SLOVENSKI STANDARD
SIST EN 1127-1:1998

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Eksplozivne atmosfere - Preprečevanje eksplozije in zaščita pred njo - 1. del: Osnovni pojmi im metodologija

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

Explosionsfähige Atmosphären - Explosionsschutz - Teil 1: Grundlagen und Methodik

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

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English version

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

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

Explosionsfähige Atmosphären - Explosionsschutz - Teil 1: Grundlagen und Methodik

This European Standard was approved by CEN on 1997-03-26. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 114 "Safety of machinery", 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of an identical text or by endorsement, at the latest by February 1998, and conflicting national standards shall be withdrawn at the latest by February 1998.

This standard is a general guideline for explosion prevention and protection by design and construction of equipment, protective systems and components .

Detailed information on specific equipment, protective systems and components is comprised in appropriate individual standards. The design and construction of explosion prevention and protection measures need safety relevant data of flammable substances and explosive atmospheres. Detailed information is available from appropriate standards.

This European Standard 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 Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

0 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 4.8 of EN 292-1:1991.

The present standard was drawn up on request and by mandate of CEC and EFTA to fulfil

- the Council directive on the Approximation of the Laws of the member states relating to Machinery (89/392/EEC) which demands in its Annex I, Section 1.5.7 that machinery shall be so designed and constructed to avoid any risk of explosion as well as

- the Council directive (94/9/EC) on equipment and protective systems intended for use in potentially explosive atmospheres (called ATEX-100a-Directive).

In accordance with EN 292-1 it is a type A standard.

This standard has been prepared to be a harmonized standard in the sense of the appropriate Directives of the EU and associated EFTA regulations.

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

- materials processed or used by the equipment, protective systems and components,
- materials released by the equipment, protective systems and components,
- materials in the vicinity of the equipment, protective systems and components,
- 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, i.e. the manufacturer should consider how and for what the equipment, protective systems and components will be used and take this into account during its design and construction. Only in this way can hazards inherent in equipment, protective systems and components be reduced.

NOTE 1: 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.

NOTE 2: During the preparation of this standard, the Commission of the European Community, General Directorate V, has begun the preparation of a directive intended to improve the safety and health protection of workers potentially at risk from explosive atmospheres, based on Article 118a of the

Treaty. It is intended that this Directive will contain the zone definitions for the classification of hazardous places. The zone definitions used in this standard will be aligned, where necessary, with this directive.

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

- hazard identification;
- risk assessment;
- elimination or minimization of risk;
- information for use.

The safety of equipment, protective systems, and components can be achieved, as described in 5.7 of EN 414:1992, by removal of hazards and/or limiting the risk, i.e.

a) by design without using safeguarding;
b) by safeguarding;
c) by communication links if necessary to convey information to the user;
d) by any other precautions.

NOTE: The "design" in accordance with 5.7 of EN 414:1992 should not be confused with the "design" in accordance with 6.5 of this standard.

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 standard. They are dealt with in clause 6 of EN 292-2:1991.

The preventive and protective measures described in this standard will not provide the required level of safety unless the equipment, protective systems, and components is operated within its intended use and is 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 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.

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

This 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 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 explosive substances or unstable chemical substances;
- 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;
- 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;
- personal protective equipment covered by Directive 89/686/EEC;
- seagoing vessels and mobile offshore units together with equipment on board such vessels or units;
- 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;

– 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

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 292-1, 1991
Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology

EN 292-2, 1991
Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications

EN 414, 1992
Safety of machinery - Rules for the drafting and presentation of safety standards

EN 954-1, 1996
Safety of machinery - Safety related parts of control systems - Part 1: General principles for design

EN 1050, 1996
Safety of machinery - Risk assessment

EN 50014
Electrical apparatus for potentially explosive atmospheres - General requirements

EN 50015
Electrical apparatus for potentially explosive atmospheres - Oil immersion "o"

EN 50016
Electrical apparatus for potentially explosive atmospheres - Pressurized apparatus "p"

EN 50017
Electrical apparatus for potentially explosive atmospheres - Powder filling "q"

EN 50018
Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure "d"

EN 50019
Electrical apparatus for potentially explosive atmospheres - Increased safety "e"

EN 50020
Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i"

prEN 50021
Specification for electrical apparatus with type of protection "n"

EN 50028
Electrical apparatus for potentially explosive atmospheres - Encapsulation "m"

EN 50039
Electrical apparatus for potentially explosive atmospheres - Intrinsically safe electrical systems "i"

EN 50050
Electrical apparatus for potentially explosive atmospheres - Electrostatic hand-held spraying equipment

EN 50053-1
Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials -Part 1: Hand-held electrostatic paint spray guns with an energy limit of 0,24 mJ and their associated apparatus

EN 50053-2
Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials -Part 2: Hand-held electrostatic powder spray guns witn an energy limit of 5 mJ and their associated apparatus

EN 50053-3
Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials -Part 3: Hand-held electrostatic flock spray guns with an energy limit of 0,24 mJ or 5 mJ and their associated apparatus

EN 50054
Electrical apparatus for the detection and measurement of combustible gases - General requirements and test methods

EN 50055
Electrical apparatus for the detection and measurement of combustible gases - Performance requirements for Group I apparatus indicating up to 5 % (V/V) methane in air

EN 50056
Electrical apparatus for the detection and measurement of combustible gases - Performance requirements for Group I apparatus indicating up to 100 % (V/V) methane

EN 50057
Electrical apparatus for the detection and measurement of combustible gases - Performance requirements for Group II apparatus indicating up to 100 % lower explosive limit

EN 50058
Electrical apparatus for the detection and measurement of combustible gases - Performance requirements for Group II apparatus indicating up to 100 % (V/V) gas

EN 50059
Specification for electrostatic hand-held spraying equipment for non-flammable material for painting and finishing

prEN 50154
Electrical installations in potentially explosive gas atmospheres (other than mines)

EN 60079-10
Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas

ISO 8421-1
Fire protection - Vocabulary - Part 1: General terms and phenomena of fire

IEC 50 (426)
International Electrotechnical Vocabulary; chapter 426: Electrical apparatus for explosive atmospheres

IEC 79-4
Electrical apparatus for explosive gas atmospheres - Part 4: Method of test for ignition temperature

IEC 79-15
Electrical apparatus for explosive gas atmospheres - Part 15: Electrical apparatus with type of protection "n"

3 Definitions and abbreviations

For the purposes of this European standard, the following definitions apply:

3.1 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.

3.2 component: "Component" means any item essential to the safe functioning of equipment and protective system but with no autonomous function [Directive 94/9/EC, Chapter I, Article 1].

3.3 deflagration: Explosion propagating at subsonic velocity [ISO 8421-1, 1987-03-01, 1.11].

3.4 detonation: Explosion propagating at supersonic velocity and characterized by a shock wave [ISO 8421-1, 1987-03-01, 1.12].

3.5 equipment: "Equipment" means 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 [Directive 94/9/EC, Chapter I, Article 1].

3.6 explosion: Abrupt oxidation or decomposition reaction producing an increase in temperature, pressure, or in both simultaneously [ISO 8421-1, 1987-03-01, 1.13].

3.7 explosion limits: The limits of the explosion range.

3.8 lower explosion limit (LEL): The lower limit of the explosion range.

3.9 upper explosion limit (UEL): The upper limit of the explosion range.

3.10 explosion points: The lower and upper explosion point.

3.11 lower explosion point: Temperature of a combustible liquid at which the concentration of the saturated vapour in air is equal to the lower explosion limit.

3.12 upper explosion point: Temperature of a combustible liquid at which the concentration of the saturated vapour in air is equal to the upper explosion limit.

3.13 explosion range: Range of the concentration of a flammable substance in air, within which an explosion can occur.

3.14 explosion-resistant: Property of vessels and equipment designed to be either explosion-pressure-resistant or explosion-pressure-shockresistant.

3.15 explosion-pressure-resistant: Property of vessels and equipment designed to withstand the expected explosion pressure without becoming permanently deformed.

3.16 explosion-pressure-shock resistant: Property of vessels and equipment designed to withstand the expected explosion pressure without rupturing, but allowing permanent deformation.

3.17 explosive atmosphere: Mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts, in which, after ignition has occured, combustion spreads to the entire unburned mixture (see also Directive 94/9/EC, Chapter I, Article 1).

3.18 flash point: Minimum temperature at which, under specified test conditions, a liquid gives off sufficient combustible gas or vapour to ignite momentarily on application of an effective ignition source.

3.19 hazardous explosive atmosphere: Explosive atmosphere which, if it explodes, causes damage.

3.20 hybrid mixture: Mixture of flammable substances with air in different physical states.

NOTE: Examples for hybrid mixtures are mixtures of methane, coal dust and air or mixtures of gasoline vapour and gasoline droplets with air.

3.21 inerting: Addition of inert substances to prevent explosive atmospheres.

3.22 intended use: The use of equipment, protective systems, and devices in accordance with the equipment group and category as specified in Directive 94/9/EC, Annex I, and taking into account all the information supplied by the manufacturer which is required for the safe functioning of equipment, protective systens, and devices (see also Directive 94/9/EEC, Chapter I, Article 1).

3.23 limiting oxygen concentration (LOC): Maximum oxygen concentration in a mixture of a flammable substance and air and an inert gas, in which an explosion will not occur, determined under specified test conditions.

3.24 machinery: An assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging a material (material is equivalent to substance or product).

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 (89/392/EEC, article 1.2).

3.25 malfunction: The equipment, protective systems and components do not perform the intended function (see also 5.2.2.b of EN 292-1:1991).

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

- variation of a property or of a dimension of the processed material or of the workpiece;
- failure of one (or more) of component parts of the equipment, protective systems and 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).

3.26 maximum experimental safe gap (MESG): The maximum gap of the joint between the two parts of the interior chamber of a test apparatus which, when the internal gas mixture is ignited and under specified conditions, prevents ignition of the external gas mixture through a 25 mm long joint, for all concentrations of the tested gas or vapour in air. The MESG is a property of the respective gas mixture (see also IEC 50(426), 1990-10, 426-02-11) .

3.27 maximum explosion pressure (p_{max}): Maximum pressure occurring in a closed vessel during the explosion of an explosive atmosphere determined under specified test conditions.

3.28 maximum rate of explosion pressure rise ($(dp/dt)_{max}$): Maximum value of the pressure rise per unit time during explosions of all explosive atmospheres in the explosion range of a combustible substance in a closed vessel under specified test conditions.

3.29 minimum ignition energy (MIE): Lowest electrical energy stored in a capacitor which upon discharge is sufficient to effect ignition of the most ignitable atmosphere under specified test conditions.

3.30 minimum ignition temperature of an explosive atmosphere: The ignition temperature of a combustible gas or of a vapour of a combustible liquid or the minimum ignition temperature of a dust cloud under specified test conditions.

3.31 ignition temperature (of a combustible gas or of a combustible liquid): The lowest temperature of a heated wall as determined under specified test conditions, at which the ignition of a combustible substance in the form of gas or vapour mixture with air will occur.

3.32 minimum ignition temperature of a dust cloud: The lowest temperature of a hot surface on which the most ignitable mixture of the dust with air is ignited under specified test conditions.

3.33 minimum ignition temperature of a dust layer: The lowest temperature of a hot surface at which ignition occurs in a dust layer under specified test conditions.

3.34 normal operation: The situation when the equipment, protective systems, and components perform their intended function within their design parameters (see also 5.2.2.a of EN 292-1:1991).

Minor releases of flammable material may be part of normal operation. For example, releases of substances from seals which rely on wetting by the fluid which is being pumped are considered to be minor releases.

Failures (such as a breakdown of pump seals, flange gaskets or releases of substances caused by accidents) which involve repair or shut-down are not considered to be part of normal operation.

3.35 potentially explosive atmosphere: An atmosphere which could become explosive due to local and operational conditions [Directive 94/9/EC, Chapter I, Article 1].

3.36 protective system: "Protective system" means design units which are intended to halt incipient explosions immediately and/or to limit the effective range of explosion flames and explosion pressures. Protective systems may be integrated into equipment or separately placed on the market for use as autonomous systems [Directive 94/9/EC, Chapter I, Article 1].

3.37 reduced explosion pressure: Pressure generated by an explosion of an explosive atmosphere in a vessel, protected by either explosion relief or explosion suppression.

3.38 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.

4 Hazard identification

4.1 General

The explosion hazard is 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 materials and 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.

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.

This potential hazard associated with explosive atmosphere is released when ignited by an effective ignition source.

The safety data listed in 4.2, 4.3 and 4.4 describe safety relevant properties of substances. They can be obtained by laboratory experiments, and in a few cases also by calculation methods[1]). The safety data obtained are used for the identification of the hazard.

It is necessary to bear in mind that such safety data are not physical 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 to be present in the equipment should be tested and the data obtained used in the identification of the hazard.

4.2 Combustion properties

Since in this context it is not the material itself that represents the potential hazard but its contact or mixing with the 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.

- flash point;
- explosion limits (LEL, UEL);
- limiting oxygen concentration (LOC).

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[1]) Appropriate standards have been or are being developed by CEN and CENELEC.

4.3 Ignition requirements

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

- minimum ignition energy;
- minimum ignition temperature of an explosive atmosphere;
- minimum ignition temperature of a dust layer.

4.4 Explosion behaviour

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

- maximum explosion pressure (p_{max});
- maximum rate of explosion pressure rise $((dp/dt)_{max})$;
- maximum experimental safe gap (MESG).

5 Elements of risk assessment

5.1 General

This risk assessment shall always be carried out for each individual situation in accordance with EN 1050. Risk assessment includes the following elements for which the standard gives guidance:

a) Hazard identification. The safety data in accordance with clause 4 assist in the identification of hazards by demonstrating whether substances are flammable and indicate their ease of ignition;
b) determine whether an explosive atmosphere is likely to occur and the amount involved (in accordance with 5.2);
c) determine the presence and likelihood of ignition sources that are capable of igniting the explosive atmosphere in accordance with 5.3);
d) determine the possible effects of an explosion (in accordance with 5.4);
e) evaluate the risk;
f) consider measures for the minimization of risks (in accordance with 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

- the equipment, protective systems, and components itself;
- the interaction between the equipment, protective systems, and components and the substances being handled;
- the particular industrial process performed in the equipment, protective systems, and components;
- interactions of individual processes in different parts of the equipment, protective systems, and components;
- the surroundings of the equipment, protective systems, and components and possible interaction with neighbouring processes.

5.2 Determining the amount and likelihood of an occurrence of an explosive atmosphere

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

- the 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 by 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.