Explosion prevention and protection in underground mines — Equipment and protective systems for firedamp drainage

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British Standards

National foreword

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Explosionsschutz in untertägigen Bergwerken - Geräte und Schutzsysteme zur Absaugung von Grubengas

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Foreword

This document (EN 14983:2007) 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 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2007, and conflicting national standards shall be withdrawn at the latest by September 2007.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 Directive(s).

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

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Introduction

Firedamp drainage is a technical process for selected gas removal, the purpose of which is to reduce the risks presented by inflammable gas and air mixtures. Firedamp drainage is therefore a measure for preventive explosion protection.

In the mining industry, firedamp is drained from the underground workings of gassy mines, from boreholes and abandoned mine workings to ensure that mine workers are not exposed to the risks associated with the occurrence of an explosive atmosphere at their place of work. In this case, the explosion risk results from unacceptable accumulations of firedamp occurring in the waste areas and cavities left in the in the rock strata after the coal has been extracted from the coal seam. In such cases, the need to drain these accumulations, and the complexity of the drainage system, depends on the amount of firedamp produced by the coal and the likelihood of it occurring in explosive quantities in the mine roadways and coal face. Examples of situations that might cause firedamp to move in dangerous concentrations from the waste area or cavities into the mine roadways: a breakdown of the mine ventilation system or a sudden reduction in the underground atmospheric pressure. National legislation in EU coal mining member countries requires workers to be withdrawn to a safe place if firedamp levels attain a specific nationally defined value in the general body of mine air. Firedamp drainage is therefore often used in gassy mines in an attempt to ensure that the concentration of firedamp in the general body of mine air is kept well below this critical level, even during abnormal situations such as those described above.

Once the accumulations of firedamp have been drained from the affected areas, it is usually discharged to the mine surface, but in some cases it is discharged into the mine return ventilation system. In systems where the firedamp is brought to the mine surface, it is discharged to the atmosphere through an earthed metallic discharge stack or pressurized and delivered to a utilisation system, such as a gas-fired boiler.

In abandoned mines, firedamp drainage is used

— to prevent gas pressure building up and gas issuing at the surface in an uncontrolled manner, and

— to protect workers at an adjacent nearby mine or

— to allow it to be utilized, for example by burning it in a gas-fired boiler to produce heat or to generate electricity.

1 Scope

This standard specifies the requirements for equipment and protective systems for firedamp drainage at mines. It also contains requirements for the construction and monitoring of this equipment and protective systems (see EN 1127-2).

This standard does not apply to firedamp utilization systems beyond the utilization shut-off device.

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 1127-2:2002, *Explosive atmospheres — Explosion prevention and protection — Part 2: Basic concepts and methodology for mining*

EN 1710:2005, *Equipment and components intended for use in potentially explosive atmospheres in underground mines*

EN 1333, *Flanges and their joints — Pipework components — Definition and selection of PN*

EN 12874, *Flame arresters — Performance requirements, test methods and limits for use*

EN 13237:2003, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

prEN 15089, *Explosion isolation systems*

prEN 61024-1, *Protection of structures against fire, explosion and life hazards*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1127-2:2002 and EN 13237:2003 and the following apply:

3.1
electrostatic leakage resistance
electrical resistance measured between an object and earth

3.2
active explosion isolation system
system which is designed to be activated by a detector and control and indicating equipment (CIE) which are inherent parts of the system and stop explosions from travelling through pipelines or limit destructive effects of the explosion

[prEN 15089:2004, 3.12.1]

3.3
starting by-pass
temporary and specific by-passing of a safety device when starting the exhauster of a firedamp drainage plant

3.4
design pressure
p_d
pressure at the top of each chamber of the pressure equipment chosen for the derivation of the calculation pressure of each component[2]

[EN 764-1:2004, 3.10]

3.5
pressure
pressure relative to atmospheric pressure, i.e. gauge pressure. As a consequence, vacuum is designated by a negative value

[EN 764-1:2004, 3.3]

3.6
flame arrester
device fitted to the opening of an enclosure or to the connecting pipework of a system of enclosures and whose intended function is to allow flow, but prevent the transmission of flame

NOTE This device should not be confused with a fire barrier, which is ineffective in case of explosion.

[EN 13237:2003, 3.41]

3.7
firedamp
any potentially explosive mixture of flammable gases naturally occurring, which may form a hazardous mixture when combined with air

NOTE As firedamp mainly consists of methane, in mining practice, the terms “firedamp” and “methane” are frequently used as synonyms.

[EN 1127-2:2003, 3.1]

3.8
firedamp collector pipe
gas pipes connected directly to one or more boreholes or gas drainage points

3.9
firedamp mains pipe
gas pipes connected to more than one gas collector pipe

3.10
extinguishing system
system that is used to discharge suppressant agent to extinguish flame and keep it from propagating into the vent pipe

3.11
technically leaktight
made in such a way that no changes in gas composition occur.

NOTE 1 Gas pipes, items of plant and equipment, including all detachable and non-detachable connections can be technically leaktight.

NOTE 2 The term “technically leaktight” means that diffusion through statically stressed seals can occur.

3.12
t_{90}-path
distance between the monitoring position and the shut-off device

NOTE This distance depends on the measured gas/air mixture, taking account of the velocity of flow, the response time (according to EN 61779-1) of the measurement device, the tripping time and the closing time of the rapid shut-off device; the response time is the time taken to achieve 90% of the final indication.

4 Equipment and protective systems for firedamp drainage

4.1 General

Electrical and mechanical equipment used in firedamp drainage shall not pose an explosion risk. For this reason:

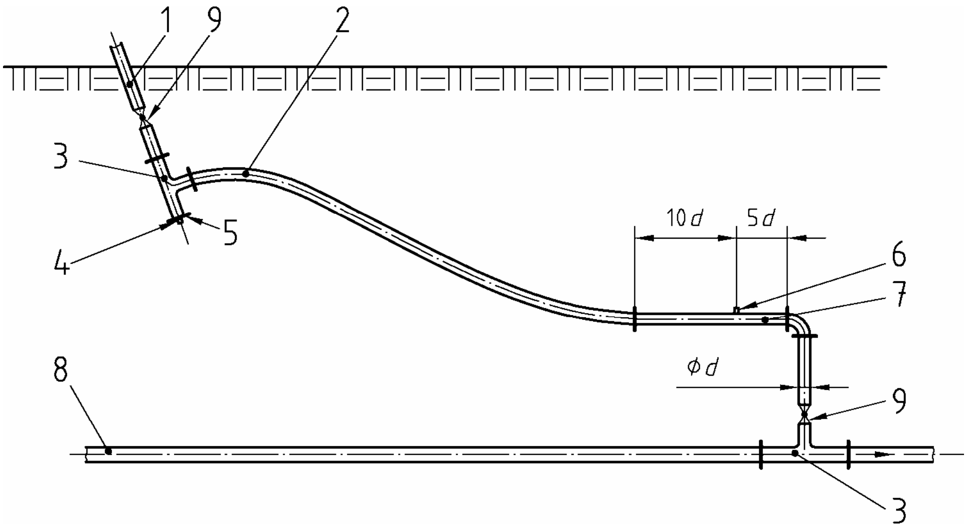
- equipment used in the firedamp drainage systems where flammable gas is likely to occur shall be explosion protected either Group I Category M1 or M2, or, if on the surface, Group II Category 1 or 2;
- where measuring equipment is in direct contact with firedamp/air concentration within the explosive range (e.g. the purity measuring instruments), it shall be category M1 ignition protected. In surface installations, Group II, Category 1 equipment may be used;
- the drainage system shall have a facility to allow it to be shut down, usually automatically, where the concentration of extracted firedamp in the pipework reaches a prescribed limit, taking into account the response time of the monitoring equipment and the t_{90}-path (see Annex E).

NOTE 1 Care is needed during start-up of the firedamp drainage system when the pipework will be full of air and will at some stage pass through the explosive range.

NOTE 2 Normally, the explosive range for firedamp/air mixtures is specified within a range of about 5 % by volume to 15 % by volume methane. Automatic shut down usually takes place when a methane concentration reaches a level of approx. 22 % by volume.

4.2 Borehole standpipes

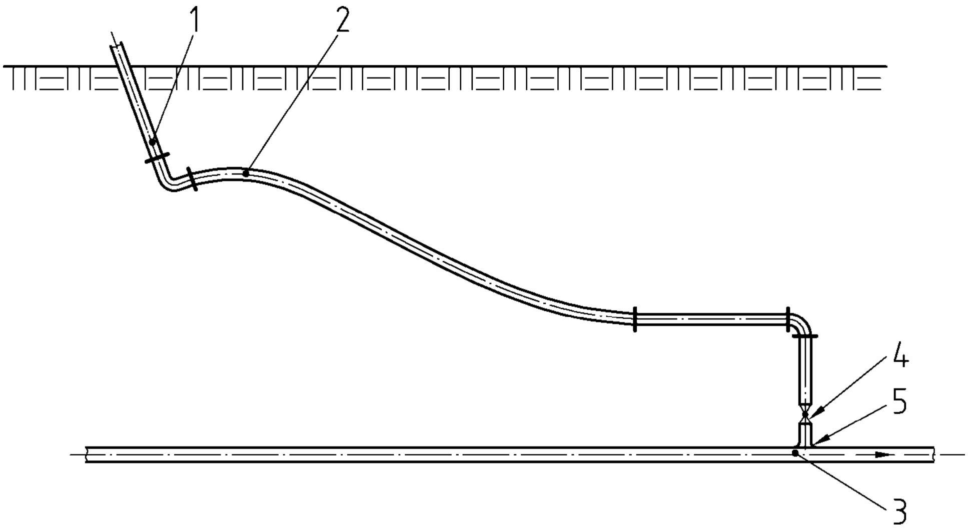
Standpipes shall be made in such a way that devices (Y- or T-pieces) for the insertion of borehole probes can be attached to them. The standpipe shall have connection facilities to allow it to be connected, it shall be made in such a way and arranged so that no reduction in cross-section occurs, and should contain a suitable facility for measuring the volume flow and vacuum pressure where the boreholes are accessible for measuring and taking firedamp samples, e.g. a measuring section (see Figures 1 to 4).



Key

d Diameter
1 Borehole standpipe
2 Flexible hose suitable for the required flow and pressure
3 T-piece
4 Connection for water separator
5 Facility for measurements
6 Facility for measurements
7 Measuring section
8 Collector pipe
9 Shut off device

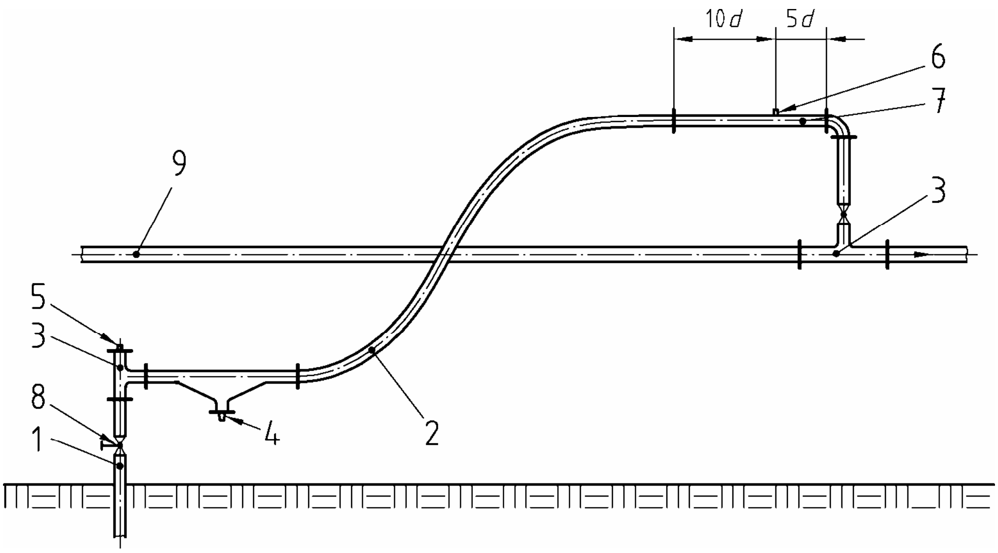
Figure 1 — Example of connection of roof borehole to collector pipe when measurement and control are accessible



Key

1 Borehole standpipe
2 Flexible hose suitable for the required flow and pressure
3 Collector pipe
4 Shut-off device
5 Suitable connection for collector pipe

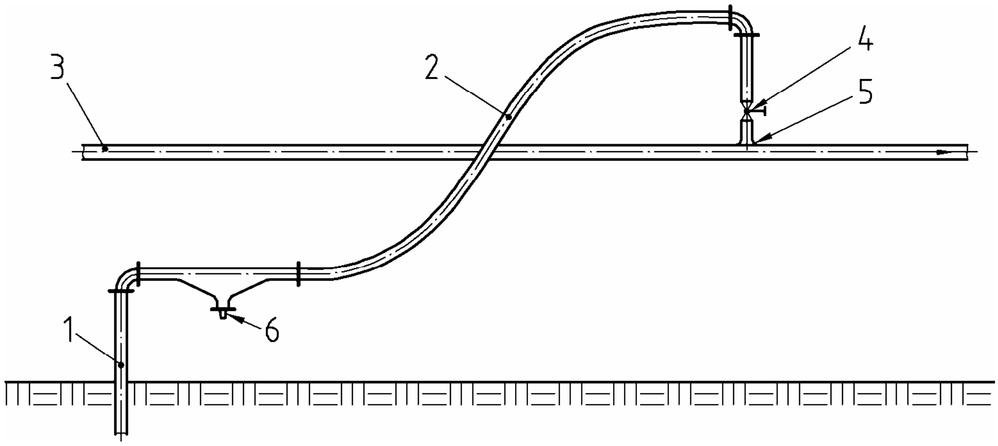
Figure 2 — Example of connection of roof borehole to collector pipe when measurement and control are not accessible



Key

d Diameter
1 Borehole standpipe
2 Flexible hose suitable for the required flow and pressure
3 T-piece
4 Connection for water separator
5 Facility for measurements
6 Facility for measurements
7 Measuring section
8 Shut-off device
9 Collector pipe

Figure 3 — Example of connection of floor borehole to collector pipe when measurement and control are accessible



Key

1 Borehole standpipe
2 Flexible hose suitable for the required flow and pressure
3 Collector pipe
4 Shut-off device
5 Suitable connection for collector pipe
6 Water separator

Figure 4 — Example of connection of floor borehole to collector pipe when measurement and control are not accessible

4.3 Drainage pipes for seals and stoppings

When firedamp drainage pipes are installed in seals and stoppings to drain methane, pipes shall be of sufficient diameter, equipped with devices for controlling firedamp flows and be monitored in accordance with 4.2.

The requirements of 4.2 are to be applied accordingly for gas measuring devices in seals and stoppings.

4.4 Water separators at drainage points

Where water is a problem, water separators should be provided between the drainage points and the measuring sections. These separators shall be made in such a way that they can separate any water that collects in the gas pipe without allowing the admission of the ambient atmosphere.

4.5 Firedamp pipes

4.5.1 General requirements for firedamp pipes

Firedamp pipes and their fittings (e.g. shut-off devices, controls, borehole connections) shall comply at least with the nominal pressure stage PN 6 (see EN 1333). This strength rating is sufficient provided that the permissible operating pressure in the gas drainage plant, based on the design of the exhauster and/or regulating equipment, does not exceed 0,3 bar.

Firedamp pipes shall only be fitted with pipe connections which are deemed suitable and necessary for operation and control purposes.

Shut-off devices shall be provided in firedamp pipes in such a way that each branch pipe can be shut off independently.

With the exception of the drainage points, all pipes shall be manufactured exclusively from materials suitable for the transportation of methane underground.

Firedamp pipes shall be installed in such a manner as to be protected from damage.

Where necessary, vertical firedamp pipes shall be secured by the fitting of expansion pieces.

Firedamp pipes are to be positioned in such a way that any water which collects in the pipes can be removed. Connections for water separators are to be provided at the lowest points and in the transfer zone between the horizontal and the vertical pipe sections.

Where required, firedamp pipes are to be protected from the effects of frost and freezing.

4.5.2 Measuring points for measuring equipment in firedamp drainage pipes

Measuring points shall be provided at all places where the gas collector pipe joins a firedamp drainage main and where the firedamp main enters a mine shaft. A damping section of at least $10 \times d$ shall be maintained in front of the measuring point, and a further damping section of at least $5 \times d$ behind it.

Measuring points in firedamp main pipes, installed for monitoring pipes for leakage, shall be sited at a minimum distance of $70 \times d$ behind points where the firedamp collector pipes join.

The dimensions of the measuring points shall be determined on the basis of the measuring equipment being installed.

4.6 Pressure vessels in firedamp drainage plant

Where pressure vessels are used in firedamp drainage plants the design pressure p_d of pressure vessels shall be at least 6 bar pressure.

NOTE Systems operating below 0,5 bar pressure are not considered to be pressure systems.

4.7 Exhausters

4.7.1 Requirements for exhausters

Each exhauster shall have a manufacturer’s certificate stating that its housing has withstood a water-pressure test for at least a 6 bar design pressure.

NOTE For further information see Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

For materials of exhausters, requirements for fans according to EN 1710:2005, 5.3 have to be applied.

Where exhausters operate below 0,5 bar pressure, they shall be tested in accordance with the manufacturer's requirements.

Exhausters shall be fitted with a temperature limiting device at the gas exit side according to the maximum permissible operating temperature recommended by the manufacturer, unless other technical measures can be used to prevent the permissible operating temperatures from being exceeded. The limiting device shall be adjusted so that the maximum permissible compression temperature specified by the manufacturer cannot be exceeded. Fluid-ring exhausters shall be monitored so that they are shut down automatically and immediately in the event of fluid deficiency. At the same time as this shut-down, an audible and visual warning signal shall also be emitted at the permanently manned position (see A.4).

Exhausters (e.g. rotary compressors, fluid-ring exhausters and discharge nozzles) and pipe mains shall be designed so that a sufficient vacuum is available at each firedamp drainage point.

Where practicable, exhausters shall be fitted additionally with:

- inlet and outlet gas pressure monitors;
- indicators showing the state of all inlet, outlet and bypass valves;
- mechanical fault monitoring (including driving motor) including an audible and visual warning signal;
- indicators showing the state of power supply to driving motors.

All devices intended to automatically cut off power supply shall be designed so that they can only be reset at the location of the exhauster.

The control system shall ensure, that exhausters cannot be started unless the outlet valve is open, and if the outlet valve closes while the exhauster is running the exhauster is shut down.

4.7.2 Reserve exhausters

Exhausters shall be designed in such a way that they can be changed easily due to maintenance or after breakdown.

NOTE The number of exhausters should be sufficient to cater for the maximum expected volume of firedamp, and additional capacity should be provided for periods when exhausters would be unavailable.

4.7.3 Location of exhausters

Exhausters for firedamp drainage are, in principle, to be installed above ground. The place of installation is subject to the regulations which apply to areas where there is a risk of fire and explosion. Examples of requirements for the location of exhausters are given in Annex C.

Firedamp which is released into the water collector tanks of liquid-ring exhausters shall be removed in a safe manner. If necessary, an explosion barrier is to be provided at the discharge end.

4.8 Venting of the drained firedamp

Where firedamp is vented underground, the point of discharge shall have a dilution chamber around it, so located that when firedamp discharge is taking place the concentration of firedamp at the dilution chamber outlet does not exceed a value which has to be defined taking into account the LEL of methane and the local explosion safety requirements.

NOTE The values are normally defined in national regulations.

Firedamp drainage plants above ground shall be provided with a firedamp pipe which allows the firedamp to be vented to the atmosphere (firedamp vent pipe).

In practice, the mouth of the surface firedamp vent pipe shall be defined by a risk assessment, but it shall be:

- at a minimum distance of 20 m, measured radially, from surface shafts and any areas presenting a fire or explosion hazard. This shall not apply to the location of an exhauster);
- at least 10 m above ground level and 3 m above any buildings sited within a radius of 20 m.

Any possible ingress of water into drainage pipes shall be considered.

Firedamp vent pipe outlets on the surface shall be protected against risks from lightning.

4.9 Explosion prevention systems for pipelines

4.9.1 Explosion barriers

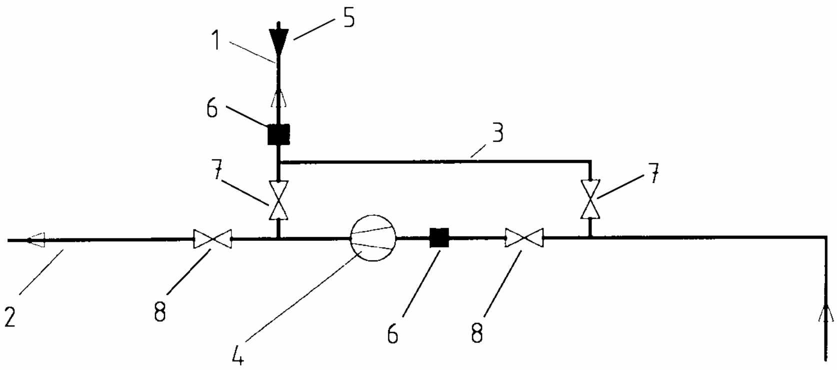
Explosion barriers (flame arrestors according to EN 12874 or active explosion isolation systems according to prEN 15089) shall be provided:

— at firedamp vent outlets, designed and located to prevent an explosion at the vent outlet propagating in the direction of the exhauster;

— in the drainage pipes between the pressure generator and the mine, designed and located to prevent an explosion at the exhauster propagating in the direction of the mine.

It is acceptable to dispense with the installation of an explosion barrier between the exhauster and the mine provided that the exhauster is of the water-filled fluid-ring non-sparking type, subject to a minimum flow of water through the pump being proven.

Measures shall be taken to ensure that a flame cannot propagate into the pipeline system of the firedamp drainage plant via feed pipes leading to firedamp measuring equipment or shut-off devices.



Key

1 Vent pipe
2 Utilisation pipe
3 Circulating pipe
4 Exhauster
5 Vent outlet automatic extinguishing system
6 Explosion barrier (flame arrester with extinguishing system or active explosion isolation system)
7 Shut-off device
8 Rapid-action shut-off device

Figure 5 — Example of explosion prevention system for pipelines with one firedamp vent pipe

4.9.2 Non-flammable firedamp vent pipe outlets and flame arrester outlets

Non-flammable firedamp vent outlet pipes and flame arrestor outlet pipes shall be equipped with an automatic extinguishing system, including temperature sensors and extinguishing containers. The fire extinguishing system shall quench the fire on the ignition source side within 60 s.

It is acceptable to dispense with the installation of an automatic extinguishing system at the outlet vent pipe if the flame arrester is 3 m or closer to the outlet and the extinguishing system of the flame arrester covers the vent pipe outlet also.

It is acceptable to dispense with the installation of an automatic extinguishing system at the outlet to a flame arrester if an automatic rapid-action shut-off device closes on detection of a flammable mixture and the endurance time of the flame arrester is greater then the duration of the flammable mixture.

It is acceptable to dispense with the installation of an automatic extinguishing system at the outlet vent pipe if it is equipped with a flame or temperature detection system, which shall cause automatic rapid-action shut-off devices to be operated that will stop the flow of firedamp to the outlet**.**

4.9.3 Reserve container and operating state

Each extinguishing medium container which is intended for the extinguishing of fires and explosions shall be provided with a second container (reserve container) and be connected to the firedamp pipes.

The reserve containers used in extinguishing systems shall be capable of being activated manually as soon as practicable after the initial activation of the extinguishing system.

The reserve containers in active explosion isolation systems containing an extinguishing medium shall operate automatically after the initial activation of the explosion isolation system.

The operational readiness of extinguishing systems and active explosion isolation systems, their activation history and any faults which may be present shall be displayed in the firedamp drainage plant and this information shall be relayed to a permanently-manned station (mine safety room or similar).

4.10 Requirements for the design of electrical safety devices

The measurement, control, regulation safety devices including increased-performance telecommunication circuits (e.g. in monitoring, measurement and limit-value circuits) shall be designed in accordance with EN 61508. The appropriate safety integrity level (SIL) according to EN 61508 shall be defined as a result of a risk assessment.

If part of the measurement, control, regulation system fails, measures shall be introduced in such a way as to prevent the shutdown of the entire firedamp drainage plant.

A starting by-pass is permissible provided that the operation of the constructional explosion protection system (flame arresters, fluid-ring non-sparking exhausters or active explosion isolation system) is ensured during this period.

Devices for by-passing safety equipment shall be set up in such a way that they can only be activated by authorized persons.

In the case of fixed measuring equipment, a two-way interlock shall be provided such that, when maintenance and calibration work is being carried out, one measurement device is always available to maintain the monitoring and shut-down system.

A manually-operated emergency stop switch shall be provided at each exhauster. This emergency stop switch shall be mechanically latched to prevent unintentional release.

4.11 Electrostatic ignition risks

In order to prevent electrostatic charges, all pipes shall be bonded together and earthed. A leakage resistance of $10^9\ \Omega$ shall not be exceeded at any point along the pipe circuit.

Measures shall be taken at discharge nozzles to prevent electrostatic discharges arising. A leakage resistance of $10^9\ \Omega$ shall not be exceeded.

The earth connections shall be made substantially strong to withstand the mining environment.

Firedamp vent pipes and conducting parts that are in contact with the stream of firedamp being vented shall be interconnected to form an equipotential bond.

5 Instructions for installation and use

The instructions for installation and use shall take into account the information on installation and use of the firedamp drainage system and monitoring of the firedamp drainage system (see Annex A and Annex B).

Annex A
(informative)

Installation and use of firedamp drainage system

A.1 General

The design and equipment of the firedamp drainage plant, such as deployed exhausters, safety equipment and water separators, should be arranged in such a way that the safety-related requirements of the standard are met and the gas drainage plant can be operated in a safe and reliable manner.

Gas drainage points should be cased and sealed.

If, when preparing the gas drainage points, the quantity of firedamp anticipated is such that the airflow is no longer sufficient to ensure an immediate and adequate dilution of the firedamp, a standpipe should first be installed and sealed. The firedamp should then be drained- off using appropriate equipment, with special attention being paid to the gas pressure.

Gas drainage points which are not connected to the firedamp pipe and are accessible should be sealed in a safe and gastight manner. Means should be provided for taking firedamp samples and for measuring the firedamp pressure for as long as the gas drainage points are accessible.

Recognized leaks in firedamp pipes should be rectified immediately.

Firedamp pipes should be installed in upcast shafts.

Each firedamp drainage point should be assigned a permanent identification mark.

Firedamp pipes should be clearly and visibly identified by means of a yellow paint mark applied to the flange connections or by means of a ring of yellow paint at least 50 mm in width to be applied to both ends of each pipe.

Shut-off devices are to be clearly and visibly identified by means of yellow paint.

A.2 Work on firedamp pipes

When undertaking work on firedamp pipes which involves opening up the pipes, it is necessary to consider how this will affect the methane content of the mine air.

When replacing pipeline components, the section of pipe concerned can be flushed using the exhauster. For this purpose, the shut-off device located ahead of the working point in the direction of flow should first be closed, and then the pipe behind the shut-off device should be opened and visibly separated so that mine air can enter the pipe and flush it clear.

Care should be taken to ensure that there is sufficient flushing velocity in the pipeline (≥ 2 m/s) and that the flushing time t_{flush} is maintained in accordance with the following equation:

$$t_{flush} = 5 \times \frac{pipelength}{velocity} \quad \text{(A.1)}$$

The flushed section of pipe should be protected by sealing plates. After flushing has been completed, measurements should be carried out to establish that the methane content in the pipeline is not greater than that of the surrounding atmosphere.

If methane drainage pipes are located in trolley-wire roadways where firedamp may present a hazard when maintenance and/or alteration work is being carried out on the firedamp pipes, the trolley wire should first be de-energized and protected against re-connection. On completion of the maintenance or alteration work the pipe should first be re-connected in the direction of the exhauster and then in the direction of the firedamp drainage point.

A.3 Measures to be taken when gas levels fall below or exceed limit values during firedamp drainage

Where possible, the methane content of the drained firedamp mixture should be at least above the limit value at the firedamp drainage points. If the methane content of the drained firedamp mixture falls below the limit value, measures should be taken to increase the methane level (e.g. re-sealing of the standpipe, reducing the applied pressure).

The methane content of the firedamp mixture at the end of the gas collector pipes and in firedamp mains pipes shall be at least above the limit value. If the methane content of the firedamp mixture falls below the minimum limit value, measures are to be taken to restore the methane content to an acceptable level.

If the methane content of the firedamp mixture at the final measurement point before the exhauster falls below the limit value, this should be indicated by a warning signal.

If the methane content of the firedamp mixture at the final measurement point before the exhauster falls below the limit value, the exhauster should immediately shut down automatically. This does not apply to cases where the methane content falls below the limit value for short periods when a firedamp drainage plant is being brought into service (see 4.9.2). Manual by-pass devices should only be activated on instructions from a responsible person. Cases in which a by-pass is allowed should be specified in writing.

If the firedamp mixture is being delivered to a utilizing plant, the pipeline supplying the firedamp mixture to the user should be immediately shut off automatically as soon as, and as long as, the methane content is below the limit value (automatic rapid-acting shut-off device).

Where continuous monitoring of the carbon monoxide content of the firedamp mixture is carried out and the carbon monoxide content rises above the operationally established basic value, the source of the carbon monoxide should be identified, as this may indicate the presence of a mine fire. Gas drainage points which display increased or rising carbon monoxide contents should be shut down.

A.4 Failure or shutdown of exhausters

In the event of failure of exhausters, an audible and visual signal should be emitted at the permanently-manned station.

The operator or a person appointed by him should draw up a plan for those measures which are to be taken in the event of a significant reduction in the output, or complete failure, of exhausters, so that safety levels are maintained. The output of exhausters is considered to be significantly reduced if the pressure falls by more than half or if the drained volume flow is reduced by more than half.

In the event of shutdown of main fans or booster fans or of auxiliary ventilated equipment other than headings, the surface firedamp drainage plant should not be taken out of service unless this is to prevent a dangerous situation arising.

In order to rectify faults to firedamp drainage plant, at least one competent person who has been appointed by the operator should be contactable at all times.

Annex B
(informative)

Monitoring of firedamp drainage system

B.1 Examination and inspection by competent persons

Examination and inspection of all the methane drainage system and equipment should be carried out by competent persons at suitable intervals according to individual national legislative requirements.

B.2 Measurement of the drained firedamp mixture and pressure

B.2.1 Measurements taken by hand

Where possible, volume flow and methane content of the drained firedamp mixture and the applied pressure should be measured at the gas drainage points at least once every week. Gas drainage points which are no longer connected to the firedamp pipe, but which are still accessible, should be kept under observation in respect of their gas emission characteristics.

At measuring points, which shall be provided in the firedamp collector pipes in accordance with 4.5.2, methane contents should be tested twice a week at minimum intervals of two days. When testing for carbon monoxide content is required, this should be carried out at maximum intervals of one week. Volume flow and the pressure should also be measured at least at weekly intervals.

The methane content of the firedamp mixture and, if necessary, the volume flow and the pressure, should be measured at intervals of not more than 14 days at measuring points which, in accordance with 4.5.2, shall be provided before the firedamp mains pipe enters a mine shaft.

B.2.2 Fixed monitoring equipment

If the methane and/or the CO content in a firedamp collector pipe are being monitored using a fixed monitoring device, the measurements specified in B.2.1, paragraph 1, only need to be taken at intervals of not more than 14 days and the relevant measurements specified in B.2.1, paragraph 2, only need to be taken as and when required.

If the methane content in the firedamp mains pipe before it enters a mine shaft (see 4.5.2) is being monitored using a fixed monitoring device, the measurements specified in B.2.1, paragraph 3, only need to be taken as and when required.

At the monitoring points where the methane content is being monitored on a fixed basis, volume flow and pressure should also be measured using fixed monitoring equipment.

Irrespective of B.2.2, paragraphs 1 and 2, the methane content of the firedamp mixture in the area of the exhausters or at the start of the t_{90} path (see example in Annex E) should be monitored using fixed methane monitoring equipment by means of which the warning signals and switching functions laid down in A.3 are automatically and immediately triggered. The t_{90} path should be designed as technically leaktight or should be monitored for leaks. The triggering of switching functions should be indicated by warning signals. At exhausters, total volume flow and pressure should be monitored by fixed monitoring equipment.

The measurement data from fixed monitoring equipment of the plant should be recorded (e.g. using plotting recorders or electronic data recording systems as indicated in 4.10) and transmitted to the permanently-manned station. Warning signals indicating that limit values have been reached should also be triggered audibly and visually at this station.

B.3 Documentation

A record should be kept of the results of the tests laid down in B.1.

A record should be kept of the results of the measurements as laid down in B.2, as well as of the drilling sites and the length and direction of the boreholes.

The measured data related to the monitoring equipment used in the firedamp drainage system should be kept for at least 6 months.

A record should be kept of all incidents associated with the operation of the firedamp drainage plant and equipment (e.g. safety equipment faults and responses, failure or shutdown of exhausters).

B.4 Firedamp circuit plan

A scale plan should be drawn up of the underground firedamp drainage circuit, which should include branch pipes leading to the gate-roads, and this should be amended as and when alterations are made to the circuit (firedamp drainage circuit plan). The firedamp drainage circuit plan should contain the following information:

— location of exhausters and routing of firedamp pipes;

— nominal diameter of the pipes;

— location of the shut-off devices;

— location of the monitoring points;

— location of the water separators;

— stoppings which under normal circumstances are being drained;

— installation points of mechanical flame barriers and extinguishing-agent barriers.

Annex C
(informative)

Requirements for location of exhausters

A risk assessment shall be carried out taking into consideration the points for location of exhausters. Examples of requirements are given below:

— exhausters shall be located within a suitable housing that is of fire-resistant construction;

— any adjoining room should be sealed from the exhauster housing;

— there should be no enclosed pockets where firedamp could accumulate;

— walls should be solid or have a ventilated cavity;

— there should be no under-drawn ceilings;

— permanent natural ventilation of the housing should be provided;

— the housing shall have general body monitoring with alarm to the Mine Control Room and shutdown of exhausters at specific nationally defined values relative to the lower explosion limit of firedamp;

— the housing shall have means of detecting and warning of outbreak of fire;

— telephone communication shall be provided between the place of installation and the Mine Control Room.

Annex D
(informative)

Requirements for gas removal equipment for abandoned surface outlets

A risk assessment shall be carried out for the use of gas removal equipment. Some examples of requirements for gas removal equipment for abandoned surface outlets are given in Table D.1. A distinction shall be made between three types of applications:

Type I: active drainage of abandoned surface outlets with connection to abandoned workings;

Type II: passive gas removal from abandoned surface outlets with connection to abandoned workings;

Type III: passive gas removal from abandoned stowed/sealed surface outlets.

NOTE The efficiency of protective systems may be reduced if water condenses when the dew point is reached.

Safety requirements are to be laid down in specific cases in respect of active gas removal equipment (Type I).

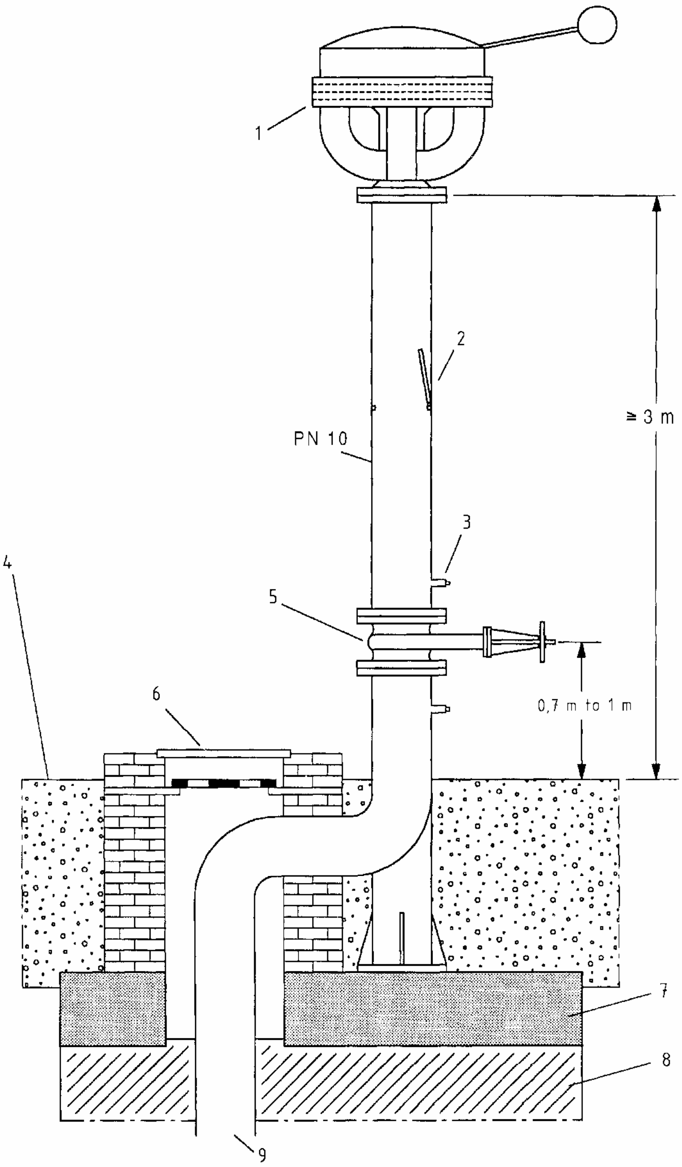
Table D.1 — Requirements for gas removal equipment for abandoned surface outlets

Degassing equipment		Active Type I	Passive Type II	Passive Type III
Design and equipment	Minimum height above floor level	see 4.8	3 m	3 m
	Stability	PN 6	PN 10	PN 10
	Protection at discharge end	Flame arrester and either automatic fire extinguishing equipment or automatic rapid-action shut-off device	Flame arrester	Flame arrester
	Automatic shut-off device	x	–	–
	Manual shut-off device	–	x	x
	Regulating equipment	x	x*)	–
	Non-return valve	–	x*)	–
	Control measurement connections	x	x	x
	Earthing/lightning protection to prEN 61024-1	x	x	x
	Requirements for mechanical explosion barrier	PN 6	PN 10 + continuous fireproofing	PN 10 + continuous fireproofing
	Refilling aperture	–	gastight	gastight
Protection equipment	Starting/overrun protection	–	x	x
	Protection from manipulation	x	x	x
Safety/protection zones	Minimum distance from discharge end for roadways and buildings which are at least 1 m lower than the discharge end	see 4.8	Radius 10 m	Radius 10 m
	Minimum distance from buildings whose height is greater than the discharge end	see 4.8	Radius 15 m	Radius 15 m
	Minimum distance from areas where there is a risk of fire and explosion	see 4.8	Radius 20 m	Radius 20 m
Other requirements	Provision of signs for areas which present a risk of fire and explosion	x	x	x
	Handwheel for shut-off device	–	Dismantle or lock	Dismantle or lock
	Examination and testing by competent persons	see B.1	see B.1	see B.1

*) alternative

In Table D.1:
x = is required
– = is not required

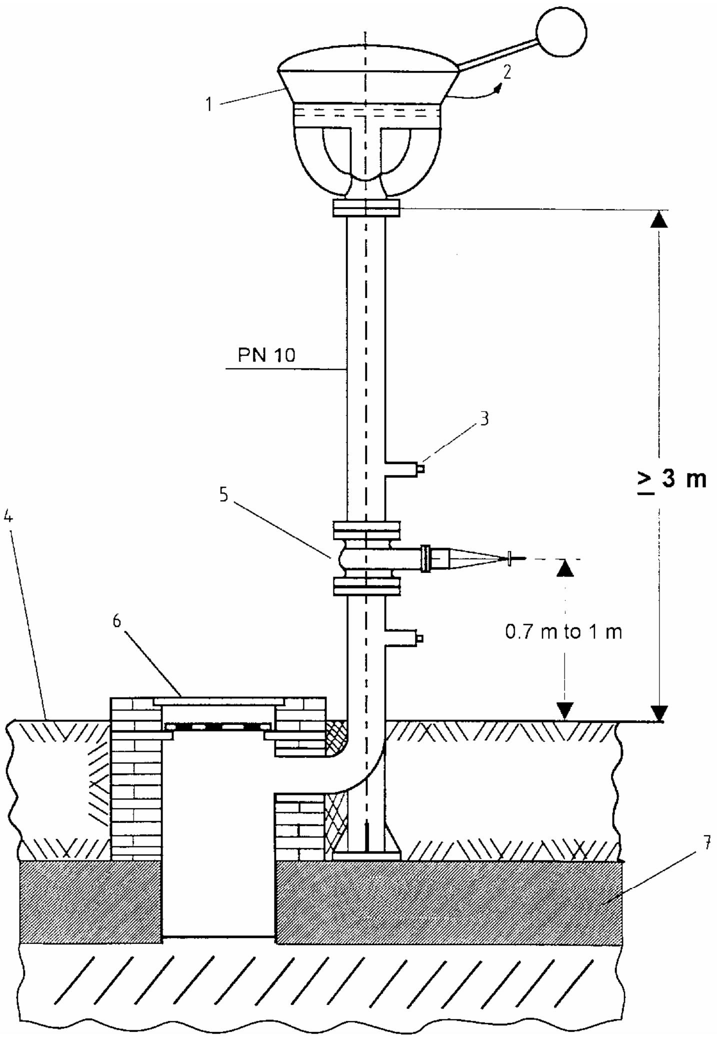
Examples of the fundamental design of passive gas removal systems in respect of their safety equiments are shown in Figures D.1 and D.2.



Key

1 Mechanical explosion barrier
2 Non-return valve (alternative regulating equipment)
3 Monitoring point
4 Top of surface or walkway level
5 Shut-off device PN 10
6 Refill opening
7 Covering plate
8 Shaft plugging
9 Connection to abandoned workings

Figure D.1 — Passive gas removal equipment (Type II)



Key

1 Mechanical explosion barrier
2 Gas exhaust
3 Monitoring point
4 Top of surface or walkway level e.g. when constructed on buildings
5 Shut-off device PN 10
6 Refill opening
7 Covering plate

Figure D.2 — Passive gas removal equipment (Type III)

Annex E
(informative)

Example for calculation of t_{90} path

E.1 General

A sufficiently safe length of the t_{90}-path exists when from the CH_4-measuring device (1) to the rapid shut-off device (2), the flow time of a gas mixture is not less than the total of the t_{90}-time and any other delays resulting prior to full shutting off of the gas pipe by the rapid shut-off device.

Most of these total times to be considered for safety are defined by the CH_4-measuring device. However, any other delays from triggering switching by the CH_4-measuring device until fully reaching the protection target (in this case: shutting off the gas pipe by a rapid shut-off device) shall not be neglected in the process.

E.2 Example for calculation of t_{90}-path

An example of a schematically-drawn situation (see Figure E.1) will be used to examine how large the distance (the total of partial paths S_1, S_2 and S_3) shall be between a CH_4-measuring device (1) and a rapid shut-off device (2) in order to meet the length requirements for a t_{90}-path, with the gas pipe diameter of all partial paths being identical.

The following data will be used for calculation:

Speed of gas mixture between 1 and 2	$v_{1\text{-}2}$ = 20 m/s
t_{90}-time of CH_4-measuring device	t_{90} = 38 s
Other delay times	t_s = 2 s
	$t_{90} + t_s$ = 40 s

Any other delay times t_s result, for instance, from the time delay of the CH_4-measuring device control signal before triggering the shut-down procedure, based on the response time of the shut-off device to full shut off and any other time delays.

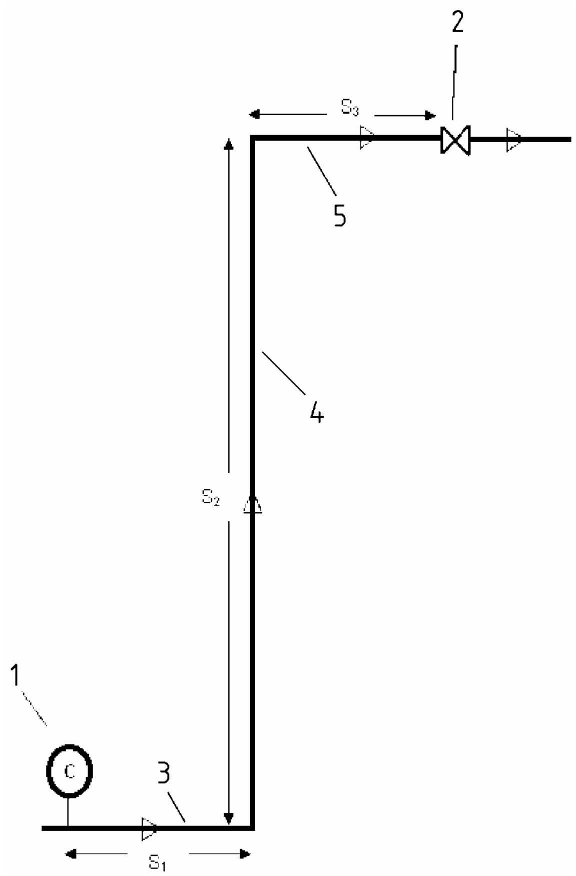
Result: The flow time $t_{1\text{-}2}$ from the CH_4-measuring device (1) to the rapid shut-off device (2) shall be a minimum of 40 s (condition $t_{1\text{-}2} \geq (t_{90} + t_s)$ shall be met).

The length $L_{1\text{-}2}$ of the t_{90}-path (the distance between 1 and 2) results from the product of flow time $t_{1\text{-}2}$ and speed $v_{1\text{-}2}$ of the gas mixture:

$$L_{1-2} = t_{1-2} \times v_{1-2} = 40\,s \times 20\frac{m}{s} = 800\,m \qquad \text{(E.1)}$$

Based on an existing flow speed of 20 m/s, the length of the t_{90}-path of 800 m shall not be less.

Should the evacuated volume flow and therefore also the flow speed be larger in the situation presented, the t_{90}-path shall be extended.



Key

1 CH_4-content measuring device
2 Rapid shut-off device
3 Underground pipe
4 Shaft pipe
5 Surface pipe

Figure E.1 — Schematic arrangement of a t_{90}-path

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 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.

Once this standard is cited in the Official Journal of the European Communities 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 the European Standard and Directive 94/9/EC

Essential Safety & Health Requirements …		**Reference in this standard**
1	**Common requirements**	
1.0.1	Principles of integrated explosion safety	1
1.0.2	Equipment and protective systems must be designed and manufactured after due analysis of possible operating faults in order as far as possible to preclude dangerous situations	4.10, 4.4
1.0.3	Special checking and maintenance conditions	4.6, 4.10, B.1, B.2
1.0.4	Surrounding area conditions	4.7.1
1.0.5	Marking	A.1
1.0.6	Manufacturer's instructions	5, Annex A, Annex B
1.1	**Selection of materials**	
1.1.1	Must not trigger an explosion	4.5.1
1.1.3	Effects on predictable changes in materials characteristics	4.5.1
1.2	**Design and construction**	
1.2.2	Functionally safe components	4.4
1.2.3	Enclosed structures and prevention of leaks	4.4, 4.8
1.2.5	Additional means of protection for external stresses	4.5.1
1.2.7	Protection against other hazards	
b)	Surface temperatures	4.5.1, 4.9.2
1.3	**Potential ignition sources**	
1.3.2	Hazards arising from static electricity	4.11
1.3.4	Hazards arising from overheating	4.9.2

Table ZA.1 (*concluded*)

1.3.5	Hazards arising from pressure compensation operations	4.5.1, 4.9.1, 4.9.2
1.4	**Hazards arising from external effects**	
1.4.2	Mechanical and thermal stresses effects of existing or foreseeable aggressive substances.	4.5.1
1.5	**Requirements in respect of safety-related devices**	
1.5.1	Safety devices independent of any measurement or control devices required for operation	4.10
1.5.2	In the event of a safety device failure, equipment and/or protective systems shall, wherever possible, be secured	4.10
1.5.5	Requirements in respect of devices with a measuring function for explosion protection	4.5.2
1.5.6	Possibility to check the reading accuracy and serviceability of devices with a measuring function	4.1
1.5.7	Safety factor of devices with a measuring function	4.1
1.6	**Integration of safety requirements relating to the system**	
1.6.1	Manual override	4.9.3, 4.10
1.6.2.	Emergency shutdown system	4.10
1.6.3	Hazards arising from power failure	4.7.2, 4.8, A.4
1.6.4	Hazards arising from connections	4.2
1.6.5	Placing of warning devices as parts of equipment	4.5.2
2	**Supplementary requirements in respect of equipment**	
2.0.2.1	Sources of ignition not to become active in normal operation	4.9.3
2.0.2.2	Opening of equipment only under non-active conditions	4.10
3	**Supplementary requirements in respect of protective systems**	
3.0	**General requirements**	
3.0.2	Spreading of explosions	4.9.1
3.0.3	Power failure	4.7.2, 4.8, A.4
3.1	**Planning and design**	
3.1.7	Explosion decoupling systems	4.9.1, 4.9.3, 4.10

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

Bibliography

[1] EN 764-1, *Pressure equipment — Terminology — Part 1: Pressure, temperature, volume, nominal size*

[2] EN 61779-2, *Electrical apparatus for the detection and measurement of flammable gases — Part 1: General requirements and test methods*

[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] Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment

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