BS EN 1127-1:2011

BSI Standards Publication

Explosive atmospheres — Explosion prevention and protection

Part 1: Basic concepts and methodology

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National foreword

This British Standard is the UK implementation of EN 1127-1:2011. It supersedes BS EN 1127-1:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EXL/23, Explosion and fire precautions in industrial and chemical plant.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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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 CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists 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 CEN-CENELEC Management Centre has the same status as the official versions.

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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of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by July 2014.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) <u>Presence of a flammable substance</u>

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) <u>Degree of dispersion of flammable substances</u>

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).

4.3.3 Likelihood of occurrence of effective ignition sources

The potential ignition sources shall be classified according to the likelihood to become effective in the following manner:

a) sources of ignition which can occur continuously or frequently;

b) sources of ignition which can occur in rare situations;

c) sources of ignition which can occur in very rare situations.

In terms of the equipment, protective systems and components used this classification shall be considered equivalent to:

d) sources of ignition which can occur during normal operation;

e) sources of ignition which can occur solely as a result of malfunctions;

f) sources of ignition which can occur solely as a result of rare malfunctions.

NOTE Protective measures can be used to make the ignition source non-effective (see 6.4).

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

4.4 Estimation of the possible effects of an explosion

To estimate the possible effects of an explosion the following shall be considered, e.g.:

— flames and hot gases;

— thermal radiation;

— pressure waves;

— flying debris;

— hazardous releases of materials.

The consequences of the above are related to the:

— chemical and physical properties of the flammable substances;

— quantity and confinement of the explosive atmosphere;

— geometry of the surroundings taking into account obstacles;

— strength of enclosure and supporting structures;

— protective equipment worn by the endangered personnel;

— physical properties of the endangered objects.

Information on the consequences of an explosion is required for the estimation of the expected injury to persons, domestic animals or properties and the size of the endangered place by the user. Appropriate information shall be part of the user instructions.

NOTE This procedure 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.

5 Possible ignition sources

5.1 Hot surfaces

If an explosive atmosphere comes into contact with a heated surface ignition can occur. Not only a hot surface itself can act as an ignition source, but a dust layer or a combustible solid in contact with a hot surface and ignited by the hot surface can also act as an ignition source for an explosive atmosphere (see 5.2).

The capability of a heated surface to cause ignition depends on the type and concentration of the particular substance in the mixture with air. This capability becomes greater with increasing temperature and increasing surface area. Moreover, the temperature that triggers ignition depends on the size and shape of the heated body, on the concentration gradient in the vicinity of the surface and, to a certain extent, also on the surface material. Thus, for example, an explosive gas or vapour atmosphere inside fairly large heated spaces (approximately 1 l or more) can be ignited by surface temperatures lower than those measured in accordance with EN 14522 or by other equivalent methods. On the other hand, in the case of heated bodies with convex rather than concave surfaces, a higher surface temperature is necessary for ignition; the minimum ignition temperature increases, for example, with spheres or pipes as the diameter decreases. When an explosive atmosphere flows past heated surfaces, a higher surface temperature could be necessary for ignition owing to the brief contact time.

If the explosive atmosphere remains in contact with the hot surface for a relatively long time, preliminary reactions can occur, e.g. cool flames, so that more easily ignitable decomposition products are formed, which promote the ignition of the original atmospheres.

In addition to easily recognizable hot surfaces such as radiators, drying cabinets, heating coils and others, mechanical and machining processes can also lead to hazardous temperatures. These processes also include equipment, protective systems and components which convert mechanical energy into heat, i.e. all kinds of friction clutches and mechanically operating brakes (e.g. on vehicles and centrifuges). Furthermore, all moving parts in bearings, shaft passages, glands, etc. can become sources of ignition if they are not sufficiently lubricated. In tight housings of moving parts, the ingress of foreign bodies or shifting of the axis can also lead to friction which, in turn, can lead to high surface temperatures, in some cases quite rapidly.

Consideration shall also be given to temperature increases due to chemical reactions (e.g. with lubricants and cleaning solvents).

For ignition hazards in welding and cutting work, see 5.2.

For protective measures against ignition hazards from hot surfaces, see 6.4.2.

5.2 Flames and hot gases (including hot particles)

Flames are associated with combustion reactions at temperatures of more than 1 000 °C. Hot gases are produced as reaction products and, in the case of dusty and/or sooty flames, glowing solid particles are also produced. Flames, their hot reaction products or otherwise highly heated gases can ignite an explosive atmosphere. Flames, even very small ones, are among the most effective sources of ignition.

If an explosive atmosphere is present inside as well as outside an equipment, protective system or component or in adjacent parts of the installation and if ignition occurs in one of these places, the flame can spread to the other places through openings such as ventilation ducts. The prevention of flame propagation calls for specially designed protective measures (see 6.5).

Welding beads that occur when welding or cutting is carried out are sparks with a very large surface and therefore they are among the most effective sources of ignition.

For protective measures against ignition hazards due to flames and hot gases, see 6.4.3.

5.3 Mechanically generated sparks

As a result of friction, impact or abrasion processes such as grinding, particles can become separated from solid materials and become hot owing to the energy used in the separation process. If these particles consist of oxidizable substances, for example iron or steel, they can undergo an oxidation process, thus reaching even higher temperatures. These particles (sparks) can ignite combustible gases and vapours and certain dust/air-mixtures (especially metal dust/air mixtures). In deposited dust, smouldering can be caused by the sparks and this can be a source of ignition for an explosive atmosphere.

The ingress of foreign materials to equipment, protective systems and components, e.g. stones or tramp metals, as a cause of sparking shall be considered.

Rubbing friction, even between similar ferrous metals and between certain ceramics, can generate hot spots and sparks similar to grinding sparks. These can cause ignition of explosive atmospheres.

Impacts involving rust and light metals (e.g. aluminium and magnesium) and their alloys can initiate a thermite reaction which can cause ignition of explosive atmospheres.

The light metals titanium and zirconium can also form incendive sparks under impact or friction against any sufficiently hard material, even in the absence of rust.

For ignition hazards in welding and cutting work, see 5.2.

For protective measures against ignition hazards due to mechanically generated sparks, see 6.4.4.

5.4 Electrical apparatus

In the case of electrical apparatus, electric sparks and hot surfaces (see 5.1) can occur as sources of ignition. Electric sparks can be generated, e.g.:

— when electric circuits are opened and closed;

— by loose connections;

— by stray currents (see 5.5).

It is pointed out explicitly that an extra low voltage (ELV, e.g. less than 50 V) is designed for personal protection against electric shock and is not a measure aimed at explosion protection. However, voltages lower than this can still produce sufficient energy to ignite an explosive atmosphere.

For protective measures against ignition hazards due to electrical apparatus, see 6.4.5.

5.5 Stray electric currents, cathodic corrosion protection

Stray currents can flow in electrically conductive systems or parts of systems as:

— return currents in power generating systems — especially in the vicinity of electric railways and large welding systems — when, for example, conductive electrical system components such as rails and cable sheathing laid underground lower the resistance of this return current path;

— a result of a short-circuit or of a short-circuit to earth owing to faults in the electrical installations;

— a result of magnetic induction (e.g. near electrical installations with high currents or radio frequencies, see also 5.8); and

— a result of lightning (see 5.7).

If parts of a system able to carry stray currents are disconnected, connected or bridged — even in the case of slight potential differences — an explosive atmosphere can be ignited as a result of electric sparks and/or arcs. Moreover, ignition can also occur due to the heating up of these current paths.

When impressed current cathodic corrosion protection is used, the above-mentioned ignition risks are also possible. However, if sacrificial anodes are used, ignition risks due to electric sparks are unlikely, unless the anodes are aluminium or magnesium.

For protective measures against ignition hazards due to stray electric currents and cathodic corrosion protection, see 6.4.6.

5.6 Static electricity

Incendive discharges of static electricity can occur under certain conditions (see CLC/TR 50404). The discharge of charged, insulated conductive parts can easily lead to incendive sparks. With charged parts made of non-conductive materials, and these include most plastics as well as some other materials, brush discharges and, in special cases, during fast separation processes (e.g. films moving over rollers, drive belts), or by combination of conductive and non-conductive materials) propagating brush discharges are also possible. Cone discharges from bulk material and cloud discharges can also occur.

Sparks, propagating brush discharges, cone discharges and cloud discharges can ignite all types of explosive atmospheres, depending on their discharge energy. Brush discharges can ignite almost all explosive gas and vapour atmospheres. According to the present state of knowledge, the ignition of explosive dust/air atmospheres by brush discharges can be excluded.

For protective measures against ignition hazards due to static electricity see 6.4.7.

5.7 Lightning

If lightning strikes in an explosive atmosphere, ignition will always occur. Moreover, there is also a possibility of ignition due to the high temperature reached by lightning conductors.

Large currents flow from where the lightning strikes and these currents can produce sparks in the vicinity of the point of impact.

Even in the absence of lightning strikes, thunderstorms can cause high induced voltages in equipment, protective systems and components and can lead to ignition hazards.

For protective measures against ignition hazards due to lightning see 6.4.8.

5.8 Radio frequency (RF) electromagnetic waves from 10^4 Hz to 3×10^{11} Hz

Electromagnetic waves are emitted by all systems that generate and use radio-frequency electrical energy (radio-frequency systems), e.g. radio transmitters or industrial or medical RF generators for heating, drying, hardening, welding, cutting.

All conductive parts located in the radiation field function as receiving aerials. If the field is powerful enough and if the receiving aerial is sufficiently large, these conductive parts can cause ignition in explosive atmospheres. The received radio-frequency power can, for example, make thin wires glow or generate sparks during the contact or interruption of conductive parts. The energy picked up by the receiving aerial, which can lead to ignition, depends mainly on the distance between the transmitter and the receiving aerial as well as on the dimensions of the receiving aerial at any particular wavelength and RF power.

For protective measures against ignition hazards due to electromagnetic waves in the RF spectrum see 6.4.9.

5.9 Electromagnetic waves from 3 x 10^{11} Hz to 3 x 10^{15} Hz

Radiation in this spectral range can – especially when focused – become a source of ignition through absorption by explosive atmospheres or solid surfaces.

Sunlight, for example, can trigger an ignition if objects cause convergence of the radiation (e.g. bottles acting as lenses, concentrating reflectors).

Under certain conditions, the radiation of intense light sources (continuous or flashing) is so intensively absorbed by dust particles that these particles become sources of ignition for explosive atmospheres or for dust deposits.

With laser radiation (e.g. in communications, distance measuring devices, surveying work, visual-range meters), even at great distances, the energy or power density of even an unfocussed beam can be so great that ignition is possible. Here, too, the process of heating up occurs mainly when the laser beam strikes a solid body surface or when it is absorbed by dust particles in the atmosphere or on dirty transparent parts.

It is to be noted that any equipment, protective system and component that generates radiation (e.g. lamps, electric arcs, lasers) can itself be a source of ignition as defined in 5.1 and 5.4.

For protective measures against ignition hazards due to electromagnetic waves in this spectral range see 6.4.10.

5.10 Ionizing radiation

Ionizing radiation generated, for example, by X-ray tubes and radioactive substances can ignite explosive atmospheres (especially explosive atmospheres with dust particles) as a result of energy absorption. Moreover, the radioactive source itself can heat up owing to internal absorption of radiation energy to such an extent that the minimum ignition temperature of the surrounding explosive atmosphere is exceeded.

Ionizing radiation can cause chemical decomposition or other reactions which can lead to the generation of highly reactive radicals or unstable chemical compounds. This can cause ignition.

NOTE Such radiation can also create an explosive atmosphere by decomposition (e.g. a mixture of oxygen and hydrogen by radiolysis of water).

For protective measures against ignition hazards due to ionizing radiation see 6.4.11.

5.11 Ultrasonics

In the use of ultrasonic sound waves, a large proportion of the energy emitted by the electroacoustic transducer is absorbed by solid or liquid substances. As a result, the substance exposed to ultrasonics warms up so that, in extreme cases, ignition may be induced.

For protective measures against ignition hazards due to ultrasonics see 6.4.12.

5.12 Adiabatic compression and shock waves

In the case of adiabatic or nearly adiabatic compression and in shock waves, such high temperatures can occur that explosive atmospheres (and deposited dust) can be ignited. The temperature increase depends mainly on the pressure ratio, not on the pressure difference.

NOTE 1 In pressure lines of air compressors and in containers connected to these lines, explosions can occur as a result of compression ignition of lubricating oil mists.

Shock waves are generated, for example, during the sudden venting of high-pressure gases into pipelines. In this process the shock waves are propagated into regions of lower pressure faster than the speed of sound.

When they are diffracted or reflected by pipe bends, constrictions, connection flanges, closed valves, etc., very high temperatures can occur.

NOTE 2 Equipment, protective systems and components containing highly oxidizing gases, e.g. pure oxygen or gas atmospheres with a high oxygen concentration or unstable gases can become an effective ignition source under the action of adiabatic compression, shock waves or even pure flow because lubricants, gaskets and even construction materials can be ignited. If this leads to destruction of the equipment, protective systems and components, parts of it will ignite a surrounding explosive atmosphere.

For protective measures against ignition hazards due to adiabatic compression and shock waves see 6.4.13.

5.13 Exothermic reactions, including self-ignition of dusts

Exothermic reactions can act as an ignition source when the rate of heat generation exceeds the rate of heat loss to the surroundings. Many chemical reactions are exothermic. Whether a reaction can reach a high temperature is dependent, among other parameters, on the volume/surface ratio of the reacting system, the ambient temperature and the residence time. These high temperatures can lead to ignition of explosive atmospheres and also the initiation of smouldering and/or burning.

NOTE 1 No standard test exists to identify materials which are capable of sustaining smouldering combustion.

NOTE 2 Materials that are not capable of self-sustained combustion or smouldering in dust layers may still be capable to dust explosions when dispersed in air.

Such reactions include those of pyrophoric substances with air, alkali metals with water, self-ignition of combustible dusts[1)], self-heating of feed-stuffs, induced by biological processes, the decomposition of organic peroxides, or polymerization reactions.

Catalysts can also induce energy-producing reactions (e.g. hydrogen/air atmospheres and platinum).

NOTE 3 Some chemical reactions (e.g. pyrolysis and biological processes) can also lead to the production of flammable substances, which in turn can form an explosive atmosphere with the surrounding air.

Violent reactions resulting in ignition can occur in some combinations of construction materials with chemicals (e.g. copper with acetylene, heavy metals with hydrogen peroxide).

Some combinations of substances, especially when finely dispersed, (e.g. aluminium/rust or sugar/chlorate) react violently when exposed to impact or friction (see 5.3).

For protective measures against ignition hazards due to chemical reactions, see 6.4.14.

NOTE 4 Hazards can also arise from chemical reactions due to thermal instability, high heat of reaction and/or rapid gas evolution. These hazards are not considered in this standard.

6 Risk reduction

6.1 Fundamental principles

The necessity of a coincidence of an explosive atmosphere and the effective ignition source, and the anticipated effects of an explosion as described in Clause 4 lead immediately to the basic principles of explosion prevention and protection in the following order:

a) Prevention:

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1) For determination of the spontaneous ignition behaviour of dust accumulations, see EN 15188.

1) avoid or reduce explosive atmospheres; this objective can mainly be achieved by modifying either the concentration of the flammable substance to a value outside the explosion range or the concentration of oxygen to a value below the limiting oxygen concentration (LOC);

2) avoid any possible effective ignition source;

b) Protection:

1) halting the explosion and/or limiting the range to a sufficient level by protection methods, e.g isolation, venting, suppression and containment; in contrast to the two measures described above, here the occurrence of an explosion is accepted.

The risk reduction could be achieved by applying only one of the above prevention or protection principles. A combination of these principles can also be applied.

The avoidance of an explosive atmosphere shall always be the first choice.

The more likely the occurrence of an explosive atmosphere is, the higher the extent of measures against effective ignition sources shall be and vice versa.

To allow selection of the appropriate measures, an explosion safety concept shall be developed for each individual case.

In the planning of explosion prevention and protection measures, consideration shall be given to normal operation, which includes start-up and shut-down. Moreover, possible technical malfunctions as well as foreseeable misuse according to EN ISO 12100 shall be taken into account. Application of explosion prevention and protection measures requires a thorough knowledge of the facts and sufficient experience. It is thus advisable to seek expert guidance.

6.2 Avoidance or reduction of the amount of explosive atmosphere

6.2.1 Process parameters

6.2.1.1 Substitution or reduction of amount of substances which are capable of forming explosive atmospheres

Wherever possible, flammable substances shall be replaced by non-flammable substances or by substances not capable of forming explosive atmospheres.

The amount of combustible material shall be reduced to the minimum.

6.2.1.2 Limitation of concentration

If it is not possible to avoid handling substances that are capable of forming explosive atmospheres, the formation of a hazardous amount of an explosive atmosphere inside the equipment, protective systems and components can be prevented or limited by measures to control the amount and/or concentration.

These measures shall be monitored if the concentrations inherent in the process are not sufficiently outside the explosion range. Such monitoring, e.g. gas detectors or flow detectors, shall be coupled to alarms, other protective systems or automatic emergency functions.

When carrying out these control measures, the concentration of the flammable substances shall be sufficiently below the lower or sufficiently above the upper explosion limit. Consideration shall be given to the fact that the concentrations can enter the explosion range during start-up or shut-down of the process.

If the concentration in the equipment, protective systems and components is above the upper explosion limit, there is no risk of explosion inside; however independent of the dust concentration inside the equipment possible releases can result in an explosion risk outside the equipment, protective systems and components owing to air entrainment. An explosion hazard can also arise inside of equipment, protective systems and components by the entry of air into them.

In the case of combustible liquids, where an explosive mist atmosphere can be excluded, the objective to keep the concentration below the lower explosion limit is achieved when the temperature at the liquid surface is always sufficiently below the explosion point. This depends on the chemical nature and composition of the combustible liquid.

NOTE 1 For solutions of combustible gases in combustible liquids the use of the explosion point can be misleading. Explosion point can also be misleading if liquids are stored at temperatures at which degradation or slow oxidation might occur (e.g. bitumen, heavy heating oil).

NOTE 2 Often an appropriate selection of the operating conditions makes it possible to maintain a sufficiently high vapour concentration in the entire equipment, protective systems and components, thus keeping the concentration above the upper explosion limit. However, in some cases – e.g. during storage in tanks and when condensation can occur – the concentration decreases in the upper section so that the atmosphere can become explosive. Only after extremely long storage periods in virtually non breathing storage containers and when the surface temperature is well above the upper explosion point the atmosphere will have a concentration that is above the upper explosion limit in the entire storage container.

NOTE 3 Some halogenated hydrocarbon liquids can form explosive atmospheres, even though a explosive point for the liquid cannot be determined.

In the case of dust, it is difficult to achieve the objective of avoiding explosive atmospheres by limiting the concentration since dust-air mixtures are usually inhomogeneous.

Calculation of dust concentration from the total amount of dust and the total equipment, protective systems and components volume usually leads to erroneous results. Local dust concentrations can be present that differ greatly from the globally calculated ones.

6.2.1.3 Inerting

The addition of inert gases (e.g. nitrogen, carbon dioxide, noble gases), water vapour or inert powdery substances (e.g. calcium carbonate) compatible with the processed products can prevent the formation of explosive atmospheres (inerting), see CEN/TR 15281.

When water vapour is used for inerting, the influence of condensation shall be considered.

Inerting by the use of inert gases is based on reduction of the oxygen concentration in the atmosphere so that the atmosphere is no longer explosive. The highest permissible oxygen concentration is derived by applying a safety factor to the limiting oxygen concentration. The limiting oxygen concentration required for inerting depends on the inert gas used.

For mixtures of different flammable substances, including hybrid mixtures, the component with the lowest limiting oxygen concentration shall be used in the determination of the highest permissible oxygen concentration otherwise.

Explosive dust-air mixtures also can be made inert by adding a compatible inert dust.

6.2.2 Design and construction of equipment, protective systems and components

6.2.2.1 General

In the planning stage of equipment, protective systems and components which will contain flammable substances, efforts shall be made to keep the substances in closed systems at all times.

Non-combustible materials of construction should be used wherever possible.

Work processes in adjacent installations shall be carried out in such a manner that no hazardous influence can arise. This can be achieved, for example, by spatial separation or by shielding the installations from each other. Consistently dividing the flammable substances into smaller amounts and, at the same time, keeping only small amounts of the substances at a certain place — even in the case of large volume flows — can be beneficial in terms of safety.

6.2.2.2 Avoidance or reduction of releases of flammable substances

To minimize the explosion risk outside the equipment, protective systems and components due to leakage of flammable substances, such equipment, protective systems and components shall be designed, constructed and operated so that they are and remain durably leak-free. At seals and gaskets which are subject to dynamic stress, e.g. at pump glands, or at sampling points, small leaks may occur.

By means of, e.g., enclosure and diversion of the escaping vapours into an area where there are no ignition hazards present, the occurrence of a dangerous explosive atmosphere in the immediate vicinity of the point of release can be prevented.

This shall be taken into account in the design of the equipment, protective systems and components. Arrangements shall be made to limit leak rates and to prevent the flammable substances from spreading. Where necessary a leak detector shall be fitted. Special attention shall be paid to:

— The selection of construction materials including those for gaskets, joints, packed glands and thermal insulations with respect to possible corrosion, wear and hazardous interactions with the substances being handled;

— Fittings with respect to their tightness (see Annex B). Number and dimensions of removable connections shall be kept to the necessary minimum;

— Piping with respect to its integrity. This can be achieved e.g. by suitable protection from impact or by suitable siting. Flexible piping shall be kept to the minimum;

— Drainage and local ventilation in order to control minor leaks;

— Removable connections which should be provided with sealed end couplings;

— Filling and emptying operations. The use of the vapour balance system shall be considered and the number and dimensions of openings kept to a minimum.

6.2.2.3 Dilution by ventilation

Ventilation is of importance in the control of the effects of releases of combustible gases and vapours. It can be used inside and outside equipment, protective systems and components.

For dusts, ventilation as a rule provides sufficient protection only when the dust is extracted from the place of origin (local extraction) and hazardous deposits of combustible dust are reliably prevented.

Dust release shall be expected from equipment, protective systems and components which can be open during normal operation (e.g. at transfer points or at inspection and cleaning openings) or during malfunctions. Protection is achieved by either creating a pressure in the dust-carrying equipment, protective systems and components slightly below ambient pressure (aspiration) or carefully collecting the dust at the source or the point of release (local extraction).

6.2.2.4 Avoiding dust accumulations

In order to prevent the formation of an explosive atmosphere resulting from the dispersion of dust deposits in air, equipment, protective systems and components shall be constructed so that deposits of combustible dust are avoided as far as possible.

In addition to the measures already mentioned under 6.2.2.1 to 6.2.2.3, the following points shall also receive special attention:

- The design of dust conveying and removal systems shall be based on the principles of flow dynamics with special regard to pipe run, flow velocity, surface roughness;
- Surfaces such as structural elements, T-beams, cableways, window-sills and so called dead spaces in dust-carrying equipment, protective systems and components shall be kept to a minimum. This can be partially achieved, e.g. by selecting structural elements which offer smaller deposit surfaces as a result of sheathing or by tilting of the unavoidable deposit surfaces. By creating smooth surfaces (e.g. tiles, coating with oil paint), adhesion of the dust can be at least partially prevented and cleaning can be facilitated. The use of contrasting colours makes dust deposits more visible;
- Proper provisions for cleaning shall be made (e.g. smooth surfaces, good accessibility for cleaning, installation of central vacuum cleaning systems, power supply for mobile vacuum cleaners). The instruction for the user shall point out that dust shall be removed from hot surfaces, e.g. pipes, radiators, electrical apparatus;
- The choice of appropriate emptying devices for dryers, granulators, silos and dust collection units;
- Equipment for cleaning shall be suitable for use with combustible dust (e.g. free from effective ignition sources).

6.3 Hazardous areas

The hazardous areas may be dependent on the design and use of certain equipment and shall be taken into account when planning the design and the intended use (see EN 60079-10-1 and EN 60079-10-2).

The extent of measures necessary to avoid effective ignition sources are dependent on the frequency and duration of occurrence of a hazardous explosive atmosphere.

NOTE 1 In the following text where the term "gas" or "gas/vapour" is used, it implicitly covers mist atmospheres.

An area in which an explosive atmosphere is not expected to occur in such quantities as to require special precautions shall be regarded as non-hazardous within the meaning of this standard.

NOTE 2 Taking into account the sedimentation of dust and the possible formation of an explosive atmosphere from dispersion of dust layers different sets of zones have been defined for gases/vapours and dusts.

In view of this, other measures for the avoidance of effective ignition sources for combustible dusts compared to combustible gases/vapours are required.

6.4 Requirements for the design and construction of equipment, protective systems and components by avoidance of effective ignition sources

6.4.1 General

When equipment, protective systems and components are used in hazardous areas, checks shall be made to see whether ignition hazards can occur, by considering the ignition processes discussed in Clause 5. If ignition hazards are possible, efforts shall be made to remove the sources of ignition from the hazardous area. If this is not possible, the protective measures described in 6.4.2 to 6.4.14 shall be implemented with attention being paid to the following information.

The measures shall render the sources of ignition harmless or shall reduce the likelihood of occurrence of the effective ignition sources. This can be achieved by proper design and construction of equipment, protective systems and components, by operational procedures, and also by means of appropriate measuring and control systems (see 6.7).

The extent of the protective measures depends on the likelihood of occurrence of an explosive atmosphere and the consequences of a possible explosion.

NOTE This is realized by discriminating between different categories of equipment as specified by the Directive 94/9/EC. These categories reflect the requirements of the different zones. The zones for the classification of hazardous areas are defined in Directive 1999/92/EC.

The criteria determining the classification into categories are defined in EN 13237.

Dependent on the type of explosive atmosphere (gas/vapour/mist or dust as the flammable substance) and on the category the following general requirements for equipment, protective systems and components shall be complied with:

Equipment, protective systems and components *for use in explosive gas/air, vapour/air and mist/air atmospheres:*

— *Category 3*: Sources of ignition which can occur continuously or frequently (e.g. during normal operation of equipment, protective systems and components) shall be avoided.

— *Category 2*: In addition to the avoidance of sources of ignition specified for Category 3, sources of ignition that can occur in rare situations (e.g. due to malfunctions of equipment, protective systems and components) shall also be avoided.

— *Category 1*: In addition to the avoidance of sources of ignition specified for Category 2, even sources of ignition that can occur in very rare situations only (e.g. resulting from rare malfunctions of equipment, protective systems and components) shall be avoided.

Equipment, protective systems and components *for use in explosive dust/air atmospheres:*

— *Category 3*: Ignition sources which can occur continuously or frequently (e.g. during normal operation of equipment, protective systems and components) shall be avoided. This applies to the ignition of a dust cloud as well as a dust layer. This includes also the limitation of surface temperatures to prevent the ignition of deposited dust during heat exposure for long periods.

— *Category 2*: In addition to the avoidance of sources of ignition as specified for Category 3, even sources of ignition which can occur in rare situations only (e.g. due to malfunctions of equipment, protective systems and components) shall be avoided. This applies to the ignition of a dust cloud as well as a dust layer.

— *Category 1*: In addition to the avoidance of sources of ignition as specified for Category 2, even sources of ignition which can occur in very rare situations only (e.g. due to rare malfunctions of equipment, protective systems and components) shall be avoided. This applies to the ignition of a dust cloud as well as a dust layer.

Equipment, protective systems and components of all categories:

These shall also be designed taking into account the different characteristics of the flammable substances.

If the explosive atmosphere contains several types of flammable gases, vapours, mists or dusts, the protective measures shall, as a rule be based on the results of special investigations.

Avoidance of effective ignition sources as the only measure is only applicable if all types of ignition sources have been identified and are effectively controlled (see 6.4.2 to 6.4.14).

The specific requirements from the classification of zones to the equipment of the different categories to avoid ignition sources are described in 6.4.2 to 6.4.14.

6.4.2 Hot surfaces

For the identification of hazards due to hot surfaces, see 5.1.

If hazards due to hot surfaces have been identified, dependent on the type of explosive atmosphere (gas/vapour/mist or dust as the flammable substance) and on the category, the following specific requirements for equipment, protective systems and components shall be complied with:

Equipment, protective systems and components *for use in explosive gas/air, vapour/air and mist/air atmospheres:*

— *Category 1:* The temperatures of all equipment, protective systems and components surfaces which can come into contact with explosive atmospheres shall not – even in the case of rare malfunctions – exceed 80 % of the auto ignition temperature of the combustible gas or liquid in °C.

— *Category 2:* The temperatures of all equipment, protective systems and components surfaces which can come into contact with explosive atmospheres shall not exceed the minimum ignition temperature of the combustible gas or liquid in °C during normal operation and in the case of malfunctions. However, where it cannot be excluded that the gas or vapour can be heated to the temperature of the surface, this surface temperature shall not exceed 80 % of the auto ignition temperature of the gas or liquid measured in °C, (see 5.1). This limit may only be exceeded in the case of rare malfunctions.

— *Category 3:* The temperatures of all equipment, protective systems and components surfaces which can come into contact with explosive atmospheres, shall not exceed the auto ignition temperature of the gas or liquid in normal operation.

Equipment, protective systems and components *of all categories:*

In special cases the above temperature limits may be exceeded if there is proven evidence that ignition is not to be expected.

Equipment, protective systems and components *for use in explosive dust/air atmospheres:*

— *Category 1:* The temperature of all surfaces which can come into contact with dust clouds shall not exceed 2/3 of the minimum ignition temperature in °C of the dust cloud concerned even in the case of rare malfunctions. Moreover, the temperature of surfaces on which dust can be deposited shall be lower by a safety margin (see EN 61241-14) than the minimum ignition temperature of the thickest layer that can be formed of the dust concerned; this shall be ensured even in the case of rare malfunctions. If the layer thickness is unknown the thickest foreseeable layer shall be assumed.

— *Category 2:* The temperature of all surfaces which can come into contact with dust clouds shall not exceed 2/3 of the minimum ignition temperature in °C of the dust cloud concerned even in the case of malfunctions. Moreover, the temperature of surfaces on which dust can be deposited shall be lower by a safety margin (see EN 61241-14) than the minimum ignition temperature of a layer of the dust concerned; this shall be ensured even in the case of malfunctions.

— *Category 3:* The temperature of all surfaces which can come into contact with dust clouds shall not – in normal operation – exceed 2/3 of the minimum ignition temperature in °C of the dust cloud. Moreover, the temperature of surfaces on which dust can be deposited shall be lower by a safety margin (see EN 61241-14) than the minimum ignition temperature of a layer of the dust concerned.

Equipment, protective systems and components *of all categories:*

In special cases the above temperature limits may be exceeded if there is proven evidence that ignition is not to be expected.

6.4.3 Flames and hot gases

For the identification of hazards from flames and hot gases, see 5.2.

As far as hot solid particles (e.g. flying sparks) are concerned, reference is made to 6.4.4 (mechanically generated sparks) and to 6.5 in connection with the flame propagation.

If hazards due to flames and/or hot gases have been identified, dependent on the category the following specific requirements for equipment, protective systems and components shall be complied with:

a) *All categories:* Naked flames are not permitted except as described below.

b) *Category 1:* In addition to the elimination of naked flames, gases from flames, (e.g. exhaust gases for inerting purposes) or other heated gases are not permissible unless special preventive measures are taken, e.g. restricting the temperature or eliminating incendive particles.

c) *Categories 2 and 3:* Devices with flames are only permissible if the flames are safely enclosed and the temperatures specified in 6.4.2 are not exceeded on the outer surfaces of the installation parts. Furthermore, for equipment, protective systems and components with enclosed flames (e.g. special heating systems), assurance shall be given that the enclosure is adequately resistant to the effect of the flames and that flame propagation into the hazardous area cannot occur. If the air needed for the combustion shall be taken from areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dust mixtures:

   1) are likely to occur or

   2) do occur only infrequently and for a short period,

   hazards must be prevented by implementing the appropriate protective measures (see 6.5).

NOTE Devices in Category 2 must not generate an effective source of ignition even in the case of malfunction.

6.4.4 Mechanically generated sparks

For the identification of hazards due to mechanically generated sparks, see 5.3.

If hazards due to mechanically generated sparks have been identified, dependent on the type of explosive atmosphere (gas/vapour/mist or dust as the flammable substance) and from the category the following specific requirements for equipment, protective systems and components shall be complied with:

— *Category 1:* Equipment, protective systems and components which, even in the case of rare malfunctions, can give rise to incendive friction, impact or abrasion sparks, shall be excluded. In particular, friction shall be avoided between aluminium or magnesium and iron or steel. Friction and impact between titanium or zirconium with any hard material shall be avoided.

— *Category 2* The requirements for Category 1 should be complied with whenever possible. Sparks shall be excluded in the case of normal operation and in the case of malfunctions.

— *Category 3:* It is sufficient to implement protective measures against incendive friction, impact or abrasion sparks during normal operation.

— *All categories:* Equipment intended for use in explosive gas/air, vapour/air and mist/air atmospheres which can produce mechanically generated sparks shall be excluded if the possible explosive atmosphere can contain one or more of the gases acetylene, carbon disulphide, hydrogen, hydrogen sulphide, ethylen oxide, unless there is proven evidence that there is no explosion risk.

NOTE 1 The requirements for tools which can be present in explosive atmosphere should be in accordance with Annex A.

NOTE 2 It is possible in some cases to protect light metals from mechanical contact with rust by coating. If coated with non-conductive materials such as plastics precautions against static electricity can be necessary. The coating should not contain high percentages of aluminium.

NOTE 3 The likelihood of mechanically generated incendive sparks can be reduced, for example, by wetting. Possible reactions with the wetting medium should be considered, see EN 13463-8.

6.4.5 Electrical apparatus

For the identification of hazards arising from electrical apparatus, see 5.4.

— *All categories:* Electrical apparatus shall be designed, constructed, installed and maintained in accordance with the relevant European Standards.

6.4.6 Stray electric currents and cathodic corrosion protection

For the identification of hazards arising from stray electric currents and cathodic corrosion protection, see 5.5.

If hazards due to stray electric currents and/or cathodic corrosion protection have been identified, dependent on the type of explosive atmosphere (gas/vapour/mist or dust as the flammable substance) and from the category the following specific requirements for equipment, protective systems and components shall be complied with

a) *Category 1 (and Category 2 for use in explosive dust/air mixtures):* Compensation of the potential shall be carried out for all conductive parts of the installation. It is permissible to deviate from this requirement within the areas enclosed by conductive walls that are included in a potential compensation system. If conductive parts of the system are incorporated in areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dust mixtures are present:

   1) continuously or

   2) for long periods or

   3) frequently or

   4) if they are incorporated in areas in which explosive atmospheres caused by air/dust mixtures are likely to occur, (e.g. ventilation and suction pipes in tanks), first they shall be included in a potential compensation system.

   These requirements shall be included in the information for use (see Clause 7).

b) *Category 2:* Protective measures identical to those for Category 1 shall be provided. However, for conductive parts of the system which are not adjacent to electric installations, it is permissible to dispense with special measures to compensate the potential, e.g. additional bridges, when such a compensation system formed by interconnected parts of the electrically conductive system, e.g. pipe networks or extensive earthing systems already exists.

   Before the connections of conductive parts of the system are opened or closed, e.g. during dismantling of fittings and parts of pipes, bridges comprising connection lines having an adequate cross section shall be provided, if the possibility exists that the adequacy of the interconnection might be impaired. These requirements shall be included in the information for use (see Clause 7).

c) *Category 3:* It is generally acceptable to dispense with the requirements for Categories 1 and 2, i.e. the compensation of the potential, unless arcs or sparks due to stray currents occur frequently.

Special protective measures shall be provided for systems with impressed current cathodic corrosion protection.

6.4.7 Static electricity

For the identification of hazards due to static electricity, see 5.6.

If hazards due to static electricity have been identified, dependent on the category the following specific requirements for equipment, protective systems and components shall be complied with:

— *All categories:* The most important protective measure is bonding all the conductive parts that could become hazardously charged and earth them. This protective measure, however, is not sufficient when non-conductive materials are present. In this case hazardous levels of charging of the non-conductive parts and materials, including solids, liquids and dusts shall be avoided. This information shall be included in the information for use (see Clause 7).

NOTE 1 Test methods for FIBCs designed to avoid the risk from electrostatic discharges are given in EN 61340-4-4:2005.

— *Category 1:* Incendive discharges shall be eliminated and rare malfunctions shall be taken into account.

— *Category 2:* Incendive discharges shall not occur during intended use of the installations, including maintenance and cleaning, or during malfunctions that can be expected normally.

— *Category 3:* As a rule, measures other than earthing requirements are necessary only when incendive discharges occur frequently (e.g. in the case of inadequately conductive drive belts).

NOTE 2 Additional protection measures are given in CLC/TR 50404.

6.4.8 Lightning

Protective measures for Categories 1 and 2: The conductive paths for the lightning shall be achieved in such a way, that warming up, ignitable sparks alternatively spray sparks cannot become the ignition source of the explosive atmosphere. That applies also to lightning strikes in greater distances.

The measures have at least to be implemented in such a way, that a bolt of lightning of a radius of 30 m can be controlled.

Lightning protection measures by their effect or configuration need not impair other protective measures, e.g. cathodic corrosion protection.

In addition to electric lines, metallic plant parts which are reliable conductively connected are presumed to be conductors between metal parts and earth connection

Equipotential bonding as well as circuit points and connection with pipes are to be designed in such a way, that during the electric flow of a lightning no sparks or improper high warming up occurs.

Appropriate connections at pipes are welded flags or bolts or tapped holes in the flanges for the input of screws.

For equipment Category 1, these connections shall be so dimensioned, that they can bear the electric current of the lightning.

Additionally, for equipment Category 1, overvoltage protection systems are to be installed outside of hazardous places.

Protective measures for Category 3: Lightning arrestors are not necessary, as the probability of the coincidence of a lightning and the occurrence of explosive atmosphere can be regarded to be extremely low. If necessary, organisational precautions can be applied (e.g. during maintenance).

For the identification of hazards due to lightning, see 5.7.

If hazards due to lightning have been identified, the following specific requirements for equipment, protective systems and components shall be complied with:

— *All categories:* Installations shall be protected by the appropriate lightning protection measures.

Deleterious effects of lightning occurring outside of areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dust mixtures are present continuously, for long periods or frequently on such areas shall be prevented, e.g. overvoltage protection systems could be installed at appropriate areas. For earth-covered tank installations or electrically conductive system components which are electrically insulated from the tank, bonding shall be carried out and an earth ring electrode system provided. These requirements shall be included in the information for use (see Clause 7).

Protective measures against lightning shall not impair cathodic corrosion protection measures according to 6.4.6.

NOTE For protection against lightning, see EN 62305-2 and EN 62305-3.

6.4.9 Radio frequency (RF) electromagnetic waves from 10^4 Hz to 3×10^{11} Hz

For the identification of hazards due to radio-frequency electromagnetic waves, see 5.8.

If hazards due to radio frequency electromagnetic waves have been identified, the following specific requirements for equipment, protective systems and components shall be complied with:

— *All categories:* As a general safety measure against the ignition effect of electromagnetic waves, a safety distance shall be maintained in all directions between the nearest radiating parts and the receiving aerial (see 5.8) in the area which could contain explosive atmosphere.

NOTE 1 For transmission systems with a directional pattern, it should be noted that this safety distance depends on the direction. It should also be noted that the radio frequency source, depending on its output power, antenna gain and operating frequency, may be located even several kilometres distant. In case of doubt, the safety distance should be ascertained by measurements.

If an adequate safety distance cannot be maintained, special protective measures, for example shielding, shall be taken.

NOTE 2 An operating permit on the level of electromagnetic interference, issued e.g. by the national Telecom Authority, the respective radio interference protection label or information on the degree of radio interference does not say anything about whether the device or its radiation field gives rise to an ignition risk.

— *All categories:* Radio-frequency systems shall also comply with 6.4.5.

6.4.10 Electromagnetic waves from 3×10^{11} Hz to 3×10^{15} Hz

For the identification of hazards arising from this spectral range electromagnetic waves, see 5.9.

Note shall be taken that equipment, protective systems and components that generate radiation (e.g. lamps, electric arcs, lasers) can itself also be a source of ignition as defined 5.1 and 5.4.

If hazards due to electromagnetic waves from 3×10^{11} Hz to 3×10^{15} Hz have been identified, dependent on the category the following specific requirements for equipment, protective systems and components shall be complied with:

a) *All categories:* Devices which can cause ignition by resonance absorption (see 5.9) shall not be permitted.

b) *Category 3:* Electrical equipment which generates radiation and which is approved or suitable for areas with explosive atmospheres corresponding to Category 3 (see 6.4.5) is admissible provided that the energy of a radiated pulse or energy flux (power) of continuous radiation is limited to such a low value that it cannot ignite the explosive atmosphere,

or

the radiation is safely enclosed ensuring that:

1) any escape of radiation that could ignite explosive atmosphere from the enclosure into the hazardous area is safely prevented and hot surfaces that could ignite explosive atmosphere on the outside of the enclosure due to the radiation do not occur

and

2) the explosive atmosphere cannot penetrate into the enclosure or an explosion inside the enclosure cannot propagate into the hazardous area.

This shall be ensured during normal operation.

c) *Category 2:* The above conditions shall be ensured also in the case of rare situations (e.g. malfunctions).

d) *Category 1:* The above conditions shall be ensured even in the case of very rare situations (e.g. rare malfunctions).

NOTE See EN 60079-28 and EN 60079-0 for some applications like equipment with optical radiation to be used in mixtures of gas and vapour/air, when the radiation is completely absorbed by an absorber.

6.4.11 Ionizing radiation

For the identification of hazard arising from ionizing radiation, see 5.10.

If hazards due to ionizing radiation have been identified, dependent on the category the following specific requirements for equipment, protective systems and components shall be complied with:

a) *All categories:* The directions in 6.4.5 shall be followed for the electrical systems needed for operation of the sources of radiation.

The protective measures for lasers are given in 6.4.10.

b) *Category 3:* Ionizing radiation is admissible provided that:

1) the energy of a radiated pulse or energy flux (power) of continuous radiation is limited to such a low value that it cannot ignite the explosive atmosphere, or

2) the radiation is safely enclosed ensuring that:

i) any escape of radiation that could ignite explosive atmosphere from the enclosure into the hazardous area is safely prevented and hot surfaces that could ignite explosive atmosphere on the outside of the enclosure due to the radiation do not occur and

ii) the explosive atmosphere cannot penetrate into the enclosure or an explosion inside the enclosure cannot propagate into the hazardous area.

This shall be ensured during normal operation.

c) *Category* 2: The above conditions shall be ensured also in the case of rare situations (e.g. malfunctions).

d) Category 1: The above conditions shall be ensured even in the case of very rare situations (e.g. rare malfunctions).

6.4.12 Ultrasonics

For the identification of hazards arising from ultrasonics, see 5.11.

If hazards due to ultrasonics have been identified, dependent on the category the following specific requirements for equipment, protective systems and components shall be complied with:

— *All categories:* Ultrasonic waves with a frequency of more than 10 MHz shall not be permitted, unless the absence of an ignition risk is proved for the case in point by demonstrating that there is no absorption due to molecular resonance.

The information in this subclause refers only to ignition hazards caused by acoustic power. 6.4.5 shall be taken into consideration for the associated electrical systems.

For ultrasonic waves with a frequency up to 10 MHz the following is required:

— *All categories:* Ultrasonic waves shall be permitted only if the safety of the work procedure is ensured. The power density of the generated acoustic field shall not exceed 1 mW/mm^2, unless it is proved for the case in point that ignition is not possible.

— *Categories 2 and 3:* In work procedures with conventional ultrasonic devices (e.g. ultrasonic echo testing devices), special protective measures against ignition risks from the ultrasonic waves themselves are only necessary if the power density in the generated acoustic field exceeds 1 mW/mm^2, unless it is proved for the case in point that ignition is not possible.

6.4.13 Adiabatic compression and shock waves

For the identification of hazards due to adiabatic compression and shock waves, see 5.12.

If hazards due to adiabatic compression and/or shock waves have been identified, dependent on the category the following specific requirements for equipment, protective systems and components shall be complied with:

— *Category 1:* Processes that can cause compressions or shock waves which could produce ignition shall be avoided. This shall be ensured even in the case of rare malfunctions. As a rule, hazardous compressions and shock waves can be eliminated if, for example, the slides and valves between sections of the system where high pressure ratios are present can only be opened slowly.

— *Category 2:* Processes which can cause adiabatic compressions or shock waves can be tolerated only in the case of rare malfunctions.

— *Category 3:* Only those shock waves or compressions occurring during normal operation that could ignite explosive atmospheres shall be prevented.

NOTE If equipment, protective systems and components containing highly oxidizing gases have to be used, special precautions should be taken to prevent the ignition of construction materials and auxiliary materials.

6.4.14 Exothermic reactions, including self-ignition of dusts

For the identification of hazards due to exothermic reactions, see 5.13.

If hazards due to exothermic reactions have been identified, the following specific requirements for equipment, protective systems and components shall be complied with[2].

— *All categories:* Substances with a tendency to self-ignition shall be avoided whenever possible.

When such substances have to be handled, the necessary protective measures shall be adapted in each individual case. The following protective measures can be suitable:

a) inerting;

b) stabilization;

c) improvement of heat dissipation, e.g. by dividing the substances into smaller portions;

d) limiting temperature and pressure;

e) storage at lowered temperatures;

f) limiting residence times.

Construction materials which react hazardously with the substances being handled shall be avoided.

For protective measures against hazards due to impact and friction involving rust and light metals (e.g. aluminium, magnesium, or their alloys), see 6.4.4.

WARNING — Pyrophoric materials can be generated under certain conditions, e.g. in the storage of sulphur-containing petroleum products or milling of light metal in inert atmosphere.

6.5 Requirements for the design and construction of equipment, protective systems and components to reduce the explosion effects

If the measures described in 6.2 or 6.4 cannot be implemented or are not pertinent, the equipment, protective systems and components shall be designed and constructed in such a way as to limit the effects of an explosion to a safe level. Such measures are:

— explosion-resistant design (see EN 14460);

— explosion venting (see EN 14797);

— explosion suppression (see EN 14373);

— explosion isolation (see EN 15089, EN ISO 16852).

These measures generally refer to the mitigation of hazardous effects from explosions inside equipment, protective systems and components.

NOTE Additional measures may be needed for buildings or surroundings of the equipment, protective systems and components, but these are not dealt with in this standard.

2) Owing to the wide variety of possible chemical reactions, it is not practicable to describe all required precautions in this standard. It is therefore essential to seek expert guidance.

WARNING — In connected equipment, protective systems, components, pipeworks, or elongated vessels it is possible that an explosion will propagate through the entire system with flame front acceleration. Built-in elements or obstacles which increase the turbulence (e.g. measuring baffle plates) can also accelerate the flame front. Depending on the geometry of the system, such acceleration can lead to a transition from deflagration to detonation where high pressure pulses occur.

6.6 Provisions for emergency measures

Special emergency measures may be required for explosion prevention and/or protection, e.g.:

— emergency shut-down of the total plant or parts of it;

— emergency emptying of parts of the plant;

— interrupting material flows between parts of the plant;

— flooding of parts of the plant by appropriate substances (e.g. nitrogen, water).

These measures shall be integrated into the explosion safety concept (see 6.1) during the design and construction of the equipment, protective systems and components.

6.7 Principles of measuring and control systems for explosion prevention and protection

General principles of this field are dealt with in EN ISO 13849-1.

The explosion prevention and protection measures described in 6.2, 6.4 and 6.5 may be put into practice or monitored using measuring and control systems. This means that process control can be used for the basic principles of explosion prevention and protection:

— avoidance of explosive atmosphere;

— avoidance of effective ignition sources, see EN 13463-1 and -6;

— reduction of explosion effects.

The relevant safety parameters shall be identified and where appropriate monitored. Measuring and control systems used shall produce the appropriate response.

NOTE The response time of the measuring and control systems is also a relevant safety parameter.

The required reliability of the monitoring and control system (see EN 50495 and EN 13463-6) follows from the risk assessment (see EN 15198 and EN 13463-1).

7 Information for use

7.1 General

This clause specifies information for use including maintenance which shall be supplied with the equipment, protective systems and components or as part of the instructions for use, e.g. an instruction handbook.

The requirements in EN ISO 12100 shall be complied with. Particular attention shall be given to the special requirements for use in explosive atmospheres.

The information for use shall clearly state the equipment group and the category, if applicable and include especially the intended use and the application limits.

The following information, as appropriate, shall be provided:

a) specific parameters related to explosion protection; this can include:

   1) maximum surface temperatures, pressures etc.;

   2) protection against mechanical hazards;

   3) ignition prevention;

   4) prevention and/or limitation of dust accumulation;

b) safety systems; this can include:

   1) temperature monitoring;

   2) vibration monitoring;

   3) spark detection and extinguishing systems;

   4) inerting systems;

   5) explosion venting systems;

   6) explosion suppression systems;

   7) process isolation systems;

   8) vent systems for overpressures generated from processes other than explosion;

   9) fire detection and fighting systems;

   10) explosion isolation systems;

   11) emergency shut-down systems;

   12) explosion resistant design;

c) specific requirements to ensure safe operation; this can include:

   1) appropriate accessories;

   2) use with other equipment, protective systems and components.

Annex A provides information for the use of tools in explosive atmospheres.

7.2 Information for commissioning, maintenance and repair to prevent explosion

Particular attention shall be paid to provide the following:

- Instructions covering normal operation including start-up and shut-down;
- Instructions covering systematic maintenance and repair including safe opening of equipment, protective systems and components;
- Instructions with regard to required cleaning, including dust removal and safe working processes;
- Instructions covering fault identification and actions required;

— Instructions covering the testing of equipment, safety systems and components, also after explosions;

— Information on risks requiring action, e.g. information shall be supplied about the possible existence of explosive atmosphere identified as part of the risk assessment to avoid that the operator or other person causes an ignition source.

7.3 Qualifications and training

Information on required qualifications and training shall be supplied to enable the user to select qualified staff for the tasks where explosive atmospheres can occur.

Annex A
(informative)

Information for the use of tools in potentially explosive atmospheres

Those responsible for operating plants and processes where potentially explosive atmospheres exist should provide information to all who work on the site about the safe use of hand tools. Two different types of tools can be distinguished:

a) tools which can only cause single sparks when they are used (e.g. screw-drivers, spanners, impact screw-drivers);

b) tools which generate a shower of sparks when used during sawing or grinding.

In Zones 0 and 20, no tools which can cause sparks should be allowed.

In Zones 1 and 2, only steel tools according to a) should be allowed. Tools according to b) should only be permissible if no hazardous explosive atmosphere is present at the workplace.

However, the use of any kind of steel tools should be prohibited in Zone 1 if the risk of explosion exists because of the presence of substances belonging to explosion group II C (according to EN 60079-20, acetylene, carbon disulphide, hydrogen), and hydrogen sulphide, ethylene oxide, carbon monoxide, unless no hazardous explosive atmosphere is present at the workplace during the work with these tools.

Steel tools according to a) may be allowed in Zones 21 and 22. Steel tools according to b) may only be allowed if the workplace is shielded from the remaining area of Zones 21 and 22 and the following additional measures have been taken:

1) dust deposits have been removed from the workplace or

2) the workplace is kept so wet that no dust can be dispersed in the air nor that any smouldering processes can develop.

When grinding or sawing in Zones 21 and 22 or in their vicinity, sparks produced can fly over great distances and lead to the formation of smouldering particles. For this reason the other areas around the workplace also should be included in the protective measures mentioned.

The use of tools in Zones 1, 2, 21 and 22 should be subject to a "permit to work" system. This should be included in the information for use.

Annex B
(informative)

Tightness of equipment

B.1 General

The formation of a hazardous explosive atmosphere outside the equipment can be prevented or limited by means of the tightness of the equipment. Here, a differentiation is made between:

— equipment which is durably technically tight;

— technically tight equipment where the escape of flammable materials is due to operation.

NOTE 1 When designing equipment for the handling of flammable gases, liquids and dusts, the materials should be selected such that they are able to withstand the mechanical, thermal and chemical stresses to be expected. Dangers resulting from reactions of the surface material with the flammable mixtures shall be ruled out.

NOTE 2 When selecting the materials, the corrosion behaviour should be considered. For surface abrasion, allowances should be taken into account when calculating the surface thickness; as a basic protective measure against pitting corrosion the appropriate materials should be selected and, particularly, also the proper preservation measures be performed during phases of standstill.

B.2 Equipment which is durably technically tight

a) In the case of equipment which is durably technically tight, no release is to be expected.

b) Equipment is regarded as durably technically tight, if:

   1) it is constructed such that it remains technically tight due to its design; or

   2) its technical tightness is permanently ensured by means of maintenance and supervision.

c) Equipment with a durably technically tight construction does not cause any hazardous areas in its surroundings while closed.

d) Examples of equipment which is durably technically tight are:

   1) welded equipment with:

      i) detachable components where the required detachable connections are rarely detached due to operation and are designed like the below-mentioned detachable pipework connections (exception: metallically sealing connections);

      ii) detachable connections with pipeworks, fittings or blind covers where the required detachable connections are rarely detached and are designed like the below-mentioned detachable pipework connections;

   2) shaft passages with double-acting axial seal ring (e.g. pumps, agitators);

   3) canned motor pumps;

   4) magnetically coupled seal-less pumps;

5) fittings where the sealing of the spindle passage is by means of bellows or safety glands, gland seals with self-adjusting packings;

6) glandless fittings with permanent magnetic drive.

e) Examples of pipework connections which are durably technically tight are:

1) non-detachable connections, e.g. welded;

2) detachable connections which are rarely detached due to operation, e.g.

i) weld-lip seal flanges;

ii) tongue and groove flanges;

iii) projection and recess flanges;

iv) flanges with V-tongues and V-tongue seals;

v) flanges with smooth sealing strips and special seals, soft packings of up to PN 25 bars, metallic insert gaskets or metal-coated gaskets, provided in cases of using DIN flanges, calculatory verification gives sufficient safety as to the yield strength;

vi) metallically sealing connections, with the exception of cutting and clamping ring connections, in lines of diameters exceeding DN 32.

f) Provided they are rarely detached, durably technically tight connections for fittings are, for example,

1) the above-mentioned pipework connections and

2) NPT threads (National Pipe Taper Threads) or other tapered pipe threads with gaskets in threads of up to DN 50, as long as they are not subject to cyclic thermal stress ($Dt > 100$ °C).

g) In addition to the purely constructive measures, also technical measures, in combination with organizational measures, can result in durably technically tight equipment. Given the proper monitoring and servicing, this includes, among other things,

1) seals and gaskets subject to dynamic stress, e.g., shaft passages on pumps;

2) seals and gaskets subject to thermal stress on plant parts.

h) The scope and frequency of the monitoring and servicing depend on the individual type of the connection, design, operational mode and degree of exposure as well as the individual state and properties of the materials. They are intended to ensure durable technical tightness. Care shall be taken that the scope and frequency of the monitoring and servicing intended to maintain the durable technical tightness are specified, from the manufacturer's perspective, in the instructions for use or in documents referenced therein.

i) For monitoring, one of the following measures may be sufficient:

1) Visual inspection of the equipment and checking for, e.g., flowmarks, the formation of ice, odour and noise resulting from leaks;

2) Checking of the equipment by means of mobile leak indicators or portable gas detectors;

3) Continuous or periodic monitoring of the atmosphere by means of automatic, permanently installed measuring devices with warning function.

NOTE The scope and frequency of the monitoring for tightness can be reduced by the appropriate preventive maintenance.

B.3 Technically tight equipment

a) In the case of technically tight equipment, infrequent releases can be expected.

b) Equipment is considered technically tight when any of the tightness tests or tightness monitorings/checks appropriate for the application, e.g. by applying foam-producing agents or leak detectors or indicators, does not reveal any obvious leaks.

c) Examples of technically tight equipment are:

1) flange with smooth sealing strip and no special requirements for the construction of the sealing;

2) cutting and clamping ring connections in lines with diameters exceeding DN 32;

3) pumps whose tightness relies solely upon a single-acting axial seal ring;

4) detachable connections which are detached not just rarely.

Annex C
(informative)

Significant technical changes between this document and the previous edition of this European Standard

The significant changes with respect to EN 1127-1:2007 are as listed below.

Table C.1 — Significant technical changes between this document and EN 1127-1:2007

		Type		
Significant changes	**Clause**	**Minor and editorial changes**	**Extension**	**Major technical changes**
terms and definitions have been moved to EN 13237	3	X		
risk assessment has been modified	4		X	
information about relationship between categories and zones has been deleted	Annex C	X		
information about classification of zones for gases/vapours and for dusts has been deleted	Annex B (old)	X		
information on tightness of equipment has been added	Annex B (new)		X	
information about concepts for the use of measuring and control systems to avoid effective ignition sources has been deleted	Annex D	X		

Definitions

Minor and editorial changes — clarification
decrease of technical requirements
minor technical change
editorial corrections

Changes in a standard classified as 'Minor and editorial changes' refer to changes regarding the previous standard, which modify requirements in an editorial or a minor technical way. Also changes of the wording to clarify technical requirements without any technical change are classified as 'Minor and editorial changes'.

A reduction in level of existing requirement is also classified as 'Minor and editorial changes'

Extension	addition of technical options

Changes in a standard classified as ‘extension’ refers to changes regarding the previous standard, which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore these ‘extensions’ will not have to be considered for products in conformity with the preceding edition.

Major technical change	addition of technical requirements increase of technical requirements

Changes in a standard classified as ‘Major technical change’ refer to changes regarding the previous standard, which add new or increase the level of existing technical requirements, in a way that a product in conformity with the preceding standard will not always be able to fulfil the requirements given in the standard. ‘Major technical changes’ have to be considered for products in conformity with the preceding edition. For every change classified as ‘Major Technical Change’, additional information is provided in this Annex.

NOTE These changes represent current technological knowledge[3)]. However, these changes should not normally have an influence on equipment already placed on the market.

3) See also ATEX Guide 10.3, and Annex C.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 94/9/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 94/9/EC of 23 March 1994 concerning equipment and protective systems intended for use in potentially explosive atmospheres.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 94/9/EC

Clause(s)/subclause(s) of this EN	Essential Requirements (ERs) of Directive 94/9/EC	Qualifying remarks/Notes
Clause 4 to Clause 7 and Annex A	Annex II, with the exception of the following clauses: 1.0.5 Marking 1.2.6 Safe opening 1.2.7 Protection against other hazards 1.2.8 Overloading of equipment 1.4 Hazards arising from external effects 1.5 Requirements in respect of safety-related devices 1.6 Integration of safety requirements relating to the system 2.0 Requirements applicable to equipment in category M of equipment-group I	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Annex ZB
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with Essential Requirement 1.5.7 of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] Non-binding Guide of Good Practice for implementing of the European Parliament and Council Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres; 2003-08-25

[2] Council Directive 89/686/EEC of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment

[3] Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres

[4] Commission Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

[5] ATEX Guidelines, Guidelines on the application of Directive 94/9/EC of the European Parliament and the Council of 23 march 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially Explosive Atmospheres - Third edition June 2009, http://ec.europa.eu/enterprise/sectors/mechanical/documents/guidance/atex/application/index_en.htm

[6] EN 1127-2, Explosive atmospheres — Explosion prevention and protection — Part 2: Basic concepts and methodology for mining

[7] EN 1710, Equipment and components intended for use in potentially explosive atmospheres in underground mines

[8] EN 13463-2, Non-electrical equipment for use in potentially explosive atmospheres — Part 2: Protection by flow restricting enclosure 'fr'

[9] EN 13463-3, Non-electrical equipment for use in potentially explosive atmospheres — Part 3: Protection by flameproof enclosure 'd'

[10] EN 13463-5, Non-electrical equipment intended for use in potentially explosive atmospheres — Part 5: Protection by constructional safety 'c'

[11] EN 13463-8, Non-electrical equipment for potentially explosive atmospheres — Part 8: Protection by liquid immersion 'k'

[12] EN 13980, Potentially explosive atmospheres — Application of quality systems

[13] EN 14591-1, Explosion prevention and protection in underground mines — Protective systems — Part 1: 2-bar explosion proof ventilation structure

[14] EN 14591-2, Explosion prevention and protection in underground mines — Protective systems — Part 2: Passive water trough barriers

[15] EN 14591-4, Explosion prevention and protection in underground mines — Protective systems — Part 4: Automatic extinguishing systems for road headers

[16] EN 14983, Explosion prevention and protection in underground mines — Equipment and protective systems for firedamp drainage

[17] EN 14986, Design of fans working in potentially explosive atmospheres

[18] EN 15188, Determination of the spontaneous ignition behaviour of dust accumulations

[19] EN 15233, Methodology for functional safety assessment of protective systems for potentially explosive atmospheres

[20] EN 50017, Electrical apparatus for potentially explosive atmospheres — Powder filling "q"

[21] EN 50050, Electrical apparatus for potentially explosive atmospheres — Electrostatic hand-held spraying equipment

[22] 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

[23] 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 with an energy limit of 5 mJ and their associated apparatus

[24] 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

[25] EN 50303, Group 1, category M1 equipment intended to remain functional in atmospheres endangered by firedamp and/or coal dust

[26] EN 60079-0, Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2007 + corrigendum Dec. 2010, modified)

[27] EN 60079-2, Explosive atmospheres -- Part 2: Equipment protection by pressurized enclosure "p"

[28] prEN 60079-5, Electrical apparatus for explosive gas atmospheres — Part 5: Powder filling 'q'

[29] EN 60079-6, Explosive atmospheres — Part 6: Equipment protection by oil immersion "o" (IEC 60079-6:2007)

[30] EN 60079-7, Explosive atmospheres — Part 7: Equipment protection by increased safety "e" (IEC 60079-7:2006)

[31] EN 60079-10, Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:2002)

[32] EN 60079-11, Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i" (IEC 60079-11:2006 + corrigendum Dec. 2006)

[33] EN 60079-14, Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations in hazardous areas (other than mines) (IEC 60079-14:2002)

[34] EN 60079-15, Electrical apparatus for explosive gas atmospheres — Part 15: Construction, test and marking of type of protection "n" electrical apparatus (IEC 60079-15:2005)

[35] EN 60079-18, Electrical apparatus for explosive gas atmospheres — Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus (IEC 60079-18:2004)

[36] prEN 60079-20, Electrical apparatus for explosive gas atmospheres — Part 20: Non-metallic parts of flameproof enclosures

[37] EN 60079-20-1, Explosive atmospheres — Part 20-1: Material characteristics for gas and vapour classification — Test methods and data

[38] EN 60079-25, Electrical apparatus for explosive gas atmospheres — Part 25: Intrinsically safe systems (IEC 60079-25:2003)

[39] EN 60079-26, Explosive atmospheres — Part 26: Equipment with equipment protection level (EPL) Ga (IEC 60079-26:2006)

[40] EN 60079-28, Explosive atmospheres — Part 28: Protection of equipment and transmission systems using optical radiation (IEC 60079-28:2006)

[41] EN 60079-30-1, Explosive atmospheres — Part 30-1: Electrical resistance trace heating — General and testing requirements

[42] EN 60079-30-2, Explosive atmospheres — Part 30-2: Electrical resistance trace heating — Application guide for design, installation and maintenance (IEC 60079-30-2:2007)

[43] EN 60079-31, Explosive atmospheres — Part 31: Equipment dust ignition protection by enclosure "t"

[44] EN 61241-0, Electrical apparatus for use in the presence of combustible dust — Part 0: General requirements (IEC 61241-0:2004, modified, + corrigendum Nov. 2005)

[45] EN 61241-1, Electrical apparatus for use in the presence of combustible dust — Part 1: Protection by enclosures "tD" (IEC 61241-1:2004)

[46] EN 61241-2-2, Electrical apparatus for use in the presence of combustible dust — Part 2: Test methods — Section 2: Methods for determining the electrical resistivity of dust in layers (IEC 61241-2-2:1993 + corrigendum May 1994)

[47] EN 61241-4, Electrical apparatus for use in the presence of combustible dust — Part 4: Type of protection "pD" (IEC 61241-4:2001)

[48] EN 61241-11, Electrical apparatus for use in the presence of combustible dust — Part 11: Protection by intrinsic safety "iD" (IEC 61241-11:2005 (EQV) + corrigendum Feb. 2006)

[49] EN 61241-17, Electrical apparatus for use in the presence of combustible dust — Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines) (IEC 61241-17:2005)

[50] EN 61241-18, Electrical apparatus for use in the presence of combustible dust — Part 18: Protection by encapsulation "mD" (IEC 61241-18:2004)

[51] EN 61340-4-4:2005, Electrostatics — Part 4-4: Standard test methods for specific applications — Electrostatic classification of flexible intermediate bulk containers (FIBC) (IEC 61340-4-4:2005)

[52] EN 62305-2, Protection against lightning — Part 2: Risk management (IEC 60305-2:2010)

[53] EN 62305-3, Protection against lightning — Part 3: Physical damage to structure and life hazard (IEC 60305-3:2010, modified)

[54] CLC/TR 50426, Assessment of inadvertent initiation of bridge wire electro-explosive devices by radio-frequency radiation — Guide

[55] CLC/TR 50427, Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation — Guide

[56] IEC 60079-4, Electrical apparatus for explosive gas atmospheres — Part 4: Method of test for ignition temperature

[57] IEC 60050-426, International Electrotechnical Vocabulary — Part 426: Equipment for explosive atmospheres

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