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**Explosive Atmospheres – Part 2:
Equipment protection by
pressurized enclosures “p”**

Approved 27 August 2010

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Explosive atmospheres - Part 2: Equipment protection by pressurized enclosures "p"

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

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J. West	Expo Technologies Inc.

The following people served as members of ISA Committee ISA12:

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M. Coppler, Managing Director	Ametek Inc.
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W. Fiske
G. Garcha
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F. Kent
P. Kovscek
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USCG
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Schlumberger
Dow Chemical Company
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This standard was approved for publication by the ISA Standards and Practices Board on 11 August 2010.

NAME

J. Tatera
P. Brett
M. Coppler
E. Cosman
B. Dumortier
D. Dunn
R. Dunn
J. Gilsinn
E. Icyan
J. Jamison
D. Kaufman
K. P. Lindner
V. Maggioli
T. McAvinew
A. McCauley
R. Reimer
N. Sands
H. Sasajima
T. Schnaare
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R. Webb
W. Weidman
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M. Widmeyer
M. Wilkins
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FOREWORD

All text of IEC 60079-2:2007 (Edition 5) is included. U.S. National Deviations are shown by ~~strikeout~~ through text deleted and underline under text added. Tables, or portions of tables, that are to be deleted are shown as shaded; figures to be deleted are marked with the overlay "X." There are ten annexes in this standard. Annexes B, C, D, F, H, I and J are informative and are not considered part of this standard. Annexes A, E and G are normative and are considered part of this standard.

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INTRODUCTION

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

- a) a protective gas maintained at a pressure above that of the external atmosphere is used to guard against the formation of an explosive gas atmosphere within enclosures which do not contain an internal source of release of flammable gas or vapour and, where necessary;
- b) a protective gas is provided in sufficient quantity to ensure that the resultant mixture concentration around the electrical parts is maintained at a value outside the explosive limit appropriate to the particular conditions of use. The protective gas is supplied to an enclosure containing one or more internal sources of release in order to guard against the formation of an explosive gas atmosphere.

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

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1 Scope

This ~~part of IEC 60079 standard~~ contains the specific requirements for the construction and testing of electrical apparatus with pressurized enclosures, of type of protection “p”, intended for use in ~~explosive gas atmospheres~~ hazardous (classified) locations defined as Class I, Zone 1 or Zone 2 by the National Electrical Code (NEC®), ANSI/NFPA 70. It specifies requirements for pressurized enclosures containing a limited release of a flammable substance.

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

This standard does not contain the requirements for:

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

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

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

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

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

~~IEC~~ ANSI/ISA-60079-0:2007, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

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

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

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

ANSI/NFPA 70 National Electrical Code

3 Terms and definitions

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

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

3.1

alarm

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

3.2

containment system

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

3.3

dilution

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

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

3.4

dilution area

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

3.5

enclosure volume

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

3.6

flammable substance

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

3.7

hermetically sealed device

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

3.8

ignition-capable apparatus (ICA)

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

3.9

indicator

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

3.10

internal source of release

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

3.11

leakage compensation

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

3.12

overpressure

pressure above ambient pressure within a pressurized enclosure

3.13

pressurization

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

3.14

pressurization system

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

3.15

pressurized enclosure

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

3.16

protective gas

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

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

3.17**protective gas supply**

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

3.18**purging**

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

3.19**routine test**

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

[IEV 151-04-16, modified]

3.20**static pressurization**

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

3.21**type px**

pressurization that reduces the classification (equipment protection level) within the pressurized enclosure from Zone 1 (Gb) to unclassified (non-hazardous) ~~or Mb to non-hazardous~~

3.22**type py**

pressurization that reduces the classification (equipment protection level) within the pressurized enclosure from Zone 1 (Gb) to Zone 2 (Gc)

3.23**type pz**

pressurization that reduces the classification (equipment protection level) within the pressurized enclosure from Zone 2 (Gc) to unclassified (non-hazardous) unclassified (non-hazardous)

3.24**type test**

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

[IEV 151-04-15]

3.25**safety device**

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

3.26**hazardous area**

an area in which an flammable gas atmosphere is or may be expected to be present in quantites such as to require special precautions for the construction, installation and use of electrical apparatus. (IEC 60050-426-03-01)

NOTE The NEC uses "Hazardous (Classified) Location" to describe these areas. The definition for hazardous location is "a location in which fire or explosion hazards may exist due to an flammable atmosphere of flammable gases or vapors, flammable liquids, combustibile dust, or easily ignitable fibers or flyings."

3.27**non-hazardous area**

an area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installations and use of electrical apparatus. (IEC 60050-426-03-02)

NOTE The NEC uses "unclassified" to describe these areas.

3.28**autoignition temperature**

the minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heated element

3.29**protected equipment**

the electrical equipment internal to the protected enclosure.

4 Protection types

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

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Table 1 – Determination of protection type

Flammable substance in the containment system	<u>External Zone classification</u> (Equipment protection level requirement for external explosive gas atmosphere)	Enclosure contains ignition-capable apparatus	Enclosure does not contain ignition-capable apparatus
No containment system	<u>Zone 1</u> (Gb) or Mb	Type px ^a	Type py
No containment system	<u>Zone 2</u> (Gc)	Type pz	No pressurization required
Gas/vapour	<u>Zone 1</u> (Gb) or Mb	Type px ^a	Type py
Gas/vapour	<u>Zone 2</u> (Gc)	Type px (and ignition-capable apparatus is not located in the dilution area)	Type py ^b
Liquid	<u>Zone 1</u> (Gb)	Type px ^a (inert) ^c	Type py
Liquid	<u>Zone 2</u> (Gc)	Type pz (inert) ^c	No pressurization required ^d
NOTE If the flammable substance is a liquid, normal release is never permitted.			
^a ~~Type of protection px also applies to group I.~~ ^b If no normal release; see Annex E. ^c The protective gas shall be inert if "(inert)" is shown after the pressurization type; see Clause 13. ^d Protection by pressurization is not required since it is considered unlikely that a fault causing a release of liquid will simultaneously occur with a fault in the equipment that would provide an ignition source.			

Table 2 – Design criteria based upon type of protection

Design criteria	Type px	Type py	Type pz with indicator	Type pz with alarm
Degree of enclosure protection according to IEC 60529 or IEC 60034-5	IP4X minimum	IP4X minimum	IP4X minimum	IP3X minimum
Resistance of enclosure to impact	~~IEC~~ ANSI/ISA-60079-0, Table 8	~~IEC~~ ANSI/ISA-60079-0, Table 8	~~IEC~~ ANSI/ISA-60079-0, Table 8	~~IEC~~ ANSI/ISA-60079-0, half the value in Table 8
Verifying purge period	Requires a timing device and monitoring of pressure and flow	Time and flow marked	Time and flow marked	Time and flow marked
Preventing incandescent particles from exiting a normally closed relief vent into <u>a Zone 1 area</u> (an area requiring EPL Gb) ~~or Mb~~	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	No requirement, see Note 1	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced
Preventing incandescent particles from exiting a normally closed relief vent into <u>a Zone 2 area</u> (an area requiring EPL Gc)	No requirement, see Note 2	No requirement, see Note 2	No requirement, see Note 2	No requirement, see Note 2
Preventing incandescent particles from exiting a vent that opens during normal operation, to <u>a Zone 1 area</u> (an area requiring EPL Gb) ~~or Mb~~	Spark and particle barrier required, see 5.8	Spark and particle barrier required, see 5.8	Spark and particle barrier required; see 5.8	Spark and particle barrier required, see 5.8
Preventing incandescent particles from exiting a vent that opens during normal operation to <u>a Zone 2 area</u> (an area requiring EPL Gc)	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	No requirement, see Note 1	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced	Spark and particle barrier required, see 5.8, unless incandescent particles not normally produced
Door or cover removable only with use of a tool	Warning, see 5.3 and 6.2 b) ii)	Warning, see 5.3.6 and Note 1	Warning, see 5.3.6 and Note 3	Warning, see 5.3.6 and Note 3
Door or cover removable without use of a tool	Interlock, see 7.12 (no internal hot parts)	Warning, see 5.3.6 and Note 1	Warning, see 5.3.6 and Note 3	Warning, see 5.3.6 and Note 3
Internal hot parts that require a cool-down period before opening enclosure	Comply with 6.2 b) ii)	No requirement, see Note 1	Warning, see 5.3.6	Warning, see 5.3.6
NOTE 1 Subclause 6.2 b) ii) is not applicable for type py since neither hot internal parts nor normally created incandescent particles are permitted.				
NOTE 2 There is no requirement for spark and particle barriers since in abnormal operation, where the relief vent opens, it is unlikely that the external atmosphere is within the explosive limits.				
NOTE 3 There is no requirement for tool accessibility on a type of protection pz enclosure since in normal operation the enclosure is pressurized with all covers and doors in place. If a cover or door is removed, it is unlikely that the atmosphere is within the explosive limits.				

5 Constructional requirements for pressurized enclosures

5.1 Enclosure

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

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

5.2 Materials

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

5.3 Doors and covers

~~5.3.1 Group I pressurized enclosures~~

~~Doors and covers shall either~~

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

~~5.3.2 Group I pressurized enclosures with static pressurization~~

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

5.3.3 Group II pressurized enclosures

The requirements for special fasteners in ~~IEC~~ ANSI/ISA-60079-0 do not apply.

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

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

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

- a) use multiple fasteners so that the enclosure will safely vent before all fasteners are released; or
- b) use a two-position fastener to allow safe venting of the pressure when opening the enclosure; or
- c) limit the maximum internal pressure to not greater than 2,5 kPa.

5.3.4 Group II pressurized enclosures with static pressurization

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

5.3.5 Type px

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

5.3.6 Marking for ~~Group I or~~ Group II

Doors and covers shall be marked:

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

5.4 Mechanical strength

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

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

5.5 Apertures, partitions, compartments and internal components

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

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

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

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

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

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

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

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

NOTE Vents providing not less than 1 cm² of vent area for each 1 000 cm³, with a minimum vent size of 6,3 mm diameter should be sufficient for adequate purging.

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

5.5.4 Components with a free internal volume less than 20 cm³ are not considered to be internal compartments requiring purging as long as the total volume of all such components is not more than 1 % of the free internal volume of the pressurized equipment.

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

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

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

5.6 ~~Insulating materials~~

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

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

5.7 Sealing

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

5.8 Spark and particle barriers

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

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

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

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

If the manufacturer does not provide the spark and particle barriers, the equipment shall be marked with the symbol "X" in accordance with ~~29.2 i) of IEC 60079-0 and~~ ANSI/ISA-60079-0 to indicate that there are specific conditions of use and the specific conditions of use shall specify the requirements for the spark and particle barriers. the special condition for safe use shall be included on the certificate.

5.9 Internal batteries

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