# IEC 60079-2

Edition 6.0 2014-07
REDLINE VERSION

# INTERNATIONAL STANDARD

colour inside



## Explosive atmospheres –
## Part 2: Equipment protection by pressurized enclosure "p"

IEC 60079-2:2014-07 RLV(en)

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INTERNATIONAL
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COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# EXPLOSIVE ATMOSPHERES –

# Part 2: Equipment protection by pressurized enclosure "p"

## FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60079-2 has been prepared by technical committee 31: Explosive atmospheres.

This sixth edition cancels and replaces the fifth edition published in 2007. This sixth edition cancels and replaces the first edition of IEC 61241-4 published in 2001. This sixth edition constitutes a technical revision.

The significance of changes between IEC 60079-2, Edition 6.0, 2014 and IEC 60079-2, Edition 5.0, 2007 are as listed below:

| | | Type | | |
|---|---|---|---|---|
| **Changes** | **Clause** | **Minor and Editorial Changes** | **Extension** | **Major Technical Changes** |
| Scope<br>Expanded to include combustible dust | 1 | | X | |
| Protective Gas<br>Replaced “apparatus” with “equipment” | 3 | | | |
| Protective Gas<br>Revised to show that purging is not required for explosive dust atmospheres | 3.16 | X | | |
| Level of Protection “pxb”<br>Term and definitions revised to reflect EPL and level of protection | 3.21 | X | | |
| Level of Protection “pyb”<br>Term and definitions revised to reflect EPL and level of protection | 3.22 | X | | |
| Level of Protection “pzc”<br>Term and definitions revised to reflect EPL and level of protection | 3.23 | X | | |
| Lower Flammable Limit<br>Term and definition revised to agree with 60079-0 | 3.26 | X | | |
| Upper Flammable Limit<br>Term and definition revised to agree with 60079-0 | 3.27 | X | | |
| Table 1 – Determination of protection level<br>Revised to use EPL terminology | Table 1 | X | | |
| Table 2 – Design Criteria based upon level of protection<br>Revised to use EPL terminology | Table 2 | X | | |
| Enclosure<br>Requirements relaxed for specific designs | 5.1 | | X | |
| Group II and Group III pressurized enclosures<br>Text revised to use EPL terminology | 5.3.3 | X | | |
| Group II and Group III Level of Protection “pxb”<br>Added that warning also applies for explosive dust atmospheres | 5.3.5 | | X | |
| Group II and Group III door and cover warning<br>Added that warning also applies for explosive dust atmospheres | 5.3.6 | | X | |
| Group II and Group III door and cover warning<br>Revised warning from atmosphere “may be present” to “is present” | 5.3.6 | X | | |

| | | Type | | |
|---|---|---|---|---|
| **Changes** | **Clause** | **Minor and Editorial Changes** | **Extension** | **Major Technical Changes** |
| Mechanical Strength<br>Removed reference to 60079-0 by clause number for “X” condition | 5.4 | X | | |
| Spark and particle barriers<br>Removed reference to 60079-0 by clause number for “X” condition | 5.9 | X | | |
| Cells and batteries<br>Added requirements for cells and batteries | 5.10 | | | C1 |
| For Level of Protection “pxb” or Level of Protection “pyb”<br>Revised Table to use terminology consistent with EPLs | 6.2 | X | | |
| Suitability of safety devices for hazardous area<br>Word “explosion” changed to “ignition” to reflect UFL/LFL terms | 7.1 | X | | |
| Integrity of safety devices<br>Added requirement for detecting fan failure | 7.2 | | | C2 |
| Table 3 – Safety devices based upon Level of Protection<br>Revised column labels to use Level of Protection terminology | Table 3 | X | | |
| Provider of safety devices<br>Remove reference to 60079-0 by clause number for “X” condition | 7.3 | X | | |
| Pressurization System evaluated as associated equipment<br>Added requirements for pressurization systems | 7.4 | | | C3 |
| Sequence diagram for Level of Protection “pxb”<br>Revised text to use Level of Protection terminology | 7.5 | X | | |
| Group I and Group II purging automated for Level of Protection “pxb”<br>Revised text to use Level of Protection terminology | 7.7 | X | | |
| Group I and Group II purging automated for Level of Protection “pxb”<br>Added text specifying that for “pxb”, control must be automated | 7.7 | | | C4 |
| Group I or Group II – purging criteria<br>Revised text to use Level of Protection terminology | 7.8 | X | | |
| Group III – cleaning<br>Added text for cleaning enclosures used in explosive dust atmospheres | 7.9 | | X | |
| Safety devices to detect minimum overpressure<br>Add word “minimum” to clause title to be consistent with text | 7.11 | X | | |
| Safety devices to detect minimum overpressure<br>Revised text to use Level of Protection terminology | 7.11 d) | X | | |
| Value of minimum overpressure<br>Added word “minimum” to clause title to be consistent with text | 7.12 | X | | |
| Value of minimum overpressure<br>Revised text to use Level of Protection terminology | 7.12 | X | | |
| Value of minimum overpressure<br>Added text to reflect a note in Annex C | 7.12 | | X | |
| Pressurizing multiple enclosures<br>Revised text to use Level of Protection terminology | 7.13 | X | | |

| Changes | Clause | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Safety devices on doors and covers<br>Revised text to use Level of Protection terminology | 7.14 | X | | |
| Equipment that may remain energized<br>Revised text to use EPL and level of protection terminology | 7.15 | X | | |
| Equipment permitted within Level of Protection “pyb”<br>Revised text to use EPL and level of protection terminology | 7.16 | X | | |
| Group I and Group II Filling procedure<br>Allow filling in a hazardous location if tested as non-hazardous | 8.4 | | X | |
| Group III Filling Procedure<br>Added static pressurization filling procedure for combustible dust | 8.5 | | X | |
| Safety devices<br>Revised text to use Level of Protection terminology | 8.6 | X | | |
| Equipment that may remain energized<br>Revised text to use EPL terminology | 8.7 | X | | |
| Overpressure<br>Removed reference to 60079-0 by clause number | 8.8 | X | | |
| Backup supply<br>Added requirements for a backup supply of protective gas | 9.1 | | | C5 |
| Independent supplies<br>Provided requirements for independence of pressurization | 9.2 | | X | C6 |
| Release Conditions<br>Removed reference to 60079-0 by clause number for “X” condition | 11.1.2 | X | | |
| Containment system with a limited release<br>Removed reference to 60079-0 by clause number for “X” condition | 12.3 | X | | |
| 13.3.3 Limited release of a gas or vapour<br>Revised text to reflect UFL/LFL terms | 13.3.3 | X | | |
| Ignition-capable equipment<br>Revised text to use Level of Protection terminology | 14 | X | | |
| Type verification and tests<br>Edition 5 clauses 16.1 to 16.7 moved to Edition 6 clauses 16.2 to 16.8 | 16 | X | | |
| Determining the maximum overpressure rating<br>Added requirements to determine maximum overpressure | 16.1 | | | C7 |
| Maximum overpressure test<br>Moved Maximum overpressure test to 16.2 | 16.2 | | | C7 |
| Leakage test<br>Clarify the acceptance criteria for the test | 16.3.2 | | X | |
| Tests for an infallible containment system<br>Clarify the rating used for the test | 16.7.1 | | | C8 |
| Tests for an infallible containment system<br>Modified test for infallible containment | 16.7.2 | | | C9 |

| Changes | Clause | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Edition 5 – Verifying ability of the pressurized enclosure to limit internal pressure<br>Eliminated test | 16.8 | | | C7 |
| Functional test<br>Clarified that applies only to safety devices provided with enclosures | 17.1 | X | | |
| Tests for an infallible containment system<br>Waived helium leak tests for liquid systems | 17.3 | | X | |
| Supplementary marking<br>Allowed continued use of type of protection marking | 18.3 | | | |
| Pressurization systems<br>Clarified use of Ex [p] and [Ex p] marking | 18.6 | X | | |
| Warnings required in other clauses<br>Added table number | 18.7 | X | | |
| Warnings required in other clauses<br>Added warning from 7.9 | 18.7 | | X | |
| Warnings required in other clauses<br>Added warnings from Annex G and Annex H | 18.7 | | | C1 |
| Instructions<br>Added requirements for Group III | 19 | | X | |
| Edition 5 Annex G – Infallibility test for containment system<br>Deleted and replaced | Annex G | X | | |
| Edition 5 Annex H – Introduction of an alternative risk assessment method encompassing “equipment protection levels”<br>Deleted and replaced | Annex H | X | | |
| Annex G – Internal Cells and Batteries for Level of Protection “pxb” and Level of Protection “pyb”<br>Added requirements for cells and Batteries | | | X | |
| Annex H – Internal Cells and Batteries for Level of Protection “pzc”<br>Added requirements for cells and Batteries | | | X | |



**Explanations:**

**A) Definitions**

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

These are changes which modify requirements in an editorial or a minor technical way. They include changes of the wording to clarify technical requirements without any technical change, or a reduction in level of existing requirement.

**Extension** addition of technical options

These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore, these will not have to be considered for products in conformity with the preceding edition. 5.

**Major technical changes** addition of technical requirements increase of technical requirements

These are changes to technical requirements (addition, increase of the level or removal) made in a way that a product in conformity with the preceding edition will not always be able to fulfill the requirements given in the later edition. These changes have to be considered for products in conformity with the preceding edition. For these changes additional information is provided in clause B) below

B) Information about the background of 'Major Technical Changes'

C1 – Added annexes with requirements for using cells and batteries.

C2 – Added requirement that fan failure cannot be based upon loss of power to the fan.

C3 – Added requirements for equipment evaluated as a pressurization system to provide uniformity in the testing of such equipment.

C4 – Although, in Edition 5, the title of clause 7.6 stated automated purging, the word automated was not in the requirement. It is intended that all "pxb" equipment have an automated purging system to prevent energizing of ignition capable circuits until the purge cycle has been properly completed. This requires verifying that the flow is at least the minimum required for the purge time as well as verifying that the minimum overpressure exists within the enclosure.

C5 – If a backup supply of protective gas is provided, then both the primary and the backup supply needs to be capable of maintaining the required pressurization.

C6 – If a pressurized enclosure is used within a larger pressurized enclosure the protective gas supplies need to be independent.

C7 – The previous text in 16.1 of Edition 5, assumed that the enclosures had a maximum overpressure rating, but this is rarely the case. Some test houses relied upon the test in 16.8 to determine the maximum overpressure. Various methods were used to simulate regulator failure such as removing the regulator, but this also removed the orifices that would limit the flow. Based upon test house experience, the danger of flying fragments from the enclosure is acceptably small as either the enclosure or the gaskets will deform to relieve the internal pressure. A decision was taken to eliminate the overpressure test based upon the failed regulator. In addition, the definition of maximum overpressure is now based upon the value obtained when the pressurized enclosure is operated within its ratings. This maximum overpressure will generally occur when the equipment is in rapid purge mode with the maximum rated pressure applied to the inlet of the regulator. The Edition 5 text of 16.1 was modified and moved to 16.2.

C8 – The term overpressure in most cases implies operation outside of the normal ratings. Text was clarified to use the term "maximum operating pressure" rather than maximum internal overpressure. Test was 16.6.1 in Edition 5.

C9 – The test was modified to use helium leak detection rather than rely on maintaining a vacuum since this would depend upon the capability of the vacuum system. Test was 16.6.2 in Edition 5.



The significance of changes between IEC 60079-2, Edition 6.0, 2014 and IEC 61241-4, Edition 5.0, 2007 are as listed below:

| | | Type | | |
|---|---|---|---|---|
| **Changes** | **Clause in 61241-4** | **Minor and Editorial Changes** | **Extension** | **Major Technical Changes** |
| Removed type of protection "pD". Included in 3.20, 3.21 and 3.22 | 3.1 | | X | |
| Definition of pressurization now accommodates both gas and dust | 3.3 | | X | |
| Definition of protective gas now accommodates both gas and dust | 3.4 | | X | |
| Removed definition for an enclosure. Defined in IEC 60079-0 | 3.5 | X | | |
| Removed note in definition for pressurized enclosure. | 3.6 | X | | |

| | | Type | | |
|---|---|---|---|---|
| **Changes** | **Clause in 61241-4** | **Minor and Editorial Changes** | **Extension** | **Major Technical Changes** |
| Replaced definition of static pressurization with 60079-2 definition | 3.7 | X | | |
| Removed definition for “pressurization with continuous flow of the protective gas”. Term not used in 61241-4 | 3.9 | X | | |
| Removed definition for “electrical apparatus”. Definition is covered in IEV | 3.10 | X | | |
| Definition of ignition-capable apparatus now accommodates both gas and dust | 3.11 | X | | |
| Removed definition for “self-revealing fault”. Term not used in 61241-4 | 3.12 | X | | |
| Removed definition for “opening”. Term not used in 61241-4 | 3.13 | X | | |
| Removed definition for “protective device”. These are mostly referred to as a “safety device” throughout 61241-4. | 3.14 | X | | |
| Removed definition for “protected apparatus”. This was only used to address batteries which are now covered in Annex G and Annex H. | 3.17 | X | | |
| Replaced definition of “pressurization system” with 60079-2 definition | 3.18 | X | | |
| Removed definition for “alternate (or auxiliary) source of supply of protective gas”. Term used is “second source of Supply. This is now addressed in 60079-2, 9.1 | 3.19 | X | | |
| Removed definition for “zones in Area Classification” This definition is provided in 60079-10-2. | 3.20 | X | | |
| Removed definition for “zone 20 in Area Classification”. See above | 3.21 | X | | |
| Removed definition for “zone 21 in Area Classification”. See above | 3.22 | X | | |
| Removed definition for “zone 22 in Area Classification”. See above | 3.23 | X | | |
| Removed Clause on “Pressurization principle” including sub-clauses. This information is covered by the definition of “Pressurization”, see 3.13 and other clauses in the standard. | 4 | X | | |
| Removed Clause on “Electrical performance of apparatus”. Safe performance of equipment is addressed by 60079-0, 6.1 b) | 5.1 | X | | |
| Removed note about equipment with large surface areas subjected to pressures > 1kPa may be subject to pressure vessel legislation. | 5.2 | X | | |
| Text on apertures is equivalently covered by 5.5 and 5.6 | 5.3 | X | | |
| Text on electrical connections is equivalently covered in 60079-0, clause 14. | 5.4 | X | | |
| Text on delaying opening of an enclosure because of internal hot surface is equivalently covered in clause 15. | 5.5 | X | | |
| Removed text on providing suitable amount of doors or covers to provide for effective removal of dust from the enclosure. The text in 61241-4 would not lend itself to consistent assessments from different CBs. | 5.5 | X | | |
| Text on temperature limits is equivalently covered in clause 6 and 60079-0, 26.5.1.3. | 6 | X | | |
| Removed text on the responsibility of the manufacturer. Addressed in 60079-0. | 7.1 | X | | |
| Removed text on the responsibility of the user. Addressed in 60079-14. | 7.1 | X | | |
| Removed text that manufacturer shall provide instructions for cleaning the enclosure. Addressed in 60079-14. | 7.1 | X | | |
| Removed text requiring a safety device to operate when the pressure within the enclosure exceeds the permitted maximum pressure. It is the user responsibility to not exceed the rated maximum pressure. | 7.2 | X | | |
| Removed text requiring the isolation of the neutral conductor. Addressed in 60079-14. | 7.4 | X | | |
| Text on failure of pressurization is equivalently covered by clause 7 & 13.3. | 7.5 | X | | |

| Changes | Clause in 61241-4 | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Removed text on location of visible or audible alarms. Addressed in 60079-14. | 7.5.1 | X | | |
| Removed text requiring both disconnection and alarming for Zone 21 Db. Addressed in 60079-14. | 7.5.1.1 | X | | |
| Text on warning marking on doors and covers is equivalently covered in 5.3.6. | 7.5.1.2 | X | | |
| Removed text about providing means for removing oil or moisture. Addressed in 60079-14, 13.1.6. | 9.1 | X | | |
| Removed text requiring the minimum overpressure be verified over a 5 minute period. It is not considered that this measurement is time dependent. | 10.4.1 | X | | |
| Removed text requiring the minimum overpressure be verified with through-the-wall moving parts operating in normal use. It is not considered that operating such parts will affect the internal pressure. | 10.4.2 | X | | |
| Removed text requiring that the Leakage Test be done at a minimum of 200 Pa. The Leakage Test is only applicable to maximum overpressure specified by the manufacturer for normal service. | 10.5 | X | | |
| Text on conformity for Leakage Testing of Static Pressurization is equivalently covered in 16.3.2. | 10.5 | X | | |
| 60079-2, Ed 6 does not have an exception to the impact test for pressurized enclosures that are not subject to mechanical damage. | 10.6 | | | B1 |
| Removed text on routine Overpressure test | 10.7 | X | | |
| Added text for routine tests of containment systems. 61241-4 did not address enclosures which contained an internal release of a flammable substance. | 10.7 | | X | |
| Text on Marking is equivalently covered in clause 60079-0, clause 29 | 11.1 | X | | |
| Removed text requiring that “limitations affecting the safe use of the apparatus” be marked. This is covered in the instructions, see 60079-0, clause 30. | 11.2 | X | | |
| Removed text requiring that “the position at which the pressure and flow are monitored” be marked. | 11.2 | X | | |
| Removed text requiring that “the maximum wattage of the lamp for a light fitting” be marked. | 11.2 | X | | |
| Removed text “As agreed upon between the certificate applicant and testing station if necessary.” | 11.4 | X | | |



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B) Information about the background of 'Major Technical Changes'

B1 – Pressurized enclosure must be subjected to impact testing as shown in Table 2.

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 31/1119/FDIS | 31/1131/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This standard is to be read in conjunction with IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 60079 series, under the general title Explosive atmospheres can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the new edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of July 2015 have been included in this copy.

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# INTRODUCTION

This part of IEC 60079 gives requirements for the design, construction, testing and marking of electrical ~~apparatus~~ equipment 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~~ 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 and ~~. 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; or

c) a protective gas maintained at a pressure above that of the external atmosphere, is used to prevent the entry of combustible dust which might otherwise lead to the formation of an explosive dust atmosphere within enclosures, but only where there is no internal source of release of combustible dust.

This standard includes requirements for the ~~apparatus~~ equipment and its associated equipment including the inlet and exhaust ducts, and also for the auxiliary control ~~apparatus~~ equipment 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~~ equipment with pressurized enclosures, of type of protection “p”, intended for use in explosive gas atmospheres or explosive dust atmospheres. It ~~specifies~~ also includes the 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 take precedence.

This standard does not include 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 where the oxygen is in a proportion greater than 21 %.
- pressurized rooms or analyser houses; see IEC 60079-13 ~~and IEC 60079-16.~~;
- pressurized enclosures used where “explosives” or pyrotechnics are present;
- pressurized enclosures used where hybrid mixtures of gas/vapour and combustible dust are present;

~~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.~~

- pressurized enclosures used where pyrophoric substances such as explosives or propellants containing their own oxidizers are present;
- pressurized enclosures with an internal source of release of combustible dust.

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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 (all parts), *International Electrotechnical Vocabulary*

~~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*~~ *Explosive atmospheres – Part 0: Equipment – General requirements*

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

IEC 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

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

IEC 60127, (All parts) *Miniature fuses*

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~~ equipment that generates a visual or audible signal that is intended to attract attention

**3.2**
**containment system**
part of the ~~apparatus~~ equipment 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 1 to entry: Dilution of oxygen by inert gas may result in a concentration of flammable gas or vapour above the upper ~~explosive~~ flammable limit (U~~E~~FL).

**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~~ equipment. 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

Note 1 to entry: Examples of fusion include brazing, welding or the fusion of glass to metal.

**3.8**
**ignition-capable ~~apparatus (ICA)~~ equipment**
**ICE**
~~apparatus~~ equipment 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~~ equipment that shows whether flow or pressure is adequate and which is intended to be 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**
provision of 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 and purging

Note 1 to entry: 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

Note 1 to entry: The protective gas supply includes inlet (suction) pipes or ducts, pressure regulators, outlet pipes, ducts, and supply valves.

Note 2 to entry: Components of the pressurization system other than the pressure regulator, 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]~~

**3.19**
**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 theequipment 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~~

**3.20**
**Level of Protection “pxb”**
pressurized enclosure providing Equipment Protection Level Mb, Gb or Db

Note 1 to entry: This permits unprotected equipment to be installed within the pressurized enclosure except for safety devices, see 3.23.

**3.21**
**Level of Protection "pyb"**
pressurized enclosure providing Equipment Protection Level Gb or Db with Equipment Protection Level Gc or Dc internal to the pressurized enclosure

Note 1 to entry: This permits Equipment Protection Level Gc or Dc equipment to be installed within the pressurized enclosure, except for safety devices, see 3.23

**3.22**
**Level of Protection "pzc"**
pressurized enclosure providing Equipment Protection Level Gc or Dc

Note 1 to entry: This permits unprotected equipment to be installed within the pressurized enclosure except for safety devices, see 3.23.

~~**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]~~

**3.23**
**safety device**
device used to implement or maintain the integrity of the type of protection

**3.24**
**lower flammable limit**
**LFL**
volume fraction of flammable gas or vapour in air below which an explosive gas atmosphere will not form, expressed as a percentage (see IEC 60079-20-1)

Note 1 to entry: This is also known as Lower Explosive Limit (LEL).

**3.25**
**upper flammable limit**
**UFL**
volume fraction of flammable gas or vapour in air above which an explosive gas atmosphere will not form, expressed as a percentage (see IEC 60079-20-1)

Note 1 to entry: This is also known as Upper Explosive Limit (UEL).

## 4 Protection ~~types~~ levels

Protection by pressurization is subdivided into three ~~types of protection (px, py and pz)~~ Levels of Protection ("pxb", "pyb" and "pzc") which are selected based upon the Equipment Protection Level required ~~for the external explosive gas atmosphere~~ (Mb, Gb, Db, Gc or Dc), 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~~ Level of Protection then defines design criteria for the pressurized enclosure and the pressurization system; see Table 2.

**Table 1 – Determination of protection ~~type~~ level**

| ~~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.~~<br>~~[b] If no normal release; see Annex E.~~<br>~~[c] The protective gas shall be inert if "(inert)" is shown after the pressurization type; see Clause 13 13.~~<br>~~[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.~~ | | | |

| Is there an internal release condition? | Highest Equipment Protection Level requirement for external explosive atmosphere | Does enclosure contain ignition-capable equipment? | Level of Protection |
|---|---|---|---|
| No | Mb, Gb or Db | Yes or no | Level of Protection “pxb” |
| No | Gb or Db | No | Level of Protection “pyb” |
| No | Gc or Dc | Yes or no | Level of Protection “pzc” |
| Yes, gas/vapour | Mb, Gb or Db | No or Yes and the ignition-capable equipment is not located in the dilution area | Level of Protection “pxb” |
| Yes, gas/vapour | Gb or Db | No | Level of Protection “pyb” |
| Yes, gas/vapour | Gc or Dc | Yes and the ignition-capable equipment is not located in the dilution area | Level of Protection “pxb” |
| Yes, gas/vapour | Gc or Dc | No | Level of Protection “pyb” |
| Yes liquid | Gb or Db | Yes or No | Level of Protection “pxb” (inert) |
| Yes liquid | Gb or Db | No | Level of Protection “pyb” (inert) |
| Yes liquid | Gc or Dc | Yes or No | Level of Protection “pzc” (inert) |
| If the flammable substance is a liquid, normal release is never permitted.<br>The protective gas shall be inert if "(inert)" is shown after the pressurization level; see Clause 13. | | | |

**Table 2 – Design criteria based upon ~~type~~ level of protection**

| Design criteria | ~~Type px~~ Level of Protection "pxb" | ~~Type py~~ Level of Protection "pyb" | ~~Type pz~~ Level of Protection "pzc" with indicator | ~~Type pz~~ Level of Protection "pzc" 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~~ applies | IEC 60079-0~~, Table 8~~ applies | IEC 60079-0~~, Table 8~~ applies | apply half the value shown in ~~Table 8~~ IEC 60079-0 |
| Verifying purge period for Group I and Group II | 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 Mb, Gb or Db | Spark and particle barrier required, see ~~5.8~~ 5.9, unless incandescent particles not normally produced | No requirement[a] ~~see Note 1~~ | ~~Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced~~ Level of protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db | ~~Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced~~ Level of protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db |
| Preventing incandescent particles from exiting a normally closed relief vent into an area requiring EPL Gc or Dc | No requirement[b] ~~see Note 2~~ | No requirement[b] ~~see Note 2~~ | No requirement[b] ~~see Note 2~~ | No requirement[b] ~~see Note 2~~ |
| Preventing incandescent particles from exiting a vent that opens during normal operation, to an area requiring EPL Mb, Gb or Db | Spark and particle barrier required, see ~~5.8~~ 5.9 | Spark and particle barrier required, see ~~5.8~~ 5.9 | ~~Spark and particle barrier required; see 5.8~~ Level of Protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db | ~~Spark and particle barrier required, see 5.8~~ Level of Protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db |
| Preventing incandescent particles from exiting a vent that opens during normal operation to an area requiring EPL Gc or Dc | Spark and particle barrier required, see ~~5.8~~ 5.9, unless incandescent particles not normally produced | No requirement[a] ~~see Note 1~~ | Spark and particle barrier required, see ~~5.8~~ 5.9, unless incandescent particles not normally produced | Spark and particle barrier required, see ~~5.8~~ 5.9, unless incandescent particles not normally produced |
| Door or cover ~~removable~~ opens only with use of a tool | Warning, see 5.3 and 6.2 b) ii) | Warning, see 5.3.6 [b] ~~and Note 1~~ | Warning, see 5.3.6 [c] ~~and Note 3~~ | Warning, see 5.3.6 [c] ~~and Note 3~~ |
| Door or cover ~~removable~~ opens without use of a tool | Interlock, see ~~7.12~~ 7.14 (no internal hot parts) | Warning, see 5.3.6 [a] ~~and Note 1~~ | Warning, see 5.3.6 [c] ~~and Note 3~~ | Warning, see 5.3.6 [c] ~~and Note 3~~ |
| Internal hot parts that require a cool-down period before opening enclosure | Comply with 6.2 b) ii) | No requirement[a] ~~see Note 1~~ | Warning, see 5.3.6 | Warning, see 5.3.6 |

~~NOTE 1~~ [a] 6.2b) ii) is not applicable for ~~type py~~ Level of Protection "pyb" since neither hot internal parts nor normally created incandescent particles are permitted.

~~NOTE 2~~ [b] 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~~ [c] There is no requirement for tool accessibility on a ~~type~~ Level of Protection "pzc" 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.~~

For Level of Protection "pxb" with no internal components that exceed the marked temperature class and for Levels of Protection "pyb" and "pzc", the tests for thermal endurance to heat and thermal endurance to cold for non-metallic enclosures and non-metallic parts of enclosures of IEC 60079-0 need not be applied to the pressurized enclosure.

This is because degradation of the enclosure that results in increased leakage will result in alarm or removal of power to ignition capable circuits. Therefore, the pre-conditioning testing of non-metallic enclosures and non-metallic parts of enclosures is not considered necessary.

### 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~~ providing an EPL as shown in 7.15 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed. The requirements of ~~7.6~~ 7.7 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 and Group III pressurized enclosures

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

For ~~type px~~ Level of Protection "pxb", doors and covers ~~except for those~~ which can be opened ~~only by~~without the use of a tool or key shall be interlocked so that the electrical supply to electrical equipment not identified in ~~7.13~~ 7.15 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~~ Level of Protection "pyb" and Level of Protection "pzc", the use of a tool or key is not required.

~~NOTE~~ Consideration should be given to the possibility that the ~~high~~ internal pressure ~~may~~ could cause a door or cover to open violently when the fastener is moved. The operator or 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 and Group III pressurized enclosures with static pressurization

Doors and covers ~~can be~~ shall not be capable of being opened ~~only by~~ readily without the use of a key or tool.

#### 5.3.5 ~~Type px~~ Group II and Group III Level of Protection "pxb"

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 and Group III Door and Cover warning

To prevent the ignition of an explosive gas atmosphere or an explosive dust atmosphere which may be present when an enclosure is opened, doors and covers shall be marked:

WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE ~~MAY BE~~ IS 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~~ the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard.

### 5.5 Group I and Group II 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~~ are typically 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 (L~~E~~FL) of hydrogen; see 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.

## 5.6 Apertures for Static Pressurization

~~**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~~5.7 Insulating materials for Group I equipment

~~For Group I equipment, insulating material~~ Insulating materials 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 (CTI) of pollution degree 3 in ~~Table 4 of~~ IEC 60664-1.

### ~~5.7~~5.8 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~~5.9 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:~~ Enclosures in which incandescent particles are not normally produced, do not require a spark and particle barrier on any normally closed relief vent exhausting into an area requiring EPL Gb or Mb.

~~EXCEPTION 2:~~ Enclosures in which incandescent particles are not normally produced, do not require a spark and particle barrier on any vent exhausting into an area requiring EPL Gc.

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~~ the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard.

~~**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.~~

### 5.10 Cells and batteries

Annex G provides requirements for Levels of Protection "pxb" and "pyb". Annex H provides requirements for Level of Protection "pzc".

## 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~~ Level of Protection "pxb" or Level of Protection "pyb"

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~~ Level of Protection "pxb" and complies with the requirements for opening times in IEC 60079-0. 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~~ For Level of Protection “pyb”, hot ignition-capable parts in normal operation are not permitted within the enclosure.

### 6.3 For ~~type pz~~ Level of Protection “pzc”

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 explosion 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~~ reduce electrical equipment protected by pressurization from causing ~~an explosion~~ ignition shall themselves not be capable of causing ~~an explosion~~ ignition (see ~~7.13~~ 7.15) 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~~ Level of Protection “pxb” or Level of Protection “pyb”, a single fault evaluation;

– for ~~type pz~~ Level of Protection “pzc”, normal operation.

NOTE For guidance on the single fault evaluation, IEC 61511 series or similar standards can be used.

An electrical interlock on the fan motors or controls is not sufficient to indicate failure of pressurization because this may not indicate failures such as the fan belt slipping, the fan becoming loose on the shaft or reverse rotation of the fan.

**Table 3 – Safety devices based upon ~~protection type~~ Level of Protection**

| Design criteria | ~~Type px~~ Level of Protection “pxb” | ~~Type py~~ Level of Protection “pyb” | ~~Type pz~~ Level of Protection “pzc” |
|---|---|---|---|
| Safety device to detect loss of minimum overpressure | Pressure sensor, see ~~7.9~~ 7.11 | Pressure sensor, see ~~7.9~~ 7.11 | Indicator or pressure sensor, see ~~7.9~~ 7.11 d) |
| Safety device(s) to verify purge period for Group I and Group II | Timing device, pressure sensor, and flow sensor at outlet; see ~~7.6~~ 7.7 | Time and flow marked, see ~~7.7~~ 7.8 c) | Time and flow marked, see ~~7.7~~ 7.8 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~~ 7.14 (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~~ level 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~~ the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard.

### 7.4 Pressurization System evaluated as associated equipment

#### 7.4.1 Pressurization systems for Level of Protection ”pzc”.

The pressurization system shall include as a minimum: a means for controlling the minimum overpressure, (e.g. a regulator) and a means to verify the minimum overpressure, (e.g. an indicator) all in accordance with7.11.

If a vent is provided, it shall have a spark and particle barrier.

If a regulator is provided and if it is of a type that a single failure mode will put full inlet pressure on the regulator outlet, then a means (e.g. relief vent) shall be provided that will limit the internal pressure of an enclosure to a defined value. This value is to be stated in the instructions and established by either test or calculation. If multiple regulators or relief vents are provided as options, then the value for each set of available regulator/relief vent options shall be determined.

The pressurization system shall be tested to verify correct operation.

#### 7.4.2 Pressurization systems for Level of Protection ”pyb”.

The pressurization system shall include: a means for controlling the minimum overpressure, (e.g. a regulator), a means to verify the minimum overpressure, (e.g. a pressure sensor) and an automatic safety device all in accordance with7.11.

If a regulator is provided and if it is of a type that a single failure mode will put full inlet pressure on the regulator outlet, then a means (e.g. relief vent) shall be provided that will limit the internal pressure of an enclosure to a defined value. This value is to be stated in the instructions and established by either test or calculation. If multiple regulators or relief vents are provided as options, then the value for each set of available regulator/relief vent options shall be determined.

The pressurization system shall be tested to verify correct operation.

#### 7.4.3 Pressurization systems for Level of Protection ”pxb”.

The pressurization system shall include: a means for controlling the minimum overpressure, (e.g. a regulator), a means to verify the minimum overpressure, (e.g. a pressure sensor), an automatic safety device all in accordance with 7.11 and an automated control system incorporating a flow sensor in accordance with7.7.

If a regulator is provided and if it is of a type that a single failure mode will put full inlet pressure on the regulator outlet, then a means (e.g. relief vent) shall be provided that will limit the internal pressure of an enclosure to a defined value. This value is to be stated in the instructions and established by either test or calculation. If multiple regulators or relief vents are provided as options, then the value for each set of available regulator/relief vent options shall be determined.

The pressurization system shall be tested to verify correct operation including the function of the automatic control system.

### ~~7.4~~7.5 Sequence diagram for ~~type px~~ Level of Protection "pxb"

For ~~type px~~ Level of Protection "pxb" 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~~7.6 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~~ ratings specified by the manufacturer.

### ~~7.6~~7.7 Group I and Group II – Purging automated for ~~type px~~ Level of Protection "pxb"

An automatic control system including safety devices shall be provided to ~~prevent~~ energize the electrical equipment within a pressurized enclosure ~~becoming energized until~~ only after purging has been completed.

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

a) following the initiation of the sequence, the purging flow through and the minimum 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~~7.8 Group I or Group II – Purging criteria

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

a) for ~~type px or type py~~ Level of Protection "pxb" or Level of Protection "pyb", the manufacturer shall specify the minimum purge flow and time to satisfy the test in ~~16.3~~ 16.4 or 16.5 as appropriate. For other than rotating machines and equipment with complex geometries, 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~~ Level of Protection "pzc", for other than rotating machines and equipment with complex geometries, 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~~ 16.4 or 16.5, as appropriate.

   The purge test for rotating machines and for equipment with complex geometries may be omitted if the purge time is based on tests made with similar or comparable enclosures.

c) the purging flow rate shall be monitored at the outlet of the pressurized enclosure. For ~~type px~~ Level of Protection "pxb", the actual flow shall be monitored. For ~~type py or type pz~~ Level of Protection "pyb" or Level of Protection "pzc", the flow may be deduced, for example, from the enclosure pressure and a defined orifice at the outlet. For ~~type py or~~

~~type pz~~ Level of Protection "pyb"or Level of Protection "pzc", 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.

## 7.9 Group III – Cleaning

A warning shall be marked on the equipment stating that combustible dust shall be removed from the interior prior to switching on the electrical supply. The marking shall include the following or similar:

WARNING – POWER SHALL NOT BE RESTORED AFTER THE ENCLOSURE HAS BEEN OPENED UNTIL COMBUSTIBLE DUST ACCUMULATIONS WITHIN THE ENCLOSURE HAVE BEEN REMOVED.

### ~~7.8~~7.10 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~~7.11 Safety devices to detect minimum 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~~ 7.12:

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~~ Level of Protection "pzc", 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;

9) the exclusion for non-metallic enclosures and non-metallic parts of enclosures in 5.1 has not been applied;

~~9)~~10) no isolating valve shall be fitted between the indicator and the pressurized enclosure.

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

~~NOTE 2~~ A flowmeter used only to indicate pressure normally 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.

### ~~7.10~~7.12 Value of minimum overpressure

A minimum overpressure of 50 Pa for ~~type px or type py~~ Level of Protection “pxb” or Level of Protection “pyb”, and 25 Pa for ~~type pz~~ Level of Protection “pzc” 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 normal overpressure in service, the maximum overpressure during purging and the maximum leakage rate at the maximum normal overpressure.

Consideration should be given in the application of pressurized equipment having an internally enclosed cooling circuit in which circulation is assisted by an internal fan (e.g. motors), since the effect of such fans may be to produce a negative pressure in parts of the casing with consequent risk of ingress of gas or dust if pressurization ceases (see Figure C.3).

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~~ should not introduce a hazard. The basic requirements for the installation of ducting systems are given in Annex D.

### ~~7.11~~7.13 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~~ Level of Protection "pxb", 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~~ 7.15;

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; and

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~~ 7.7.

### ~~7.12~~7.14 Safety devices on doors and covers

For ~~type px~~ Level of Protection "pxb", 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~~ 7.15 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed. The requirements of ~~7.6~~ 7.7 shall also apply.

### ~~7.13~~7.15 ~~Protection types~~ Equipment 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".~~

For Group I or Group II pressurized enclosures, the electrical equipment that may remain energized when Level of Protection "pxb" or Level of Protection "pyb" is not in operation shall be protected by EPL Ma or Mb for Group I and EPL Ga or Gb for Group II.

For Group II pressurized enclosures, the electrical equipment that may remain energized when Level of Protection "pzc" is not in operation shall be protected by EPL Ga, Gb or Gc.

For Group III pressurized enclosures, the electrical equipment that may remain energized when Level of Protection "pxb" is not in operation shall be protected by EPL Da or Db.

For Group III pressurized enclosures, the electrical equipment that may remain energized when Level of Protection "pzc" is not in operation shall be protected by EPL Da, Db or Dc.

### ~~7.14~~7.16 ~~Protection types~~ Equipment permitted within ~~type py~~ Level of Protection "pyb"

Electrical equipment within a ~~type py~~ Level of Protection "pyb" pressurized enclosure shall be protected by ~~types of protection "d", "e", "ia", "ib", "ic", "ma", "mb", "mc", "o", "q", "nA", "nC" or "nL"~~ EPL Ga, Gb or Gc for Group II.

Electrical equipment within a Level of Protection "pyb" pressurized enclosure shall be protected by EPL Da, Db, Dc for Group III.

## 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

There shall be no internal sources of release.

### 8.4 Group I and Group II – Filling procedure

The Instructions shall specify that the pressurized enclosure shall be filled with inert gas in an area known to be non-hazardous using the procedure specified by the manufacturer.

### 8.5 Group III – Filling Procedure

The Instructions shall specify that the pressurized enclosure shall be cleaned as necessary to ensure there is no hazardous accumulation of combustible dust within the enclosure. The Instructions shall specify that after cleaning, the pressurized enclosure shall be filled with inert gas in an area known to be non-hazardous using the procedure specified by the manufacturer.

### ~~8.5~~8.6 Safety devices

Two automatic safety devices for ~~type px or type py~~ Level of Protection "pxb" or Level of Protection "pyb" or one automatic safety device for ~~type pz~~ Level of Protection "pzc" 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~~8.7 ~~Protection types~~ Equipment 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~~ have an EPL as shown in 7.15.

### ~~8.7~~8.8 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)~~ the opening times requirements 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 Backup supply

If a backup supply of protective gas is required in the event of failure of the primary supply, then each supply shall be capable of maintaining, independently, the required level of pressure or rate of supply of protective gas. The two sources may share common ductwork or piping.

NOTE A backup supply can be advisable where it is necessary to maintain operation of the electrical equipment.

### 9.2 Independent supplies

When the enclosure of an ignition-capable product is protected by Level of Protection “pzc” pressurized enclosure and this enclosure is then located within a Level of Protection “pyb” pressurized enclosure, the protective gas supplies shall be independent.

#### ~~9.1~~9.3 Type of gas

The protective gas shall be non-flammable.

The ~~manufacturer~~ Instructions shall specify the protective gas and any alternative permitted.

~~NOTE 1~~ Where other than air of normal instrument quality or nitrogen is specified, 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~~ shall be affixed to the enclosure, (see18.9). ~~Alternatively,~~ Consideration should be given to providing 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~~9.4 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~~ equipment 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 L~~E~~FL; 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 typically 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.~~

The certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user 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

An infallable 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~~ The Instructions should provide suitable guidance to reduce the risk of damage for those conditions ~~to be~~ agreed between manufacturer and user ~~may include~~ such as 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.

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~~ the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard 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.

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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.

~~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 when there is an internal source of release

### 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** | **UEFL < 80 %** | **UEFL > 80 %** | **UEFL < 80 %** | **UEFL > 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 U~~E~~FL 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 U~~E~~FL greater than 80 %).

### 13.3 Pressurization with dilution

#### 13.3.1 General

~~NOTE 2~~ If the flammable substance has a U~~E~~FL 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~~ shall be used to dilute the flammable substance.

#### ~~13.3.1~~13.3.2 No release

The protective gas shall be air or inert gas.

#### ~~13.3.2~~13.3.3 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 L~~E~~FL;

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 U~~E~~FL greater than 80 %, any release shall be diluted with air to a concentration not exceeding 25 % of the L~~E~~FL.

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

#### ~~13.3.3~~13.3.4 Limited release of a liquid

The protective gas shall be inert and the provisions of ~~13.3.2~~ 13.3.3 b) shall be complied with. There shall not be any normal release (see Annex E) of the flammable substance.

## 14 Ignition-capable ~~apparatus~~ equipment

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

**Table 5 – Equipment Protection ~~types~~ Levels permitted within the dilution area based upon the Level of Protection of the pressurized enclosure**

| Internal release is | ~~Type px,~~ ~~type py~~ Level of Protection "pxb", Level of Protection "pyb" | ~~Type pz~~ Level of Protection "pzc" |
|---|---|---|
| abnormal | ~~d, e, ia, ib, ma, mb, o, q~~ Ga or Gb | ~~d, e, ia, ib, ic, ma, mb, mc, o, q, nA, nC, nL~~ Ga, Gb or Gc |
| normal | ~~ia, ma~~ Ga | ~~ia, ma~~ Ga |

~~NOTE 1~~ Generally, any internal source of release should be near to the outlet and any ignition-capable ~~apparatus~~ equipment 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~~ equipment.

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 L~~E~~FL 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

Where xxx is replaced with the value in minutes for the delay required.

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 Determining the maximum overpressure rating

The maximum overpressure rating of the enclosure is the highest internal operating pressure attained by following the manufacturer's instructions.

NOTE The maximum overpressure generally occurs when purging the enclosure.

The measured internal pressure shall not exceed the maximum rated internal pressure for the enclosure if specified.

### ~~16.1~~16.2 Maximum overpressure test

A pressure equal to 1,5 times the maximum overpressure ~~specified~~ determined in 16.1 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~~16.3 Leakage test

#### ~~16.2.1~~16.3.1 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.

Normal service does not include the overpressure required to open a vent in order to purge the enclosure at a higher flow rate.

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

#### ~~16.2.2~~16.3.2 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~~ 8.8. The ~~change of~~ pressure shall ~~be not greater than~~ not drop below the minimum overpressure ~~specified for normal service~~.

### ~~16.3~~16.4 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

#### 16.4.1 General

This test applies whether leakage compensation is used or not used (i.e. continuous flow).

#### ~~16.3.1~~16.4.2 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 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~~16.4.3 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 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~~16.4.4 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~~ 16.4.2.

### ~~16.3.4~~16.4.5 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~~16.5 Purging and dilution tests for a pressurized enclosure with an internal source of release

### ~~16.4.1~~16.5.1 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~~16.5.2 Pressurized enclosure where the flammable substance has less than 2 % (V/V) oxygen and the protective gas is inert

#### ~~16.4.2.1~~16.5.2.1 Purging test

The test shall be carried out using the test procedure specified in ~~16.3.2~~ 16.4.3. 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~~16.5.2.2 Dilution test

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

### ~~16.4.3~~16.5.3 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~~16.5.3.1 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~~ equipment 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 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~~16.5.3.2 Dilution test

Immediately after the purging test specified in ~~16.4.3.1~~ 16.5.3.1, 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~~ 16.5.3.1.

The oxygen concentration measured over a period of time not less than 30 min shall not exceed the concentration as specified in 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~~ equipment, that is outside the dilution area, shall not exceed 1,5 times the oxygen concentration specified in 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~~16.5.4 Pressurized enclosure where the flammable substance is not a liquid, pressurization by continuous flow and the protective gas is air

#### ~~16.4.4.1~~16.5.4.1 Purging test

The test shall be carried out using the test procedure specified in ~~16.3.1~~ 16.4.2.

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~~ equipment that is outside the dilution area.

The time taken until there is no sample point where there is a test gas concentration exceeding that specified in 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~~16.5.4.2 Dilution test

Immediately after the purging test specified in ~~16.4.4.1~~ 16.5.4.1, 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~~ 16.5.3.1.

The test gas concentration measured during a time period of not less than 30 min shall not exceed that specified in 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~~ equipment, that is outside the dilution area, shall not exceed twice the value specified in 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~~16.6 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~~ 7.12 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~~16.7 Tests for an infallible containment system

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

#### ~~16.6.1~~16.7.1 Overpressure test

A test pressure of at least 5 times the maximum ~~internal overpressure~~ operating pressure 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~~16.7.2 is passed.

#### ~~16.6.2~~16.7.2 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.~~

The containment system shall be flushed and pressurized with pure helium (95,0 % V/V or higher) to a pressure equal to the maximum operating pressure of the containment system. A helium leak detector shall then be used to check for leaks. The test is considered satisfactory if the leak detector does not indicate any leaks.

NOTE Leaks are indicated by a reading higher than the ambient room reading.

### ~~16.7~~16.8 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 provided with the pressurized enclosure shall be verified.

### 17.2 Leakage test

The leakage of protection gas shall be tested as specified in ~~16.2~~ 16.3.

### 17.3 Tests for an infallible containment system

An infallible containment system shall be tested as specified in ~~16.6~~ 16.7. However, for liquid systems, it is adequate to check for liquid leaks during the overpressure test in place of the helium leak test.

### 17.4 Test for a containment system with a limited release

The containment system shall be tested as specified in ~~16.7~~ 16.8.

## 18 Marking

### 18.1 ~~Warnings~~ General

In addition to the requirements of IEC 60079-0, the marking shall include the following. 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.

### 18.2 Identifying as pressurized

The pressurized enclosure shall be marked “WARNING – PRESSURIZED ENCLOSURE”.

### 18.3 Supplementary marking

The following supplementary information shall also be marked as appropriate:

a) the ~~type of protection px, py or pz~~ Level of Protection “pxb”, “pyb”, or “pzc”;

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~~ Level of Protection “pzc” and Level of Protection “pyb”, 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~~ 7.8 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~~ shall not exceed 2 %;

d) a restriction that the flammable substance shall not have a U~~E~~FL 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~~ pressurization equipment.

~~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.~~

When a pressurization system with a separate certificate is marked for installation in a hazardous area, the symbol ""[p]" shall be included in the "Ex marking". When a pressurization with a separate certificate is marked for installation only in a non-hazardous area, the "Ex marking" shall be "[Ex p]".

NOTE Markings "[p]" and "[Ex p]" do not appear in IEC 60079-0, Ed. 6 or earlier.

### 18.7 Warnings required in other clauses

**Table 6 – Text of warning markings**

| Clause or subclause | Recommended warning (similar wording is permitted) |
|---|---|
| 5.3.6 | WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE ~~MAY BE~~ IS PRESENT |
| ~~7.7~~ 7.8 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 | WARNING – POWER SHALL NOT BE RESTORED AFTER THE ENCLOSURE HAS BEEN OPENED UNTIL COMBUSTIBLE DUST ACCUMULATIONS WITHIN THE ENCLOSURE HAVE BEEN REMOVED |
| ~~7.9~~ 7.11 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 |
| G.7.1 | WARNING – BATTERIES ARE LOCATED INSIDE THIS ENCLOSURE. DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT |
| G.7.2 | WARNING – THIS PRESSURIZED ENCLOSURE CONTAINS A BATTERY WHICH REMAINS CONNECTED AFTER THE EXTERNAL POWER HAS BEEN ISOLATED. CONSIDERATION SHOULD BE GIVEN TO THE REMOVAL OF THE BATTERY IF THE ENCLOSURE IS TO REMAIN UNPROTECTED BY EX P FOR A SIGNIFICANT TIME |
| G.7.3 | WARNING – BATTERIES IN THIS PRESSURIZED ENCLOSURE REQUIRE ROUTINE MAINTENANCE. SEE INSTRUCTIONS |
| H.3.1 | WARNING – BATTERIES ARE LOCATED INSIDE THIS ENCLOSURE. DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT |
| H.3.2 | WARNING – THIS PRESSURIZED ENCLOSURE CONTAINS A BATTERY WHICH REMAINS CONNECTED AFTER THE EXTERNAL POWER HAS BEEN ISOLATED. CONSIDERATION SHOULD BE GIVEN TO THE REMOVAL OF THE BATTERY IF THE ENCLOSURE IS TO REMAIN UNPROTECTED BY EX P FOR A SIGNIFICANT TIME |
| H.3.3 | WARNING – BATTERIES IN THIS PRESSURIZED ENCLOSURE REQUIRE ROUTINE MAINTENANCE. SEE INSTRUCTIONS |

### 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

In addition to the instructions required by IEC 60079-0,

- the protective gas and any alternative permitted shall be specified;
- instructions for Group III equipment shall identify the need to remove the combustible dust in an appropriate manner before restoring power.

NOTE It is the responsibility of the user to determine what is an appropriate manner for removing the combustible dust.

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~~ equipment, 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 L~~E~~FL;
– where one specific flammable gas is covered, a value equivalent to 25 % of its L~~E~~FL;
– 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 L~~E~~FL 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

Table B.1 gives 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**

| S0 | 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 |

Figure B.1 demonstrates a state diagram of a leakage-compensation purge control system.

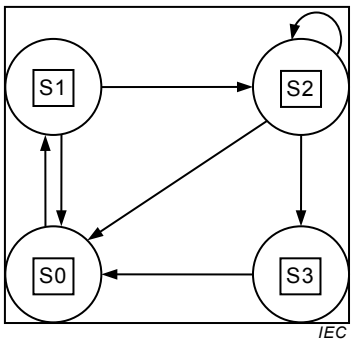



**Figure B.1 – State diagram of a leakage-compensation purge control system**

LEAKAGE-COMPENSATION LOGICAL DEFINITIONS

Exceeds maximum overpressure = [XOP]

Overpressure > 50 Pa (25 Pa for ~~pz~~ Level of Protection "pzc") = [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

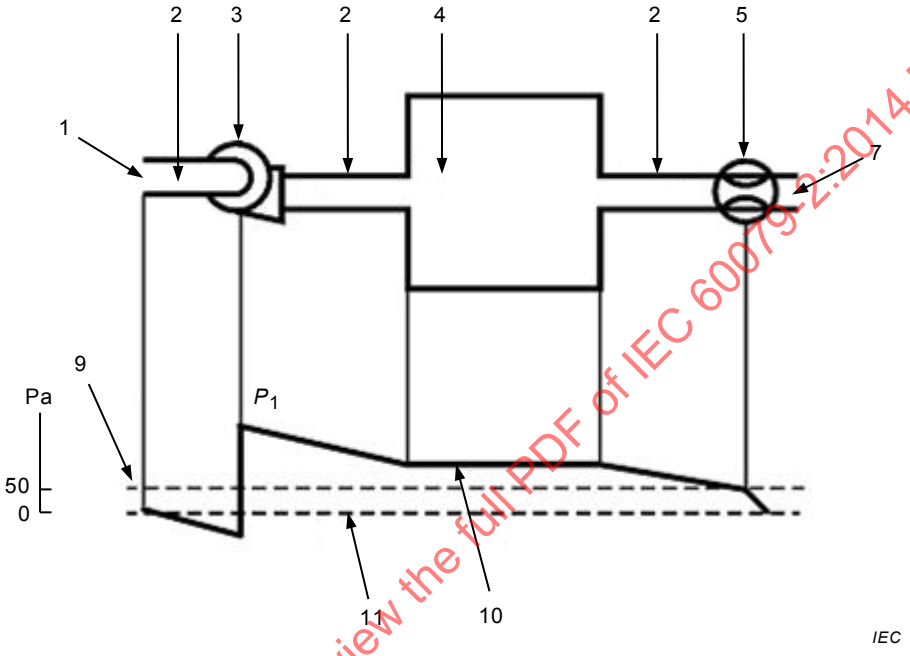
Each state of the system is defined in response to the inputs of the monitoring devices. The states are unique. Transitions between states are only allowed along paths defined by the arrows and in the direction of the arrows. The logical conditions for the occupation of each state are uniquely defined 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

Figures C.1 to C.4 show 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.

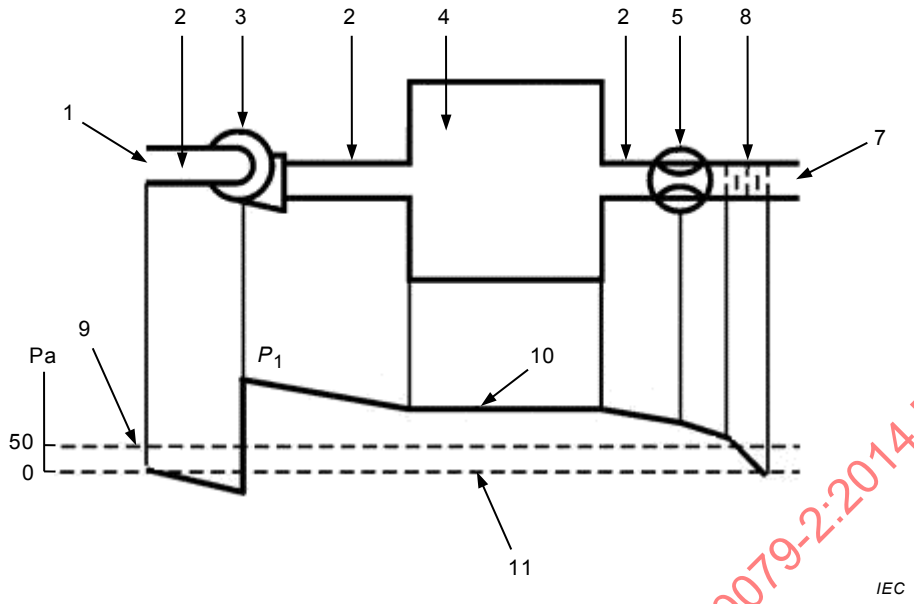



**Key**

$P_1$ 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**



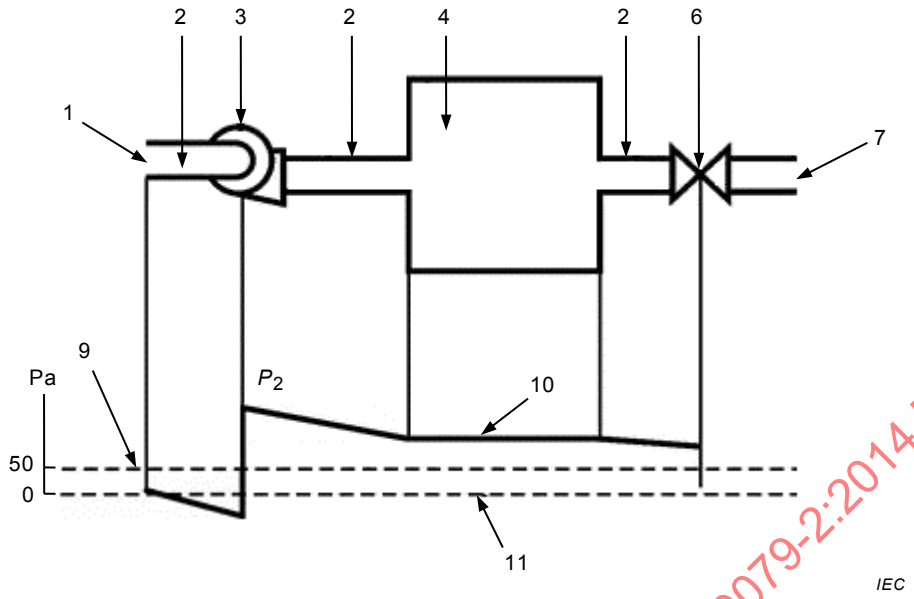

**Key**

$P_1$ 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**

**Figure C.1 – Protective gas outlet**

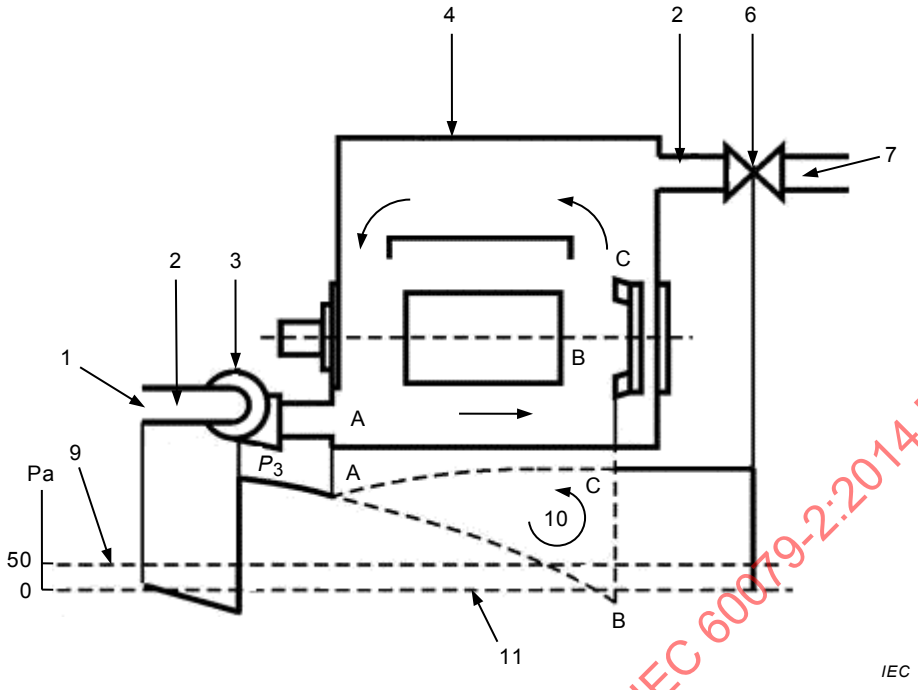



**Key**

$P_2$ 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**




**Key**

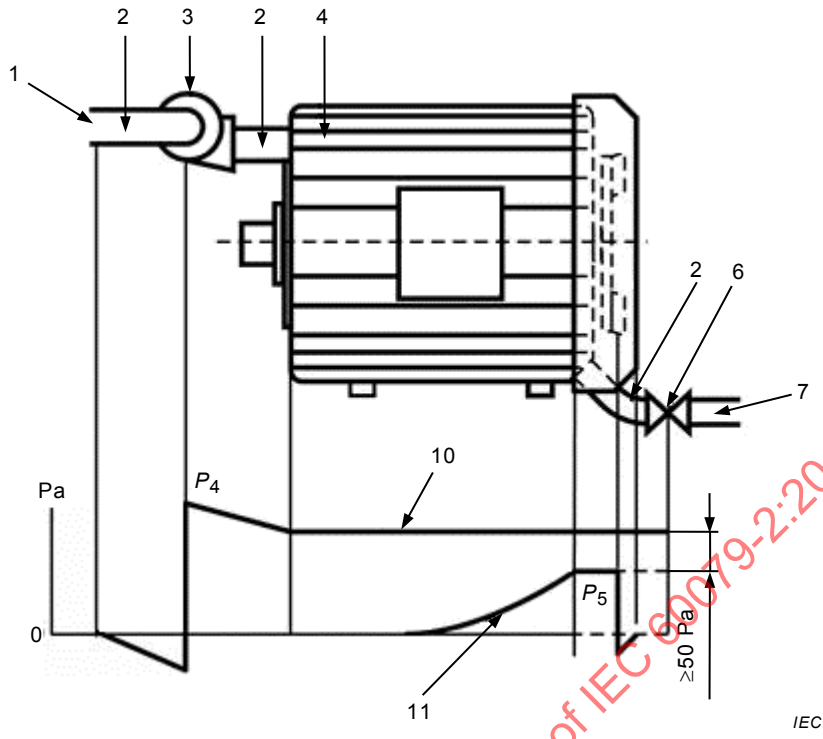
$P_3$ Pressure of the protective gas (determined by the flow resistance of the internal parts, and influenced between A, B and C by the internal cooling fan)

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

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

Pressure at every point where leakage can occur is above the minimum of 50 Pa for ~~type px~~ Level of Protection "pxb".

~~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.




**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 or combustible dusts 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.2.5 Temperature of protective gas at the inlet

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

## 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, (e.g. disconnector) 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.

Consideration should be given 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.

## 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~~ 16.7 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

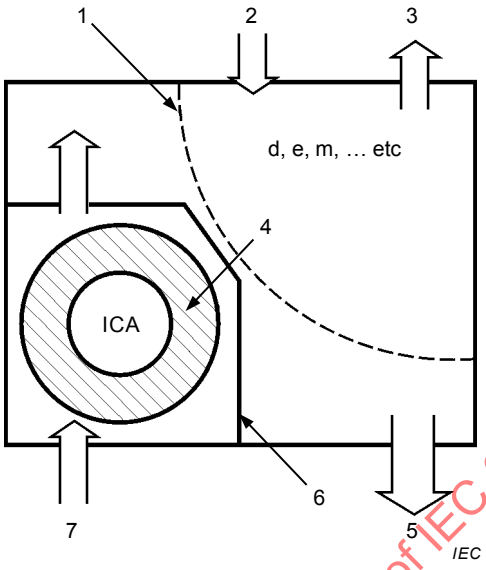
Systems which cannot meet the requirements for "no normal release" shall be considered to have a limited normal release. This includes containment systems with joints subject to routine maintenance. Such joints shall be clearly identified.

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

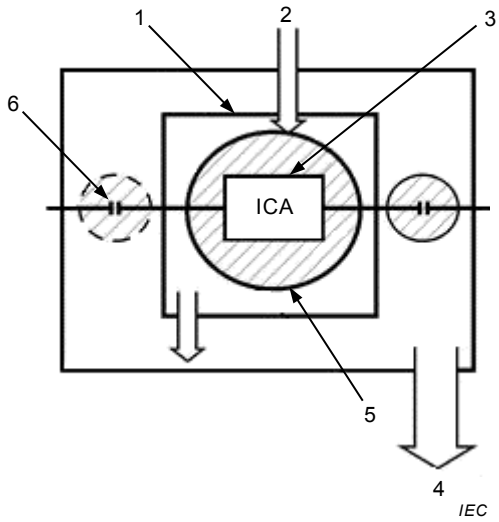



**Key**

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~~E~~
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)~~ equipment (shown as ICA in Figures F.1 to F.3) within an inner enclosure or through the use of partitions, it can be demonstrated by a simple test that the IC~~A~~E 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 IC~~A~~E.

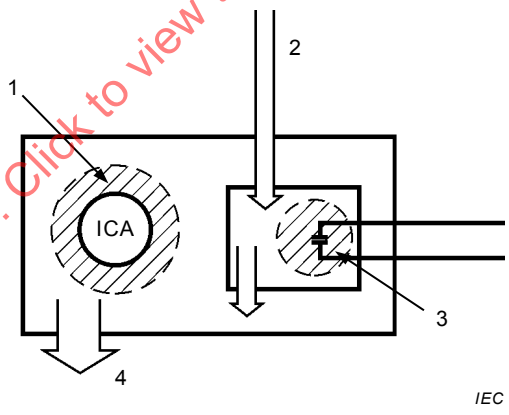



**Key**

1 Internal partition
2 Purge inlet
3 Infallible parts of containment system
4 Purge outlet
5 Location of IC~~A~~E
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 IC~~A~~E**

Since those parts of the containment system lying within the internal partition meet the requirements for infallible containment, the IC~~A~~E (shown as ICA in Figures F.1 to F.3) cannot be within a dilution area.




**Key**

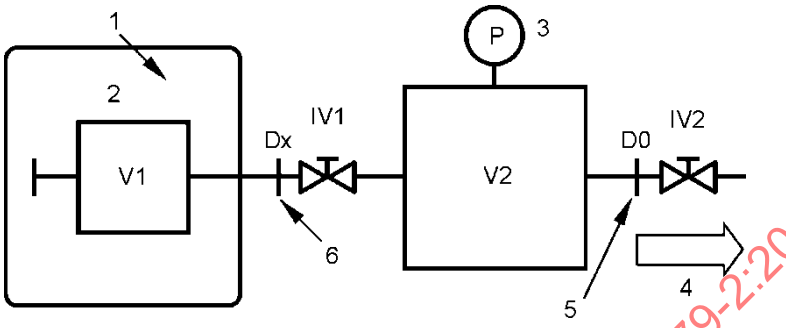
1 Area of dilution testing
2 Purge inlet with inert gas
3 Potential source of release with nominal dilution area
4 Purge outlet

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

Since the dilution area is contained within the internal partition, the IC~~A~~E (shown as ICA in Figures F.1 to F.3) is not within a dilution area.

# Annex G
(normative)

## Infallibility test for containment system




**Key**

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<br>Group | Performance of protection | Conditions of operation |
|---|---|---|---|
| Very high | Ma<br>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<br>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<br>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 | Suitable for normal | Equipment de-energised |

| Protection afforded | Equipment protection level<br>Group | Performance of protection | Conditions of operation |
|---|---|---|---|
| | Group I | operation and severe operating conditions | when explosive atmosphere present |
| High | Gb<br>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<br>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<br>Group II | Suitable for normal operation | Equipment remains functioning in Zone 2 |
| Enhanced | Dc<br>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.

# Annex G
(normative)

# Internal Cells and Batteries for Level of Protection "pxb" and Level of Protection "pyb"

## G.1 General Requirements

### G.1.1 General

When the protected equipment incorporates batteries, suitable precautions shall be taken in the design of the equipment to prevent the production of explosive gas, sparks or hot spots.

### G.1.2 Accepted Electrochemical Systems

Only those cells listed in IEC 60079-0 for which an IEC cell standard exists shall be used in pressurized enclosures.

### G.1.3 Secondary cells and secondary batteries

Secondary cells and secondary batteries are permitted if:

- the individual cells are sealed cells (either sealed gas-tight cell or sealed valve-regulated cell); or
- the battery volume does not exceed 1 % of the pressurized enclosure internal free volume.

Where the pressurized enclosure contains more than one independent battery, each with its own charging system, only the most onerous case of gas release from one independent battery shall be considered.

### G.1.4 Mechanical Protection

Live exposed parts of cells, batteries and their associated protective components, which are located in the pressurized enclosure, shall be provided with protection to at least IP30, even while the pressurized enclosure access door(s) or cover(s) are open. Where cells are encapsulated, care shall be taken to ensure that any pressure relief facilities are not obstructed. The vent size shall be sufficiently large to prevent dangerous pressurisation of the encapsulated assembly at the most onerous predictable release rate from the battery. A minimum of one vent for each cell is required.

The encapsulation of cells and batteries shall allow for possible expansion of the cells during charging.

For the purposes of this standard the terms "encapsulate" and "encapsulation" do not imply conformity to IEC 60079-18.

The physical characteristic of vents will depend upon the type and capacity of the battery arrangements. The effects of ageing on battery capacity and therefore on the rate of gas evolution from the battery should also be considered.

Cells, batteries and their associated protective components shall be securely mounted.

## G.2 Electrical Protection by energy limiting circuits.

### G.2.1 Assessing as energy limited

The intent of this section is to allow circuits that can be assessed using the principles of IEC 60079-11 as a guideline.

### G.2.2 Protective Components

Except for inherently safe batteries (see G.5), protective components such as a resistor and/or a fuse shall be provided to establish an energy limited circuit to guard against withdrawal of current from a battery greater than the current for which safety has been assessed.

Protective Components shall conform to the following requirements. The manufacturer's technical literature is sufficient to verify conformity with these requirements without further testing.

- Diodes used to prevent charging or reverse charging of primary cells shall not be exposed to a reverse applied voltage exceeding two thirds of their rated Peak Inverse Voltage (PIV), (or Repetitive Peak Reverse Voltage ($Vrrm$) if specified).
- These diodes shall be capable of withstanding a reverse voltage of 400 Vdc with a reverse leakage current of < 10 uA at the most extreme conditions of temperature (taking account of a single fault within the associate circuit).
- The maximum forward current (taking account of a single fault within the associated circuit) of diodes whose purpose is to prevent the charging of a primary cell shall be limited e.g. by a fuse or resistor, to a value not exceeding 50 % of the manufacturer's rated peak forward current.
- Fuses shall conform to IEC 60127 (any part) as follows:

  The voltage to be used when assessing a fuse depends upon the maximum voltage to which it can be subjected plus tolerances. In the case of a battery supplied voltage, the voltage to be considered shall be the nominal voltage defined in the appropriate IEC standard for the electrochemical system used.

  Where a fuse is used to protect a battery, 1,7 In (nominal current rating of fuse) shall be assumed to flow continuously. The fuse time-current characteristics shall ensure that the transient ratings of protected components are not exceeded.
- Current limiting resistors shall be one of the following types and may be used at up to two thirds of the manufacturer's rating:
  - film type;
  - wire wound type with protection to prevent unwinding of the wire in case of breakage or;
  - printed resistors as used in hybrid and similar circuits covered by a coating conforming to IEC 60079-11 or encapsulated in accordance with IEC 60079-11.

  A Current Limiting Resistor shall be considered as failing only to an open circuit.
- Other components shall conform to the appropriate requirements of IEC 60079-11.

### G.2.3 Preventing excessive gas pressure

Means to prevent the build-up of excessive gas pressure shall be provided:

d) under reverse charge, e.g. shunt diodes fitted across each cell of a battery;

e) under excessive discharge rates, e.g. a fuse fitted in series with the battery;

f) for secondary batteries, under excessive charge rates, e.g. a charger designed to limit the charging conditions to those recommended by the manufacturer.

## G.3 Additional requirements for Primary batteries

### G.3.1 Prevention of reverse charging.

No additional protection need be fitted to prevent the release of electrolytic gas by polarity reversal, or reverse charging of a cell by other cells in the same battery is required if:

- a capacity of 1,5 Ah or less (at a 1 h discharge rate); and
- a volume less than 1 % of the free volume of the enclosure;

or if the battery manufacturer confirms that the cells are electro-chemically balanced, and at the end of discharge the internal resistance of an individual cell will exceed 25 kΩ.

These relaxations should not be interpreted as allowing the release of electrolytic gas from such cells.

If a primary battery contains 3 or more cells in series, one or more components, shall be fitted to prevent gas generation within an expired cell by reverse charging (see figure G.1).

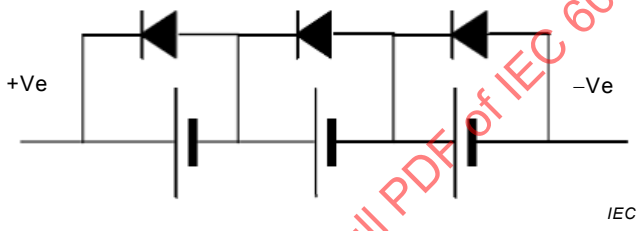



**Figure G.1 – Reverse charging protection**

For this protective arrangement to be effective, the forward voltage drop across each diode used to prevent reverse charging of a cell shall not exceed the safe reverse charge voltage of that cell. Silicon diodes are considered suitable to meet this requirement.

### G.3.2 Prevention of accidental charging of primary batteries

Where there is more than one battery or another voltage source in the equipment, and there is the possibility of interconnection, protective components such as blocking diodes shall be provided to prevent charging currents passing into primary batteries.

At least two serially connected devices shall be provided such as to limit the charging of primary batteries, even under single fault conditions, to a level not exceeding 10 μA or to 2/3rds of that specified by the battery manufacturer, whichever is the lower (e.g.2 diodes or a diode and a resistor (see Figure G.2).

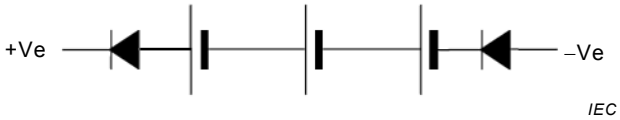



**Figure G.2 – Accidental charging protection**

The battery should be connected between the protective components to reduce the risk of a single fault causing both protective components to be short circuited.

## G.4 Additional requirements for secondary batteries

### G.4.1 Charging of secondary batteries inside the pressurized housing

Where batteries are to be charged whilst inside the pressurized enclosure, the charging conditions shall be fully specified and protective components shall be fitted to ensure that these conditions are not exceeded.

Where batteries are used having a capacity of 1,5 Ah or less, and a volume less than 1 % of the free volume of the enclosure, no additional protective component(s) needs to be fitted to the battery to prevent the release of electrolytic gas by recharging currents.

These relaxations should not be interpreted as allowing the release of electrolytic gas from such cells.

NOTE The above effectively limits the use of cells (or batteries) not fitted with a protective component, to those types commonly known as “button type cells” used, for example to retain memory on programmable electronic circuits.

Where batteries are to be removed from the pressurized enclosure for charging, the manufacturer’s requirements for correct charging apply.

Where the consequences of deep discharging may, during subsequent charging, result in either the increased release of electrolytic gas and/or internal mechanical damage, a device or devices shall be provided to prevent deep discharging.

Suitable precautions shall be taken to prevent incorrect assembly (e.g. plugs and sockets which are polarized or that are clearly marked to indicate correct assembly).

Where plugs and sockets are used, provision shall be made to open the circuit safely before plugs are disconnected.

The position of the battery within the pressurized enclosure shall be chosen with due regard to the location of ignition-capable equipment and to allow for the free diffusion of the released gases throughout the enclosure. Ignition-capable equipment shall not be located in an area subject to the gas released from the battery.

## G.5 Specific requirements for Inherently Safe (IhS) cells and batteries

An IhS battery is a primary battery in which the following conditions are met:

- the internal resistance of the battery limits the short-circuit current from the battery to a value not exceeding that tabulated in Permitted short-circuit current corresponding to the voltage and the equipment group tabulated in IEC 60079-11 based upon the maximum open circuit voltage of the battery and
- the maximum temperature of the external surface of the battery does not exceed the maximum surface temperature for the stated Temperature Class for the equipment, referred to the local ambient temperature when the battery is short-circuited by a conductor of negligible resistance compared with the internal resistance of the battery. The resistance of the short-circuit is considered to be negligible when it is not greater than one-tenth of the internal resistance of the battery.

It is not necessary to consider faults within an IhS cell, except when more than two cells are connected to form a battery in which case reverse charging shall be prevented.

IhS batteries may be formed by the interconnection of IhS cells if the internal resistance of the battery limits the maximum value of the short-circuit current to a value not exceeding the value tabulated in Permitted short-circuit current corresponding to the voltage and the

equipment group tabulated in IEC 60079-11 based upon the maximum open circuit voltage of the battery.

The nature of the circuit to which the IhS battery may be connected is specified in G.6.

To facilitate the correct replacement of Inherently Safe batteries the essential parameters shall be marked adjacent to the battery and in the instructions, (e.g. Type, nominal voltage and minimum internal resistance etc.)

## G.6 Equipment located inside a pressurized enclosure connected to a battery which is also located inside the pressurized enclosure and not disconnected in the event of loss of pressurization

### G.6.1 General

For the purpose of evaluation and test of the circuit connected to the battery the voltage to be considered is the Maximum Open Circuit Voltage.

The Temperature Class of the equipment shall take into account the surface area of individual components comprising the equipment connected to the battery. The method of assessment shall be either by test, or by the use of small component temperature evaluation in IEC 60079-0.

### G.6.2 Circuit Isolation

For the purpose of this clause, equipment is considered to be connected to the battery unless the battery is connected to the equipment only after purging has been completed and provision is made for the disconnection of the battery on pressure or flow failure and the disconnection or isolation meets the following requirements:

- it is disconnected by suitably rated contacts; or
- it is isolated by a suitably rated opto-isolating device; or
- it is isolated by a suitably rated double wound transformer capable of withstanding an insulation test between windings of 5 times the battery maximum open circuit voltage with a minimum of 500 Vac RMS for at least 60 seconds;
- and the creepage distance and clearance between the battery and the isolated or disconnected components and associated circuits is as specified in the creepage and clearance table in IEC 60079-11 using the ia or ib columns.

### G.6.3 Intrinsically safe battery or inherently safe battery used with “Ex” equipment

If the battery is protected by Intrinsic Safety to IEC 60079-11 or is inherently safe and the connected equipment is protected by one of the types of protection listed in IEC 60079-0 or is assessed as simple apparatus as defined in IEC 60079-11, there are no additional requirements.

### G.6.4 Intrinsically Safe or Inherently Safe battery with non-"Ex" equipment.

When an intrinsically safe or an inherently safe battery located inside the pressurized enclosure is intended to be connected to non-"Ex" equipment before purging has been completed, and/or intended to remain connected to the equipment during the absence of pressure (and flow if specified), the following additional requirements apply to the connected equipment:

Either:

g) The following conditions shall be satisfied:

– maximum open circuit voltage of the battery and associated circuits does not exceed 6 V;

– the short circuit current from the battery shall not exceed 2 A. This may be achieved by the internal resistance of the battery alone or be limited to this value by the addition of an external current limiting resistor mounted as close as possible to the battery and conforming to the requirements of G.2.1;

– the total aggregate circuit capacitance, including tolerances, does not exceed 1000 μF;

– the total aggregate circuit inductance, including tolerances, does not exceed the value for $L$ given by the following formula:

$$L = \frac{2e}{I^2}$$

where:

$L$ is the permitted inductance in μH

$I$ is the available short circuit current in A

$e$ is the ignition energy for a given Equipment Group in μJ

| Equipment Group | Ignition energy |
|---|---|
| IIC | 40 μJ |
| IIB | 160 μJ |
| IIA | 320 μJ |
| I | 525 μJ |

or

h) the pressurised enclosure shall be marked in accordance with G.7 and the following conditions shall be satisfied:

– the maximum open circuit voltage of the battery and associated circuits does not exceed 6 V;

– the short circuit current shall be limited to 2 A;

– the effective capacitance remaining connected to the battery, as determined by examination of the circuit does not exceed 1 000 μF;

Protective components, e.g. resistors, associated with the capacitance and conforming to the requirements for similar components in G.2.1 may be taken into account in determining the effective capacitance by the use IEC 60079-11 with a factor of safety of 1,0;

– the effective inductance remaining connected to the battery, as determined by examination of the circuit does not exceed the values given for L shown above.

Protective components, e.g. resistors, associated with the inductance and conforming to the requirements for similar components in G.2.1 may be taken into account in determining the effective inductance by the use of IEC 60079-11 with a factor of safety of 1,0.

or

i) where the sources voltage is greater than 6 V or the short circuit current is greater than 2 A, the connected equipment shall be assessed according IEC 60079-11 category 'ib';

or

j) a cell embedded within a solid state electronic component (e.g. a Lithium cell within an integrated circuit) is permitted if the following criteria are met:

– the cell shall be Inherently Safe; and

– no external voltage shall be detectable; and

– the internal capacitance and inductance of the solid state electronic component as declared by the manufacturer shall not exceed the values given in a)) above.

Since the cell voltage is not externally detectable the short circuit test in conformity with the requirements of G.5 may be carried out by assessment.

## G.7 Supplementary marking and constructional requirements for pressurized enclosures containing one or more cells or batteries

### G.7.1 General

Doors and covers of pressurized enclosure may only be openable by the use of a tool or key.

Enclosures shall be marked as follows, or equivalent:

"WARNING – BATTERIES ARE LOCATED INSIDE THIS ENCLOSURE. DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT".

### G.7.2 Battery removal warning

Where required by G.6.4 b) the enclosure shall be marked with the following or equivalent:

WARNING – This pressurized enclosure contains a battery which remains connected after the external power has been isolated. Consideration should be given to the safe removal of the battery if the enclosure is to remain unprotected by Ex p for a significant time.

### G.7.3 Batteries requiring routine maintenance

The enclosure shall be marked:

"WARNING – Batteries in this Pressurized Enclosure require routine maintenance. See instructions".

## G.8 Type tests

### G.8.1 Voltage

For temperature testing purposes the voltage to be used is the battery nominal voltage.

### G.8.2 Short circuit test for an Inherently Safe Cell or Battery

A new cell or battery shall have a short circuit applied and the following shall be monitored:

- current flowing in the circuit, and
- the temperature of the outer surface of the cell or battery to which any external explosive atmosphere will have access when the pressurized enclosure door is open.

The maximum current shall not exceed the value given in G.5.

The maximum temperature shall not exceed the temperature class of the equipment.

The cell or battery shall not distort, explode, or emit smoke.

### G.8.3 Full load test for other than Inherently safe batteries

A new primary battery, or a fully charged secondary battery, shall be connected to the load it will supply in normal service. The case temperature shall not exceed the temperature class of the equipment or the maximum temperature permitted by the manufacturer of the battery, whichever is lower.

# Annex H
(normative)

# Internal Cells and Batteries for Level of Protection “pzc”

## H.1 General Requirements

### H.1.1 General

When the protected equipment incorporates batteries, suitable precautions shall be taken in the design of the equipment to prevent the production of explosive gas, sparks or hot spots.

### H.1.2 Accepted Electrochemical Systems

Only those cells listed in IEC 60079-0 for which an IEC cell standard exists shall be used in pressurized enclosures.

### H.1.3 Secondary cells and secondary batteries

Secondary cells and secondary batteries are permitted if:

– The individual cells are sealed cells (either sealed gas-tight cell or sealed valve-regulated cell); or

– The battery volume does not exceed 1 % of the pressurized enclosure internal free volume.

Where the pressurized enclosure contains more than one independent battery, each with its own charging system, only the most onerous case of gas release from one independent battery shall be considered.

### H.1.4 Mechanical Protection

Where cells are encapsulated, care shall be taken to ensure that any pressure relief facilities are not obstructed. The vent size shall be sufficiently large to prevent dangerous pressurisation of the encapsulated assembly at the most onerous predictable release rate from the battery. A minimum of one vent for each cell is required.

The encapsulation of cells and batteries shall allow for possible expansion of the cells during charging.

For the purposes of this standard the terms "encapsulate" and "encapsulation" do not imply conformity to IEC 60079-18.

The physical characteristic of vents will depend upon the type and capacity of the battery arrangements. The effects of ageing on battery capacity and therefore on the rate of gas evolution from the battery should also be considered.

Cells, batteries and their associated protective components shall be securely mounted.

## H.2 Equipment located inside a pressurized enclosure connected to a battery which is also located inside the pressurized enclosure and is not disconnected when power is removed from the enclosure.

Equipment that is not disconnected shall not have any make/break components unless the circuit can be assessed as non-ignition-capable using IEC 60079-15 or IEC 60079-11 for Level of Protection “ic”.

## H.3 Supplementary marking and constructional requirements for pressurized enclosures containing one or more cells or batteries

### H.3.1 General

Doors and covers of pressurized enclosure providing access to the cells or batteries may only be opened by the use of a tool or key.

Enclosures shall be marked as follows, or equivalent:

"Warning – Batteries are located inside this enclosure. Do not open when an explosive atmosphere IS present".

### H.3.2 Battery removal warning

Where the cell or battery is not disconnected when pressurization is not present, the enclosure shall be marked with the following or equivalent:

Warning – This pressurized enclosure contains a battery which remains connected after the external power has been isolated. Consideration should be given to the removal of the battery if the enclosure is to remain unprotected by Ex p for a significant time.

### H.3.3 Batteries requiring routine maintenance

The enclosure shall be marked:

"WARNING – Batteries in this Pressurized Enclosure require routine maintenance. See instructions."

# Bibliography

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

IEC 60050-426, *International Electrotechnical Vocabulary – Chapter 426: Equipment for explosive atmospheres*

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

IEC 60079-1, ~~*Electrical apparatus for explosive gas*~~ *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-5, ~~*Electrical apparatus for explosive gas*~~ *Explosive atmospheres – Part 5: Equipment protection by powder filling "q"*

IEC 60079-6, ~~*Electrical apparatus for explosive gas*~~ *Explosive atmospheres – Part 6: Equipment protection by oil-immersion "o"*

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

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

IEC 60079-13, ~~*Electrical apparatus for explosive gas atmospheres – Part 13: Construction and use of rooms or buildings protected by pressurization*~~ *Explosive atmospheres – Part 13: Equipment protection by pressurized room "p"*

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

~~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*~~ *Explosive atmospheres – Part 18: Equipment protection by encapsulation "m"*

IEC 60079-20-1, *Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data*

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

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

IEC 61511 (all parts) *Functional safety – Safety instrumented systems for the process industry sector*

# IEC 60079-2

Edition 6.0 2014-07

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Explosive atmospheres –**
**Part 2: Equipment protection by pressurized enclosure "p"**

**Atmosphères explosives –**
**Partie 2: Protection du matériel par enveloppe à surpression interne "p"**

IEC 60079-2:2014-07(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

# EXPLOSIVE ATMOSPHERES –

## Part 2: Equipment protection by pressurized enclosure "p"

## FOREWORD

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International Standard IEC 60079-2 has been prepared by technical committee 31: Explosive atmospheres.

This sixth edition cancels and replaces the fifth edition published in 2007. This sixth edition cancels and replaces the first edition of IEC 61241-4 published in 2001. This sixth edition constitutes a technical revision.

The significance of changes between IEC 60079-2, Edition 6.0, 2014 and IEC 60079-2, Edition 5.0, 2007 are as listed below:

| Changes | Clause | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Scope<br>Expanded to include combustible dust | 1 | | X | |
| Protective Gas<br>Replaced “apparatus” with “equipment” | 3 | | | |
| Protective Gas<br>Revised to show that purging is not required for explosive dust atmospheres | 3.16 | X | | |
| Level of Protection “pxb”<br>Term and definitions revised to reflect EPL and level of protection | 3.21 | X | | |
| Level of Protection “pyb”<br>Term and definitions revised to reflect EPL and level of protection | 3.22 | X | | |
| Level of Protection “pzc”<br>Term and definitions revised to reflect EPL and level of protection | 3.23 | X | | |
| Lower Flammable Limit<br>Term and definition revised to agree with 60079-0 | 3.26 | X | | |
| Upper Flammable Limit<br>Term and definition revised to agree with 60079-0 | 3.27 | X | | |
| Table 1 – Determination of protection level<br>Revised to use EPL terminology | Table 1 | X | | |
| Table 2 – Design Criteria based upon level of protection<br>Revised to use EPL terminology | Table 2 | X | | |
| Enclosure<br>Requirements relaxed for specific designs | 5.1 | | X | |
| Group II and Group III pressurized enclosures<br>Text revised to use EPL terminology | 5.3.3 | X | | |
| Group II and Group III Level of Protection “pxb”<br>Added that warning also applies for explosive dust atmospheres | 5.3.5 | | X | |
| Group II and Group III door and cover warning<br>Added that warning also applies for explosive dust atmospheres | 5.3.6 | | X | |
| Group II and Group III door and cover warning<br>Revised warning from atmosphere “may be present” to “is present” | 5.3.6 | X | | |
| Mechanical Strength<br>Removed reference to 60079-0 by clause number for “X” condition | 5.4 | X | | |
| Spark and particle barriers<br>Removed reference to 60079-0 by clause number for “X” condition | 5.9 | X | | |
| Cells and batteries<br>Added requirements for cells and batteries | 5.10 | | | C1 |
| For Level of Protection “pxb” or Level of Protection “pyb”<br>Revised Table to use terminology consistent with EPLs | 6.2 | X | | |

| | | Type | | |
|---|---|---|---|---|
| **Changes** | **Clause** | **Minor and Editorial Changes** | **Extension** | **Major Technical Changes** |
| Suitability of safety devices for hazardous area<br>Word “explosion” changed to “ignition” to reflect UFL/LFL terms | 7.1 | X | | |
| Integrity of safety devices<br>Added requirement for detecting fan failure | 7.2 | | | C2 |
| Table 3 – Safety devices based upon Level of Protection<br>Revised column labels to use Level of Protection terminology | Table 3 | X | | |
| Provider of safety devices<br>Remove reference to 60079-0 by clause number for “X” condition | 7.3 | X | | |
| Pressurization System evaluated as associated equipment<br>Added requirements for pressurization systems | 7.4 | | | C3 |
| Sequence diagram for Level of Protection “pxb”<br>Revised text to use Level of Protection terminology | 7.5 | X | | |
| Group I and Group II purging automated for Level of Protection “pxb”<br>Revised text to use Level of Protection terminology | 7.7 | X | | |
| Group I and Group II purging automated for Level of Protection “pxb”<br>Added text specifying that for “pxb”, control must be automated | 7.7 | | | C4 |
| Group I or Group II – purging criteria<br>Revised text to use Level of Protection terminology | 7.8 | X | | |
| Group III – cleaning<br>Added text for cleaning enclosures used in explosive dust atmospheres | 7.9 | | X | |
| Safety devices to detect minimum overpressure<br>Add word “minimum” to clause title to be consistent with text | 7.11 | X | | |
| Safety devices to detect minimum overpressure<br>Revised text to use Level of Protection terminology | 7.11 d) | X | | |
| Value of minimum overpressure<br>Added word “minimum” to clause title to be consistent with text | 7.12 | X | | |
| Value of minimum overpressure<br>Revised text to use Level of Protection terminology | 7.12 | X | | |
| Value of minimum overpressure<br>Added text to reflect a note in Annex C | 7.12 | | X | |
| Pressurizing multiple enclosures<br>Revised text to use Level of Protection terminology | 7.13 | X | | |
| Safety devices on doors and covers<br>Revised text to use Level of Protection terminology | 7.14 | X | | |
| Equipment that may remain energized<br>Revised text to use EPL and level of protection terminology | 7.15 | X | | |
| Equipment permitted within Level of Protection “pyb”<br>Revised text to use EPL and level of protection terminology | 7.16 | X | | |
| Group I and Group II Filling procedure<br>Allow filling in a hazardous location if tested as non-hazardous | 8.4 | | X | |

| Changes | Clause | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Group III Filling Procedure<br>Added static pressurization filling procedure for combustible dust | 8.5 | | X | |
| Safety devices<br>Revised text to use Level of Protection terminology | 8.6 | X | | |
| Equipment that may remain energized<br>Revised text to use EPL terminology | 8.7 | X | | |
| Overpressure<br>Removed reference to 60079-0 by clause number | 8.8 | X | | |
| Backup supply<br>Added requirements for a backup supply of protective gas | 9.1 | | | C5 |
| Independent supplies<br>Provided requirements for independence of pressurization | 9.2 | | X | C6 |
| Release Conditions<br>Removed reference to 60079-0 by clause number for “X” condition | 11.1.2 | X | | |
| Containment system with a limited release<br>Removed reference to 60079-0 by clause number for “X” condition | 12.3 | X | | |
| 13.3.3 Limited release of a gas or vapour<br>Revised text to reflect UFL/LFL terms | 13.3.3 | X | | |
| Ignition-capable equipment<br>Revised text to use Level of Protection terminology | 14 | X | | |
| Type verification and tests<br>Edition 5 clauses 16.1 to 16.7 moved to Edition 6 clauses 16.2 to 16.8 | 16 | X | | |
| Determining the maximum overpressure rating<br>Added requirements to determine maximum overpressure | 16.1 | | | C7 |
| Maximum overpressure test<br>Moved Maximum overpressure test to 16.2 | 16.2 | | | C7 |
| Leakage test<br>Clarify the acceptance criteria for the test | 16.3.2 | | X | |
| Tests for an infallible containment system<br>Clarify the rating used for the test | 16.7.1 | | | C8 |
| Tests for an infallible containment system<br>Modified test for infallible containment | 16.7.2 | | | C9 |
| Edition 5 – Verifying ability of the pressurized enclosure to limit internal pressure<br>Eliminated test | 16.8 | | | C7 |
| Functional test<br>Clarified that applies only to safety devices provided with enclosures | 17.1 | X | | |
| Tests for an infallible containment system<br>Waived helium leak tests for liquid systems | 17.3 | | X | |

| Changes | Clause | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Supplementary marking<br>Allowed continued use of type of protection marking | 18.3 | | | |
| Pressurization systems<br>Clarified use of Ex [p] and [Ex p] marking | 18.6 | X | | |
| Warnings required in other clauses<br>Added table number | 18.7 | X | | |
| Warnings required in other clauses<br>Added warning from 7.9 | 18.7 | | X | |
| Warnings required in other clauses<br>Added warnings from Annex G and Annex H | 18.7 | | | C1 |
| Instructions<br>Added requirements for Group III | 19 | | X | |
| Edition 5 Annex G – Infallibility test for containment system<br>Deleted and replaced | Annex G | X | | |
| Edition 5 Annex H – Introduction of an alternative risk assessment method encompassing “equipment protection levels”<br>Deleted and replaced | Annex H | X | | |
| Annex G – Internal Cells and Batteries for Level of Protection “pxb” and Level of Protection “pyb”<br>Added requirements for cells and Batteries | | | X | |
| Annex H – Internal Cells and Batteries for Level of Protection “pzc”<br>Added requirements for cells and Batteries | | | X | |



**Explanations:**

**A) Definitions**

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

These are changes which modify requirements in an editorial or a minor technical way. They include changes of the wording to clarify technical requirements without any technical change, or a reduction in level of existing requirement.

**Extension** addition of technical options

These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore, these will not have to be considered for products in conformity with the preceding edition. 5.

**Major technical changes** addition of technical requirements increase of technical requirements

These are changes to technical requirements (addition, increase of the level or removal) made in a way that a product in conformity with the preceding edition will not always be able to fulfill the requirements given in the later edition. These changes have to be considered for products in conformity with the preceding edition. For these changes additional information is provided in clause B) below

B) Information about the background of ‘Major Technical Changes’

C1 – Added annexes with requirements for using cells and batteries.

C2 – Added requirement that fan failure cannot be based upon loss of power to the fan.

C3 – Added requirements for equipment evaluated as a pressurization system to provide uniformity in the testing of such equipment.

C4 – Although, in Edition 5, the title of clause 7.6 stated automated purging, the word automated was not in the requirement. It is intended that all "pxb" equipment have an automated purging system to prevent energizing of ignition capable circuits until the purge cycle has been properly completed. This requires verifying that the flow is at least the minimum required for the purge time as well as verifying that the minimum overpressure exists within the enclosure.

C5 – If a backup supply of protective gas is provided, then both the primary and the backup supply needs to be capable of maintaining the required pressurization.

C6 – If a pressurized enclosure is used within a larger pressurized enclosure the protective gas supplies need to be independent.

C7 – The previous text in 16.1 of Edition 5, assumed that the enclosures had a maximum overpressure rating, but this is rarely the case. Some test houses relied upon the test in 16.8 to determine the maximum overpressure. Various methods were used to simulate regulator failure such as removing the regulator, but this also removed the orifices that would limit the flow. Based upon test house experience, the danger of flying fragments from the enclosure is acceptably small as either the enclosure or the gaskets will deform to relieve the internal pressure. A decision was taken to eliminate the overpressure test based upon the failed regulator. In addition, the definition of maximum overpressure is now based upon the value obtained when the pressurized enclosure is operated within its ratings. This maximum overpressure will generally occur when the equipment is in rapid purge mode with the maximum rated pressure applied to the inlet of the regulator. The Edition 5 text of 16.1 was modified and moved to 16.2.

C8 – The term overpressure in most cases implies operation outside of the normal ratings. Text was clarified to use the term "maximum operating pressure" rather than maximum internal overpressure. Test was 16.6.1 in Edition 5.

C9 – The test was modified to use helium leak detection rather than rely on maintaining a vacuum since this would depend upon the capability of the vacuum system. Test was 16.6.2 in Edition 5.

The significance of changes between IEC 60079-2, Edition 6.0, 2014 and IEC 61241-4, Edition 5.0, 2007 are as listed below:

| | | Type | | |
|---|---|---|---|---|
| **Changes** | **Clause in 61241-4** | **Minor and Editorial Changes** | **Extension** | **Major Technical Changes** |
| Removed type of protection "pD". Included in 3.20, 3.21 and 3.22 | 3.1 | | X | |
| Definition of pressurization now accommodates both gas and dust | 3.3 | | X | |
| Definition of protective gas now accommodates both gas and dust | 3.4 | | X | |
| Removed definition for an enclosure. Defined in IEC 60079-0 | 3.5 | X | | |
| Removed note in definition for pressurized enclosure. | 3.6 | X | | |
| Replaced definition of static pressurization with 60079-2 definition | 3.7 | X | | |
| Removed definition for "pressurization with continuous flow of the protective gas". Term not used in 61241-4 | 3.9 | X | | |
| Removed definition for "electrical apparatus". Definition is covered in IEV | 3.10 | X | | |
| Definition of ignition-capable apparatus now accommodates both gas and dust | 3.11 | X | | |
| Removed definition for "self-revealing fault". Term not used in 61241-4 | 3.12 | X | | |
| Removed definition for "opening". Term not used in 61241-4 | 3.13 | X | | |
| Removed definition for "protective device". These are mostly referred | 3.14 | X | | |

| Changes | Clause in 61241-4 | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| to as a “safety device” throughout 61241-4. | | | | |
| Removed definition for “protected apparatus”. This was only used to address batteries which are now covered in Annex G and Annex H. | 3.17 | X | | |
| Replaced definition of “pressurization system” with 60079-2 definition | 3.18 | X | | |
| Removed definition for “alternate (or auxiliary) source of supply of protective gas”. Term used is “second source of Supply. This is now addressed in 60079-2, 9.1 | 3.19 | X | | |
| Removed definition for “zones in Area Classification” This definition is provided in 60079-10-2. | 3.20 | X | | |
| Removed definition for “zone 20 in Area Classification”. See above | 3.21 | X | | |
| Removed definition for “zone 21 in Area Classification”. See above | 3.22 | X | | |
| Removed definition for “zone 22 in Area Classification”. See above | 3.23 | X | | |
| Removed Clause on “Pressurization principle” including sub-clauses. This information is covered by the definition of “Pressurization”, see 3.13 and other clauses in the standard. | 4 | X | | |
| Removed Clause on “Electrical performance of apparatus”. Safe performance of equipment is addressed by 60079-0, 6.1 b) | 5.1 | X | | |
| Removed note about equipment with large surface areas subjected to pressures > 1kPa may be subject to pressure vessel legislation. | 5.2 | X | | |
| Text on apertures is equivalently covered by 5.5 and 5.6 | 5.3 | X | | |
| Text on electrical connections is equivalently covered in 60079-0, clause 14. | 5.4 | X | | |
| Text on delaying opening of an enclosure because of internal hot surface is equivalently covered in clause 15. | 5.5 | X | | |
| Removed text on providing suitable amount of doors or covers to provide for effective removal of dust from the enclosure. The text in 61241-4 would not lend itself to consistent assessments from different CBs. | 5.5 | X | | |
| Text on temperature limits is equivalently covered in clause 6 and 60079-0, 26.5.1.3. | 6 | X | | |
| Removed text on the responsibility of the manufacturer. Addressed in 60079-0. | 7.1 | X | | |
| Removed text on the responsibility of the user. Addressed in 60079-14. | 7.1 | X | | |
| Removed text that manufacturer shall provide instructions for cleaning the enclosure. Addressed in 60079-14. | 7.1 | X | | |
| Removed text requiring a safety device to operate when the pressure within the enclosure exceeds the permitted maximum pressure. It is the user responsibility to not exceed the rated maximum pressure. | 7.2 | X | | |
| Removed text requiring the isolation of the neutral conductor. Addressed in 60079-14. | 7.4 | X | | |
| Text on failure of pressurization is equivalently covered by clause 7 & 13.3. | 7.5 | X | | |
| Removed text on location of visible or audible alarms. Addressed in 60079-14. | 7.5.1 | X | | |
| Removed text requiring both disconnection and alarming for Zone 21 Db. Addressed in 60079-14. | 7.5.1.1 | X | | |
| Text on warning marking on doors and covers is equivalently covered in 5.3.6. | 7.5.1.2 | X | | |
| Removed text about providing means for removing oil or moisture. Addressed in 60079-14, 13.1.6. | 9.1 | X | | |
| Removed text requiring the minimum overpressure be verified over a 5 minute period. It is not considered that this measurement is time dependent. | 10.4.1 | X | | |

| Changes | Clause in 61241-4 | Type | | |
|---|---|---|---|---|
| | | Minor and Editorial Changes | Extension | Major Technical Changes |
| Removed text requiring the minimum overpressure be verified with through-the-wall moving parts operating in normal use. It is not considered that operating such parts will affect the internal pressure. | 10.4.2 | X | | |
| Removed text requiring that the Leakage Test be done at a minimum of 200 Pa. The Leakage Test is only applicable to maximum overpressure specified by the manufacturer for normal service. | 10.5 | X | | |
| Text on conformity for Leakage Testing of Static Pressurization is equivalently covered in 16.3.2. | 10.5 | X | | |
| 60079-2, Ed 6 does not have an exception to the impact test for pressurized enclosures that are not subject to mechanical damage. | 10.6 | | | B1 |
| Removed text on routine Overpressure test | 10.7 | X | | |
| Added text for routine tests of containment systems. 61241-4 did not address enclosures which contained an internal release of a flammable substance. | 10.7 | | X | |
| Text on Marking is equivalently covered in clause 60079-0, clause 29 | 11.1 | X | | |
| Removed text requiring that “limitations affecting the safe use of the apparatus” be marked. This is covered in the Instructions, see 60079-0, clause 30. | 11.2 | X | | |
| Removed text requiring that “the position at which the pressure and flow are monitored” be marked. | 11.2 | X | | |
| Removed text requiring that “the maximum wattage of the lamp for a light fitting” be marked. | 11.2 | X | | |
| Removed text “As agreed upon between the certificate applicant and testing station if necessary.” | 11.4 | X | | |

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**Extension** addition of technical options
These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore, these will not have to be considered for products in conformity with the preceding edition. 5.

**Major technical changes** addition of technical requirements increase of technical requirements
These are changes to technical requirements (addition, increase of the level or removal) made in a way that a product in conformity with the preceding edition will not always be able to fulfill the requirements given in the later edition. These changes have to be considered for products in conformity with the preceding edition. For these changes additional information is provided in clause B) below

B) Information about the background of ‘Major Technical Changes’

B1 – Pressurized enclosure must be subjected to impact testing as shown in Table 2.

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 31/1119/FDIS | 31/1131/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This standard is to be read in conjunction with IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 60079 series, under the general title Explosive atmospheres can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the new edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of July 2015 have been included in this copy.

# INTRODUCTION

This part of IEC 60079 gives requirements for the design, construction, testing and marking of electrical equipment for use in 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;

b) 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 and 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; or

c) a protective gas maintained at a pressure above that of the external atmosphere, is used to prevent the entry of combustible dust which might otherwise lead to the formation of an explosive dust atmosphere within enclosures, but only where there is no internal source of release of combustible dust.

This standard includes requirements for the equipment and its associated equipment including the inlet and exhaust ducts, and also for the auxiliary control equipment 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 equipment with pressurized enclosures, of type of protection “p”, intended for use in explosive gas atmospheres or explosive dust atmospheres. It also includes the 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 take precedence.

This standard does not include 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 where the oxygen is in a proportion greater than 21 %.
- pressurized rooms or analyser houses; see IEC 60079-13;
- pressurized enclosures used where “explosives” or pyrotechnics are present;
- pressurized enclosures used where hybrid mixtures of gas/vapour and combustible dust are present;
- pressurized enclosures used where pyrophoric substances such as explosives or propellants containing their own oxidizers are present
- pressurized enclosures with an internal source of release of combustible dust.

NOTE 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.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 (all parts), *International Electrotechnical Vocabulary*

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

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

IEC 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

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

IEC 60127, (All parts) *Miniature fuses*

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

IEC 60664-1, *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 equipment that generates a visual or audible signal that is intended to attract attention

**3.2**
**containment system**
part of the equipment 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 1 to entry: Dilution of oxygen by inert gas may result in a concentration of flammable gas or vapour above the upper flammable limit (UFL).

**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 equipment. 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

Note 1 to entry: Examples of fusion include brazing, welding or the fusion of glass to metal.

**3.8**
**ignition-capable equipment**
**ICE**
equipment which in normal operation constitutes a source of ignition for a specified explosive atmosphere.

**3.9**
**indicator**
piece of equipment that shows whether flow or pressure is adequate and which is intended to be 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**
provision of 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 maintaining an overpressure and, if required, dilution and purging

Note 1 to entry: 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

Note 1 to entry: The protective gas supply includes inlet (suction) pipes or ducts, pressure regulators, outlet pipes, ducts, and supply valves.

Note 2 to entry: Components of the pressurization system other than the pressure regulator, 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**
**static pressurization**
maintenance of an overpressure within a pressurized enclosure without the addition of protective gas in a hazardous area

**3.20**
**Level of Protection "pxb"**
pressurized enclosure providing Equipment Protection Level Mb, Gb or Db

Note 1 to entry: This permits unprotected equipment to be installed within the pressurized enclosure except for safety devices, see 3.23.

**3.21**
**Level of Protection "pyb"**
pressurized enclosure providing Equipment Protection Level Gb or Db with Equipment Protection Level Gc or Dc internal to the pressurized enclosure

Note 1 to entry: This permits Equipment Protection Level Gc or Dc equipment to be installed within the pressurized enclosure, except for safety devices, see 3.23

**3.22**
**Level of Protection "pzc"**
pressurized enclosure providing Equipment Protection Level Gc or Dc

Note 1 to entry: This permits unprotected equipment to be installed within the pressurized enclosure except for safety devices, see 3.23.

**3.23**

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

**3.24**
**lower flammable limit**
**LFL**
volume fraction of flammable gas or vapour in air below which an explosive gas atmosphere will not form, expressed as a percentage (see IEC 60079-20-1)

Note 1 to entry: This is also known as Lower Explosive Limit (LEL).

**3.25**
**upper flammable limit**
**UFL**
volume fraction of flammable gas or vapour in air above which an explosive gas atmosphere will not form, expressed as a percentage (see IEC 60079-20-1)

Note 1 to entry: This is also known as Upper Explosive Limit (UEL).

## 4 Protection levels

Protection by pressurization is subdivided into three Levels of Protection ("pxb", "pyb" and "pzc") which are selected based upon the Equipment Protection Level required (Mb, Gb, Db, Gc or Dc), whether there is the potential for an internal release, and whether the equipment within the pressurized enclosure is ignition-capable; see Table 1. The Level of Protection then

defines design criteria for the pressurized enclosure and the pressurization system; see Table 2.

**Table 1 – Determination of protection level**

| Is there an internal release condition? | Highest Equipment Protection Level requirement for external explosive atmosphere | Does enclosure contain ignition-capable equipment? | Level of Protection |
|---|---|---|---|
| No | Mb, Gb or Db | Yes or no | Level of Protection “pxb” |
| No | Gb or Db | No | Level of Protection “pyb” |
| No | Gc or Dc | Yes or no | Level of Protection “pzc” |
| Yes, gas/vapour | Mb, Gb, or Db | No or Yes and the ignition-capable equipment is not located in the dilution area | Level of Protection “pxb” |
| Yes, gas/vapour | Gb or Db | No | Level of Protection “pyb” |
| Yes, gas/vapour | Gc or Dc | Yes and the ignition-capable equipment is not located in the dilution area | Level of Protection “pxb” |
| Yes, gas/vapour | Gc or Dc | No | Level of Protection “pyb” |
| Yes liquid | Gb or Db | Yes or No | Level of Protection “pxb” (inert) |
| Yes liquid | Gb or Db | No | Level of Protection “pyb” (inert) |
| Yes liquid | Gc or Dc | Yes or No | Level of Protection “pzc” (inert) |
| If the flammable substance is a liquid, normal release is never permitted.<br>The protective gas shall be inert if "(inert)" is shown after the pressurization level; see Clause 13. | | | |

**Table 2 – Design criteria based upon level of protection**

| Design criteria | Level of Protection "pxb" | Level of Protection "pyb" | Level of Protection "pzc" with indicator | Level of Protection "pzc" 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 applies | IEC 60079-0 applies | IEC 60079-0 applies | apply half the value shown in IEC 60079-0 |
| Verifying purge period for Group I and Group II | 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 Mb, Gb or Db | Spark and particle barrier required, see 5.9, unless incandescent particles not normally produced | No requirement[a)] | Level of protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db | Level of protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db |
| Preventing incandescent particles from exiting a normally closed relief vent into an area requiring EPL Gc or Dc | No requirement[b)] | No requirement[b)] | No requirement, see footnote b) | No requirement[b)] |
| Preventing incandescent particles from exiting a vent that opens during normal operation, to an area requiring EPL Mb, Gb or Db | Spark and particle barrier required, see 5.9 | Spark and particle barrier required, see 5.9 | Level of Protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db | Level of Protection "pzc" does not apply to areas requiring EPL Mb, Gb or Db |
| Preventing incandescent particles from exiting a vent that opens during normal operation to an area requiring EPL Gc, or Dc | Spark and particle barrier required, see 5.9, unless incandescent particles not normally produced | No requirement [a)] | Spark and particle barrier required, see 5.9, unless incandescent particles not normally produced | Spark and particle barrier required, see 5.9, unless incandescent particles not normally produced |
| Door or cover opens only with use of a tool | Warning, see 5.3 and 6.2 b) ii) | Warning, see 5.3.6[b)] | Warning, see 5.3.6[c)] | Warning, see 5.3.6[c)] |
| Door or cover opens without use of a tool | Interlock, see 7.14 (no internal hot parts) | Warning, see 5.3.6[a)] | Warning, see 5.3.6[c)] | Warning, see 5.3.6[c)] |
| Internal hot parts that require a cool-down period before opening enclosure | Comply with 6.2 b) ii) | No requirement[a)] | Warning, see 5.3.6 | Warning, see 5.3.6 |

a) 6.2b) ii) is not applicable for Level of Protection "pyb" since neither hot internal parts nor normally created incandescent particles are permitted.

b) 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.

c) There is no requirement for tool accessibility on a Level of Protection "pzc" 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.

For Level of Protection “pxb” with no internal components that exceed the marked temperature class and for Levels of Protection “pyb” and “pzc”, the tests for thermal endurance to heat and thermal endurance to cold for non-metallic enclosures and non-metallic parts of enclosures of IEC 60079-0 need not be applied to the pressurized enclosure.

This is because degradation of the enclosure that results in increased leakage will result in alarm or removal of power to ignition capable circuits. Therefore, the pre-conditioning testing of non-metallic enclosures and non-metallic parts of enclosures is not considered necessary.

## 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 providing an EPL as shown in 7.15 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed. The requirements of 7.7 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 and Group III pressurized enclosures

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

For Level of Protection “pxb”, doors and covers which 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 7.15 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed.

For Level of Protection “pyb” and Level of Protection “pzc”, the use of a tool or key is not required.

Consideration should be given to the possibility that the internal pressure could cause a door or cover to open violently when the fastener is moved. The operator or 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 and Group III pressurized enclosures with static pressurization

Doors and covers shall not be capable of being opened readily without the use of a key or tool

### 5.3.5 Group II and Group III Level of Protection “pxb”

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 Group II and Group III Door and Cover warning

To prevent the ignition of an explosive gas atmosphere or an explosive dust atmosphere which may be present when an enclosure is opened, doors and covers shall be marked:

WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS 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 certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard.

## 5.5 Group I and Group II Apertures, partitions, compartments and internal components

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

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.

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.

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.

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

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.

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.

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 are typically 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 (LFL) of hydrogen; see A.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.

### 5.6 Apertures for Static Pressurization

The enclosure shall have one or more aperture(s). After filling and pressurization, all apertures shall be closed.

### 5.7 Insulating materials for Group I equipment

Insulating materials 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 (CTI) of pollution degree 3 in IEC 60664-1.

### 5.8 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.

### 5.9 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.

Enclosures in which incandescent particles are not normally produced, do not require a spark and particle barrier on any normally closed relief vent exhausting into an area requiring EPL Gb or Mb.

Enclosures in which incandescent particles are not normally produced, do not require a spark and particle barrier on any vent exhausting into an area requiring EPL Gc.

If the manufacturer does not provide the spark and particle barriers, the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard.

### 5.10 Cells and batteries

Annex G provides requirements for Levels of Protection “pxb” and “pyb”. Annex H provides requirements for Level of Protection “pzc”.

## 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 Level of Protection “pxb” or Level of Protection “pyb”

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 Level of Protection “pxb” and complies with the requirements for opening times in IEC 60079-0. 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.

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.

For Level of Protection “pyb”, hot ignition-capable parts in normal operation are not permitted within the enclosure.

### 6.3 For Level of Protection “pzc”

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

In determining temperature class, account should be taken of any internal equipment with its own explosion 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 reduce lectrical equipment protected by pressurization from causing ignition shall themselves not be capable of causing ignition (see 7.15) 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 Level of Protection “pxb” or Level of Protection “pyb”, a single fault evaluation;

– for Level of Protection “pzc”, normal operation.

NOTE For guidance on the single fault evaluation, IEC 61511 series or similar standards can be used.

An electrical interlock on the fan motors or controls is not sufficient to indicate failure of pressurization because this may not indicate failures such as the fan belt slipping, the fan becoming loose on the shaft or reverse rotation of the fan.

**Table 3 – Safety devices based upon Level of Protection**

| Design criteria | Level of Protection “pxb” | Level of Protection “pyb” | Level of Protection “pzc” |
|---|---|---|---|
| Safety device to detect loss of minimum overpressure | Pressure sensor, see 7.11 | Pressure sensor, see 7.11 | Indicator or pressure sensor, see 7.11 d) |
| Safety device(s) to verify purge period for Group I and Group II | Timing device, pressure sensor, and flow sensor at outlet; see 7.7 | Time and flow marked, see 7.8 c) | Time and flow marked, see 7.8 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 7.14 (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 level 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 certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard.

## 7.4 Pressurization System evaluated as associated equipment

### 7.4.1 Pressurization systems for Level of Protection ”pzc”.

The pressurization system shall include as a minimum: a means for controlling the minimum overpressure, (e.g. a regulator) and a means to verify the minimum overpressure, (e.g. an indicator) all in accordance with 7.11.

If a vent is provided, it shall have a spark and particle barrier.

If a regulator is provided and if it is of a type that a single failure mode will put full inlet pressure on the regulator outlet, then a means (e.g. relief vent) shall be provided that will limit the internal pressure of an enclosure to a defined value. This value is to be stated in the instructions and established by either test or calculation. If multiple regulators or relief vents are provided as options, then the value for each set of available regulator/relief vent options shall be determined.

The pressurization system shall be tested to verify correct operation.

### 7.4.2 Pressurization systems for Level of Protection ”pyb”.

The pressurization system shall include: a means for controlling the minimum overpressure, (e.g. a regulator), a means to verify the minimum overpressure, (e.g. a pressure sensor) and an automatic safety device all in accordance with 7.11.

If a regulator is provided and if it is of a type that a single failure mode will put full inlet pressure on the regulator outlet, then a means (e.g. relief vent) shall be provided that will limit the internal pressure of an enclosure to a defined value. This value is to be stated in the instructions and established by either test or calculation. If multiple regulators or relief vents are provided as options, then the value for each set of available regulator/relief vent options shall be determined.

The pressurization system shall be tested to verify correct operation.

### 7.4.3 Pressurization systems for Level of Protection ”pxb”.

The pressurization system shall include: a means for controlling the minimum overpressure, (e.g. a regulator), a means to verify the minimum overpressure, (e.g. a pressure sensor), an automatic safety device all in accordance with 7.11 and an automated control system incorporating a flow sensor in accordance with 7.7.

If a regulator is provided and if it is of a type that a single failure mode will put full inlet pressure on the regulator outlet, then a means (e.g. relief vent) shall be provided that will limit the internal pressure of an enclosure to a defined value. This value is to be stated in the instructions and established by either test or calculation. If multiple regulators or relief vents are provided as options, then the value for each set of available regulator/relief vent options shall be determined.

The pressurization system shall be tested to verify correct operation including the function of the automatic control system.

### 7.5 Sequence diagram for Level of Protection “pxb”

For Level of Protection “pxb” 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.

### 7.6 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 ratings specified by the manufacturer.

### 7.7 Group I and Group II Purging automated for Level of Protection “pxb”

An automatic control system including safety devices shall be provided to energize the electrical equipment within a pressurized enclosure only after purging has been completed.

The sequence of operations of the control system shall be as follows:

a) following the initiation of the sequence, the purging flow through and the minimum 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.

### 7.8 Group I or Group II – Purging criteria

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

a) for Level of Protection “pxb” or Level of Protection “pyb”, the manufacturer shall specify the minimum purge flow and time to satisfy the test in 16.4 or 16.5 as appropriate. For other than rotating machines and equipment with complex geometries, 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 Level of Protection “pzc”, for other than rotating machines and equipment with complex geometries, 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 16.4 or 16.5, as appropriate.

   The purge test for rotating machines and for equipment with complex geometries may be omitted if the purge time is based on tests made with similar or comparable enclosures.

c) the purging flow rate shall be monitored at the outlet of the pressurized enclosure. For Level of Protection “pxb”, the actual flow shall be monitored. For Level of Protection “pyb” or Level of Protection “pzc”, the flow may be deduced, for example, from the enclosure pressure and a defined orifice at the outlet. For Level of Protection “pyb” or Level of Protection “pzc”, 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.

### 7.9 Group III – Cleaning

A warning shall be marked on the equipment stating that combustible dust shall be removed from the interior prior to switching on the electrical supply. The marking shall include the following or similar:

WARNING – POWER SHALL NOT BE RESTORED AFTER THE ENCLOSURE HAS BEEN OPENED UNTIL COMBUSTIBLE DUST ACCUMULATIONS WITHIN THE ENCLOSURE HAVE BEEN REMOVED.

### 7.10 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.

### 7.11 Safety devices to detect minimum 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 7.12:

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 Level of Protection "pzc", 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;

9) the exclusion for non-metallic enclosures and non-metallic parts of enclosures in 5.1 has not been applied;

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

A flowmeter used to indicate both enclosure pressure and purging flow normally should be located on the outlet.

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

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

### 7.12 Value of minimum overpressure

A minimum overpressure of 50 Pa for Level of Protection "pxb" or Level of Protection "pyb", and 25 Pa for Level of Protection "pzc" 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 normal overpressure in service, the maximum overpressure during purging and the maximum leakage rate at the maximum normal overpressure.

Consideration should be given in the application of pressurized equipment having an internally enclosed cooling circuit in which circulation is assisted by an internal fan (e.g. motors), since the effect of such fans may be to produce a negative pressure in parts of the casing with consequent risk of ingress of gas or dust if pressurization ceases (see Figure C.3).

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

The installation of the associated ducts and of the compressor or fan should not introduce a hazard. The basic requirements for the installation of ducting systems are given in Annex D.

### 7.13 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 Level of Protection “pxb”, 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 7.15;

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; and

c) the subsequent connecting of the supply to the electrical equipment in the particular pressurized enclosure is preceded by the purging procedure specified in 7.7.

### 7.14 Safety devices on doors and covers

For Level of Protection “pxb”, 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 7.15 is disconnected automatically when they are opened and so that the supply cannot be restored until they are closed. The requirements of 7.7 shall also apply.

### 7.15 Equipment that may remain energized

For Group I or Group II pressurized enclosures, the electrical equipment that may remain energized when Level of Protection “pxb” or Level of Protection “pyb” is not in operation shall be protected by EPL Ma or Mb for Group I and EPL Ga or Gb for Group II.

For Group II pressurized enclosures, the electrical equipment that may remain energized when Level of Protection “pzc” is not in operation shall be protected by EPL Ga, Gb or Gc.

For Group III pressurized enclosures, the electrical equipment that may remain energized when Level of Protection “pxb” is not in operation shall be protected by EPL Da or Db.

For Group III pressurized enclosures, the electrical equipment that may remain energized when Level of Protection “pzc” is not in operation shall be protected by EPL Da, Db or Dc.

### 7.16 Equipment permitted within Level of Protection “pyb”

Electrical equipment within a Level of Protection “pyb” pressurized enclosure shall be protected by EPL Ga, Gb or Gc for Group II.

Electrical equipment within a Level of Protection “pyb” pressurized enclosure shall be protected by EPL Da, Db, Dc for Group III.

## 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.

### 8.3 Internal sources of release

There shall be no internal sources of release.

### 8.4 Group I and Group II Filling procedure

The Instructions shall specify that the pressurized enclosure shall be filled with inert gas in an area known to be non-hazardous using the procedure specified by the manufacturer.

### 8.5 Group III Filling Procedure

The Instructions shall specify that the pressurized enclosure shall be cleaned as necessary to ensure there is no hazardous accumulation of combustible dust within the enclosure. The Instructions shall specify that after cleaning, the pressurized enclosure shall be filled with inert gas in an area known to be non-hazardous using the procedure specified by the manufacturer.

### 8.6 Safety devices

Two automatic safety devices for Level of Protection “pxb” or Level of Protection “pyb” or one automatic safety device for Level of Protection “pzc” 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.

### 8.7 Equipment that may remain energized

Electrical equipment within the pressurized enclosure that may be energized when type of protection “p” is not in operation shall have an EPL as shown in 7.15.

### 8.8 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 the opening times requirements 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 Backup supply

If a backup supply of protective gas is required in the event of failure of the primary supply, then each supply shall be capable of maintaining, independently, the required level of pressure or rate of supply of protective gas. The two sources may share common ductwork or piping.

NOTE A backup supply can be advisable where it is necessary to maintain operation of the electrical equipment.

### 9.2 Independent supplies

When the enclosure of an ignition-capable product is protected by Level of Protection "pzc" pressurized enclosure and this enclosure is then located within a Level of Protection "pyb" pressurized enclosure, the protective gas supplies shall be independent.

### 9.3 Type of gas

The protective gas shall be non-flammable.

The Instructions shall specify the protective gas and any alternative permitted. Where other than air of normal instrument quality or nitrogen is specified, 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.

When an inert gas is used, a risk of asphyxiation exists. Therefore a warning shall be affixed to the enclosure, (see 18.9.) Consideration should be given to providing a suitable means of purging the enclosure to remove the inert gas prior to the opening of doors or covers.

### 9.4 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.

## 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 equipment 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 LFL; 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 typically the responsibility of the user.

The certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user 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. 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

An infallable 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.

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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 manufacturer should carefully consider damage to a potentially fragile containment system by adverse operating conditions. The Instructions should provide suitable guidance to reduce the risk of damage for those conditions agreed between manufacturer and user such as 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.

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; 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 certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the necessary information required by the user to ensure conformity with the requirements of this standard 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.

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.

## 13 Protective gas and pressurizing techniques when there is an internal source of release

### 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** | **UFL < 80 %** | **UFL > 80 %** | **UFL < 80 %** | **UFL > 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 UFL of the flammable substance shall not exceed 80 %.

NOTE 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 UFL greater than 80 %).

### 13.3 Pressurization with dilution

#### 13.3.1 General

If the flammable substance has a UFL 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 shall be used to dilute the flammable substance.

#### 13.3.2 No release

The protective gas shall be air or inert gas.

### 13.3.3 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 LFL;

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 UFL greater than 80 %, any release shall be diluted with air to a concentration not exceeding 25 % of the LFL.

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

### 13.3.4 Limited release of a liquid

The protective gas shall be inert and the provisions of 13.3.3 b) shall be complied with. There shall not be any normal release (see Annex E) of the flammable substance.

## 14 Ignition-capable equipment

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

**Table 5 – Equipment Protection Levels permitted within the dilution area based upon the Level of Protection of the pressurized enclosure**

| Internal release is | Level of Protection "pxb", Level of Protection "pyb" | Level of Protection "pzc" |
|---|---|---|
| abnormal | Ga or Gb | Ga, Gb or Gc |
| normal | Ga | Ga |

Generally, any internal source of release should be near to the outlet and any ignition-capable equipment 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 equipment.

NOTE 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 LFL 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

Where xxx is replaced with the value in minutes for the delay required.

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 Determining the maximum overpressure rating

The maximum overpressure rating of the enclosure is the highest internal operating pressure attained by following the manufacturer's instructions.

NOTE The maximum overpressure generally occurs when purging the enclosure.

The measured internal pressure shall not exceed the maximum rated internal pressure for the enclosure if specified.

### 16.2 Maximum overpressure test

A pressure equal to 1,5 times the maximum overpressure determined in 16.1 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.

### 16.3 Leakage test

#### 16.3.1 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.

Normal service does not include the overpressure required to open a vent in order to purge the enclosure at a higher flow rate.

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

#### 16.3.2 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 8.8. The pressure shall not drop below the minimum overpressure.

### 16.4 Purging test for pressurized enclosures with no internal source of release and filling procedure test for static pressurization

#### 16.4.1 General

This test applies whether leakage compensation is used or not used (i.e. continuous flow).

#### 16.4.2 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 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.

#### 16.4.3 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 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.

#### 16.4.4 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 16.4.2

#### 16.4.5 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.

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

#### 16.5.1 Test gas

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

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

#### 16.5.2.1 Purging test

The test shall be carried out using the test procedure specified in 16.4.3. 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.

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 %.

#### 16.5.2.2 Dilution test

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

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

#### 16.5.3.1 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 equipment 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 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.

#### 16.5.3.2 Dilution test

Immediately after the purging test specified in 16.5.3.1, 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 16.5.3.1.

The oxygen concentration measured over a period of time not less than 30 min shall not exceed the concentration as specified in 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 equipment, that is outside the dilution area, shall not exceed 1,5 times the oxygen concentration specified in 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.

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

##### 16.5.4.1 Purging test

The test shall be carried out using the test procedure specified in 16.4.2.

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 equipment that is outside the dilution area.

The time taken until there is no sample point where there is a test gas concentration exceeding that specified in 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.

##### 16.5.4.2 Dilution test

Immediately after the purging test specified in 16.5.4.1, 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 16.5.3.1.

The test gas concentration measured during a time period of not less than 30 min shall not exceed that specified in 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 equipment, that is outside the dilution area, shall not exceed twice the value specified in 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.

### 16.6 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 7.12 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.

### 16.7 Tests for an infallible containment system

#### 16.7.1 Overpressure test

A test pressure of at least 5 times the maximum operating pressure 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 16.7.2 is passed.

#### 16.7.2 Infallibility test

The containment system shall be flushed and pressurized with pure helium (95,0 % V/V or higher) to a pressure equal to the maximum operating pressure of the containment system. A helium leak detector shall then be used to check for leaks. The test is considered satisfactory if the leak detector does not indicate any leaks.

NOTE Leaks are indicated by a reading higher than the ambient room reading.

### 16.8 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.

## 17 Routine tests

### 17.1 Functional test

The performance of safety devices provided with the pressurized enclosure shall be verified.

### 17.2 Leakage test

The leakage of protection gas shall be tested as specified in 16.3.

### 17.3 Tests for an infallible containment system

An infallible containment system shall be tested as specified in 16.7. However, for liquid systems, it is adequate to check for liquid leaks during the overpressure test in place of the helium leak test.

### 17.4 Test for a containment system with a limited release

The containment system shall be tested as specified in 16.8.

## 18 Marking

### 18.1 General

In addition to the requirements of IEC 60079-0, the marking shall include the following. 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.

### 18.2 Identifying as pressurized

The pressurized enclosure shall be marked “WARNING – PRESSURIZED ENCLOSURE”.

### 18.3 Supplementary marking

The following supplementary information shall also be marked as appropriate:

a) the Level of Protection “pxb”, “pyb”, or “pzc”;

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.

For Level of Protection “pzc” and Level of Protection “pyb”, the minimum pressure may be used in place of the flow rate if the pressure is a positive indication of the correct flow (see 7.8 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 shall not exceed 2 %;

d) a restriction that the flammable substance shall not have a UFL 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 pressurization equipment.

When a pressurization system with a separate certificate is marked for installation in a hazardous area, the symbol “”[p]” shall be included in the “Ex marking”. When a pressurization with a separate certificate is marked for installation only in a non-hazardous area, the “Ex marking” shall be “[Ex p]”.

NOTE Markings “[p]” and “[Ex p]” do not appear in IEC 60079-0, Ed. 6 or earlier.

### 18.7 Warnings required in other clauses

**Table 6 – Text of warning markings**

| Clause or subclause | Recommended warning (similar wording is permitted) |
|---|---|
| 5.3.6 | WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT |
| 7.8 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 | WARNING – POWER SHALL NOT BE RESTORED AFTER THE ENCLOSURE HAS BEEN OPENED UNTIL COMBUSTIBLE DUST ACCUMULATIONS WITHIN THE ENCLOSURE HAVE BEEN REMOVED |
| 7.11 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 |
| G.7.1 | WARNING – BATTERIES ARE LOCATED INSIDE THIS ENCLOSURE. DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT |
| G.7.2 | WARNING – THIS PRESSURIZED ENCLOSURE CONTAINS A BATTERY WHICH REMAINS CONNECTED AFTER THE EXTERNAL POWER HAS BEEN ISOLATED. CONSIDERATION SHOULD BE GIVEN TO THE REMOVAL OF THE BATTERY IF THE ENCLOSURE IS TO REMAIN UNPROTECTED BY EX P FOR A SIGNIFICANT TIME |
| G.7.3 | WARNING – BATTERIES IN THIS PRESSURIZED ENCLOSURE REQUIRE ROUTINE MAINTENANCE. SEE INSTRUCTIONS |
| H.3.1 | WARNING – BATTERIES ARE LOCATED INSIDE THIS ENCLOSURE. DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT |
| H.3.2 | WARNING – THIS PRESSURIZED ENCLOSURE CONTAINS A BATTERY WHICH REMAINS CONNECTED AFTER THE EXTERNAL POWER HAS BEEN ISOLATED. CONSIDERATION SHOULD BE GIVEN TO THE REMOVAL OF THE BATTERY IF THE ENCLOSURE IS TO REMAIN UNPROTECTED BY EX P FOR A SIGNIFICANT TIME |
| H.3.3 | WARNING – BATTERIES IN THIS PRESSURIZED ENCLOSURE REQUIRE ROUTINE MAINTENANCE. SEE INSTRUCTIONS |



### 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

In addition to the instructions required by IEC 60079-0,

- the protective gas and any alternative permitted shall be specified;
- instructions for Group III equipment shall identify the need to remove the combustible dust in an appropriate manner before restoring power.

NOTE It is the responsibility of the user to determine what is an appropriate manner for removing the combustible dust.

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 equipment, 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.

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 LFL;
– where one specific flammable gas is covered, a value equivalent to 25 % of its LFL;
– 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 LFL 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

Table B.1 gives 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**

| S0 | 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 |



Figure B.1 demonstrates a state diagram of a leakage-compensation purge control system.

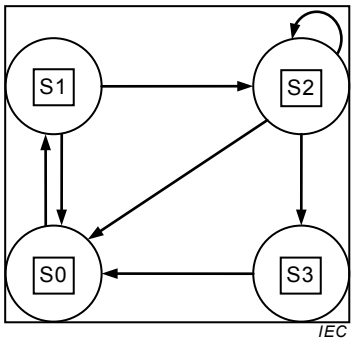



**Figure B.1 – State diagram of a leakage-compensation purge control system**

LEAKAGE-COMPENSATION LOGICAL DEFINITIONS

Exceeds maximum overpressure = [XOP]

Overpressure > 50 Pa (25 Pa for Level of Protection “pzc”) = [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

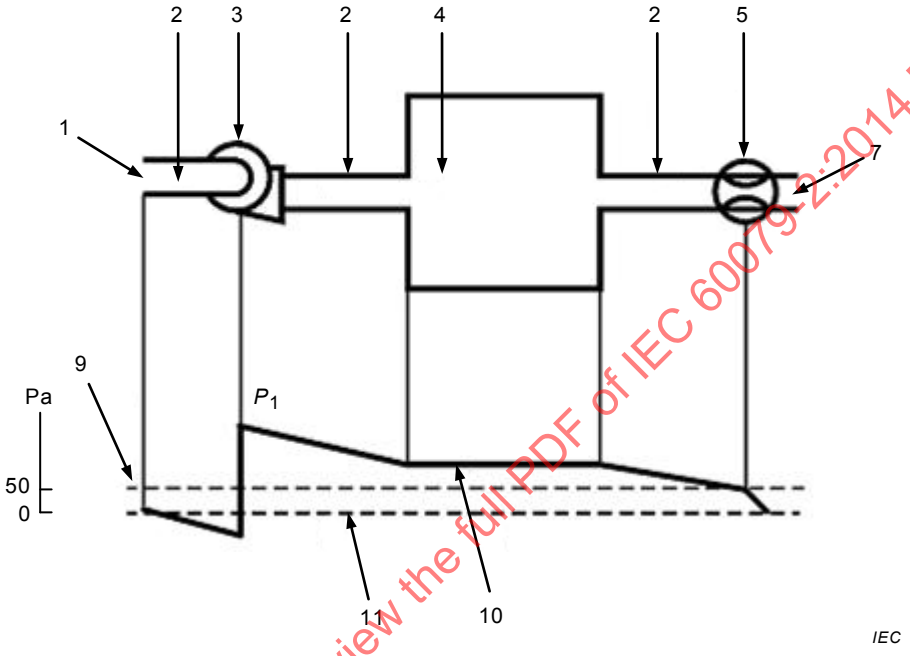
Each state of the system is defined in response to the inputs of the monitoring devices. The states are unique. Transitions between states are only allowed along paths defined by the arrows and in the direction of the arrows. The logical conditions for the occupation of each state are uniquely defined 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

Figures C.1 to C.4 show 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.

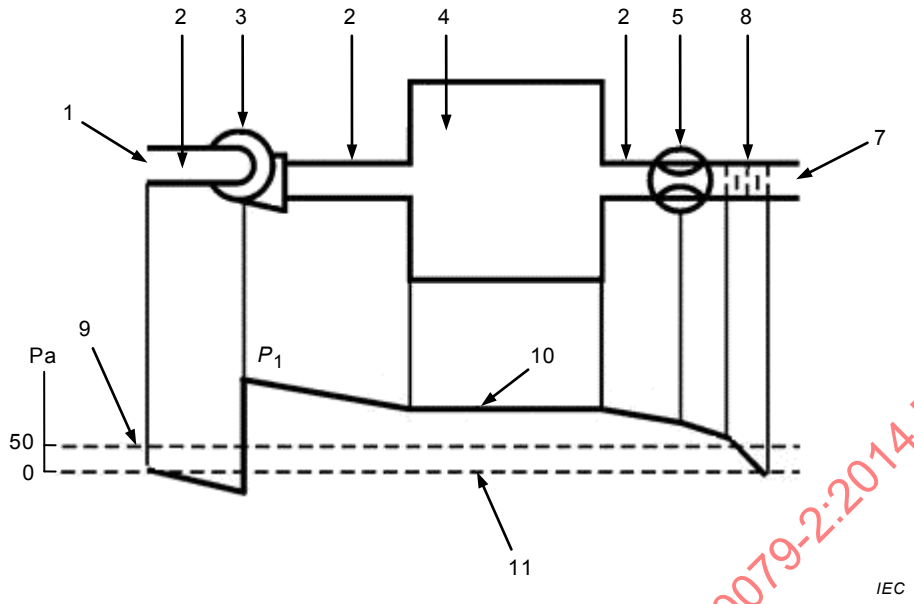



**Key**

$P_1$ 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**



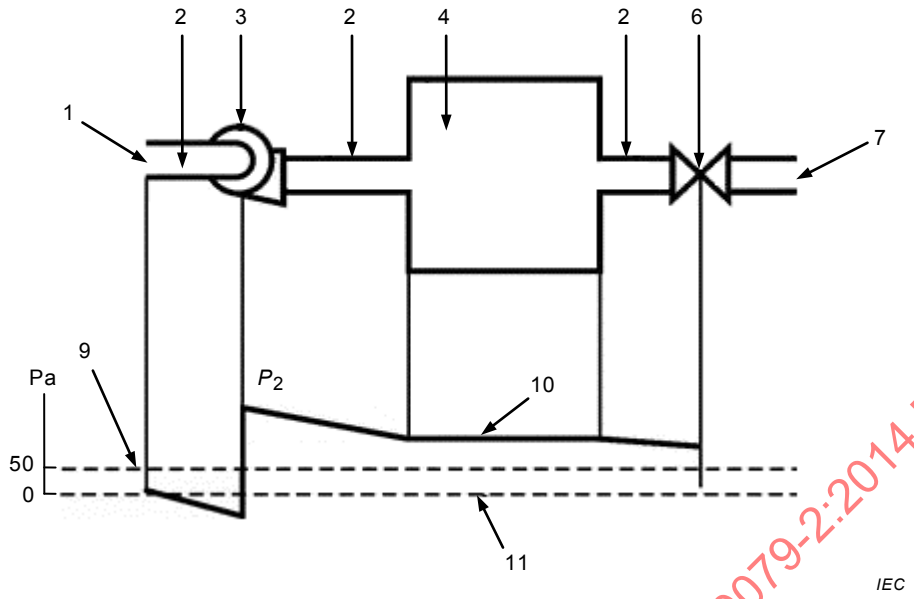

**Key**

$P_1$ 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**

**Figure C.1 – Protective gas outlet**

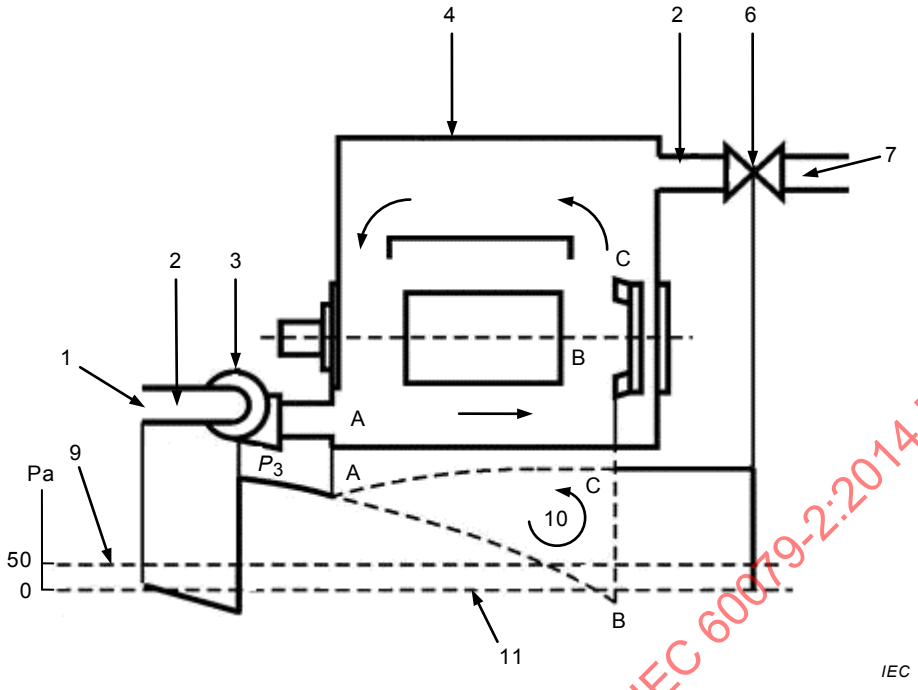



**Key**

$P_2$ 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**




**Key**

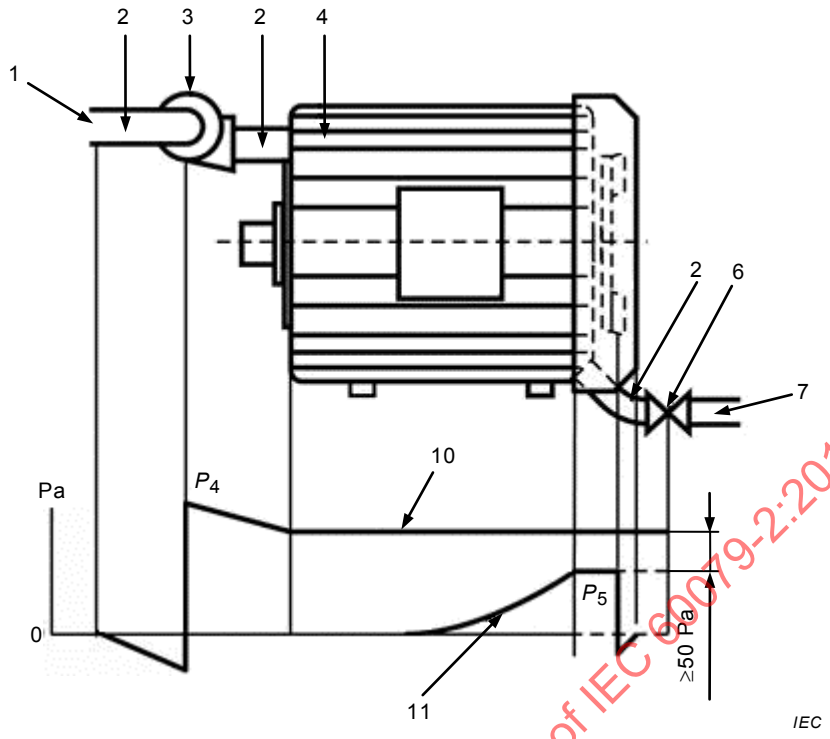
$P_3$ Pressure of the protective gas (determined by the flow resistance of the internal parts, and influenced between A, B and C by the internal cooling fan)

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

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

Pressure at every point where leakage can occur is above the minimum of 50 Pa for Level of Protection “pxb”.

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.




**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 or combustible dusts 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.2.5 Temperature of protective gas at the inlet

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

### 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, (e.g. disconnector) 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.

Consideration should be given 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.

### 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 16.7 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

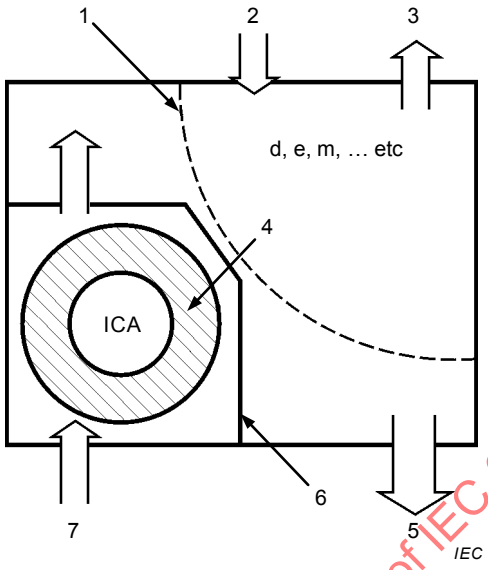
Systems which cannot meet the requirements for "no normal release" shall be considered to have a limited normal release. This includes containment systems with joints subject to routine maintenance. Such joints shall be clearly identified.

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

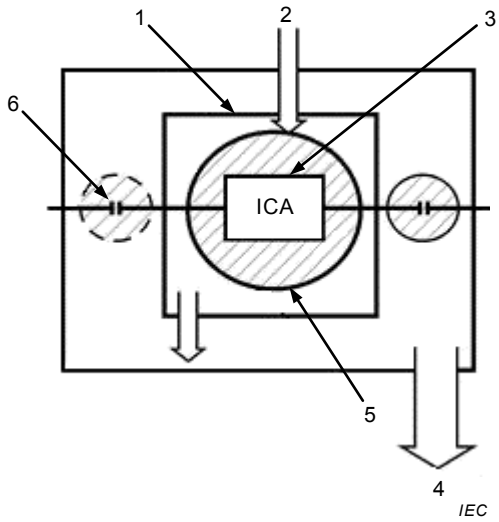



**Key**

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 ICE
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 equipment (shown as ICA in Figures F.1 to F.3) within an inner enclosure or through the use of partitions, it can be demonstrated by a simple test that the ICE 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 ICE.

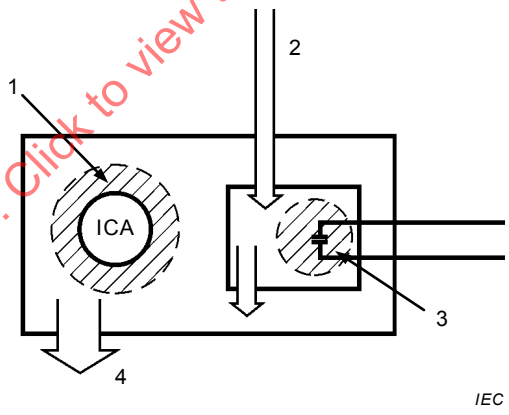



**Key**

1 Internal partition
2 Purge inlet
3 Infallible parts of containment system
4 Purge outlet
5 Location of ICE
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 ICE**

Since those parts of the containment system lying within the internal partition meet the requirements for infallible containment, the ICE (shown as ICA in Figures F.1 to F.3) cannot be within a dilution area.




**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 ICE located outside the partitions**

Since the dilution area is contained within the internal partition, the ICE (shown as ICA in Figures F.1 to F.3) is not within a dilution area.

# Annex G
(normative)

# Internal Cells and Batteries for Level of Protection "pxb" and Level of Protection "pyb"

## G.1 General Requirements

### G.1.1 General

When the protected equipment incorporates batteries, suitable precautions shall be taken in the design of the equipment to prevent the production of explosive gas, sparks or hot spots.

### G.1.2 Accepted Electrochemical Systems

Only those cells listed in IEC 60079-0 for which an IEC cell standard exists shall be used in pressurized enclosures.

### G.1.3 Secondary cells and secondary batteries

Secondary cells and secondary batteries are permitted if:

- the individual cells are sealed cells (either sealed gas-tight cell or sealed valve-regulated cell); or
- the battery volume does not exceed 1 % of the pressurized enclosure internal free volume.

Where the pressurized enclosure contains more than one independent battery, each with its own charging system, only the most onerous case of gas release from one independent battery shall be considered.

### G.1.4 Mechanical Protection

Live exposed parts of cells, batteries and their associated protective components, which are located in the pressurized enclosure, shall be provided with protection to at least IP30, even while the pressurized enclosure access door(s) or cover(s) are open. Where cells are encapsulated, care shall be taken to ensure that any pressure relief facilities are not obstructed. The vent size shall be sufficiently large to prevent dangerous pressurisation of the encapsulated assembly at the most onerous predictable release rate from the battery. A minimum of one vent for each cell is required.

The encapsulation of cells and batteries shall allow for possible expansion of the cells during charging.

For the purposes of this standard the terms "encapsulate" and "encapsulation" do not imply conformity to IEC 60079-18.

The physical characteristic of vents will depend upon the type and capacity of the battery arrangements. The effects of ageing on battery capacity and therefore on the rate of gas evolution from the battery should also be considered.

Cells, batteries and their associated protective components shall be securely mounted.

## G.2 Electrical Protection by energy limiting circuits.

### G.2.1 Assessing as energy limited

The intent of this section is to allow circuits that can be assessed using the principles of IEC 60079-11 as a guideline.

### G.2.2 Protective Components

Except for inherently safe batteries (see G.5), protective components such as a resistor and/or a fuse shall be provided to establish an energy limited circuit to guard against withdrawal of current from a battery greater than the current for which safety has been assessed.

Protective Components shall conform to the following requirements. The manufacturer's technical literature is sufficient to verify conformity with these requirements without further testing.

- Diodes used to prevent charging or reverse charging of primary cells shall not be exposed to a reverse applied voltage exceeding two thirds of their rated Peak Inverse Voltage (PIV), (or Repetitive Peak Reverse Voltage ($Vrrm$) if specified).
- These diodes shall be capable of withstanding a reverse voltage of 400 Vdc with a reverse leakage current of < 10 uA at the most extreme conditions of temperature (taking account of a single fault within the associate circuit).
- The maximum forward current (taking account of a single fault within the associated circuit) of diodes whose purpose is to prevent the charging of a primary cell shall be limited e.g. by a fuse or resistor, to a value not exceeding 50 % of the manufacturer's rated peak forward current.
- Fuses shall conform to IEC 60127 (any part) as follows:

  The voltage to be used when assessing a fuse depends upon the maximum voltage to which it can be subjected plus tolerances. In the case of a battery supplied voltage, the voltage to be considered shall be the nominal voltage defined in the appropriate IEC standard for the electrochemical system used.

  Where a fuse is used to protect a battery, 1,7 In (nominal current rating of fuse) shall be assumed to flow continuously. The fuse time-current characteristics shall ensure that the transient ratings of protected components are not exceeded.
- Current limiting resistors shall be one of the following types and may be used at up to two thirds of the manufacturer's rating:
  - film type;
  - wire wound type with protection to prevent unwinding of the wire in case of breakage or;
  - printed resistors as used in hybrid and similar circuits covered by a coating conforming to IEC 60079-11 or encapsulated in accordance with IEC 60079-11.

  A Current Limiting Resistor shall be considered as failing only to an open circuit.
- Other components shall conform to the appropriate requirements of IEC 60079-11.

### G.2.3 Preventing excessive gas pressure

Means to prevent the build-up of excessive gas pressure shall be provided:

a) under reverse charge, e.g. shunt diodes fitted across each cell of a battery;

b) under excessive discharge rates, e.g. a fuse fitted in series with the battery;

c) for secondary batteries, under excessive charge rates, e.g. a charger designed to limit the charging conditions to those recommended by the manufacturer.

## G.3 Additional requirements for Primary batteries

### G.3.1 Prevention of reverse charging.

No additional protection need be fitted to prevent the release of electrolytic gas by polarity reversal, or reverse charging of a cell by other cells in the same battery is required if:

- a capacity of 1,5 Ah or less (at a 1 h discharge rate); and
- a volume less than 1 % of the free volume of the enclosure;

or if the battery manufacturer confirms that the cells are electro-chemically balanced, and at the end of discharge the internal resistance of an individual cell will exceed 25 kΩ.

These relaxations should not be interpreted as allowing the release of electrolytic gas from such cells.

If a primary battery contains 3 or more cells in series, one or more components, shall be fitted to prevent gas generation within an expired cell by reverse charging (see figure G.1).

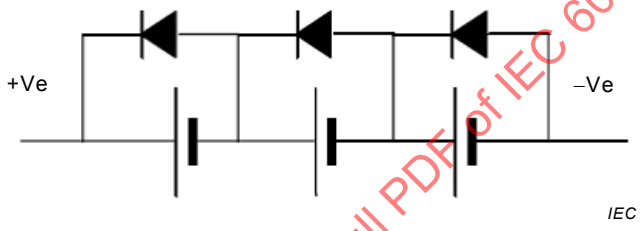



**Figure G.1 – Reverse charging protection**

For this protective arrangement to be effective, the forward voltage drop across each diode used to prevent reverse charging of a cell shall not exceed the safe reverse charge voltage of that cell. Silicon diodes are considered suitable to meet this requirement.

### G.3.2 Prevention of accidental charging of primary batteries

Where there is more than one battery or another voltage source in the equipment, and there is the possibility of interconnection, protective components such as blocking diodes shall be provided to prevent charging currents passing into primary batteries.

At least two serially connected devices shall be provided such as to limit the charging of primary batteries, even under single fault conditions, to a level not exceeding 10 μA or to 2/3rds of that specified by the battery manufacturer, whichever is the lower (e.g.2 diodes or a diode and a resistor (see Figure G.2).

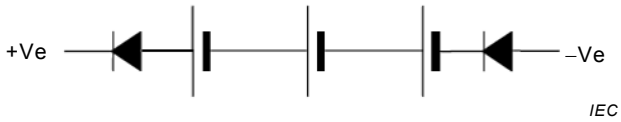



**Figure G.2 – Accidental charging protection**

The battery should be connected between the protective components to reduce the risk of a single fault causing both protective components to be short circuited.

## G.4 Additional requirements for secondary batteries

### G.4.1 Charging of secondary batteries inside the pressurized housing

Where batteries are to be charged whilst inside the pressurized enclosure, the charging conditions shall be fully specified and protective components shall be fitted to ensure that these conditions are not exceeded.

Where batteries are used having a capacity of 1,5 Ah or less, and a volume less than 1 % of the free volume of the enclosure, no additional protective component(s) needs to be fitted to the battery to prevent the release of electrolytic gas by recharging currents.

These relaxations should not be interpreted as allowing the release of electrolytic gas from such cells.

NOTE The above effectively limits the use of cells (or batteries) not fitted with a protective component, to those types commonly known as “button type cells” used, for example to retain memory on programmable electronic circuits.

Where batteries are to be removed from the pressurized enclosure for charging, the manufacturer’s requirements for correct charging apply.

Where the consequences of deep discharging may, during subsequent charging, result in either the increased release of electrolytic gas and/or internal mechanical damage, a device or devices shall be provided to prevent deep discharging.

Suitable precautions shall be taken to prevent incorrect assembly (e.g. plugs and sockets which are polarized or that are clearly marked to indicate correct assembly).

Where plugs and sockets are used, provision shall be made to open the circuit safely before plugs are disconnected.

The position of the battery within the pressurized enclosure shall be chosen with due regard to the location of ignition-capable equipment and to allow for the free diffusion of the released gases throughout the enclosure. Ignition-capable equipment shall not be located in an area subject to the gas released from the battery.

## G.5 Specific requirements for Inherently Safe (IhS) cells and batteries

An IhS battery is a primary battery in which the following conditions are met:

- the internal resistance of the battery limits the short-circuit current from the battery to a value not exceeding that tabulated in Permitted short-circuit current corresponding to the voltage and the equipment group tabulated in IEC 60079-11 based upon the maximum open circuit voltage of the battery and
- the maximum temperature of the external surface of the battery does not exceed the maximum surface temperature for the stated Temperature Class for the equipment, referred to the local ambient temperature when the battery is short-circuited by a conductor of negligible resistance compared with the internal resistance of the battery. The resistance of the short-circuit is considered to be negligible when it is not greater than one-tenth of the internal resistance of the battery.

It is not necessary to consider faults within an IhS cell, except when more than two cells are connected to form a battery in which case reverse charging shall be prevented.

IhS batteries may be formed by the interconnection of IhS cells if the internal resistance of the battery limits the maximum value of the short-circuit current to a value not exceeding the value tabulated in Permitted short-circuit current corresponding to the voltage and the

equipment group tabulated in IEC 60079-11 based upon the maximum open circuit voltage of the battery.

The nature of the circuit to which the IhS battery may be connected is specified in G.6.

To facilitate the correct replacement of Inherently Safe batteries the essential parameters shall be marked adjacent to the battery and in the instructions, (e.g. Type, nominal voltage and minimum internal resistance etc.)

## G.6 Equipment located inside a pressurized enclosure connected to a battery which is also located inside the pressurized enclosure and not disconnected in the event of loss of pressurization

### G.6.1 General

For the purpose of evaluation and test of the circuit connected to the battery the voltage to be considered is the Maximum Open Circuit Voltage.

The Temperature Class of the equipment shall take into account the surface area of individual components comprising the equipment connected to the battery. The method of assessment shall be either by test, or by the use of small component temperature evaluation in IEC 60079-0.

### G.6.2 Circuit Isolation

For the purpose of this clause, equipment is considered to be connected to the battery unless the battery is connected to the equipment only after purging has been completed and provision is made for the disconnection of the battery on pressure or flow failure and the disconnection or isolation meets the following requirements:

- it is disconnected by suitably rated contacts; or
- it is isolated by a suitably rated opto-isolating device; or
- it is isolated by a suitably rated double wound transformer capable of withstanding an insulation test between windings of 5 times the battery maximum open circuit voltage with a minimum of 500 Vac RMS for at least 60 seconds;
- and the creepage distance and clearance between the battery and the isolated or disconnected components and associated circuits is as specified in the creepage and clearance table in IEC 60079-11 using the ia or ib columns.

### G.6.3 Intrinsically safe battery or inherently safe battery used with “Ex” equipment

If the battery is protected by Intrinsic Safety to IEC 60079-11 or is inherently safe and the connected equipment is protected by one of the types of protection listed in IEC 60079-0 or is assessed as simple apparatus as defined in IEC 60079-11, there are no additional requirements.

### G.6.4 Intrinsically Safe or Inherently Safe battery with non-"Ex" equipment.

When an intrinsically safe or an inherently safe battery located inside the pressurized enclosure is intended to be connected to non-"Ex" equipment before purging has been completed, and/or intended to remain connected to the equipment during the absence of pressure (and flow if specified), the following additional requirements apply to the connected equipment:

Either:

a) The following conditions shall be satisfied:

– maximum open circuit voltage of the battery and associated circuits does not exceed 6 V;

– the short circuit current from the battery shall not exceed 2 A. This may be achieved by the internal resistance of the battery alone or be limited to this value by the addition of an external current limiting resistor mounted as close as possible to the battery and conforming to the requirements of G.2.1;

– the total aggregate circuit capacitance, including tolerances, does not exceed 1000 μF;

– the total aggregate circuit inductance, including tolerances, does not exceed the value for $L$ given by the following formula:

$$L = \frac{2e}{I^2}$$

where:

$L$ is the permitted inductance in μH

$I$ is the available short circuit current in A

$e$ is the ignition energy for a given Equipment Group in μJ

| Equipment Group | Ignition energy |
|---|---|
| IIC | 40 μJ |
| IIB | 160 μJ |
| IIA | 320 μJ |
| I | 525 μJ |

or

b) the pressurised enclosure shall be marked in accordance with G.7 and the following conditions shall be satisfied:

– the maximum open circuit voltage of the battery and associated circuits does not exceed 6 V;

– the short circuit current shall be limited to 2 A;

– the effective capacitance remaining connected to the battery, as determined by examination of the circuit does not exceed 1 000 μF;

Protective components, e.g. resistors, associated with the capacitance and conforming to the requirements for similar components in G.2.1 may be taken into account in determining the effective capacitance by the use IEC 60079-11 with a factor of safety of 1,0;

– the effective inductance remaining connected to the battery, as determined by examination of the circuit does not exceed the values given for L shown above.

Protective components, e.g. resistors, associated with the inductance and conforming to the requirements for similar components in G.2.1 may be taken into account in determining the effective inductance by the use of IEC 60079-11 with a factor of safety of 1,0.

or

c) where the sources voltage is greater than 6 V or the short circuit current is greater than 2 A, the connected equipment shall be assessed according IEC 60079-11 category 'ib';

or

d) a cell embedded within a solid state electronic component (e.g. a Lithium cell within an integrated circuit) is permitted if the following criteria are met:

– the cell shall be Inherently Safe; and

– no external voltage shall be detectable; and

– the internal capacitance and inductance of the solid state electronic component as declared by the manufacturer shall not exceed the values given in a)) above.

Since the cell voltage is not externally detectable the short circuit test in conformity with the requirements of G.5 may be carried out by assessment.

## G.7 Supplementary marking and constructional requirements for pressurized enclosures containing one or more cells or batteries

### G.7.1 General

Doors and covers of pressurized enclosure may only be openable by the use of a tool or key.

Enclosures shall be marked as follows, or equivalent:

"WARNING – BATTERIES ARE LOCATED INSIDE THIS ENCLOSURE. DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT".

### G.7.2 Battery removal warning

Where required by G.6.4 b) the enclosure shall be marked with the following or equivalent:

WARNING – This pressurized enclosure contains a battery which remains connected after the external power has been isolated. Consideration should be given to the safe removal of the battery if the enclosure is to remain unprotected by Ex p for a significant time.

### G.7.3 Batteries requiring routine maintenance

The enclosure shall be marked:

"WARNING – Batteries in this Pressurized Enclosure require routine maintenance. See instructions".

## G.8 Type tests

### G.8.1 Voltage

For temperature testing purposes the voltage to be used is the battery nominal voltage.

### G.8.2 Short circuit test for an Inherently Safe Cell or Battery

A new cell or battery shall have a short circuit applied and the following shall be monitored:

- current flowing in the circuit, and
- the temperature of the outer surface of the cell or battery to which any external explosive atmosphere will have access when the pressurized enclosure door is open.

The maximum current shall not exceed the value given in G.5.

The maximum temperature shall not exceed the temperature class of the equipment.

The cell or battery shall not distort, explode, or emit smoke.

### G.8.3 Full load test for other than Inherently safe batteries

A new primary battery, or a fully charged secondary battery, shall be connected to the load it will supply in normal service. The case temperature shall not exceed the temperature class of the equipment or the maximum temperature permitted by the manufacturer of the battery, whichever is lower.

# Annex H
(normative)

# Internal Cells and Batteries for Level of Protection “pzc”

## H.1 General Requirements

### H.1.1 General

When the protected equipment incorporates batteries, suitable precautions shall be taken in the design of the equipment to prevent the production of explosive gas, sparks or hot spots.

### H.1.2 Accepted Electrochemical Systems

Only those cells listed in IEC 60079-0 for which an IEC cell standard exists shall be used in pressurized enclosures.

### H.1.3 Secondary cells and secondary batteries

Secondary cells and secondary batteries are permitted if:

– The individual cells are sealed cells (either sealed gas-tight cell or sealed valve-regulated cell); or

– The battery volume does not exceed 1 % of the pressurized enclosure internal free volume.

Where the pressurized enclosure contains more than one independent battery, each with its own charging system, only the most onerous case of gas release from one independent battery shall be considered.

### H.1.4 Mechanical Protection

Where cells are encapsulated, care shall be taken to ensure that any pressure relief facilities are not obstructed. The vent size shall be sufficiently large to prevent dangerous pressurisation of the encapsulated assembly at the most onerous predictable release rate from the battery. A minimum of one vent for each cell is required.

The encapsulation of cells and batteries shall allow for possible expansion of the cells during charging.

For the purposes of this standard the terms "encapsulate" and "encapsulation" do not imply conformity to IEC 60079-18.

The physical characteristic of vents will depend upon the type and capacity of the battery arrangements. The effects of ageing on battery capacity and therefore on the rate of gas evolution from the battery should also be considered.

Cells, batteries and their associated protective components shall be securely mounted.

## H.2 Equipment located inside a pressurized enclosure connected to a battery which is also located inside the pressurized enclosure and is not disconnected when power is removed from the enclosure.

Equipment that is not disconnected shall not have any make/break components unless the circuit can be assessed as non-ignition-capable using IEC 60079-15 or IEC 60079-11 for Level of Protection “ic”.

## H.3 Supplementary marking and constructional requirements for pressurized enclosures containing one or more cells or batteries

### H.3.1 General

Doors and covers of pressurized enclosure providing access to the cells or batteries may only be opened by the use of a tool or key.

Enclosures shall be marked as follows, or equivalent:

> "Warning – Batteries are located inside this enclosure. Do not open when an explosive atmosphere IS present".

### H.3.2 Battery removal warning

Where the cell or battery is not disconnected when pressurization is not present, the enclosure shall be marked with the following or equivalent:

> Warning – This pressurized enclosure contains a battery which remains connected after the external power has been isolated. Consideration should be given to the removal of the battery if the enclosure is to remain unprotected by Ex p for a significant time.

### H.3.3 Batteries requiring routine maintenance

The enclosure shall be marked:

> "WARNING – Batteries in this Pressurized Enclosure require routine maintenance. See instructions."

# Bibliography

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

IEC 60050-426, *International Electrotechnical Vocabulary – Chapter 426: Equipment for explosive atmospheres*

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

IEC 60079-1, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-5, *Explosive atmospheres – Part 5: Equipment protection by powder filling "q"*

IEC 60079-6, *Explosive atmospheres – Part 6: Equipment protection by oil-immersion "o"*

IEC 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

IEC 60079-13, *Explosive atmospheres – Part 13: Equipment protection by pressurized room "p"*

IEC 60079-18, *Explosive atmospheres – Part 18: Equipment protection by encapsulation "m"*

IEC 60079-20-1, *Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data*

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

IEC 61511 (all parts) *Functional safety – Safety instrumented systems for the process industry sector*

# SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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# ATMOSPHÈRES EXPLOSIVES –

## Partie 2: Protection du matériel par enveloppe à surpression interne "p"

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La Norme Internationale IEC 60079-2 a été établie par le comité d'études 31 de la CEI: Équipements pour atmosphères explosives.

Cette sixième édition annule et remplace la cinquième édition parue en 2007. Cette sixième édition annule et remplace la première édition de l'IEC 61241-4 parue en 2001. Cette sixième édition constitue une révision technique.

L'importance des modifications entre l'IEC 60079-2, Édition 6.0, 2014 et l'IEC 60079-2, Édition 5.0, 2007, est indiquée ci-dessous:

| | | Type | | |
|---|---|---|---|---|
| **Modifications** | **Article** | **Modifications mineures et rédactionnelles** | **Extension** | **Modifications techniques majeures** |
| Domaine d'application<br>Etendu pour inclure les poussières combustibles | 1 | | X | |
| Gaz de protection<br>Le terme "apparatus" ("appareil") a été remplacé par "equipment" («matériel») | 3 | | | |
| Gaz de protection<br>Révisé pour indiquer que le balayage n'est pas requis pour les atmosphères explosives de poussière | 3.16 | X | | |
| Niveau de Protection "pxb"<br>Terme et définition révisés pour refléter l'EPL (equipment protection level – niveau de protection du matériel) et le niveau de protection | 3.21 | X | | |
| Niveau de Protection "pyb"<br>Terme et définition révisés pour refléter l'EPL et le niveau de protection | 3.22 | X | | |
| Niveau de Protection "pzc"<br>Terme et définition révisés pour refléter l'EPL et le niveau de protection | 3.23 | X | | |
| Limite inférieure d'inflammabilité<br>Terme et définition révisés pour la conformité à l'IEC 60079-0 | 3.26 | X | | |
| Limite supérieure d'inflammabilité<br>Terme et définition révisés pour la conformité à l'IEC 60079-0 | 3.27 | X | | |
| Tableau 1 – Détermination du niveau de protection<br>Révisé pour utiliser la terminologie EPL | Tableau 1 | X | | |
| Tableau 2 – Critères de Conception sur la base du niveau de protection<br>Révisé pour utiliser la terminologie EPL | Tableau 2 | X | | |
| Enveloppe<br>Assouplissement des exigences pour les conceptions spécifiques | 5.1 | | X | |
| Enveloppes à surpression interne du groupe II et du groupe III<br>Texte révisé pour utiliser la terminologie EPL | 5.3.3 | X | | |
| Niveau de Protection "pxb" du groupe II et du groupe III<br>Indication du fait que cet avertissement s'applique aussi aux atmosphères explosives de poussière | 5.3.5 | | X | |
| Mise en garde au sujet des portes et des couvercles du groupe II et du groupe III<br>Indication du fait que cet avertissement s'applique aussi aux atmosphères explosives de poussière | 5.3.6 | | X | |

| | | Type | | |
|---|---|---|---|---|
| **Modifications** | **Article** | **Modifications mineures et rédactionnelles** | **Extension** | **Modifications techniques majeures** |
| Mise en garde au sujet des portes et des couvercles du groupe II et du groupe III<br>Avertissement révisé: l'atmosphère "est présente" au lieu de "peut être présente" | 5.3.6 | X | | |
| Résistance mécanique<br>Suppression de la référence au numéro d'article de l'IEC 60079-0 pour la condition "X" | 5.4 | X | | |
| Barrières contre les étincelles et les particules<br>Suppression de la référence au numéro d'article de l'IEC 60079-0 pour la condition "X" | 5.9 | X | | |
| Éléments de batterie et piles<br>Ajout d'exigences relatives aux éléments de batterie et piles | 5.10 | | | C1 |
| Pour le niveau de Protection "pxb" ou le niveau de Protection "pyb"<br>Tableau révisé pour utiliser une terminologie cohérente par rapport aux EPL | 6.2 | X | | |
| Adéquation des dispositifs de sécurité pour zone dangereuse<br>Remplacement du mot "explosion" par "inflammation" pour refléter les termes LSI/LII | 7.1 | X | | |
| Intégrité des dispositifs de sécurité<br>Ajout d'exigences pour détecter une défaillance du ventilateur | 7.2 | | | C2 |
| Tableau 3 – Dispositifs de sécurité en fonction du niveau de protection<br>Intitulés des colonnes révisés pour utiliser la terminologie du Niveau de Protection | Tableau 3 | X | | |
| Fournisseur de dispositifs de sécurité<br>Suppression de la référence au numéro d'article de l'IEC 60079-0 pour la condition "X" | 7.3 | X | | |
| Système de pressurisation évalué en tant que matériel associé<br>Ajout d'exigences pour systèmes de pressurisation | 7.4 | | | C3 |
| Diagramme séquentiel pour le niveau de protection "pxb"<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.5 | X | | |
| Balayage automatisé du groupe I et du groupe II pour le niveau de protection "pxb"<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.7 | X | | |
| Balayage automatisé du groupe I et du groupe II pour le niveau de protection "pxb"<br>Ajout de texte indiquant que pour "pxb", la commande doit être automatique | 7.7 | | | C4 |

| | | Type | | |
|---|---|---|---|---|
| **Modifications** | **Article** | **Modifications mineures et rédactionnelles** | **Extension** | **Modifications techniques majeures** |
| Groupe I ou groupe II – Critères de balayage<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.8 | X | | |
| Groupe III – Nettoyage<br>Ajout de texte relatif au nettoyage des enveloppes utilisées dans les atmosphères explosives de poussière | 7.9 | | X | |
| Dispositifs de sécurité pour détecter la surpression minimale<br>Ajout du mot “minimale” au titre de l’article par souci de cohérence avec le texte | 7.11 | X | | |
| Dispositifs de sécurité pour détecter la surpression minimale<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.11 d) | X | | |
| Valeur de surpression minimale<br>Ajout du mot “minimale” au titre de l’article par souci de cohérence avec le texte | 7.12 | X | | |
| Valeur de surpression minimale<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.12 | X | | |
| Valeur de surpression minimale<br>Ajout de texte pour refléter une note de l’Annexe C | 7.12 | | X | |
| Mise en surpression d'enveloppes multiples<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.13 | X | | |
| Dispositifs de sécurité pour portes et couvercles<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 7.14 | X | | |
| Matériel qui peut rester sous tension<br>Texte révisé pour utiliser la terminologie EPL et du Niveau de Protection | 7.15 | X | | |
| Matériel autorisé dans le niveau de protection "pyb"<br>Texte révisé pour utiliser la terminologie EPL et du Niveau de Protection | 7.16 | X | | |
| Procédure de remplissage du groupe I et du groupe II<br>Autorisation du remplissage dans un emplacement dangereux si, à l’issue de l’essai, il est considéré comme non dangereux | 8.4 | | X | |
| Procédure de remplissage du groupe III<br>Ajout d’une procédure de remplissage pour enveloppes à surpression interne statique pour les atmosphères explosives de poussière | 8.5 | | X | |
| Dispositifs de sécurité<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 8.6 | X | | |

| | | Type | | |
|---|---|---|---|---|
| **Modifications** | **Article** | **Modifications mineures et rédactionnelles** | **Extension** | **Modifications techniques majeures** |
| Matériel qui peut rester sous tension<br>Texte révisé pour utiliser la terminologie EPL | 8.7 | X | | |
| Surpression<br>Suppression de la référence au numéro d'article de l'IEC 60079-0 | 8.8 | X | | |
| Alimentation de secours<br>Ajout d'exigences relatives à l'alimentation de secours en gaz de protection | 9.1 | | | C5 |
| Alimentations indépendantes<br>Spécification d'exigences relatives à l'indépendance de la surpression | 9.2 | | X | C6 |
| Conditions de dégagement<br>Suppression de la référence au numéro d'article de l'IEC 60079-0 pour la condition "X" | 11.1.2 | X | | |
| Système de confinement à dégagement limité<br>Suppression de la référence au numéro d'article de l'IEC 60079-0 pour la condition "X" | 12.3 | X | | |
| 13.3.3 Dégagement limité de gaz ou vapeur<br>Texte révisé pour refléter les termes LSI/LII | 13.3.3 | X | | |
| Matériel susceptible de provoquer une inflammation<br>Texte révisé pour utiliser la terminologie du Niveau de Protection | 14 | X | | |
| Vérification et essais de type<br>Articles 16.1 à 16.7 de l'Édition 5 déplacés vers Articles 16.2 à 16.8 dans l'Édition 6 | 16 | X | | |
| Détermination de la surpression maximale nominale<br>Ajout d'exigences pour déterminer la surpression maximale | 16.1 | | | C7 |
| Essai de surpression maximale<br>Déplacement de l'essai de surpression maximale vers 16.2 | 16.2 | | | C7 |
| Essai de fuite<br>Clarification des critères d'acceptation pour l'essai | 16.3.2 | | X | |
| Essais pour un système de confinement infaillible<br>Clarification des caractéristiques assignées utilisées pour l'essai | 16.7.1 | | | C8 |
| Essais pour un système de confinement infaillible<br>Modification de l'essai pour le confinement infaillible | 16.7.2 | | | C9 |

| | | Type | | |
|---|---|---|---|---|
| **Modifications** | **Article** | **Modifications mineures et rédactionnelles** | **Extension** | **Modifications techniques majeures** |
| Édition 5 – Vérification de la capacité de l'enveloppe à surpression interne à limiter la pression interne<br>Suppression de l'essai | 16.8 | | | C7 |
| Essais fonctionnels<br>Clarification du fait qu'ils ne s'appliquent qu'aux dispositifs de sécurité fournis avec enveloppes | 17.1 | X | | |
| Essais pour un système de confinement infaillible<br>Suppression des essais de fuite d'hélium pour les systèmes liquides | 17.3 | | X | |
| Marquage supplémentaire<br>Autorisation de l'utilisation continue du marquage du mode de protection | 18.3 | | | |
| Systèmes de pressurisation<br>Clarification de l'utilisation du marquage Ex [p] et [Ex p] | 18.6 | X | | |
| Avertissements exigés par d'autres articles<br>Ajout du numéro de tableau | 18.7 | X | | |
| Avertissements exigés par d'autres articles<br>Ajout de l'avertissement de 7.9 | 18.7 | | X | |
| Avertissements exigés par d'autres articles<br>Ajout des avertissements de l'Annexe G et de l'Annexe H | 18.7 | | | C1 |
| Instructions<br>Ajout d'exigences relatives au Groupe III | 19 | | X | |
| Édition 5 Annexe G — Essai d'infaillibilité d'un système de confinement<br>Supprimé et remplacé | Annexe G | X | | |
| Édition 5 Annexe H — Introduction à une méthode alternative d'évaluation des risques incluant les «niveaux de protection du matériel»<br>Supprimée et remplacée | Annexe H | X | | |
| Annexe G — Éléments de batterie et piles internes pour le niveau de protection "pxb" et le niveau de protection "pyb"<br>Ajout d'exigences relatives aux éléments de batterie et piles | | | X | |
| Annexe H — Éléments de batterie et piles internes pour le niveau de protection "pzc"<br>Ajout d'exigences relatives aux éléments de batterie et piles | | | X | |



**Explications:**

**A) Définitions**

**Modifications mineures et rédactionnelles** clarification, réduction des exigences techniques, modifications techniques mineures, corrections d'ordre rédactionnel

Ces modifications portent sur les exigences et sont de nature rédactionnelle ou technique mineure. Elles comprennent des modifications de formulation destinées à clarifier les exigences techniques sans apporter de modification technique ni réduire le niveau actuel de l'exigence.

**Extension** ajout d'options techniques

Ces modifications ajoutent de nouvelles exigences techniques ou modifient les exigences techniques existantes, de façon à fournir de nouvelles options, mais sans augmenter les niveaux d'exigences pour tout matériel qui était totalement conforme à la précédente norme. Ces modifications ne sont donc pas à prendre en compte dans le cas de produits conformes à la précédente édition. 5.

**Modifications techniques majeures** ajout d'exigences techniques, augmentation des exigences techniques

Ces modifications sont apportées aux exigences techniques (ajout, augmentation du niveau ou suppression) de telle façon qu'un produit conforme à la précédente édition n'a pas toujours la capacité de satisfaire aux exigences indiquées dans la dernière édition. Ces modifications sont à prendre en compte dans le cas de produits conformes à la précédente édition. L'Article B) ci-dessous fournit des informations supplémentaires sur ces modifications

B) Informations sur l'origine des "Modifications techniques majeures"

C1 – Ajout d'annexes comportant des exigences relatives à l'utilisation des éléments de batterie et piles.

C2 – Ajout d'exigences spécifiant que la défaillance du ventilateur ne peut être causée par la perte de puissance du ventilateur.

C3 – Ajout d'exigences relatives aux matériels évalués comme système de pressurisation, afin de garantir l'uniformité des essais auxquels sont soumis ces matériels.

C4 – Dans l'Édition 5, bien que le titre de 7.6 indiquait «balayage automatisé», le mot «automatisé» n'apparaissait pas dans l'exigence. Tous les matériels "pxb" sont destinés à avoir un système de balayage automatisé pour empêcher la mise sous tension de circuits susceptibles de provoquer une inflammation, avant que le cycle de balayage n'ait correctement été effectué. Cela exige de vérifier que le débit correspond au moins au minimum requis pour le temps de balayage, ainsi que de vérifier l'existence de la surpression minimale dans l'enveloppe.

C5 – Si une alimentation de secours en gaz de protection est fournie, il est alors nécessaire que l'alimentation principale et l'alimentation de secours soient capables de maintenir la surpression requise.

C6 – Si une enveloppe à surpression interne est utilisée dans une plus grande enveloppe à surpression interne, il est nécessaire que les alimentations en gaz de protection soient indépendantes.

C7 – Le texte de 16.1 de l'Édition 5 supposait que les enveloppes ont une valeur assignée de surpression maximale nominale, mais c'est rarement le cas. Certaines installations d'essai se basaient sur l'essai de 16.8 pour déterminer la surpression maximale. Différentes méthodes ont été utilisées pour simuler la défaillance du régulateur, telles que retirer le régulateur, mais cela retire aussi les orifices pouvant limiter le débit. D'après les informations fournies par les installations d'essai, le danger de volées d'éclats depuis l'enveloppe est suffisamment faible car l'enveloppe ou les garnitures se déforment pour relâcher la pression interne. Il a été décidé de supprimer l'essai de surpression basé sur le régulateur défaillant. De plus, la définition de la suppression maximale se base désormais sur la valeur obtenue lorsque l'enveloppe à surpression interne fonctionne dans le cadre de ses caractéristiques assignées. Cette surpression maximale se produit généralement lorsque le matériel est en mode balayage rapide avec la pression assignée maximale appliquée à l'entrée du régulateur. Le texte de 16.1 de l'Édition 5 a été modifié et déplacé en 16.2.

C8 – Le terme surpression implique dans la plupart des cas un fonctionnement hors des caractéristiques assignées normales. Le texte a été clarifié pour utiliser le terme

"pression de service maximale" plutôt que le terme «surpression interne maximale». L'essai était décrit au 16.6.1 de l'Édition 5.

C9 – L'essai a été modifié pour utiliser un détecteur de fuite d'hélium plutôt que d'utiliser un vide maintenu, car cela dépendrait de la capacité du système à vide. L'essai était décrit au 16.6.2 de l'Édition 5.

L'importance des modifications entre l'IEC 60079-2, Édition 6.0, 2014 et l'IEC 61241-4, Édition 5.0, 2007, est indiquée ci-dessous:

| | | Type | | |
|---|---|---|---|---|
| **Modifications** | **Article de l'IEC 61241-4** | **Modifications mineures et rédactionnelles** | **Extension** | **Modifications techniques majeures** |
| Suppression du mode de protection "pD". Inclus en 3.20, 3.21 et 3.22 | 3.1 | | X | |
| La définition de pressurisation concerne désormais à la fois le gaz et la poussière | 3.3 | | X | |
| La définition de gaz de protection concerne désormais à la fois le gaz et la poussière | 3.4 | | X | |
| Suppression de la définition d'enceinte. Remplacé par le terme "enveloppe" tel que défini dans l'IEC 60079-0 | 3.5 | X | | |
| Suppression de la note dans la définition d'enceinte pressurisée. | 3.6 | X | | |
| Remplacement de la définition de pressurisation statique par la définition de l'IEC 60079-2 | 3.7 | X | | |
| Suppression de la définition "pressurisation avec circulation continue du gaz de protection". Terme non utilisé dans l'IEC 61241-4 | 3.9 | X | | |
| Suppression de la définition "appareil électrique". La définition est traitée dans le VEI | 3.10 | X | | |
| La définition d'appareil à risque d'inflammation concerne désormais à la fois le gaz et la poussière | 3.11 | X | | |
| Suppression de la définition "défaut se révélant de lui-même". Terme non utilisé dans l'IEC 61241-4 | 3.12 | X | | |
| Suppression de la définition "ouverture". Terme non utilisé dans l'IEC 61241-4 | 3.13 | X | | |
| Suppression de la définition " dispositif de protection ". Ce type de dispositif est la plupart du temps désigné sous le terme "dispositif de sécurité" dans l'IEC 61241-4. | 3.14 | X | | |
| Suppression de la définition "appareil protégé". Elle ne concernait que les batteries, qui sont à présent traitées en Annexe G et en Annexe H. | 3.17 | X | | |
| Remplacement de la définition "système de pressurisation" par la définition de l'IEC 60079-2 | 3.18 | X | | |
| Suppression de la définition "source d'alimentation de secours (ou auxiliaire) en gaz de protection". Le terme utilisé est "seconde source d'alimentation". Elle est à présent traitée dans l'IEC 60079-2, 9.1 | 3.19 | X | | |
| Suppression de la définition "zones dans la classification des emplacements". Cette définition est donnée dans l'IEC 60079-10-2. | 3.20 | X | | |
| Suppression de la définition "zone 20 dans la classification des emplacements ". Voir ci-dessus | 3.21 | X | | |
| Suppression de la définition "zone 21 dans la classification des emplacements ". Voir ci-dessus | 3.22 | X | | |
| Suppression de la définition "zone 22 dans la classification des emplacements ". Voir ci-dessus | 3.23 | X | | |
| Suppression de l'article "Principe de la pressurisation", y compris les paragraphes. Ces informations sont traitées dans la définition de "pressurisation", voir 3.13 et d'autres articles de la norme. | 4 | X | | |

| Modifications | Article de l'IEC 61241-4 | Type | | |
|---|---|---|---|---|
| | | Modifications mineures et rédactionnelles | Extension | Modifications techniques majeures |
| Suppression de l'article “Performances électriques de l'appareil”. Le fonctionnement en toute sécurité de l'appareil est traité dans l'IEC 60079-0, 6.1 b) | 5.1 | X | | |
| Suppression de la note concernant les équipements présentant de grandes surfaces soumises à des pressions > 1kPa, qui peuvent être assujettis à la législation relative aux récipients sous pression. | 5.2 | X | | |
| Le texte relatif aux ouvertures est traité de manière équivalente dans 5.5 et 5.6 | 5.3 | X | | |
| Le texte relatif aux raccordements électriques est traité de manière équivalente dans l'IEC 60079-0, article 14. | 5.4 | X | | |
| Le texte relatif au fait de retarder l'ouverture d'une enceinte en raison d'une surface interne chaude est traité de manière équivalente à l'article 15. | 5.5 | X | | |
| Suppression du texte relatif au fait de prévoir une quantité appropriée de portes ou capots pour permettre un dépoussiérage efficace de l'enceinte. Le texte de l'IEC 61241-4 ne se prêterait pas à des évaluations cohérentes provenant de différents Organismes Certificateurs. | 5.5 | X | | |
| Le texte relatif aux limites de température est traité de manière équivalente à l'article 6 et dans l'IEC 60079-0, 26.5.1.3. | 6 | X | | |
| Suppression du texte concernant la responsabilité du fabricant. Traité dans l'IEC 60079-0. | 7.1 | X | | |
| Suppression du texte concernant la responsabilité de l'utilisateur. Traité dans l'IEC 60079-14. | 7.1 | X | | |
| Suppression du texte indiquant que le fabricant doit fournir des instructions relatives au nettoyage de l'enceinte. Traité dans l'IEC 60079-14. | 7.1 | X | | |
| Suppression du texte exigeant qu'un dispositif de sécurité réagisse lorsque la pression à l'intérieur de l'enceinte dépasse la valeur maximale permise. Il incombe à l'utilisateur de ne pas dépasser la pression maximale assignée. | 7.2 | X | | |
| Suppression du texte exigeant l'isolement du conducteur neutre. Traité dans l'IEC 60079-14. | 7.4 | X | | |
| Le texte relatif à la panne de la pressurisation est traité de manière équivalente dans 7 et 13.3. | 7.5 | X | | |
| Suppression du texte relatif à l'emplacement des alarmes visuelles ou sonores. Traité dans l'IEC 60079-14. | 7.5.1 | X | | |
| Suppression du texte exigeant à la fois la déconnexion et le déclenchement de l'alarme pour la Zone 21 Db. Traité dans l'IEC 60079-14. | 7.5.1.1 | X | | |
| Le texte relatif au marquage d'avertissement sur les portes et capots est traité de manière équivalente à 5.3.6. | 7.5.1.2 | X | | |
| Suppression du texte concernant l'installation d'un système d'élimination de l'huile ou de l'humidité. Traité dans l'IEC 60079-14, 13.1.6. | 9.1 | X | | |
| Suppression du texte exigeant que la surpression minimale soit vérifiée pendant une durée de 5 minutes. Cette mesure n'est pas considérée comme dépendant du temps. | 10.4.1 | X | | |
| Suppression du texte exigeant que la surpression minimale soit vérifiée avec des parties mobiles traversant la paroi de l'enceinte, fonctionnant en utilisation normale. Il n'est pas considéré que le fait de faire fonctionner des parties de ce type affectera la pression interne. | 10.4.2 | X | | |
| Suppression du texte exigeant que l'essai de fuites soit réalisé à un minimum de 200 Pa. L'essai de fuites est uniquement applicable à la valeur de surpression maximale spécifiée par le fabricant pour le service normal. | 10.5 | X | | |

| Modifications | Article de l'IEC 61241-4 | Type | | |
|---|---|---|---|---|
| | | Modifications mineures et rédactionnelles | Extension | Modifications techniques majeures |
| Le texte relatif à la conformité pour l'essai de fuites de la pressurisation statique est traité de manière équivalente à 16.3.2. | 10.5 | X | | |
| L'IEC 60079-2, Ed 6 ne contient pas d'exception concernant l'essai de choc pour les enveloppes à surpression interne qui ne sont pas soumises à des dommages mécaniques. | 10.6 | | | B1 |
| Suppression du texte relatif à l'essai individuel de surpression | 10.7 | X | | |
| Ajout de texte concernant les essais individuels des systèmes de confinement. L'IEC 61241-4 ne traitait pas des enveloppes qui contenaient un dégagement interne de substances inflammables. | 10.7 | | X | |
| Le texte relatif au marquage est traité de manière équivalente dans l'IEC 60079-0, article 29 | 11.1 | X | | |
| Suppression du texte exigeant que les “limitations restreignant l'utilisation de l'appareil du point de vue de la sécurité” soient marquées. Ceci est traité dans les Instructions, voir IEC 60079-0, article 30. | 11.2 | X | | |
| Suppression du texte exigeant que “l'emplacement où sont contrôlés la pression et le débit” soit marqué. | 11.2 | X | | |
| Suppression du texte exigeant que “la puissance maximale de la lampe pour un luminaire ” soit marquée. | 11.2 | X | | |
| Suppression du texte “Selon accord entre le demandeur du certificat et le centre d'essai si nécessaire.” | 11.4 | X | | |

**Explications:**
**A) Définitions**

**Modifications mineures et rédactionnelles** clarification, réduction des exigences techniques, modifications techniques mineures, corrections d’ordre rédactionnel
Ces modifications portent sur les exigences et sont de nature rédactionnelle ou technique mineure. Elles comprennent des modifications de formulation destinées à clarifier les exigences techniques sans apporter de modification technique ni réduire le niveau actuel de l'exigence.

**Extension** ajout d’options techniques
Ces modifications ajoutent de nouvelles exigences techniques ou modifient les exigences techniques existantes, de façon à fournir de nouvelles options, mais sans augmenter les niveaux d’exigences pour tout matériel qui était totalement conforme à la précédente norme. Ces modifications ne sont donc pas à prendre en compte dans le cas de produits conformes à la précédente édition. 5.

**Modifications techniques majeures** ajout d’exigences techniques, augmentation des exigences techniques
Ces modifications sont apportées aux exigences techniques (ajout, augmentation du niveau ou suppression) de telle façon qu'un produit conforme à la précédente édition n'a pas toujours la capacité de satisfaire aux exigences indiquées dans la dernière édition. Ces modifications sont à prendre en compte dans le cas de produits conformes à la précédente édition. L'Article B) ci-dessous fournit des informations supplémentaires sur ces modifications

B) Informations sur l'origine des "Modifications techniques majeures"

B1 – L'enveloppe à surpression interne doit être soumise à l'essai de choc, comme indiqué dans le Tableau 2.

Le texte de cette norme est issu des documents suivants:

| FDIS | Rapport de vote |
|---|---|
| 31/1119/FDIS | 31/1131/RVD |

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

La présente Norme est à lire conjointement à l'IEC 60079-0, *Atmosphères explosives – Partie 0: Matériel – Exigences générales*.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60079, publiées sous le titre général *Atmosphères explosives*, peut être consultée sur le site web de l'IEC.

Les normes futures de cette série porteront dorénavant le nouveau titre général cité ci-dessus. Le titre des normes existantes déjà dans cette série sera mis à jour lors d'une prochaine édition.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

Le contenu du corrigendum de juillet 2015 a été pris en considération dans cet exemplaire.

# INTRODUCTION

La présente partie de l'IEC 60079 définit des exigences pour la conception, la construction, les essais et le marquage du matériel électrique utilisable dans les atmosphères explosibles où

a) un gaz de protection, maintenu à une pression supérieure à celle de l'atmosphère extérieure, est utilisé pour empêcher la formation d'une atmosphère explosive gazeuse à l'intérieur des enveloppes qui ne contiennent pas de source interne de dégagement de gaz ou de vapeurs inflammables;

b) un gaz de protection, maintenu à une pression supérieure à celle de l'atmosphère extérieure, est utilisé pour empêcher la formation d'une atmosphère explosive gazeuse à l'intérieur des enveloppes et est fourni à une enveloppe contenant une ou plusieurs sources internes de dégagement afin de prévenir la formation d'une atmosphère explosive gazeuse; ou

c) un gaz de protection, maintenu à une pression supérieure à celle de l'atmosphère extérieure, est utilisé pour empêcher la pénétration de poussière combustible susceptible de conduire à la formation d'une atmosphère de poussière explosive à l'intérieur des enveloppes, mais uniquement s'il n'y a pas de source interne de dégagement de poussière combustible.

La présente Norme comprend des exigences pour le matériel et ses éléments associés, y compris les canalisations d'admission et d'évacuation, et aussi pour les matériels auxiliaires de commande nécessaires pour assurer que la surpression interne et/ou la dilution est établie et maintenue.

# ATMOSPHÈRES EXPLOSIVES –

# Partie 2: Protection du matériel par enveloppe à surpression interne "p"

## 1 Domaine d'application

La présente partie de l'IEC 60079 contient les exigences spécifiques pour la construction et les essais des matériels électriques avec enveloppes à surpression interne à mode de protection "p", destinés à l'utilisation dans les atmosphères explosives gazeuses ou les atmosphères de poussière explosives. Elle inclut également les exigences pour les enveloppes à surpression interne contenant un dégagement limité de substance inflammable.

La présente Norme complète et modifie les exigences générales de l'IEC 60079-0. Lorsqu'une exigence de la présente Norme entre en conflit avec une exigence de l'IEC 60079-0, c'est l'exigence de la présente Norme qui prévaut.

La présente Norme ne comprend pas les exigences pour:

- les enveloppes à surpression interne lorsque le système de confinement peut dégager
  a) de l'air avec une teneur en oxygène supérieure à la normale, ou
  b) un mélange d'oxygène et de gaz inerte dans une proportion d'oxygène supérieure à 21 %;
- les salles à surpression interne ou les bâtiments pour analyseurs; voir l'IEC 60079-13;
- les enveloppes à surpression interne utilisées lorsque des "explosifs" ou des éléments pyrotechniques sont présents;
- les enveloppes à surpression interne utilisées lorsque des mélanges hybrides de gaz/vapeur et de poussière combustible sont présents;
- les enveloppes à surpression interne utilisées lorsque des substances pyrophoriques telles que des explosifs ou des charges de poudre contenant leurs propres oxydants sont présentes;
- les enveloppes à surpression interne avec une source interne de dégagement de poussière combustible.

NOTE Lorsque l'utilisateur assume le rôle du fabricant, il lui incombe normalement de s'assurer que toutes les parties concernées de la présente Norme sont appliquées à la fabrication et aux essais du matériel.



## 2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60034-5, *Machines électriques tournantes – Partie 5: Degrés de protection procurés par la conception intégrale des machines électriques tournantes (code IP) – Classification*

IEC 60050 (toutes les parties), *Vocabulaire électrotechnique international*

IEC 60079-0, *Atmosphères explosives – Partie 0: Matériel – Exigences générales*

IEC 60079-11, *Atmosphères explosives – Partie 11: Protection de l'équipement par sécurité intrinsèque "i"*

IEC 60079-15, *Atmosphères explosives – Partie 15: Protection du matériel par mode de protection "n"*

IEC 60112, *Méthode de détermination des indices de résistance et de tenue au cheminement des matériaux isolants solides*

IEC 60127, (toutes les parties) *Coupe-circuit miniatures*

IEC 60529, *Degrés de protection procurés par les enveloppes (Code IP)*

IEC 60664-1, *Coordination de l'isolement des matériels dans les systèmes (réseaux) à basse tension – Partie 1: Principes, exigences et essais*

## 3 Termes et définitions

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC 60050-151, l'IEC 60050-426 et l'IEC 60079-0, ainsi que les suivants, s'appliquent.

NOTE Sauf spécification contraire, on entend par les termes "tension" et "courant" les valeurs efficaces d'une tension ou d'un courant alternatifs, directs ou composites.

**3.1**
**alarme**
pièce de matériel qui génère un signal visuel ou acoustique destiné à attirer l'attention

**3.2**
**système de confinement**
partie du matériel contenant la substance inflammable qui peut constituer une source interne de dégagement

**3.3**
**dilution**
alimentation continue en gaz de protection, après balayage, à un débit tel que la concentration d'une substance inflammable à l'intérieur de l'enveloppe à surpression interne soit maintenue à une valeur en dehors des limites d'explosivité de toute source d'inflammation potentielle (c'est-à-dire en dehors de la zone de dilution)

Note 1 à l'article: La dilution d'oxygène par gaz inerte peut aboutir à une concentration de gaz ou de vapeur inflammable supérieure à la limite supérieure d'inflammabilité (LSI).

**3.4**
**zone de dilution**
zone à proximité d'une source interne de dégagement où la concentration d'une substance inflammable n'est pas diluée à une concentration sûre

**3.5**
**volume de l'enveloppe**
volume de l'enveloppe vide sans matériel interne. Pour les machines électriques tournantes, le volume interne libre plus le volume déplacé par le rotor

**3.6**
**substance inflammable**
gaz, vapeurs, liquides ou mélanges de ceux-ci, capables de s'enflammer

**3.7**
**dispositif hermétiquement étanche**
dispositif construit de telle manière que l'atmosphère extérieure ne puisse y pénétrer et dans lequel tout scellement est effectué par fusion

Note 1 à l'article: Des exemples de fusion sont le brasage, le soudage et la fusion de verre et métal.

**3.8**
**matériel susceptible de provoquer une inflammation**
**ICE**
matériel qui, en service normal, constitue une source d'inflammation pour une atmosphère explosive spécifiée

Note 1 à l'article: L'abréviation "ICE" est dérivée du terme anglais développé correspondant "ignition-capable equipment".

**3.9**
**indicateur**
pièce de matériel qui indique si un débit ou une pression est suffisant et qui est destiné à être contrôlé périodiquement, conformément à l'exigence de l'application

**3.10**
**source interne de dégagement**
point ou emplacement où une substance inflammable sous forme de gaz, de vapeur ou de liquide inflammable peut se dégager dans l'enveloppe à surpression interne, de telle façon qu'en présence d'air, une atmosphère explosive gazeuse puisse se former

**3.11**
**compensation de fuite**
fourniture d'un débit de gaz de protection suffisant pour compenser toute fuite de l'enveloppe à surpression interne et de ses canalisations

**3.12**
**surpression**
pression supérieure à la pression ambiante à l'intérieur d'une enveloppe à surpression interne

**3.13**
**surpression interne**
technique qui consiste à empêcher la pénétration à l'intérieur d'une enveloppe de l'atmosphère extérieure en y maintenant un gaz de protection à une pression supérieure à celle de l'atmosphère extérieure

**3.14**
**système de pressurisation**
groupement de dispositifs de sécurité et autres composants utilisés pour soumettre à une surpression interne et contrôler une enveloppe à surpression interne

**3.15**
**enveloppe à surpression interne**
enveloppe dans laquelle un gaz de protection est maintenu à une pression supérieure à celle de l'atmosphère externe

**3.16**
**gaz de protection**
air ou gaz inerte utilisé pour maintenir une surpression interne et, si nécessaire, pour la dilution et le balayage

Note 1 à l'article: Pour les besoins de la présente Norme, on entend par "gaz inerte" l'azote, le dioxyde de carbone, l'argon ou tout autre gaz qui, lorsqu'il est mélangé à de l'oxygène dans le rapport 4:1 comme dans l'air, ne rend pas les propriétés d'inflammation et d'inflammabilité, telles que les limites d'explosivité, plus défavorables.

**3.17**
**alimentation en gaz de protection**
compresseur, ventilateur ou conteneur de gaz comprimé qui fournit le gaz de protection à une pression positive

Note 1 à l'article: L'alimentation en gaz de protection comprend les conduits ou les canalisations d'arrivée (d'aspiration), les régulateurs de pression, les conduits d'évacuation, les canalisations et les vannes d'alimentation.

Note 2 à l'article: Les composants du système de pressurisation autre que le régulateur de pression ne sont pas inclus.

**3.18**
**balayage**
dans une enveloppe à surpression interne, opération qui consiste à faire passer une quantité de gaz de protection dans l'enveloppe et les canalisations, de telle façon que la concentration de l'atmosphère explosive gazeuse soit ramenée à un niveau de sécurité

**3.19**
**surpression interne statique**
maintien d'une surpression à l'intérieur d'une enveloppe à surpression interne sans ajout de gaz de protection dans une zone dangereuse

**3.20**
**niveau de protection "pxb"**
enveloppe à surpression interne fournissant le niveau de protection du matériel (EPL – Equipment Protection Level) Mb, Gb ou Db

Note 1 à l'article: Cela permet au matériel non protégé d'être installé à l'intérieur de l'enveloppe à surpression interne, sauf pour les dispositifs de sécurité; voir 3.23.

**3.21**
**niveau de protection "pyb"**
enveloppe à surpression interne fournissant le niveau de protection du matériel (EPL) Gb ou Db avec le niveau de protection du matériel (EPL) Gc ou Dc à l'intérieur de l'enveloppe à surpression interne

Note 1 à l'article: Cela permet au matériel de niveau de protection du matériel (EPL) Gc ou Dc d'être installé à l'intérieur de l'enveloppe à surpression interne, sauf pour les dispositifs de sécurité; voir 3.23.

**3.22**
**niveau de protection "pzc"**
enveloppe à surpression interne fournissant le niveau de protection du matériel (EPL) Gc ou Dc

Note 1 à l'article: Cela permet au matériel non protégé d'être installé à l'intérieur de l'enveloppe à surpression interne, sauf pour les dispositifs de sécurité (voir 3.23).

**3.23**
**dispositif de sécurité**
dispositif utilisé pour créer ou maintenir l'intégrité du mode de protection

**3.24**
**limite inférieure d'inflammabilité**
**LII**
fraction en volume de gaz ou vapeur inflammable dans l'air au-dessous de laquelle aucune atmosphère explosive gazeuse ne va se former, exprimée sous forme de pourcentage (voir IEC 60079-20-1)

Note 1 à l'article: Cette valeur est également appelée limite inférieure d'explosivité (LIE).

**3.25**
**limite supérieure d'inflammabilité**
**LSI**
fraction en volume de gaz ou vapeur inflammable dans l'air au-dessus de laquelle aucune atmosphère explosive gazeuse ne va se former, exprimée sous forme de pourcentage (voir IEC 60079-20-1)

Note 1 à l'article: Cette valeur est également appelée limite supérieure d'explosivité (LSE).

## 4 Niveaux de protection

La protection par surpression interne est divisée en trois niveaux de protection ("pxb", "pyb" et "pzc") qui sont sélectionnés en fonction du niveau de protection requis pour le matériel (Mb, Gb, Db, Gc ou Dc), de l'existence d'un dégagement interne potentiel et selon que le matériel dans l'enveloppe à surpression interne est susceptible de provoquer une inflammation; voir le Tableau 1. Le mode de protection définit alors les critères de conception pour l'enveloppe à surpression interne et le système de pressurisation; voir le Tableau 2.

**Tableau 1 – Détermination du niveau de protection**

| Existe-t-il une situation de dégagement interne? | Exigence de Niveau de protection du matériel (EPL) le plus élevé pour l'atmosphère explosive extérieure | L'enveloppe contient-elle un matériel susceptible de provoquer une inflammation? | Niveau de protection |
|---|---|---|---|
| Non | Mb, Gb ou Db | Oui ou non | Niveau de protection "pxb" |
| Non | Gb ou Db | Non | Niveau de protection "pyb" |
| Non | Gc ou Dc | Oui ou non | Niveau de protection "pzc" |
| Oui, gaz/vapeur | Mb, Gb ou Db | Non ou Oui, et le matériel susceptible de provoquer une inflammation n'est pas situé dans la zone de dilution | Niveau de protection "pxb" |
| Oui, gaz/vapeur | Gb ou Db | Non | Niveau de protection "pyb" |
| Oui, gaz/vapeur | Gc ou Dc | Oui, et le matériel susceptible de provoquer une inflammation n'est pas situé dans la zone de dilution | Niveau de protection "pxb" |
| Oui, gaz/vapeur | Gc ou Dc | Non | Niveau de protection "pyb" |
| Oui, liquide | Gb ou Db | Oui ou non | Niveau de protection "pxb" (inerte) |
| Oui, liquide | Gb ou Db | Non | Niveau de protection "pyb" (inerte) |
| Oui, liquide | Gc ou Dc | Oui ou non | Niveau de protection "pzc" (inerte) |
| Si la substance inflammable est un liquide, un dégagement normal n'est jamais autorisé.<br>Le gaz de protection doit être inerte si la mention "inerte" est présente après le niveau de surpression interne, voir Article 13. | | | |

**Tableau 2 – Critères de conception fondés sur le niveau de protection**

| Critères de conception | Niveau de protection "pxb" | Niveau de protection "pyb" | Niveau de protection "pzc" avec indicateur | Niveau de protection "pzc" avec alarme |
|---|---|---|---|---|
| Degré de protection des enveloppes selon l'IEC 60529 ou l'IEC 60034-5 | IP4X minimal | IP4X minimal | IP4X minimal | IP3X minimal |
| Résistance de l'enveloppe aux chocs | L'IEC 60079-0 s'applique | L'IEC 60079-0 s'applique | L'IEC 60079-0 s'applique | Appliquer la moitié de la valeur indiquée dans l'IEC 60079-0 |
| Vérification de la période de balayage pour les Groupes I et II | Exige un dispositif temporel et un contrôle de la pression et du débit | Temps et débit marqués | Temps et débit marqués | Temps et débit marqués |
| Empêcher les particules incandescentes de sortir par un orifice d'évacuation normalement fermé dans une zone exigeant un niveau de protection Mb, Gb ou Db | Barrière contre étincelles et particules requise, voir 5.9, sauf s'il n'y a normalement pas de particules incandescentes produites | Pas d'exigence[a)] | Le niveau de protection "pzc" ne s'applique pas aux zones nécessitant un niveau de protection du matériel (EPL) Mb, Gb ou Db | Le niveau de protection "pzc" ne s'applique pas aux zones nécessitant un niveau de protection du matériel (EPL) Mb, Gb ou Db |
| Empêcher les particules incandescentes de sortir par un orifice d'évacuation normalement fermé dans une zone exigeant un niveau de protection du matériel Gc ou Dc | Pas d'exigence[b)] | Pas d'exigence[b)] | Pas d'exigence, voir note de pied b) | Pas d'exigence[b)] |
| Empêcher les particules incandescentes de sortir par un orifice qui s'ouvre en fonctionnement normal, dans une zone exigeant un niveau de protection du matériel Mb, Gb ou Db | Barrière contre étincelles et particules requise, voir 5.9 | Barrière contre étincelles et particules requise, voir 5.9 | Le niveau de protection "pzc" ne s'applique pas aux zones nécessitant un niveau de protection du matériel (EPL) Mb, Gb ou Db | Le niveau de protection "pzc" ne s'applique pas aux zones nécessitant un niveau de protection du matériel (EPL) Mb, Gb ou Db |
| Empêcher les particules incandescentes de sortir par un orifice qui s'ouvre en fonctionnement normal, dans une zone exigeant un niveau de protection du matériel Gc ou Dc | Barrière contre étincelles et particules requise, voir 5.9, sauf s'il n'y a normalement pas de particules incandescentes produites | Pas d'exigence[a)] | Barrière contre étincelles et particules requise, voir 5.9, sauf s'il n'y a normalement pas de particules incandescentes produites | Barrière contre étincelles et particules requise, voir 5.9, sauf s'il n'y a normalement pas de particules incandescentes produites |
| Porte ou couvercle qui ne s'ouvre qu'avec un outil | Mise en garde; voir 5.3 et 6.2 b) ii) | Mise en garde; voir 5.3.6[b)] | Mise en garde; voir 5.3.6[c)] | Mise en garde; voir 5.3.6[c)] |
| Porte ou couvercle qui s'ouvre sans outil | Verrouillage, voir 7.14<br>(pas de parties internes chaudes) | Mise en garde; voir 5.3.6[a)] | Mise en garde; voir 5.3.6[c)] | Mise en garde; voir 5.3.6[c)] |

| Critères de conception | Niveau de protection "pxb" | Niveau de protection "pyb" | Niveau de protection "pzc" avec indicateur | Niveau de protection "pzc" avec alarme |
|---|---|---|---|---|
| Parties internes chaudes qui exigent une période de refroidissement avant l'ouverture de l'enveloppe | Satisfait à 6.2 b) ii) | Pas d'exigence[a)] | Mise en garde; voir 5.3.6 | Mise en garde; voir 5.3.6 |

a) Le paragraphe 6.2b) ii) n'est pas applicable pour le niveau de protection "pyb" dans la mesure où ni des parties internes chaudes, ni des particules incandescentes normalement créées ne sont autorisées.

b) Il n'y a pas d'exigence relative aux barrières contre les particules et les étincelles dans la mesure où, en fonctionnement anormal, lorsque l'orifice d'évacuation s'ouvre, il est peu probable que l'atmosphère externe soit dans les limites d'explosivité.

c) Il n'y a pas d'exigence relative à l'accessibilité d'outil sur une enveloppe du niveau de protection "pzc" dans la mesure où, en fonctionnement normal, l'enveloppe est en surpression interne avec tous ses couvercles et portes en place. En cas d'enlèvement d'un couvercle ou d'une porte, il est peu probable que l'atmosphère soit dans les limites d'explosivité.

# 5 Exigences de construction pour enveloppes à surpression interne

## 5.1 Enveloppe

L'enveloppe à surpression interne doit posséder un degré de protection conforme au Tableau 2.

Pour le niveau de protection "pxb" sans composants internes qui dépassent la classe de température marquée, et pour les niveaux de protection «pyb» et «pzc», les essais d'endurance thermique à la chaleur et au froid pour les enveloppes non métalliques et les parties non métalliques des enveloppes de l'IEC 60079-0 ne nécessitent pas d'être appliqués à l'enveloppe à surpression interne.

Cela s'explique par le fait que la dégradation de l'enveloppe provoquant une augmentation de la fuite produit une alarme ou la coupure de l'alimentation des circuits susceptibles de provoquer une inflammation. Il n'est donc pas considéré comme nécessaire de soumettre à l'essai de préconditionnement les enveloppes non métalliques et les parties non métalliques des enveloppes.

## 5.2 Matériaux

Les gaz de protection spécifiés ne doivent pas avoir d'influence défavorable sur les matériaux utilisés pour l'enveloppe, les canalisations et les parties de raccordement.

## 5.3 Portes et couvercles

### 5.3.1 Enveloppes à surpression interne du groupe I

Les portes et couvercles doivent

– soit posséder des fermetures spéciales qui satisfont à l'IEC 60079-0;

– soit être verrouillés de manière à ce que l'alimentation électrique du matériel ne fournissant pas un niveau de protection du matériel tel qu'indiqué en 7.15 soit déconnectée automatiquement en cas d'ouverture des portes et couvercles, et de telle façon que l'alimentation ne puisse être rétablie avant qu'ils ne soient fermés. Les exigences de 7.7 doivent également s'appliquer.

### 5.3.2 Enveloppes à surpression interne statique du groupe I

Les portes et couvercles doivent posséder des fermetures spéciales qui satisfont à l'IEC 60079-0.

### 5.3.3 Enveloppes à surpression interne du groupe II et du groupe III

Les exigences de l'IEC 60079-0 concernant les fermetures spéciales ne s'appliquent pas.

Pour le niveau de protection "pxb", les portes et couvercles pouvant être ouverts sans l'aide d'un outil ou d'une clé, doivent être verrouillés de telle sorte que l'alimentation électrique d'un matériel électrique non identifié en 7.15 soit automatiquement déconnectée en cas d'ouverture et de telle sorte que l'alimentation électrique ne puisse être rétablie avant leur fermeture.

Pour le niveau de protection "pyb" et le niveau de protection "pzc", l'utilisation d'un outil ou d'une clé n'est pas exigée.

Il convient de prendre en compte la possibilité qu'une pression interne puisse provoquer l'ouverture violente d'une porte ou d'un couvercle lorsqu'une fermeture est déplacée. Il convient que les opérateurs et le personnel de maintenance soient protégés pour éviter les blessures, au moyen de méthodes telles que les suivantes:

a) utiliser des fermetures à plusieurs attaches de sorte que l'enveloppe permette une mise à l'atmosphère sans danger avant que toutes les fermetures soient relâchées; ou
b) utiliser une fermeture à deux positions pour permettre une mise à l'atmosphère sans danger de la pression lors de l'ouverture de l'enveloppe; ou
c) limiter la pression interne maximale à un niveau inférieur ou égal à 2,5 kPa.

### 5.3.4 Enveloppes à surpression interne statique du groupe II et du groupe III

Les portes et les couvercles ne doivent pas pouvoir s'ouvrir facilement sans l'utilisation d'une clé ou d'un outil.

### 5.3.5 Niveau de protection "pxb" du groupe II et du groupe III

Une enveloppe à surpression interne qui contient des parties chaudes exigeant une période de refroidissement ne doit pas pouvoir s'ouvrir aisément sans l'utilisation d'une clé ou d'un outil.

### 5.3.6 Mise en garde au sujet des portes et des couvercles du groupe II et du groupe III

Pour prévenir l'inflammation d'une atmosphère explosive gazeuse ou d'une atmosphère de poussière explosive pouvant être présente lorsque l'on ouvre une enveloppe, les portes et les couvercles doivent être marqués.

AVERTISSEMENT – NE PAS OUVRIR SI UNE ATMOSPHÈRE EXPLOSIVE EST PRÉSENTE

## 5.4 Résistance mécanique

Les enveloppes à surpression interne, les canalisations le cas échéant et leurs pièces de raccordement doivent résister à une pression égale à 1,5 fois la surpression maximale spécifiée par le fabricant pour le service normal avec toutes les évacuations fermées avec un minimum de 200 Pa.

Si, en service, une pression peut provoquer une déformation de l'enveloppe, des canalisations le cas échéant ou des pièces de raccordement, un dispositif de sécurité doit être installé pour limiter la surpression interne maximale à un niveau inférieur à celui qui est susceptible d'influer défavorablement sur le mode de protection. Si le fabricant ne fournit pas le dispositif de sécurité, le numéro de certificat doit comporter le suffixe "X", conformément aux exigences relatives au marquage de l'IEC 60079-0, et les conditions particulières d'utilisation énumérées sur le certificat doivent donner toutes les informations nécessaires à l'utilisateur pour lui permettre de se conformer aux exigences de la présente Norme.

### 5.5 Orifices, cloisons, compartiments et composants internes du groupe I et du groupe II

**5.5.1** Les orifices et cloisons doivent être situés de telle sorte que soit assuré un balayage efficace.

Les zones sans balayage peuvent être éliminées par un placement approprié de l'admission et de l'évacuation de l'alimentation en gaz de protection, et en tenant compte de l'effet des cloisons.

Pour les gaz ou vapeurs plus lourds que l'air, il convient que l'admission du gaz de protection soit à proximité du haut de l'enveloppe à surpression interne, l'évacuation se trouvant à proximité du bas de l'enveloppe.

Pour les gaz ou vapeurs plus légers que l'air, il convient que l'admission du gaz de protection soit à proximité du bas de l'enveloppe, l'évacuation se trouvant à proximité du haut de l'enveloppe.

Disposer les admissions et les évacuations sur les côtés opposés de l'enveloppe favorise la ventilation transversale.

Il convient que les cloisons internes (par exemple, des cartes de circuit) soient situées de sorte que le débit de gaz de protection ne soit pas obstrué. L'utilisation d'un tuyau distributeur ou de séparateurs peut également améliorer le débit autour des obstructions.

Il convient que le nombre d'orifices soit choisi en tenant compte de la conception du matériel, en prenant particulièrement en considération le balayage des sous-compartiments qui peuvent subdiviser le matériel.

**5.5.2** Des compartiments internes doivent être mis en communication avec l'enveloppe principale ou soumis au balayage séparément.

Les orifices ayant une surface de ventilation d'au moins 1 $cm^2$ pour 1 000 $cm^3$, et un diamètre de ventilation d'au moins 6,3 mm sont généralement suffisants pour un balayage adéquat.

**5.5.3** Les tubes cathodiques (CRT) et autres dispositifs hermétiques n'exigent pas de balayage.

**5.5.4** Les composants de volume interne libre de moins de 20 $cm^3$ ne sont pas considérés comme étant des compartiments internes nécessitant un balayage tant que le volume total de l'ensemble de tels composants ne dépasse pas 1 % du volume interne libre du matériel à surpression interne.

NOTE 1 Le chiffre de 1 % est basé sur 25 % de la limite inférieure d'explosivité (LIE) de l'hydrogène; voir A.2.

Des composants électriques considérés comme étant étanches, tels que des transistors, des microcircuits, des condensateurs, etc., ne sont pas à inclure dans le calcul du volume total de composants.

### 5.6 Orifices pour l'application de la surpression interne statique

L'enveloppe doit comporter un ou plusieurs orifices. Après remplissage et application de la surpression interne, tous les orifices doivent être fermés.

### 5.7 Matériaux isolants pour le matériel du groupe I

Les matériaux isolants soumis aux contraintes électriques susceptibles de créer des arcs dans l'air et provenant de courants de valeurs assignées de plus de 16 A (dans du matériel de

contact tel que des coupe-circuits, des contacteurs et des isolateurs) doivent posséder au moins une des propriétés suivantes:

– un indice de résistance au cheminement comparatif égal ou supérieur à l'IRC 400 M, conformément à l'IEC 60112;
– un dispositif approprié pour détecter une possible décomposition du matériau isolant à l'intérieur de l'enveloppe, conduisant à une situation dangereuse et qui déconnecte automatiquement l'alimentation électrique de l'enveloppe côté réseau. La présence et le bon fonctionnement de ce dispositif doivent être vérifiés;
– des lignes de fuite entre conducteurs sous tension qui satisfont à celles montrées pour la tension équivalente du groupe III de matériels (IRC) de degré de pollution 3 de l'IEC 60664-1.

### 5.8 Obturation

Tous les raccordements de câbles et conduits à des enveloppes à surpression interne doivent être étanches pour maintenir les caractéristiques assignées IP de l'enveloppe, ou, s'ils ne sont pas étanches, ils doivent être considérés comme faisant partie de l'enveloppe.

### 5.9 Barrières contre les étincelles et les particules

L'enveloppe à surpression interne et, le cas échéant, les canalisations pour le gaz de protection doivent être munies d'une barrière contre les étincelles et les particules pour empêcher les projections de particules incandescentes dans la zone dangereuse.

On doit partir du principe que des particules incandescentes sont normalement présentes, sauf si les contacts travail/repos fonctionnent à moins de 10 A et si la tension de service ne dépasse pas soit 275 V c.a., soit 60 V c.c. et si les contacts possèdent un couvercle.

Les enveloppes dans lesquelles il n'y a normalement pas de production de particules incandescentes ne nécessitent pas de mise en place de barrière contre les étincelles et les particules sur un orifice d'évacuation normalement fermé débouchant sur une zone nécessitant un niveau de protection du matériel (EPL) Gb ou Mb.

Les enveloppes dans lesquelles il n'y a normalement pas de production de particules incandescentes ne nécessitent pas la mise en place de barrière contre les étincelles et les particules sur un orifice débouchant sur une zone nécessitant un niveau de protection du matériel (EPL) Gc.

Si le fabricant ne fournit pas les barrières contre les étincelles et les particules, le numéro de certificat doit comporter le suffixe "X", conformément aux exigences relatives au marquage de l'IEC 60079-0, et les conditions particulières d'utilisation énumérées sur le certificat doivent donner toutes les informations nécessaires à l'utilisateur pour lui permettre de se conformer aux exigences de la présente Norme.

### 5.10 Éléments de batterie et piles

L'Annexe G donne les exigences relatives aux niveaux de protection "pxb" et "pyb". L'Annexe H donne les exigences relatives au niveau de protection "pzc".

## 6 Limites de température

### 6.1 Généralités

Le matériel doit être classé suivant les exigences relatives au classement des températures de l'IEC 60079-0. Le classement des températures doit être déterminé conformément à 6.2 et 6.3.

### 6.2 Pour le niveau de protection "pxb" ou le niveau de protection "pyb"

Le classement des températures doit être basé sur la plus élevée des températures suivantes:

a) la surface externe la plus chaude de l'enveloppe; ou

b) la surface interne la plus chaude des composants.

Exception: Un composant intérieur peut se situer au-delà du classement des températures marquées dans les cas suivants:

i) il satisfait aux exigences pour "petit composant" de l'IEC 60079-0, ou

ii) l'enveloppe à surpression interne est de niveau de protection "pxb" et satisfait aux exigences relatives aux durées d'ouverture de l'IEC 60079-0. On doit prendre des mesures appropriées pour empêcher, en cas de disparition de la surpression interne, toute atmosphère explosive gazeuse pouvant exister d'entrer en contact avec la surface chaude du composant avant que celle-ci n'ait suffisamment refroidi pour être revenue à une température inférieure à la valeur maximale autorisée.

On peut le réaliser par la conception et la construction des joints de l'enveloppe à surpression interne et des canalisations ou par d'autres moyens, par exemple, par la mise en marche de systèmes de ventilation auxiliaires ou en prenant des dispositions pour que la surface chaude dans l'enveloppe à surpression interne soit dans un boîtier étanche au gaz ou encapsulé.

Pour le niveau de protection "pyb", les parties chaudes susceptibles de provoquer une inflammation pendant un fonctionnement normal ne sont pas admises à l'intérieur de l'enveloppe.

### 6.3 Pour le niveau de protection "pzc"

Le classement des températures doit être basé sur la surface extérieure la plus chaude de l'enveloppe.

En déterminant le classement des températures, il convient de prendre en compte tout matériel interne avec sa propre protection contre les explosions qui peut rester sous tension lorsque le système de pressurisation est déconnecté.

## 7 Dispositions de sécurité et dispositifs de sécurité (sauf pour la surpression interne statique)

### 7.1 Adéquation des dispositifs de sécurité pour zone dangereuse

Tous les dispositifs de sécurité utilisés pour réduire le matériel électrique protégé par la surpression interne de provoquer une inflammation doivent eux-mêmes ne pas être en mesure de provoquer une inflammation (voir 7.15) ou doivent être installés à l'extérieur de la zone dangereuse.

### 7.2 Intégrité des dispositifs de sécurité

Les dispositifs de sécurité requis par la présente Norme (voir Tableau 3) sont des parties liées à la sécurité d'un système de commande. La sécurité et l'intégrité du système de commande doivent être compatibles avec

– pour le niveau de protection "pxb" ou le niveau de protection "pyb", une évaluation de défaut simple;

– pour le niveau de protection "pzc", un fonctionnement normal.

NOTE Concernant l'évaluation unique des défauts, la série IEC 61511 ou toute autre norme similaire peut être utilisée.

Disposer un verrouillage électrique sur les moteurs ou les commandes de ventilateur n'est pas suffisant pour signaler la défaillance de la surpression interne, car certaines défaillances telles qu'une courroie de ventilateur qui dérape, un ventilateur qui n'est pas bien maintenu sur son axe ou un ventilateur tournant dans le mauvais sens peuvent ne pas être signalées par ce dispositif.

**Tableau 3 – Dispositifs de sécurité en fonction du niveau de protection**

| Critères de conception | Niveau de protection "pxb" | Niveau de protection "pyb" | Niveau de protection "pzc" |
|---|---|---|---|
| Dispositif de sécurité de détection de la perte de surpression minimale | Capteur de pression; voir 7.11 | Capteur de pression; voir 7.11 | Indicateur ou capteur de pression; voir 7.11 d) |
| Dispositif(s) de sécurité de vérification de la période de balayage pour les Groupes I et II | Dispositif temporel, capteur de pression, et capteur de débit à l'évacuation, voir 7.7 | Temps et débit marqués; voir 7.8 c) | Temps et débit marqués; voir 7.8 c) |
| Dispositif de sécurité pour une porte ou un couvercle qui ne peut s'enlever qu'avec un outil | Mise en garde; voir 6.2 b) | Aucune exigence (parties internes chaudes non autorisées) | Aucune exigence |
| Dispositif de sécurité pour une porte ou un couvercle qui peut s'enlever sans outil | Verrouillage; voir 7.14 (parties internes chaudes non autorisées) | Aucune exigence (parties internes chaudes non autorisées) | Aucune exigence |
| Dispositif de sécurité pour parties internes chaudes lorsqu'il existe un système de confinement (voir Article 15) | Alarme et débit d'arrêt de substance inflammable | Ne s'applique pas pour le niveau de protection puisque les parties internes chaudes ne sont pas autorisées | Alarme (dégagement normal non autorisé) |



### 7.3 Fournisseur de dispositifs de sécurité

Les dispositifs de sécurité doivent être fournis par le fabricant du matériel ou par l'utilisateur. Si le fabricant ne fournit pas les dispositifs de sécurité, le numéro de certificat doit comporter le suffixe "X", conformément aux exigences relatives au marquage de l'IEC 60079-0, et les conditions particulières d'utilisation énumérées sur le certificat doivent donner toutes les informations nécessaires à l'utilisateur pour lui permettre de se conformer aux exigences de la présente Norme.

### 7.4 Système de pressurisation évalué en tant que matériel associé

#### 7.4.1 Systèmes de pressurisation pour niveau de protection "pzc"

Le système de pressurisation doit comprendre au minimum: un moyen pour contrôler la surpression minimale (par exemple, un régulateur) et un moyen pour vérifier la surpression minimale (par exemple, un indicateur), le tout en conformité avec 7.11.

Si un orifice est présent, il doit disposer d'une barrière contre les étincelles et les particules.

Si un régulateur est présent et que celui-ci est d'un type tel qu'un mode de défaillance unique applique la totalité de la pression d'entrée à la sortie du régulateur, un moyen (par exemple, un orifice d'évacuation) doit être mis en place pour limiter la pression interne d'une enveloppe à une valeur définie. Cette valeur est à indiquer dans les instructions et à établir par essai ou par calcul. Si plusieurs régulateurs ou orifices d'évacuation sont installés en tant qu'options, on doit déterminer la valeur correspondant à chaque ensemble d'options régulateur/orifice d'évacuation disponibles.

Le système de pressurisation doit être soumis à essai pour que l'on puisse en vérifier le bon fonctionnement.

### 7.4.2 Systèmes de pressurisation pour niveau de protection "pyb"

Le système de pressurisation doit comprendre: un moyen pour contrôler la surpression minimale (par exemple, un régulateur), un moyen pour vérifier la surpression minimale (par exemple, un capteur de pression) et un dispositif de sécurité automatique, le tout en conformité avec 7.11.

Si un régulateur est présent et que celui-ci est d'un type tel qu'un mode de défaillance unique applique la totalité de la pression d'entrée à la sortie du régulateur, un moyen (par exemple, un orifice d'évacuation) doit être mis en place pour limiter la pression interne d'une enveloppe à une valeur définie. Cette valeur est à indiquer dans les instructions et à établir par essai ou par calcul. Si plusieurs régulateurs ou orifices d'évacuation sont installés en tant qu'options, on doit déterminer la valeur correspondant à chaque ensemble d'options régulateur/orifice d'évacuation disponibles.

Le système de pressurisation doit être soumis à essai pour que l'on puisse en vérifier le bon fonctionnement.

### 7.4.3 Systèmes de pressurisation pour niveau de protection "pxb"

Le système de pressurisation doit comprendre: un moyen pour contrôler la surpression minimale (par exemple, un régulateur), un moyen pour vérifier la surpression minimale (par exemple, un capteur de pression) et un dispositif de sécurité automatique, le tout en conformité avec 7.11, et un système de commande automatique contenant un capteur de débit conforme à 7.7.

Si un régulateur est présent et que celui-ci est d'un type tel qu'un mode de défaillance unique applique la totalité de la pression d'entrée à la sortie du régulateur, un moyen (par exemple, un orifice d'évacuation) doit être mis en place pour limiter la pression interne d'une enveloppe à une valeur définie. Cette valeur est à indiquer dans les instructions et à établir par essai ou par calcul. Si plusieurs régulateurs ou orifices d'évacuation sont installés en tant qu'options, on doit déterminer la valeur correspondant à chaque ensemble d'options régulateur/orifice d'évacuation disponibles.

Le système de pressurisation doit être soumis à essai pour que l'on puisse en vérifier le bon fonctionnement, y compris celui du système de commande automatique.

## 7.5 Diagramme séquentiel pour le niveau de protection "pxb"

Pour les systèmes de pressurisation de niveau de protection "pxb", un diagramme séquentiel fonctionnel doit être fourni par le fabricant, par exemple, une table de vérité, un diagramme d'états, un organigramme, etc., afin de définir l'action du système de commande. Le diagramme séquentiel doit clairement identifier et montrer les états opérationnels des dispositifs de sécurité et les actions qui s'ensuivent. Des essais fonctionnels doivent être exigés pour vérifier la conformité au diagramme. Ces essais nécessitent d'être exécutés dans des conditions atmosphériques normales, seulement sauf spécification contraire de la part du fabricant.

NOTE Un exemple de l'information à fournir par le fabricant est proposé à l'Annexe B.

## 7.6 Caractéristiques assignées des dispositifs de sécurité

Le fabricant doit spécifier les niveaux d'action minimaux et maximaux et les tolérances des dispositifs de sécurité. Les dispositifs de sécurité doivent être utilisés dans les limites des caractéristiques assignées, spécifiées par le fabricant.

### 7.7 Balayage automatisé du groupe I et du groupe II pour le niveau de protection "pxb"

Un système de commande automatique contenant des dispositifs de sécurité doit être fourni pour mettre sous tension le matériel électrique présent dans une enveloppe à surpression interne seulement après que le balayage a été effectué.

La séquence des opérations du système de commande doit être la suivante:

a) à la suite du lancement de la séquence, le débit de balayage dans l'enveloppe à surpression interne et la surpression minimale dans celle-ci doivent être contrôlés conformément à la présente Norme;

b) lorsque le débit minimal de gaz de protection est établi et que la surpression se situe dans les limites spécifiées, le chronomètre du balayage peut démarrer;

c) après expiration du temps, le matériel électrique est alors prêt à être mis sous tension;

d) dans l'éventualité d'une défaillance à n'importe quelle étape de la séquence, le circuit doit être réinitialisé tel qu'il était au départ.

### 7.8 Groupe I ou groupe II – Critères de balayage

Le fabricant doit spécifier les conditions requises pour un balayage approprié après qu'une enveloppe a été ouverte ou que la surpression est tombée au-dessous du minimum spécifié par le fabricant.

a) Pour le niveau de protection "pxb" ou le niveau de protection "pyb", le fabricant doit spécifier le débit de balayage minimal et le temps minimal pour satisfaire à l'essai de 16.4 ou 16.5, selon le cas. Pour les matériels autres que les machines tournantes et les matériels possédant des géométries complexes, le débit de balayage minimal et le temps minimal peuvent être fondés sur un balayage de cinq fois le volume de l'enveloppe s'il est déterminé qu'un tel balayage est approprié sans essai. .

b) Pour le niveau de protection "pzc", pour les matériels autres que les machines tournantes et les matériels possédant des géométries complexes, le fabricant doit spécifier le débit de balayage minimal et le temps minimal garantissant que l'enveloppe à surpression interne est balayée par une quantité de gaz de protection équivalente à cinq fois le volume de l'enveloppe. La quantité de gaz de protection peut être réduite, si l'essai de 16.4 ou 16.5, selon le cas, démontre l'efficacité du balayage.

   L'essai de balayage pour les machines tournantes et pour les matériels à géométries complexes peut être omis si le temps de balayage est basé sur des essais réalisés avec des enveloppes similaires ou comparables.

c) le débit de balayage doit être contrôlé à l'évacuation de l'enveloppe à surpression interne. Pour le niveau de protection "pxb", le débit réel doit être contrôlé. Pour le niveau de protection "pyb" ou le niveau de protection "pzc", le débit peut être déduit, par exemple, de la pression de l'enveloppe et d'un orifice défini à l'échappement. Pour le niveau de protection "pyb" ou le niveau de protection "pzc", une étiquette d'instruction doit être fournie pour permettre le balayage de l'enveloppe à surpression interne avant la mise sous tension du matériel électrique. L'étiquette doit comporter ce qui suit ou une formulation similaire:

   AVERTISSEMENT – À LA SUITE D'UNE OUVERTURE, LA MISE SOUS TENSION NE DOIT PAS ÊTRE EFFECTUÉE AVANT QUE L'ENVELOPPE N'AIT ÉTÉ BALAYÉE PENDANT ___ MINUTES SOUS UN DÉBIT DE ____.

NOTE Il incombe à l'utilisateur de déterminer l'espace libre des canalisations associées ne faisant pas partie du matériel et d'établir le temps de balayage complémentaire pour le débit minimal donné.

### 7.9 Groupe III – Nettoyage

Un avertissement, indiquant que la poussière combustible présente à l'intérieur doit être éliminée avant la mise en route de l'alimentation électrique, doit être apposé sur le matériel. Le marquage doit comporter ce qui suit ou une formulation similaire:

AVERTISSEMENT – À LA SUITE D'UNE OUVERTURE, LA MISE SOUS TENSION NE DOIT PAS ÊTRE EFFECTUÉE AVANT QUE LES ACCUMULATIONS DE POUSSIÈRE COMBUSTIBLE N'AIENT ÉTÉ ÉLIMINÉES DE L'ENVELOPPE.

### 7.10 Exigences lorsqu'un débit minimal est requis

Lorsqu'un débit minimal de gaz de protection est spécifié par le fabricant (par exemple, si le matériel intérieur développe des températures plus chaudes que les caractéristiques assignées de classement des températures marquées), on doit prévoir un ou plusieurs dispositifs de sécurité automatiques s'actionnant lorsque le débit de gaz de protection à l'évacuation chute en dessous de la valeur spécifiée minimale.

### 7.11 Dispositifs de sécurité pour détecter la surpression minimale

Un ou plusieurs dispositifs de sécurité automatiques doivent être mis en place et s'actionner lorsque la surpression de l'enveloppe à surpression interne tombe au-dessous de la valeur minimale spécifiée par le fabricant.

a) le signal reçu par le capteur du dispositif de sécurité automatique doit provenir directement de l'enveloppe à surpression interne;

b) aucune vanne ne doit être autorisée entre le capteur du dispositif de sécurité automatique et l'enveloppe à surpression interne;

c) il doit être possible de vérifier le bon fonctionnement des dispositifs de sécurité. Leur emplacement et leur réglage doivent prendre en compte les exigences de 7.12;

NOTE Il incombe normalement à l'utilisateur de définir l'objet pour lequel les dispositifs de sécurité automatiques sont prévus (c'est-à-dire mise hors tension, déclenchement d'une alarme sonore ou tout autre moyen pour assurer la sécurité de l'installation).

d) Pour le niveau de protection "pzc", les conditions suivantes doivent être respectées si l'enveloppe à surpression interne est équipée d'un indicateur au lieu d'un dispositif de sécurité automatique:

1) l'alimentation en gaz de protection doit être équipée d'une alarme se déclenchant si l'alimentation en gaz de protection ne maintient pas la pression minimale dans l'enveloppe à surpression interne;

2) il ne doit exister aucun dispositif entre l'enveloppe à surpression interne et l'alarme de l'alimentation en gaz de protection autre qu'une vanne d'isolation et/ou un mécanisme de commande de la pression ou du débit;

3) toute vanne d'isolation doit

– porter le marquage suivant

AVERTISSEMENT – VANNE D'ALIMENTATION EN GAZ DE PROTECTION – SUIVRE LES INSTRUCTIONS AVANT LA FERMETURE

– pouvoir être scellée ou fixée en position ouverte;

– préciser l'information "ouvert" ou "fermé";

– être immédiatement adjacente à l'enveloppe à surpression interne;

– être utilisée seulement au cours de l'entretien de l'enveloppe à surpression interne.

NOTE Cette vanne est destinée à rester ouverte, sauf si l'on sait que la zone est dépourvue d'atmosphère explosive gazeuse ou si le matériel présent dans l'enveloppe à surpression interne a été mis hors tension et a refroidi.

4) tout mécanisme de commande de la pression ou du débit, s'il est réglable, doit nécessiter un outil pour qu'il puisse fonctionner;

5) aucun filtre ne doit être installé entre l'enveloppe à surpression interne et l'alarme du système de gaz de protection;

6) l'indicateur doit être situé de façon à permettre une visualisation aisée;

7) l'indicateur doit préciser la pression de l'enveloppe;