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Explosive atmospheres - Explosion prevention and protection - Part 2: Basic concepts and methodology for mining

Explosionsfähige Atmosphären - Explosionsschutz - Teil 2: Grundlagen und Methodik in Bergwerken

Atmosphères explosives - Prévention de l'explosion et protection contre l'explosion - Partie 2: Notions fondamentales et méthodologie dans l'exploitation des mines

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Foreword

This document (EN 1127-2:2014) has been prepared by Technical Committee CEN/TC 305 “Potentially explosive atmospheres - Explosion prevention and protection”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2014 and conflicting national standards shall be withdrawn at the latest by December 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1127-2:2002+A1:2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directives.

For relationship with EU Directives, see informative Annexes ZA and ZB, which are an integral part of this document.

EN 1127, *Explosive atmospheres — Explosion prevention and protection* is composed of the following parts:

— *Part 1: Basic concepts and methodology*

— *Part 2: Basic concepts and methodology for mining* (the present document)

Annex C provides details of significant changes between this document and the previous edition.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

General

CEN and CENELEC are producing a series of standards to assist designers, manufacturers and other interested bodies to interpret the essential safety requirements in order to achieve conformity with European legislation. Within this series of standards, CEN has undertaken to draw up a standard to give guidance in the field of explosion prevention and protection, as hazards from explosions are to be considered in accordance with EN ISO 12100.

In accordance with EN ISO 12100, it is a type A standard.

Special considerations for mining

Explosions can result from:

— materials processed or used by the equipment and components, e.g. minerals obtained as part of the winning process;

— materials released by the equipment and components;

— materials in the vicinity of the equipment, protective systems and components;

— materials of which the equipment, protective systems and components are constructed.

As the explosion protection of equipment, protective systems and components depends on:

— the design and construction of the equipment, protective systems and components;

— the intended use;

— the foreseeable misuse;

— the ambient conditions;

— the materials extracted and handled.

This standard also includes safety aspects related to these factors, i.e. it is imperative that the manufacturer consider how and for what the equipment, protective systems and components will be used and take this into account during their design and construction. Only in this way can hazards inherent in equipment, protective systems and components be reduced.

NOTE 1 This standard can also serve as a guide for users of equipment, protective systems and components when assessing the risk of explosion in the workplace and selecting the appropriate equipment, protective systems and components.

Mines can be either gassy or non-gassy depending upon the mineral/material being extracted and whether or not firedamp can occur in the workings. It is usual practice to consider all coal mines as gassy mines. Non-coal mines can, however, also be susceptible to the occurrence of firedamp, e.g. if minerals/materials are being extracted in the vicinity of oil-bearing strata or unworked coal seams which are disturbed by the extraction process or mines susceptible to outbursts of flammable gas.

In mines where flammable minerals/materials are extracted, there can also be a risk of explosions because small particles of the extracted product can be blown into the air to form dust/air mixtures able to support rapid combustion. Combustible dust can either be an explosion risk on its own (when in the form of an explosive dust/air mixture), or it can settle in layers which may be blown from the floor and sides of the roadways by a

firedamp explosion. In the latter case, the explosive violence can increase many times as more and more fuel in the form of combustible dust is raised by a blast wave and added to the flame as it travels along the roadways.

The risk of an explosive atmosphere occurring and its consequences will therefore vary from mine to mine, depending on the type of mine, its layout, the mineral being extracted and the likelihood of firedamp and/or combustible dust occurring.

In **coal mining**, firedamp and coal dust naturally associated with the coal is released by the activity of the miners. Therefore, the potential explosion risk is greater as a result of explosive air/gas or air/dust mixtures forming that cannot be totally excluded by the preventive measures taken.

Firedamp/air mixtures are usually diluted by the ventilation and evacuated to the surface via the mine workings so that the gas content in normal operation is kept far below the lower explosion limit. However, as a result of system malfunction (e.g. fan failure), sudden release of large gas quantities (gas outbursts) or intensified gas release caused by decreasing air pressure or by increased coal production, the permissible gas concentration thresholds may be exceeded. The explosive atmosphere caused in this way, even though limited in space and/or time, may cause a hazard not just at its point of origin but also in the escape roads, waste air paths and other connected mine structures in the mine layout.

Coal dust/air mixtures are usually neutralized at the dust source by water sprays, dust removal systems on heading machines and/or treating with inert dust in order to reduce the explosive potential. However, an explosion hazard can exist if explosive dust can become airborne, e.g. at transfer points, in bunkers and other conveying systems.

In contrast to surface industries, in gassy mines electrical and non-electrical equipment and mining personnel are in permanent contact with gas and/or dust/air mixtures which, under unfavourable conditions, may constitute explosive atmospheres. Accordingly, particularly stringent safety requirements are in force for explosion protection and escape possibilities in the event of a hazard. Due to the possibly devastating effects of underground gas/dust explosions, underground mining is permitted only well outside the explosion range.

In gassy mines, the decision as to whether or not mine workers can operate in a particular workplace depends upon the atmospheric conditions prevailing at the time. Traditionally, a factor of safety is also introduced so that it is common practice throughout the European member states for equipment to be de-energized or made safe and for miners to be withdrawn from their workplace if the atmospheric conditions attain a specific percentage of the lower explosion limit (LEL) of methane (firedamp) in air as defined by the relevant national legislation of the member states.

NOTE 2 The current limit values for disconnecting equipment and withdrawing personnel are different in each member state.

Two different ranges of explosive atmospheres originating from the intended installation and use of the equipment are taken into account when dealing with requirements for Equipment Groups M 2 and M 1:

— **potentially explosive atmosphere** — range between 0 % and below LEL or above UEL up to 100 % of firedamp in air;

— **explosive atmosphere** — range between LEL and UEL of firedamp in air.

In mine workings with explosive atmospheres, only M 1 equipment is acceptable as it has a very high level of protection. M 1 equipment, e.g. telephones or gas measuring equipment may continue to be operated in explosive atmospheres, because they are safe even in the event of rare equipment faults. This is ensured by the existence of two independent protective measures or double fail-safe systems.

In mine workings with potentially explosive atmospheres, both M 1 and M 2 equipment may be used. M 2 equipment may be used as it has a high level of protection and is suitable for the severe conditions in mining. In an explosive atmospheres, M 2 equipment needs to be capable of being disconnected or made safe.

NOTE 3 Under special conditions, it might be necessary to operate M 2 equipment in an explosive atmosphere for a short time, e.g. when personnel are escaping from mine workings with high firedamp readings with their M 2 caplights switched on, when personnel are being recovered by the mine rescue service or the firedamp extraction system has been started up.

M 1 and M 2 equipment can only be operated with the characteristics specified by the manufacturer as only then do they ensure the relevant level of protection. The manufacturer specifies the operating characteristics for the equipment.

In practice, national regulations require that gas measurements be taken at certain points and at specific intervals and suitable measures are taken to de-energize the equipment either manually or automatically if the firedamp concentration reaches a certain value. A subdivision into hazards caused by an explosive gas atmosphere and those caused by an explosive dust atmosphere is, in contrast to EN 1127-1:2011, not advisable in underground mining as the hazard to the mine workings can be caused simultaneously by firedamp and by clouds of combustible dust. Therefore, the explosion protection measures will always cover both, i.e. the hazard caused by firedamp and the one caused by combustible dust.

The definition of potentially explosive atmospheres in coal mines susceptible to firedamp based on Directive 94/9/EC extends the definition of potentially explosive atmosphere to include combustible dust as well as firedamp. Extensive research has shown that the minimum ignition energy (MIE) of coal dust/air mixtures is several hundred times that of firedamp/air mixtures and that the maximum experimental safe gap (MESG) of coal dust particles is more than double that for firedamp. It is therefore reasonable to assume that the equipment, protective systems and components which are designed and constructed for use in firedamp/air mixtures are also suitable for use in coal dust/air mixtures.

The comparison of methane and coal dust experimental data relates only to atmospheres (mixtures of gas and/or dust with air), not to dust layers. Additional precautions are required when considering coal dust deposits as, in this case, the maximum surface temperature of the equipment (limited to 150 °C for Group I equipment) on which the deposits can form can be limited to values below the minimum ignition temperature.

It is vital to bear in mind that in both coal mines and non-coal mines there can be areas where firedamp does not occur but where there is a risk of explosion because of combustible dust.

1 Scope

This European Standard specifies methods for explosion prevention and protection in mining by outlining the basic concepts and methodology for the design and construction of equipment, protective systems and components.

This European Standard applies to Group I equipment, protective systems and components intended for use in underground parts of mines and those parts of their surface installations at risk from firedamp and/or combustible dust.

NOTE Detailed information on specific equipment, protective systems and components is contained in the relevant individual standards. Safety-relevant data regarding flammable materials and explosive atmospheres are required for the design and construction of the explosion protection measures.

This European Standard specifies methods for the identification and assessment of hazardous situations that may lead to explosions and describes the design and construction measures appropriate for the required safety. This is achieved by

— risk assessment;

— risk reduction.

The safety of equipment, protective systems, and components can be achieved by eliminating hazards and/or limiting the risk, i.e.

a) by appropriate design (without using safeguarding);

b) by safeguarding;

c) by information for use;

d) by any other preventive measures.

Measures in accordance with a) (prevention) and b) (protection) against explosions are dealt with in Clause 6 of this standard; measures according to c) against explosions are dealt with in Clause 7 of this standard. Measures in accordance with d) are not described in this European Standard. They are dealt with in EN ISO 12100:2010, Clause 6.

The preventive and protective measures described in this European Standard will not provide the required level of protection unless the equipment, protective systems and components are operated in line with their intended use and are installed and maintained according to the relevant codes of practice or requirements.

This standard is applicable to any equipment, protective systems and components intended to be used in potentially explosive atmospheres. These atmospheres can arise from flammable materials processed, used or released by the equipment, protective systems and components or from materials in the vicinity of the equipment, protective systems and components and/or from the materials of construction of the equipment, protective systems and components.

As shot firing can release potentially explosive atmospheres, this standard is also applicable to the equipment used for shot firing, apart from the explosives and detonators.

This standard is applicable to equipment, protective systems and components at all stages of use.

This standard is not applicable to:

— medical devices intended for use in a medical environment;

— equipment, protective systems and components where the explosion hazard results exclusively from the presence of explosives or unstable chemical substances;

— equipment, protective systems and components where the explosion can result from reaction of substances with oxidising agents other than atmospheric oxygen or by other hazardous reactions or conditions other than atmospheric conditions;

— equipment intended for use in domestic and non-commercial environments where explosive atmospheres may only rarely be created and solely as a result of the accidental leakage of fuel gas;

— personal protective equipment covered by Directive 89/686/EEC; the design and construction of systems containing desired, controlled combustion processes, unless they can act as ignition sources in potentially explosive atmospheres;

— mines where firedamp and/or combustible dust are not naturally present and surface installations such as coal preparation plants, power plants, coke oven plants etc. in which an explosive atmosphere can be present, but which are not part of a coal mine. These are covered by EN 1127-1:2011.

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.

EN 1127-1:2011, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 1710, *Equipment and components intended for use in potentially explosive atmospheres in underground mines*

EN 13237, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN 13463-1:2009, *Non-electrical equipment for use in potentially explosive atmospheres — Part 1: Basic method and requirements*

EN 13463-6, *Non-electrical equipment for use in potentially explosive atmospheres — Part 6: Protection by control of ignition source 'b'*

EN 13478, *Safety of machinery — Fire prevention and protection*

EN 14373, *Explosion suppression systems*

EN 14460, *Explosion resistant equipment*

EN 14797, *Explosion venting devices*

EN 15089, *Explosion isolation systems*

EN 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*

EN 60079-2, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosure “p”*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13237:2012 and the following apply.

3.1
firedamp
any potentially explosive mixture of gases or any flammable gas 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.

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 combustible dust

3.3
component
any item essential to the safe functioning of equipment and protective systems but with no autonomous function

[SOURCE: Directive 94/9/EC, Chapter I, Article 1, modified]

3.4
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 are capable of causing an explosion through their own potential sources of ignition

[SOURCE: Directive 94/9/EC, Chapter I, Article 1, modified]

3.5
machinery
— an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application;

— an assembly referred to in the first indent, missing only the components to connect it on site or to sources of energy and motion;

— an assembly referred to in the first and second indents, ready to be installed and able to function as it stands only if mounted on a means of transport, or installed in a building or a structure;

— assemblies of machinery referred to in the first, second and third indents or partly completed machinery which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole;

— an assembly of linked parts or components, at least one of which moves and which are joined together, intended for lifting loads and whose only power source is directly applied human effort

[SOURCE: Directive 2006/42/EC, modified]