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Explosion isolation systems

Explosions-Entkopplungssysteme

Systèmes d'isolation d'explosion

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13.230 Varstvo pred eksplozijo Explosion protection

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Explosion isolation systems

Systèmes d'isolement d'explosion

Explosions-Entkopplungssysteme

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 305.

If this draft becomes a European Standard, 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.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

European foreword

This document (prEN 15089:2024) 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 document is currently submitted to the CEN Enquiry.

This document will supersede EN 15089:2009.

The significant changes between this document and EN 15089:2009 are given in Annex H.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document.

1 Scope

This document specifies the general requirements for explosion isolation systems. An explosion isolation system is an autonomous protective system which aims to prevent an explosion pressure wave and a flame or only a flame from propagating via connecting pipes or ducts into other parts of apparatus or plant areas.

This document also specifies methods for evaluating the efficacy of the various explosion isolation systems, and methods for evaluating design tools for such explosion isolation systems when applying these in practice.

This document also sets out the criteria for alternative test methods and interpretation means to validate the efficacy of explosion isolation systems.

This document does not cover flame arresters, diverters, and explosion isolation flap valves. For these devices refer to EN ISO 16852:2016[1], EN 16020:2011, and EN 16447:2014 respectively.

This standard covers e.g.:

a) general requirements for the explosion isolation components;

b) evaluating the efficacy of an explosion isolation system;

c) evaluating design tools for explosion isolation systems.

This document is applicable only to the use of explosion isolation systems that are intended for avoiding explosion propagation between interconnected enclosures, in which an explosion can result as a consequence of ignition of explosive mixtures, e.g. dust-air mixtures, gas-(vapour-)air mixtures, dust-, gas-(vapour-)air mixtures and mists. It is not applicable to detonation events.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1127-1:2019, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

prEN 13237:2022, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN 14034-1:2004+A1:2011, *Determination of explosion characteristics of dust clouds — Part 1: Determination of the maximum explosion pressure* p_{max} *of dust clouds*

EN 14034-2:2006+A1:2011, *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 14373:2021, *Explosion suppression systems*

EN 14460:2018, *Explosion resistant equipment*

EN 15233:2007, *Methodology for functional safety assessment of protective systems for potentially explosive atmospheres*

[1] Will be replaced by EN ISO/IEC 80079-49:2024.

EN 15967:2022, *Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours*

EN 16020:2011, *Explosion diverters*

EN 16447:2014, *Explosion isolation flap valves*

EN 61508:2010, (all parts) *Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508:2010)*

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation (ISO 13849-2:2012)*

EN ISO 16852:2016, *Flame arresters — Performance requirements, test methods and limits for use (ISO 16852:2016)*[2]

EN ISO 80079-36:2016, *Explosive atmospheres — Part 36: Non-electrical equipment for explosive atmospheres — Basic method and requirements (ISO 80079-36:2016)*[3]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 13237:2022, EN 14373:2021, EN 14460:2018 and EN ISO 16852:2016 the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
indicating equipment
IE
explosion protection equipment, which monitors the explosion sensors/detectors and the explosion protection devices

3.2
carbonaceous
refers to any organic material that contains a large amount of carbon content such as char coal, coal, coke, carbon black, lignite including carbon nanotubes (CNTs), graphine and activated carbon (AC)

3.3
closing time
time needed for closing an isolation device

[2] Will be replaced by EN ISO/IEC 80079-49:2024.
[3] As impacted by EN ISO 80079-36:2016/AC:2019.

3.4
closing time of the system
sum of the activation time of sensor, activation time of isolation device and closing time of the isolation device

3.5
explosion diverter
mechanical device, which will divert the explosion to a safe area

Note 1 to entry: It prevents flame jet ignition and pressure piling but cannot effectively stop explosions from travelling, see EN 16020.

3.8
explosion isolation valve
fast acting valve able to stop explosions from travelling through pipelines

3.9
explosion proof interlocked double valve arrangement
device, which will act in closed position as isolation valve

3.10
extinguishing barrier
system that is used to discharge suppressant agent into ductwork to isolate a flame and keep it from propagating to other process areas

3.11
suppressor
vessel with opening mechanism, which upon activation discharges the explosion suppressant into ductwork

3.12
explosion detector
device that responds to an explosion (e.g. developing pressure and/or radiation) and provides a signal to the control and indicating equipment

3.13
flame velocity
S_f
velocity of a flame front relative to a fixed reference point

3.14
installation distance
L
distance between outlet of the enclosure and isolation system

3.15
maximum installation distance
L_{max}
longest distance from the outlet of the enclosure with the potential explosion to the isolation system, which is limited by the explosion resistance of the isolation device or pipe but still guaranteeing a successful isolation

3.16
minimum installation distance
L_{min}
shortest distance from the outlet of the enclosure with the potential explosion to the isolation system guaranteeing a successful isolation

3.17
extinguishing distance
L_E
needed distance behind an extinguishing barrier to guarantee a proper isolation of the flame of an explosion

3.18
barrier activity distance
L_{chem}
total distance given by the sum of the installation distance and the extinguishing distance

3.19
response time
time necessary for actuation of the system after a detection of an explosion

3.20
protected area
area beyond the isolation device, opposite to the ignition source

3.21
$p_{duct, max}$
maximum explosion overpressure measured directly in front of the explosion isolation device

3.22
MESG (dust)
maximum experimental safe gap for dusts, calculated from MIE and MIT

3.23
explosion duration
time period from ignition to the moment of reaching constant atmospheric pressure

4 Requirements of explosion isolation systems

4.1 General

4.1.1 Types of explosion isolation systems

There are several types of explosion isolation systems. They stop either flame or flame and pressure.

Flame (F): objective is to stop flame propagation from travelling beyond the isolation device into the protected area.

Pressure (P): objective is to stop the pressure wave from travelling beyond the isolation device into the protected area.

Explosion isolation systems mitigate against the effects of explosion pressure or flame but do not prevent the transfer of hot or burning particles before or after an explosion.

4.1.2 Explosion protection valve (active or passive) – F&P

To prevent flame and damaging pressure propagation in pipes/ducts, valves or gates may be used which close in a sufficient short time. The closure can be affected by means of an actuating mechanism initiated by a pressure detector or a flame detector or a combination thereof or by the explosion overpressure itself.

NOTE Explosion protection valves need not be gas tight.

4.1.3 Extinguishing barrier (active) – F

The extinguishing medium is dispersed into the pipe/duct to extinguish the flame. The extinguishing medium shall be suitable for the specific explosive atmosphere according to the intended use.

4.1.4 Rotary valve (passive) – F&P

The effectiveness of the rotary valve against flame propagation and its explosion resistance shall be proven. Depending on the number of rotor blades, gap width and gap length, a flame breakthrough can be prevented.

Upon detection of an explosion the rotary valve should be stopped automatically to prevent the transfer of burning material.

NOTE 2 Rotary valves are not gas tight.

4.1.5 Explosion proof interlocked double valve arrangement (passive) – F&P

Enclosures that are explosion-resistant can be protected by at least two explosion proof process valves in series. By means of proper control, it shall be ensured that at least one of the valves is always closed.

Upon detection of an explosion the explosion proof interlocked double valve arrangement should be stopped automatically.

4.1.6 Diverters, explosion isolation flap valves and flame arresters

The isolation systems diverters, explosion isolation flap valves and flame arresters are covered in separate standards (see EN 16020:2011, EN 16447:2014 and EN ISO 16852:2016[4]).

4.2 Essential requirements

4.2.1 General

- Explosion isolation system shall prevent an explosion flame from propagating via connecting pipes or ducts from one part of the installation into other parts or plant areas.
- The system as installed or any of its components shall not introduce ignition hazards, such as electrostatic discharge, mechanical friction, electrical sparks, hot surfaces, or hot gases (according to EN 1127-1:2019).
- The explosion isolation system shall have a defined reliability for safety-functions under the process conditions according to the intended use (according to EN ISO 80079-36:2016).
- The isolation system shall withstand the loads imposed by any explosion that can be expected in accordance with its intended use, without losing its ability to perform its safety function. The construction can be either explosion-pressure resistant or explosion-pressure shock resistant according to EN 14460:2018.

[4] Will be replaced by EN ISO/IEC 80079-49:2024.

- The explosion pressure acting on the explosion isolation device may be higher than the (reduced) explosion pressure of the vessel being isolated as a result of flame accelerations through the ducting and reflections.

- Installation instructions, service and maintenance requirements and intervals shall be specified in the system documentation, (see Clause 7).

4.2.2 Additional requirements to active systems

4.2.2.1 Explosion detector

Explosion detector shall identify the onset of the explosion or the passage of a flame and communicate that to the CIE in time to achieve successful isolation.

NOTE 1 Detection methods can be e.g. based upon static pressure, rate of pressure rise and/or radiation.

If bursting discs, vent panels or explosion doors are fitted with switches or break wires, which actuate an isolation system, the tolerance in activation pressure of the venting device shall be taken into account in the design of the explosion isolation system.

NOTE 2 The performance of explosion detectors depends upon the response time of the detector from detection criteria.

4.2.2.2 Control and indication equipment (CIE)

CIE will actively control the operation of the protection device and provide status indication of the device and is therefore critical for the correct functioning of the device/system.

Control and indication equipment (CIE) shall have a defined reliability in accordance with EN 61508:2010, and ensure explosion isolation system functionality by undertaking the following:

- process detection signals;

- initiate the isolation device;

- initiate interlocks/alarms;

- enable safe isolation;

- enable an automatic and orderly safe-mode of the protected process upon activation, fault / trouble condition.

4.2.2.3 Emergency power

Emergency power shall be specified and facilitated such that full uninterrupted explosion protection is ensured at least four hours after a mains power failure to enable the CIE to accomplish the following actions:

1) power all detection devices;

2) energize all electrically operated actuating devices;

3) initiate visual and audible alarms;

4) transfer all auxiliary control and alarm contacts;

5) control system–disabling interlock and process shutdown circuits;

6) provide interlocks / alarms to signal power failure.

Emergency backup power is not required when the isolation valve closes (fast acting valve) in a failsafe mode automatically at power failure.

4.2.2.4 Extinguishing barriers

4.2.2.4.1 General

Unlike mechanical isolation devices, extinguishing barriers are transient in nature since the duration and pressure of the initiating explosion can cause the extinguishing barrier to become purged from the connection.

Consequently, special design constraints apply to the concept of explosion isolation where extinguishing barriers are used. Their use is typically limited to applications where the source vessel(s) are protected by venting or suppression, but not normally by containment.

Since extinguishing barriers are transitory, scenarios where explosion detection is early or the source explosion pressure pulse duration is very long increase the risk that flame can pass the barrier location and therefore certain limitations are apparent regarding the applicability of specific hardware and process/plant scenarios.

4.2.2.4.2 Suppressors

Suppressors shall inject sufficient suppressant into the duct to establish an effective barrier in the required time and duration. The extinguishing barrier is effective as long as the minimum sectional density of suppressant is maintained.

NOTE The performance of suppressors depends upon at least:

- volume, shape and outlet diameter of the suppressor;
- filling ratio and pressure inside the suppressor;
- opening time of the suppressor.

4.2.2.4.3 Dispersion assembly

The dispersion assembly (nozzle, flexible, hose) shall spread the suppressant into the ductwork to achieve both required throw and spatial distribution / concentration.

NOTE The performance of a dispersion nozzle depends upon at least:

- design of the nozzle;
- characteristics of the suppressor and the suppressant;
- length and diameter of flexible, hose.

Depending on the intended use specific dispersion nozzles can be applied, with special performances, for example to obtain strong directional effects.

4.2.2.4.4 Suppressant

The suppressant shall have dispersion characteristics and extinguishing properties allowing for extinguishing an explosion flame for a given intended use.

NOTE The properties influencing these characteristics include:

- the particle/droplet size distribution;
- chemical and thermal properties.

Apart from the effectiveness of the suppressant applied, also the compatibility of the suppressant with the process shall be considered:

- temperature stability;
- any adverse reaction with the process products;
- toxicity levels of the suppressant.

4.3 Functional safety

Systematic and transparent system analyses shall be made in all design stages to prevent potential defects. This methodical and comprehensible design approach ensures a clearly specified level of functional safety.

Dependent on the specific type of application a first identification of the required level of safety and the resulting safety functions for the explosion isolation system followed by an assessment of functional safety shall be done (see Annex D for further information).

The reliability of the isolation system shall be quantified by the manufacturer according to EN 61508:2010 and EN ISO 13849-1:2015 and EN ISO 13849-2:2012 where appropriate.

The minimum requirements shall include supervision of the following:

a) wiring circuits for continuity, earth faults and open circuits;

b) mains power supply;

c) emergency power supply;

d) system safety interlock circuitry;

e) system-disabling interlock circuitry;

f) electrically operated actuating devices;

g) detection devices;

h) health monitoring of isolation device (e.g. pressure of suppressors).

In addition, one shall assess the functional safety according to EN 15233:2007 where appropriate. As a minimum the following aspects shall be addressed:

1) design faults in the hardware;

2) adverse environmental conditions, including electromagnetic disturbance;

3) design faults in the software.

In case of an identifiable fault such that the safety function of the system cannot be guaranteed to the agreed level of safety integrity, the isolation system shall provide a fail-safe means to place the installation into a safe condition.

Reliability and functional safety of the mechanical parts shall be assessed according to the application. Regular maintenance shall be described in relationship to the application.