SLOVENSKI STANDARD
SIST EN 1127-1:2011

01-oktober-2011

Nadomešča:
SIST EN 1127-1:2008

Eksplozivne atmosfere - Protieksplozijska zaščita - 1. del: Osnovni pojmi in metodologija

Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology

Explosionsfähige Atmosphären - Explosionsschutz - Teil 1: Grundlagen und Methodik

Atmosphères explosives - Prévention de l'explosion et protection contre l'explosion - Partie 1: Notions fondamentales et méthodologie

Ta slovenski standard je istoveten z: **EN 1127-1:2011**

ICS:

13.230	Varstvo pred eksplozijo	Explosion protection

SIST EN 1127-1:2011 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1127-1

July 2011

ICS 13.230

Supersedes EN 1127-1:2007

English Version

Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology

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Explosionsfähige Atmosphären - Explosionsschutz - Teil 1: Grundlagen und Methodik

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 1127-1:2011) 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of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by July 2014.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 1127-1:2007.

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 Annex ZA and ZB, which is an integral part of this document.

Annex C provides details of significant technical changes between this European Standard and the previous edition EN 1127-1:2007.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

CEN and CENELEC are producing a set 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.

This standard describes the basic concepts and methodology of explosion prevention and protection.

CEN/TC 305 has a mandate in this area to produce B-type, and C-type standards, which will allow verification of conformity with the essential safety requirements.

Explosions can occur from:

a) materials processed or used by the equipment, protective systems and components;

b) materials released by the equipment, protective systems and components;

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

d) materials of construction of the equipment, protective systems and components.

Since safety depends not only on equipment, protective systems and components but also on the material being handled and its use, this standard includes aspects related to the intended use and foreseeable misuse, i.e. the manufacturer should consider in which way and for which purpose the equipment, protective systems and components will be used and take this into account during its design and construction. This is the only way hazards inherent in equipment, protective systems and components can be reduced.

NOTE This standard may 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.

1 Scope

This European Standard specifies methods for the identification and assessment of hazardous situations leading to explosion and 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. by:

a) appropriate design (without using safeguarding);

b) safeguarding;

c) information for use;

d) any other preventive measures.

Measures in accordance with a) (prevention) and b) (protection) against explosions are dealt with in Clause 6, measures according to c) against explosions are dealt with in Clause 7. Measures in accordance with d) are not specified 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 safety unless the equipment, protective systems and components are operated within their intended use and are installed and maintained according to the relevant codes of practice or requirements.

This standard specifies general design and construction methods to help designers and manufacturers in achieving explosion safety in the design of equipment, protective systems and components.

This European Standard is applicable to any equipment, protective systems and components intended to be used in potentially explosive atmospheres, under atmospheric conditions. 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.

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

This European Standard is only applicable to equipment group II which is intended for use in other places than underground parts of mines and those parts of surface installations of such mines endangered by firedamp and/or flammable dust.

This European Standard is not applicable to:

1) medical devices intended for use in a medical environment;

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

3) equipment, protective systems and components where the explosion can occur by reaction of substances with other oxidizers than atmospheric oxygen or by other hazardous reactions or by other than atmospheric conditions;

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

5) personal protective equipment covered by Directive 89/686/EEC;

6) seagoing vessels and mobile offshore units together with equipment on board such vessels or units;

7) means of transport, i.e. vehicles and their trailers intended solely for transporting passengers by air or by road, rail or water networks, as well as means of transport insofar as such means are designed for transporting goods by air, by public road or rail networks or by water; vehicles intended for use in a potentially explosive atmosphere shall not be excluded;

8) the design and construction of systems containing desired, controlled combustion processes, unless they can act as ignition sources in potentially explosive atmospheres.

2 Normative references

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

EN 1839, *Determination of explosion limits of gases and vapours*

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

EN 13463-1, *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 13821, *Potentially explosive atmospheres — Explosion prevention and protection — Determination of minimum ignition energy of dust/air mixtures*

EN 14034-1, *Determination of explosion characteristics of dust clouds — Part 1: Determination of the maximum explosion pressure p_{max} of dust clouds*

EN 14034-2, *Determination of explosion characteristics of dust clouds — Part 2: Determination of the maximum rate of explosion pressure rise $(dp/dt)_{max}$ of dust clouds*

EN 14034-3, *Determination of explosion characteristics of dust clouds — Part 3: Determination of the lower explosion limit LEL of dust clouds*

EN 14034-4, *Determination of explosion characteristics of dust clouds — Part 4: Determination of the limiting oxygen concentration LOC of dust clouds*

EN 14373, *Explosion suppression systems*

EN 14460, *Explosion resistant equipment*

EN 14491, *Dust explosion venting protective systems*

EN 14522, *Determination of the auto ignition temperature of gases and vapours*

EN 14756, *Determination of the limiting oxygen concentration (LOC) for flammable gases and vapours*

EN 14797, *Explosion venting devices*

EN 15089, *Explosion isolation systems*

EN 15198, *Methodology for the risk assessment of non-electrical equipment and components for intended use in potentially explosive atmospheres*

CEN/TR 15281, *Guidance on Inerting for the Prevention of Explosions*

EN 15794, *Determination of explosion points of flammable liquids*

EN 15967, *Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours*

EN 50281-2-1, *Electrical apparatus for use in the presence of combustible dust — Part 2-1: Test methods — Methods for determining the minimum ignition temperatures of dust*

CLC/TR 50404, *Electrostatics — Code of practice for the avoidance of hazards due to static electricity*

EN 50495, *Safety devices required for the safe functioning of equipment with respect to explosion risks*

EN 60079-1, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d" (IEC 60079-1:2007)*

EN 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres (IEC 60079-10-1:2008)*

EN 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas — Combustible dust atmospheres (IEC 60079-10-2:2009)*

EN 61241-14, *Electrical apparatus for use in the presence of combustible dust — Part 14: Selection and installation (IEC 61241-14:2004)*

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 13849-1:2006)*

EN ISO 16852, *Flame arresters — Performance requirements, test methods and limits for use (ISO 16852:2008, including Cor 1:2008 and Cor 2:2009)*

3 Terms and definitions

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

4 Risk assessment

4.1 General

This risk assessment shall be carried out for each individual situation in accordance with EN ISO 12100 and/or EN 15198, unless other standards can be identified as being more appropriate to the situation:

a) Identification of explosion hazards and determination of the likelihood of occurrence of a hazardous explosive atmosphere (see 4.2);

b) Identification of ignition hazards and determination of the likelihood of occurrence of potential ignition sources (see 4.3);

c) estimation of the possible effects of an explosion in case of ignition (see 4.4);

d) evaluation of the risk and whether the intended level of protection has been achieved;

NOTE The intended level of protection is defined by at least legal requirements and, if necessary, additional requirements specified by the user.

e) consideration of measures to reduce of the risks (see Clause 6).

A comprehensive approach shall be taken, especially for complicated equipment, protective systems and components, plants comprising individual units and, above all, for extended plants. This risk assessment shall take into account the ignition and explosion hazard from:

1) the equipment, protective systems and components themselves;

2) the interaction between the equipment, protective systems and components and the substances being handled;

3) the particular industrial process performed in the equipment, protective systems and components;

4) the surroundings of the equipment, protective systems and components and possible interaction with neighbouring processes.

4.2 Identification of explosion hazards

4.2.1 General

The explosion hazard is generally related to the materials and substances processed, used or released by equipment, protective systems and components and materials used to construct equipment, protective systems and components. Some of these released substances can undergo combustion processes in air. These processes are often accompanied by the release of considerable amounts of heat and can be associated with a pressure build-up and the release of hazardous materials. In contrast to burning in a fire, an explosion is essentially a self-sustained propagation of the reaction zone (flame) through the explosive atmosphere. This potential hazard associated with explosive atmosphere is released when ignited by an effective ignition source.

The safety characteristics listed in 4.2.2 and 4.2.3 describe safety relevant properties of flammable substances. The material properties and the safety characteristics are used for the identification of the explosion hazard.

NOTE It is necessary to bear in mind that such safety characteristics are not constants but depend for instance on the techniques used for their measurement. Also, for dusts, tabulated safety data are for guidance only because the values depend on particle size and shape, moisture content and the presence of additives even in trace concentrations. For a specific application, samples of the dust present in the equipment should be tested and the data obtained used in the hazard identification.

4.2.2 Combustion properties

Since in this context it is not the material itself that represents the potential hazard but its contact or mixing with air, the properties of the mixture of the flammable substance with air shall be determined. These properties give information about a substance's burning behaviour and whether it could give rise to fire or explosions. Relevant data are e.g.:

a) lower explosion point, substituted by flash point (see EN 15794);

b) explosion limits (LEL, UEL) (see EN 1839, EN 14034-3 and EN 14756);

c) limiting oxygen concentration (LOC) (see EN 14034-4 and EN 14756).

4.2.3 Explosion behaviour

The behaviour of the explosive atmosphere after ignition shall be characterized by data such as:

a) maximum explosion pressure (p_{max}) (see EN 14034-1, EN 14034-4 and EN 15967);

b) maximum rate of explosion pressure rise $((dp/dt)_{max})$, (see EN 14034-2, EN 14491 and EN 15967);

c) maximum experimental safe gap (MESG) (see EN 60079-1).

4.2.4 Likelihood of occurrence of a hazardous explosive atmosphere

The likelihood of occurrence of a hazardous explosive atmosphere depends on the following:

— presence of a flammable substance;

— degree of dispersion of the flammable substance (e.g. gases, vapours, mists, dusts);

— concentration of the flammable substance in air within the explosion range;

— amount of explosive atmosphere sufficient to cause injury or damage in case of ignition.

In assessment of the likelihood of occurrence of a hazardous explosive atmosphere, possible formation of the explosive atmosphere through chemical reactions, pyrolysis and biological processes from the materials present shall be taken into account.

If it is impossible to estimate the likelihood of occurrence of a hazardous explosive atmosphere, the assumption shall be made that such an atmosphere is always present.

a) Presence of a flammable substance

Flammable and/or combustible substances shall be considered as materials which can form an explosive atmosphere unless an investigation of their properties has shown that in mixtures with air they are incapable of self-sustained propagation of an explosion. In assessment of the likelihood of occurrence of a hazardous explosive atmosphere, possible formation of the explosive atmosphere through chemical reactions, pyrolysis and biological processes from the materials present shall be taken into account.

b) Degree of dispersion of flammable substances

By their very nature, gases, vapours and mists have a degree of dispersion high enough to produce an explosive atmosphere. For dusts the occurrence of an explosive atmosphere can be assumed if the particle size fractions fall below 0,5 mm.

NOTE Numerous mists, aerosols and types of dusts that occur in actual practice have particle sizes between 0,001 mm and 0,1 mm.

Attention shall be paid to the fact that explosions can occur in hybrid mixtures though none of the flammable/combustible substances of the mixture is within the explosion range.

c) **Concentration of flammable substances**

An explosion is possible when the concentration of the dispersed flammable substance in air achieves a minimum value (lower explosion limit). An explosion will not occur when the concentration exceeds a maximum value (upper explosion limit).

NOTE 1 Some chemically unstable substances, e.g. acetylene and ethylene oxide, can undergo exothermic reactions even in the absence of oxygen and have an upper explosion limit of 100 %.

The explosion limits vary with pressure and temperature. As a rule, the concentration range between the explosion limits increases with increasing pressure and temperature. In the case of mixtures with oxygen, the upper explosion limits are far higher than for mixtures with air.

If the surface temperature of a combustible liquid exceeds the lower explosion point, an explosive atmosphere can be formed (see 6.2.1.2). Aerosols and mists of combustible liquids can form an explosive atmosphere at temperatures below the lower explosion point.

NOTE 2 Aerosols and mists may become an explosive mixture at temperatures that are far below the lower explosion point (LEP).

The explosion limits for dusts do not have the same significance as those for gases and vapours. Dust clouds are usually inhomogeneous. The dust concentration can fluctuate greatly due to dust depositing and dispersion into the atmosphere. Consideration shall always be given to the possible formation of explosive atmospheres when deposits of combustible dust are present.

d) **Amount of explosive atmosphere**

The assessment whether an explosive atmosphere is present in a hazardous amount depends on the possible effects of the explosion (see 4.4).

NOTE According to experience a volume of 10 dm³ of connected explosive atmosphere is always hazardous.

4.3 Identification of ignition hazards

4.3.1 General

At first it shall be determined which types of ignition sources are possible and equipment related. The different ignition sources are considered in Clause 5. The significance of all ignition sources that could come into contact with the explosive atmosphere shall be assessed.

The ignition capability of all equipment related ignition sources shall then be compared with the ignition properties of the flammable substance (see 4.3.2).

This step shall result in a complete list of all potential ignition sources of the equipment or component type or the equipment or component. Afterwards the likelihood of occurrence of the potential ignition sources to become effective shall be assessed, taking also into account those that can be introduced e.g. by maintenance and cleaning activities.

4.3.2 Ignition properties

The ignition properties of the explosive atmosphere shall be determined. Relevant data are, e.g.:

a) minimum ignition energy (see EN 13821);

b) minimum ignition temperature of an explosive atmosphere (see EN 14522 and EN 50281-2-1);

c) minimum ignition temperature of a dust layer (see EN 50281-2-1).