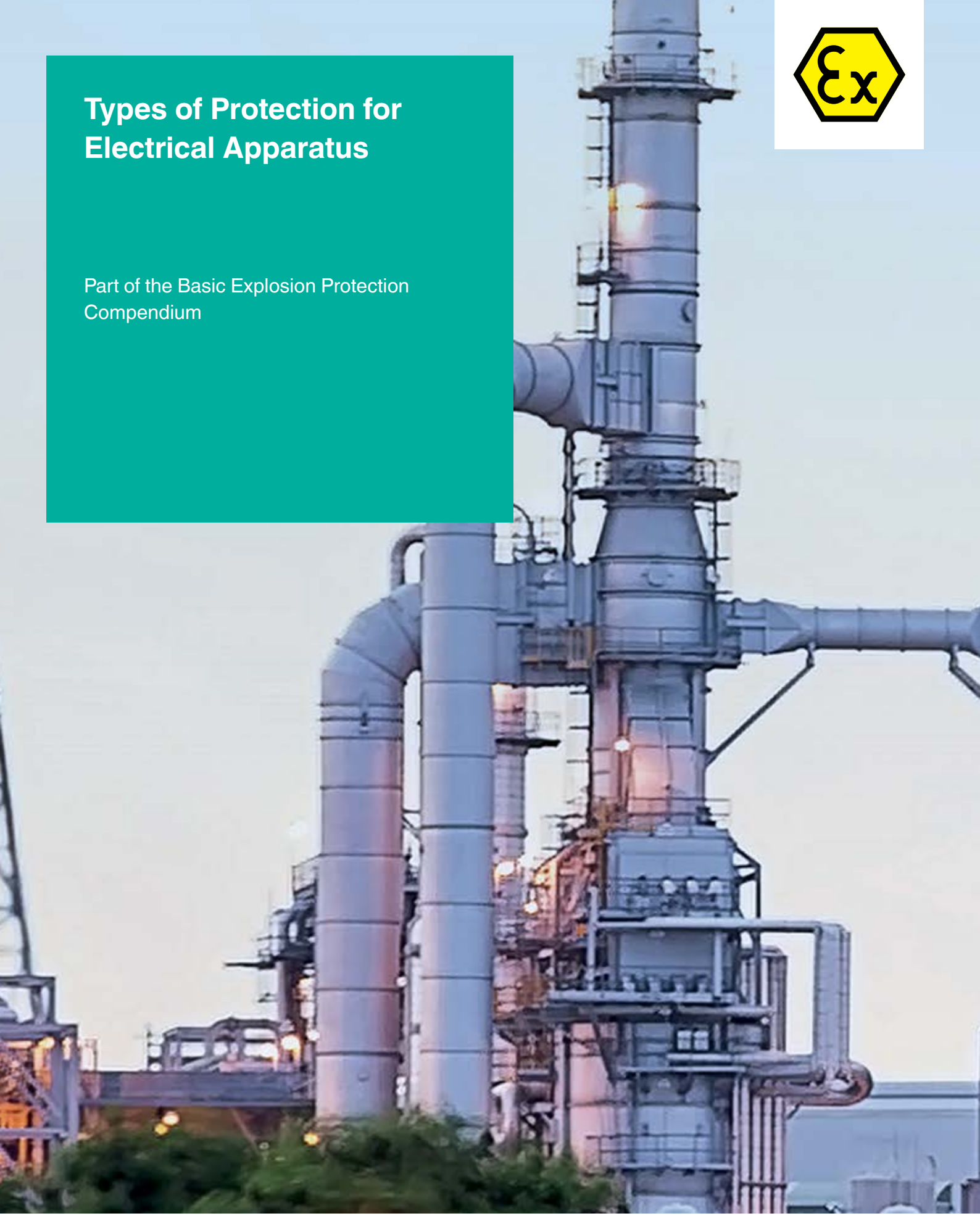
Types of Protection for Electrical Apparatus

Part of the Basic Explosion Protection Compendium



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The content of this publication has been compiled by the editor with due and thorough regard of the legal regulations valid at the date of publication and of established technical measures. Nevertheless, incomplete, inaccurate, or ambiguous assertions cannot be excluded in the publication. The publication consists of several individual brochures containing general fundamental information on explosion protection. The content of the publication is not intended for and is not suitable for assessing the hazard situation of a specific plant.
All regulations on explosion protection are established by German law, including the German Protection at Work Act, and national and international standards. Adherence to these regulations and the German Protection at Work Act are fundamental obligations of the plant designer, plant operator, and employer.
Explosion protection regulations are subject to legal guidelines and can vary by country.
Furthermore, industrial plants can differ greatly from one another in their design, materials used, and methods of operation. The individual brochures of this compendium provide an overview of topics relating to explosion protection. With this in mind, the technical and organizational measures for explosion protection can only be detailed generally and thus incompletely. In a given specific case, each plant operator must determine the requirements and approach based on an individual hazard assessment, and implement and document these in a fashion verifiable in accordance with the national regulations.
Reference is made to IEC/EN standards where appropriate. Many other countries have similar national standards in force. Reference to other national standards is made when necessary for clarity or accuracy.
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About This Basic Brochure

This brochure is part of the “Explosion Protection” compendium. The brochure offers an overview of the possible types of protection that plant designers and owners can use to protect various electrical apparatus in their plant from explosion hazards.
The brochure contains all the most important information on the subject of types of protection in accordance with the series of standards IEC/EN 60079.

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Introduction

Causes of Explosion and Possible Precautions

Explosions always come about because 3 criteria are fulfilled simultaneously and in the same location:

- Combustible substance: gas, mist, vapor, or dust
- Oxidizing agent: oxygen, normally from the air
- Ignition energy: minimum ignition energy (e. g., through sparks or heating)

Ignition Triangle

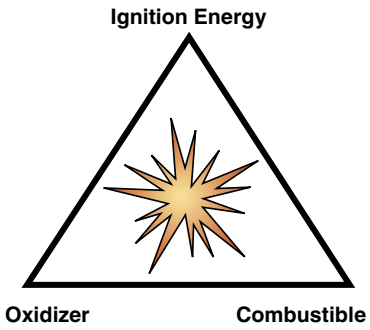

Figure 1. The ignition triangle consists of 3 components

If a combustible substance mixes sufficiently with air such that a concentration within the explosion limits is reached, we speak of a potentially explosive atmosphere or mixture.

Dust hazards also typically require suspension and containment to generate the needed conditions for explosion. However, the dust material itself may be a combustible substance.

Evaluation of each application and the hazards present should be part of every risk assessment.

Hazardous Area Classification

Areas that can exhibit a potentially explosive atmosphere are particularly at risk. According to the frequency and duration of occurrence of the atmosphere, such areas are distinguished and categorized into zones.

Hazardous Area Classification According to the Zone Model

The following zone definitions are derived from the 2015 German Ordinance on Hazardous Substances, Annex I, 1.7 and are based on the Directive 1999/99/EG (ATEX 137).

Zone 0	Area in which a dangerous potentially explosive atmosphere is constantly, persistently, or frequently present as a mixture of air and combustible gases, vapors, or mists.
Zone 1	Area in which a dangerous potentially explosive atmosphere can occasionally form as a mixture of air and combustible gases, vapors, or mists during normal operation.
Zone 2	Area in which a dangerous potentially explosive atmosphere as a mixture of air and combustible gases, vapors, or mists does not normally arise and, if so, only rarely and for a short period of time.

Table 1. For definitions of Zones 0 ... 2 see also IEC/EN 60079-10-1.

Zone 20	Area in which a dangerous potentially explosive atmosphere in the form of combustible dust contained in the air is present frequently or for long periods of time.
Zone 21	Area in which a dangerous potentially explosive atmosphere can occasionally form during normal operation in the form of combustible dust contained in the air.
Zone 22	Area in which a dangerous potentially explosive atmosphere in the form combustible dust contained in the air does not normally arise and, if so, only rarely and for a short period of time.

Table 2. For definitions of Zones 20 ... 22 see also IEC/EN 60079-10-2.

In the reissues of the standards series IEC/EN 60079, the designation “zone” is avoided and “equipment protection level” (EPL) is introduced instead.

Example: “Zone 1” is now “an area of the equipment of level of protection Gb”.

Hazardous Area Classification According to the Division Model

The following definitions are derived from the National Electric Code (NEC, NFPA 70 for the US) and the Canadian Electric Code (CEC, CSA C22.1 for Canada).

Division 1	Area in which explosive atmospheres are likely to be present continuously,
Division 2	Area in which explosive atmospheres are not likely to occur or, if they do occur, only exist for a short time.

Table 3. Definition of the North-American Divisions.

Class I	Area in which flammable gas or vapors may be present.
Class II	Area in which flammable dust may be found.
Class III	Area in which flammable fibers or flyings may be found.

Table 4. Definition of the North-American Classes.

Comparison of Zones and Divisions

Hazard Occurrence	Zone	Class/Division
Continuous gas hazard is normal	0	Class I, Division 1
Intermittent gas hazard is normal	1	Class I, Division 1
Gas hazard in abnormal condition	2	Class I, Division 2
Continuous dust hazard is normal	20	Class II, Division 1
Intermittent dust hazard is normal	21	Class II, Division 1
Dust hazard in abnormal condition	22	Class II, Division 2

Table 5. Comparison of the IEC and the North American classification of explosion hazardous locations.

Normal Operation

Normal operation is the state whereby plants are operated within their design parameters. If in doubt, the stricter Zone/Division is to be selected. Layers, deposits, and accumulations of combustible dust are to be considered like any other cause that can form a potentially explosive atmosphere. The classification is to be documented in the documentation of the hazard assessment (explosion protection document).

Permissible Equipment Categories According to IEC/EN 60079-14

Alongside the existing ATEX device categories, in the standard IEC/EN 60079-14 the “equipment protection level” (EPL) has been introduced in the device marking. Equipment that is intended for use in hazardous areas must bear this marking.

The equipment protection level provides information as to which equipment may be used in which zone of the hazardous area.

Assignment of Explosion Hazard Zone, Equipment Category, Equipment Protection Level (EPL)

Zone (ATEX/IEC)	Equipment category (ATEX Directive)	EPL (IEC/EN)
0	1G	Ga
1	2G, 1G	Gb, Ga
2	3G, 2G, 1G	Gc, Gb, Ga

Table 6. Equipment of the category 1G (EPL Ga) may be used in all gas zones.

Zone (ATEX/IEC)	Equipment category (ATEX Directive)	EPL (IEC/EN)
20	1D	Da
21	2D, 1D	Db, Da
22	3D, 2D, 1D	Dc, Db, Da

Table 7. Equipment of the category 1D (EPL Da) may be used in all dust zones.

Basic Principles of the Types of Protection

Types of protection are explosion protection measures. Types of protection prevent a device from becoming an ignition source or prevent the explosion from being propagated.

Hazard Posed by Electrical Apparatus

For electrical apparatus, the ignition hazard is predominantly due to sparks and heat generation.

What protective measures are possible against the ignition of a surrounding potentially explosive atmosphere? The following measures are fundamental:

- **Prevention of explosion propagation by encapsulation:** This method enables explosions under controlled conditions. To prevent the explosion from propagating to the surrounding atmosphere, this method specifies exactly which areas to limit the effects of the explosions to. The “flameproof enclosure” type of protection is based on this method.

- **Spatial separation between the ignition source and potentially explosive atmosphere:** This method maintains spatial separation between possible ignition sources--electrical component and hot surfaces--and the potentially explosive mixture. The “purge and pressurization,” “powder filling,” and “equipment protection by encapsulation” types of protection are based on this method. For combustible dusts, the type of protection “protection by enclosure” is used in addition to “equipment protection by encapsulation.”

- **Prevention of an effective ignition source:** This method prevents thermal effects such as hot surfaces and electrical sparks altogether. This corresponds to the type of protection “increased safety.” Alternatively, this method limits the electrical energy of a spark--also under certain fault conditions--to a safe level. This corresponds to the type of protection “intrinsic safety.”

Explosion Protection through Protected Apparatus

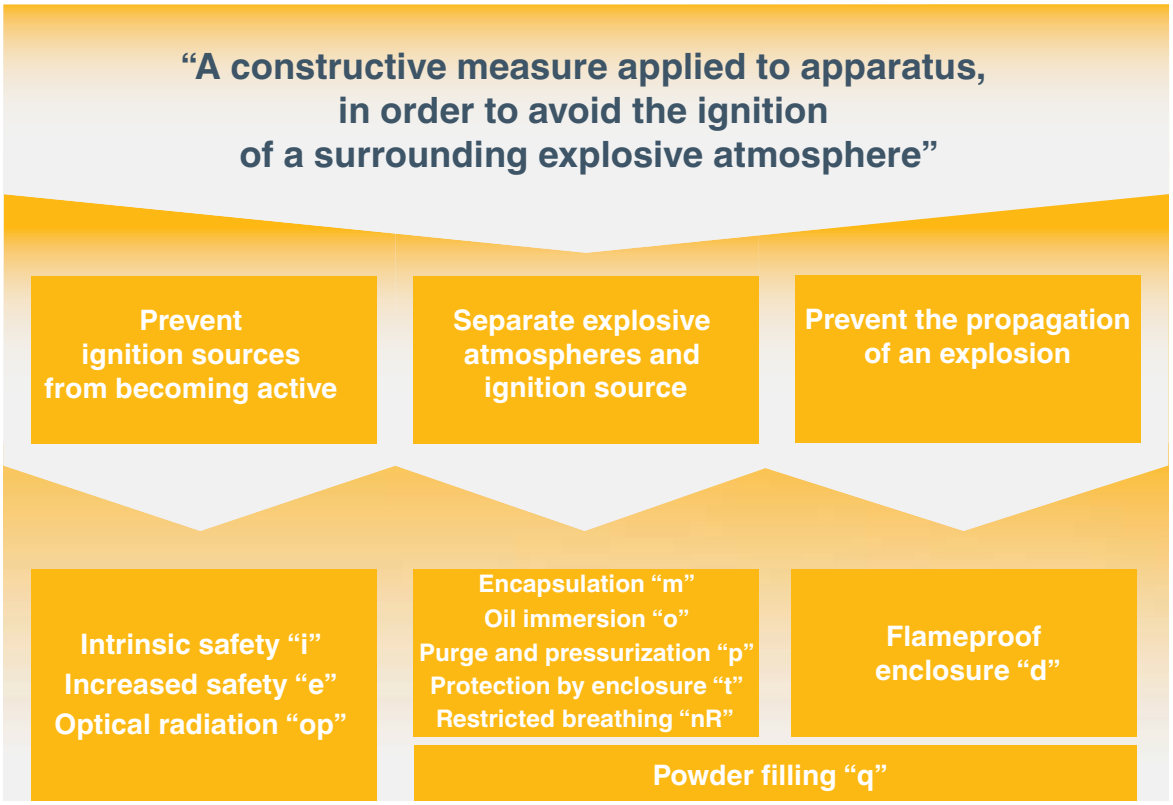

Figure 2. Type of Protection Ex e - Increased Safety

Type of Protection Ex e - Increased Safety

This type of protection that applicable to zone-classified ares. It is applied to electrical devices and includes additional measures with an increased degree of safety to prevent the possibility for exceedingly high temperatures and the generation of sparks or arcs. This applies for intended operation and under determined improper operating conditions, depending on the zone of application.

Figure 3. Ex e terminal box

Functional Principle of the Type of Protection Ex e

The potential ignition sources are located in the enclosure, into which a potentially explosive atmosphere can penetrate.

Type of Protection “Increased Safety”

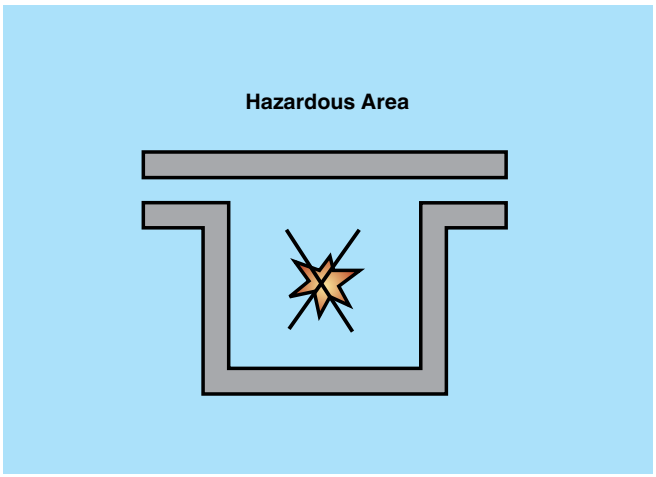

Figure 4. Schematic diagram of „increased safety“ (IEC 60079-7, EN 60079-7 and UL 60079-7)

An overdimensioning (e. g., an increased measure of the insulation) plus particular measures for the mechanical strength of the enclosure and for the fixing of connection cables (protection against self-loosening) and other constructional performance criteria prevent sparks from being generated or the device from becoming exceedingly hot. Additional possibilities include an increased degree of protection (IP) of the device and overload protection through thermal monitoring.

Level of Protection and Equipment Protection Level for Ex e

In accordance with IEC/EN 60079-7:2015, the type of protection “e” is subdivided into 2 levels of protection: “eb” and “ec.”

The protection method “eb” is limited to terminals, terminal connections, motors, and lights. The protection method “nA” was recently moved to this standard and renamed “ec.” Therefore, “ec” allows additional items, such as more complex electronics, that are not permitted under “eb.”

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere.

The EPLs available for this type of protection are Gb and Gc.

Main Applications and Marking

Enclosure for control units with components that are separately U certified.

- Connection enclosure of Ex de control panels
- Terminal boxes
- Measuring instruments
- Transformers
- Motors
- Hand lights and cap lights
- Zone 2 devices that were previously handled under non-sparking “nA”

Product Marking Containing Ex “e”

Typical examples of Ex “e” markings
II 2 G Ex eb IIC T4 Gb
II 3 G Ex ec IIC T4 Gc

Type of Protection Ex d - Flameproof Enclosure

This type of protection is used where parts that can ignite a potentially explosive atmosphere are arranged in a special enclosure. This enclosure withstands the pressure that can be produced by an internal explosion and prevents the explosion from spreading to a potentially explosive atmosphere that surrounds the enclosure.

Under the “Ex d” protection method, Class/Division applications have “explosion-proof” enclosures while zone applications have “flameproof” enclosures. In both cases, the safety principle is basically the same.

Figure 5. Ex d enclosure solution

Functional Principle of the Type of Protection Ex d

The potential ignition sources are located in an enclosure into which a potentially explosive atmosphere can penetrate.

An interior explosion does not result in the destruction of the enclosure, meaning it can withstand the maximum explosion pressure of the permitted gases. The pressure is relieved by means of a flameproof joint. These enclosures typically require third-party verification from a certification agency or a “notified body,” e. g., the Physikalisch Technische Bundesanstalt (PTB, National Metrology Institute of Germany). This organization determines the suitability of the enclosure and the applications in which it can be used.

Type of Protection “Flameproof Enclosure”

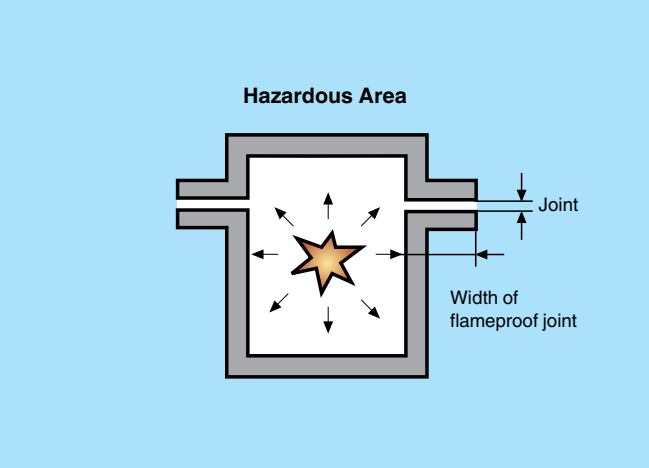

Figure 6. Schematic diagram of a flameproof enclosure (IEC 60079-1, EN 60079-1, FM 3615, UL 2279.P1, EN 13463-3)

The user is responsible for suitable cable entries and sealing plugs. In accordance with IEC/EN 60079-14, a cable entry is possible in 3 ways:

- Proper seals from the Ex d enclosure leading into a terminal compartment of increased safety.
- Direct cable entry with Ex d cable glands or seals
- A conduit installation and, depending on the permitted length of the conduit, additional seals

In accordance with NEC and CEC for Class/Division classification, a cable entry is possible in 2 ways:

- Direct cable entry with flameproof cable glands or seals
- A conduit and, depending on the permitted length of the conduit, additional seals

A modification of the flameproof enclosure and the content is permitted only if this is intended and described in the instruction manual. The user is not permitted to perform any modification or overhaul of the flameproof joint whatsoever.

Motors in the inverter operation: There are 2 possibilities here:

1. Motor and electrical drive inverter are examined as a unit and the results are considered during the type examination of the motor.

2. The outside temperature of the enclosure surrounding the motor and electrical drive inverter is monitored effectively and protected with a protective switch.

Level of Protection and Equipment Protection Level for Ex d

The type of protection “d” is, in accordance with IEC/EN 60079-1:2014, subdivided into 3 levels of protection: “da,” “db,” and “dc.”

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere. Equipment of the type of protection “d” is protected by the level of protection “da” (EPL “Ga”) or “db” (EPL “Gb”), or “dc” (EPL “Gc”).

One way of achieving the level of protection “da” is to combine 2 independent types of protection with level of protection “db.”

The level of protection “da” can only be used for catalytic sensors and portable sensors for combustible gases. Alongside other conditions, the free internal volume must not exceed 5 cm^3.

The type of protection “explosion-proof” for Class/Division classifications is covered by several standards, including UL 1203, CSA 22.2 No. 30, and CSA 22.2 No. 25 for enclosures. UL 2225 and CSA 22.2 No. 174 cover cable glands. Enclosures and connection fittings are designated with the permitted Class and Division.

Main Applications and Marking

- Switching devices and control panels
- Control units, e. g., as control interface for sensors
- Motor protective switches and protective switches for lines
- Transformers
- Motors
- Light fittings

Product Marking Containing Ex “d”

Typical examples of Ex “d” markings
II 1 G Ex da IIC T4 Ga
II 2 G Ex db IIC T4 Gb
II 3 G Ex dc IIC T4 Gc

Type of Protection Ex i - Intrinsic Safety

Type of protection that is based on limiting the electrical energy to a defined value. This value lies below the limit value, which can trigger an ignition by spark generation or thermal effect. These parameters apply within the devices and for all connecting cables and lines that are exposed to a potentially explosive atmosphere.

Figure 7. Valve status request with an Ex i sensor

Functional Principle of the Type of Protection Ex i

In intrinsically safe circuits, currents and voltages are safely limited, as well as power and thermal considerations are taken into account.

Further, the energy storage is limited safely, e. g., coils and capacitors.
This also takes into account distributed reactance values of cables and lines.

Typical configuration includes the following two elements:

- An associated apparatus (or “barrier”) that provides energy limitation into the explosion hazardous area
- An apparatus (or “device”) that is designed with certain limitations to comply with the type of protection

Type of Protection “Intrinsic Safety”

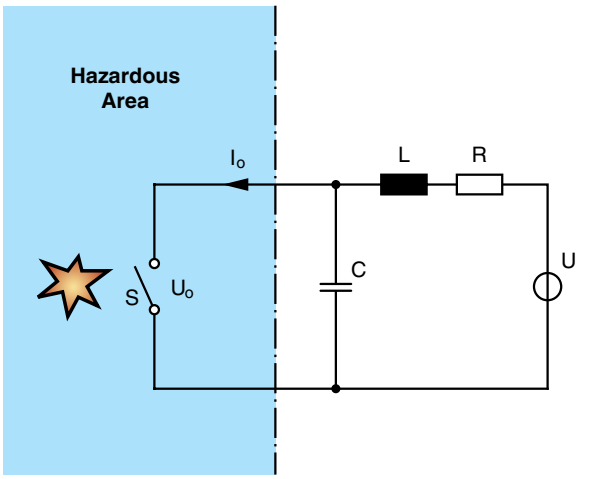

Figure 8. Schematic diagram of an intrinsically safe circuit(IEC 60079-1, EN 60079-1, and UL 60079-1)

The user undertakes the verification of intrinsic safety and documents this verification in the plant documentation. In accordance with IEC/EN 60079-14:2013 (sections 4.2 and 16.2.4), NEC Article 504, or CEC Section 18, the verification is required as part of the plant documentation, which must be available in the plant. In Germany, this must take place in accordance with §6(9) of the German Hazardous Substances Ordinance in the explosion protection document. Most commonly, this is done as part of or appendix of the apparatus list.

Intrinsically safe circuits must be protected from any kind of coupling. To achieve this, minimum distances are observed on the terminals, for example 50 mm from intrinsically safe terminals to non-intrinsically safe terminals.

Cables and lines must be marked and protected.

Level of Protection and Equipment Protection Level for Ex i

The type of protection intrinsic safety “i” is subdivided into 3 levels of protection: “ia,” “ib,” and “ic.”

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere.

Equipment protection level (EPL)	Equipment category Gas	Degree of safety
ia	1G	Safe if 2 independent errors occur.
ib	2G	Safe if 1 error occurs.
ic	3G	Safe in normal operation.
[ia Ga]	Associated apparatus	Installation outside of the hazardous area. Supply possible for field devices in the Zones 0, 1, or 2.

Table 8. Levels of protection for the type of protection “Intrinsic Safety (Ex i)” in gas hazardous areas

Equipment protection level (EPL)	Equipment category Dust	Degree of safety
ia	1D	Safe if 2 independent errors occur.
ib	2D	Safe if 1 error occurs.
ic	3D	Safe in normal operation.
[ib Db]	Associated apparatus	Installation outside of the hazardous area. Supply possible for field devices in the Zones 21 or 22 in this case.
[ia Da]	Associated apparatus	Supply permitted for field devices in Zone 20.

Table 9. Levels of protection for the type of protection “Intrinsic Safety (Ex i)” in dust hazardous areas

Main Applications and Marking

- Measurement and control engineering
- Sensors and actuators
- Fieldbus technology
- Instrumentation

Product Marking Containing Ex “i”

Typical examples of Ex “i” markings
II 1 G Ex ia IIC T6 Ga
II (1) G [Ex ia Ga] IIC

Type of Protection Ex p - Purge and Pressurization

Protection technology safeguarding against a surrounding atmosphere penetrating into an enclosure through the use of a protective gas under overpressure.

Figure 9. Control unit for a pressurization system

Functional Principle of the Type of Protection Ex p

The potential ignition sources are located in a robust enclosure under a low overpressure: 25 Pa ... 50 Pa, or 0.25 mbar ... 0.5 mbar. If air is used as a protective gas, this air must be drawn from the non-hazardous area.

Type of Protection “Purge and Pressurization”

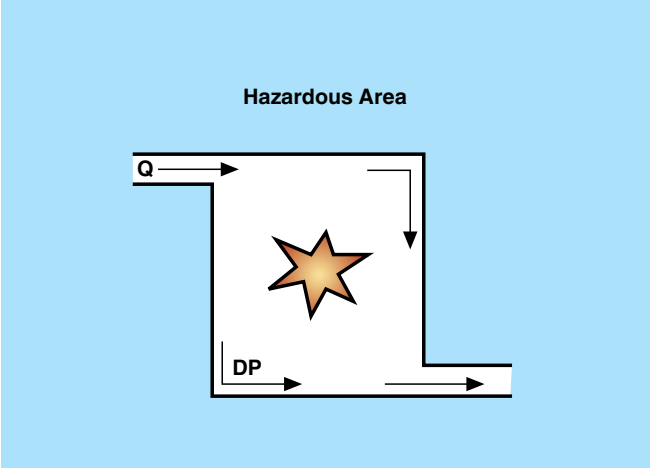

Figure 10. Schematic diagram of a pressurizing system (IEC 60079-2, EN 60079-2, FM 3620 and NFPA 496)

Level of Protection and Equipment Protection Level for Ex p

The type of protection purge and pressurization “p” is subdivided into 3 levels of protection: “px,” “py,” and “pz.” An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere.

Equipment protection level (EPL)	Equipment category gas/dust	Degree of safety
px	2G, 2D	Installation of the device in Zone 1 or Zone 21: no explosion hazard in interior. Use of standard devices safe.
py	3G, 3D	Installation of the device in Zone 1 or Zone 21: interior of the device Zone 2 or Zone 22. Use of devices from Zone 2 or Zone 22 and EPL Gc or Dc safe.
pz	3G, 3D	Installation of the device in Zone 2 or Zone 22: no explosion hazard in interior. Use of standard devices safe.

Table 10. Levels of protection for the type of protection “Purge and Pressurization (Ex p)” in gas or dust hazardous areas

If the overpressure fails, an alarm signal is necessary.

For type of protection Ex pxb in Zone 1 or Zone 21 with internal devices that do not fulfill the EPL Gc or Dc, the unprotected device in the interior of the enclosure must also be shut down.

For Zone 1 and Zone 2 applications, the enclosure must be purged prior to power being applied. The purge cycle depends on several factors. Typically, a purge cycle is made up of 4 volume exchanges for applications that follow NFPA 496 for Class/Division applications or 5 volume exchanges for applications that are based on IEC 60079-2 series standard. Depending on the application, the number of required volume exchanges may be higher or lower.

Main Applications and Marking

- Switch cabinets
- Large motors
- Measuring instruments and analysis equipment

Product Marking Containing Ex “p”

Typical examples of Ex “p” markings
II 2 G Ex pxb IIB T4 Gb
II 3 G Ex pzc IIC T4 Gc
II 2 D Ex pxb IIIC T80 °C Db

Type of Protection Ex m - Equipment Protection by Encapsulation

Type of protection that encapsulates parts, capable of igniting a potentially explosive gas atmosphere through the generation of sparks or heating, in a casting compound. This means that the surrounding potentially explosive atmosphere cannot be ignited under conditions of operation or installation.

Functional Principle of the Type of Protection Ex m

The equipment protection by encapsulation “m” method prevents the potentially explosive atmosphere from penetrating into an enclosure with potential ignition sources.

Type of Protection “Equipment Protection by Encapsulation”

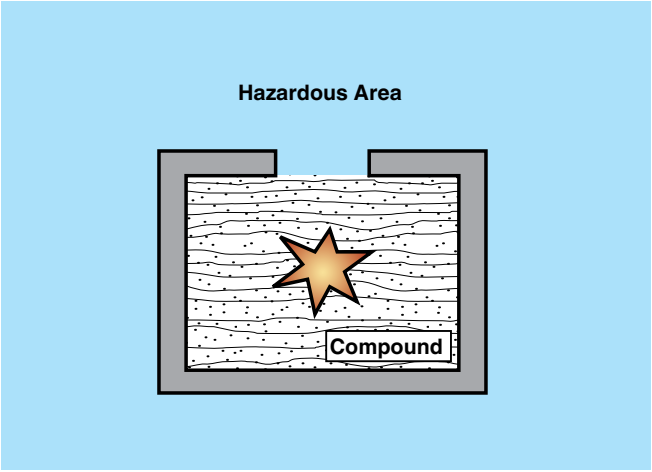

Figure 11. Schematic diagram of equipment protection by encapsulation (IEC 60079-18, EN 60079-18 and UL 60079-18)

The enclosure has sufficient mechanical strength and is chemically resistant to the materials in the vicinity of which it is to be used.

The filling material must not come away from the enclosure wall during permitted temperature fluctuations.

The user is responsible for following the manufacturer's instruction manual to install, bring into service, and operate the apparatus.

Level of Protection and Equipment Protection Level for Ex m

The type of protection “m” is, in accordance with IEC/EN 60079-18:2014, subdivided into 3 levels of protection: “ma,” “mb,” and “mc.”

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere.

Equipment of the type of protection “m” is protected by the level of protection “ma” (EPL “Ga” or “Da”) or “mb” (EPL “Gb” or “Db”) or “mc” (EPL “Gc” or “Dc”).

Main Applications and Marking

- Display devices
- Sensors
- Switching devices for low power
- Control units

Product Marking Containing Ex “m”

Typical examples of Ex “m“ markings
II 1 G Ex ma IIC T4 Ga
II 2 G Ex mb IIC T4 Gb
II 2 D Ex mb IIIC T90 ˚C Db
II 3 D Ex mc IIIC T90 ˚C Dc

Type of Protection Ex o - Equipment Protection by Liquid Immersion

Type of protection used for protecting electrical equipment or components by immersing them in a protective liquid. Consequently, a potentially explosive gas atmosphere above the liquid level or external to the enclosure cannot be ignited.

Functional Principle of the Type of Protection Ex o

The potential ignition sources are located in the enclosure. The potentially explosive atmosphere is kept away from the ignition source.

Type of Protection “Equipment Protection by Liquid Immersion”

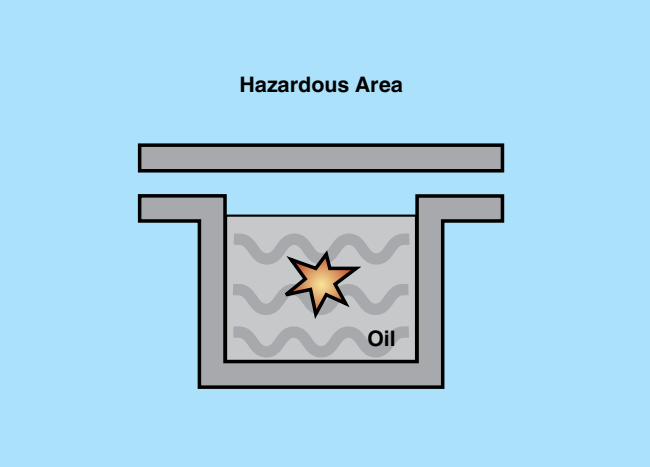

Figure 12. Schematic diagram of equipment protection by liquid immersion (IEC 60079-6, EN 60079-6 and UL 60079-6)

The fill level of the protective liquid must be monitored. The mounting position must also ensure that the ignition sources are permanently located beneath the liquid level.

The user himself is responsible for following the manufacturer's instruction manual to install, bring into service, and operate the apparatus.

Level of Protection and Equipment Protection Level for Ex o

The type of protection “o” is, in accordance with IEC/EN 60079-6:2015, subdivided into 2 levels of protection: “ob” and “oc.”

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere.

Equipment of the type of protection “o” is protected by the level of protection “ob” (EPL “Gb” or “Db”) or “oc” (EPL “Gc” or “Dc”).

Main Applications and Marking

- Transformers
- Starting resistors
- Switching devices

Product Marking Containing Ex “o”

Typical examples of Ex “o“ markings
II 2 G Ex ob IIB T4 Gb
II 3 G Ex oc IIC T4 Gc

Type of Protection Ex q - Powder Filling

Type of protection where fixed installed parts that are able to ignite a potentially explosive gasatmosphere are completely surrounded by filling material. This prevents the ignition of a surrounding potentially explosive atmosphere.

Figure 13. Powder-filled operator workstation

Functional Principle of the Type of Protection Ex q

By using very fine-grain silicia beads, the free enclosure space is filled up and the likelihood for penetration of the potentially explosive atmosphere is greatly reduced. Should ignition occur in the remaining space, the thermal capacity of the filling material extinguishes the emergent flame.

Type of Protection “Powder Filling”

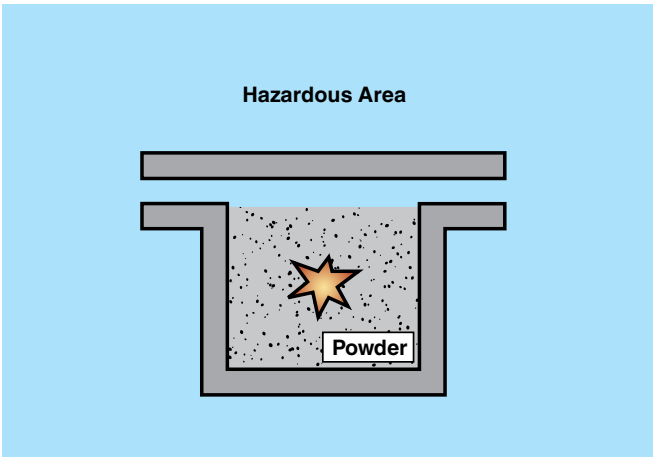

Figure 14. Schematic diagram of „powder filling“ (IEC 60079-5, EN 60079-5 and UL 60079-5)

The user himself is responsible for following the manufacturer's instruction manual to install, bring into service, and operate the apparatus.

Level of Protection and Equipment Protection Level for Ex q

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the device becoming an ignition source in a potentially explosive atmosphere.

In accordance with IEC/EN 60079-5:2015, the equipment of the type of protection “q” is protected by the level of protection “qb” (EPL “Gb” or “Db”).

Main Applications and Marking

- Operating devices and display devices
- Transformers
- Electronic ballasts

Product Marking Containing Ex “q”

Typical examples of Ex “q” markings
II 2 G Ex qb IIB T4 Gb

Type of Protection Ex n

Type of protection accompanied by a set of mostly constructive measures, ensuring that electrical equipment cannot ignite a surrounding potentially explosive atmosphere during intended operation and under determined improper conditions.

Functional Principle of the Type of Protection Ex n

The type of protection “non-incendive” or “non-sparking” features different possibilities to safely construct apparatus. This prevents the apparatus from igniting a surrounding potentially explosive gas atmosphere during normal operation.

Non-Sparking Installation “ec” (Previously “nA”)

Since 2016, the type of protection non-sparking installation “nA” has been named “ec” in accordance with IEC/EN 60079–7:2015.

A device with this type of protection is constructed to minimize the risk of occurrence of arcs or sparks that present an ignition hazard during normal operation.

Restricted-Breathing Enclosure “nR”

An enclosure that limits penetration by gas, vapor, or mist.

Type of Protection “n” (Non-Incendive)

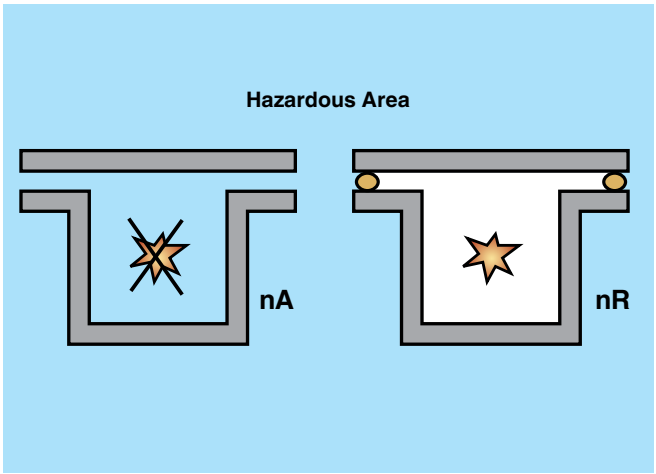

Figure 15. Schematic diagram of the type of protection „n“ (non-incendive)(IEC 60079-15, EN 60079-15, and UL 60079-15)

Enclosed-Break Device “dc” (Previously “nC”)

Since 2016, the type of protection enclosed-break device “nC,” in accordance with IEC/EN 60079-1:2014, has been named “dc.”

A device with this type of protection contains electrical contacts that are made and broken and without damage withstands an internal explosion of any ingressing flammable gas or vapor and without transferring the internal explosion to a surrounding potentially explosive atmosphere.

In accordance with IEC/EN 60079-5:2015, the equipment of the type of protection “q” is protected by the level of protection “qb” (EPL “Gb” or “Db”).

Main Applications and Marking

- Motors
- Light fittings
- Switching devices
- All other types of electrical apparatus for Zone 2

Product Marking Containing Ex “n”

Typical examples of Ex “n” markings
II 3 G Ex nR IIB T4 Gc

Type of Protection Ex t - Equipment Dust Protection by Enclosure

The type of protection “t,” previously “tD,” in accordance with IEC/EN 61241-1, is a special type of protection for dust hazardous areas. In order to fulfill this type of protection, the electrical apparatus is installed in an enclosure with protection against dust entry and precautions for limiting the surface temperature.

Functional Principle of the Type of Protection Ex t

Devices with this type of protection have a special enclosure that prevents the entry of dust. The enclosure must also be engineered in a way that a maximum surface temperature can never be exceeded.

Devices with this type of protection can be used as apparatus for the device categories 1D (Zone 20), 2D (Zone 21), and 3D (Zone 22).

Type of Protection “Equipment Dust Protection by Enclosure”

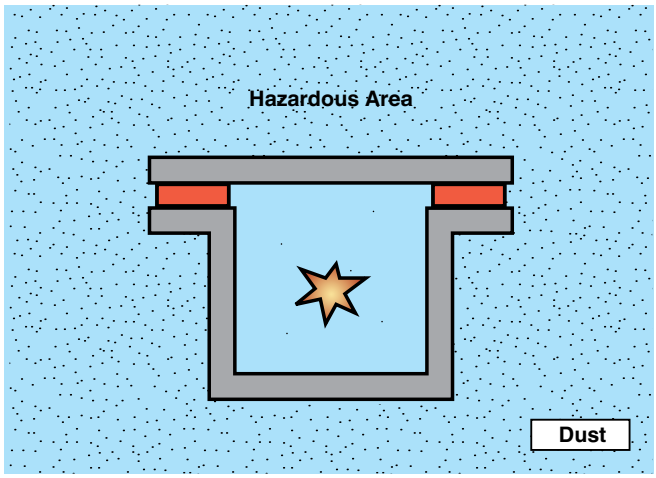

Figure 16. Schematic diagram of equipment dust protection by enclosure (IEC 60079-31, EN 60079-31 and UL 60079-31)

Level of Protection and Equipment Protection Level (EPL) for Ex t

The type of protection “t” is, in accordance with IEC/EN 60079-31:2016, subdivided into 3 levels of protection: “ta,” “tb,” and “tc.”

An equipment protection level is assigned to every level of protection. This EPL is based on the likelihood of the equipment becoming an ignition source in a potentially explosive atmosphere.

Equipment of the type of protection “t” is protected by the level of protection “ta” (EPL “Da”) or “tb” (EPL “Db”) or “tc” (EPL “Dc”).

For equipment of the type of protection “ta,” the maximum permitted short circuit current of the current source must be cited in the identification. For the level of protection “ta,” the enclosure must undergo a thermal examination where an at least 200 mm thick dust layer is deposited all over the surface.

The devices must be protected against dust entry and meet the following requirements.

Level of protection	IIIC	IIIB	IIIA
ta	IP6X	IP6X	IP6X
tb	IP6X	IP6X	IP5X
tc	IP6X	IP5X	IP5X

Table 11. Type of protection “t”: Level of protection according to equipment group

Main Applications and Marking

- For all electrical apparatus in dust hazardous areas
- Light fittings
- Sensors
- Actuators

Product Marking Containing Ex “t”

Typical example of Ex “t” marking
II 2D Ex tb IIIC T80 ˚C Gb

Type of Protection Ex op

Type of protection in accordance with IEC/EN 60079-28:2015 for the protection of equipment and transmission systems that operate with optical radiation.

Functional Principle of the Type of Protection Ex op

Type of protection applied to an optical device in order to prevent optical radiation from igniting a potentially explosive surrounding atmosphere. This is achieved in accordance with IEC/EN 60079-28:2015 through the following protection concepts:

Inherently Safe Optical Radiation “op is”

Visible or infrared radiation that cannot, under normal circumstances or under determined fault conditions, produce sufficient energy to ignite a potentially explosive atmosphere.

The concept is akin to that of intrinsic safety, providing energy limitation in the system to safe values, and enables the exchange of components during operation. If the limited values do not suffice for the application, other options must be implemented.

In accordance with IEC/EN 60079-28:2015, table 1, this protection concept is suitable for EPL Gc and Dc. When considering and avoiding errors, Gb, Db, Ga, and Da are also possible.

Protected Optical Radiation “op pr”

Visible or infrared radiation constructed and encapsulated normally or with mechanical protection in an optical fiber or another transmitting medium. No radiation should leak from this encapsulation.

To prevent radiation leaking from its encapsulation, fiber optic cables must be set out in an appropriately robust fashion or a manner that makes them safe from destruction. In this construction, no simple exchange is possible during operation. If optical components must be exchanged frequently, alternative options must be considered.

In accordance with IEC/EN 60079-28:2015, table 1, this protection concept is suitable for EPL Gc and Dc. With additional mechanical protection, Gb and Db are also possible.

Optical Systems with Locking “op sh”

System for encapsulating visible or infrared radiation that is encapsulated in fiber optic cables or other transmitting mediums. If the protection guaranteed by the encapsulation fails and the radiation is released, this is locked and the radiation is shut down. This way, the unprotected ray strength is reduced to safe values in a defined time and the radiation can even be shut down entirely.

In accordance with IEC/EN 60079-28:2015, table 1, this protection concept is suitable for EPL Gc and Dc. When operating a protected fiber optic cable “op pr,” Gb, Db is also possible. EPL Ga or Da is possible when using a protected fiber optic cable “op pr” that fulfills the EPL Gb or Db.

Type of Protection “Equipment Using Optical Radiation”

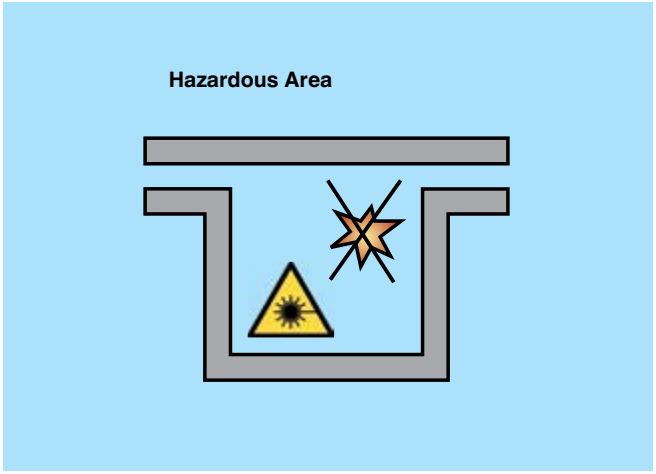

Figure 17. Schematic diagram for the protection of equipment using optical radiation (IEC 60079-28, EN 60079-28 and ISA 60079-28)

Main Applications and Marking

This type of protection ist typically used with the following components for connecting sensors and sensing elements that also serve to transfer data in general:

- Light fittings
- Laser
- LEDs
- Fiber optic cable

Product Marking Containing Ex “op”

Typical examples of Ex “op” marking
II 1G Ex op is IIB T4 Ga
II 2G Ex op pr IIC T4 Gb
II 3D Ex op sh IIC T90 ˚C Dc

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IEC 60079-0 Explosive atmospheres--Part 0:
Equipment- General requirements

IEC 60079-1 Explosive atmospheres--Part 1:
Equipment protection by flameproof enclosures “d”

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Equipment protection by purge and pressurization

IEC 60079-5 Explosive atmospheres--Part 5:
Equipment protection by powder filling “q”

IEC 60079-6 Explosive atmospheres--Part 6:
Equipment protection by oil immersion “o”

IEC 60079-7 Explosive atmospheres--Part 7:
Equipment protection by increased safety “e”

DIN EN 60079-10-1 Explosive atmospheres--Part 10-1:
Classification of areas--Explosive gas atmospheres

DIN EN 60079-10-2 Explosive atmospheres--Part 10-2:
Classification of areas--Explosive dust atmospheres

IEC 60079-11 Explosive atmospheres--Part 11:
Equipment protection by intrinsic safety “i”

IEC/EN 60079-14 Explosive atmospheres--Part 14:
Electrical installations design, selection and erection

IEC 60079-15 Explosive atmospheres--Part 15:
Equipment protection by type of protection “n”

IEC 60079-18 Explosive atmospheres--Part 18:
Equipment protection by encapsulation “m”

IEC 60079-28 Explosive atmospheres--Part 28:
Protection of equipment and transmission systems using optical radiation “op”

IEC 60079-31 Explosive atmospheres--Part 31:
Equipment dust explosion protection by enclosure “t”

Directive 1999/92/EC
of the European Parliament and Council of December 16, 1999 regarding minimum provisions to improve health protection and safety of employees who may be endangered by potentially explosive atmospheres (Fifteenth Individual Directive for the Purpose of Article 16, Para. 1 of Directive 89/391/EEG)

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Pepperl+Fuchs, ed., Testing and maintenance--Testing and maintenance in accordance with IEC/EN 60079-17.

Pepperl+Fuchs, ed., Type of protection intrinsic safety--Verification of intrinsic safety particularly in fieldbus applications.

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Pepperl+Fuchs, ed., Rules and directives worldwide-- Legal regulations of regions and countries for market access of explosion-protected equipment.

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Pepperl+Fuchs, ed., Nonelectric explosion protection: Specifics of nonelectric equipment, ignition hazard assessment, types of protection, identification.

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Industrial Sensors

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- Photoelectric Sensors
- Industrial Vision
- Ultrasonic Sensors
- Rotary Encoders
- Positioning Systems
- Inclination and Acceleration Sensors
- Fieldbus Modules
- AS-Interface
- Identification Systems
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