SLOVENSKI STANDARD
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Varnostne naprave, potrebne za varno obratovanje opreme glede tveganja eksplozije

Safety devices required for the safe functioning of equipment with respect to explosion risks

Sicherheitseinrichtungen für den sicheren Betrieb von Geräten im Hinblick auf Explosionsgefahren

Dispositifs de sécurité nécessaires pour le fonctionnement sûr d'un matériel vis-à-vis des risques d'explosion

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

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 31, Electrical apparatus for potentially explosive atmospheres. The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50495 on 2009-12-01.

This European Standard is to be read in conjunction with the European Standards for the specific types of protection listed in EN 60079 or EN 61241 series of standards.

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

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2010-12-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2012-12-01

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 94/9/EC. See Annex ZZ.

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Introduction

Safety devices, controlling devices and regulating devices which are used for the protection concept of equipment for explosive atmospheres, shall function reliably for the intended purpose. This shall be expressed in terms of some measure of confidence that the devices will be able to maintain a required level of safety at all times. This measure of confidence needs to be in conformity with [1], CENELEC standards of the series EN 60079 and EN 61241 for apparatus for use in explosive atmospheres and relevant control standards.

CENELEC identified the need for research to determine whether existing and proposed standards in the field of safety-related control systems were suitable for this purpose. Research proposals on this topic were invited under the Standardisation, Measurement and Testing (SMT) Programme of the EU-commission and the SAFEC project was selected for funding (contract SMT4-CT98-2255). The project was a 12 month project which began in January 1999. The SAFEC partners were the Health and Safety Laboratory (HSL) of the Health and Safety Executive in the UK (the project coordinator), the Deutsche Montan Technologie (DMT) in Germany, the National Institute for Industrial Environment and Risks (INERIS) in France and the Laboratorio Oficial J.M. Madariaga (LOM) in Spain. The result of this project is summarised in [2] and recommends the application of Safety Integrity Levels as specified in EN 61508-1 for safety devices. A short description of the basic concept is provided in Annex E of this standard.

1 Scope

This European Standard specifies the requirements of electrical safety devices, which are used to avoid potential ignition sources of equipment in explosive atmospheres.

This also includes safety devices, which are operated outside areas with explosive atmospheres, to guarantee the safe function of equipment with respect to explosion hazards.

NOTE 1 This European Standard can also be used to design and assess safety devices for protective systems.

Electrical equipment, which is intended for use in explosive atmospheres, may rely on the correct operation of safety devices which for example maintain certain characteristics of the equipment within acceptable limits. Examples of such safety devices are motor protection devices (to limit temperature rise during stall conditions) and controlling devices for pressurisation protection.

By means of control or monitoring devices, sources of ignition can be avoided. Therefore these devices shall execute the appropriate measures in the appropriate reaction time, for example the initiation of an alarm or an automatic shut down.

NOTE 2 Some potential ignition sources might not be controllable by safety devices, e.g. electrostatic discharges, ignition sparks caused by mechanical impact. Also some protection measures might not be controllable by safety devices, e.g. flameproof enclosures.

Safety devices, whose safety function can not adequately be specified under the existing EN 60079 or EN 61241 series of standards, shall additionally be designed according to the requirements of this standard. Generally for complex safety devices appropriate design requirements are not provided in the existing types of protection (see 3.13 for the definition of a complex device).

NOTE 3 In general the levels of safety required by this standard are considered to be equivalent to those provided by conformity to EN 60079-0 or EN 61241-0. No increase or decrease of safety is intended or required. Similarly neither increase nor decrease of safety with respect to EN 61508 series is intended.

Safety devices can be classified in 2 types:

a) devices, which are included as component in the equipment under control (see 3.8). The combined apparatus is considered as equipment.

   EXAMPLES
   - thermal switch or thermistor to avoid overheating,
   - temperature monitoring devices to control the surface temperature.

b) devices, which are installed separately from the equipment under control and considered as associated apparatus exclusively for a specific type of protection or specific equipment under control. The combined apparatus is considered as a system.

   EXAMPLES
   - external control devices or safety related parts of a control system for type of protection pressurisation,
   - overload protective device for electric motors of type of protection Ex e 'Increased Safety',
   - control devices for battery charging equipment (protection against overcharging or deep discharging),
   - level detectors for the control of submersible pumps.

Exclusions from this standard:

Safety devices, where the safety function is adequately covered in the existing standards of EN 60079 and EN 61241 series do not need any additional assessment according to this standard.

EXAMPLES Intrinsically safe associated apparatus, fuses, electromechanical overload protection, simple thermal protection devices (e.g. thermal fuses, thermal switches).

The standard does not include devices or systems to prevent the occurrence of explosive atmospheres, e.g. inerting systems, ventilation in workplaces and containers/vessels.

Gas detectors, which are covered under EN 61779 series, EN 50271 or EN 50402 are also excluded from the scope of this standard.

This standard does not deal with protection by control of ignition source ‘b’ for non-electrical equipment as defined in EN 13463-6.

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

EN 13463-6 *Non-electrical equipment for use in potentially explosive atmospheres – Part 6: Protection by control of ignition source ‘b’*

EN 50271 *Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen – Requirements and tests for apparatus using software and/or digital technologies*

EN 50402 + A1 *Electrical apparatus for the detection and measurement of combustible or toxic gases or vapours or of oxygen – Requirements on the functional safety of fixed gas detection systems*

EN 60079 series *Explosive atmospheres* (IEC 60079 series)

EN 60079-0 *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements* (IEC 60079-0, mod.)

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

EN 60079-30-1 *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements* (IEC 60079-30-1)

EN 60079-30-2 *Explosive atmospheres – Part 30-2: Electrical resistance trace heating – Application guide for design, installation and maintenance* (IEC 60079-30-2)

EN 60812 *Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)* (IEC 60812)

EN 61010-1 *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements* (IEC 61010-1)

EN 61025 *Fault tree analysis (FTA)* (IEC 61025)

EN 61165 *Application of Markov techniques* (IEC 61165)

EN 61241 series *Electrical apparatus for use in the presence of combustible dust* (IEC 61241 series)

EN 61241-0 *Electrical apparatus for use in the presence of combustible dust – Part 0: General requirements* (IEC 61241-0, mod.)

EN 61496-1 *Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests* (IEC 61496-1, mod.)

EN 61508 series *Functional safety of electrical/electronic/programmable electronic safety-related systems* (IEC 61508 series)

EN 61508-1	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements* (IEC 61508-1)
EN 61508-2:2001	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems* (IEC 61508-2:2000)
EN 61508-3	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements* (IEC 61508-3)
EN 61508-4	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations* (IEC 61508-4)
EN 61508-7:2001	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures* (IEC 61508-7:2000)
EN 61511 series	*Functional safety – Safety instrumented systems for the process industry sector* (IEC 61511 series)
EN 61511-1:2004	*Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and software requirements* (IEC 61511-1:2003)
EN 61779 series	*Electrical apparatus for the detection and measurement of flammable gases* (IEC 61779 series, mod.)
EN 62061	*Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems* (IEC 62061)
EN ISO 13849-1	*Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design* (ISO 13849-1)
EN ISO 13849-2	*Safety of machinery – Safety-related parts of control systems – Part 2: Validation* (ISO 13849-2)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 60079-0 and the following apply.

3.1
types of protection
the types of protection, as referred to in this standard, are the explosion protection measures for electrical equipment

NOTE The protection measures are defined in EN 60079-0 or EN 61241-0.

3.2
equipment category
classification of equipment into different levels of safety with respect to the ignition risk

[EN 13237, EN 60079-0, [1]]

NOTE The equipment category is equivalent to the appropriate Equipment Protection Levels (EPLs), defined in the EN 60079-0. This standard may be applied for EPLs correspondingly.

3.3
functional safety
part of the overall safety relating to the EUC and the EUC control system which depends on the correct functioning of the safety-related systems and external risk reduction facilities

[EN 61508-4]

3.4
safety device
safety devices, controlling devices and regulating devices required for or contributing to the safe functioning of equipment with respect to the risks of explosion

Safety devices provide explosion protection by executing a safety function that works independently of the normal functions of the equipment under its control. A safety device may consist of one or more safety components, forming a Safety Instrumented System (SIS)

NOTE A regulating device which is controlling an ignition risk is also considered as a safety device.

3.5
Safety Instrumented System (SIS)
instrumented system used to implement one or more safety instrumented functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final elements(s) [see EN 61511-1:2004, 3.2.72]. A safety instrumented system is equivalent to a safety-related system, which is defined under EN 61508-4

NOTE Safety device is a term of [EN 13237], [1] and can also be a safety related system.

3.6
safety component
one of the parts of a system or device performing a specific safety function

[EN 61511-1]

3.7
safety function
a function to be implemented by a safety device, which is intended to achieve or maintain a safe state for the EUC, in respect of ignition hazards

[EN 61508-4]

3.8
Equipment Under Control (EUC)
equipment, machines, apparatus or components which contain a potential ignition source, which is controlled by a safety device

[EN 61508-4]

3.9
safe state
state of the safety device which leads to a safe condition of the EUC

[EN 61508-4]

3.10
safe condition
the safe condition of an Equipment Under Control (EUC) defines the operating mode in which an acceptable ignition risk according to the category of the protected equipment is provided by the equipment. The safe condition of the EUC is intended to be ensured by activating the safety function of the safety device

3.11
combined equipment
combination of a safety device and the Equipment Under Control (EUC). It may be physically combined in one unit or as separate units. In both cases the combination is considered as equipment according to [1]

3.12
simple safety device
safety devices where the safety function does not depend on complex technology (e.g. microprocessor technology)

3.13
complex safety device
safety devices where the safety function depends on complex technology, e.g. microprocessor technology

3.14
Safety Integrity Level (SIL)
discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety function(s) to be performed by the safety device, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest [EN 61508-4]. If the safety device consists of several safety components the Safety Integrity Level is defined for the complete safety instrumented system

NOTE SIL 4 is not applied in this standard.

3.15
SIL capability
if a safety component is provided separately, its specified SIL capability is the maximum SIL that can be achieved by a safety device using this component in single channel mode

3.16
Failure Mode and Effect Analysis (FMEA)
analysis of possible failures of any component of the safety device and determination of their consequences for the overall safety function. Allows to classify any failure as safe, dangerous, detected or undetected with respect to the safety function

3.17
Probability of a Failure on Demand (PFD)
specifies the average probability of a failure to perform the safety function on demand. In the low demand mode the frequency of demands for operation made on a safety-related system is not greater than one per year and no greater than twice the proof-test frequency

[EN 61508-4]

EXAMPLES FOR LOW DEMAND SYSTEMS Running dry protection, circuit breaker, thermistor relay

3.18
Probability of a dangerous Failure per Hour (PFH)
specifies the failure rate (e.g. per hour) to perform the safety function continuously. This value shall be considered if the safety device is operated in high demand or continuous mode of operation, where the frequency of demands for operation made on a safety-related system is greater than one per year or greater than twice the proof-test frequency

[EN 61508-4]

EXAMPLE FOR HIGH DEMAND SYSTEM Continuous flow control of pressurisation

3.19
Safe Failure Fraction (SFF)
the ratio, expressed as a percentage, of the average rate of safe and detected failures to the total average failure rate of a safety device. A safe failure is a failure which does not put the safety device into a fail-to-function state (see EN 61508-4 and EN 61508-2:2001, Annex C). A detected failure is a failure which is detected by the automatic diagnostic tests, or through normal operation

3.20
Hardware Fault Tolerance (HFT)
ability of a safety device to continue to perform a required function in the presence of faults [EN 61508-4]

EXAMPLE HFT = 1 means, the required function is still performed in the presence of 1 arbitrary fault of the safety device

Regarding the equipment under control, the requisite level of protection is assured in the event of faults occurring independently of each other.

EXAMPLE Category 1 equipment is characterised by HFT=2, which means
- either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection,
- or the requisite level of protection is assured in the event of two faults occurring independently of each other.

3.21
trip level
a threshold for a safety critical parameter pre-adjusted in the safety device. When exceeding this threshold the safety device activates the safety function

3.22
architecture
specific configuration of hardware and software elements in a system

[EN 61508-4]

3.23
channel
element or group of elements that independently performs a function

[EN 61508-4]

EXAMPLE A two channel (or dual channel) configuration is one with two channels that independently perform the same function

3.24
confidence level
the confidence level is the probability, that the confidence interval around the mean value of a statistical distribution of test results includes the real value. It indicates the significance of a statistical evaluation. A specified confidence level for a probabilistic proven-in-use evaluation allows to determine the minimum number of treated demands (low demand mode) or the minimum hours of operation (continuous mode)

[see EN 61508-7:2001, Annex D]

3.25
average ambient temperature
the average ambient temperature is the mean value of the ambient temperature of the components in comparable applications. This may involve averaging temperature fluctuations with time ([5])

4 Ignition prevention by safety devices

4.1 General concept of ignition risk reduction

The ignition risk analysis of electrical apparatus starts with the evaluation of potential ignition sources even under the presumption of faults related to the equipment. If appropriate types of protection (EN 60079 or EN 61241 series of standards) are applied the ignition risk of the protected equipment is reduced to comply with the required equipment category. E.g. if equipment shall be classified in Category 1, even rare incidents related to the equipment must be considered. Hence, the equipment must

- either be safe with 2 faults occurring independently in the equipment. If a type of protection is only safe up to one fault, the fault tolerance of the equipment may be enhanced by the control with an appropriate safety device,
- or, in the event of one means of protection fails, provide at least an independent second means to ensure the requisite the level of protection. For this purpose also a suitable safety device can be used.

For category 2 equipment frequently occurring disturbances or single equipment faults must be considered with respect to potential ignition sources. If equipment would only be safe in normal operation, those disturbances or equipment faults can be controlled with a suitable safety device and the ignition risk reduced correspondingly.

If equipment contains several potential ignition sources, for each ignition source the same consideration must be performed and the ignition risk decreased by appropriate measures. The controlled equipment shall comply with the relevant standards EN 60079-0 and/or EN 61241-0 with respect to the final equipment category.