UL 60079-2

STANDARD FOR SAFETY

Explosive Atmospheres – Part 2: Equipment Protection by Pressurized Enclosure "p"

UL Standard for Safety for Explosive atmospheres – Part 2: Equipment protection by pressurized enclosure "p", UL 60079-2

Sixth Edition, Dated June 2, 2017

Summary of Topics

This revision of ANSI/UL 60079-2 dated September 15, 2021 is being issued to update the title page to reflect the reaffirmation of its ANSI approval. No changes in requirements have been made.

UL 60079-2 is an adoption of IEC 60079-2, Explosive Atmospheres – Part 2: Equipment Protection by Pressurized Enclosure "p" (Edition 6, issued by IEC July, 2014 including corrigendum 1:2015). Please note that the national difference document incorporates all of the U.S. national differences for UL 60079-2.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated June 25, 2021.

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JUNE 2, 2017
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UL 60079-2

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

First Edition – Not Printed
Second Edition – Not Printed
Third Edition – Not Printed
Fourth Edition – Not Printed
Fifth Edition – August, 2010

Sixth Edition

June 2, 2017

This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through September 15, 2021.

The most recent designation of ANSI/UL 60079-2 as a Reaffirmed American National Standard (ANS) occurred on September 15, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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Preface (UL)

This UL Standard is based on IEC Publication 60079-2: Edition 6 Standard for Safety for Explosive Atmospheres – Part 2: Equipment protection by pressurized enclosure "p" issued July, 2014, as revised by corrigendum 1 (2015). IEC publication 60079-2 is copyrighted by the IEC.

Efforts have been made to synchronize the UL edition number with that of the corresponding IEC standard with which this standard is harmonized. As a result, one or more UL edition numbers have been skipped to match that of the IEC edition number.

Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

The following people served as members of STP 60079 and participated in the review of this standard:

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National Differences from the text of International Electrotechnical Commission (IEC) Publication 60079-2, Explosive Atmospheres – Part 2: Equipment Protection by Pressurized Enclosure "p", copyright 2014, are indicated by notations (differences) and are presented within the body of the UL printed standard in bold text with legislative mark-ups (strike-out and underline).

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

DR – These are National Differences based on the **national regulatory requirements**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES – Part 2: Equipment protection by pressurized enclosure "p"

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 nongovernmental 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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6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

Changes	Clause	Type		
		Minor and Editorial Changes	Extension	Major Technical Changes
Suitability of safety devices for hazardous area Word “explosion” changed to “ignition” to reflect UFL/LFL terms	7.1	X		
Integrity of safety devices Added requirement for detecting fan failure	7.2			C2
Table 3 – Safety devices based upon Level of Protection Revised column labels to use Level of Protection terminology	Table 3	X		
Provider of safety devices Remove reference to 60079-0 by clause number for “X” condition	7.3	X		
Pressurization System evaluated as associated equipment Added requirements for pressurization systems	7.4			C3
Sequence diagram for Level of Protection “pxb” Revised text to use Level of Protection terminology	7.5	X		
Group I and Group II purging automated for Level of Protection “pxb” Revised text to use Level of Protection terminology	7.7	X		
Group I and Group II purging automated for Level of Protection “pxb” Added text specifying that for “pxb”, control must be automated	7.7			C4
Group I or Group II – purging criteria Revised text to use Level of Protection terminology	7.8	X		
Group III – cleaning Added text for cleaning enclosures used in explosive dust atmospheres	7.9		X	
Safety devices to detect minimum overpressure Add word “minimum” to clause title to be consistent with text	7.11	X		
Safety devices to detect minimum overpressure Revised text to use Level of Protection terminology	7.11 d)	X		
Value of minimum overpressure Added word “minimum” to clause title to be consistent with text	7.12	X		
Value of minimum overpressure Revised text to use Level of Protection terminology	7.12	X		
Value of minimum overpressure Added text to reflect a note in Annex C	7.12		X	
Pressurizing multiple enclosures Revised text to use Level of Protection terminology	7.13	X		
Safety devices on doors and covers Revised text to use Level of Protection terminology	7.14	X		
Equipment that may remain energized Revised text to use EPL and level of protection terminology	7.15	X		
Equipment permitted within Level of Protection “pyb” Revised text to use EPL and level of protection terminology	7.16	X		
Group I and Group II Filling procedure Allow filling in a hazardous location if tested as non-hazardous	8.4		X	
Group III Filling Procedure	8.5		X	

Changes	Clause	Type		
		Minor and Editorial Changes	Extension	Major Technical Changes
Added static pressurization filling procedure for combustible dust				
Safety devices Revised text to use Level of Protection terminology	8.6	X		
Equipment that may remain energized Revised text to use EPL terminology	8.7	X		
Overpressure Removed reference to 60079-0 by clause number	8.8	X		
Backup supply Added requirements for a backup supply of protective gas	9.1			C5
Independent supplies Provided requirements for independence of pressurization	9.2		X	C6
Release Conditions Removed reference to 60079-0 by clause number for “X” condition	11.1.2	X		
Containment system with a limited release Removed reference to 60079-0 by clause number for “X” condition	12.3	X		
13.3.3 Limited release of a gas or vapour Revised text to reflect UFL/LFL terms	13.3.3	X		
Ignition-capable equipment Revised text to use Level of Protection terminology	14	X		
Type verification and tests 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 Added requirements to determine maximum overpressure	16.1			C7
Maximum overpressure test Moved Maximum overpressure test to 16.2.	16.2			C7
Leakage test Clarify the acceptance criteria for the test	16.3.2		X	
Tests for an infallible containment system Clarify the rating used for the test	16.7.1			C8
Tests for an infallible containment system Modified test for infallible containment	16.7.2			C9
Edition 5 − Verifying ability of the pressurized enclosure to limit internal pressure Eliminated test	16.8			C7
Functional test Clarified that applies only to safety devices provided with enclosures	17.1	X		
Tests for an infallible containment system Waived helium leak tests for liquid systems	17.3		X	
Supplementary marking Allowed continued use of type of protection marking	18.3			
Pressurization systems Clarified use of Ex [p] and [Ex p] marking	18.6	X		

Changes	Clause	Type		
		Minor and Editorial Changes	Extension	Major Technical Changes
Warnings required in other clauses Added table number	18.7	X		
Warnings required in other clauses Added warning from 7.9	18.7		X	
Warnings required in other clauses Added warnings from Annex G and Annex H	18.7			C1
Instructions Added requirements for Group III	19		X	
Edition 5 Annex G – Infallibility test for containment system Deleted and replaced	Annex G	X		
Edition 5 Annex H – Introduction of an alternative risk assessment method encompassing “equipment protection levels” Deleted and replaced	Annex H	X		
Annex G – Internal Cells and Batteries for Level of Protection “pxb” and Level of Protection “pyb” Added requirements for cells and Batteries			X	
Annex H – Internal Cells and Batteries for Level of Protection “pzc” Added requirements for cells and Batteries			X	

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

Changes	Clause in 61241-4	Type		
		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 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		

Changes	Clause in 61241-4	Type		
		Minor and Editorial Changes	Extension	Major Technical Changes
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 > 1 kPa 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 5.3.5.	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 routing 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		

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 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.

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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.

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EXPLOSIVE ATMOSPHERES – Part 2: Equipment protection by pressurized enclosure "p"

1 Scope

1DV DR *Modification of Clause 1 to replace with the following:*

This ~~part of IEC 60079~~ standard 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~~ UL 60079-0. Where a requirement of this standard conflicts with a requirement of ~~IEC 60079-0~~ UL 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.

Where references are made to other IEC 60079 standards, the reference requirements found in these standards apply as modified by any applicable U.S. National Differences.

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.

2DV DR ***Modification of Clause 2 references to replace with the following:***

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, ~~***EXxplosive 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***

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

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

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

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”

Table 1 Continued on Next Page

Table 1 Continued

Is there an internal release condition?	Highest Equipment Protection Level requirement for external explosive atmosphere	Does enclosure contain ignition-capable equipment?	Level of Protection
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. 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	Spark and particle barrier required, see 5.9, unless	No requirement [a)]	Spark and particle barrier required, see 5.9, unless	Spark and particle barrier required, see 5.9, unless

Table 2 Continued on Next Page

Table 2 Continued

Design criteria	Level of Protection "pxb"	Level of Protection "pyb"	Level of Protection "pzc" with indicator	Level of Protection "pzc" with alarm
opens during normal operation to an area requiring EPL Gc, or Dc	incandescent particles not normally produced		incandescent particles not normally produced	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.

5.4DV.1 DE *Modification of Clause 5.4, second paragraph to replace with the following*

5.4DV.1.1 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~~ in accordance with UL 60079-0 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.

5.5.2DV D2 *Modification of Clause 5.5.2 to replace with the following:*

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. Other geometries and arrangements that meet the basic requirements are also sufficient.

NOTE Non-circular vents or perforated hole arrangements that result in the same area and freedom of gas movement would typically meet this requirement.

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, microcircuits, 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.

5.9DV.1 DE *Modification of Clause 5.9, fifth paragraph to replace with the following*

5.9DV.1.1 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~~ in accordance with UL 60079-0 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"

6.2DV DR *Modification of Clause 6.2 to replace with the following:*

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~~ UL 60079-0, or

ii) the pressurized enclosure is Level of Protection "pxb" and complies with the requirements for opening times in ~~IEC~~ UL 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.**~~

NOTE Examples of "appropriate measures" include but are not limited to the design and construction of the joints of the pressurized enclosure and ducts or by bringing auxiliary ventilation systems into operation or by placing the hot surface within the pressurized enclosure 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

7.1DV DE *Modification of Clause 7.1 to replace with the following:*

All safety devices used to reduce the likelihood of electrical 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

7.3DV DE *Modification of Clause 7.3, to replace with the following:*

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~~ in accordance with UL 60079-0 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.

7.4.1DV.1 DE *Modification of Clause 7.4.1, second paragraph to replace with the following:*

7.4.1DV.1.1 If a vent is provided, it shall comply with the applicable requirements in Table 2 ~~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.

7.4.2DV.1 DE *Modification of Clause 7.4.2 to add the following after the second paragraph:*

7.4.2DV.1.1 If a vent is provided, it shall comply with the requirements in Table 2.

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.

7.4.3DV.1 DE *Modification of Clause 7.4.3 to add the following after the second paragraph:*

7.4.3DV.1.1 If a vent is provided, it shall comply with the requirements in Table 2.

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;

7.11DV.1 DE *Modification of Clause 7.11, first paragraph (item 9 of d) to delete text, it does not apply:*

~~**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 Figure C.1 to Figure 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.

11.1.2DV.1 DE *Modification of Clause 11.1.1, second paragraph to replace with the following:*

11.1.2DV.1.1 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~~ in accordance with UL 60079-0 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)].

[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.

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

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.

12.3DV.1 DE *Modification of Clause 12.3, fourth paragraph to replace with the following:*

12.3DV.1.1 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~~ in accordance with UL 60079-0 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”; or

18.3DV.1 DE *Modification of Clause 18.3, item a) to include permissible substitute marking for the level of protection marking for Group III with the following:*

60079-2 level of protection	EPL	Permissible substitute product marking	Added zone marking
“pxb”	Db	“pb”	21
“pyb”	Db	“pb”	21
“pzc”	Dc	“p”	22

NOTE 1 The 2017, and prior, National Electrical Code®, NFPA 70, does not recognize “pxb”, “pyb” and “pzc” as a Type of Protection for Zones 21 and 22. Product marking “pb” and “p” are substituted until this can be rectified. Example markings: Zone 21 AEx pb IIIC T70 °C Db, Zone 22 AEx p IIIC T70 °C Dc.

NOTE 2 This standard does not prohibit the use of a second EX marking string including the permissible substitute marking as appropriate. For example:

Zone 21 AEx pxb IIIC T70 °C Db

Zone 21 AEx pb IIIC T70 °C Db

or

Zone 22 AEx pzc IIIC T70 °C Dc

Zone 22 AEx p IIIC T70 °C Dc

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]”.

18.6DV.1 DE *Modification of Clause 18.6, NOTES to replace with the following:*

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

NOTE Markings "[p]" and "[Ex p]" do not appear in NEC 2017 and prior, National Electrical Code®, NFPA 70.

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 smallbore 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)

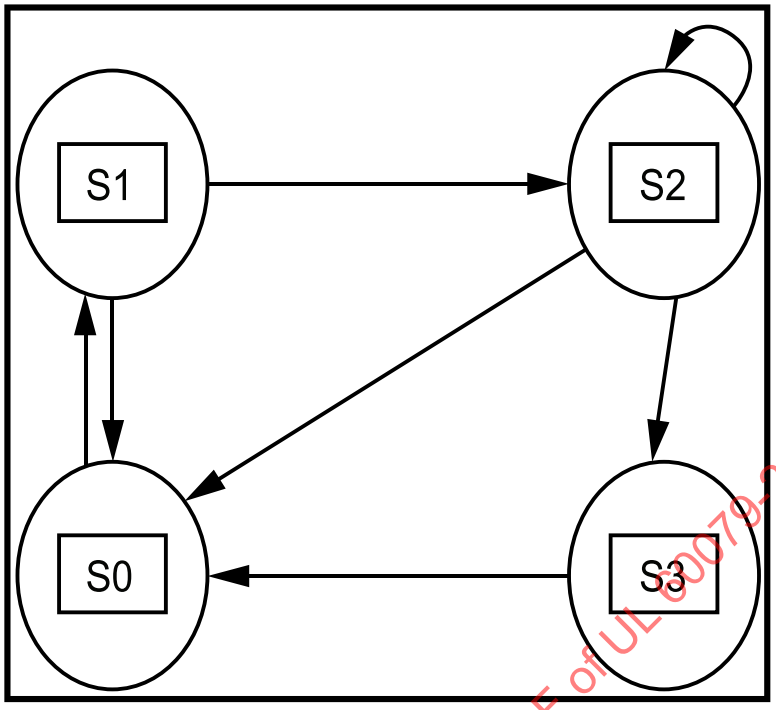
Examples of functional sequence diagram

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.



su1941

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

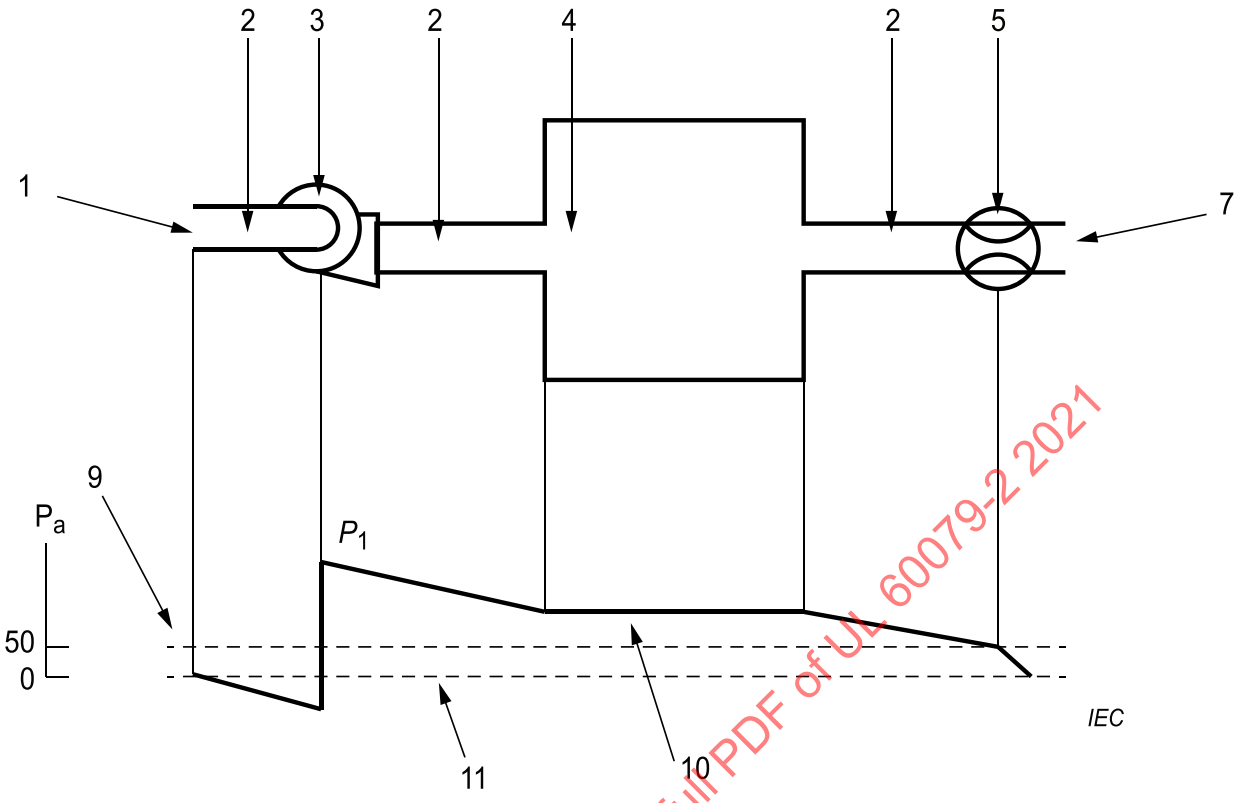
Each state of the system is defined in response to the inputs of the monitoring devices. The states are unique. Transitions between states are only allowed along paths defined by the arrows and in the direction of the arrows. The logical conditions for the occupation of each state are uniquely defined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

Figure C.1 to Figure 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.



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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

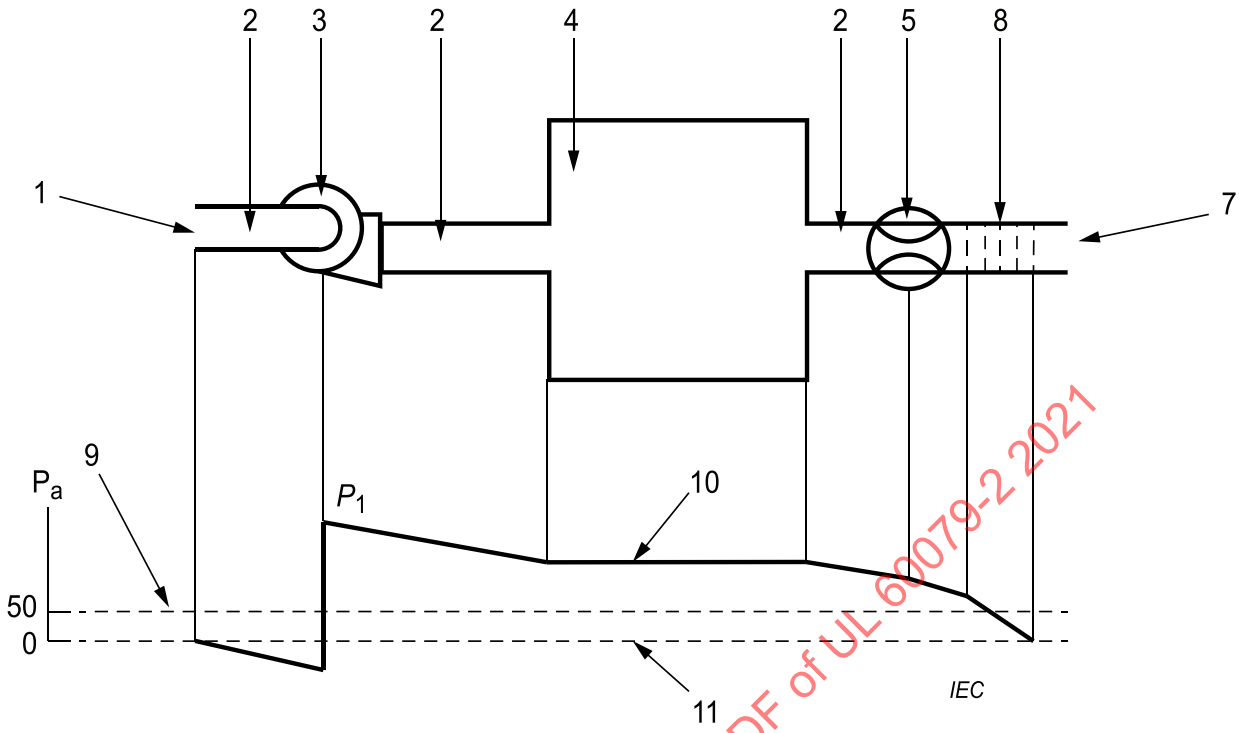
8 (Not used on this diagram)

9 Overpressure

10 Internal pressure

11 External pressure

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



su1943

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

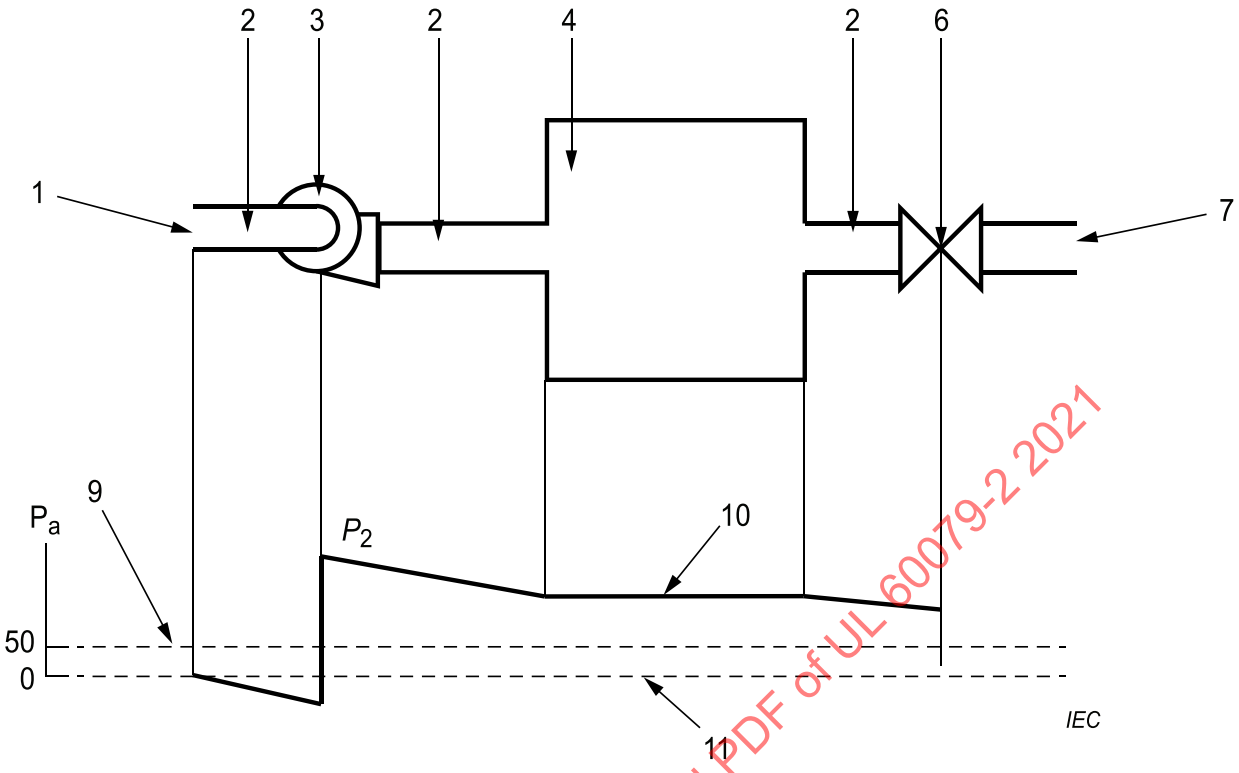
10 Internal pressure

11 External pressure

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

Figure C.1

Protective gas outlet



su1944

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)

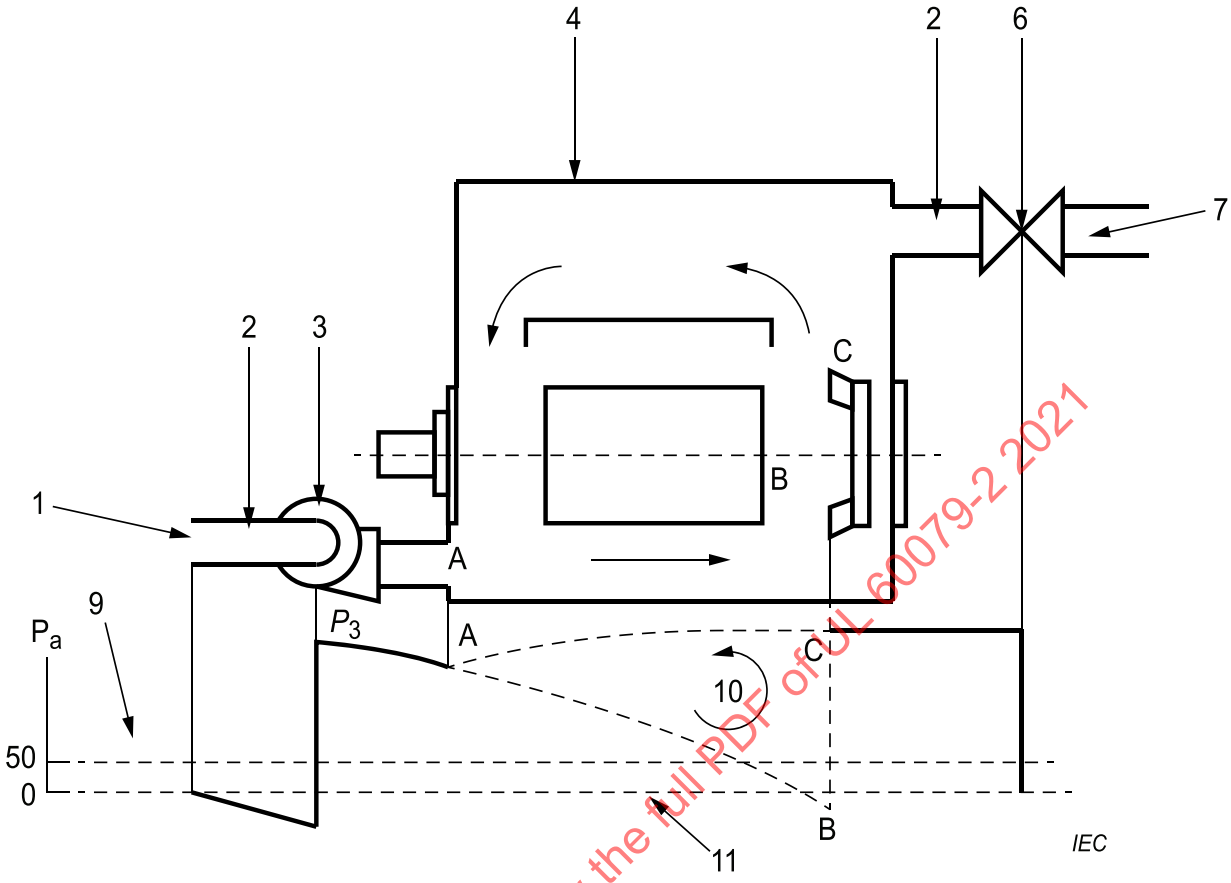
9 Overpressure

10 Internal pressure

11 External pressure

Figure C.2

Pressurized enclosures with leakage compensation, enclosures without moving parts



su1945

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

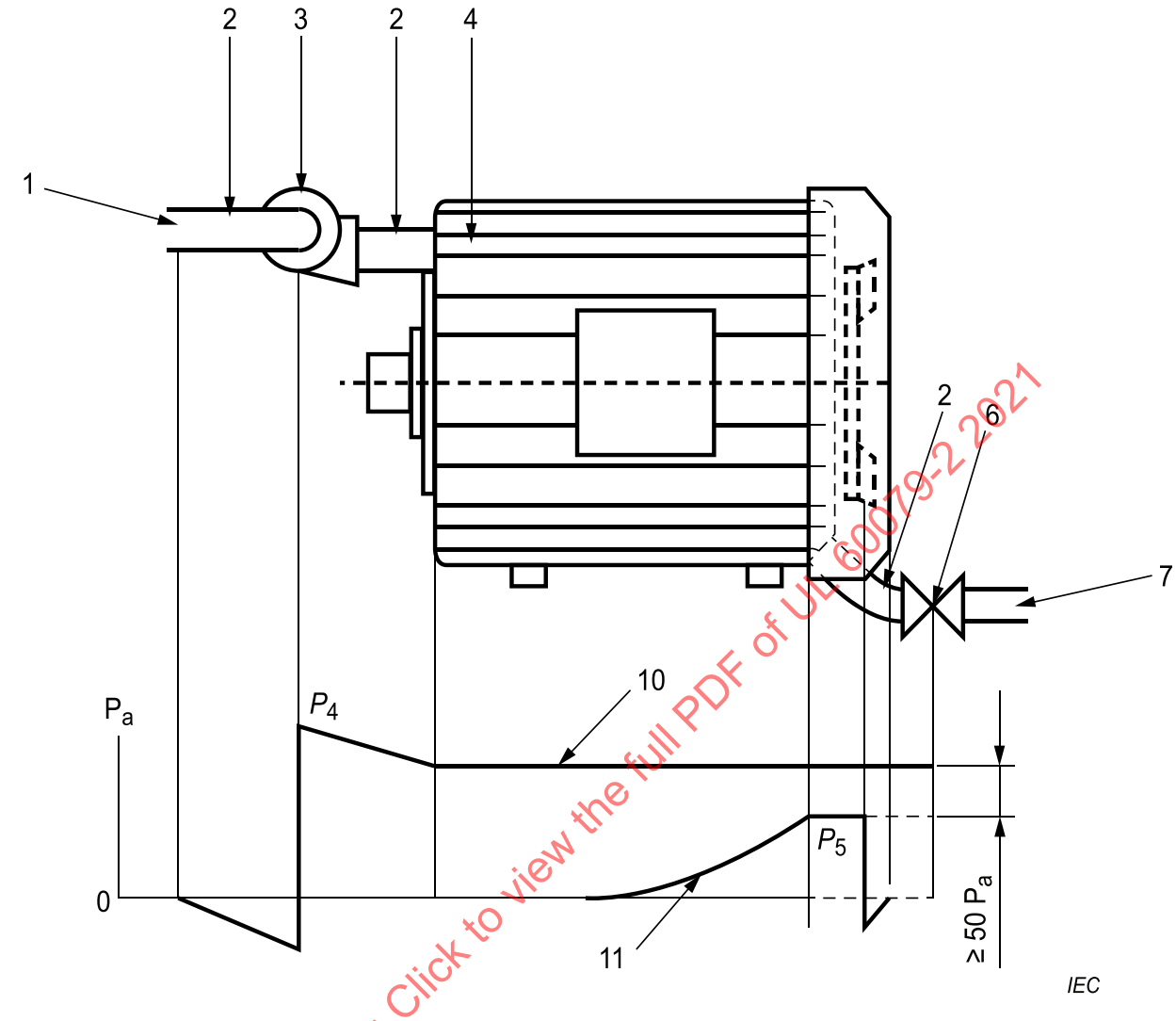
11 External pressure

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

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