Indication of failure shall be provided where possible.

NOTE Local installation rules or code of practice or an ignition hazard assessment by the manufacturer can require gas monitoring systems to be fitted to the equipment and audible and visual warning when a predetermined gas level is reached.

6 Fire protection

6.1 General

An ignition hazard assessment requires the inclusion of those components which, if they failed, could ignite any flammable substances (e.g. lubricating oil) contained within the equipment and which could become or create an ignition source. In the case of mining equipment, the ignition temperature of mineral oils or grease used to lubricate moving parts is often below the maximum surface temperature allowed for firedamp. In some cases, there is also a risk that non-metallic substances, such as plastics, may also ignite before the surrounding atmosphere is ignited. Where possible, fire-resistant materials shall be used. Where this is not possible, the fire protection used shall avoid the atmosphere being ignited. The following paragraphs deal with specific types of fire protection and the use of fire-resistant materials.

NOTE 1 Experience has shown that one of the major hazards is of bearing failure, which can ignite coal dust, lubricants or other flammable substances. In addition, 4.2.6 also requires the identification of hazards from flames and hot gases.

NOTE 2 National legislation can require further fire protection measures, and can also require certain machines to be fitted with at least one portable fire extinguisher or adequate capacity and suitable extinguishing medium. Also, where the users risk assessment indicates a need for additional provisions or machines present a greater risk of fire, they can be provided with suitably designed fire extinguishing systems.

6.2 Non-metallic materials

Where the ignition hazard assessment establishes a need of fire resistance materials then non-metallic materials shall meet the requirements for fire resistance when a naked flame is applied to them, irrespective of whether or not they form part of the ignition protection.

Where the relevant industrial standard includes a fire resistance test for the material used, it shall apply to that material. Where no fire resistance test exists, the following test shall be used.

The test flame shall be as specified in ISO 340, the application period shall be 10 s and the burning time after removal of the flame shall not exceed 15 s.

NOTE Additionally, an oxygen index test according to ISO 4589-2 with an index ≥ 28 % can be considered.

This does not apply to parts where the manufacturer's ignition hazard assessment has established that the consequences of a fire are acceptable, e.g. materials with a mass $< 0,5$ kg, air filters, small pipes/ducting, warning labels, seals, O-rings, shims and covers.

6.3 Hydraulic and pneumatic equipment

Pneumatic and hydraulic equipment of machinery shall be designed so that:

- the maximum rated pressure cannot be exceeded in the circuits (e.g. by means of pressure limiting devices);
- no hazard results from pressure surges or rises, pressure losses or drops or losses of vacuum;
- no hazardous fluid jet or sudden hazardous movement of the hose (whiplash) results from leakage or component failures;

- air receivers, air reservoirs or similar vessels (e.g. in gas loaded accumulators) comply with the design rules for these elements;
- all elements of the equipment, and especially pipes and hoses, be protected against harmful external effects;
- as far as possible, reservoirs and similar vessels (e.g. in gas loaded accumulators) are automatically depressurized when isolating the machine from its power supply and, if it is not possible, means are provided for their isolation, local depressurizing and pressure indication (see also ISO 14118:2000, Clause 5);
- all elements which remain under pressure after isolation of the machine from its power supply be provided with clearly identified exhaust devices, and a warning label drawing attention to the necessity of depressurizing those elements before any setting or maintenance activity on the machine.

NOTE 1 See also ISO 4413 and ISO 4414.

To avoid ignition of the explosive atmosphere by burning liquid, the power transmission fluid shall have a suitable fire resistance rating.

Hydraulic equipment should be designed and constructed to operate with hydraulic fluids for which the fluid manufacturer has provided proof that they are fire-resistant (see ISO 80079-37 and ISO 12922).

The fire resistance of hydraulic fluids can be confirmed by ISO 15029-1 or the "stabilized flame heat release spray method" according to ISO/TS 15029-2 ("Buxton test"), and the wick test according to ISO 14935.

Hydraulic fluids need not to be fire resistant if a spray in the field of the intended use is unlikely to be in contact with a potential ignition source.

The test for the determination of spray ignition characteristics of fire-resistant fluids and the calculation of the ignitability factor RI shall be carried out according to ISO/TS 15029-2 (see Table 2).

NOTE 2 User legislation in countries can require the use of different levels of fire resistant fluids and can also require a pass in the following tests:

- ISO 20823 (Manifold ignition test) – is not required if the surface temperature of the equipment is limited to 150 °C;
- ISO 2592 (Cleveland open cup flash point test) – Pass to exceed 200 °C.

Table 2 – Limit values for hydraulic fluids

Group	HFA	HFC	HFB, HFDR	HFDU
Category ^a	A non flammable	B fire-resistant	C fire-resistant	D fire-resistant
Ignitability factor RI	> 100	100 to 65	64 to 36	35 to 24
Flame length index RL	> 100	100 to 51	50 to 7	≤ 6
Smoke density D	< 0,01	0,01 to 0,1	> 0,1	-
^a The meaning of the categories is as follows: A not ignitable B unable to ignite a spray flame C Spray is self-extinguishing D Spray ignites less easily than mineral oil but able to stabilize a spray flame under certain conditions				

The tests for the determination of fire resistance shall also include a determination of the effective life of the fire resistant properties.

6.4 Requirements for cable-reeled equipment

6.4.1 General

Where cable reels are fitted to machines, the driven reel shall maintain positive tension of the trailing cable during reeling and unreeling operations, within the cable manufacturers' specified operating tensions for the cables under all operating conditions.

6.4.2 Special requirements

For equipment incorporating a cable-reeling device, the reel and the flexible cable on it constitute part of the machine. Therefore, the following requirements apply to such equipment:

- means shall be provided on the equipment to allow the equipment operator to disconnect the power supply to the flexible cable;
- the reel shall be designed not to exceed the cable manufacturer's recommended minimum bending radius;
- the cable reel shall be designed so that, under all operating conditions, the permissible temperature of the cable is not exceeded even when the reel is full;
- the cable reel shall be capable of reeling in the cable at a speed not less than the maximum speed of the equipment;
- cable reels shall be fitted with a protective device to stop, remove power from the trailing cable and apply the brakes, if
 - a) the cable reel becomes over full or protrudes past the side plates of the reel (over fill limit); or
 - b) the machine exceeds the minimum safe limit of cable on the reel (run out limit).
- The above mentioned device shall be part of a control circuit so arranged that resetting of the device does not automatically restart the equipment.
- the driven reel shall maintain positive tension of the trailing cable during reeling and unreeling operations, within the cable manufacturers' specified operating tensions for the cables under all operating conditions;
- cable reel bearings shall not be an integral part of a circuit for transmitting electrical energy nor form part of the earthing circuit.

Consideration should be given to the inclusion of cable reel motion detection and indication.

6.5 Fire prevention on electric cables that are part of the machine

The outer sheath of electric cables external to electrical equipment enclosures shall be flame-retardant and self-extinguishing in accordance with IEC 60332-1.

All power cables shall be isolated from any fuel, lubrication or hydraulic lines, except where the cables and pipes are armoured or otherwise mechanically protected, or where hydraulic or fuel lines and cables terminate at the same components, or where fire-resistant fluid is used in the hydraulic lines.

6.6 Conveyor belting

Fires on conveyors are hazards for the ignition of methane and dust.

Hazards leading to fires on conveyors include:

- Tracking of conveyor belting against other materials and belt slip (e.g. structure, seized idlers, stalled pulleys);
- Ignition from the discharge of static electricity accumulated on the conveyor belting;

- The rate of propagation of fire on the belting material.

Tests shall be carried out to supply evidence that risks associated with the above hazards are minimized and acceptable.

Detailed requirements and test procedures for the fire protection of conveyer belts are not part of this standard.

NOTE The following tests can give helpful information to ensure acceptable risk:

- Europe: Electrical Resistance: ISO 284 in the context of EN 14973+A1
Frictional Heating: EN 1554 in the context of EN 14973+A1
Resistance to Ignition: ISO 340 in the context of EN 14973+A1
Fire Propagation: EN 12881-1+A1, EN 12881-2+A1 in the context of EN 14973+A1
- Australia: AS 4606
- USA: 30 CFR 18.65 and 30 CFR 14.21.

7 Information for use

7.1 Signals and warning notices

Where foreseeable actions of personnel may lead to a risk of ignition, warning notices as specified in ISO 7010 shall be placed on the machine, e.g.,

- WARNING Do not open when energized!
- WARNING Only use a flame-retardant fluid, type...!

7.2 Instructions

7.2.1 Information on use

In addition to the markings required in Clause 8, the manufacturer shall state the equipment group and EPL and the following information:

- the machine shall be shut down and immobilized against restart if damage to the explosion protection equipment is detected;
- the operator shall stop the machine and disconnect the power to it if damage to the protection devices on the machine is detected;
- any information on residual risks, e.g. ignition through sparks or hot cutting tools.

7.2.2 Information on maintenance and repair

The manufacturer shall state the following information:

- measures to isolate and maintain the explosion protection;
- information on residual risks, such as temporary removal of protective or warning devices;
- instructions to maintain regularly and to check the operability of equipment on the machine for the prevention or elimination of ignition hazards.

8 Marking

Non-electrical equipment meeting the requirements of this standard supplemental to those of ISO 80079-36 shall be marked in accordance with ISO 80079-36, there is no additional marking with regard to the Type of Protection applied.

Group I equipment protected by constructional safety, liquid immersion and/or control of ignition sources shall be marked with Ex h I Mb.

EXAMPLE

Manufacturer LTD	= name of the manufacturer
Type 123MKII	= manufacturer's type identification
Ex h I Mb	= marking according to Ex symbol, the letter "h", equipment group I, EPL Mb
Ser. No. 12345	= serial number

NOTE The specific explosion protection marking is given in ISO 80079-36 for non-electrical equipment and in IEC 60079-0 for electrical equipment.

Annex A **(informative)**

Example of an ignition hazard assessment for a conveyor belt intended for use in a coal mine

A.1 General

The following paragraphs are intended as an example of how a manufacturer would record the ignition hazard assessment for a conveyor, intended for use in a gassy mine. They are not based on any particular manufacturer's machine, they are not definitive and alternative ignition control measures could be applied to avoid that the identified potential ignition sources become active. Any modification that affects the ignition risk to a machine will need further assessment.

A.2 EPL and intended use of the equipment

The equipment consists of components which are assembled to form a belt conveyor intended for transporting coal in a coal mine having a potentially explosive atmosphere of firedamp and/or coal dust. The manufacturer has decided to construct it to meet the requirements for EPL Mb equipment. It is therefore necessary to produce an ignition hazard assessment report for inclusion in the technical file in accordance with the requirements of ISO 80079-36 for EPL Mb equipment. This means the conveyor has to incorporate a high level of ignition protection, irrespective of the fact that it is intended to be de-energized in the event of an explosive atmosphere occurring. The reason for this is that it might operate unintentionally for a short period of time in an explosive atmosphere if, for example, a sudden outburst of firedamp was to occur in the mine roadway or if the occurrence of an explosive atmosphere at the conveyor location has not been immediately detected by the manual/automatic firedamp detection and monitoring devices and a shut-down initiated.

Ignition protection measures shall, therefore, be applied to some potential ignition sources that are not present in normal operation, but the risk of them becoming effective cannot be discounted.

Potential ignition sources arising from rare malfunctions can, however, be neglected because the conveyor is not intended to operate in an atmosphere containing concentrations of gas/dust exceeding those allowed by national regulations.

A.3 Construction and description of the equipment

The conveyor consists of a continuous belt, made of fire-resistant plastic-coated textile material, mounted on a metallic structure incorporating drive and idler rollers. It is driven by a flameproof electric motor and an oil-filled gearbox through a large diameter drive drum. The assembly has a drive-end tensioning roller on a movable frame and a freewheeling return-end roller drum. The belt is supported throughout its length by top and bottom belt idler rollers forming part of the structure. A calliper-type brake is provided on a brake drum at the drive end. The brake is gravity-applied by weights and released by a flameproof electrically-driven thruster motor that energizes 5 s after the main drive motor has applied drive power to the belt drum. This is to avoid runback of the belt on starting. The delivery chute is made of steel and is connected to the metallic belt structure. Except for the fire-resistant plastic-coated conveyor belt, all other fixed and moving parts are made from steel. All metallic parts of the structure are connected together to provide an electrical bonding connection that will leak any unintentional electrical or electrostatic charges to earth.

A.4 Assessment

a) Electrical equipment

The drive motor and brake thruster motors are explosion protected electrical equipment meeting the requirements of IEC 60079-0 and IEC 60079-1 as flameproof equipment and are covered by a certificate.

The signal and interlock circuits and the conveyor control and monitoring equipment comply with IEC 60079-0 and IEC 60079-11 as intrinsically safe assembly and are covered by a certificate.

b) Non-electrical equipment

All exposed parts of the conveyor which, if damaged, could reduce the ignition protection have been subjected to the impact tests in ISO 80079-36. Any non-metallic parts on which the ignition protection depends have been subjected to environmental exposure tests described in ISO 80079-36 and meet the requirements. The conveyor has no exposed light metals (aluminium, magnesium, titanium, zirconium) that could give rise to incendive sparking when struck by rusty iron/steel. The instructions, marking, electrostatic ignition risk and other identified potential ignition sources are dealt with in Table A.1:

**Table A.1 – Example of an ignition hazard assessment for a mining conveyor,
EPL Mb (1 of 2)**

Potential ignition sources		Measures applied to avoid that the ignition sources become effective	Ignition protection used
Normal operation	Faults that cannot be ignored		
Bearings (other than idler bearings)	-	All bearings are lubricated by grease. Replenishment of grease is required every 6 months. The applied forces on the bearings are 50 % of their rated load. The calculated operating life of bearings on this conveyor is estimated as 25 000 h of use, after which time they need to be replaced. This information will be included in the instructions. NOTE See ISO 80079-37:2016, 5.7.1 (regarding bearing rated life).	ISO 80079-36 (Instructions) and ISO 80079-37 Constructional safety "c"
	Bearing failure or loss of lubrication	The bearing housings need to be examined for signs of overheating, abnormal noise or discoloration on a daily basis. Where practical, continuous temperature monitoring can be fitted and set to trip the drive power at 10 K above normal operating temperature.	ISO 80079-36 (Instructions)
	Belt rubbing on spilled coal	The user shall clean spilled coal away from contact with moving parts. This will be included in the user instructions.	ISO 80079-36 (Instructions)
Frictional heat from moving parts inside the gearbox	-	The moving parts inside the gearbox are submersed in oil, which acts as a lubricant, spark-quenching agent and coolant.	ISO 80079-37 Liquid immersion "k"
	Unacceptable loss of oil from the gearbox	A dipstick is provided on the gearbox. The oil level shall be checked weekly. This is included in the instructions.	ISO 80079-36 (Instructions)
Frictional heat from the brakes	-	In consultation with brake manufacturers, calculations have shown that the brakes do not overheat in normal use and do not produce incendive sparks.	ISO 80079-37 Constructional safety "c" ISO/IEC 80079-38:2015, 5.7

Table A.1 (2 of 2)

Potential ignition sources		Example of measures applied to avoid that the ignition sources become effective	Ignition protection used
Normal operation	Faults that cannot be ignored		
	Brakes left on too long after the drive motor has started	The power supply of the main drive motor is coupled to the brake release thruster motor to avoid the main drive motor driving through unreleased brakes for more than 2 s. The surface temperature of the brake was determined to be 140 °C under this fault condition. In addition, the braking surface has a temperature monitoring device that stops the main drive motor before the temperature of the braking surface reaches 150 °C.	ISO 80079-37 Control of ignition source "b"
Dust entering brake housing	-	An IP54 cover is provided to avoid deposits of dust entering the housing.	ISO 80079-36
	Brake disengagement fails	The brake-operating linkage is fitted with a limit switch arranged to trip the conveyor main drive motor if the brake does not release correctly. In addition, the braking surface has a temperature monitoring device that stops the main drive motor before the temperature of the braking surface reaches 150 °C.	ISO 80079-37 Control of ignition source "b"
Frictional heat from the belt idler rollers	-	The idler rollers are sealed for life with fire-resistant grease and the actual maximum loading on them is 50 % of their rated load. They are designed so that the idler roller barrel wears out before the end of the bearing service life. NOTE Details for safe use (e.g. maintenance cycles) are included in the user instructions.	ISO 80079-37 Constructional safety "c"
	Belt idler roller seizes and is rubbed by the moving conveyor belt	Weekly examination is required for signs of deterioration e.g. abnormal bearing noise, visible discoloration and overheating. The conveyor belt is made of fire-resistant (self-extinguishing) material to avoid flame propagation.	ISO 80079-36 (Instructions) and ISO 80079-37 Constructional safety "c"
Dust deposits on gearbox	-	Regular cleaning is needed to avoid dust deposits forming on gearboxes and any resulting temperature rise.	ISO 80079-36 (Instructions)
	Slippage of conveyor belt on the driving drum due to loss of tension or stalling of the belt	The fire-resistant belt has been subjected to a rotating drum friction test with a stalled belt and breaks before flames are produced. The belt tension and behaviour during start-up shall be checked weekly. The belt is protected against locking by monitoring the preliminary tension of the belt and the operating speed. The speed transducers are arranged to trip the motor if more than 10 s of abnormal speed difference (i.e. exceeding 25 %) occurs between the drive roller and the belt.	ISO 80079-36 (Instructions) or ISO 80079-37 Control of ignition source "b" if fitted with monitoring.
Static electricity discharge	-	Sufficiently conductive belting (i.e. less than $10^9 \Omega$ surface resistivity) is used to avoid charge build-up. All other parts are metal and connected together to provide an electrically-conductive path of less than 100 Ω .	ISO 80079-36 (Electrostatic requirements and instructions on belt replacement) ISO/IEC 80079-38:2016, 6.6
	Belt driven at over-speed	It has been calculated that the conveyor is capable of operating at 20 % over-speed without increase of temperature. Normally, the electric drive motor will avoid over speeding. Mechanical brakes are needed if the conveyor is installed on a steep incline.	ISO 80079-37 Constructional safety "c"
	Friction between the belt and fixed parts	Belt alignment monitors are fitted at the drive head. These are arranged to trip the drive motor if misalignment occurs avoiding any temperature increase.	ISO 80079-37 Control of ignition source "b"
Surface temperature of all moving parts		All parts exposed to the explosive atmosphere of both gas and dust have been tested and the maximum surface temperature has been found to be 120 °C in normal operation and 140 °C under conditions that cannot be ignored.	ISO 80079-36