BRITISH STANDARD

BS EN 60079-2:2007

Explosive atmospheres —

Part 2: Equipment protection by pressurized enclosure "p"

The European Standard EN 60079-2:2007 has the status of a British Standard

ICS 29.260.20

British Standards

National foreword

This British Standard is the UK implementation of EN 60079-2:2007. It is identical to IEC 60079-2:2007. It supersedes BS EN 60079-2:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/31, Equipment for explosive atmospheres.

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.

Compliance with a British Standard cannot confer immunity from legal obligations.

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Partie 2: Protection du matériel
par enveloppe à surpression interne "p"
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(IEC 60079-2:2007)

This European Standard was approved by CENELEC on 2007-11-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC 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 CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

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Foreword

The text of document 31/668/FDIS, future edition 5 of IEC 60079-2, prepared by IEC TC 31, Equipment for explosive atmospheres, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60079-2 on 2007-11-01.

This European Standard supersedes EN 60079-2:2004 + corrigendum April 2006.

The significant changes with respect to EN 60079-2:2004 are listed below:

– introduction of the "Equipment protection level concept" – See Annex H;
– 3.13 eliminate reference to "room" in the definition of pressurization;
– 5.3.3 restrict to type px;
– 5.3.3 add warning for type pz and type py for any cover removable without the use of a tool;
– 7.6 move wording "For type px" to beginning of subclause to clarify 7.6 only applies to type px;
– 7.7 c) clarify that the instruction label should specify purge time and pressure/flow;
– 18.7 collect marking requirements throughout the document in the "Marking" clause.

This European Standard is to be read in conjunction with EN 60079-0:2006.

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)	2008-08-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2010-11-01

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

Annexes ZA and ZZ have been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60079-2:2007 was approved by CENELEC as a European Standard without any modification.

CONTENTS

INTRODUCTION

This part of IEC 60079 gives requirements for the design, construction, testing and marking of electrical apparatus for use in potentially explosive atmospheres in which

a) a protective gas maintained at a pressure above that of the external atmosphere is used to guard against the formation of an explosive gas atmosphere within enclosures which do not contain an internal source of release of flammable gas or vapour and, where necessary;

b) a protective gas is provided in sufficient quantity to ensure that the resultant mixture concentration around the electrical parts is maintained at a value outside the explosive limit appropriate to the particular conditions of use. The protective gas is supplied to an enclosure containing one or more internal sources of release in order to guard against the formation of an explosive gas atmosphere.

This standard includes requirements for the apparatus and its associated equipment including the inlet and exhaust ducts, and also for the auxiliary control apparatus necessary to ensure that pressurization and/or dilution is established and maintained.

EXPLOSIVE ATMOSPHERES –

Part 2: Equipment protection by pressurized enclosure "p"

1 Scope

This part of IEC 60079 contains the specific requirements for the construction and testing of electrical apparatus with pressurized enclosures, of type of protection "p", intended for use in explosive gas atmospheres. It specifies requirements for pressurized enclosures containing a limited release of a flammable substance.

This standard supplements and modifies the general requirements of IEC 60079-0. Where a requirement of this standard conflicts with a requirement of IEC 60079-0, the requirements of this standard takes precedence.

This standard does not contain the requirements for:

- pressurized enclosures where the containment system may release
  a) air with an oxygen content greater than normal, or
  b) oxygen in combination with inert gas in a proportion greater than 21 %;
- pressurized rooms or analyser houses; see IEC 60079-13 and IEC 60079-16.

NOTE 1 Due to the safety factors incorporated in the type of protection, the uncertainty of measurement inherent in good quality, regularly calibrated measurement equipment is considered to have no significant detrimental effect and need not be taken into account when making the measurements necessary to verify compliance of the equipment with the requirements of this standard.

NOTE 2 When the user acts in the role of the manufacturer, it is typically the user's responsibility to ensure that all relevant parts of this standard are applied to the manufacturing and testing of the equipment.

NOTE 3 Types of protection "px" and "py"provide Equipment Protection Levels (EPL) Mb or Gb. Type of protection "pz" provides Equipment Protection Level (EPL) Gc. For further information, see Annex H.

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.

IEC 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code)– Classification*

IEC 60050(151), *International Electrotechnical Vocabulary – Chapter 151: Electrical and magnetic devices*

IEC 60050(426), *International Electrotechnical Vocabulary – Chapter 426: Electrical apparatus for explosive atmospheres*

IEC 60079-0:2004, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050(151), IEC 60050(426) and IEC 60079-0, as well as the following apply.

NOTE Unless otherwise specified, the terms "voltage" and "current" mean the r.m.s. values of an alternating, direct or composite voltage or current.

3.1
alarm
piece of apparatus that generates a visual or audible signal that is intended to attract attention

3.2
containment system
part of the apparatus containing the flammable substance that may constitute an internal source of release

3.3
dilution
continuous supply of a protective gas, after purging, at such a rate that the concentration of a flammable substance inside the pressurized enclosure is maintained at a value outside the explosive limits at any potential ignition source (that is to say, outside the dilution area)

NOTE Dilution of oxygen by inert gas may result in a concentration of flammable gas or vapour above the upper explosive limit (UEL).

3.4
dilution area
area in the vicinity of an internal source of release where the concentration of a flammable substance is not diluted to a safe concentration

3.5
enclosure volume
volume of the empty enclosure without internal apparatus. For rotating electrical machines, the free internal volume plus the volume displaced by the rotor

3.6
flammable substance
gases, vapours, liquids or mixtures thereof that are capable of being ignited

3.7
hermetically sealed device
device which is so constructed that the external atmosphere cannot gain access to the interior and in which any seal is made by fusion, for example, brazing, welding or the fusion of glass to metal

3.8
ignition-capable apparatus (ICA)
apparatus which in normal operation constitutes a source of ignition for a specified explosive gas atmosphere. This includes electrical apparatus not protected by a type of protection listed in 7.13

3.9
indicator
piece of apparatus that shows whether flow or pressure is adequate and is monitored periodically, consistent with the requirement of the application

3.10
internal source of release
point or location from which a flammable substance in the form of a flammable gas or vapour or liquid may be released into the pressurized enclosure such that in the presence of air an explosive gas atmosphere could be formed

3.11
leakage compensation
providing a flow of protective gas sufficient to compensate for any leakage from the pressurized enclosure and its ducts

3.12
overpressure
pressure above ambient pressure within a pressurized enclosure

3.13
pressurization
technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere

3.14
pressurization system
grouping of safety devices and other components used to pressurize and monitor or control a pressurized enclosure

3.15
pressurized enclosure
enclosure in which a protective gas is maintained at a pressure greater than that of the external atmosphere

3.16
protective gas
air or inert gas used for purging and maintaining an overpressure and, if required, dilution

NOTE For the purposes of this standard, inert gas means nitrogen, carbon dioxide, argon or any gas which, when mixed with oxygen in the ratio 4 parts inert to 1 part oxygen as found in air, does not make the ignition and flammability properties, such as explosive limits, more onerous.

3.17
protective gas supply
compressor, blower or compressed gas container that provides the protective gas at a positive pressure. The supply includes inlet (suction) pipes or ducts, pressure regulators, outlet pipes, ducts, and supply valves. Components of the pressurization system are not included

3.18
purging
in a pressurized enclosure, the operation of passing a quantity of protective gas through the enclosure and ducts, so that the concentration of the explosive gas atmosphere is brought to a safe level

3.19
routine test
test to which each individual device (equipment) is subjected during or after manufacture to ascertain whether it complies with certain criteria

[IEV 151-04-16, modified]

3.20
static pressurization
maintenance of an overpressure within a pressurized enclosure without the addition of protective gas in a hazardous area

3.21
type px
pressurization that reduces the equipment protection level within the pressurized enclosure from Gb to non-hazardous or Mb to non-hazardous

3.22
type py
pressurization that reduces the equipment protection level within the pressurized enclosure from Gb to Gc

3.23
type pz
pressurization that reduces the equipment protection level within the pressurized enclosure from Gc to non-hazardous

3.24
type test
test of one or more devices made to a certain design to show that the design meets certain specifications

[IEV 151-04-15]

3.25
safety device
device used to implement or maintain the integrity of the type of protection

4 Protection types

Protection by pressurization is subdivided into three types of protection (px, py and pz) which are selected based upon the equipment protection level required for the external explosive gas atmosphere (Mb, Gb or Gc), whether there is the potential for an internal release, and whether the equipment within the pressurized enclosure is ignition-capable; see Table 1. The type of protection then defines design criteria for the pressurized enclosure and the pressurization system; see Table 2.

Table 1 – Determination of protection type

Flammable substance in the containment system	Equipment protection level requirement for external explosive gas atmosphere	Enclosure contains ignition-capable apparatus	Enclosure does not contain ignition-capable apparatus
No containment system	Gb or Mb	Type px [a]	Type py
No containment system	Gc	Type pz	No pressurization required
Gas/vapour	Gb or Mb	Type px [a]	Type py
Gas/vapour	Gc	Type px (and ignition-capable apparatus is not located in the dilution area)	Type py [b]
Liquid	Gb	Type px [a] (inert) [c]	Type py
Liquid	Gc	Type pz (inert) [c]	No pressurization required [d]

NOTE If the flammable substance is a liquid, normal release is never permitted.

[a] Type of protection px also applies to group I.

[b] If no normal release; see Annex E.

[c] The protective gas shall be inert if "(inert)" is shown after the pressurization type; see Clause 13.

[d] Protection by pressurization is not required since it is considered unlikely that a fault causing a release of liquid will simultaneously occur with a fault in the equipment that would provide an ignition source.

Table 2 – Design criteria based upon type of protection

Design criteria	Type px	Type py	Type pz with indicator	Type pz with alarm
Degree of enclosure protection according to IEC 60529 or IEC 60034-5	IP4X minimum	IP4X minimum	IP4X minimum	IP3X minimum
Resistance of enclosure to impact	IEC 60079-0, Table 8	IEC 60079-0, Table 8	IEC 60079-0, Table 8	IEC 60079-0, half the value in Table 8
Verifying purge period	Requires a timing device and monitoring of pressure and flow	Time and flow marked	Time and flow marked	Time and flow marked
Preventing incandescent particles from exiting a normally closed relief vent into an area requiring EPL Gb or Mb	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	No requirement, see Note 1	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced
Preventing incandescent particles from exiting a normally closed relief vent into an area requiring EPL Gc	No requirement, see Note 2	No requirement, see Note 2	No requirement, see Note 2	No requirement, see Note 2
Preventing incandescent particles from exiting a vent that opens during normal operation, to an area requiring EPL Gb or Mb	Spark and particle barrier required, see 5.8	Spark and particle barrier required, see 5.8	Spark and particle barrier required; see 5.8	Spark and particle barrier required, see 5.8
Preventing incandescent particles from exiting a vent that opens during normal operation to an area requiring EPL Gc	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	No requirement, see Note 1	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced
Door or cover removable only with use of a tool	Warning, see 5.3 and 6.2 b) ii)	Warning, see 5.3.6 and Note 1	Warning, see 5.3.6 and Note 3	Warning, see 5.3.6 and Note 3
Door or cover removable without use of a tool	Interlock, see 7.12 (no internal hot parts)	Warning, see 5.3.6 and Note 1	Warning, see 5.3.6 and Note 3	Warning, see 5.3.6 and Note 3
Internal hot parts that require a cool-down period before opening enclosure	Comply with 6.2 b) ii)	No requirement, see Note 1	Warning, see 5.3.6	Warning, see 5.3.6

NOTE 1 Subclause 6.2 b) ii) is not applicable for type py since neither hot internal parts nor normally created incandescent particles are permitted.

NOTE 2 There is no requirement for spark and particle barriers since in abnormal operation, where the relief vent opens, it is unlikely that the external atmosphere is within the explosive limits.

NOTE 3 There is no requirement for tool accessibility on a type of protection pz enclosure since in normal operation the enclosure is pressurized with all covers and doors in place. If a cover or door is removed, it is unlikely that the atmosphere is within the explosive limits.

5 Constructional requirements for pressurized enclosures

5.1 Enclosure

The pressurized enclosure shall have a degree of protection in accordance with Table 2.

NOTE The degree of protection of IP44 may be required on a coal face under humid and dusty conditions.

5.2 Materials

The materials used for the enclosure, ducts and connecting parts shall not be adversely affected by the specified protective gas.

5.3 Doors and covers

5.3.1 Group I pressurized enclosures

Doors and covers shall either

– have special fasteners complying with IEC 60079-0, or
– be interlocked so that the electrical supply to equipment not protected by a type of protection listed in 7.13 of this standard is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed. The requirements of 7.6 shall also apply.

5.3.2 Group I pressurized enclosures with static pressurization

Doors and covers shall have special fasteners complying with IEC 60079-0.

5.3.3 Group II pressurized enclosures

The requirements for special fasteners in IEC 60079-0 do not apply.

For type px, doors and covers except for those which can be opened only by the use of a tool or key shall be interlocked so that the electrical supply to electrical equipment not identified in 7.13 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed.

For type py and type pz, the use of a tool or key is not required.

NOTE High internal pressures may cause doors or covers to open violently. Operators and maintenance personnel should be protected from injury by methods such as the following:

a) use multiple fasteners so that the enclosure will safely vent before all fasteners are released; or

b) use a two-position fastener to allow safe venting of the pressure when opening the enclosure; or

c) limit the maximum internal pressure to not greater than 2,5 kPa.

5.3.4 Group II pressurized enclosures with static pressurization

Doors and covers can be opened only by the use of a tool.

5.3.5 Type px

A pressurized enclosure that contains hot parts requiring a cool-down period shall not be capable of being opened readily without the use of a key or tool.

5.3.6 Marking for Group I or Group II

Doors and covers shall be marked:

WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT

5.4 Mechanical strength

The pressurized enclosure, ducts if any, and their connecting parts shall withstand a pressure equal to 1,5 times the maximum overpressure specified by the manufacturer for normal service with all outlets closed with a minimum of 200 Pa.

If a pressure can occur in service that can cause a deformation of the enclosure, ducts if any, or connecting parts, a safety device shall be fitted to limit the maximum internal overpressure to a level below that which could adversely affect the type of protection. If the manufacturer does not provide the safety device, the equipment shall be marked "X" in accordance with 29.2 i) of IEC 60079-0 and the description documents shall contain all necessary information required by the user to ensure conformity with the requirements of this standard.

5.5 Apertures, partitions, compartments and internal components

5.5.1 Apertures and partitions shall be located in such a way that effective purging is ensured.

NOTE 1 Unpurged areas can be eliminated by the proper location of the protective gas supply inlet and outlet and by consideration of the effect of partitions.

NOTE 2 For gases or vapours that are heavier than air the inlet for the protective gas should be near the top of the pressurized enclosure, with the outlet near the bottom of the enclosure.

NOTE 3 For gases or vapours that are lighter than air, the inlet for the protective gas should be near the bottom of the enclosure, with the outlet near the top of the enclosure.

NOTE 4 Locating inlets and outlets at opposite sides of the enclosure promotes cross ventilation.

NOTE 5 Internal partitions (for example, circuit boards) should be located in such a way that the flow of protective gas is not obstructed. The use of a manifold or baffles can also improve the flow around obstructions.

NOTE 6 The number of apertures should be chosen with regard to the design of the equipment, particular consideration being given to the purging of sub-compartments into which the equipment might be divided.

5.5.2 Internal compartments shall be vented to the main enclosure or separately purged.

NOTE Vents providing not less than 1 cm^2 of vent area for each 1 000 cm^3, with a minimum vent size of 6,3 mm diameter should be sufficient for adequate purging.

5.5.3 Cathode ray tubes (CRTs) and other hermetically sealed devices do not require purging.

5.5.4 Components with a free internal volume less than 20 cm^3 are not considered to be internal compartments requiring purging as long as the total volume of all such components is not more than 1 % of the free internal volume of the pressurized equipment.

NOTE 1 The 1 % is based upon 25 % of the lower explosive limit (LEL) of hydrogen; see Clause A.2.

NOTE 2 Electrical components considered to be environmentally sealed such as transistors, micro-circuits, capacitors, etc., are not to be included in the calculation of the total component volume.

5.5.5 In the case of static pressurization, the enclosure shall have one or more aperture(s). After filling and pressurization, all apertures shall be closed.

5.6 Insulating materials

For Group I equipment, insulating material subjected to electrical stresses capable of causing arcs in air and which result from rated currents of more than 16 A (in switching equipment such as circuit-breakers, contactors, isolators) shall have at least one of the following:

– a comparative tracking index equal to or greater than CTI 400 M in accordance with IEC 60112;
– a suitable device which detects possible decomposition of the insulating materials inside the enclosure leading to a dangerous condition, and automatically disconnects the power supply to the enclosure on the supply side. The presence and function of such a device shall be verified.
– creepage distances between live exposed conductors complying with those shown for the equivalent voltage in material Group III of pollution degree 3 in Table 4 of IEC 60664-1.

5.7 Sealing

All cable and conduit connections to a pressurized enclosure shall be sealed to maintain the IP rating of the enclosure or, if unsealed, be considered as part of the enclosure.

5.8 Spark and particle barriers

The pressurized enclosure and the ducting, if any, for the protective gas shall be provided with a spark and particle barrier to guard against the ejection of incandescent particles into the hazardous area.

Incandescent particles shall be assumed to be normally produced unless make/break contacts operate at less than 10 A and the working voltage does not exceed either 275 V a.c. or 60 V d.c., and the contacts have a cover.

EXCEPTION 1: The spark and particle barrier is not required for a normally closed relief vent exhausting into an area requiring EPL Gb or Mb if incandescent particles are not normally produced.

EXCEPTION 2: The spark and particle barrier is not required when exhausting into an area requiring EPL Gc if incandescent particles are not normally produced.

If the manufacturer does not provide the spark and particle barriers, the equipment shall be marked with the symbol “X” in accordance with 29.2 i) of IEC 60079-0 and the special condition for safe use shall be included on the certificate.

5.9 Internal batteries

NOTE Requirements for internal batteries are under consideration for Edition 6. Guidance for internal batteries for Type pz are found in IEC 60079-0 and IEC 60079-15.

6 Temperature limits

6.1 General

The equipment shall be classified in accordance with the temperature classification requirements of IEC 60079-0. The temperature class shall be determined in accordance with 6.2 and 6.3.

6.2 For type px or type py

The temperature class shall be based on the higher of the following temperatures:

a) the hottest external surface of the enclosure; or

b) the hottest internal component surface.

Exception: An internal component may exceed the marked temperature class if

i) it complies with the relevant "small component" requirements of IEC 60079-0, or

ii) the pressurized enclosure is type px and is marked as required in IEC 60079-0, with the time period sufficient to permit the component to cool to the marked temperature class. Appropriate measures shall be taken to prevent, if pressurization ceases, any explosive gas atmosphere which may exist making contact with the hot component surface before it has cooled below the permitted maximum value.

NOTE This may be achieved either by the design and construction of the joints of the pressurized enclosure and ducts or by other means, for example, by bringing auxiliary ventilation systems into operation or by arranging that the hot surface within the pressurized enclosure is in a gas-tight or encapsulated housing.

In a py-enclosure, hot ignition-capable parts in normal operation are not permitted.

6.3 For type pz

The temperature class shall be based on the hottest external surface of the enclosure.

NOTE In determining temperature class, account should be taken of any internal equipment with its own protection which may remain energized when the pressurization system is switched off.

7 Safety provisions and safety devices (except for static pressurization)

7.1 Suitability of safety devices for hazardous area

All safety devices used to prevent electrical equipment protected by pressurization from causing an explosion shall themselves not be capable of causing an explosion (see 7.13) or shall be mounted outside the hazardous area.

7.2 Integrity of safety devices

The safety devices required by this standard (see Table 3) form safety related parts of a control system. The safety and integrity of the control system shall be consistent with,

– for type px or type py, a single fault evaluation;

– for type pz, normal operation.

Table 3 – Safety devices based upon protection type

Design criteria	Type px	Type py	Type pz
Safety device to detect loss of minimum overpressure	Pressure sensor, see 7.9	Pressure sensor, see 7.9	Indicator or pressure sensor, see 7.9 d)
Safety device(s) to verify purge period	Timing device, pressure sensor, and flow sensor at outlet; see 7.6	Time and flow marked, see 7.7 c)	Time and flow marked, see 7.7 c)
Safety device for a door or cover removable only with use of a tool	Warning, see 6.2 b)	No requirement (internal hot parts not permitted)	No requirement
Safety device for a door or cover removable without use of a tool	Interlock, see 7.12 (internal hot parts not permitted)	No requirement (internal hot parts not permitted)	No requirement
Safety device for hot internal parts when there is a containment system (see Clause 15)	Alarm and stop flow of flammable substance	Not applicable for protection type since internal hot parts not permitted	Alarm (normal release not permitted)

7.3 Provider of safety devices

The safety devices shall be provided by the manufacturer of the equipment or by the user. If the manufacturer does not provide the safety devices, the equipment shall be marked "X" in accordance with 29.2 i) of IEC 60079-0 and the description documents shall contain all necessary information required by the user to ensure conformity with the requirements of this standard.

7.4 Sequence diagram for type px

For type px pressurization systems, a functional sequence diagram shall be provided by the manufacturer, for example, truth table, state diagram, flow chart, etc., to define the action of the control system. The sequence diagram shall clearly identify and show the operational states of the safety devices and ensuing actions. Functional tests shall be required to verify conformity to the diagram. These tests need be carried out under normal atmospheric conditions, only unless otherwise specified by the manufacturer.

NOTE An example of the information to be supplied by the manufacturer is given in Annex B.

7.5 Ratings for safety devices

The manufacturer shall specify the maximum and minimum action levels and tolerances of the safety devices. The safety devices shall be used within the normal operational limits as specified by the manufacturer.

7.6 Purging automated for type px

Safety devices shall be provided to prevent electrical equipment within a pressurized enclosure becoming energized until purging has been completed.

The sequence of operations of the safety devices shall be as follows:

a) following the initiation of the sequence, the purging flow through and the overpressure in the pressurized enclosure shall be monitored in accordance with this standard;
b) when the minimum flow rate of protective gas is achieved and the overpressure is within the specified limits, the purge timer can be started;
c) after expiry of the time, the electrical equipment is then available to be energized;
d) in the event of failure of any step in the sequence, the circuit shall be arranged to reset to the beginning.

7.7 Purging criteria

The manufacturer shall specify the conditions required for proper purging after an enclosure has been opened or the overpressure dropped below the minimum specified by the manufacturer.

a) For type px or type py, the manufacturer shall specify the minimum purge flow and time to satisfy the test in 16.3 or 16.4 as appropriate. The minimum purge flow and time may be based upon a five-enclosure-volume purge if it is determined that such a purge is adequate without test.
b) For type pz, the manufacturer shall specify the minimum purge flow and time to ensure that the pressurized enclosure is purged by a quantity of protective gas equivalent to five enclosure volumes. The quantity of protective gas may be reduced if effective purging is demonstrated by the test in 16.3 or 16.4, as appropriate.
c) The purging flow rate shall be monitored at the outlet of the pressurized enclosure. For type px, the actual flow shall be monitored. For type py or type pz, the flow may be deduced, for example, from the enclosure pressure and a defined orifice at the outlet. For type py or type pz, an instruction label shall be provided to permit purging the pressurized enclosure before energizing the electrical equipment. The label shall include the following or similar:

WARNING – POWER SHALL NOT BE RESTORED AFTER ENCLOSURE HAS BEEN OPENED UNTIL ENCLOSURE HAS BEEN PURGED FOR ___MINUTES AT A FLOW RATE OF ____.

NOTE It is typically the user's responsibility to determine the free space of the associated ducts which are not part of the equipment and to set up the additional purging time for the given minimum flow rate.

7.8 Requirements when a minimum flow rate required

When a minimum rate of flow of protective gas is specified by the manufacturer (for example, if internal equipment would develop temperatures hotter than the marked temperature classification rating), one (or more) automatic safety device(s) shall be provided to operate when the flow rate of protective gas at the outlet falls below the specified minimum value.

7.9 Safety devices to detect overpressure

One or more automatic safety devices shall be provided to operate when the pressurized enclosure overpressure falls below the minimum value specified by the manufacturer.

a) The automatic safety device sensor shall take its signal directly from the pressurized enclosure.

b) No valves shall be permitted between the automatic safety device sensor and the pressurized enclosure.

c) It shall be possible to check the correct operation of the safety devices. Their location and setting shall take into account the requirements of 7.10.

NOTE The purpose(s) for which the automatic safety device(s) are used (i.e. to disconnect power or to sound an alarm or otherwise ensure the safety of the installation) is typically the responsibility of the user.

d) For type pz, the following conditions shall be observed if the pressurized enclosure is equipped with an indicator in place of the automatic safety device:

1) the protective gas supply shall be equipped with an alarm to indicate failure of the protective gas supply to maintain the minimum pressurized enclosure pressure;

2) there shall be no devices between the pressurized enclosure and the protective gas supply alarm other than an isolating valve and/or a pressure or flow controlling mechanism;

3) any isolating valve shall

– be marked

WARNING – PROTECTIVE GAS SUPPLY VALVE –
FOLLOW INSTRUCTIONS BEFORE CLOSING

– be capable of being sealed or secured in the open position;

– have an indication of whether it is open or closed;

– be located immediately adjacent to the pressurized enclosure;

– be used only during servicing of the pressurized enclosure;

NOTE This valve is intended to be kept open unless the area is known to be free of an explosive gas atmosphere or unless all equipment within the pressurized enclosure is de-energised and cooled.

4) any pressure or flow controlling mechanism, if adjustable, shall require a tool to operate it;

5) no filters shall be fitted between the pressurized enclosure and the protective gas system alarm;

6) the indicator shall be located for convenient viewing;

7) the indicator shall indicate the enclosure pressure;

8) the sensing point for the indicator shall be located to take into account the most onerous conditions of service;

NOTE 1 A flowmeter, if used to indicate both enclosure pressure and purging flow, should be located on the outlet.

NOTE 2 A flowmeter, if used only to indicate pressure, may be located anywhere on the enclosure, except the inlet.

NOTE 3 Only in exceptional circumstances will a flowmeter located at the inlet indicate the pressure in the enclosure or the flow through the enclosure.

9) no isolating valve shall be fitted between the indicator and the pressurized enclosure.

7.10 Value of overpressure

A minimum overpressure of 50 Pa for type px or type py, and 25 Pa for type pz shall be maintained relative to the external pressure at every point, within the pressurized enclosure and its associated ducts, at which leakage can occur.

The manufacturer shall specify the minimum and maximum overpressure in service and the maximum leakage rate at the maximum overpressure.

The distribution of pressure in different systems and ducts is illustrated in Figures C.1 to C.4.

NOTE It is essential for the safety of an installation of pressurized enclosures that the installation of the associated ducts and of the compressor or fan does not introduce a hazard. The basic requirements for the installation of ducting systems are given in Annex D.

7.11 Pressurizing multiple enclosures

When a source of protective gas is common to a number of separate pressurized enclosures, the safety device or devices may be common to several of these, provided that the resulting control takes account of the most unfavourable configuration of the group of enclosures. When a common safety device is fitted, the opening of a door or cover need not switch off all the electrical equipment in the pressurized enclosures or initiate the alarm, provided that the following three conditions are met:

a) for type px, the opening of the door or cover shall be preceded by disconnecting the supply to the electrical equipment in the particular pressurized enclosure, except if permitted by 7.13;
b) the common safety device continues to monitor the overpressure in, and where necessary the flow through, all the other pressurized enclosures of the group;
c) the subsequent connecting of the supply to the electrical equipment in the particular pressurized enclosure is preceded by the purging procedure specified in 7.6.

7.12 Safety devices on doors and covers

For type px, doors and covers that can be opened without the use of a tool or key, shall be interlocked so that the electrical supply to electrical equipment not identified in 7.13 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed. The requirements of 7.6 shall also apply.

7.13 Protection types that may remain energized

Electrical equipment within the pressurized enclosure that may be energized when type px or type py protection is not in operation shall be protected by types of protection “d”, “e”, “ia”, “ib”, “ma”, “mb”, “o” or “q”.

Electrical apparatus within the pressurized enclosure that may be energized when type pz protection is not in operation shall be protected by types of protection “d”, “e”, “ia”, “ib”, “ic”, “ma”, “mb”, “mc”, “o”, “q”, “nA”, “nC” or “nL”.

7.14 Protection types permitted within type py

Electrical equipment within a type py pressurized enclosure shall be protected by types of protection “d”, “e”, “ia”, “ib”, “ic”, “ma”, “mb”, “mc”, “o”, “q”, “nA”, “nC” or “nL”.

8 Safety provisions and safety devices for static pressurization

8.1 Suitability of safety devices for hazardous area

All safety devices used to prevent electrical equipment protected by static pressurization causing an explosion shall themselves not be capable of causing an explosion and, if the safety device is electrically operated, it shall be protected by one of the types of protection recognized in IEC 60079-0 which is suitable for the application, or shall be mounted outside the hazardous area.

8.2 Protective gas

The protective gas shall be inert. The concentration of oxygen after filling with inert gas shall be less than 1 % by volume.

8.3 Internal sources of release

Internal sources of release are not permitted.

8.4 Filling procedure

The pressurized enclosure shall be filled with inert gas in a non-hazardous area using the procedure specified by the manufacturer.

8.5 Safety devices

Two automatic safety devices for type px or type py or one automatic safety device for type pz shall be provided to operate when the overpressure falls below the minimum value specified by the manufacturer. It shall be possible to check the correct operation of the devices when the equipment is in service. The automatic safety devices shall be capable of being reset only by the use of a tool or a key.

NOTE The purpose for which the automatic safety devices are used (that is, to disconnect power or to sound an alarm or otherwise ensure safety of the installation) is typically the responsibility of the user.

8.6 Protection types that may remain energized

Electrical equipment within the pressurized enclosure that may be energized when type of protection “p” is not in operation shall be protected by one of the types of protection listed in 7.13.

8.7 Overpressure

The minimum overpressure shall be greater than the maximum pressure loss in normal service measured over a period not less than 100 times the time necessary for the cooling of enclosed components in accordance with 6.3 b) of IEC 60079-0, with a minimum of 1 h. The minimum level of overpressure shall not be less than 50 Pa above the external pressure under the most onerous conditions specified for normal service.

9 Supply of protective gas

9.1 Type of gas

The protective gas shall be non-flammable. The manufacturer shall specify the protective gas and any alternative permitted.

NOTE 1 The protective gas should not, by reason of its chemical characteristics or the impurities that it may contain, reduce the effectiveness of the type of protection “p”, or adversely affect the satisfactory operation and integrity of the enclosed equipment.

NOTE 2 Air of normal instrument quality, nitrogen, or other non-flammable gas is considered acceptable as a protective gas.

NOTE 3 When an inert gas is used, a risk of asphyxiation exists. Therefore a suitable warning should be affixed to the enclosure. Alternatively, a suitable means of purging the enclosure to remove the inert gas prior to the opening of doors or covers should be provided.

9.2 Temperature

The temperature of the protective gas shall not normally exceed 40 °C at the inlet of the enclosure. In special circumstances, a higher temperature may be permitted or a lower temperature may be required; in this case, the temperature shall be marked on the enclosure.

NOTE If necessary, measures should be taken to avoid condensation and freezing.

10 Pressurized equipment with an internal source of release

The release conditions, containment system design requirements, the appropriate pressurization techniques and the restrictions on ignition-capable apparatus and internal hot surfaces are given in Clauses 11 to 15.

11 Release conditions

11.1 No release

11.1.1 There is no internal release when the containment system is infallible; see 12.2.

11.1.2 No internal release is deemed to exist when the flammable substances inside the containment system are in the gas or vapour phase when operating between the specified temperature limits and either

a) the gas mixture within the containment system is always below the LEL; or
b) the minimum pressure specified for the pressurized enclosure is at least 50 Pa higher than the maximum pressure specified for the containment system and an automatic safety device is provided to operate if the pressure difference falls below 50 Pa.

NOTE The purpose(s) for which the signal from the automatic safety device is used (that is, to disconnect power or to sound an alarm or otherwise maintain the safety of the installation) is the responsibility of the user.

The conditions to be met in this subclause require the equipment to be marked with the symbol “X” in accordance with 29.2 i) of IEC 60079-0 and the special condition for safe use shall specify the measures to be taken to ensure safe use.

11.2 Limited release of a gas or vapour

The rate of release of the flammable substance into the pressurized enclosure shall be predictable in all conditions of containment system failure; see 12.3.

NOTE For the purposes of this standard, release of a liquefied gas is considered as release of a gas.

11.3 Limited release of a liquid

The rate of release of the flammable substance into the pressurized enclosure is limited as in 11.2, but the conversion of the liquid into a flammable vapour is not predictable. Consideration shall be given to the possible accumulation of liquid inside the pressurized enclosure and the consequences thereof.

If oxygen may be released from the liquid, the maximum flow rate of oxygen shall be predicted; see 13.2.2.

12 Design requirements for the containment system

12.1 General design requirements

The design and construction of the containment system, which will determine whether leakage is likely to occur or not, shall be based on the most onerous conditions of service specified by the manufacturer.

The containment system shall be either infallible or have a limited release upon failure. If the flammable substance is a liquid, there shall be no normal release (see Annex E) and the protective gas shall be inert.

NOTE The protective gas needs to be inert to prevent the evolved vapours from exceeding the capabilities of the diluting protective gas.

The manufacturer shall specify the maximum inlet pressure to the containment system.

Details of the design and construction of the containment system, the types and operating conditions of the flammable substance it may contain and the expected release rate or rates at given locations, shall be provided by the manufacturer in order for the containment system to be classified as an infallible containment system (12.2) or a containment system with limited release (12.3).

12.2 Infallible containment system

The containment system shall be composed of metallic, ceramic or glass, pipes, tubes or vessels which have no moving joints. Joints shall be made by welding, brazing, glass to metal sealing, or by eutectic methods [1]).

Low temperature solder alloys such as lead/tin composites are not acceptable.

NOTE The manufacturer should carefully consider damage to a potentially fragile containment system by adverse operating conditions. Adverse operating conditions to be agreed between manufacturer and user may include vibration, thermal shock and maintenance operations when doors or access covers of the pressurized enclosure are open.

12.3 Containment system with a limited release

The design of a containment system with limited release shall be such that the rate of release of the flammable substance is predictable in all conditions of containment system failure. The quantity of flammable substance released into the pressurized enclosure includes the quantity of flammable substance in the containment system and the flow of the flammable substance entering the containment system from the process. The flow shall be limited to a predictable rate by appropriate flow limiting devices, fitted outside the pressurized enclosure.

However, if that part of the containment system from the entry point into the pressurized enclosure up to and including the inlet to the flow limiting device conforms to 12.2, the flow limiting device may be installed inside the pressurized enclosure, in which case the flow limiting device shall be permanently secured and shall have no movable parts.

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1) A method of joining two or more components, normally metallic, employing a binary or ternary alloy system which solidifies at a constant temperature which is lower than the beginning of solidification of any of the components being joined.

The process flow into the containment system need not be limited if the maximum release rate from the containment system into the pressurized enclosure can be predicted. This condition can be met when

a) the containment system comprises connected parts which individually meet the requirements of 12.2 and the joints between the parts are so constructed that the maximum release rate can be predicted and the joints are permanently secured, and/or

b) the containment system includes orifices, or nozzles, for the purpose of release in normal operation (for example, flames) but otherwise meets the requirements of 12.2.

If the flow limiting device is not included as part of the equipment, the pressurized enclosure shall be marked with the symbol "X" in accordance with 29.2 i) of IEC 60079-0 and the special condition for safe use shall specify the measures to be taken to ensure safe use including the maximum pressure and flow of the flammable substance into the containment system.

Pressurized enclosures containing a flame shall be assessed as though the flame had been extinguished. The maximum quantity of the fuel/air mixture which supplies the flame shall be added to the quantity of release from the containment system.

NOTE 1 Elastomeric seals, windows and other non-metallic parts of the containment system are permissible. Pipe threads, compression joints (for example, metallic compression fittings), and flanged joints are also permissible.

NOTE 2 Consideration should be given by the user to the possible formation of a flammable mixture due to the possibility of air penetration into the containment system and the resulting additional precautions that may be necessary.

13 Protective gas and pressurizing techniques

13.1 General

The choice of protective gas depends upon the probability, quantity and constituents of the release from the containment system. See Table 4 for tabulation of the permitted protective gas.

Table 4 – Protective gas requirements for a pressurized enclosure with a containment system

Internal release (see Annex E)				Continuous dilution		Leakage compensation	
Substance	**Normal**	**Abnormal**	**Annex**	**UEL < 80 %**	**UEL > 80 %**	**UEL < 80 %**	**UEL > 80 %**
Gas or liquid	None	None	E.2	Not applicable		Not applicable	
Gas	None	Limited	E.3	Air or inert	Air	Inert only	<no>
Gas	Limited	Limited	E.4	Air or inert	Air	<no>	<no>
Liquid	None	Limited	E.3	Inert only	<no>	Inert only	<no>
Liquid	Limited	Limited	E.4	<no>	<no>	<no>	<no>
<no> means pressurization technique not acceptable.							

The design of the pressurized enclosure with a containment system and a limited release shall be such that no explosive gas atmosphere can be formed inside the pressurized enclosure at a potential ignition source, that is, outside the dilution area. Annex F provides examples of how internal partitions may be used to ensure potential ignition sources are outside the dilution area.

Where inert gas is used as the protective gas, the pressurized enclosure shall be marked in accordance with 18.9.

The applicable pressurizing techniques depend upon the release condition and on the constituents of the release as follows.

13.2 Pressurization with leakage compensation

13.2.1 No release

The protective gas shall be air or inert gas.

13.2.2 Limited release of a gas or liquid

The protective gas shall be inert gas.

The concentration of oxygen in the flammable substance shall not exceed 2 % (V/V).

There shall not be any normal release (see Annex E) of the flammable substance.

The UEL of the flammable substance shall not exceed 80 %.

NOTE 1 It is difficult or impossible to protect with leakage compensation using inert gas when the flammable substance is capable of reacting with little or no oxygen present (that is to say it has a UEL greater than 80 %).

NOTE 2 If the flammable substance has a UEL exceeding 80 %, or if it has a concentration of oxygen exceeding 2 % (V/V), or if there is a normal release (see Annex E) of the flammable substance, then continuous flow in accordance with 13.3 should be used to dilute the flammable substance.

13.3 Pressurization with dilution

13.3.1 No release

The protective gas shall be air or inert gas.

13.3.2 Limited release of a gas or vapour

The flow rate of protective gas after purging shall be sufficient, under all conditions of containment system failure, to dilute the maximum release at a potential ignition source, that is outside the dilution area, as follows:

a) when the protective gas is air, the flammable substance in the release shall be diluted to a concentration not exceeding 25 % of the LEL;
b) when the protective gas is inert, any oxygen in the release shall be diluted to a concentration not exceeding 2 % (V/V).

When the flammable substance released from the containment system has a UEL greater than 80 %, any release shall be diluted with air to a concentration not exceeding 25 % of the LEL.

NOTE It is necessary to dilute to 25 % of the LEL when the flammable substance is capable of reacting with little or no oxygen present, that is to say it has a UEL greater than 80 %.

13.3.3 Limited release of a liquid

The protective gas shall be inert and the provisions of 13.3.2 b) shall be complied with. There shall not be any normal release (see Annex E) of the flammable substance.

14 Ignition-capable apparatus

Electrical apparatus in the dilution area shall be protected by a type of protection listed in Table 5. Exceptions from this requirement are flames, igniters or other similar apparatus intended to ignite a flame. The dilution area emanating from the flame shall not overlap any other dilution area.

Table 5 – Protection types permitted within the dilution area

Internal release is	Type px, type py	Type pz
abnormal	d, e, ia, ib, ma, mb, o, q	d, e, ia, ib, ic, ma, mb, mc, o, q, nA, nC, nL
normal	ia, ma	ia, ma

NOTE 1 Generally, any internal source of release should be near to the outlet and any ignition-capable apparatus near to the inlet of the protective gas, to allow the shortest possible way for released flammable gas to leave the pressurized enclosure without passing ignition-capable apparatus.

NOTE 2 To avoid ignition from an ignition source within the containment system back into the plant, the use of a flame arrestor can be necessary. Such measures are not covered by this standard.

15 Internal hot surfaces

An automatic safety device shall be provided if the pressurized enclosure contains any surface having a temperature which exceeds the ignition temperature of the flammable substance potentially released from the containment system. The action of the safety device following the operation of the safety device specified in 11.1.2 b) is shown in Table 3.

Additionally,

a) if the protective gas is air, the release of the remaining flammable substance in the containment system shall not form a concentration greater than 50 % of the LEL in the vicinity of the hot surface(s); or

b) if the protective gas is inert, the design and construction of the joints of the pressurized enclosure shall be such as to prevent significant mixing of external air with the internal inert gas (or internal flammable gas or vapour) during the cooling period. The ingress of external air shall not increase the concentration of oxygen to a value greater than 2 % (V/V).

The pressurized enclosure shall be marked:

WARNING – DO NOT OPEN ANY DOOR OR COVER FOR xxx MINUTES AFTER REMOVING POWER

This delay shall be the longer of the times taken for the hot surface to cool below the ignition temperature of the flammable substance released from the containment system or below the temperature class of the pressurized enclosure.

16 Type verification and tests

16.1 Maximum overpressure test

A pressure equal to 1,5 times the maximum overpressure specified or 200 Pa, whichever is the greater, shall be applied to the pressurized enclosure and, where they are an integral part of the enclosure, the associated ducts and their connecting parts.

The test pressure shall be applied for a period of 2 min ± 10 s.

The test is considered to be satisfactory if no permanent deformation occurs which would invalidate the type of protection.

16.2 Leakage test

16.2.1 Other than static pressurization

The pressure in the pressurized enclosure shall be adjusted to the maximum overpressure specified by the manufacturer for normal service. With the outlet aperture closed, the leakage flow rate shall be measured at the inlet aperture.

The measured flow rate shall be not greater than the maximum leakage flow rate specified by the manufacturer.

16.2.2 Static pressurization

The pressure in the pressurized enclosure shall be adjusted to the maximum overpressure that can occur in normal service. With the aperture(s) closed, the internal pressure shall be monitored for a period of time, in accordance with 8.7. The change of pressure shall be not greater than the minimum overpressure specified for normal service.

16.3 Purging test for pressurized enclosures with no internal source of release (pressurization technique may be leakage compensation or continuous flow) and filling procedure test for static pressurization

16.3.1 Pressurized enclosure where the protective gas is air

The pressurized enclosure shall be prepared for test as described in Annex A. The pressurized enclosure shall be filled with the test gas to a concentration of not less than 70 % at any point. As soon as the pressurized enclosure is filled, the test gas supply shall be turned off and the air supply turned on at the minimum purging rate specified by the manufacturer. The time taken until there is no sample point where there is a test gas concentration in excess of that specified in Clause A.2 shall be measured and noted as the purging time. If a second test is required, the pressurized enclosure shall be filled with a second test gas, representing the other end of the density range, to a concentration of not less than 70 % at any point and the purging time for the second test shall be measured. The minimum purging duration specified by the manufacturer shall be not less than the measured purging time or the longer of the two measured purging times where two tests are carried out.

16.3.2 Pressurized enclosure where the protective gas is inert

The pressurized enclosure shall be prepared for test as described in Annex A. The enclosure shall be filled initially with air at normal atmospheric pressure. The enclosure shall then be purged with the inert gas specified by the manufacturer.

The time taken until there is no sample point where there is an oxygen concentration exceeding that specified in Clause A.3 shall be measured and noted as the purging time.

The minimum purging duration specified by the manufacturer shall be not less than the measured purging time.

16.3.3 Pressurized enclosure where the protective gas may be either air or an inert gas with a density equal to air ±10 %

Where air and inert gas are permitted as alternative protective gases with the same purging time, the purging time shall be measured by the method specified in 16.3.1.

16.3.4 Filling procedure test for a pressurized enclosure protected by static pressurization

In the case of static pressurization, the enclosure shall be filled initially with air at normal atmospheric pressure. The equipment shall then be filled with inert gas in accordance with the manufacturer's specifications. It shall then be verified that there is no sample point where there is an oxygen concentration exceeding 1 % (V/V), referred to atmospheric conditions.

16.4 Purging and dilution tests for a pressurized enclosure with an internal source of release

16.4.1 Test gas

The choice of test gas or gases shall take account of both the external gases and the internally released flammable substance.

16.4.2 Pressurized enclosure where the flammable substance has less than 2 % (V/V) oxygen and the protective gas is inert

16.4.2.1 Purging test

The test shall be carried out using the test procedure specified in 16.3.2. The minimum purge flow rate shall not be less than the maximum release rate from the containment system.

The minimum purging time specified by the manufacturer shall be not less than 1,5 times the measured purging time.

NOTE To make allowance for oxygen that could be released from the containment system during purging, the purging time confirmed in the test is increased by 50 %.

16.4.2.2 Dilution test

A dilution test is not required because the flammable substance does not contain more than 2 % (V/V) oxygen.

16.4.3 Pressurized enclosure with pressurization by continuous flow, containment system with less than 21 % (V/V) oxygen and the protective gas is inert

16.4.3.1 Purging test

The enclosure shall be filled with air. Air shall also be injected into the enclosure through the containment system at a flow rate corresponding to the maximum release rate in a manner representing the most onerous conditions of release, taking into account the position, number and nature of the releases and their proximity to potentially ignition-capable apparatus that is outside the dilution area.

The supply of protective gas shall then be turned on at the minimum purging flow rate specified by the manufacturer.

The time taken until there is no sample point where there is an oxygen concentration exceeding that specified in Clause A.3 shall be recorded as the measured purging time.

The minimum purging duration specified by the manufacturer shall be not less than the measured purging time.

16.4.3.2 Dilution test

Immediately after the purging test specified in 16.4.3.1, the supply of the protective gas shall be adjusted to the minimum flow rate specified by the manufacturer, the oxygen flow rate from the containment system being maintained at that specified in 16.4.3.1.

The oxygen concentration measured over a period of time not less than 30 min shall not exceed the concentration as specified in Clause A.3.

A quantity of air containing an equivalent quantity of oxygen to that within the containment system shall then be released into the pressurized enclosure from the containment system together with a release of air in accordance with 12.3.

During the period of release, the concentration of oxygen in the vicinity of potentially ignition-capable apparatus, that is outside the dilution area, shall not exceed 1,5 times the oxygen concentration specified in Clause A.3 and shall, in a time not greater than 30 min, be reduced below the specified concentration.

NOTE This test is used to simulate a bulk release equating to a catastrophic failure of the containment system.

16.4.4 Pressurized enclosure where the flammable substance is not a liquid, pressurization by continuous flow and the protective gas is air

16.4.4.1 Purging test

The test shall be carried out using the test procedure specified in 16.3.1.

In addition, during the test, the test gas shall be injected into the pressurized enclosure through the containment system at the maximum release rate, in a manner representing the most onerous conditions of release, taking into account the position, number and nature of the releases and their proximity to potentially ignition-capable apparatus, that are outside the dilution area.

The time taken until there is no sample point where there is a test gas concentration exceeding that specified in Clause A.2 shall be measured.

If a second test is required, the test shall be repeated using the second test gas and the purging time recorded as the measured purging time.

The minimum purging duration specified by the manufacturer shall be not less than the measured purging time or the longer of the two measured purging times where two tests are carried out.

16.4.4.2 Dilution test

Immediately after the purging test specified in 16.4.4.1, the supply of protective gas shall be adjusted, if necessary, to the minimum dilution flow rate specified by the manufacturer, the test gas flow rate from the containment system being maintained at that specified in 16.4.3.1.

The test gas concentration measured during a time period of not less than 30 min shall not exceed that specified in Clause A.2.

A quantity of test gas equivalent to the volume of flammable gas within the containment system shall then be released into the pressurized enclosure from the containment system together with a flow of test gas equivalent to the maximum release of flammable gas in accordance with 12.3.

During the period of release, the concentration of a test gas in the vicinity of potentially ignition-capable apparatus, that is outside the dilution area, shall not exceed twice the value specified in Clause A.2 and shall be reduced below the specified value within 30 min.

If a second test is required, the test shall be repeated using the second test gas.

NOTE This test is used to simulate a bulk release equating to a catastrophic failure of the containment system.

16.5 Verification of minimum overpressure

A test shall be made to verify that the pressurization system is capable of operating and maintaining an overpressure complying with 7.10 under normal service conditions.

The pressure in the enclosure shall be measured at points where leakage is likely to occur, and especially where the lowest pressure will occur.

Protective gas shall be supplied to the pressurized enclosure at the minimum overpressure, and if necessary, at the minimum flow rate specified by the manufacturer.

For rotating electrical machines, the tests shall be carried out both with the machine stopped and with it running at its maximum rated speed.

16.6 Tests for an infallible containment system

NOTE These tests are carried out on a containment system designed to be infallible.

16.6.1 Overpressure test

A test pressure of at least 5 times the maximum internal overpressure specified for normal service with a minimum of 1 000 Pa shall be applied to the containment system for a period of 2 min ± 10 s. The containment system shall be tested under the most onerous conditions of rated temperature.

The increase of the test pressure should achieve the maximum pressure within 5 s.

The test is considered to be satisfactory if no permanent deformation occurs and the test specified in 16.6.2 is passed.

16.6.2 Infallibility test

a) The containment system shall be surrounded by helium at a pressure equal to the maximum pressure specified for normal service. The containment system shall be evacuated down to an absolute pressure of 0,1 Pa or better. A schematic diagram of this test is given in Annex G.

b) Alternatively, the containment system shall be located in a vacuum chamber and be connected to a helium supply at the maximum pressure specified for normal service. The vacuum chamber shall be evacuated down to an absolute pressure of 0,1 Pa or better.

The test is considered satisfactory if an absolute pressure of 0,1 Pa can be maintained with the evacuating system operating.

16.7 Overpressure test for a containment system with a limited release

NOTE This test is carried out on a containment system which has a limited release during normal operation.

A test pressure of at least 1,5 times the maximum internal overpressure specified for normal service, with a minimum of 200 Pa, shall be applied to the containment system and maintained for a time of 2 min ±10 s. The test is considered to be satisfactory if no permanent deformation occurs.

16.8 Verifying ability of the pressurized enclosure to limit internal pressure

This test is applicable when an enclosure is designed for use with compressed air (or other compressed gas) and where leakage, vents, or pressure relief devices are relied upon to limit the maximum overpressure when a regulator fails.

NOTE The following tests can be inherently dangerous unless adequate safeguards for personnel and property are employed.

The pressurization system and enclosure shall be tested using the maximum rated supply pressure or 690 kPa, whichever is the greater, applied to the inlet of the pressurization system. The regulator in the pressurization system shall be by-passed to simulate failure of the regulator.

NOTE The 690 kPa pressure represents a maximum pressure for a typical instrument air supply.

All openings, excluding vents and pressure relief devices, that can be closed during normal operation of the equipment shall be closed.

The measured internal pressure shall not exceed the specified maximum overpressure.

17 Routine tests

17.1 Functional test

The performance of safety devices shall be verified.

17.2 Leakage test

The leakage of protection gas shall be tested as specified in 16.2.

17.3 Tests for an infallible containment system

An infallible containment system shall be tested as specified in 16.6.

17.4 Test for a containment system with a limited release

The containment system shall be tested as specified in 16.7.

18 Marking

18.1 Identifying as pressurized

The pressurized enclosure shall be marked "WARNING – PRESSURIZED ENCLOSURE".

18.2 Warnings

Where warning markings are required by this standard, the text following the word "WARNING" may be replaced by technically equivalent text. Multiple warnings may be combined into one equivalent warning.

18.3 Supplementary marking

The following supplementary information shall also be marked as appropriate:

a) the type of protection px, py, or pz;
b) minimum quantity of protective gas required to purge the enclosure specified by
   - minimum purging flow rate of protective gas; and
   - minimum purging duration; and
   - minimum additional purging duration per unit volume of additional ducting (where appropriate);

   NOTE 1 It is typically the responsibility of the user to increase the quantity of protective gas to ensure purging of the ducts.

   NOTE 2 For type pz and type py, the minimum pressure may be used in place of the flow rate if the pressure is a positive indication of the correct flow (see 7.7 c)).
c) type of protective gas if other than air;
d) minimum and maximum overpressure;
e) minimum flow rate of protective gas;
f) minimum and maximum supply pressure to the pressurization system;
g) the maximum leakage rate from the pressurized enclosure;
h) a special temperature or range of temperatures for the protective gas at the inlet to the pressurized enclosure when specified by the manufacturer;

i) the point or points at which the pressure is to be monitored unless this is indicated in the relevant documentation.

18.4 Internal source of release

Pressurized enclosures with a containment system shall additionally be marked with the following, as appropriate:

a) the maximum inlet pressure to the containment system;

b) the maximum flow rate into the containment system;

c) a restriction that the flammable substance oxygen concentration must not exceed 2 %;

d) a restriction that the flammable substance shall not have a UEL higher than 80 %.

18.5 Static pressurization

Pressurized enclosures protected by static pressurization shall be marked:

WARNING – THIS ENCLOSURE IS PROTECTED BY STATIC PRESSURIZATION.
THIS ENCLOSURE SHALL BE FILLED ONLY IN A NON-HAZARDOUS AREA
ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS

18.6 Pressurization systems

A pressurization system with a separate certificate is marked as associated apparatus.

NOTE A system for use in a non-hazardous area is marked [Ex p] or marked Ex [p] if for use in the hazardous area, see IEC 60079-0.

18.7 Warnings required in other clauses

Clause or subclause	Recommended warning (similar wording is permitted)
5.3.6	WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT
7.7 c)	WARNING – Power shall not be restored after enclosure has been opened until enclosure has been purged for ___minutes at a flow rate of ____.
7.9 d)	WARNING – PROTECTIVE GAS SUPPLY VALVE – FOLLOW INSTRUCTIONS BEFORE CLOSING
15	WARNING – DO NOT OPEN ANY DOOR OR COVER FOR xxx MINUTES AFTER REMOVING POWER.

18.8 Overpressure limited by user

When instructions require the user to limit the pressure, the maximum operating pressure shall be marked on the enclosure. The instructions shall contain either of the following:

a) requirements for the user to install a protective gas supply that will not exceed the maximum operating pressure of the enclosure under single-fault conditions. The fault should be self-revealing. Protection can be either with a redundant regulator or with an external pressure relief valve that is capable of handling the maximum flow rate; or

b) requirements for the user to use only a blower system and not compressed air for the protective gas supply.

Compliance is checked by inspection of the instructions and markings.

18.9 Inert gas

Pressurized enclosures using inert gas as the protective gas shall be marked as follows:

WARNING – THIS ENCLOSURE CONTAINS INERT GAS AND MAY BE AN ASPHYXIATION HAZARD. THIS ENCLOSURE ALSO CONTAINS A FLAMMABLE SUBSTANCE THAT MAY BE WITHIN THE FLAMMABLE LIMITS WHEN EXPOSED TO AIR.

19 Instructions

Annex D provides recommendations with respect to pressurization.

Annex A
(normative)

Purging and dilution tests

A.1 General

The internal atmosphere of the pressurized enclosure shall be tested at different points where it is considered that the test gas is most likely to persist and in the vicinity of potentially ignition-capable apparatus, that is outside the normal dilution area.

The gas concentration at the test points shall be analysed or measured throughout the period of the test(s). For example, the pressurized enclosure may be fitted with a number of small-bore tubes, the open ends of which shall be located inside the pressurized enclosure at the sampling points.

If the test consists of taking samples, the quantities taken should not significantly influence the test.

If necessary, apertures in the pressurized enclosure may be closed to enable the pressurized enclosure to be filled with the specified test gas, provided they are re-opened for the purging and dilution tests.

Where air is used as the protective gas the test method shall be as follows:

– when required for specific applications, tests may be carried out for specific flammable gases and vapours. In this case the flammable gases shall be specified and test gas(es) chosen having densities within ±10 % of the heaviest and lightest gas specified;
– in the case of a single specified gas, a single test shall be carried out with a test gas having a density within ±10 % of the specified gas;
– when it is required to cover all flammable gases, two tests shall be carried out. One test shall be made to cover lighter-than-air gases using helium as the test gas. The second test shall be made to cover heavier-than-air gases using either argon or carbon dioxide as the test gas.

NOTE Generally, test gases should be non-flammable and non-toxic.

A.2 Criteria for compliance where the protective gas is air

The concentration of test gas at the sample points after purging and applicable dilution shall not exceed the following values:

– where test(s) were conducted for specific flammable gases, a value equivalent to 25 % of the most onerous LEL;
– where one specific flammable gas is covered, a value equivalent to 25 % of its LEL;
– where all flammable gases are covered, 1 % for the helium test and 0,25 % for the argon or carbon dioxide test.

NOTE These values correspond approximately to 25 % of the LEL for light and heavy flammable gases respectively.

A.3 Criteria for compliance where the protective gas is inert

Where the protective gas is inert, the concentration of oxygen after purging and applicable dilution shall not exceed 2 % (V/V).

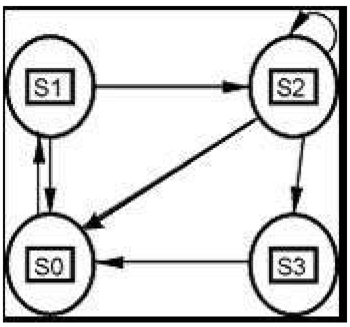
Annex B
(informative)

Examples of functional sequence diagram

The following is an example of information to be provided by the manufacturer for a simple control system for a pressurized enclosure with leakage compensation.

Table B.1 – Truth table of a leakage-compensation purge control system

SO	S1	S2	S3	MOP	XOP	PFLO	PTIM
1	0	0	0	0	1	0	1
1	0	0	0	0	0	0	1
1	0	0	0	1	1	1	0
1	0	0	0	1	1	0	1
1	0	0	0	1	1	1	1
1	0	0	0	0	1	1	1
1	0	0	0	0	0	1	1
1	0	0	0	1	1	0	0
1	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0
1	0	0	0	0	0	1	0
1	0	0	0	0	1	1	0
0	1	0	0	1	0	0	0
0	0	1	0	1	0	1	0
0	0	0	1	1	0	0	1
0	0	0	1	1	0	1	1



IEC 2311/2000

Figure B.1 – State diagram of a leakage-compensation purge control system

<u>LEAKAGE-COMPENSATION LOGICAL DEFINITIONS</u>

Exceeds maximum overpressure = [XOP]

Overpressure > 50 Pa (25 Pa for pz) = [MOP]

Purge flow > minimum = [PFLO]

Purge time incomplete = $\overline{[PTIM]}$

Purge time complete = [PTIM]

Initial state = S0

[MOP] & $\overline{[XOP]}$ & $\overline{[PFLO]}$ & $\overline{[PTIM]}$ = S1 Minimum conditions to start purge

[MOP] & $\overline{[XOP]}$ & [PFLO] & $\overline{[PTIM]}$ = S2 Purging

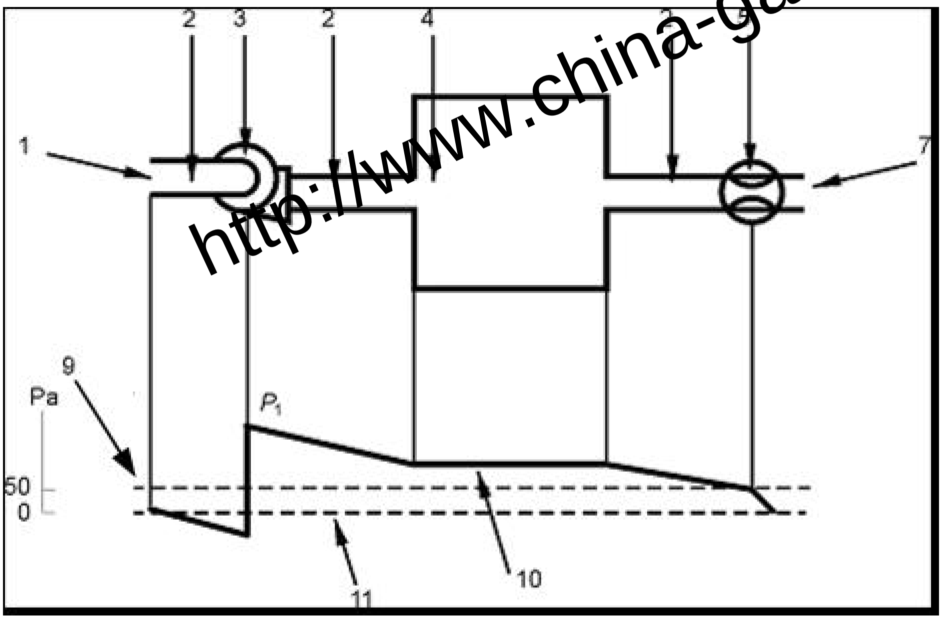
[MOP] & $\overline{[XOP]}$ & [PTIM] = S3 Purging complete, power connected

Each state of the system is defined in response to the inputs of the monitoring devices. The states are unique. Transitions between states are only allowed along paths defined by the arrows and in the direction of the arrows. The logical conditions for the occupation of each state are uniquely defined by Boolean logical expressions. All possible combinations of input conditions are shown in the table. Other systems with more monitoring devices can be described by this method provided each operational state is uniquely defined by its inputs.

Annex C
(informative)

Examples of the changes in pressure in ducts and enclosures

NOTE In the figures, examples are shown where the overpressure is maintained by a fan. This can however also be provided by other means, for example, by feeding air from compressed air cylinders, compressors, etc. In such cases, there would be different pressure drops up to the enclosure entry.



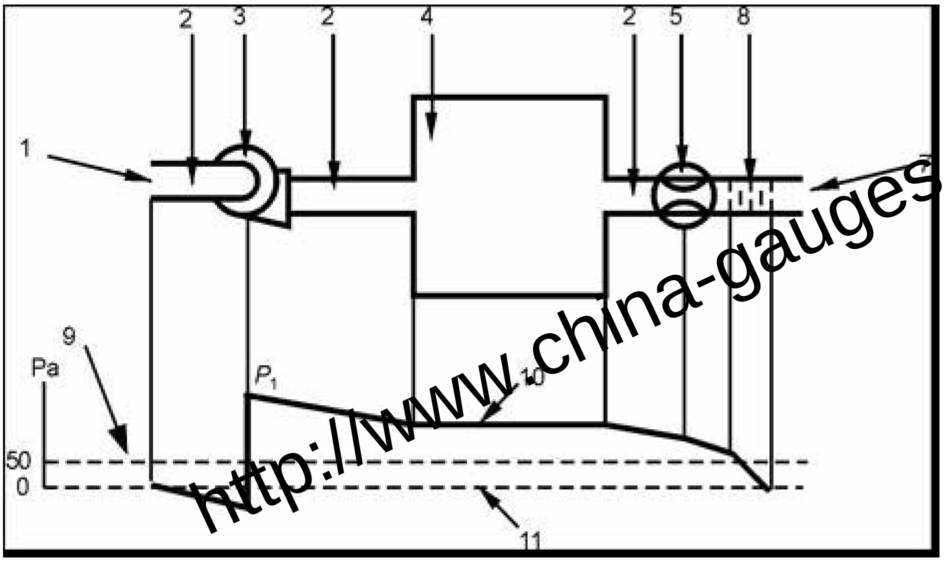
IEC 2312/2000

Key

P_1 Pressure of the protective gas (determined by the flow resistance through the ducting, the parts within the enclosure and in certain cases through a choke)

1 Protective gas inlet (in a non-hazardous area)
2 Ducting
3 Fan
4 Enclosure
5 Choke (where required to maintain the overpressure)
6 (Not used on this diagram)
7 Protective gas outlet
8 (Not used on this diagram)
9 Overpressure
10 Internal pressure
11 External pressure

Figure C.1 a) – Protective gas outlet without a spark and particle barrier



IEC 2313/2000

Key

P_1 Pressure of the protective gas (determined by the flow resistance through the ducting, the parts within the enclosure and in certain cases through a choke and spark and particle barrier)

1 Protective gas inlet (in a non-hazardous area)

2 Ducting

3 Fan

4 Enclosure

5 Choke (where required to maintain the overpressure)

6 (Not used on this diagram)

7 Protective gas outlet

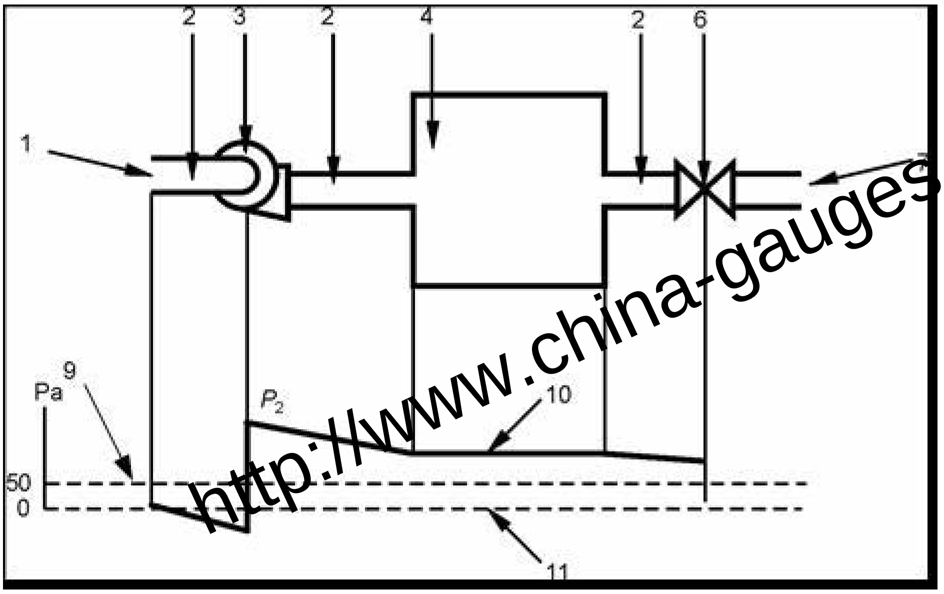
8 Spark and particle barrier

9 Overpressure

10 Internal pressure

11 External pressure

Figure C.1 b) – Protective gas outlet with a spark and particle barrier



IEC 2314/2000

Key

P_2 Pressure of the protective gas (almost constant)

1 Protective gas inlet (in a non-hazardous area)

2 Ducting

3 Fan

4 Enclosure

5 (Not used on this diagram)

6 Outlet valve

7 Protective gas outlet

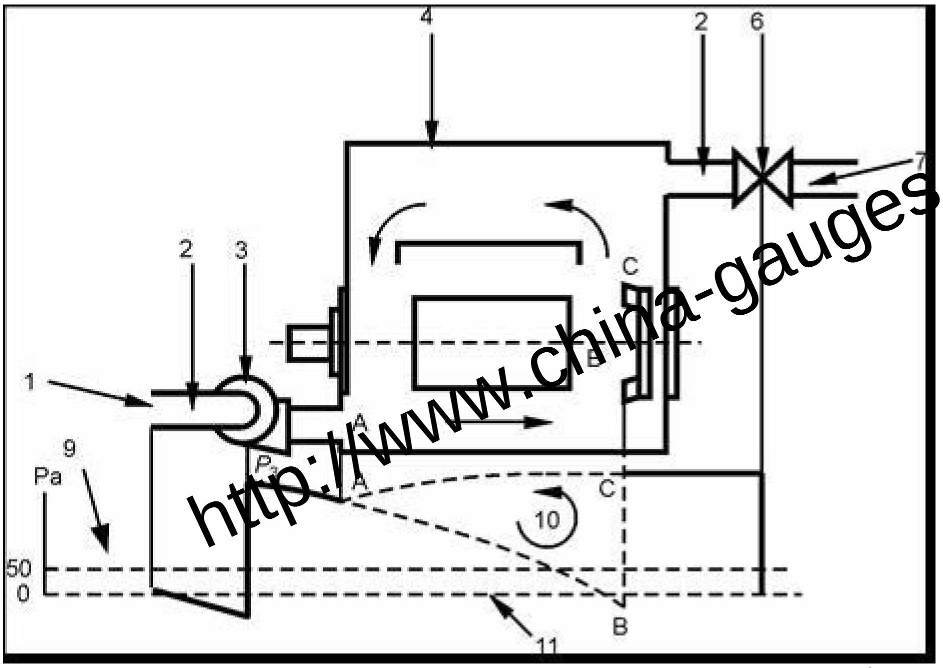
8 (Not used on this diagram)

9 Overpressure

10 Internal pressure

11 External pressure

Figure C.2 – Pressurized enclosures with leakage compensation, enclosures without moving parts



IEC 2315/2000

Key

P_3 Pressure of the protective gas (determined by the flow resistance of the internal parts, and influenced between A, B and C by the internal cooling fan)

1 Protective gas inlet (in a non-hazardous area)

2 Ducting

3 Fan

4 Enclosure

5 (Not used on this diagram)

6 Outlet valve

7 Protective gas outlet

8 (Not used on this diagram)

9 Overpressure

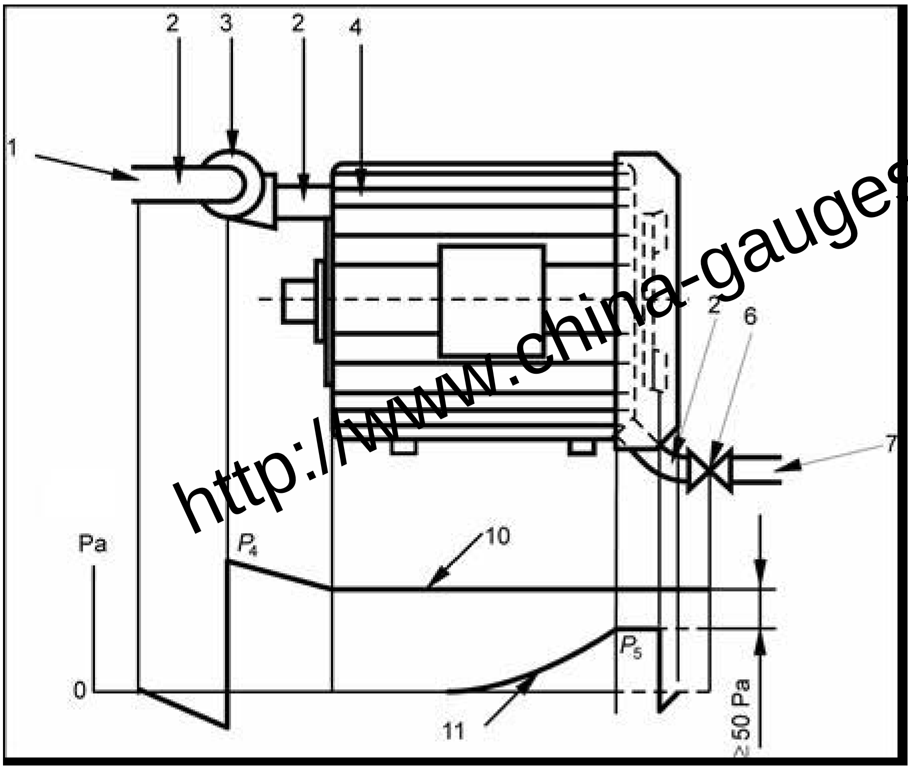
10 Internal pressure

11 External pressure

Pressure at every point where leakage can occur is above the minimum of 50 Pa for type px.

NOTE Care should be taken in the application of pressurization to motors having an internally enclosed cooling circuit in which circulation is assisted by an internal fan, since the effect of such fans may be to produce a negative pressure in parts of the casing with consequent risk of ingress of the external atmosphere. Any proposal to pressurize an internally ventilated motor should be submitted to the manufacturer of the motor.

Figure C.3 – Pressurized enclosures with leakage compensation, rotating electrical machine with an internal cooling fan



IEC 2316/2000

Key

P_4 Pressure of protective gas (determined by the flow resistance of the internal parts and by the uppermost value of pressure of the external air)

P_5 Pressure of the external air, caused by the external cooling fan

1 Protective gas inlet (in a non-hazardous area)

2 Ducting

3 Fan

4 Enclosure

5 (Not used on this diagram)

6 Outlet valve

7 Protective gas outlet

8 (Not used on this diagram)

9 (Not used on this diagram)

10 Internal pressure

11 External pressure

Figure C.4 – Pressurized enclosure with a leakage compensation, rotating electrical machine with an external cooling fan

Annex D
(informative)

Information to be provided to the user

D.1 General

It is essential for safety that information about proper installation of the pressurization system be provided to the user.

Specific issues that the manufacturer should address as appropriate are as follows in Clause D.2 to Clause D.6 inclusive.

D.2 Ducting of protective gas

D.2.1 Location of inlet

Except for cylinder-supplied gases and some Group I applications, the point at which the protective gas enters the supply duct(s) should be situated in a non-hazardous area.

Consideration should be given to minimizing the migration of flammable gases from the hazardous area to the non-hazardous area upon loss of pressurization.

For Group I applications where the protective gas enters the supply ducts from a hazardous area, the following precautions should be taken:

a) two independent firedamp detectors should be fitted at the discharge side of the fan or compressor, each arranged to automatically disconnect the electricity supply to the pressurized enclosure if the concentration of firedamp exceeds 10 % of the lower explosive limit;
b) the time taken to achieve automatic disconnection should not be greater than one half the transit time for the protective gas to flow from the detection point to the pressurized enclosure;
c) in the event of automatic disconnection, the pressurized enclosure should be repurged before the electricity supply is restored. The purging time should not start until the firedamp concentration at the source of protective gas falls below 10 % of the lower explosive limit.

D.2.2 Ducting between pressurized enclosure and inlet

The intake ducting to a compressor should not normally pass through a hazardous area.

If the compressor intake line passes through a hazardous area, it should be constructed of non-combustible material and protected against mechanical damage and corrosion.

Adequate precautions should be taken to ensure that the ducting is free from leaks in case the internal pressure is below that of the external atmosphere (see Annex C). Additional protective measures, for example, combustible gas detectors, should be considered to ensure that the ducting is free of flammable concentrations of gas or vapour.

D.2.3 Outlets for protective gas

Ducts for exhausting the protective gas should preferably have their outlets in an area which would, apart from the area in close proximity to the outlets, be non-hazardous, unless spark and particle barriers have been provided by the manufacturer or added by the user.

D.2.4 Additional purge time to account for ducting

The purge duration should be increased by the time necessary to purge the free volume of those associated ducts which are not part of the equipment by at least five times their volume at the minimum flow rate specified by the manufacturer.

D.3 Power for protective gas supply

The electrical power for the protective gas supply (blower, compressor, etc.) should be either taken from a separate power source or taken from the supply side of the electrical isolator for the pressurized enclosure.

D.4 Static pressurization

If the overpressure falls below the minimum specified, the pressurized enclosure should be removed to a non-hazardous area before refilling.

D.5 Enclosures with a containment system

The maximum pressure and flow of the flammable substance into the containment system should not exceed the ratings specified by the manufacturer.

Additional precautions may be necessary if an explosive mixture may possibly form due to air penetration into the containment system.

Adequate precautions should be taken to prevent adverse operating conditions that may damage the containment system. The description documents should explain these conditions such as vibration, thermal shock and maintenance operations when doors or access covers of the pressurized enclosure are open.

A flow switch may be required to stop the flow of the flammable substance, for example, if it could be ignited by a hot internal surface and the positive internal pressure is relied upon to prevent release from the containment system.

Additional precautions may be necessary if the abnormal release may adversely affect the external area classification.

D.6 Enclosure maximum overpressure

The user should limit the pressure as specified by the manufacturer.

Annex E
(normative)

Classification of the type of release within enclosures

E.1 General

The consequences of a release of flammable substances within an enclosure are more severe than a similar release in free air. A temporary leak inside an enclosure will build up flammable substances which will remain inside the enclosure for a long time even after the leak stops. Because of this, it is necessary to assign greater importance to “normal release” and “abnormal release” than for a release in open air.

In all cases, devices shall be fitted to limit the flow of flammable substances from the containment system into the pressurized enclosure. Only limited releases are permitted.

E.2 No normal release, no abnormal release

The containment system meets the design requirements in 12.2 and the test requirements in 16.6 for infallible containment.

E.3 No normal release, limited abnormal release

A containment system which does not meet the requirements for infallible containment and comprises metallic pipes, tubes or elements such as Bourdon tubes, bellows or spirals, with joints not subject to disconnection during routine maintenance and made with pipe threads, welding, eutectic methods, or metallic compression fittings shall be considered to have no normal release but limited abnormal release.

Rotating or sliding joints, flanged joints, elastomeric seals and non-metallic flexible tubing do not satisfy this criterion.

E.4 Limited normal release

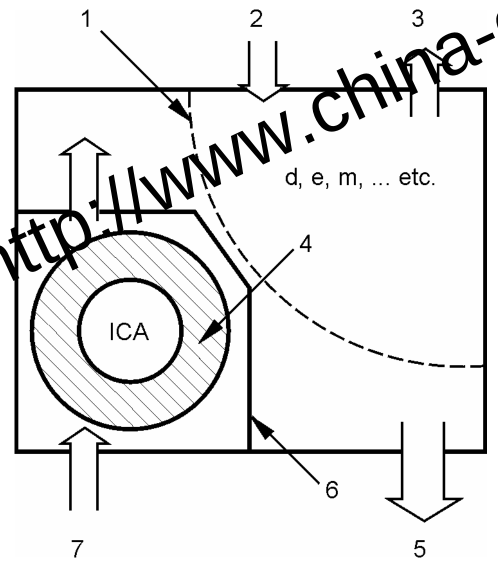
Systems which cannot meet the requirements for "no normal release" shall be considered to have a limited normal release. This includes containment systems with joints subject to routine maintenance. Such joints shall be clearly identified.

Containment systems whose construction comprises non-metallic pipes, tubes, or elements such as Bourdon tubes, bellows, diaphragms, spirals, elastomeric seals, rotating or sliding joints shall be considered to be a source of release in normal operation.

Enclosures having a flame in normal operation shall be assessed with the flame extinguished. It shall be assumed that extinguishing of the flame is a normal occurrence and that the equipment shall be classified as having a normal release unless devices are fitted to stop the flow of flammable gas or vapour automatically upon flame extinction.

Annex F
(informative)

Examples for the use of the dilution area concept

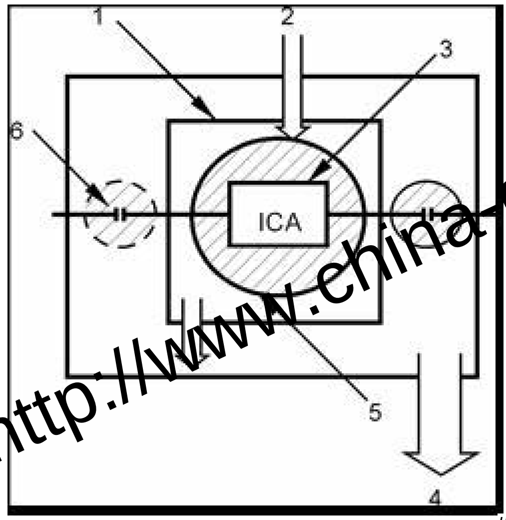


Key

1 Nominal boundary of dilution area
2 Inlet of flammable material
3 Outlet of flammable material
4 Area of dilution testing
5 Purge outlet
6 Partition to enclose ICA
7 Purge inlet

Figure F.1 – Diagram showing the use of the dilution area concept to simplify the purge and dilution test requirements

By enclosing ignition-capable apparatus (ICA) within an inner enclosure or through the use of partitions, it can be demonstrated by a simple test that the ICA does not lie within a dilution area. It is not necessary to determine the extent of the dilution area, merely to determine that the dilution area does not extend to the ICA.



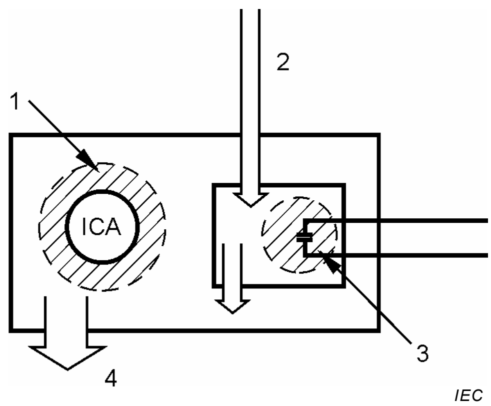
IEC 2318/2000

Key

1 Internal partition
2 Purge inlet
3 Infallible parts of containment system
4 Purge outlet
5 Location of ICA
6 Potential source of release with nominal dilution area

Figure F.2 – Diagram showing the use of the infallible containment system concept to simplify the purging and dilution requirements around ICA

Since those parts of the containment system lying within the internal partition meet the requirements for infallible containment, the ICA cannot be within a dilution area.



IEC 2319/2000

Key

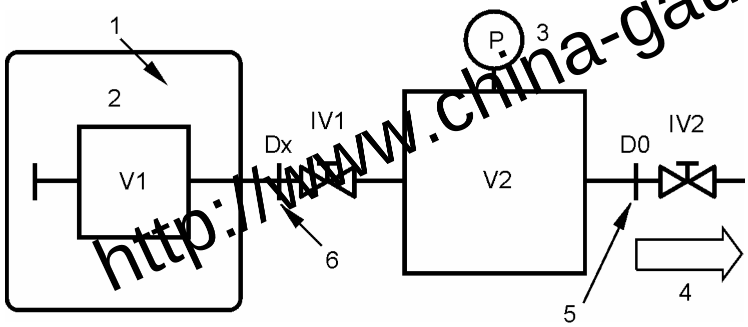
1 Area of dilution testing
2 Purge inlet with inert gas
3 Potential source of release with nominal dilution area
4 Purge outlet

Figure F.3 – Diagram showing the use of internal partitions around the potential source of release to simplify the purging and dilution requirements around ICA located outside the partitions

Since the dilution area is contained within the internal partition, the ICA is not within a dilution area.

Annex G
(normative)

Infallibility test for containment system



Key

IEC 2320/2000

1 Helium-filled chamber

2 System under test

3 Pressure-monitoring device

4 Evacuating system

5 Critical orifice diameter

6 Connecting-orifice diameter

NOTE 1 The volume V2 is greater than the volume V1 of the system under test.

NOTE 2 The cross-sectional area of the critical orifice diameter D0 is less than the cross-sectional area of the connecting orifice Dx.

NOTE 3 The pressure monitoring device P should be corrected to take account of the properties of the leak testing gas (for example, helium).

NOTE 4 The test is satisfactory if an absolute pressure of less than, or equal to, 0,1 Pa can be maintained in V2 with both valves open (IV1 and IV2).

NOTE 5 The leak rate (if any) can be determined with IV1 open and IV2 closed.

Figure G.1 – Schematic diagram of the infallibility test described in 16.6.2 a)

Annex H
(informative)

Introduction of an alternative risk assessment method encompassing “equipment protection levels” for Ex equipment

H.0 Introduction

This annex provides an explanation of the concept of a risk assessment method encompassing equipment protection levels (EPLs). These EPLs are introduced to enable an alternative approach to current methods of selecting Ex equipment.

H.1 Historical background

Historically, it has been acknowledged that not all types of protection provide the same level of assurance against the possibility of an incendive condition occurring. The installation standard, IEC 60079-14, allocates specific types of protection to specific zones, on the statistical basis that the more likely or frequent the occurrence of an explosive atmosphere, the greater the level of security required against the possibility of an ignition source being active.

Hazardous areas (with the normal exception of coal mining) are divided into zones, according to the degree of hazard. The degree of hazard is defined according to the probability of the occurrence of explosive atmospheres. Generally, no account is taken of the potential consequences of an explosion, nor of other factors such as the toxicity of materials. A true risk assessment would consider all factors.

Acceptance of equipment into each zone is historically based on the type of protection. In some cases the type of protection may be divided into different levels of protection which again historically correlate to zones. For example, intrinsic safety is divided into levels of protection “ia” and “ib”. The encapsulation “m” standard includes two levels of protection “ma” and “mb”.

In the past, the equipment selection standard has provided a solid link between the type of protection for the equipment and the zone in which the equipment can be used. As noted earlier, nowhere in the IEC system of explosion protection is there any account taken of the potential consequences of an explosion, should it occur.

However, plant operators often make intuitive decisions on extending (or restricting) their zones in order to compensate for this omission. A typical example is the installation of "zone 1 type" navigation equipment in zone 2 areas of offshore oil production platforms, so that the navigation equipment can remain functional even in the presence of a totally unexpected prolonged gas release. In the other direction, it is reasonable for the owner of a remote, well secured, small pumping station to drive the pump with a "zone 2 type" motor, even in zone 1, if the total amount of gas available to explode is small and the risk to life and property from such an explosion can be discounted.

The situation became more complex with the publication of the first edition of IEC 60079-26 which introduced additional requirements to be applied for equipment intended to be used in zone 0. Prior to this, Ex ia was considered to be the only technique acceptable in zone 0.

It has been recognized that it is beneficial to identify and mark all products according to their inherent ignition risk. This would make equipment selection easier and provide the ability to better apply a risk assessment approach, where appropriate.

H.2 General

A risk assessment approach for the acceptance of Ex equipment has been introduced as an alternative method to the current prescriptive and relatively inflexible approach linking equipment to zones. To facilitate this, a system of equipment protection levels has been introduced to clearly indicate the inherent ignition risk of equipment, no matter what type of protection is used.

The system of designating these equipment protection levels is as follows.

H.2.1 Coal mining (Group I)

H.2.1.1 EPL Ma

Equipment for installation in a coal mine, having a "very high" level of protection, which has sufficient security that it is unlikely to become an ignition source, even when left energized in the presence of an outbreak of gas.

NOTE Typically communications circuits and gas detection equipment will be constructed to meet the Ma requirements, for example an Ex ia telephone circuit.

H.2.1.2 EPL Mb

Equipment for installation in a coal mine, having a "high" level of protection, which has sufficient security that it is unlikely to become a source of ignition in the time span between there being an outbreak of gas and the equipment being de-energized.

NOTE Typically all the coal winning equipment will be constructed to meet the Mb requirements, for example Ex d motors and switchgear.

H.2.2 Gases (Group II)

H.2.2.1 EPL Ga

Equipment for explosive gas atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, expected malfunction faults or when subject to rare faults.

H.2.2.2 EPL Gb

Equipment for explosive gas atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or when subject to faults that may be expected, though not necessarily on a regular basis.

NOTE The majority of the standard protection concepts bring equipment within this equipment protection level.

H.2.2.3 EPL Gc

Equipment for explosive gas atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp).

NOTE Typically, this will be Ex n equipment.

H.2.3 Dusts (Group III)

H.2.3.1 EPL Da

Equipment for combustible dust atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation or when subject to rare faults.

H.2.3.2 EPL Db

Equipment for combustible dust atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or when subject to faults that may be expected, though not necessarily on a regular basis.

H.2.3.3 EPL Dc

Equipment for combustible dust atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences.

For the majority of situations, with typical potential consequences from a resultant explosion, it is intended that the following would apply for use of the equipment in zones. (This is not directly applicable for coal mining, as the zone concept does not generally apply). See Table H.1.

Table H.1 – Traditional relationship of EPLs to zones (no additional risk assessment)

Equipment protection level	Zone
Ga	0
Gb	1
Gc	2
Da	20
Db	21
Dc	22

H.3 Risk of ignition protection afforded

The various levels of protection of equipment must be capable of functioning in conformity with the operational parameters established by the manufacturer to that level of protection See Table H.2.

Table H.2 – Description of risk of ignition protection provided

Protection afforded	Equipment protection level	Group	Performance of protection	Conditions of operation
Very high	Ma	Group I	Two independent means of protection or safe even when two faults occur independently of each other	Equipment remains functioning when explosive atmosphere present
Very high	Ga	Group II	Two independent means of protection or safe even when two faults occur independently of each other	Equipment remains functioning in Zones 0, 1 and 2
Very high	Da	Group III	Two independent means of protection or safe even when two faults occur independently of each other	Equipment remains functioning in Zones 20, 21 and 22
High	Mb	Group I	Suitable for normal operation and severe operating conditions	Equipment de-energised when explosive atmosphere present
High	Gb	Group II	Suitable for normal operation and frequently occurring disturbances or equipment where faults are normally taken into account	Equipment remains functioning in Zones 1 and 2
High	Db	Group III	Suitable for normal operation and frequently occurring disturbances or equipment where faults are normally taken into account	Equipment remains functioning in Zones 21 and 22
Enhanced	Gc	Group II	Suitable for normal operation	Equipment remains functioning in Zone 2
Enhanced	Dc	Group III	Suitable for normal operation	Equipment remains functioning in Zone 22

H.4 Implementation

The fourth edition of IEC 60079-14 will introduce the EPLs to make provision for an extended “risk assessment" approach as an alternative method for the selection of equipment. Reference will also be included in the classification standards IEC 60079-10-1 and IEC 60079-10-2.

The additional marking and the correlation of the existing types of protection are being introduced into the revisions to the following IEC standards:

- IEC 60079-0 (encompassing the former requirements of IEC 61241-0)
- IEC 60079-1
- IEC 60079-2 (encompassing the former requirements of IEC 61241-4)

- IEC 60079-5
- IEC 60079-6
- IEC 60079-7
- IEC 60079-11 (encompassing the former requirements of IEC 61241-11)
- IEC 60079-15
- IEC 60079-18 (encompassing the former requirements of IEC 61241-18)
- IEC 60079-26
- IEC 60079-28

For the types of protection for explosive gas atmospheres the EPLs require additional marking. For explosive dust atmospheres the present system of marking the zones on equipment is being replaced by marking the EPLs.

Bibliography

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

NOTE Harmonized in EN 60051 series (not modified).

IEC 60079-1, *Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures "d"*

NOTE Harmonized as EN 60079-1:2007 (not modified).

IEC 60079-5, *Electrical apparatus for explosive gas atmospheres – Part 5: Powder filling "q"*

NOTE Harmonized as EN 60079-5:2007 (not modified).

IEC 60079-6, *Electrical apparatus for explosive gas atmospheres – Part 6: Oil-immersion "o"*

NOTE Harmonized as EN 60079-6:2007 (not modified).

IEC 60079-7, *Electrical apparatus for explosive gas atmospheres – Part 7: Equipment protection by increased safety "e"*

NOTE Harmonized as EN 60079-7:2007 (not modified).

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

NOTE Harmonized as EN 60079-11:2007 (not modified).

IEC 60079-13, *Electrical apparatus for explosive gas atmospheres – Part 13: Construction and use of rooms or buildings protected by pressurization*

IEC 60079-15, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, tests and marking of type of protection "n" electrical apparatus*

NOTE Harmonized as EN 60079-15:2005 (not modified).

IEC 60079-16, *Electrical apparatus for explosive gas atmospheres – Part 16: Artificial ventilation for the protection of analyser(s) houses*

IEC 60079-18, *Electrical apparatus for explosive gas atmospheres – Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus*

NOTE Harmonized as EN 60079-18:2004 (not modified).

IEC 60079-26, *Explosive atmospheres – Part 26: Equipment with equipment protection level (EPL) Ga*

NOTE Harmonized as EN 60079-26:2007 (not modified).

IEC 60079-28, *Explosive atmospheres – Part 28: Protection of equipment and transmission systems using optical radiation*

NOTE Harmonized as EN 60079-28:2007 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60034-5	–[1]	Rotating electrical machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification	EN 60034-5	2001[2]
IEC 60050-151	–[1]	International Electrotechnical Vocabulary - Part 151: Electrical and magnetic devices	–	–
IEC 60050-426	–[1]	International Electrotechnical Vocabulary - Chapter 426: Electrical apparatus for explosive atmospheres	–	–
IEC 60079-0 (mod)	2004	Electrical apparatus for explosive gas atmospheres - Part 0: General requirements	EN 60079-0	2006
IEC 60112	–[1]	Method for the determination of the proof and the comparative tracking indices of solid insulating materials	EN 60112	2003[2]
IEC 60529	–[1]	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May	1991[2] 1993
IEC 60664-1	1992	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1 [3]	2003

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[1] Undated reference.

[2] Valid edition at date of issue.

[3] EN 60664-1:2003, which includes A1:2000 + A2:2002 to IEC 60664-1:1992, is superseded by EN 60664-1:2007, which is based on IEC 60664-1:2007.

Annex ZZ
(informative)

Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers only the following essential requirements out of those given in Annex II of the EC Directive 94/9/EC:

- ER 1.0.1 to ER 1.0.6;
- ER 1.2.1, ER 1.2.2 (partly), ER 1.2.3, ER 1.2.6 to ER 1.2.8;
- ER 1.3.1, ER 1.3.5;
- ER 1.4.1 (partly);
- ER 1.5.1 to ER 1.5.8;
- ER 1.6.2 (partly), ER 1.6.3 to ER 1.6.5;
- ER 2.0.2.1, ER 2.0.2.2;
- ER 2.2.1, ER 2.2.1.1 to ER 2.2.1.3;
- ER 2.3.1, ER 2.3.1.1, ER 2.3.1.2.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

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