

# Principles of Ex-Protection



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**Preface**

This publication provides a brief survey of the essential aspects of explosion-protection.

The statutory regulations define the obligatory duties of manufacturers, installers and operators of electrical installations in explosive atmospheres. Important hints you will also find in the regulations of the professional associations.

Eaton's Crouse-Hinds Division seminars imparts expert knowledge in explosion protections in theory and practice.

(<https://www.crouse-hinds.de/de/seminar-explosionsschutz/>)





# Principles of Explosion-Protection

The history of explosion-protection and the legislative provisions

## The history of explosion-protection and the legislative provisions

As early as 1909 Concordia Elektrizitäts-Aktiengesellschaft, later called CEAG, began to manufacture firedamp-protected electrical miners' lamps for the mining industry. Until then, only lamps with a naked flame were available. The first contribution to safety was made in 1815 by the English chemist, Sir Humphry Davy, who developed an oil lamp that prevented the propagation of the flame by means of a close-meshed screen. The elementary experiments carried out by Dr.-Ing. e.h. Carl Beyling, a mining engineer, relating to the specially protected electrical motors and apparatus in coal mines against firedamp were a decisive step in the development of explosion-protection. The governing design principles of firedamp protection devices on electrical machines, transformers and switchgear issued in 1912 were based on the results of these experiments. The following types of protection were accepted as protective measures:

- Oil immersion
- Closed encapsulation
- Plate encapsulation
- Close-meshed screen
- Labyrinth encapsulation
- "Flat joint" encapsulation

Light switches had to be installed outside of the hazardous locations, and in the case of a failure or the lack of explosion-protected lighting, access to these locations was only permitted with safety lamps. Therefore, in general, electrical installations were not used in hazardous locations.

Machines with slip rings or commutators had to be designed in such a way that the slip ring or commutator was, at least, enclosed and the enclosure purged thoroughly under overpressure with extraneous air or a suitable gas. Purging had to start prior to switching on the machine or the machine had to be built into a flameproof enclosure. This requirement applied to all locations where explosive gas or vapour/air mixtures might occur.

The first German regulations on the subject of the protection of hazardous installations were the "Guiding principles on the installation of electrical equipment in hazardous production areas and storage rooms (VDE 0165/1935), which were issued in 1935.

} **Flameproof enclosure**

From 1924 incandescent lamps only were permitted for lighting hazardous areas, whereby the luminous element was hermetically sealed. The incandescent lamps had to be protected with a strong glass that also tightly enclosed the lamp holder.

The fundamental revision of these regulations began with the VDE regulations 0171 "Constructional regulations for explosion-protected apparatus", which came into force in 1943. They provided the manufacturers of electrical equipment for use in potentially explosive atmospheres with the necessary documents for a safe design and construction.

The regulation not only described the individual types of protection and the scope of their application, but also included a number of constructional



Firedamp-proof miner's lamps (combustion lamps)

specifications and introduced the  $\text{Ex}$  identification marking for electrical apparatus built in compliance with it.

The governing principles and specifications of the VDE regulations 0165 and 0171 were the basis of the police decree dated 13.10.1943 for electrical apparatus in hazardous locations and in mines subject to the hazard of firedamp. The police decree was primarily aimed at the manufacturers of electrical apparatus. It specified that explosion-protected electrical equipment could only be placed on the market, installed and operated if it conformed to the so-called VDE regulations and had successfully passed the specified type and routine tests.

The responsible factory inspectorate division was chosen to be the competent authority to define to what extent a room or plant might be subject to the hazard of explosion.



Research papers by Carl Beyling, mining engineer



Police decree dated 13.10.1943



# Principles of Explosion-Protection

The history of explosion-protection and the legislative provisions

1



Explosion-protected electrical equipment from the 60's

The "Decree concerning electrical installations in potentially explosive atmospheres (ExVO)", which was issued in 1963, not only introduced the obligation to have the explosion-protected apparatus tested by the Federal Physico-Technical Institute (Physikalisch-Technische Bundesanstalt PTB) or the Mining Test Station (BVS), but also the obligation to obtain the design approval from the authorities of the competent federal state.

In 1975 the Council of the European Community issued framework directives on explosion-protection. The European standards for electrical equipment for use in hazardous areas were drawn up by CENELEC, the "European committee for electro-technical standardization". In Germany the new European standards EN 50 014 to EN 50 020 were adopted in the national standards as VDE standards. These new standards DIN EN 50014 to 50020/ VDE 0170/0171, Parts 1 to 7, designated as VDE regulations, came into force on 01.05.1978.

The application of these European standards for the construction and testing of explosion-protected electrical apparatus was governed throughout Europe by the "EC Directive 79/196/EC". With the new regulation, now known as ElexV, among other things this EC Directive was implemented on 01.07.1980 and explosion protection newly regulated for manufacturers and operators. Furthermore, the expertise of the testing establishments and the design approval were replaced by a type sample test. The type sample test was carried out by authorized testing establishments of the member states of the EU (Notified Bodies). The certificates of conformity and inspection granted on the basis of the said tests were valid throughout Europe.

Directive 94/9/EC on the approximation of the laws of the Member States concerning equipment and protective systems for use in potentially explosive atmospheres, issued on 23.03.1994 by the European Parliament and Council, irrevocably replaced any previous directives concerning explosion-protection that existed on a European level from 01.07.2003.

On 12.12.1996, Directive 94/9/EC was converted into national law by the second decree concerning the equipment safety law and the changes relating to the equipment safety law by the explosion-protection decree (ExVO). With this decree, the acetyl decree (AcetV), the decree on flammable liquids (VbF) and the ElexV were also brought into line with the European law.

On 28.01.2000, Directive 1999/92/EC of the European Parliament and Council, dated 16.12.1999, the second important directive concerning explosion protection, was published in the official gazette of the European communities. It contains minimum requirements for the improvement of the safety and health protection of employees potentially at risk from explosive atmospheres. This EC directive, also called the European Occupational Safety Directive, lays down the rules for operational explosion protection and is aimed at the operators of installations where explosion hazards are to be expected.

The directive was converted into national law on 03.10.2002 in the "Decree on health and safety protection relating to the provision of work equipment and the use thereof during operation, safety during the operation of installations requiring supervision and the organisation of operational safety provisions (Industrial Safety Regulation – BetrSichV)".



ElexV from 1980

The BetrSichV replaces the ElexV for explosion protection. However, within the scope of the transitional regulations, the ElexV could still be applied for installations that were commissioned before 03.10.2002.

On 19.04.2014 Directive 2014/34/EU, the successor directive to 94/9/EC came into effect with a two-year transition period. This new directive had become necessary as a result of the approximation with other EU directives, without revising the technical content. On a national level, this new ATEX directive was transposed in the 11th Regulation on the Product Safety Act. (ExVO – 11. ProdSV).

As a result of the reform of national and European regulations (REACH regulation- 1907/2006/EC, the Chemicals Act ChemG and the Occupational Safety Act ArbSchG,), it was also necessary to review the Industrial Safety Regulation (BetrSichV) with the set of Technical Regulations on Industrial Safety (TRBS) and the Ordinance on Hazardous Substances (GefStoffV) with the set of Technical Rules for Hazardous Substances TRGS.



## Physical principles of explosion-protection

### Explosive mixture – explosive atmosphere

§2 of the Ordinance on Hazardous Substances (GefStoffV) contains the following terms for explosive mixture / explosive atmosphere. As these terms are not congruent with the definitions according to the standards/IEC (International Electrotechnical Vocabulary), supplement the terms of the GefStoffV found there:

1. An explosive mixture is a mixture of combustible gases, vapours, mists or whirled up dust with air or another oxidizing agent, whereby, after an ignition source has become active, an automatic flame propagation, which generally involves a sudden rise in temperature and pressure, takes place.
2. A dangerous explosive mixture is one which arises in such a quantity that special protective measures are necessary for the maintenance of the health and safety of workers or other persons.
3. A dangerous explosive atmosphere is a dangerous mixture with air as the oxidizing agent under atmospheric conditions (ambient temperature from -20 °C to +60 °C and pressure from 0.8 bar to 1.1 bar).
4. A hazardous area is the area in which a dangerous explosive atmosphere can occur.

### Combustible substance mixed with air

The description of the physical principles presupposes some basic definitions which are derived, in part, from the normative specifications. The European regulations and the associated national regulations are also based on these specifications. The definitions used in explosion protection can be found in Chapter 426 of the IEV (IEC 60050), the International Electro-technical Vocabulary.

### Definition „Explosive atmosphere“

Mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, dust, fibres or flyings which, after ignition, permits a selfsustaining propagation.

Standard atmospheric conditions (relating to the properties of an explosive atmosphere) according to IEC 60079-0, the basic standard for electrical equipment, and ISO 80079-36, the basic standard for mechanical equipment, are specified as follows:

- Temperature -20 °C to +60 °C,
- Pressure 80 kPa (0.8 bar) to 110 kPa (1.1 bar) and
- air with normal oxygen content, generally 21 %/vol.

This limitation is necessary, as the essential safety parameters for explosion protection are a function of the pressure, temperature and oxygen content and can only be considered to be sufficiently constant if they are within the limits of these parameters. The methods for determining the safety parameters and the characteristics of combustible substances are based, among other things, on the standard series ISO/IEC 80079-20.

A mixture is potentially explosive if, under atmospheric conditions, the concentration is within given, substance-specific limits. Here distinction is made between the upper and lower explosion limit, whereby the mixture is still combustible above the upper explosion limit.

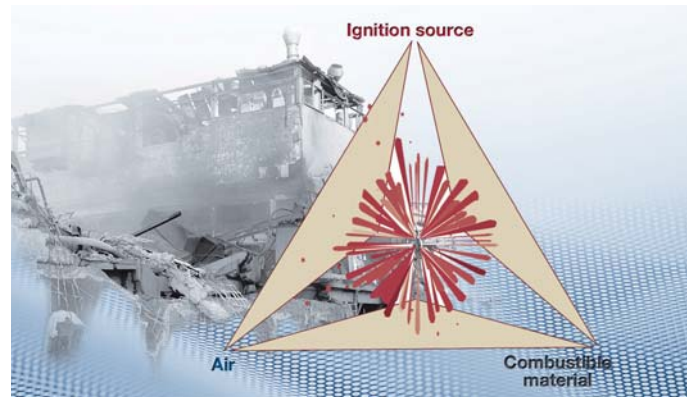
### Definition “Upper explosive limit (UEL)”

Concentration of flammable gas or vapour in air above which an explosive atmosphere will not be formed.

### Definition “Lower explosive limit (LEL)”

Concentration of flammable gas or vapour in air below which an explosive atmosphere will not be formed.

Under conditions other than atmospheric conditions, the ex-



### Physical basics of an explosion

Explosion limits change: For example, as the proportion of oxygen increases, the upper explosive limit is raised. Generally, the explosive limits are indicated in percent by volume. The percent by volume, abbreviated to %/vol., is the content by volume of the combustible matter in the mixture with air. The lower explosive limit of hydrogen is 4.0 % by volume, and the upper explosive limit 75.6 % by volume. The safety coefficients define quantitative data on the properties of most of the known substances

### Flash point

Combustible liquids are not the actual combustion agent, but the vapours that develop above the liquid, when mixed with air, form the explosive atmosphere.

### Definition „Flash point“:

lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapours in quantity such as to be capable of forming an ignitable vapour/air mixture.

Hazardous substances and preparations are classified in accordance with their properties according to §3a, Clause 1 of the Chemicals Act, i.e. as follows:

1. **explosive**, if, in a solid, liquid, pasty or gelatinous state, they may also react exothermically without atmospheric oxygen, thereby quickly evolving gases, and which, under defined test conditions, detonate, defla-

grate quickly or, upon heating, explode when partially confined.

2. **oxidizing**, if they are not normally inherently combustible, but, in contact with combustible substances or preparations, mainly due to the release of oxygen, they enhance the fire hazard and the intensity of a fire considerably
3. **highly flammable**, if:
  - a) in a liquid state, they have an extremely low flash point and a low boiling point,
  - b) in a gaseous state, they are flammable in contact with air at ambient temperature and pressure.
4. **highly flammable**, if:
  - a) they can become hot and finally catch fire in contact with air at ambient temperature without any application of energy,
  - b) in a solid state, they can readily catch fire after brief contact with a source of ignition and continue to burn or to be consumed in a hazardous manner after removal of the ignition source,
  - c) they have a very low flash point in a liquid state,
  - d) they develop highly flammable gases in dangerous quantities on contact with water or damp air.
5. **flammable**, if they have a low flash point in a liquid state.

An explosive atmosphere that causes damage in the event of an explosion is called a “hazardous explosive atmosphere.” It is possible to roughly assess



whether or not an atmosphere is explosive. In confined spaces, regardless of their size, a continuous volume of 10 litres of explosive atmosphere must already be regarded as hazardous. In the case of smaller spaces with a volume of <100 m<sup>3</sup>, this also applies for smaller quantities.

In addition to the material description of an explosive atmosphere, it is also necessary to describe its local occurrence.

## Definition „Hazardous area“

Area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical equipment.

## Ignition sources

In addition to the combustible substance and the oxidizing agent, e.g. air, a third partner, namely an ignition source, is required for an explosion. EN 1127-1 specifies 13 types of ignition sources that shall be taken into account in connection with explosion protection.

In order to prevent the ignition of a hazardous explosive atmosphere, it is necessary to be aware of all possible ignition sources that may occur and to ensure that these ignition sources cannot become effective by applying explosion protection measures.

Here a risk assessment is carried out to analyse the probability of

the simultaneous occurrence of a hazardous explosive atmosphere and an effective ignition source. Open flames and electric ignition sources have always been considered to be extremely critical and the avoidance of these ignition sources by respective protective measures has already been described in past documents. However, in order to be able to prevent the occurrence of explosions, it is necessary to take all possible effective ignition sources into consideration.

Ignition sources that can set off an explosion are:

### Hot surfaces

If an explosive atmosphere comes into contact with a heated surface, ignition can occur. Not only can a hot surface itself act as an ignition source, but a

**Heat:**  
open flames; hot surfaces;  
hot gases; gases under pressure;  
sunlight; infrared light;  
ultrasonic waves



dust layer or a combustible solid in contact with a hot surface and ignited by the hot surface can also act as an ignition source for an explosive atmosphere.

### Flames and hot gases (including hot particles)

Flames are associated with combustion reactions at temperatures of more than 1000 °C. Hot gases are produced as reaction products and, in the case of dusty and/or sooty flames, glowing solid particles are also produced.

Flames and their hot reaction products or otherwise highly heated gases can ignite an explosive atmosphere.

Flames, even very small ones, are among the most effective ignition sources.

### Mechanically generated sparks

As a result of friction, impact or abrasion processes, such as grinding, particles can become separated from solid materials and become hot due to the energy used in the separation process. If these particles consist of oxidizable substances, e.g. iron or steel, they can undergo an oxidation process, thus reaching even higher temperatures.

These particles (sparks) can ignite combustible gases and vapours and certain dust/air mixtures (in particular metal dust/air mixtures). In deposited dust, smouldering can be caused by sparks, and this can become a source of ignition for an explosive atmosphere.

### Electrical installations

In the case of electrical installations, electric sparks and hot surfaces can occur as sources of ignition. Electric sparks can, for example, be generated:

- a) when electric circuits are opened and closed;
- b) by loose connections;
- c) by stray currents.

### Stray electric currents, cathodic corrosion protection

Stray currents can flow in electrically conductive systems or parts of systems:

### Mechanical sparks:

friction; hammering; grinding



- a) as return currents in power generating systems – in particular in the vicinity of electric railways and large welding systems- if, for example, conductive electrical system components that are laid in the ground, such as rails and cable sheathing, lower the resistance of this return current path;
- b) as a result of a short circuit or of a short circuit to earth in the event of faults in the electrical installations;
- c) as a result of magnetic induction (e.g. near electrical installations with high currents or radio frequencies) and;
- d) as a result of lightning.

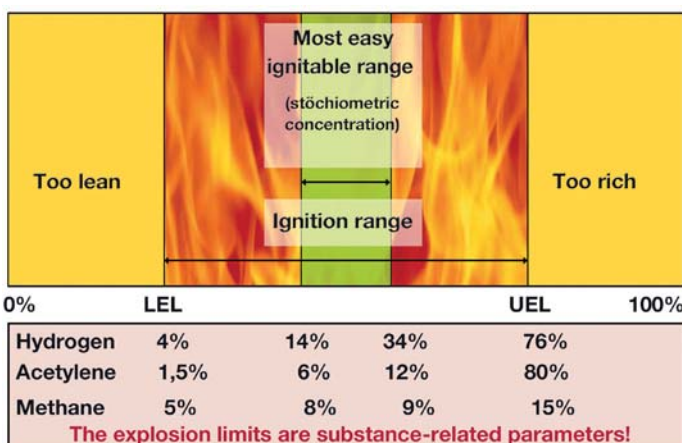
If parts of an installation that can carry stray currents are disconnected, connected or bridged, even in the case of minimal potential differences, an explosive atmosphere can be ignited as a result of electric sparks and/or arcs.

### Static electricity

Incendive discharges of static electricity can occur under given conditions. The discharge of charged, insulated conductive

### Electric sparks:

opening and closing of contacts;  
short circuits; over voltage;  
static discharges



Ignition limit of gases and vapours in air



parts can easily lead to incentive sparks. With charged parts made of non-conductive materials, which include most plastics as well as some other materials, brush discharges and, in special cases, during fast separation processes or due to a combination of conductive and non-conductive materials, propagating brush discharges are also possible. Cone discharges from bulk material and cloud discharges can also occur. Brush discharges can ignite almost all explosive gas and vapour atmospheres.

## Lightning

If lightning strikes in an explosive atmosphere, ignition will always occur. Moreover, there is also a possibility of ignition due to the high temperature attained by lightning conductors. High currents flow from where the lightning strikes and these currents can produce sparks in the vicinity of the point of impact. Even in the absence of lightning strikes, thunderstorms can cause high induced voltages in equipment, protective systems and components.

## Electromagnetic waves with frequencies ranging from $10^4$ Hz to $3 \times 10^{12}$ Hz (high frequency)

Electromagnetic waves are emitted by all systems that generate and use high-frequency electrical energy (high-frequency systems), e.g. radio transmitters or industrial or medical RF generators for heating, drying, hardening, welding, cutting, etc.

All conductive parts located in the radiation field function as receiving aerials. If the field is powerful enough and if the receiving aerial is sufficiently large, these conductive parts can cause ignition in explosive atmospheres.

The received radio-frequency power can, for example, make thin wires glow or generate sparks during the contact or interruption of conductive parts. The energy picked up by the receiving aerial, which can lead to ignition, depends mainly on the distance between the transmitter and the receiving aerial as well as on the dimensions of the receiving aerial at a given wavelength and high-frequency power.

## Electromagnetic waves with frequencies ranging from $3 \times 10^{11}$ Hz to $3 \times 10^{15}$ Hz

Radiation in this spectral range can – in particular when focussed- become a source of ignition due to absorption in explosive atmospheres or on solid surfaces. Sunlight, for example, can trigger an ignition if objects cause a convergence of the radiation. In the case of laser radiation, even at great distances the energy or power density of even an unfocused beam can be so great that ignition is possible. Here, too, the process of heating up occurs mainly when the laser beam strikes a solid body surface or when it is absorbed by dust particles in the atmosphere or on dirty transparent parts.

## Ionizing radiation

Ionizing radiation can ignite explosive atmospheres (especially explosive atmospheres with dust particles) as a result of energy absorption. Ionizing radiation can cause chemical decomposition or other reactions, which can lead to the generation of highly reactive radicals or unstable chemical compounds. This can cause ignition.

## Ultrasound

When ultrasonic sound waves are used, a large proportion of the energy emitted by the electro-acoustic transducer is absorbed by solid or liquid substances. As a result, the substance exposed to ultrasonics heats up so intensely that, in extreme cases, ignition can be induced.

## Adiabatic compression and shock waves

In the case of adiabatic or almost adiabatic compression and in shock waves, such high temperatures can occur that explosive atmospheres (and deposited dust) can be ignited. The temperature increase depends mainly on the pressure ratio, not on the pressure difference.

Note:

In pressure lines of air compressors and in containers connected to these lines, explosions can occur as a result of a compression ignition of lubricating oil mists e.g. by quick-acting valves in long pipes.

## Exothermic reactions, including self-ignition of dusts

Exothermic reactions can act as an ignition source if the rate of heat generation exceeds the rate of heat loss to the surroundings. Whether a high temperature can develop in the event of a reaction is dependent, among other parameters, on the volume/surface ratio of the reacting system, the ambient temperature and the residence time. These high temperatures can lead to both the ignition of explosive atmospheres and the initiation of smouldering and/or burning.

Catalysers can also set off reactions where energy is released, e.g. between hydrogen/air mixtures and platinum, of alkaline metals with water, the self-ignition of combustible dusts, the self-heating of animal fodder induced by biological processes, the decomposition of organic peroxides, or polymerization reactions.



Impact of a dust explosion: Rolandsmühle, Bremen, Germany



## Primary and secondary explosion-protection concepts

Explosion protection measures shall always be taken if the formation of a hazardous explosive atmosphere is to be expected and, at the same time, an ignition source with sufficient energy is present. In accordance with Directive 2014/34/EU, the measures are divided into primary, secondary and tertiary measures.

### Prevention of an ignition

Here distinction is made between two procedures:

- **Raising the flash point**

Here the flash point of a flammable liquid shall be at least 5 K to 15 K above the processing or room temperature. In the case of water soluble, flammable substances this can be achieved by adding water.

the case of liquid substances, the concentration is usually kept below the lower explosive limit, since a large amount of effort is required to keep the concentration in the upper range.

- **Inertisation**

If the proportion of oxygen in a mixture is less than 10 % by volume, then, as a general rule, a mixture is not explosive. In order to attain such a low proportion, so-called inert gaseous substances such as nitrogen, carbon dioxide, water steam or halogenated hydrocarbon are added to the mixture until the desired concentration is obtained. If the percent by volume of the inert gas to the flammable gas is in the minimum ratio of 25:1, an explosive atmosphere cannot form, regardless of the quantity of air added.

- **Ventilation**

The formation of a hazardous explosive atmosphere can be prevented or restricted by ventilation. In rooms above ground level and without special ventilation, the air is generally renewed by natural ventilation once per hour. By way of comparison, the exchange of air in cellar rooms takes up to 2.5 hours. The concentration of the mixture can, however, only be calculated if the escaping quantity per unit of time of a flammable substance is known and if an equal distribution can be assumed.

The natural flow conditions in a room can be assessed by an expert on ventilation, who will then usually recommend ventilation by technical means, as the natural ventilation cannot be considered to be a constant. Compared to natural ventilation, it ensures the exchange of larger quantities of air and a more carefully directed air flow. Moreover, the concentration occurring can be determined with a considerably higher degree of reliability. With technical ventilation, gas clouds that are released due to faults can be quickly diluted to non-critical values. On the other hand, the drawback of ventilation by tech-

nical means is that it needs constant servicing and monitoring. In addition to this, precautions have to be taken in case the installation should operate at a lower output or fail altogether.

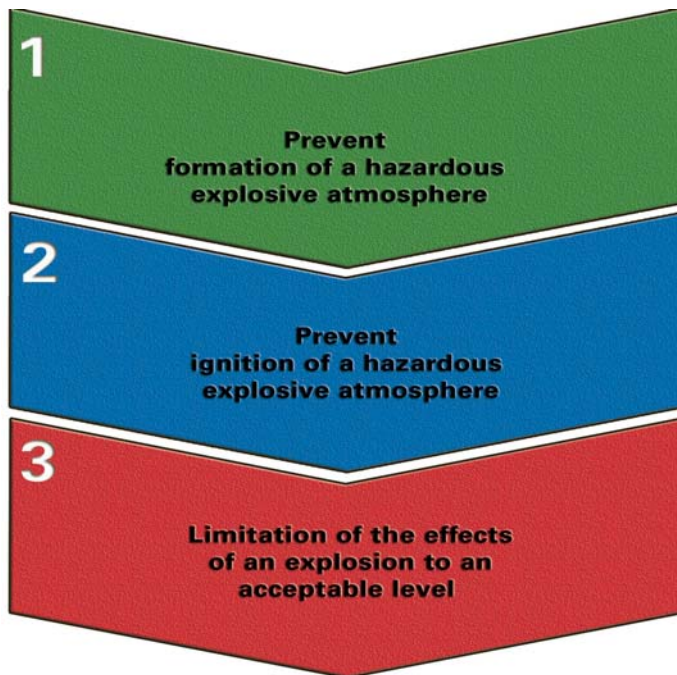
## Secondary explosion protection

Once all the possibilities of primary explosion protection have been exhausted, there can still be areas where a hazardous explosive atmosphere occurs. These areas are called hazardous areas. Here secondary explosion protection with protective measures that render ignition sources ineffective are applied. All the types of protection described in the standards of the series IEC 60079-0ff for electrical equipment and ISO/IEC 80079-36ff for mechanical equipment are secondary explosion protection measures.

## Constructional (tertiary) explosion protection

If, in spite of the measures named above, ignition sources and, as a result, explosions are to be expected, e.g. due to electrostatic discharges or chemical reactions, constructional or tertiary explosion protection measures shall be taken.

The explosion-protected design is, for example, a constructional measure that cannot prevent an explosion, but can limit the effects to a nonhazardous degree. The equipment shall be designed in such a way that it can withstand the maximum explosion pressure and, in extreme cases, even the detonation pressure. A detonation can happen quickly in pipes and elongated constructions. If the flameproof design is not able to withstand the increase in pressure, effective explosion pressure relief measures shall be taken.



## Primary explosion protection

The avoidance of a hazard is always better than any protection method. Among other things, it is possible to prevent an explosion by excluding the formation of an explosive atmosphere. Primary explosion protection can, for example, be achieved by applying the following measures:

### Avoidance of flammable substances

Whenever possible, flammable substances should be substituted by substances that are not capable of forming an explosive mixture.

- **Lowering the processing temperature**

With this method it is necessary to apply technical measures (e.g. cooling) to ensure that the processing temperature is always at least 5 - 15 K lower than the flash point. It is, however, necessary to keep faults, standstills, leakages and other influence factors safely under control.

- **Limitation of the concentration**

The formation of an explosive atmosphere can be prevented if it is possible to limit the concentration of a substance to the range below the lower or above the upper explosive limit. This is often possible with gases. However, problems arise if there is a gas leak or if the ignition range has to be passed through when starting up or closing down the installation. In

### Hazardous areas

#### Definition

An area in which an explosive atmosphere is present, or may be expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus (IEV 426-03-01).

Note:

A hazardous area is a three-dimensional region or space (EN 60079-14).

#### Zone classification

In accordance with Directive 1999/92 EG, hazardous areas are divided into six zones. The classification is based on the

probability of the occurrence of an explosive atmosphere.

In addition, distinction is made between flammable gases, vapours and mists on the one hand, and combustible dusts on the other. Information on the zone classification can also be found in the Explosion-Protection Rules of the Employers' Liability Insurance Association for the Chemical Industry and EN 60079-10.

#### Classification of hazardous areas

In national law the definition of zones given in the Ordinance on Hazardous Substances (GefStoffV) applies.

The international definition of zones is given in EN 60079-10. For this reason, both definitions, which are almost identical, are stated below.

#### Zone 0

- Area in which an explosive atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently (EN 60079-10-1).
- An area in which a hazardous explosive atmosphere consisting of a mixture of air and flammable gases, vapours or mists is present continuously, over long periods or frequently (GefStoffV).

#### Zone 1

- Area in which an explosive gas atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally (EN 60079-10-1).
- An area in which a hazardous explosive atmosphere consisting of a mixture of air and flammable gases, vapours or mists can form during normal operation (GefStoffV).

#### Zone 2

- Area in which an explosive gas atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation, but if it does occur, will persist for a short period only (EN 60079-10-1).
- An area in which a hazardous explosive atmosphere consisting of a mixture of air and flammable gases, vapours or mists does not normally occur, and if it occurs, then only rarely and for a short time (GefStoffV).

#### Zone 20

- Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently (EN 60079-10-2).
- An area in which a hazardous explosive atmosphere in the form of a cloud of combustible dust in the air is present continuously, for long periods or frequently (GefStoffV).

#### Zone 21

- Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur occasionally in normal operation (EN 60079-10-2).
- An area in which a hazardous explosive atmosphere in the form of a cloud of combustible dust in the air can only form occasionally during normal operation (GefStoffV).

#### Zone 22

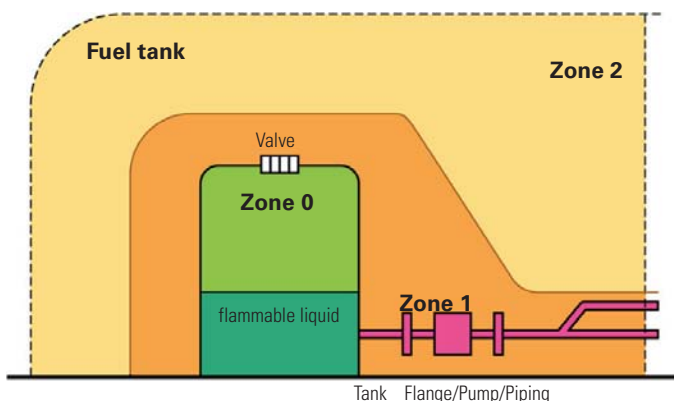
- Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation, but, if it does occur, it will persist for a short period only (EN 60079-10-2).
- Area in which an explosive atmosphere in the form of a cloud of combustible dust in air does not normally occur; if it occurs, then only rarely and for a short time (GefStoffV).

Note:

Layers, deposits and accumulations of combustible dust are to be considered in the same way as any other source that forms an explosive atmosphere.

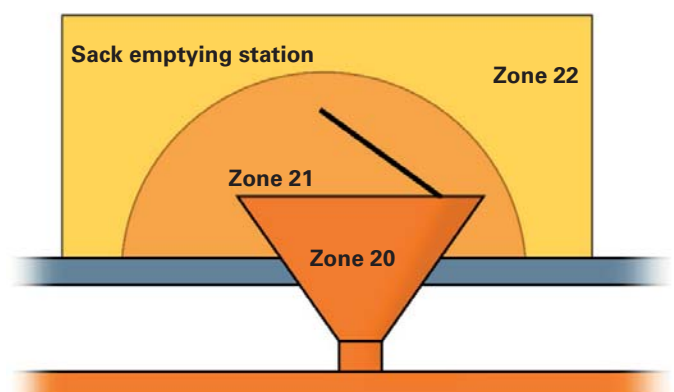
Normal operation is understood as being the state where installations are being used within their design parameters.

### Gas-Ex-areas



Example of the zone classification of explosive gas atmospheres to EN 60079-10-1

### Dust-Ex-Areas



Example of the zone classification of explosive dust atmospheres to EN 60079-10-2



## Examples of applications and the classification of suitable equipment: Gas-Ex-areas

### Gas-Ex-areas

#### Zone 0

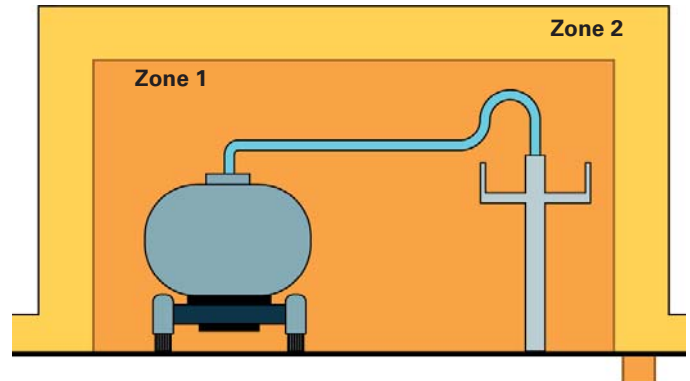
Zone 0 mainly encompasses areas such as the inside of enclosed containers, pipes and apparatus that contain flammable liquids.

Here the respective operating temperature lies above the flash point. The hazardous area is above the surface of the liquid and not in the liquid. Most gases of flammable liquids are heavier than air and spread in a similar way to liquids. Cavities such as pits or pump sumps

can usually accommodate these explosive gases for longer periods, so that it is also necessary to expect a Zone 0 area here. With equipment for Zone 0, ignition sources shall be protected against explosion even if the occurrence of failures is only rare. Hence, the equipment shall satisfy the following requirements:

Should one type of protection fail or should two faults occur simultaneously, sufficient protection against explosion shall still be ensured.

The constructional requirements DIN EN 60079-26 (VDE 0170/0171/Part 12-1) state that the necessary explosion protection is attained if the equipment is built in accordance with the



Zone classification example: Loading/discharging flammable liquids from a road transporter tanker without stand-alone ventilation.

type of protection "ia" to EN 60079-11, Intrinsic Safety, or satisfies the requirements of two types of protection of the series EN 60079, which are effective independently of each other.

For this reason, for example, flameproof luminaires were additionally pressurised or intrinsically safe apparatus in the type of protection "ib" potted.

According to Directive 2014/34/EU, equipment for Zone 0 shall satisfy the requirements for Category **1G**. In Zone 0 the hazard of an ignition due to electrostatic charges, even on rare occasions, shall be safely excluded. For this reason, the requirements according to EN 60079-0 for equipment for use in Zone 0 exceed those for equipment for Zone 1 by far.

#### Zone 1

Flammable or explosive substances are made, processed or stored in Zone 1. This includes the proximity of loading flap or filling and discharging facilities, the vicinity of fragile equipment, pipes and glands on pumps and slides that do not seal adequately. It is likely that an ignitable concentration will occur during normal operation.

Ignition sources that occur during normal, trouble-free operation and those that usually occur in the event of operating disturbances shall be safely prevented.

The chapter „Electrical equipment for use in hazardous areas“ describes the individual types of protection. According to Directive 2014/34/EU, Zone 1 equipment shall satisfy the requirements for Category **2G**.

#### Zone 2

Zone 2 encompasses areas around Zone 0 and Zone 1, as well as areas around flanged joints on pipes in enclosed rooms. Furthermore, it includes such areas in which, due to natural or forced ventilation, the lower explosive limit is only attained in exceptional cases, such as the environment of outdoor installations. Flammable or explosive substances are manufactured or stored in Zone 2. The probability of the occurrence of an ignitable concentration is rare and, if one occurs, it only persists for a short period.

During normal, trouble-free operation, ignition sources shall be safely prevented.

According to Directive 2014/34/EU, equipment for Zone 2 shall satisfy the requirements for Category **3G**. In addition, all equipment that satisfies the requirements for equipment for use in Zone 0 and Zone 1 is, of course, permitted.



Example for a Zone 0 application: The inside of a flat-bottom tank of an oil terminal



## Dust-Ex-Areas



### Zone 20

Zone 20 mainly encompasses areas inside closed containers, pipes and apparatus in which combustible dust in the form of a cloud is present continuously or for long periods or frequently. With equipment for Zone 20, ignition sources shall be protected against explosions, even if the occurrence of a malfunction is rare. For this reason, equipment shall fulfil the following requirement:

In the event of the failure of one type of protection or the simultaneous occurrence of two malfunctions, it is necessary to ensure adequate explosion protection. According to Directive 2014/34/EU, equipment for use in Zone 20 shall satisfy the requirements for Category **1D**.

### Zone 21

Among others, Zone 21 encompasses mills, warehouses for coal or grain, and the area surrounding filling stations. Here, for example, explosive clouds of dust can develop due to the occasional escaping of dust from the opening. The risk of hazards due to dust deposits is often underestimated.

Explosive dust/air mixtures can develop due to the formation of a smoulder spot or of a low temperature carbonization gas, as well as due to the deflagration of a low temperature carbonization gas or the whirling-up of dust caused by glowing combustion.

Ignition sources that occur during normal, trouble-free operation and those that normally occur in the event of malfunctions shall be safely prevented.

The individual types of protection are described in the chapter „Electrical equipment for use in hazardous areas“. According to Directive 2014/34/EU equipment for Zone 21 shall satisfy the requirements for Category **2D**



Example of dust-Ex-Zone 21: Explosion-protected terminal box

### Zone 22

In Zone 22, under normal operating conditions it is unlikely that an explosive dust/air mixture will occur. An explosive atmosphere is only to be expected in the event of malfunctions, e.g. due to whirled-up dust.

Ignition sources shall be safely prevented during normal, trouble-free operation.

According to Directive 2014/34/EU, equipment for Zone 22 shall satisfy the requirements for Category **3D**.

Detailed information on all zones can be found in the chapter „Installation and operation of electrical installations in hazardous areas“.







## European Ex-Directives

### Free movement of goods within the European Community

Article 100 of the treaty establishing the EEC (European Economic Community) was the basis for the free movement of goods within the European economic area. In 1975, to implement this article, the Council of the European Community issued the Explosion Protection Framework Directive (**Directive 76/117/EEC**).

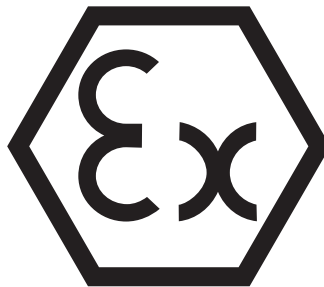
The issue of **Directive 79/116/EEC** by the European Commission concretised this basis and established a first legal basis.

A series of European standards for explosion-protected apparatus was drawn up by the European Standards Committee for electrical apparatus (CENELEC) to provide the basis for the enforcement of the requirements. In Germany these European standards, EN 50014 to EN 50020, were adopted as VDE standards in the national standards.

Directive 79/196/EEC was restricted to explosion-protected electrical equipment and the regulations that were required for the free movement of goods.

By strict reference to the European standards, the normative basis for the certification of explosion-protected electrical apparatus was regulated by "notified bodies".

This symbol was specified as the distinctive mark for the placing of explosion-protected electrical equipment on the market throughout the community:



### Directive 94/9/EC of the European Parliament and Council dated 23.03.1994 - 1st ATEX Directive

The purpose of this directive was the approximations of the laws of the member states of the European Union for equipment and protective systems intended for use in potentially explosive atmospheres. As of 01.07.2003 it replaced all previous directives on explosion protection on a European level.

The directive, also known as the ATEX directive, applied to equipment and protective systems that were intended for use in potentially explosive atmospheres. Safety devices and control systems for use outside of potentially explosive atmospheres also came under this directive. This also applied when such devices were required for the safe operation of equipment and protective systems in hazardous areas or contributed to it. Furthermore, the directive now directly included "fundamental safety requirements" for explosion-protected equipment.

This directive, which applied to both electrical and mechanical equipment, encompassed requirements relating to the approval of equipment and the requisite quality assurance systems. These requirements are graduated according to the equipment category.

As this new directive was drawn up according to the "new approach" of the EC, it also introduced the Declaration of Conformity to be issued by the manufacturer for explosion-protected equipment and the CE marking of products.

### Directive 2014/34/EU of the European Parliament and Council dated 26.02.2014 – 2nd ATEX Directive

Directive 94/9/EC had to be adapted to Resolution No. 768/2008/EC. This resolution required a common legal framework for the marketing of products and contains general principles and reference provisions that are to be applied in all sector-specific legal acts. It was, therefore, a common basis for a revised or new version of existing legal provisions.

This new ATEX directive came into effect on 20.04.2014, with a two-year transitional period. However, this did not mean that, as was the case with the transition to the 1st ATEX directive, both directives could be applied simultaneously. On the part of the European Commission only a legal certainty was provided that, when the transition period expired, the new directive only in the announced form was to be applied. Thus, the manufacturers were given the opportunity to adapt their directive-specific documents and papers within this two year period. In the case of the notified bodies, this meant, for example, that they had to complete the designation procedure for the new ATEX directive within these two years. The major changes only concern formal and legal aspects. No changes were made to the basic health and safety requirements or the

type and content of the conformity assessment procedure. Thus, for example, an EC Type Examination Certificate according to Directive 94/9/EC can be used to issue a new CE Declaration according to Directive 2014/34/EU. In accordance with Article 41, § 2, the issue of a new EU Type Examination Certificate according to the new directive is not necessary.

Directive 94/9/EC could be applied for the last time on 19.04.2016. As of 20.04.2016 only the new ATEX directive 2014/34/EU applies.

## ATEX Directive 2014/34/EU

Directive 2014/34/EU applies to products, i.e. equipment and protective systems intended for use in potentially explosive atmospheres, with the following definitions, which are new in part:

### a) "Equipment" means

machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection or prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy and/or the processing of material and which are capable of causing an explosion through their own potential sources of ignition.

### b) "Protective systems" means

devices other than components of equipment which are intended to halt incipient explosions immediately and/or to limit the effective range of an explosion and which are separately made available on the market for use as autonomous systems.

### c) "Components" means

any item essential to the safe functioning of equipment and protective systems but with no autonomous function.

This Directive shall not apply to:

- medical devices intended for use in a medical environment;
- equipment and protective systems where the explosion hazard results exclusively from the presence of explosive substances or unstable chemical substances;
- equipment intended for use in domestic and non-commercial environments where potentially explosive atmospheres may only rarely be created, solely as a result of the accidental leakage of fuel gas;
- personal protective equipment as covered by Directive 89/686/EEC;
- seagoing vessels and mobile offshore units together with equipment on board such vessels or units;

- means of transport, i.e. vehicles and their trailers intended solely for transporting passengers by air or by road, rail or water networks, as well as means of transport in so far as such means are designed for transporting goods by air, by public road or rail networks or by water. Vehicles intended for use in a potentially explosive atmosphere shall not be excluded from the scope of this Directive.

### d) "making available on the market" means

any supply of a product for distribution, consumption or use on the Union market in the course of a commercial activity, whether in return for payment or free of charge;

### e) "placing on the market" means

the first making available of a product on the Union market;

### f) "manufacturer" means

any natural or legal person who manufactures a product or has a product designed or manufactured, and markets that product under his name or trade mark or uses it for his own purposes.

## Structure and content of Directive 2014/34/EU

- **Chapter 1**  
General Provisions (Article 1-5)
- **Chapter 2**  
Obligations of economic operators (Article 6-11)
- **Chapter 3**  
Conformity of the product (Article 12-16)
- **Chapter 4**  
Notification of conformity assessment bodies (Article 17-33)
- **Chapter 5**  
Union market, surveillance and control of products entering the Union market and Union safeguard procedure (Article 34-38)
- **Chapter 6**  
Committee, transitional and final provisions (Article 39-45)
- **Annex I**  
Criteria determining the classification of equipment groups into categories
- **Annex II**  
Essential health and safety requirements relating to the design, and construction of equipment and protective systems for use in potentially explosive atmospheres
- **Annex III**  
Module B: EU-Type Examination
- **Annex IV**  
Module D: Conformity to type based on quality assurance of the production process
- **Annex V**  
Module F : Conformity to type based on product verifications
- **Annex VI**  
Module C1: Conformity to type based on internal production control plus supervised product testing
- **Annex VII**  
Module E: Conformity to type based on product quality assurance
- **Annex VIII**  
Module A: Internal production control
- **Annex IX**  
Module G: Conformity based on unit verification
- **Annex X**  
EU Declaration of Conformity
- **Annex XI**  
**Part A:** Repealed Directive with a list of the successive amendments thereto (referred to in Article 43)  
**Part B:** Time limits for transposition into national law and dates of application (referred to in Article 43)
- **Annex XII**  
Correlation table



Essential health and safety requirements

The requirements relating to equipment and protective devices are divided up into general requirements and supplementary requirements, whereby, above all, the supplementary requirements are to take both existing and potential hazards into consideration. This means that the equipment and protective systems shall satisfy one or more requirements at the same time, inasmuch as this is necessary for their correct operation or their intended use.

Adherence to the health and safety protection requirements is absolutely essential to guarantee the safety of equipment and protective devices. These requirements shall be implemented with prudence in order to fulfil the latest technological developments at the time of making equipment available on the market. This directive only defines general basic requirements. In order to make it easier to furnish proof that a piece of equipment or a protective system conforms to these requirements, uniform standards have been established on a European level. If standards are published by the European Commission in the Official Gazette of the European Communities as assigned to a given directive, they are valid as so-called “harmonized standards.”

If a product meets the requirements of the harmonized standards, the essential requirements of the directive are deemed to be fulfilled (presumption of conformity). If necessary, this list in the official gazette is adapted in line with the latest versions of the standards. These standards are, in principle, prepared by the European Committee for Standardization (CEN) and the European Committee for Electro-technical Standardization (CENELEC).

In the field of explosion protection the standardization is largely carried out by Technical Committee TC31, “Equipment for explosive atmospheres,” of the International Electro-technical Commission (IEC).

Equipment groups and equipment categories

Equipment is subdivided into groups and categories:

- Equipment group I – applies to equipment intended for use in underground parts of mines as well as those parts of surface installations of such mines that can be endangered by firedamp and/or combustible dust.
- Equipment group II – applies to equipment for use in the remaining areas that can be at risk due to an explosive atmosphere.

Categories

See adjacent tables

Making available on the market and commissioning of products

The member states must not forbid, restrict or impede the making available on the market and commissioning of equipment, protective systems and devices that conform to the terms of this directive. Similarly, the making available on the market of components accompanied by a certificate of conformity according to Article 13, § 3 of Directive 2014/34/EU shall not be forbidden, restricted or impeded if they are to be built into a piece of equipment or a protective system in line with this directive.

The EU member states assume conformity with this directive and with the conformity assessment procedures if the apparatus, protective systems and devices are accompanied by the EU Certificate of Conformity and if the products are provided with the CE marking.

Products that do not yet meet the requirements of this directive may be displayed at exhibitions, fairs and demonstrations if a visible sign clearly indicates that it will not be possible to purchase the product until compliance with the directive has been ensured.

Classification of explosion protected apparatus in equipment groups and categories according to 2014/34/EU

Equipment Group I for mines endangered by firedamp.  
The equipment Group I is subdivided into the Categories M1 and M2:

M1	<p>The equipment in this category is intended for use in both underground parts of mines and those parts of surface installations of such mines that are endangered by firedamp and/or combustible dust.</p> <p>The equipment shall continue to remain functional even in the event of rare incidents relating to the equipment with an explosive atmosphere present, and feature such protective measures that in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection, or the requisite level of protection is assured in the event of two faults occurring independently of each other.</p>
M2	<p>The equipment in this category is intended for use in both underground parts of mines and those parts of surface installations of such mines that are endangered by firedamp and/or combustible dust.</p> <p>If an explosive atmosphere occurs, it must be possible to switch off the equipment. The constructional explosion-protection measures ensure the required degree of safety during normal operation, even under severe operating conditions and, in particular, in cases of rough handling and changing environmental influences.</p>

Equipment Group II for all other hazardous areas  
The equipment Group II is subdivided into the Categories 1, 2 and 3:

1	<p>The equipment in this category is intended for use in areas in which an explosive atmosphere is present continuously or for long periods or frequently.</p> <p>Even if equipment failures only occur infrequently, the equipment must ensure the required degree of safety and feature such explosion protection measures that</p> <ul style="list-style-type: none"><li>• if one constructional protective measure fails, at least one other independent constructional protective measure ensures the required degree of safety, or</li><li>• if two independent faults occur in combination, the required degree of safety is still ensured.</li></ul>
2	<p>The equipment in this category is intended for use in areas in which an explosive atmosphere occurs occasionally. Even in the case of frequent equipment failures or faulty conditions that are normally to be expected, the constructional explosion-protection measures ensure the required degree of safety.</p>
3	<p>The equipment in this category is intended for use in areas in which no occurrence of an explosive atmosphere due to gases, vapours, mists or whirled-up dust is to be expected. If, however, it occurs, then in all probability only rarely or for a short period. During normal operation the equipment ensures the required degree of safety.</p>

**Procedure for non-compliant (e.g. unsafe) products**

Should a member state or their market surveillance authorities discover that any equipment, protective systems or devices (products) with the CE marking are unsafe; it can withdraw these from the market and forbid their being made available on the market or commissioning, or restrict their free circulation.

The member state is required to notify the commission of the European Union of such measures and to give the reasons for its decision. The commission will immediately contact the economic operators concerned (manufacturers, authorized persons, importers or retailers) and inform all member states if these measures are justified.

Equipment, protective systems or devices (products) are deemed unsafe if, when used for their intended purpose, they represent an imminent danger to the safety of people, domestic animals or goods.

According to Article 38 of the Directive, a product is formally deemed non-compliant if, for example:

- the CE marking has not been affixed;
- the specific marking of explosion protection, the symbols of the equipment-group and category and, where applicable, the other markings and information have not been affixed in violation of point 1.0.5 of Annex II;
- the identification number of the notified body, where that body is involved in the production control phase, has been affixed wrongly or has not been affixed;
- the EU declaration of conformity or the attestation of conformity, as appropriate, does not accompany the product or has not been issued correctly; or
- the technical documentation is not available or not complete.

**Marking**

In accordance with Annex II, Point 1.0.5 of the Directive, each piece of equipment and each protective system shall be marked in a clear and indelible manner with the following minimum particulars:

- name, registered trade name or registered trade mark, and address of the manufacturer,
- (The contact data shall be given in a language that is easily comprehensible for the end users and the market surveillance authorities.)
- CE marking
- designation of series or type
- batch or serial number, if any,
- year of construction
- the specific marking of explosion protection followed by the symbol of the equipment group and category,
- for equipment-group II, the letter 'G' (concerning explosive atmospheres caused by gases, vapours or mists), and/or
- the letter 'D' (concerning explosive atmospheres caused by dust).

Furthermore, and where necessary, they shall also be marked with all information essential to their safe use

**Conformity assessment procedures**

Depending upon the conformity assessment procedure to be applied, a notified body can be active during the design and engineering phase, during the production phase or during both phases. The applicable evaluation procedure is laid down in the Directive according to the product, the group and the equipment category.

**Equipment groups I and II, equipment categories M1 and 1**

In order to be permitted to affix the CE mark to his product, the manufacturer must arrange for the following procedures to be carried out:

- EU-type examination by a notified body and either
- an audit of the quality assurance for the production process or
- an audit of the products.

**Equipment groups I and II, equipment categories M2 and 2**

In the case of internal combustion motors and electrical equipment, in order to be permitted to affix the CE marking to the product, the manufacturer shall arrange for the following procedures to be carried out and/or ensure the following measures:

- EU-type examination by a notified body and either
- ensure constructional conformity or
- verification of the quality assurance of the products.

In the case of other equipment in these groups and categories, the internal production control procedure shall be applied, whereby the technical documentation shall be submitted to a notified body in accordance with Article 13, § 1, Clause b) ii).

**Equipment group II, equipment category 3**

In order to be permitted to affix the CE mark to the product, the manufacturer shall apply the internal production control procedure.

**Declaration of Conformity**

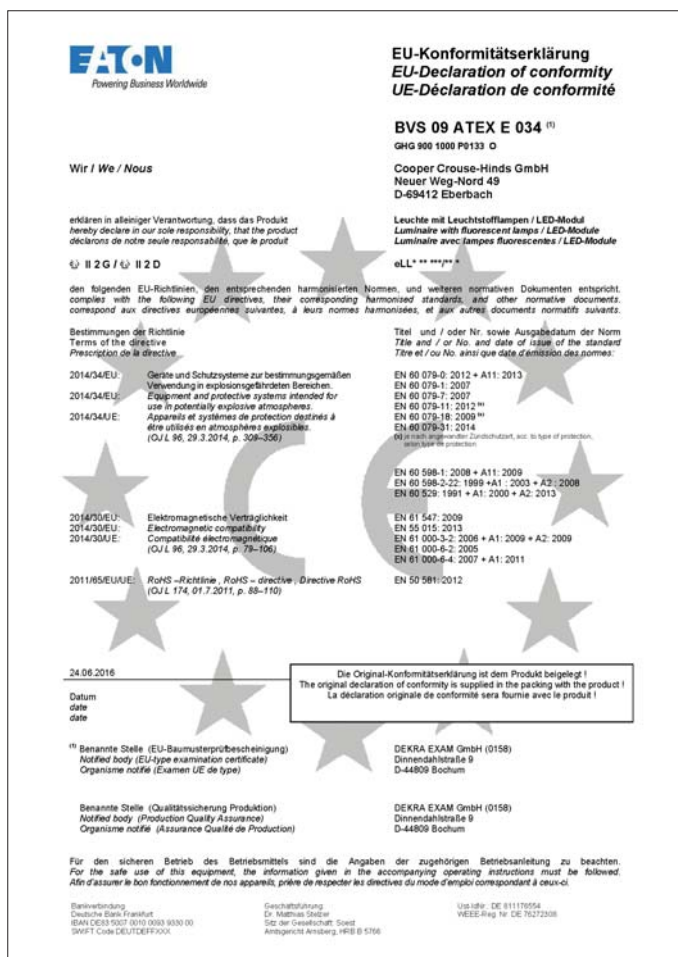
In order to make products available on the market within the EU, the EU Declaration of Conformity shall be included with all products or batches of identical products.

This does not apply to the report, if available, issued by the notified body as part of the audit of the quality assurance system of the manufacturer or the EU-Type Examination Certificate.

**EAT•N****eLLK 92036/36  
12266875101****BVS 16 ATEX E 123 / IECEx BVS 16.123****II 2G  
II 2D****Ex db eb mb ib IIC T4 Gb  
Ex tb IIIC T80°C Db****AC: 110-254V 50-60Hz****DC: 110-250V****Lampe: G13-81-IEC****Snr.: D123456 2016****CROUSE-HINDS  
SERIES****CEAG****D-69412 Eberbach****IP66/67****T<sub>a</sub>= -25°C bis +55°C****www.ceag.de  
Made in Germany**

Example for a type label according to the latest standards and directive 2014/34/EU





## Instructions

According to Annex II, point 1.0.6 of the Directive, all equipment and protective systems shall be accompanied by instructions, including at least the following particulars:

- a recapitulation of the information with which the equipment or protective system is marked, except for the batch or serial number, and, where appropriate, any additional information to facilitate maintenance (e.g. address of the importer or service workshop, etc.);
  - instructions for safe:
    - putting into service,
    - use,
    - assembling and disassembling,
    - maintenance (servicing and emergency repairs),
    - installation,
    - adjustment;
  - where necessary, an indication of the danger areas in front of pressure-relief devices,
  - where necessary, training instructions.
- pected operating conditions,
- electrical and pressure parameters, maximum surface temperatures and other limit values;
  - where necessary, special conditions of use, including particulars of possible misuse which experience has shown might occur; and
  - where necessary, the essential characteristics of tools which may be fitted to the equipment or protective system.
- The operating instructions shall be drawn up by the manufacturer or his authorized representative established in the community in one of the community languages in accordance with the decision of the respective member state and it shall be easily comprehensible for the users and other end users.

The operating instructions shall be drawn up by the manufacturer or his authorized representative established in the community in one of the community languages in accordance with the decision of the respective member state and it shall be easily comprehensible for the users and other end users.



*Explosion-protected linear light fitting type  
eLLK 92 LED 800 with operating instruction  
and Declaration of Conformity*

These operating instructions and safety information as well as all markings shall be explicit, easily comprehensible and clearly visible.

The maintenance instructions for use by the specialist personnel employed by the manufacturer or his authorized representative established in the Community may be drawn up in a single community language that is understood by this personnel.

The operating instructions contain the drawings and diagrams that are necessary for the putting into service, maintenance, inspection, checking of correct operation and, when appropriate, repair of equipment and protective systems, together with all useful instructions, in particular with regard to safety.

With regard to safety aspects, the documentation describing the equipment or protective systems shall not conflict with the operating instructions.

# Betriebsanleitung Operating instructions Mode d'emploi

## CROUSE-HINDS SERIES

Explosionsgeschützte Leuchten Serie:

Explosion protected light fittings Series:

Luminaire pour atmosphères explosives Série:

eLL 92 LED 400 (V-CG-S); eLL 92 LED 400 HT (V-CG-S)

eLL 92 LED 400-I (V-CG-S); eLL 92 LED 400-I HT (V-CG-S)

eLL 92 LED 800 (V-CG-S); eLL 92 LED 800 HT (V-CG-S)

CZ: "Tento návod k použití si můžete vydat ve svých mateřském jazyce u příslušného zastoupení společnosti Cooper Crouse-Hinds/CEAG ve vaší zemi."

DE: "Montageanweisungen kann übersetzen Sie andere EU-sprache oder referenzen von Cooper Crouse-Hinds/CEAG verwenden."

E: "Es es necesario podrá solicitar de su representante Cooper Crouse-Hinds/CEAG estas instrucciones de servicio en otro idioma de la Unión Europea"

EST: "Teada kasutajjuhendit oma riigikeelse võtte kiudite oma riigi asustat ekspansiooni Cooper Crouse-Hinds/CEAG edastuseks."

FIN: "Tämä ohjeistus tähtsi käyttöohjeen käännotin osastessamme toimittu EU:n kieleksi. Toivottu Cooper Crouse-Hinds/CEAG -edustajalta!"

"En l'en français, emplacement voir effectuer après un ou autre plusieurs pays EU, uniquement ne despatche avec les Amalgames from Cooper Crouse-Hinds/CEAG"

H: "A kezelési útmutatót az adott ország nyelven a Cooper Crouse-Hinds/CEAG cég helyi képviseletén igényelhet meg."

I: "Se desidera la traduzione del manuale operativo in un'altra lingua della Comunità è European potrete richiederla al vostro rappresentante Cooper Crouse-Hinds/CEAG"

LT: "Šios naudojimo instrukcijos, išverstos į kitą Europos kalbą, galite pamatyti atstovų "Cooper Crouse-Hinds/CEAG" atstovybėse savo šalyje."

LV: "Šio ekspluatācijas instrukciju valsts valodā varat iepazīties pie mūsu attiecīgajā Cooper Crouse-Hinds/CEAG pārstāvniecībā"

M: "Junglu johto da 3-mennel Elingye nacionali jogthon megkand-e reprezentant si Cooper Crouse-Hinds/CEAG foglalkodo."

NL: "Indien noodzakelijk kan de vertaling van deze gebruiksinstructie in een andere EU-taal worden opgevraagd bij uw Cooper Crouse-Hinds/CEAG-representant"

P: "Se for necessario a tradução destas instruções de operação para outro idioma da União Europeia, pode solicitá-la junto do seu representante Cooper Crouse-Hinds/CEAG"

PL: "Niniejsze instrukcję obsługi w odpowiedniej wersji językowej można zamówić w przedstawicielach firmy Cooper Crouse-Hinds/CEAG na danym terytorii."

S: "En översättning av denna montage- och skötselinstruktion till annat EU-språk kan vid behov beställas från Er Cooper Crouse-Hinds/CEAG-representant"

BK: "Tento návod na obsluhu Vám ve Valnem nrohom jazyku poskytnú zástupcov spoločnosti Cooper Crouse-Hinds/CEAG vo Vašej krajine."

SLO: "Navodilo za uporabo v Valnem jeziku lahko dobite pri pristojnem predstavniku podjetja Cooper Crouse-Hinds/CEAG v Vaši državi."

RUS: "При необходимости, вы можете запросить перевод данных инструкции на не русский язык. С ним вы получите от нашего Cooper Crouse-Hinds / CEAG -представителя"

3 2216 000 501 D/GB/F (d)

**Crouse-Hinds**  
by **E.T.N.**



CE-sign

## CE-marking

The manufacturer shall affix the CE marking to products that fall within the scope of given directives. This applies to products that are covered by the directives according to the new concept and include requirements relating to the technical properties of products. These EU directives constitute binding regulations of the „European Union“. This means that compliance with these requirements is the condition for marketing the products in Europe.

When the CE marking is affixed to a product, the conformity of the product with the relevant basic requirements of all directives applicable to the products is confirmed. The marking is, therefore, an imperative requirement for the making available on the market of products within the Community, as well as in the country of origin.

The CE marking is only meant as evidence of conformity with the directives for the supervising authorities and is not a quality mark.

In addition to the CE marking, the manufacturer shall also prepare a Declaration of Conformity for the product. This Declaration of Conformity shall clearly indicate which directive was applied and which standards were taken into account for the verification of conformity.

The following directives are also of particular importance for electrical equipment:

## Directive 2006/42/EC: Machinery Directive

Mechanical engineering is an important technical subsector and one of the industrial core areas of the economy in the Community. The social costs caused by the numerous accidents that occur as a result of the use of machinery can be lowered if the safety aspect is taken into consideration during the design and construction of machines and if the machines are installed and maintained correctly. If the hazards presented by machinery stated in Annex I of the Directive are covered in total or partially by other Community Directives, this directive does not apply to this machine and the hazards or no longer applies from the beginning of the application of these other directives.

Annex I, § 1.5.7 states that; *“Machinery must be designed and constructed in such a way as to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery. Machinery must comply, as far as the risk of explosion due to its use in a potentially explosive atmosphere is concerned, with the provisions of the specific Community Directives.”*

## Directive 2014/30/EU: EMC-Directive

Subject matter of this directive is the electromagnetic compatibility of equipment. This directive shall be applied to all products that can cause electromagnetic interferences or whose operation can be affected by these interference. It is intended to ensure the functioning of the single market for equipment by specifying an appropriate level of electromagnetic compatibility.

## Directive 2014/35/EU: Low Voltage Directive

The aim of this directive is to ensure that electrical equipment on the market meets the requirements that guarantee a high protective level with regard to the health and safety of people, domestic animals and livestock and with regard to property, while guaranteeing the functioning of the single market.

The Directive shall apply to electrical equipment designed for use with a voltage rating of between 50 V and 1000 V for alternating current and between 75 V and 1500 V for direct current, with the exception of the electrical equipment and areas listed in Annex II, i.a. electrical equipment for use in explosive atmospheres.

## Directive 1999/5/EC: Radio and Telecommunications Terminal Equipment (RTTE)

This directive regulates the making available on the market, free trade and putting into operation of radio installations and telecommunications transmission devices within the Community.

## Directive 89/686/EEC: Personal Protective Equipment (PPE)

For the purposes of this directive, PPE is any device or means that is intended to be worn or held by a person and protect this person against one or more risks that might endanger his health or safety.

## Directive 2014/68/EU: Pressure Equipment Directive (PED)

This directive applies to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum permissible pressure (PS) of more than 0.5 bar. This directive does not apply to equipment that, according to Article 13 of this directive, would, at most, come under Category I and is covered by one of the clauses of Directive 2014/34/EU.

## Directive 2014/29/EU: Simple Pressure Vessels (SPVD)

This directive applies to vessels that are manufactured in series.





Directive 1999/92/EC

Directive 1999/92/EC of the  
European Parliament and  
Council dated 16.12.1999

It defines the minimum requirements for the improvement of the health and safety protection of employees potentially at risk due to an explosive atmosphere and is also referred to as the *“European Workplace Directive”*.

Explosion-protection is of particular importance to safety. Explosions endanger the lives and health of workers as a result of the uncontrolled effects of flame and pressure, the presence of noxious reaction products and consumption of the oxygen in the ambient air which workers need to breathe;

For this reason, in order to establish a coherent strategy for the prevention of explosions at the workplace, organisational measures have to be taken. Directive 89/391/EEC requires the employer to take the necessary measures for the health and safety protection of employees, including measures for the prevention of occupational hazards, to inform and instruct, and to provide a suitable organization and the necessary means.

The directive was issued in accordance with Article 137 of the treaty establishing the EEC and is, as such, only a minimum requirement. It states explicitly that any provisions issued on the basis of this article shall not prevent the member states from maintaining or taking more stringent protective measures that are compatible with the treaty.

Scope

This Directive, which is the 15<sup>th</sup> individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC, lays down minimum requirements for the health and safety protection of workers potentially at risk from explosive atmospheres.

It does not apply to:

- a) areas used directly for and during the medical treatment of patients;
- b) the use of appliances burning gaseous fuels in accordance with Directive 90/396/EEC (2);
- c) the manufacture, handling, use, storage and transport of explosives or chemically unstable substances;
- d) mineral-extracting industries covered by Directive 92/91/EEC or Directive 92/104/EEC;
- e) the use of means of transport by land, water and air, to which the pertinent provisions of the international agreements (e.g. ADN, ICAO, IMO, RID), and the Community Directives for the implementation of those agreements apply.

Means of transport intended for use in a potentially explosive atmosphere shall not be excluded.

Reduction and assessment  
of explosion risks

It is the duty of the employer to carry out measures in the following order of precedence:

- 1. Where possible, the prevention of explosive atmospheres by the substitution of materials.
- 2. Prevention of the ignition of explosive atmospheres.
- 3. Mitigation of harmful effects.

This concept is already known in Germany due to the explosion-protection directives of the employers' liability insurance association and it has been put into practice for many years. The new aspect of this directive is the systematic method according to which the measures are laid down and documented.

Structure of the directive 1999/92/EC  
Enacting part

- **Section 1**  
**Article 1-2**  
General Requirements
- **Section 2**  
**Article 3-9**  
Duties of employer
  - 3: Prevent of and protection against explosions
  - 4: Assessment of the explosion risks
  - 5: General obligations
  - 6: Coordination obligations
  - 7: Areas with explosive atmospheres
  - 8: Explosion-protection document
  - 9: Special regulations relating to working materials and places of work
- **Section 3**  
**Article 10-15**  
Other requirements
- **Appendix I**  
Classification of areas where explosive atmospheres may occur
  - 1. Areas where explosive atmospheres may occur
  - 2. Classification of hazardous areas
- **Section II A**  
Minimum requirements for the improvement of the safety and health protection of employees potentially at risk from explosive atmospheres
  - 1. Organisational measures
  - 2. Explosion-protection measures
- **Section II B**  
Criteria for the selection of equipment and protective systems
- **Section II C**  
Warning signs for marking areas where explosive atmospheres may occur

After assessment of all the remaining explosion risks, whereby the interaction of installations, the materials being used, the processes and their possible interactions were taken into consideration, measures for the safety of employees at work must be laid down to ensure their health and safety at all times. Here special requirements are imposed regarding the coordination duties of the employer at the place of work

Classification of hazardous  
areas

The areas in which explosive atmospheres can occur are subdivided into zones according to the frequency and duration of the occurrence of explosive atmospheres. This classification determines the scope of the measures to be taken.

Zone 0

A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently.

Zone 1

A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.

Zone 2

A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

**Zone 20**

A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently

**Zone 21**

A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.

**Zone 22**

A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Note:

1. Layers, deposits and accumulations of combustible dust that can form an explosive atmosphere shall be treated in the same way as any other cause.
2. Normal operation is the state in which installations are used within the rated parameters.

**Explosion protection document**

As part of his obligations, the employer shall ensure that a document (hereinafter referred to as the 'explosion protection document') is drawn up and kept up to date.

- In particular, the explosion protection document shall demonstrate:
- that the explosion risks have been determined and assessed;
- that adequate measures are taken to fulfil the aims of this Directive;
- which areas which have been classified into zones in accordance with Annex I;
- the areas where the minimum requirements set out in Annex II apply;

- that the workplace and work equipment, including warning devices, are designed, operated and maintained with regard to due safety; and
- that, in accordance with Council Directive 89/655/EEC (1), arrangements have been made for the safe use of work equipment.

The explosion protection document shall be drawn up prior to commencement of work.

and shall be revised when the workplace, work equipment or organisation of the work undergoes significant changes, extensions or conversions.

The employer may combine existing explosion risk assessments, documents or other equivalent reports produced under other Community acts.

**Annex II A**

Minimum requirements for the improvement of the health and safety protection of employees potentially at risk from explosive atmospheres.

**1. Organisational measures**

- Appropriate instruction of employees
- Written instructions and work release notes
- If necessary, written instructions for the work assignment
- Work release system for hazardous tasks
- Work release by authorized person

**2. Explosion protection measures**

- Rendering any escaped Ex atmosphere harmless
- Design according to the highest risk potential
- Avoidance of all ignition hazards (e.g. static charge of persons)
- Taking into operation if authorized in the explosion document

- Installation and operation according to the lowest explosion risk
- If necessary, warning of Ex atmosphere (visual/acoustical)
- Provision of escape facilities
- Initial inspection by qualified persons
- Measures for risk assessment
- Hazards due to power failures
- Safe reduction of stored energy

**Annex II B**

Criteria for the selection of equipment and protective systems:

Unless otherwise specified in the explosion protection document, taking into account the risk evaluation, equipment and protective systems are selected in accordance with Directive 2014/34/EU

Zone	Category
0 or 20	1
1 or 21	1 or 2
2 or 22	1, 2 or 3

**Anex III**

Warning sign for marking areas in which explosive atmospheres may occur.





## Electrical equipment for use in hazardous areas:

### Basics

#### General

It would not be economical to build all explosion-protected electrical equipment in such a way that it can be used in all hazardous areas. Furthermore, there are also other boundary conditions that have to be taken into consideration, e.g. relating to the ignition temperature, flame transmission properties and the ignitability of the explosive substances.

For the gradation or allocation to the required safety level for the respective application, it is subdivided into;

- **Groups**
- **temperature classes (surface temperature) and**
- **equipment protection levels**

With all equipment it is necessary to observe the further subdivision into groups with regard to the risk of an electrostatic charge/discharge. In addition, hazards due to electromagnetic and optical radiation shall also be taken into account.

## Electrical equipment for use in gas Ex areas

### Group II

Group II electrical equipment in is subdivided into A, B, and C.

In the case of flameproof enclosures, the classification is based on the maximum experimental safe gap (MESG) and, in the case of intrinsically safe apparatus on the minimum ignition current (MIC).

## Subdivision into groups

### Group I:

Electrical equipment for use in mines susceptible to fire-damp such as coal mines

### Group II:

Electrical equipment for use in explosive gas atmospheres

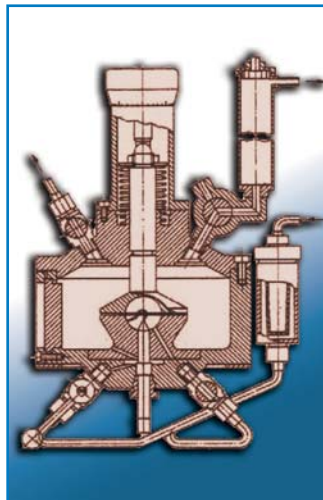
### Group III:

Electrical apparatus for use in all explosive dust atmospheres

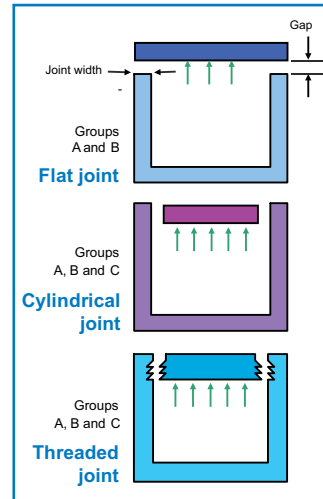
## Maximum experimental safe gap (MESG)

### Definition:

The maximum gap of the joint between the two parts of the interior chamber of a test apparatus which, under specified conditions, when the internal gas mixture is ignited, prevents ignition of the external gas mixture by flame propagation through a joint measuring 25 mm in length.



Apparatus for the experimental determination of the maximum safe gap (MESG) in accordance with IEC 60079-20-1



Different types of joint in practice:

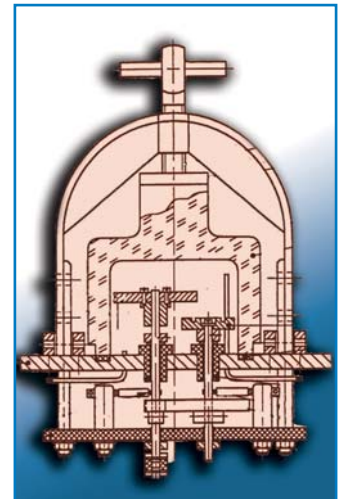
- flanged joint
- cylindrical joint
- threaded joint

## Minimum ignition current (MIC)

A minimum ignition energy is needed to ignite an explosive mixture. Due to an external ignition source, e.g. an electric spark, a high temperature develops in a small volume area of an explosive atmosphere. This then leads to combustion. The heat generated by the spark and the subsequent combustion heats the immediate layers, but, at the same time, energy is fed to the outside due to heat conduction.

If the heat dissipation is greater than the quantity of heat that is supplied and generated, a propagation of the combustion to the surrounding volume areas is not possible. Only if, due to the external ignition source, the energy input is so great that the temperature of the surrounding layers rises above its ignition temperature, the combustion is propagated autonomously and an explosion occurs.

This basic knowledge is used for the type of protection "Intrinsic Safety." The electric ratings of a circuit are limited to such a degree that the minimum ignition energy required for an ignition is not attained.



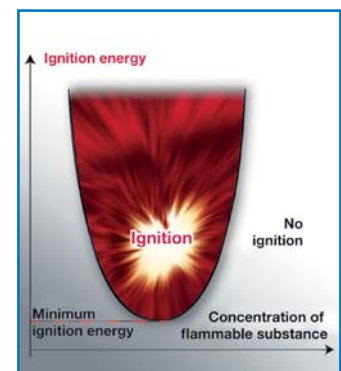
Apparatus for the experimental testing of the minimum ignition current (MIC)

## Minimum ignition energy

The smallest amount of electrical energy stored in a capacitor that, in the event of the discharge of this capacitor across a spark gap, is barely able to ignite the most easily ignitable fuel/air mixture at atmospheric pressure and room temperature.

There is a certain relationship between the safe gap and the minimum ignition current ratio.

In order to be able to classify gases and vapours to satisfy the explosion-protection requirements, it is, therefore, sufficient to determine just one of the two properties of most of the mixtures of gas and vapour with air that are used in industry.

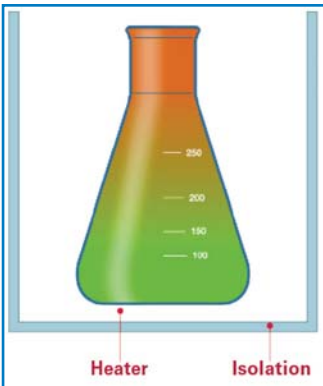


Ignition energy in relation to the concentration of a flammable substance in air

Groups	Safe Gap in mm	Minimum ignition current
II A	> 0,9	> 0,8
II B	0,5 to 0,9	0,45 to 0,8
II C	< 0,5	< 0,45

### Ignition temperature and temperature classes

The maximum surface temperature of the electrical equipment, subject to the protective measures on the interior or exterior, must not attain the ignition temperature of the hazardous explosive atmosphere. The ignition temperature of a flammable substance is determined by means of a test apparatus and is defined as the lowest temperature on a heated wall at which the flammable substance will just ignite in the mixture with air.



The ignition temperatures of the different explosive mixtures vary considerably. Whereas a mixture of air with town gas will only ignite at 560 °C, a mixture of air and petrol will ignite at ca. 250 °C.

The data can be found in IEC 60079-20-1.

To simplify matters, these different properties were classified and divided into temperature classes.

Experimental determination of the ignition temperatures of flammable substances to IEC 60079-20-1

Temperature class	Maximum permissible surface temperature of the equipment in °C	Ignition temperatures of the flammable substances in °C
<b>T 1</b>	450	> 450
<b>T 2</b>	300	> 300 ≤ 450
<b>T 3</b>	200	> 200 ≤ 300
<b>T 4</b>	135	> 135 ≤ 200
<b>T 5</b>	100	> 100 ≤ 135
<b>T 6</b>	85	> 85 ≤ 100

### Classification of gases and vapours in explosion groups and temperature classes

	T1	T2	T3	T4	T5	T6
<b>I</b>	Methane					
<b>II A</b>	Acetone					
	Ethane					
	Ethylacetate	Ethyl-	Petrol			
	Ammonia	alcohol	Diesel			
	Benzol	i-amyl-	fuel	Acetal-		
	Acetic acid	acetate	Aviation	dehyde-		
	Carbon oxide	n-butane	fuel	Ethyl-		
	Methanol	n-butyl-	Heating	ether		
<b>II, B</b>	Propane	alcohol	oils			
	Toluene		n-Hexane			
	Town gas (lamp gas)	Ethylene				
<b>II C</b>	Hydrogen	Acetylene				Carbon disulphide

### Electrical equipment for use in areas with combustible dusts

#### Group III

The subdivision of Group III electrical equipment is based on the same principle as the subdivision of Group II electrical equipment, whereby the division into Groups A, B and C is based on the properties of the „dust.“

#### Groups Substances

<b>IIIA</b>	combustible flyings
<b>IIIB</b>	non-conductive dusts
<b>IIIC</b>	conductive dusts

#### Ignition sources

Combustible dust can be ignited by electrical equipment in various ways:

- ➔ by equipment surface temperatures that are higher than the ignition or glow temperature of the respective dust. The temperature at which the dust ignites is dependent on the properties of the dust, on whether it is present in the form of a cloud or deposits, on the thickness of the layer and on the type of heat source;
- ➔ by sparks at electrical parts such as switches, contacts, commutators, brushes or similar;
- ➔ by the discharge of stored electrostatic energy;
- ➔ by radiated energy (e.g. electromagnetic radiation);
- ➔ by mechanic impact or friction sparks or a rise in temperature originating from the apparatus.



Explosion-protected portable searchlight in the dust test chamber

To avoid ignition hazards, it is necessary that:

- ➔ the temperature of any surfaces on which dust deposits can form or that can come into contact with a cloud of dust are kept at a temperature that is lower than the limiting temperatures laid down in EN 50028-1-2;
- ➔ all parts with electric sparks or with temperatures above the ignition or glow temperature of the dust are built into an enclosure that prevents the ingress of dust in a suitable manner, or
- ➔ the energy of the electric circuits is limited to such a degree, that sparks or temperature that could ignite combustible dust are avoided;
- ➔ all other ignition sources are avoided.





## Equipment protection level EPL

An alternative method for the risk assessment taking the "Equipment Protection Level" for Ex-equipment into account.

### Historical background

Hazardous areas are divided into zones according to the degree of hazard. The degree of hazard is defined according to the probability of the occurrence of an explosive atmosphere. Generally, neither the potential consequences of an explosion nor other factors, such as the toxicity of materials, are taken into account. A true risk assessment would consider all factors.

Historically, the selection of equipment for each zone is based on a firm link between the zone and the type of protection to be applied.

Not all types of protection provide the same degree of safety against the possibility of the occurrence of an ignitable state. For this reason, specific types of protection have been allocated to specific zones.



This was carried out on the statistical basis that- depending on the probability or frequency of the occurrence of an explosive atmosphere- the required level of safety against the probability of the presence of an ignition source and the probability of the occurrence of an explosive atmosphere has been adapted accordingly.

At a very early stage the type of protection "Intrinsic Safety", which was used for the instrumentation and control technology, was subdivided into various "safety categories" while maintaining the general explosion protection measures (see EN 60079-11 for details). These categories were then assigned directly to zones.

As an alternative method to the prescriptive and relatively rigid approach of the association of equipment to zones, a concept that was uncoupled from hazardous areas was introduced for the assessment of hazards for the selection of Ex equipment.

The ignition hazard posed by the equipment itself was the defining characteristic, whereby it did not matter which protection measure was being applied.

To simplify this, a system of protection levels relating to the equipment was introduced.

The concept of protective levels relating to the equipment was first implemented in the European directive 94/9/EC and described as categories.

This concept was adopted in the standards as Equipment Protection Levels (EPL).

The Equipment Protection Level (EPL) is the level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp.

### Zone classification / Equipment protection level

For most of the situations with the typical possible consequences of an occurring explosion a standard assignment from Zone to equipment protection level is possible.

Substance	Period of presence of the combustible substances	Zone	Minimum requirements for equipment				Protection level
			Directive 2014/34/EU		Standard IEC/EN 60079-0		
			Equipment group	Equipment category	Group	Equipment protection level EPL	
Gas, mist, vapour	Continuously for long periods or frequently	Zone 0	II	1 G	II	Ga	very high
	Occasional occurrence	Zone 1	II	2 G	II	Gb	high
	Not likely, but if it occurs only rarely and for a short period	Zone 2	II	3 G	II	Gc	enhanced
Dust	Continuously for long periods or frequently	Zone 20	II	1 D	III	Da	very high
	Occasional occurrence	Zone 21	II	2 D	III	Db	high
	Not likely, but if it occurs only rarely and for a short period	Zone 22	II	3 D	III	Dc	enhanced
Methane, coal dust		Mining	I	M1	I	Ma	very high
		Mining	I	M2	I	Mb	high

### Mines susceptible to firedamp (Group I)

#### EPL „Ma“

Equipment for installation in a mine susceptible to firedamp, having a “very high” level of protection, which has sufficient security that it is unlikely to become an ignition source in normal operation, during expected malfunctions or during rare malfunctions, even when left energized in the presence of an outbreak of gas.

#### EPL „Mb“

Equipment for installation in a mine susceptible to firedamp, having a “high” level of protection, which has sufficient security that it is unlikely to become a source of ignition in normal operation or during expected malfunctions in the time span between there being an outbreak of gas and the equipment being de-energized.



Picture: Ruhrkohle-AG



### Gases (Group II)

#### EPL „Ga“

Equipment for explosive gas atmospheres, having a “very high” level of protection, which is not a source of ignition in normal operation, during expected malfunctions or during rare malfunctions

#### EPL „Gb“

Equipment for explosive gas atmospheres, having a “high” level of protection, which is not a source of ignition in normal operation or during expected malfunctions

#### EPL „Gc“

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

### Dust (Group III)

#### EPL „Da“

Equipment for explosive dust atmospheres, having a “very high” level of protection, which is not a source of ignition in normal operation, during expected malfunctions, or during rare malfunctions.

#### EPL „Db“

Equipment for explosive dust atmospheres, having a “high” level of protection, which is not a source of ignition in normal operation or during expected malfunctions.

#### EPL „Dc“

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

For a large majority of situations with the typical possible consequences of the occurrence of an explosion, a standard allocation of zones to equipment protection levels is possible.





### Electrical types of protection for explosive atmospheres due to flammable gases, vapours and mists

Type	Protection level	Type of protection	Group	Equipment category	Equipment protection level (EPL)	CENELEC / IEC standard	Protection concept
d	da	Flameproof enclosure	II	1 G	Ga	EN 60079-1 / IEC 60079-1	Explosion containment, prevention of flame transmission
d	db	Flameproof enclosure	II	2 G	Gb	EN 60079-1 / IEC 60079-1	Explosion containment, prevention of flame transmission
d	dc	Flameproof enclosure	II	3 G	Gc	EN 60079-1 / IEC 60079-1	Explosion containment, prevention of flame transmission
p	pxb pyb	Pressurised enclosure	II	2 G	Gb	EN 60079-2 / IEC 60079-2	Exclusion of Ex-atmosphere
p	pzc	Pressurised enclosure	II	3 G	Gc	EN 60079-2 / IEC 60079-2	Exclusion of Ex-atmosphere
q		Powder filling	II	2 G	Gb	EN 60079-5 / IEC 60079-5	Prevention of explosion diffusion
o	ob	Liquid immersion	II	2 G	Gb	EN 60079-6 / IEC 60079-6	Exclusion of Ex-atmosphere
o	oc	Liquid immersion	II	3 G	Gc	EN 60079-6 / IEC 60079-6	Exclusion of Ex-atmosphere
e	eb	Increased safety	II	2 G	Gb	EN 60079-7 / IEC 60079-7	No arcs, sparks or hot surfaces
e	ec	Increased safety	II	3 G	Gc	EN 60079-7 / IEC 60079-7	No arcs, sparks or hot surfaces
i	ia	Intrinsic safety	II	1 G	Ga	EN 60079-11 / IEC 60079-11	Limitation of spark energy and surface temperature
i	ib	Intrinsic safety	II	2 G	Gb	EN 60079-11 / IEC 60079-11	Limitation of spark energy and surface temperature
i	ic	Intrinsic safety	II	3 G	Gc	EN 60079-11 / IEC 60079-11	Limitation of spark energy and surface temperature
p/v		Pressurised enclosure/ventilation	II	2 G	Gb	EN 50381 IEC 60079-13	Exclusion of Ex-atmosphere / dilution
nA		Non-sparking equipment	II	3 G	Gc	EN 60079-15 / IEC 60079-15	No arcs, sparks or hot surfaces
nC		Enclosed equipment	II	3 G	Gc	EN 60079-15 / IEC 60079-15	Explosion containment, prevention of flame transmission
nR		Restricted breathing enclosure	II	3 G	Gc	EN 60079-15 / IEC 60079-15	Exclusion of Ex-atmosphere for a limited period
m	ma	Encapsulation	II	1 G	Ga	EN 60079-18 / IEC 60079-18	Exclusion of Ex-atmosphere
m	mb	Encapsulation	II	2 G	Gb	EN 60079-18 / IEC 60079-18	Exclusion of Ex-atmosphere
m	mc	Encapsulation	II	3 G	Gc	EN 60079-18 / IEC 60079-18	Exclusion of Ex-atmosphere
i		Intrinsic system	II	2 G	Gb	EN 60079-25 / IEC 60079-25	Limitation of spark energy and surface temperature
		Equipment with protection level (EPL) Ga	II	1 G 1 G/2 G	Ga Ga/Gb	EN 60079-26 / IEC 60079-26	Double protection concept
op is		Inherent safe optical radiation	II	1 G	Ga	EN 60079-28 / IEC 60079-28	Limitation of radiation energy
op is		Inherent safe optical radiation	II	2 G	Gb	EN 60079-28 / IEC 60079-28	Limitation of radiation energy
op is		inherent safe optical radiation	II	3 G	Gc	EN 60079-28 / IEC 60079-28	Limitation of radiation energy
op pr op sh		Safe/interlocked optical radiation	II	2 G	Gb	EN 60079-28 / IEC 60079-28	Limitation or containment of radiation energy
op pr op sh		Safe/interlocked optical radiation	II	3 G	Gc	EN 60079-28 / IEC 60079-28	Limitation or containment of radiation energy
s	sa	Special protection	n.a.	n.a.	Ga	IEC 60079-33	Special measures
s	sb	Special protection	n.a.	n.a.	Gb	IEC 60079-33	Special measures
s	sc	Special protection	n.a.	n.a.	Gc	IEC 60079-33	Special measures

## Electrical types of protection for explosive atmospheres due to combustible dust

Type	Protection level	Type of protection	Group		Equipment category	Equipment protection level (EPL)	CENELEC / IEC standard	Protection concept
			Directive	Standard				
p	pxb	Pressurised enclosure	II	III	2 D	Db	EN 60079-2 / IEC 60079-2	Exclusion of Ex-atmosphere
p	pzc	Pressurised enclosure	II	III	3 D	Dc	EN 60079-2 / IEC 60079-2	Exclusion of Ex-atmosphere
i	ia	Intrinsic safety	II	III	1 D	Da	EN 60079-11 / IEC 60079-11	Limitation of spark energy and surface temperature
i	ib	Intrinsic safety	II	III	2 D	Db	EN 60079-11 / IEC 60079-11	Limitation of spark energy and surface temperature
i	ic	Intrinsic safety	II	III	3 D	Dc	EN 60079-11 / IEC 60079-11	Limitation of spark energy and surface temperature
m	ma	Encapsulation	II	III	1 D	Da	EN 60079-18 / IEC 60079-18	Exclusion of Ex-atmosphere
m	mb	Encapsulation	II	III	2 D	Db	EN 60079-18 / IEC 60079-18	Exclusion of Ex-atmosphere
m	mc	Encapsulation	II	III	3 D	Dc	EN 60079-18 / IEC 60079-18	Exclusion of Ex-atmosphere
op is		Inherent safe optical radiation	II	III	1 D	Da	EN 60079-28 / IEC 60079-28	Limit of radiation energy
op is		Inherent safe optical radiation	II	III	2 D	Db	EN 60079-28 / IEC 60079-28	Limit of radiation energy
op is		Inherent safe optical radiation	II	III	3 D	Dc	EN 60079-28 / IEC 60079-28	Limit of radiation energy
op pr op sh		Safe/interlocked optical radiation	II	III	2 D	Db	EN 60079-28 / IEC 60079-28	Limitation or containment of radiation energy
op pr op sh		Safe/interlocked optical radiation	II	III	3 D	Dc	EN 60079-28 / IEC 60079-28	Limitation or containment of radiation energy
t	ta	Protection by enclosure	II	III	1 D	Da	EN 60079-31 / IEC 60079-31	Exclusion of dust
t	tb	Protection by enclosure	II	III	2 D	Db	EN 60079-31 / IEC 60079-31	Exclusion of dust
t	tc	Protection by enclosure	II	III	3 D	Dc	EN 60079-31 / IEC 60079-31	Exclusion of dust
s	sa	Special protection		III	n.a.	Da	IEC 60079-33	Special measures
s	sb	Special protection		III	n.a.	Db	IEC 60079-33	Special measures
s	sc	Special protection		III	n.a.	Dc	IEC 60079-33	Special measures



**Type of protection to EN 60079-0****Explosive atmospheres – Part 0: Equipment – General requirements**

Electrical equipment for use in explosive atmosphere shall meet the general requirements of EN 60079-0 and the specific requirements of the type of protection in which it is designed. Under some circumstances, particularly harsh operating conditions, the effects of humidity, high ambient temperatures and other special demands require additional measures.

Some of the main points are listed below:

**Equipment grouping**

Electrical equipment for explosive atmospheres is divided into the following groups:

Electrical equipment of Group I is intended for use in mines susceptible to firedamp. Electrical equipment of Group II is intended for use in areas where an explosive gas atmosphere is to be expected, other than mines susceptible to firedamp. Electrical equipment of Group II is subdivided according to the nature of the explosive atmosphere for which it is intended.

**Group II subdivisions**

- IIA, a typical gas is propane
- IIB, a typical gas is ethylene
- IIC, a typical gas is hydrogen

Electrical equipment of Group III is intended for operation in areas with an explosive dust atmosphere, other than mines susceptible to firedamp. Electrical equipment of Group III is subdivided according to the nature of the explosive atmosphere for which it is intended

**Group III subdivisions**

- IIIA, combustible flyings
- IIIB, non-conductive dust
- IIIC, conductive dust

**Table 34/1: Ambient temperatures in service and additional marking**

Electrical equipment	Ambient temperature in service	Additional marking
Normal	Maximum: +40 °C Minimum: –20 °C	None
Special	Specified by the manufacturer	$T_a$ or $T_{amb}$ with the special range, e.g. –30 °C $\leq T_a \leq +40$ °C, or the symbol "X"

**Temperatures**

Electrical equipment shall be designed for use in a normal ambient temperature range of –20 to +40°C (see table 34/1).

**Mechanical strength of equipment**

The mechanical strength, suitability for the intended operating temperature range and the resistance to ageing of the materials used are verified by climatic conditioning and tests for resistance to impact and drop tests (see table 34/1).

**Electromagnetic and ultrasonic energy-radiating equipment**

In order to prevent the ignition of an explosive mixture, the signals emitted from equipment shall be below the values stated in the standard. The specified limiting values shall also apply to lasers and other continuous light sources.

**Enclosures and parts of enclosures**

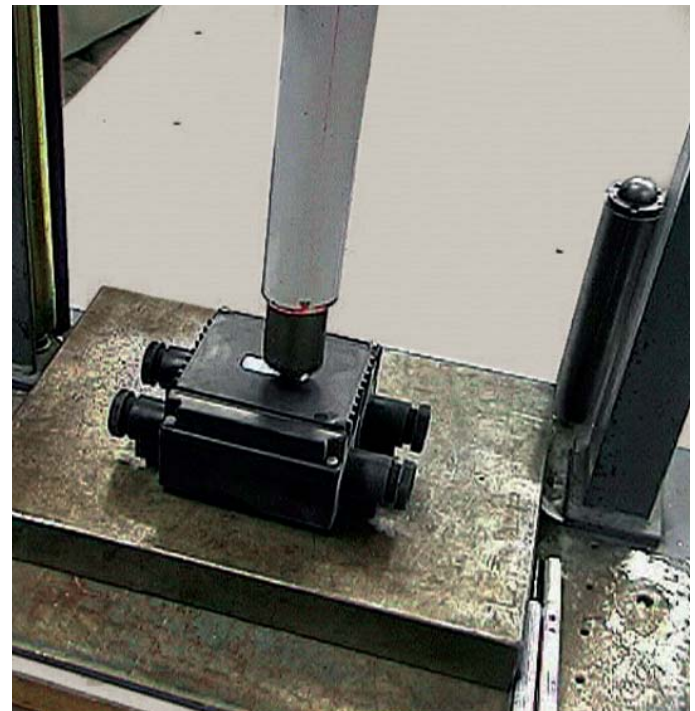
If plastics and light alloys are used, special requirements listed in the standard that apply specifically to enclosures shall be met.

To prevent an electrostatic charge, in the case of plastic enclosures, a material with a surface resistance of  $< 1 \text{ GOhm}$  is used if the area specified in the standard is exceeded.

**Special requirements**

Depending on the type of protection, special requirements apply to

fasteners and interlocks, bushings and connection pieces, rotating machines, switchgear, fuses, plugs and sockets, luminaires and batteries.



Tests for resistance to impact of an explosion-protected junction box

**Table 34/2**

Tests for resistance to impact	Drop height $h$ $+0,01^0$ with mass $1 \pm 0,01^0 \text{ kg}$ m			
	Group I		Group II or III	
Risk of mechanical danger	high	low	high	low
a) Enclosures and external accessible parts of enclosures (other than light-transmitting parts)	2	0,7	0,7	0,4
b) Guards, protective covers, fan hoods, cable glands	2	0,7	0,7	0,4
c) Light-transmitting parts without guard	0,7	0,4	0,4	0,2
d) Light-transmitting parts with guard having individual openings from 625 mm <sup>2</sup> to 2 500 mm <sup>2</sup> ; see 21.1 (tested without guard)	0,4	0,2	0,2	0,1

# Explosion-protected Electrical Equipment

Type of protection to EN 60079...



## Ex-components

An Ex component is a part of electrical equipment or a module that is marked with the symbol "U" must not be used alone and requires additional consideration when incorporated into electrical equipment or systems for use in explosive atmospheres.

## Cable entries

Cable entries must not render the special properties of the type of protection of the electrical equipment to which they are mounted ineffective and shall fulfil the requirements laid down in the standard.

## Marking

The electrical equipment shall be marked legibly on the main part on the exterior of the enclosure. The minimum requirements for the marking can be found in the standard. The following is an example of a marking.

## Operating instructions

The operating instructions shall include all the information required for the installation, commissioning, use, assembly and dismantling and, where necessary, special instructions for use and a list of the standards, including the date of issue, with which the electrical equipment is declared to comply.



## Example for a type label



Name or registered trade mark (CEAG) and address of the manufacturer

2. Serial number including year of manufacture

3. Certificate number, may end with "X" or "U"  
- "X" indicates that special conditions for safe use apply  
- "U" is used for component certificates

4. Additional IECEx certification

5. Marking according to directive: Equipment group (II) and equipment category (2); type of explosive atmosphere G (Gas, vapour or mist) D (dust)

6. Marking according to standard: IEC/EN

7. Equipment name/type

8. CE marking and number of the "notified body" responsible for monitoring the quality system (0158 = EXAM Germany)

9. Electrical parameters

<b>EATON</b>		<b>CROUSE-HINDS</b> SERIES	
⑦ <b>eLLK 92036/36</b> <b>12266875101</b>	① <b>CEAG</b> D-69412 Eberbach		
③ <b>BVS 16 ATEX E 123 / IECEx BVS 16.123</b>	⑪ <b>IP66/67</b>		
⑧ <b>CE 0158 Ex II 2G II 2D</b>	⑫ <b>T<sub>a</sub> = -25°C bis +55°C</b>		
⑨ <b>AC: 110-254V 50-60Hz</b> <b>DC: 110-250V</b>	⑬		
⑩ <b>Lampe: G13-81 IEC</b>	<b>www.ceag.de</b>		
② <b>Snr.: D123456 2016</b>	<b>Made in Germany</b>		

10. Other essential information (depends on the standard, e.g. lamp)

11. Other optional information (e.g. degree of protection)

12. Permissible ambient temperature (-25°C to +55°C); no marking required for temperatures from -20°C to 40°C (standard values for all equipment)

13. Marking according to EU-directive 2002/96/EC (WEEE-directive: Waste of Electrical and Electronic Equipment)



## EN 60079-1

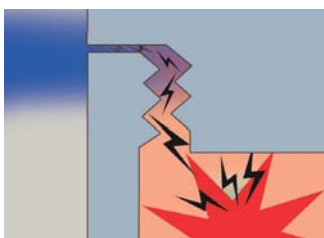
### Explosive Atmospheres– Part 1: Equipment protection by flameproof enclosures “d”

#### Scope

This part 1 of EN 60079 contains specific requirements for the construction and testing of electrical equipment in the type of protection Flameproof Enclosure “d” intended for use in explosive gas atmospheres. It supplements and modifies the general requirements of EN 60079-0.

#### Definition

Type of protection where the parts which can ignite an explosive gas atmosphere are built into a flameproof enclosure that can withstand the pressure developed during an internal explosion of an explosive mixture and prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure.



The flanged/threaded joint prevents a transission of an explosion

#### Equipment Protection Level (EPL)

Electrical equipment with flameproof enclosure “d” can be designed in various levels of protection, which determine the overall equipment protection level:

- Level of Protection “da” (EPL “Ma” or “Ga”);
- Level of Protection “db” (EPL “Mb” or “Gb”); or
- Level of Protection “dc” (EPL “Gc”).

#### Requirements for level of protection “da”

The level of protection “da” only applies to catalytic sensors or portable combustible gas detectors. The maximum free internal volume shall not exceed 5 cm<sup>3</sup>.

#### Requirements for level of protection “db”

The new level of protection “db” replaces and describes the previous flameproof enclosure “d”.

#### Requirements for level of protection “dc”

The level of protection “dc” describes a simplified flameproof encapsulation without the constructional requirements for, for example, the geometry of gaps. The maximum free internal volume shall not exceed 20 cm<sup>3</sup>.

#### General requirements

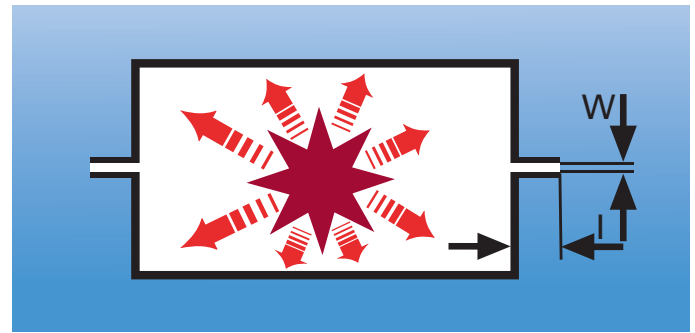
The flameproof encapsulation can be seen as a one-way street. An explosive atmosphere can enter into the enclosure, but, in the event of an explosion inside the enclosure, the transmission of the explosion to the explosive atmosphere surrounding the enclosure.

As, due to the construction principle, there are normally gaps in flameproof enclosures, these gaps shall be such that an arc-through through these gaps is prevented. In particular, it is necessary to ensure that the gaps are not damaged mechanically.

The geometry of gaps, the gaps and the width of joints shall vary according to the respective group (A, B, C).



The values stated in the standard are only minimum requirements. The suitability shall be verified by experimental tests.



Principle of flameproof enclosures



Application example: Ex-d enclosure solution for the chemical industry

The flameproof enclosure shall be able to safely withstand the pressure resulting from an explosion inside the enclosure. Depending upon the size, group and geometry, the pressures arising in the event of an explosion can vary considerably (<5 bar to > 40 bar). If flameproof enclosures are used outside of the standard ambient temperature range (-20 °C to +40 °C), the suitability shall be tested in accordance with the method specified in EN 60079-1.

Special attention shall be given to the fact that, as the ambient temperature changes, there may also be negative changes to the stability of enclosure parts. Because, when the internal compartment is divided up (e.g. by built-in equipment) and, in the event of an explosion, a pre-compaction of the remaining mixture and, as a result, increases in pressure may occur, the worst case scenarios shall be taken into consideration during experiments.

Walls and obstructions that could lead to a dynamic pressure with flange joints shall feature a minimum clearance from the joints

Oil and liquids that can form an explosive mixture with the air on decomposition must not, under any circumstances, be used in equipment in flameproof enclosures.

Equipment of Group IIC may also be used in the areas for Groups IIB and IIA, equipment of Group IIC may be used in areas for Group IIA. The temperature class of equipment denotes the permissible limiting temperature up to which the external surface of the equipment may heat up.

### Minimum distance of obstructions from flameproof "d" flange openings

Gas group	Minimum distance
IIA	10 mm
IIB	30 mm
IIC	40 mm

NOTE IEC 60079-14 limits the installation of equipment employing type of protection "d" that incorporates flanged (flat) joints. Specifically, the flanged joints of such equipment are not permitted to be installed closer to solid objects that are not part of the equipment, than the dimensions shown in Table 11, unless the equipment is so tested

### Empty enclosures

The enclosures shall be marked in accordance with the requirements for the marking of Ex components according to EN 60079-0. The Ex marking must not be affixed to the exterior. The exterior of the enclosure may only be marked with the name of the manufacturer and identification features (e.g. type or serial number).

### Cable entries

In addition to the requirements of EN 60079-0, cable entries in Ex-d enclosures shall satisfy the requirements for flameproof enclosures.

Depending on the chosen concept, entry into the enclosure can either be made:

directly ( Ex-d cable entry or conduit)

or

indirectly ( Ex-e connection box combined with Ex-d flameproof bushings).



Ex-d Emergency light fitting with self-contained battery for direct entry into the flameproof enclosure



Ex-d pendant light fitting with indirect entry by an Ex-e connection box with Ex-d flameproof bushing

### Cells and batteries for use in flameproof enclosures in the type of protection "d"

Irrespective of the type of electro-chemical cell used, the main task is to prevent the release of a combustible mixture of electrolysis gases (normally hydrogen and oxygen) inside the flameproof enclosure.

For this reason, the use of cells and batteries where the release of electrolysis gases (either due to natural ventilation or with a pressure-relief valve) is to be expected during normal operation is not permitted.



Ex-d empty enclosures, connected to each other by an Ex-d flameproof bushing

### Examples of flameproof enclosure "d" applications

- Motors with slip rings and commutators
- Three-phase cage induction motors
- Switchgear with N/C and N/O contacts such as manual motor starters, circuit breakers, air-break contactors
- Control devices
- Plugs and sockets
- Luminaires



## EN 60079-2 Explosive atmospheres – Part 2: Equipment protection by pressurised enclosure “p”

### Scope

This part 2 of EN 60079 contains the specific requirements for the construction and testing of electrical equipment with pressurised enclosures, of type of protection “p”, intended for use in explosive gas atmospheres or atmospheres with combustible dust. It specifies requirements for pressurised enclosures containing a limited release of a flammable substance. It supplements and modifies the general requirements of EN 60079-0.

### Definition

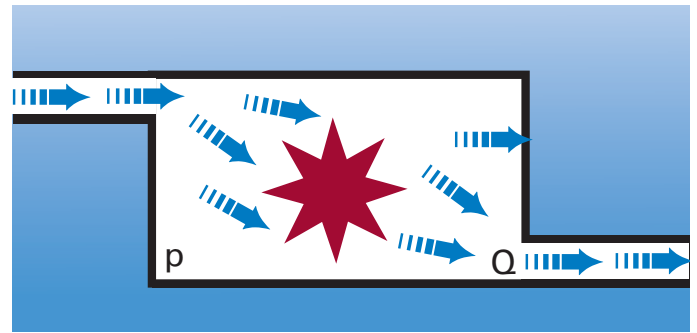
A method that prevents the ingress of the surrounding atmosphere into an enclosure, whereby a protective gas is kept at a pressure that is higher than the pressure of the surrounding atmosphere.

### Equipment protection level (EPL)

Protection by pressurised enclosures is subdivided into three levels of protection („pxb”, „pyb” and „pzc”) that, due to the equipment protection level („Mb”, „Gb”, „Db”, „Gc” or „Dc”) required for the respective external explosive atmosphere, are selected according to whether there is potential for an internal release and whether the equipment inside the pressurised enclosure is ignition-capable (Table 1). The type of protection then defines the design criteria for the pressurised enclosure and the pressurisation system (Table 2).

### General requirements

A minimum overpressure of 50 Pa for the level of protection “pxb” or the level of protection “pyb” and 25 Pa for the level of protection “pzc” shall be maintained at every point inside the pressurised enclosure and the associated conduit where leakages may occur.



Principle of pressurisation

### Protective gas

As a rule, air is used as the protective gas. The protective gas shall enter into or exit the enclosure outside of the hazardous area.

### Monitoring

It is necessary to monitor the maintenance of the overpressure and, if the pressure should fall, to issue a warning or switch off the system.

### Cells and batteries for Level of Protection „pxb” and Level of Protection „pyb”

Only the cells listed in EN 60079-0 for which there is an EN(IEC) standard may be used in pressurised enclosure.

Secondary cells and batteries may be used if

### Purging criteria

a) For Level of Protection “pxb” or Level of Protection “pyb”, the minimum purge flow and time shall be specified. For simple geometries the minimum purge flow and time may be based upon a five-enclosure-volume purge.

b) For Level of Protection “pzc”, the minimum purge flow and time shall be specified to ensure that the pressurised enclosure is purged by a quantity of protective gas equivalent to five enclosure volumes.

- the individual cells are sealed cells (either gastight sealed cells or valve-regulated cells) or
- if the volume of the battery does not exceed 1 % of the free volume inside the pressurised enclosure



Terminal in pressurised stainless steel enclosure

### Examples of pressurised enclosure “p” applications

- Electrical machines with a higher rating
- Control panels and cabinets
- Control rooms
- Measuring and analysing equipment
- Special machines and equipment

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 ignitioncapable equipment is not located in the dilution area	Level of protection „pxb“
Yes, gas/vapour	„Gb“ and „Db“	Yes or no	Level of protection „pyb“
Yes, gas/vapour	„Gc“ or „Dc“	Yes and the ignitioncapable 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)

REMARK 1 If the flammable substance is a liquid, normal release is never permitted.

REMARK 2 The protective gas shall be inert if “(inert)” is shown after the pressurisation 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 with indicator „pzc“	Level of protection with alarm „pzc“
Degree of enclosure protection according to IEC 60529 or IEC 60034-5	IP4X minimum	IP4X minimum	IP4X minimum	IP3X minimum
Impact resistance of the enclosure	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 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 b)	No requirement b)
Preventing incandescent particles from exiting a vent that opens during normal operation, to an area requiring EPL Mb, Gb or Dc	Spark and particle barrier required	Spark and particle barrier required	Level of protection pzc“ does not apply to areas requiring EPL Mb, Gb or Db	Level of protection pzc“ does not apply to areas requiring EPL Mb, Gb or Db
Preventing incandescent particles from exiting a vent that opens during normal operation, to an area requiring EPL Mb, Gb or Dc	Spark and particle barrier required, see unless incandescent particles not normally produced	No requirement a)	Spark and particle barrier required, see unless incandescent particles not normally produced	Spark and particle barrier required, see unless incandescent particles not normally produced
Door or cover opens only with use of a tool	Warning b)ii)	Warning b)	Warning	Warning c)
Door or cover opens only with use of a tool	Interlock (no internal hot parts)	Warning a)	Warning	Warning
Internal hot parts that require a cool-down period before opening enclosure	Comply with ii	No requirement a)	Warning	Warning

a) point 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 pressurised 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



## EN 60079-5 Explosive atmospheres – Part 5: Equipment protection by powder filling “q”

### Scope

This part 5 of EN 60079 contains specific requirements for the construction, testing and marking of electrical equipment, parts of electrical equipment and Ex components in the type of protection powder filling “q”, intended for use in explosive gas atmospheres. It supplements and modifies the general requirements of EN 60079-0.

### Definition

A type of protection in which the parts capable of igniting an explosive gas atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an external explosive gas atmosphere.

### Equipment Protection Level

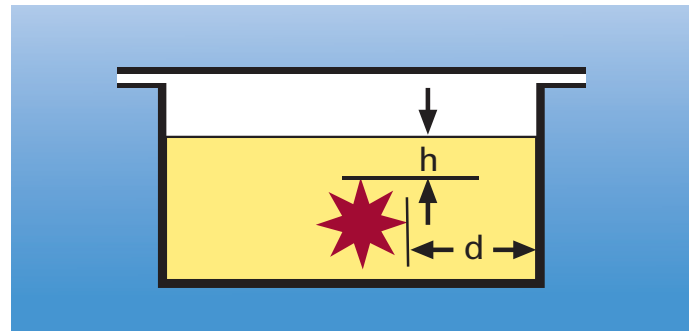
The EPL provided by the type of protection powder filling “q” is “Gb” or “Mb”.

### General requirements

With this type of protection the enclosure is normally filled with solid glass or quartz particles that have to meet specific requirements relating to the grain size, purity, moisture content and disruptive strength. The stability of the enclosure shall be verified by means of a static

pressure test. Enclosures of electrical equipment protected by the type of protection “q” shall be filled, closed and sealed during production. It shall not be possible for it to be opened without leaving visible signs. Electrical equipment where repairing is possible shall be fitted with suitable fasteners that can be opened without damaging the enclosure. After completion of repair work, the equipment shall be resealed and marked accordingly.

The built-in electrical components shall be adequately insulated, irrespective of the insulating effect of the filling material. In the case of bare, live parts, there must be sufficient space between the parts themselves and between the parts and the enclosure wall. The filling material is compressed, whereby, depending on the built-in components and requirements, the layers of filling material shall have a specified thickness.



Principle of powder filling

### Cells and batteries (Accumulators)

Containers of electrical equipment, parts of electrical equipment or Ex components protected by powder filling “q” that contain cells or batteries shall feature a venting device that leads to the outside atmosphere, except if the cells or batteries

- have a capacity of 1.5 Ah or less or
- do not release any gas under normal operating conditions and they meet the requirements according to EN 60079-7 for primary and secondary batteries with a capacity up to 25 Ah for the level of protection “eb”.



Application example: Powder filled capacitor

### Examples of powder filling “q” applications

- Capacitors
- Small transformers
- Electronic equipment

### EN 60079-6

#### Explosive atmospheres – Part 6: Equipment protection by liquid immersion „o“

#### Scope

This part of EN 60079 specifies the requirements for the design, construction, testing and marking of Ex Equipment and Ex Components with type of protection liquid immersion „o“ intended for use in explosive gas atmospheres. It supplements and modifies the general requirements of EN 60079-0.

#### Definition

A type of protection in which the electrical equipment or parts of the electrical equipment are immersed in a protective liquid in such a way that an explosive gas atmosphere which may be above the liquid or outside the enclosure cannot be ignited.

#### Equipment Protection Level (EPL)

Electrical equipment and Ex components in the type of protection liquid immersion „o“ can be designed with various levels of protection which determine the overall equipment protection level.

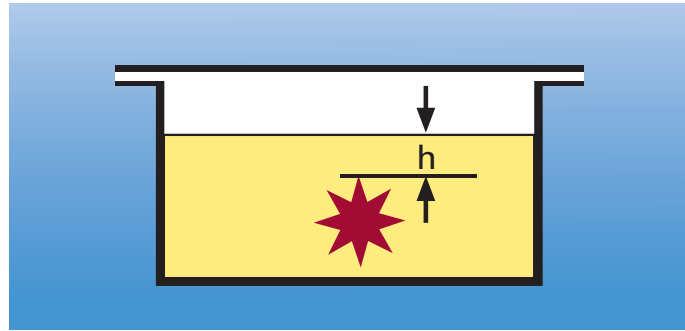
- a) Level of Protection „ob“  
(EPL Gb or Mb);  
or
- b) Level of Protection „oc“  
(EPL „Gc“).

#### Requirements for Level of Protection „ob“

- Rated voltage max. 11 kV alternating or direct voltage.
- Liquid level indication
- Switching devices rated at 2 kVA per contact or less, are permitted without further testing. Where the switching device is rated above 2 kVA per contact, neither pressure increases nor excessive decomposition products shall invalidate the type of protection.

#### Requirements for Level of Protection „oc“

- Rated voltage max. 15 kV alternating or direct voltage.
- Switching devices rated at 10 kVA per contact or less, are permitted without further testing. For switching devices rated above 10 kVA per contact, neither pressure increases nor excessive decomposition products shall invalidate the type of protection.



Principle of liquid immersion „o“

#### General requirements

With this type of protection the electrical equipment or parts of the electrical equipment are immersed in a protective liquid in such a way that an explosive gas atmosphere which may be above the liquid or outside the enclosure cannot be ignited.

This requires that the thermal output fed to the protective liquid, the thermal energy and the resulting energy density be taken into account. In addition to ensuring that the level of the protective liquid is sufficient in all operating positions of the equipment, the use of a suitable type of protective liquid is important. It shall not decompose under the influence of, for example, switching arcs. Moreover, by means of adequate dimensioning, i.e. the dimensioning of the protective liquid, it shall be ensured that the equipment does not exceed the permitted temperature. The long term quality of the liquid shall also be monitored.

Due to the use of high-performance electronics in explosive atmospheres, in the future the significance of liquid immersion could become far more significant than it is today. Here the protective liquid would fulfil two functions – namely an explosion protection and a cooling medium.

#### Protective liquid

The protective liquid can be a mineral oil to EN 60296, a silicone liquid to EN 60836, a synthetic organic ester (Type T1) to EN 61099 or a liquid that complies with the specification in the standard.

#### Examples of liquid immersion „o“ applications

- Switchgear
- Transformers
- Electronics



## EN 60079-7

### Explosive atmospheres – Part 7: Equipment protection by increased safety „e”

#### Scope

This part 7 of IEC 60079 specifies the requirements for the design, construction, testing and marking of electrical equipment and Ex Components with type of protection increased safety „e” intended for use in explosive gas atmospheres. It supplements and modifies the general requirements of IEC 60079-0.

#### Definition

A type of protection applied to electrical equipment in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and against the occurrence of arcs and sparks during the intended operation and under given extraordinary conditions.

#### Equipment protection level (EPL)

Electrical equipment and Ex components in the type of protection „e” can be designed with various levels of protection which determine the overall equipment protection level.

a) Level of Protection „eb” (EPL „Mb” or EPL „Gb”)

or

b) Level of Protection „ec” (EPL Gc”).

#### Level of Protection „eb”

Rated voltage 11 kV rms AC or DC

This applies to the equipment specified in the standard and connections, conductors, windings, lamps and batteries, but not to electronic components.

#### Level of Protection „ec”

Rated voltage 15 kV rms AC or DC

This applies to the equipment specified in the standard and connections, conductors, windings, lamps and batteries, including semiconductors or electrolytic capacitors.

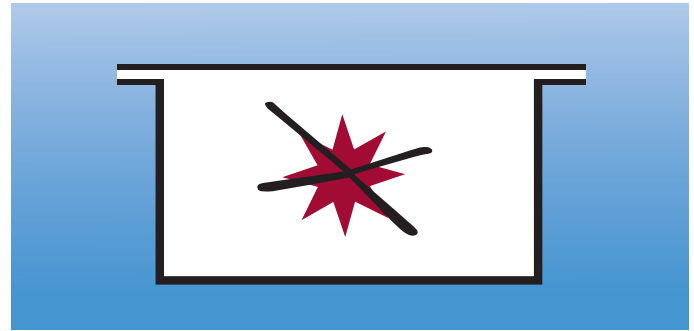
## General requirements

### Electrical connections

In accordance with the requirements, electrical connections are subdivided into those for field wiring and factory wiring and into permanent types and reconnectable/rewireable types. Each type shall, as applicable, be constructed in such a way that the conductors cannot slip out from their intended location during the tightening of a screw or after insertion, provide a means to avoid self-loosening of the connection in service, be designed in such a way that contact is assured without damage to the conductors and to provide a positive compression force to assure contact pressure in service. If intended for stranded conductors, employ a means to protect the conductors and distribute the contact pressure evenly.

### Clearances and creepage distances

The clearances and creepage distances are specified subject to the level of protection. The basis for this is EN 60644 for the use of equipment in outside areas, which is decisive for industrial equipment. To achieve an „increased safety” and exclude flashovers and the formation of creepage paths, the clearances were increased considerably for the Level of Protection „eb” (in the first instance by a factor of 1.5).



Principle of the type of protection „Increased Safety”

### Degree of protection provided by enclosures

Enclosures containing bare conductive live parts shall provide at least the degree of protection IP54.

The degree of protection IP44 is sufficient for enclosures that only contain insulated conductive parts. If rotating electrical machines in clean environments are monitored regularly by qualified personnel, the degree of protection IP 20 is sufficient for Group II.

### Surface temperatures

With this type of protection the ingress of an explosive gas atmosphere cannot be excluded. This reason, the maximum permissible surface temperatures also apply to all surfaces inside an enclosure.

### Electrical machines

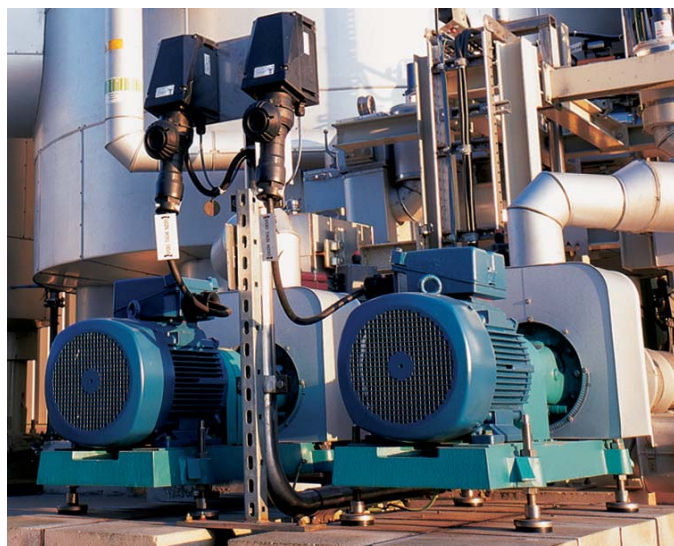
Every insulating material is subject to a natural ageing process. To extend the service life of insulating materials used for windings, the limiting temperature is lowered compared to conventional windings. This reduces the risk of damage to the windings and, consequently, the formation of arcs and sparks due to earth faults and shorted windings.

To protect the winding and to maintain the maximum permissible surface temperatures, current-dependent safety devices that respond in the event of heavy starting or malfunctions are generally used in motors. With motors with the level of protection „eb”, this protective device shall ensure that a motor that has reached its continuous service temperature after several hours of operation at rated load is still switched off safely before it reaches the permissible limiting temperature if a rotor blocks due to a malfunction and, as a result, the consumption of an increased current.

Electrical motors in the type of protection „Increased Safety” may generally only be used in continuous operation and for normal, not frequently recurring starts, so that the temperature increases occurring at the start do not exceed the permissible limiting temperatures.

### Luminaires

The requirements of the standard apply to all luminaires (fixed, portable, or transportable), hand lights, and caplights (other than for Group I); intended to be supplied by mains (with or without galvanic isolation) or powered by batteries.

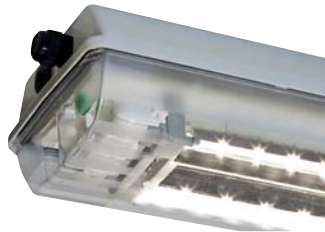


Explosion-protected electrical machine

Permissible light sources for the Levels of protection „eb“ and „ec“ are defined explicitly:

- **For Level of Protection „eb“ or „ec“,** fluorescent lamps of the cold starting type in accordance with EN 60081 with single-pin caps (Fa6) in accordance with EN 60061-1;
- **For Level of Protection „eb“ or „ec“** tubular fluorescent bi-pin lamps in accordance with EN 60081 with G5 or G13 lamp caps in accordance with EN 61195 with pins made of brass. Lamp holders and sockets shall conform to 5.3.5.3. Such lamps shall be connected in a circuit in which they start and run without preheating of the cathodes; only T8, T10, or T12 lamps shall be used. T5 lamps shall be permitted only up to 8 watts.
- **For Level of Protection „ec“,** tubular fluorescent bi-pin lamps in accordance with EN 60081 with G5 or G13 lamp caps in accordance with EN 61195 with pins made of brass. Lampholders and sockets shall conform to 5.3.5.3. Such lamps may be connected in a circuit in which they start and run with preheating of the cathodes; only T5-type HE according to EN 60081 sheet 6520 (14 W), sheet 6530 (21 W), sheet 6640 (28 W), sheet 6650 (35 W), T8, T10, or T12 lamps shall be used.
- **For Level of Protection „eb“ or „ec“** tungsten filament lamps in accordance with EN 60064 and EN 60432-1;
- **For Level of Protection „eb“** tungsten-halogen lamps in accordance with EN 60432-2, restricted to max. 100 W.
- **For Level of Protection „ec“** tungsten-halogen lamp in accordance with EN 60432-2; without power limitation.
- **For Level of Protection „ec“** discharge lamp in accordance with EN 62035
- **for Level of Protection „ec“** LEDs

All luminaires shall feature a lamp cover of sufficient strength



LED luminaire in the type of protection „e“, in Level of Protection „eb“ with LEDs in the type of protection „m“

Note:

LEDs are currently not permitted as a source of light in the Level of Protection „eb“, as these semiconductor devices are not yet considered to be sufficiently defined, with respect to safety factors and, therefore have to be protected by other suitable protective measures.

- **For the Level of Protection „eb“** the lamp holders shall either meet the requirements for the type of protection Flame-proof Enclosure „db“ or the type of protection Increased Safety „eb“, whereby, with the latter the is not live during connection or disconnection.

### Batteries and cells

Only those types of cells named explicitly in the standard are permissible. Here distinction is made between:

- Sealed cells
- Valve-regulated cells and batteries
- Vented cells and batteries

During transport in an explosive atmosphere the live parts of a battery shall have a minimum degree of protection IP 30.



In addition, the following requirements apply for the use of lamps with bi-pin holders:

Type of lamp	Type of protection „eb“	Type of protection „ec“	Temperature of luminaire	Temperature class	Maximum cathode power
T8/T10/T12	Permissible	Permissible	≤ 40 °C	T4	10 W
T8/T10/T12	Permissible	Permissible	≤ 60 °C	T4	8 W
T8/T10/T12	Permissible	Permissible	≤ 60 °C	T3	10 W
T5 (8 W)	Permissible	Permissible	≤ 40 °C	T4	4 W
T5 (8 W)	Permissible	Permissible	≤ 60 °C	T3	4 W
T5-HE (8 W bis 35 W)	Not permissible	Permissible	≤ 60 °C	T4	5 W

### Junction and connection boxes:

Rated data shall be specified for junction and terminal boxes to ensure adherence to the limiting temperature during operation.

These can, for example, be specified by determining the load data in relation to the terminal cross section (wire cross-section) and the number of connected wires.



Stainless-steel terminal box, type of protection „e“

Type of cell or battery	Capacity of cell or battery	Permitted activity in hazardous area			Remarks
		Dis-charging	Charging	Additional equipment in the same compartment	
sealed	≤ 25 Ah	yes	yes	yes	-
Valve-regulated	No restriction	yes	no	Yes Only „e“ „m“ „o“	Equipment with Type of Protection „d“, „i“ or „q“ shall be located in a separate compartment
Vented	No restriction	yes	no		

### Examples of Increased Safety „e“ applications

- Three-phase cage rotors
- Transformers
- Current and voltage transformers
- Measuring instruments
- Luminaires
- Terminal compartments for all electrical equipment
- Connections for plugs and sockets



### EN 60079-11

#### Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “I”

#### Scope

One of the more recent types of protection against explosion hazards due to electrical apparatus and installations is called “Intrinsic Safety.” The most common types of protection were conceived for electrical power engineering applications. As a result of increasing automation in hazardous areas, there has been an ever growing demand for explosion-protected measurement and control devices. This part of EN 60079 specifies the requirements for the construction and testing of intrinsically safe apparatus intended for use in an explosive atmosphere and for associated apparatus, which is intended for connection to intrinsically safe circuits which enter such atmospheres.

This type of protection is applicable to electrical equipment in which the electrical circuits themselves are incapable of causing an explosion in the surrounding explosive atmospheres. It is also applicable to electrical equipment or parts of electrical equipment located outside the explosive atmosphere or protected by another Type of Protection listed in IEC

60079-0, where the intrinsic safety of the electrical circuits in the explosive atmosphere may depend upon the design and construction of such electrical equipment or parts of such electrical equipment. The current standard supplements and modifies the general requirements of EN 60079-0.

#### Definitions

##### Intrinsic Safety “i”

Type of protection based on the restriction of electrical energy within equipment and of inter-connecting wiring exposed to the explosive atmosphere to a level below that which can cause ignition by either sparking or heating effects.

##### Intrinsically safe circuit

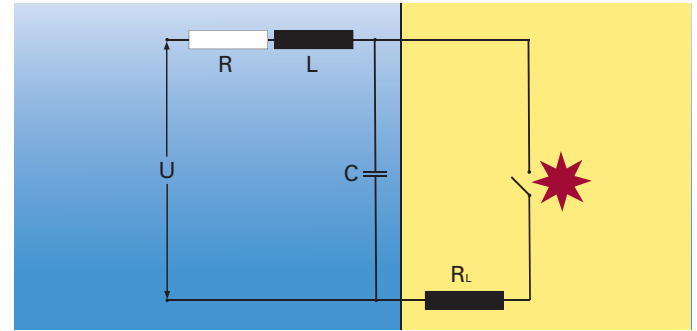
Circuit in which any spark or thermal effect produced in the conditions specified in this standard, which include normal operation and specified fault conditions, is not capable of causing the ignition of a given explosive atmosphere.

##### Intrinsically safe apparatus

Electrical equipment in which all circuits are intrinsically safe.

##### Associated apparatus

Electrical equipment which contains both intrinsically safe and non-intrinsically safe circuits and is constructed so that the



Principle of the type of protection Intrinsic Safety “I”

non-intrinsically safe circuits cannot adversely affect the intrinsically safe circuits.

#### Note:

Associated apparatus may be either:

Electrical equipment which has another type of protection for use in the appropriate explosive atmosphere;

Electrical equipment not so protected and which, therefore, is not normally used within an explosive atmosphere, e.g. a recorder which is not itself in an explosive atmosphere, but is connected to a thermocouple situated within an explosive atmosphere where only the recorder input circuit is intrinsically safe.

#### Equipment Protection Level (EPL)

Electrical apparatus in the type of protection Intrinsic Safety “i” can be subdivided into various levels of protection that determine the overall equipment protection level:

- level of protection “ia” (EPL “Ma”; “Ga” or “Da”);
- level of protection “ib” (EPL “Mb”; “Gb” or “Db”);
- level of protection “ic” (EPL “Gc” or “Dc”).

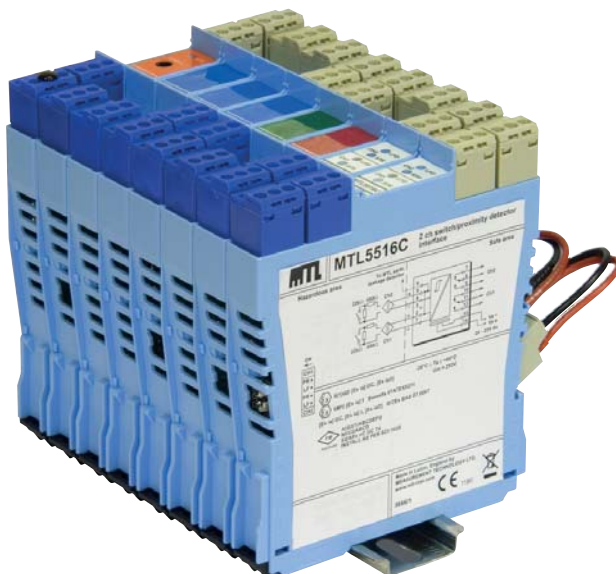
#### Level of protection “ia”

With  $U_m$  and  $U_i$  applied, the intrinsically safe circuits in electrical apparatus of level of protection “ia” shall not be capable of causing ignition in each of the following circumstances:

- in normal operation and with the application of those non-countable faults which give the most onerous condition;
- in normal operation and with the application of one countable fault plus those non-countable faults which give the most onerous condition;
- in normal operation and with the application of two countable faults plus those non-countable faults which give the most onerous condition.

#### Diode safety barriers

Assemblies that incorporate shunt diodes or diode chains (including Zener diodes) protected by fuses or resistors or a combination of these, manufactured as an individual apparatus rather than as part of a larger apparatus.



Associated electrical apparatus

### Level of protection „ib“

With  $U_M$  and  $U_i$  applied, the intrinsically safe circuits in electrical apparatus of level of protection „ib“ shall not be capable of causing ignition in each of the following circumstances:

- In normal operation and with the application of those non-countable faults which give the most onerous condition;
- In normal operation and with the application of one countable fault plus the application of those non-countable faults which give the most onerous condition.

### Level of protection „ic“

With  $U_M$  and  $U_i$  applied, the intrinsically safe circuits in electrical apparatus of level of protection „ic“ shall not be capable of causing ignition in normal operation and under the conditions specified in this standard.

Note:

The concept of countable faults does not apply to this level of protection.

### General requirements

On principle, as with all other types of protection, the associated electrical apparatus used in intrinsically safe circuits and the intrinsically safe apparatus shall be tested and certified. According to EN 60079-0, only such apparatus where, according to the details given by the manufacturer, no value exceeds 1.2 V; 0.1 A; 20  $\mu$ J or 25 mW, is exempted. Simple intrinsically safe apparatus where the electrical parameters and the thermal behaviour can be clearly defined and that conforms to the applicable constructional requirements need not be tested or certified. The general requirements according to EN 60079-0 and the design of enclosures and connection boxes with regard to the surface resistance or the selection of the aluminium alloy (surface resistance for moulded plastic enclosures <109 Ohm) shall, however, be observed here.

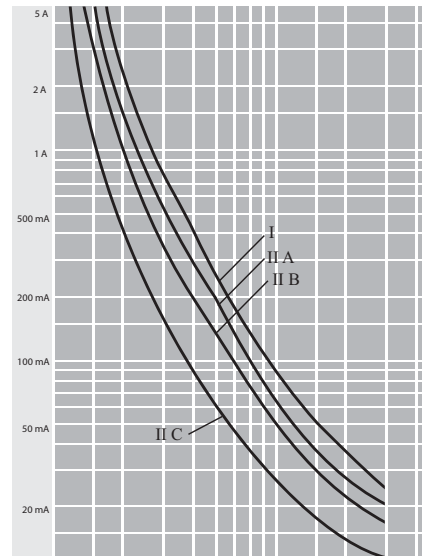
### Ignition limit curves

In the intrinsically safe circuit the energy released, even in the event of a fault, shall be limited to such an extent that no ignition can occur. To simplify matters, the ignition limit curves for the individual groups were determined using a standardized spark test apparatus.

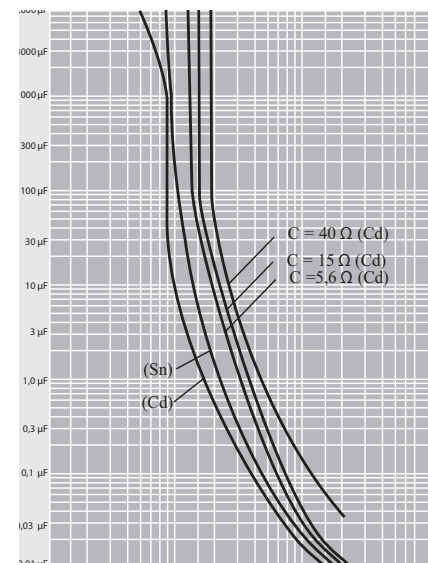
As the probability of the ignition of a mixture is also dependent on the number of makes and breaks, in accordance with EN 60079-11 it is necessary to carry out up to 1000 makes and breaks, whereby no ignition shall occur under any circumstances.

Depending on the design of the intrinsically safe circuit, it is necessary to expect the presence of energy stores. If the event of capacitances in the intrinsically safe circuit, they are charged to the voltage of the circuit. If there is a short in the circuit, in addition to the energy supplied by the associated apparatus, the energy stored in the capacitor is also released. The same applies if the event of inductances in the circuit.

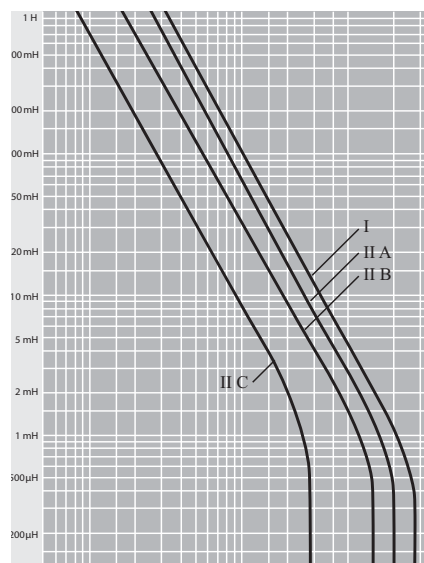
- For the reasons stated above, with intrinsically safe circuits it is necessary to take the three limiting cases:
  - resistive
  - capacitive
  - inductive circuit



Resistive circuit



Capacitive circuit



Inductive circuit

## Separation of intrinsically safe circuits from non-intrinsically safe circuits

In order to avoid any mix-ups as a result of the loosening of connection cables during connection or bridging, the terminals of intrinsically safe circuits shall always be safely segregated from the terminals of non-intrinsically safe circuits.

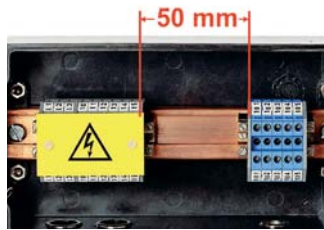
This can, for example, be achieved by positioning the connection terminals of intrinsically safe circuits at least 50 mm away from the connection terminals of non-intrinsically safe circuits or by separating the two circuits using an insulating partition or an earthed metal partition. These partitions shall either extend to within 1.5 mm from the enclosure wall or they shall ensure a minimum clearance of 50 mm between the connection terminals.

## Separation of insulated conductors of intrinsically safe and non-intrinsically safe

The clearance between the conductors of insulated cables shall satisfy given requirements.

With the exception of varnishes and similar coatings, this insulation is considered to be a solid insulation. The separation distance is determined by the addition of the radial thickness of the insulation on the wires. The minimum clearances are specified in EN 60079-11:

This clearance is not necessary if: the cores of the intrinsically safe and non-intrinsically safe circuits are fitted with an earthed screen or if, in the case of electrical apparatus with the level of protection Ib or Ic, the insulation of



Example of the separation of intrinsically safe circuits from non-intrinsically safe circuits with a minimum distance of 50 mm

the conductors of the intrinsically safe cores can withstand a test voltage of 2000 V.

It is also necessary to ensure that there can be no inductive or capacitive influences from the non-intrinsically safe circuit into the intrinsically safe circuit.

## Planning of intrinsically safe circuits

When setting up an intrinsically safe circuit with just one intrinsically safe apparatus and one associated apparatus, the limiting values for the permissible external capacitance and the permissible external inductance shall be taken from the type label of the associated apparatus. They are defining for the circuit.

Then, based on the maximum possible power supply of the associated apparatus, it is only necessary to check the heat rise behaviour of the intrinsically safe apparatus. However, when several intrinsically safe circuits are interconnected (e.g. several pieces of associated apparatus for one intrinsically safe apparatus), a further verification of the intrinsic safety is necessary. The verification of the intrinsic safety of a circuit shall be documented in detail.

## Intrinsically safe circuits with Zener barriers

Normally intrinsically safe circuits shall be insulated. They may be earthed if this is required for functional reasons. They must, however, be earthed if this is mandatory for safety reasons. The earth connection may only be made at one point by connection with the potential equalization, which has to be available throughout the area in which the intrinsically safe circuit is installed. As, in the case of safety barriers, there is no galvanic isolation of the intrinsically safe circuit from the non-intrinsically safe circuit, for safety reasons there has to be a faultless earth connection.

## Working on and testing of intrinsically safe circuits

On principle, working on live intrinsically safe circuits is allowed, as, due to their design, no ignition can take place. However, the generally valid requirements for work on live parts shall be observed.

When using measuring instruments, it is necessary to bear in mind that they might contain an internal energy store (e.g. the inductance of a moving coil indicator) that could nullify the intrinsic safety.

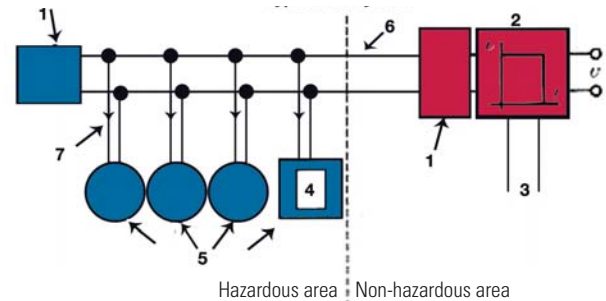
## Reduced separation distances

Under certain conditions specified in the standard, it is possible to design printed circuit boards with separation distances that are smaller than the standard distances that normally apply, thus enabling the use of smaller, more effective electronic elements.

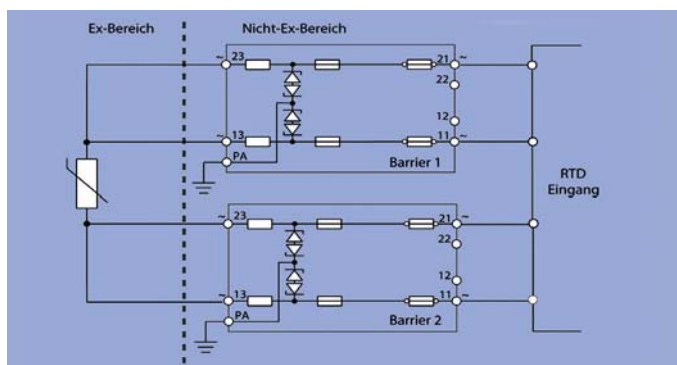
## Fieldbus intrinsically safe concept (FISCO)

The requirements for apparatus and systems for use with the Fieldbus Intrinsically Safe Concept (FISCO) are based on concepts of Manchester encoded, bus powered systems designed in accordance with IEC 61158-2, the "physical layer standard" for Fieldbus installations.

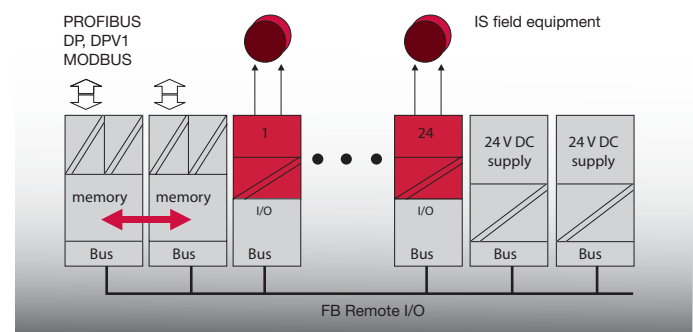
## Typical system



- |                        |                 |
|------------------------|-----------------|
| 1 Terminating resistor | 5 Field devices |
| 2 Supply unit          | 6 Main line     |
| 3 Data                 | 7 Branch line   |
| 4 Handheld controller  |                 |



Example of an intrinsically safe application: 4-wire PT 100





## EN 60079-13

**Explosive atmospheres –  
Part 13: Equipment protection  
by pressurised room “p” and  
artificially ventilated room “v”**
**Scope**

This part of EN 60079 gives requirements for the design, construction, assessment, verification and marking of rooms:

- located in an explosive atmosphere protected without an internal source of release and is protected by pressurisation or artificial ventilation;
- located in a non-hazardous area or Zone 2 area, containing an internal source of release and protected by artificial ventilation;
- located in an explosive atmosphere, containing an internal source of release and protected by pressurisation and artificial ventilation.

The term “room” used in this document includes single rooms, multiple rooms, a complete building or a room contained within a building and includes inlet and outlet ducts.

A room assembled or constructed on site, may be either on land or off-shore, and designed to facilitate the entry of personnel. The room is primarily intended for installation by an end-user but could be constructed and assessed at a manufacturer’s facility, where the final construction such as ducting is to be completed on site.

Rooms may be located in an **explosive gas atmosphere** requiring Equipment Protection Levels (EPL) Gb or Gc, or a **combustible dust atmosphere** requiring Equipment Protection Levels (EPL) Db, or Dc.

**Definitions****Pressurised room**

A room volume protected by pressurisation and of sufficient size to permit the entry of a person who may occupy the room.

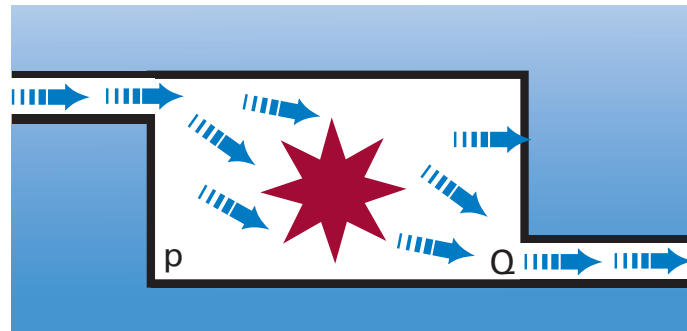
**Artificially ventilated room**

A room volume protected by artificial ventilation and of sufficient size to permit the entry of a person who may occupy the room.

**Equipment protection level**

The described concept can be subdivided into various levels of protection that determine the overall equipment protection level.

- Rooms with pressurisation Level of protection “pb” (EPL “Gb” or “Db”).
- Rooms with pressurisation Level of protection “pc” (EPL “Gc” or “Dc”).
- Rooms with artificial ventilation Level of protection “v” ( “Gb” or “Gc”), ventilated room with an internal source of release and suitable only for use in a non-hazardous area.
- Rooms with artificial ventilation Level of protection “vc”: (EPL “Gb” or “Gc”), ventilated room with or without an internal source of release and suitable for use in Zone 2 areas.



Principle of protection by a pressurised room „p” and an artificially ventilated room

**General requirements****Pressurisation “p”**

Rooms with pressurisation “p” shall be in the level of protection “pb” (EPL “Gb” or “Db”), whereby the pressurised room maintains an internal overpressure preventing the ingress of an explosive atmosphere and is suitable for use in an area requiring EPL “Gb” or “Db”, permitting unprotected equipment to be installed within the pressurised room except for pressurisation defined safety devices, or level of protection “pc” (EPL “Gc” or “Dc”), whereby the pressurised room maintains an internal overpressure preventing the ingress of an explosive atmosphere and is suitable for use in an area requiring EPL “Gc” or “Dc”, permitting unprotected equipment to be installed within the pressurised room except for pressurisation defined safety devices.

**Artificial Ventilation “v”**

Rooms with artificial ventilation “v” shall be in the level of protection “v” or “vc” (EPL Gc),

**Level of protection “vc”**

The ventilated room maintains artificial ventilation to dilute a release of flammable substance to reduce a hazardous area such that the required EPL is reduced from either “Gb” or “Gc” to non-hazardous, or from “Gb” to “Gc”, and is suitable for use in an area requiring EPL “Gc”.

**Level of protection “v”,**

The ventilated room maintains artificial ventilation to dilute a release of flammable substance to reduce a hazardous area such that the required EPL is reduced from either “Gb” or “Gc” to non-hazardous or from “Gb” to “Gc” and is suitable only for use in a non-hazardous area.

## EN 60079-15

### Explosive atmospheres - Part 15 Equipment protection by type of protection "n"

#### Scope

This part 15 of EN 60079 specifies requirements for the construction, testing and marking of Group II electrical equipment in the type of protection "n" for use in explosive gas atmospheres. This standard applies to electrical equipment where the rated voltage does not exceed 15 kV r.m.s. a.c. or 15 kV d.c. It applies to both non-sparking electrical equipment and equipment with circuits or parts producing arcs or sparks or having hot surfaces which, if not protected in one of the methods given in this standard, could be capable of igniting a surrounding explosive gas atmosphere. This standard describes several different methods by which this can be achieved which may be combined with other methods described in IEC 60079-0. This standard supplements and modifies the general requirements of IEC 60079-0.

#### Definitions

##### Type of protection "n"

Type of protection applied to electrical equipment that, during normal operation and under specified fault conditions, is not capable of igniting a surrounding explosive gas atmosphere.

##### Non-sparking device „nA“

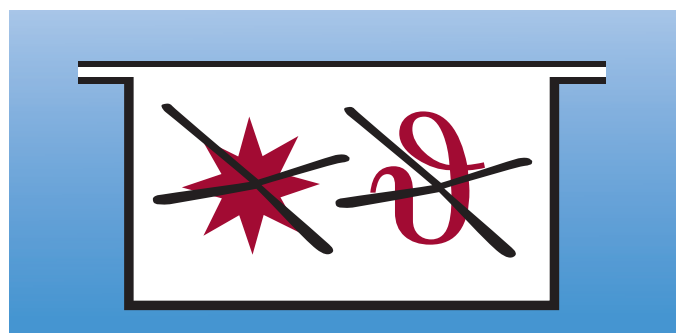
A device designed to minimize the risk of the occurrence of arcs or sparks capable of creating an ignition hazard during normal operation.

Note:

In the meantime this protection concept has been incorporated in EN 60079-7 as Level of Protection "ec".

##### Enclosed break device "nC"

A device incorporating electrical contacts that are made and broken and that will withstand an internal explosion of the flammable gas or vapour which may enter it without suffering damage and without communicating the internal explosion to the external flammable gas or vapour.



Principle of the type of protection „non-sparking“ „n“

Note:

In the meantime this protection concept has been incorporated in EN 60079-1 as Level of Protection "dc"

##### Hermetically sealed device "nC"

A device that is so constructed that the external atmosphere cannot gain access to the interior and in which the seal is made by fusion, e.g. by soldering, brazing, welding or the fusion of glass to metal.

##### Non-incendive component "nC"

A component with contacts for making or breaking a specified ignition capable circuit, but in which the contacting mechanism is designed and constructed in such a way that the component is not capable of causing ignition of a specified explosive gas atmosphere.

##### Sealed device "nC"

A device that is constructed in such a way that it cannot be opened during normal service and is sealed effectively to prevent the ingress entry of an external atmosphere.

##### Restricted-breathing enclosure "nR"

An enclosure designed to restrict the ingress of gases, vapours and mists.

##### Equipment Protection Level

Group II electrical equipment in the type of protection "n" provides equipment with Equipment Protection Level (EPL) Gc.

#### General requirements

The classification of electrical equipment into groups and temperature classes shall comply with the classification of electrical equipment into groups and temperature classes in accordance with EN 60079-0. During normal operation and under given fault conditions, as specified in this standard, the equipment must not:

- give off any arcs or sparks during operation unless measures have been taken to prevent the ignition of the surrounding explosive atmosphere as a result of these arcs or sparks;
- develop a maximum surface temperature that exceeds the maximum values for the respective temperature class of the equipment

The surface to be taken into consideration is:

- equipment in the types of protection nR and nC: the external surface of the equipment;
- equipment in the type of protection nA: the surface of any part of the electrical equipment, including the surface of parts located inside the equipment, where the ingress of an explosive gas atmosphere is possible.



Electrical machines:  
Plug-in connected pump drives by type of protection „nA“

### Supplementary requirements

In the meantime the requirements for equipment in the type of protection "nA" have been incorporated in the Level of Protection "ec" in EN 60079-7.

In the meantime the requirements for non-sparking equipment with a low power rating have been incorporated in the Level of Protection "ec" in EN 60079-7.

In the meantime the requirements for enclosed break devices have been incorporated in the Level of Protection "dc" in EN 60079-1.

In the meantime the type of protection "nL" that is still included in older editions of EN 60079-15 has been incorporated as Level of Protection "ic" in EN 60079-11.

### Hermetically sealed and sealed devices "nC"

Hermetically sealed and sealed devices shall be designed in such a way that they are sealed in a way that the ingress of an explosive atmosphere into the device is not to be expected and that they can be opened during normal operation. Hermetically sealed devices are sealed by means of a fusion process, whereas a suitable seal is used for sealed devices. The free internal volume must not exceed 100 cm<sup>3</sup>.

### Restricted-breathing enclosures "nR"

Restricted-breathing equipment shall be limited with regard to the dissipated power, so that the temperature measured on the outside does not exceed the maximum permissible surface temperature.

Restricted-breathing equipment with built-in components that give off arcs or sparks during normal operation or equipment with hot surfaces designed for frequent temperature changes shall be limited with regard to the power dissipation, so that the temperature measured on the outside of the enclosure does not exceed the external ambient temperature by more than 20 K.

Restricted-breathing electrical equipment that does not normally give off arcs or sparks, but does produce hot surfaces during normal operation shall be limited with regard to the dissipated power, so that the temperature measured on the outside does not exceed the values for designated temperature class.

Restricted-breathing equipment shall normally be fitted with a test port to allow the testing of the restricted-breathing properties after installation and during

### Overview

Definition	Temperature limitation	Test port	Routine test
Sparking	Ta + 20 K	Yes	Required
Non-sparking	T-class	No	Required
Non-sparking	T-class	Yes	Depends on type test
Type test	Test port	Routine test	
0.3 kPa - 0.15 kPa/360 s	Yes	No	
0.3 kPa - 0.15 kPa/180 s	No	0.3 kPa - 0.15 kPa/180 s 0.3 kPa - 0.27 kPa/27 s 3.0 kPa - 2.7 kPa/27 s	
0.3 kPa - 0.15 kPa/90 s	Yes	0.3 kPa - 0.15 kPa/90 s 0.3 kPa - 0.27 kPa/14 s 3.0 kPa - 2.7 kPa/14 s	

routine maintenance work. Luminaires may be exempted from the fitting of a test port if the following conditions are met:

- there are no devices that normally give off arcs or sparks in the restricted-breathing enclosure
- and
- resilient gasket seals are protected mechanically in such a way that they are not subject to mechanical damage during field installation or replacement
- and
- the gaskets or seals exposed during a re-lamping are of a type that can be readily replaced during the re-lamping process.

Equipment that does not have a test port shall be marked with the symbol "X" and the specific conditions of use shall be specified in the documentation.



Test port



## EN 60079-18

### Explosive atmospheres – Part 18: Equipment protection by encapsulation “m”

#### Scope

This part 18 of IEC 60079 gives the specific requirements for the construction, testing and marking of electrical equipment, parts of electrical equipment and Ex components with the type of protection encapsulation “m” intended for use in explosive gas atmospheres or explosive dust atmospheres. It only applies for encapsulated electrical equipment, encapsulated parts of electrical equipment and encapsulated Ex components (hereinafter always referred to as “m” equipment) where the rated voltage does not exceed 11 kV. The use of electrical equipment in atmospheres, which may contain explosive gas as well as combustible dust simultaneously, may require additional protective measures. This standard does not apply to dusts of explosives which do not require atmospheric oxygen for combustion or to pyrophoric substances and does not take account of any risk due to an emission of flam-

mable or toxic gas from the dust. It supplements and modifies the general requirements of IEC 60079-0.

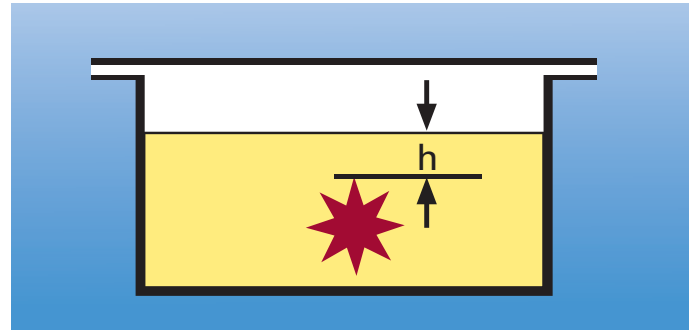
#### Definition

Type of protection whereby parts that are capable of igniting an explosive atmosphere by either sparking or heating are fully enclosed in a compound or other permitted non-metallic enclosure with adhesion in such a way as to avoid ignition of a dust layer or explosive atmosphere under operating or installation conditions.

#### Equipment protection level (EPL)

Electrical equipment in the type of protection encapsulation “m” can be designed with various levels of protection which determine the overall equipment protection level:

- Level of protection „ma” (EPL „Ma” or „Ga”);
- Level of protection „mb” (EPL „Mb” or „Gb”); or
- Level of protection „mc” (EPL „Gc”).



Principle of encapsulation “m”

#### Additional requirements for levels of protection “ma” and “mb”

Components without additional protection shall be used only if they cannot damage the encapsulation mechanically or thermally in the case of any fault conditions specified in this standard.

#### Additional requirements for level of protection “ma”

The working voltage at any point in the circuit shall not exceed 1 kV. Cells and batteries shall additionally comply with the cell and battery requirements of IEC 60079-11.; however, parallel cells are not permitted.

#### Permissible free space in the encapsulation

With Group III equipment the sum of the free spaces is not limited, but the volume of each individual free space is limited to 100 cm<sup>3</sup>. The thickness of the compound surrounding such free spaces shall meet the requirements laid down in the standard.

With Group I and Group II equipment the sum of the free spaces shall not exceed:

- 100 cm<sup>3</sup> for level of protection „mb” and „mc”;
- 10 cm<sup>3</sup> for level of protection „ma”

#### Cells and batteries

Cells and batteries that can release gas during normal operation are not permitted. If for levels of protection “ma” and “mb” the release of gas in the event of a fault cannot be precluded, the gassing shall be minimised by a control device. With secondary cells, the control device shall be effective not only during charging, but also during discharging.

#### General requirements

Duromers, thermoplasts and elastomers with and without fillers and/or other additives may be used as the compound. The selection of the compound for a particular application depends on the function to be fulfilled by the compound in the equipment. The encapsulation shall ensure the effectiveness of the type of protection subject to the level of protection, even in the event of permissible overloads and given faults. Voids in the compound for accommodating components such as relays, transistors, etc. are permissible. Specially designed multilayer circuit boards are also classed as encapsulated.

#### Examples of encapsulation “m”:

- Relays, signal and control devices
- Electronic devices
- Components, small transformer and solenoid valves.



Electrical components in encapsulation „m”

### EN 60079-25

#### Explosive atmospheres – Part 25: Intrinsically safe electrical systems

#### Scope

This part 25 of EN 60079 contains the specific requirements for the construction and assessment of intrinsically safe electrical systems, type of protection “i”, intended for use as a whole or in part in locations in which the use of Group I, II or III apparatus is required. It supplements and modifies the general requirements of EN 60079-0 and the intrinsic safety standard EN 60079-11.

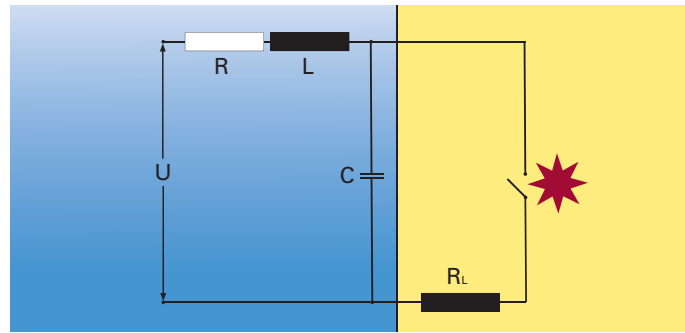
#### Definitions

##### Intrinsically safe electrical system

An assembly of interconnected items of electrical apparatus, specified in a descriptive system document, in which the circuit or parts of circuits intended for use in an explosive atmosphere are intrinsically safe circuits.

##### Certified intrinsically safe electrical system

An intrinsically safe electrical system for which a certificate has been issued confirming that the electrical system complies with the standard.



Principle of protection „intrinsic safety“ „i“

##### Uncertified intrinsically safe electrical system

An intrinsically safe electrical system for which the knowledge of the electrical parameters of the items of certified electrical apparatus, certified associated apparatus and simple apparatus and the knowledge of the electrical and physical parameters of the interconnecting wiring, permit the unambiguous deduction that the intrinsic safety is preserved.

##### Equipment protection level (EPL)

Each part of an intrinsically safe electrical system intended for use in an explosive atmosphere has a level of protection in accordance with EN 60079-11:

- level of protection „ia“ (EPL „Ma“; „Ga“ or „Da“)
- level of protection „ib“ (EPL „Mb“; „Gb“ or „Db“)
- level of protection „ic“ (EPL „Gc“ or „Dc“).

The complete system need not necessarily have a single level of protection.

##### General requirements

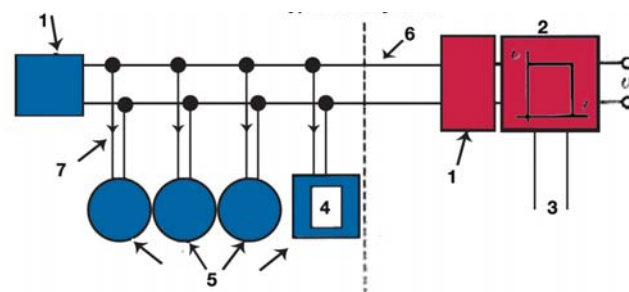
A descriptive system document shall be created for all systems. The document shall provide an adequate analysis of the level of protection achieved by the system. The minimum requirements are:

- a block diagram of the system listing all the items of apparatus within the system;
- a statement of the group subdivision, the level of protection for each apparatus, the temperature classification and the ambient temperature rating of the system;
- the requirements and permissible parameters of the interconnecting wiring;
- details of the earthing and bonding points of the system;
- where applicable, the justification of the assessment of the apparatus as “simple apparatus” in accordance with EN 60079-11.



Components for intrinsically safe systems

##### Typical system



Hazardous area<sup>1</sup> Non-hazardous area

##### Legend

- |                        |                 |
|------------------------|-----------------|
| 1 Terminating resistor | 5 Field devices |
| 2 Supply unit          | 6 Main line     |
| 3 Data                 | 7 Branch line   |
| 4 Handheld controller  |                 |

EN 60079-26

Explosive atmospheres –  
Part 26: Equipment with  
Equipment Protection Level  
(EPL) Ga

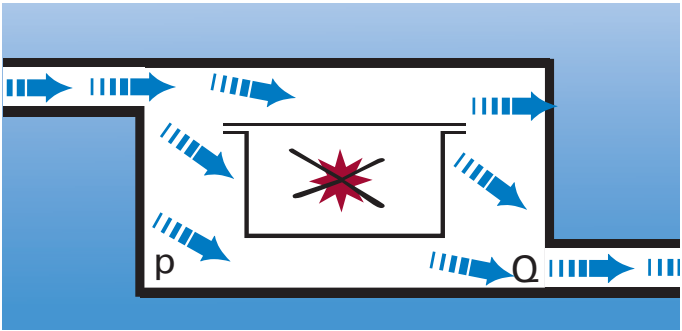
Scope

This part 26 of EN 60079 specifies alternative requirements for the construction, testing and marking of electrical equipment for use in explosive atmospheres in which explosive mixtures of air with gases, vapours or mists are present continuously, for long periods or frequently that provides the Equipment Protection Level (EPL) Ga when single, standardised types of protections (e.g. Ex “ia”, Ex “ma”

and Ex “da”) cannot be applied. This standard also applies to equipment mounted across a boundary wall where different Equipment Protection Levels may be required.

When operated within the operational parameters specified by the manufacturer, this electrical equipment ensures a very high level of protection, even in the event of the occurrence of rare malfunctions or of two malfunctions occurring independently of each other.

This standard supplements and modifies the general requirements of EN 60079-0.



Principle of the combination of two independent types of protection

Equipment Protection Level  
(EPL)

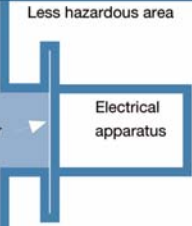
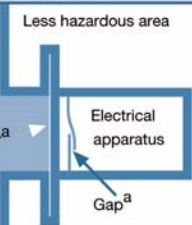
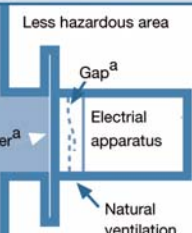
If the marking states several EPLs for the equipment (e. g. Ga/Gb), it is necessary to state which parts of equipment have which EPL.

General requirements

In order to exclude ignition hazards that can occur in connection with electrical circuits, the requisite level of protection shall either be ensured by one means of equipment protection, even in the event of the occurrence of two independent malfunctions, or, in the event of the failure of one means of equipment protection, by a second independent means of equipment protection.

Application of a type of protection providing EPL “Gb” and a separation element

The table shows the possible combinations of partition walls with types of protection for applications using separation elements.

Type of construction		Requirements to the thickness $t$ of the barrier		
		i) $t \geq 3$ mm: no additional measures		
		(ii) $3 \text{ mm} > t \geq 1 \text{ mm}$	(iii) $1 \text{ mm} > t \geq 0,2 \text{ mm}$ (X-symbol)	(iv) $t < 0,2 \text{ mm}$ (X-symbol)
a) Barrier				
EPL Ga required area		EPL Gb type of protection no ignitable sparks during operation (e.g. no open switching contacts)	Type of protection Intrinsic safety „ib“	Not permissible
b) Barrier and gap				
EPL Ga required area		EPL Gb type of protection	EPL Gb type of protection no ignitable sparks during operation (e.g. no open switching contacts)	
c) Barrier and ventilation				
EPL Ga required area		EPL Gb type of protection	EPL Gb type of portection and flameproof joint (broken line)	
a) Flameproof joint and barrier can be swapped round.				

Single type of equipment protection

The following are permitted as single types of equipment protection:

Equipment and circuits in accordance with the requirements of EN 60079-11, level of protection “ia”, and encapsulated equipment in accordance with the requirements of EN 60079-18, level of protection “ma”.

Note:

Also valid is the protection level “da”, not yet embodied in this standard.

Combined types of equipment protection

Electrical equipment shall comply with the requirements of two independent types of protection that provide EPL “Gb”. The independent types of protection shall not have a common mode of failure that can result in the simultaneous failure of both types of protection.

Combined types of protection providing EPL “Gb” shall depend on different physical protection principles.

In addition, the equipment and parts thereof in Zone 0 shall be designed in such a way that ignition sources due to sparks caused by an impact or friction are excluded and ignition hazards due to hazardous electrostatic charges cannot occur.



## EN 60079-28

**Explosive atmospheres -  
Part 28: protection of equip-  
ment and transmission sys-  
tems using optical radiation**
**Scope**

This part of EN 60079 specifies the requirements, testing and marking of equipment emitting optical radiation intended for use in explosive atmospheres. It also covers equipment located outside the explosive atmosphere or protected by a type of protection listed in IEC 60079-0, but which generates optical radiation that is intended to enter an explosive atmosphere. It covers Groups I, II and III, and EPLs Ga, Gb, Gc, Da, Db, Dc, Ma and Mb.

This standard contains requirements for optical radiation in the wavelength range from 380 nm to 10 µm. It covers the following ignition mechanisms:

- optical radiation is absorbed by surfaces or particles, causing them to heat up, and under certain circumstances this may allow them to attain a temperature which will ignite a surrounding explosive atmosphere.
- In rare special cases, direct laser induced breakdown of the gas at the focus of a strong beam, producing plasma and a shock wave both eventually acting as ignition source. These processes can be supported by a solid material close to the breakdown point.

This standard supplements and modifies the general requirements of EN 60079-0 and applies to optical fibre equipment and optical equipment, including LED and laser equipment.

**Definitions**
**• Inherently safe optical radiation "op is"**

Visible or infrared radiation that is incapable of producing sufficient energy under normal or specified fault conditions to ignite a specific explosive atmosphere.

**• Protected optical radiation "op pr"**

Visible or infrared radiation that is confined inside optical fibre or other transmission medium under normal constructions or constructions with additional mechanical protection based on the assumption that there is no escape of radiation from the confinement.

**• Optical system with interlock "op sh"**

System to confine visible or infrared radiation inside optical fibre or other transmission medium with interlock cut-off provided to reliably reduce the unconfined beam strength to safe levels within a specified time in case the confinement fails and the radiation becomes unconfined.



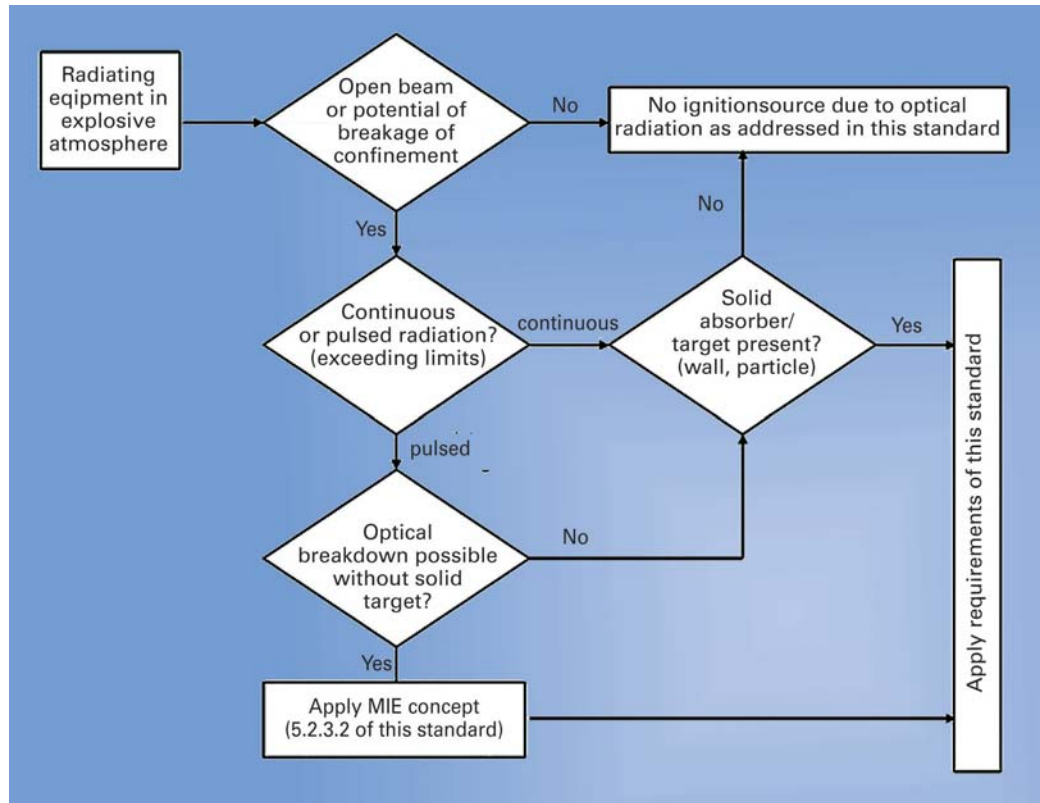
Warning of optical radiation

Equipment Protection Level	EPL Ga, DA, Ma	EPL Gb, Db, Mb	EPL Gc, Dc
<b>Inherently safe optical radiation "op is"</b>			
safe with two faults or using optical source based on the thermal failure characteristic	yes	yes	yes
safe with one fault or using optical source based on the thermal failure characteristic	no	yes	yes
safe in normal operation	no	no	yes
<b>Protected fibre optic media with ignition capable beam "op pr"</b>			
with additional mechanical protection	no	yes	yes
according to fibre manufacturers specification for normal industrial use, but without additional mechanical protection	no	no	yes
<b>Fibre optic media with ignition capable beam interlocked in case of fibre breakage "op sh"</b>			
Protected fibre optic cable "op pr" for Gb/Db/Mb + shutdown functional safety system based on ignition delay time of the explosive gas atmosphere	yes	yes	yes
Protected fibre optic cable "op pr" for Gc/Dc + shutdown functional safety system based on eye protection delay times (IEC 60825-2)	no	yes	yes
Unprotected fibre optic cable (not "op pr") + shutdown functional safety system based on eye protection delay times (IEC 60825-2)	no	no	yes
None (unconfined, ignition capable beam)	no	no	no
→ Shutdown system safe with one fault			

## General requirements

Optical equipment shall be subjected to a formally documented ignition hazard assessment using the principles stated in the standard.

This assessment shall be made to determine which possible optical ignition source can arise in the equipment under consideration, and which measures may need to be taken to mitigate the risk of ignition. If a source of optical radiation is inside an enclosure providing a protection of minimum IP 6X, after the tests specified in IEC 60079-0 for enclosures, the ingress of absorbing targets from the outside of the enclosure need not be taken into consideration, but the existence of internal targets shall be taken into consideration. However, where the optical radiation may leave such an enclosure, the requirements of this standard also apply to the emitted optical radiation.



## Safe optical power and irradiance for explosive atmosphere, categorized according to equipment group and temperature class

Equipment group	I	IIA	IIB	IIC
Temperature class		T3	T4	T6
Temperature (°C)	<150 °C	<200 °C	<135 °C	<85 °C
Radiated power (mW)	150 mW	150 mW	35 mW	15 mW
Irradiance (mW/mm <sup>2</sup> ) (Surface up to 400 mm <sup>2</sup> )	20 mW/mm <sup>2</sup>	20 mW/mm <sup>2</sup>	5 mW/mm <sup>2</sup>	5 mW/mm <sup>2</sup>

For irradiated areas of more than 30 mm<sup>2</sup> where combustible materials can enter the beam, an irradiance limit of 5 mW/mm<sup>2</sup> applies

## EN 60079-29

### Explosive atmospheres - Part 29-1 Gas detectors – Performance requirements of detectors for flammable gases

#### Scope

This part of the series EN 60079-29 contains general requirements for the construction, testing and performance and describes the test methods that apply to portable, transportable and fixed apparatus for the detection and measurement of flammable gas or air concentrations with air.

#### Further standards of series EN 60079-29

EN 60079-29-2:

Explosive atmospheres- Part 29-2 Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen

EN 60079-29-3:

Explosive atmospheres- Part 29-3 Guidance on the functional safety of fixed gas detection systems

EN 60079-29-4:

Explosive atmospheres- Part 29-4 Gas detectors – Performance requirements of open path detectors for flammable gases

## EN 60079-30-1

### Explosive atmospheres - Part 30-1 Electrical resistance trace heating – General and testing requirements

#### Scope

This standard specifies general and testing requirements for electrical resistance trace heaters for use in explosive gas atmospheres.

It covers trace heaters that comprise either factory or field-assembled units, e.g. series or parallel trace heater cables, trace heater pads or trace heater panels that have been assembled and/or terminated in accordance with the manufacturer's instructions. The electrical resistance trace heating shall be designed and constructed in such a way that it can be operated safely in the explosive gas atmosphere, whereby the components used shall comply with the relevant type of protection.

Furthermore, it is necessary to ensure that, under all circumstances and maintaining the safety clearance, the surface temperature of the resistance trace heating remains below the ignition temperature of the explosive mixture. If this cannot be ensured by the design of the heating cable, suitable safety thermostats shall be used as limiters.



*Example of a trace heating system*



*Application example: Gas detector with plug-in connection in a wastewater treatment plant*



EN 60079-31

Explosive atmospheres –  
Part 31: Equipment dust  
ignition protection by  
enclosure “t”

Scope

This part 31 of IEC 60079 is applicable to electrical equipment protected by enclosure and surface temperature limitation for use in explosive dust atmospheres. It specifies requirements for design, construction and testing of electrical equipment and Ex Components. It supplements and modifies the general requirements of EN 60079-0.

This standard does not apply to dusts of explosives which do not require atmospheric oxygen for combustion, or to pyrophoric substances. Similarly, this standard does not apply to electrical equipment or Ex Components intended for use in underground parts of mines as well as those parts of surface installations of such mines endangered by firedamp and/or combustible dust.

The use of electrical equipment in atmospheres which may contain both combustible dust and explosive gases, whether simultaneously or separately, may require additional protective measures not specified in this standard.

Definition

Dust ignition protection by enclosure “t” is a type of protection for explosive dust atmospheres where electrical equipment is provided with an enclosure providing dust ingress protection and a means to limit surface temperatures.



Dust- ignition protection by enclosure “t”: fluorescent light fitting in explosive dust atmosphere

Equipment Protection Level (EPL)

Electrical equipment in the type of protection “t” can be designed in various levels of protection which determine the overall Equipment Protection Level

- Level of Protection „ta” (EPL „Da”) or
- Level of Protection „tb” (EPL „Db”) or
- Level of Protection „tc” (EPL „Dc”).

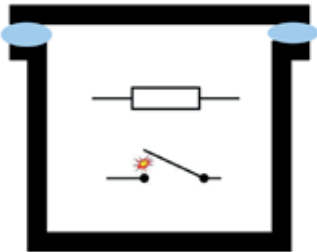


Principle of the type of protection “t” level of protection „ta”

Requirements for electrical equipment with level of protection „ta”

For electrical equipment with level of protection “ta”, the maximum surface temperature stated on the exterior of the enclosure and on the surfaces of the internal components of the electrical equipment shall be measured. The highest of the measured temperatures shall be the basis for the maximum surface temperature marking. For electrical equipment with level of protection “ta”, the maximum surface temperature shall be determined by installing the equipment in accordance with the manufacturer’s instructions and surrounded by at least a 200 mm layer of dust on all sides.

Before testing for dust exclusion, a positive internal pressure of 4kPa shall be applied to the enclosure to verify that the seal fits tightly. For normal applications, equipment with level of protection “ta” shall be rated for connection to a circuit with a prospective short circuit current of not more than 10 kA.



Principle of the type of protection “t” level of protection „tb”

Requirements for electrical equipment with level of protection “tb” and electrical equipment with level of protection “tc”

For electrical equipment with levels of protection “ta” and “tb”, the marked maximum surface temperature shall be measured on the external surfaces of the enclosure with no dust layer on the external surfaces under normal operating conditions . Before testing for dust exclusion, a positive internal pressure of 2kPa shall be applied to the enclosure to verify that the seal fits tightly, except where the design of the electrical equipment is such that gaskets or seals are physically constrained from moving e.g. an “O” ring in a groove.

IP test

The following table shows the relationship between the level of protection, group and required ingress protection against dust.

Required IP protection

Level of protection	Group IIIC	Group IIIB	Group IIIA
„ta”	IP6X	IP6X	IP6X
„tb”	IP6X	IP6X	IP5X
„tc”	IP6X	IP5X	IP5X

Ingress protection shall be determined in accordance with degree of protection (IP) of enclosures as specified in IEC 60079-0 for level of protection “tb” and “tc”. For level of protection “ta” the level of depression shall be increased to at least 4 KPa for a period of least 8 h. Any grease in the joints shall be removed before the IP test is performed.  
When IP5X is required, all enclosures including rotating machines shall satisfy the test and acceptance requirements of IP5X as specified in IEC 60529.



Dust deposits in an industrial plant

### Explosion protection of mechanical equipment

Unlike the earlier directive for equipment for use in hazardous areas (Directive 79/196/EC), which was restricted to electrical equipment, ATEX Directive 2014/34/EU and its precursor, Directive 94/9/EC, apply to all products (electrical and mechanical). For this reason, analog to electrical equipment at CENELEC TC 31, a series of standards with constructional and testing requirements has also been compiled for mechanical equipment by CEN TC 305, the responsible committee.

On an international level, IEC TC 31 is the standards body for explosion protection, whereas the standards body responsible for mechanical equipment on an international level is, in fact, ISO. In 2007 ISO and IEC agreed to form the subcommittee SC 31M at IEC TC 31 and not to have an independent ISO committee. This subcommittee can issue both ISO and ISO/IEC standards. The numbering of these standards is 80079 (instead of 60079) to make it clear that these standards were drawn up by SC 31M. These standards are agreed on at both CEN and CENELEC parallel to ISO and IEC and can then also be published as EN standards and harmonized by the EU commission.

These requirements for mechanical equipment are laid down in the standards of the series EN 13463 (as European standards only) and, as of 2016, also in standards of the series ISO 80079-36, -37 and -38. The

basic philosophy and methodology for assessing the ignition hazard have not changed, because the ISO standards are based on the European standards. Analogously, it is also possible to apply the electrical standards, e.g. the types of protection Flameproof Enclosure "d" or Pressurization "p".

Further purely mechanical standards are currently being prepared by IEC SC31M.

However, special mention shall be made of one change, namely **the marking:**

#### Marking

All mechanical equipment shall only be marked with the letter "h", irrespective of whether only the general part ISO 80079-36 was applied or whether it was applied in combination with one of the types of protection from part ISO 80079-37.

The EPL (equipment protection level) for the complete equipment shall be included at the end of the marking, e.g.  
Ex h IIB T4 Gb or  
Ex h IICT120°C Db.

#### ISO 80079-36: Basic methods and requirements (Previous standard in Europe: EN 13463-1)

This part specifies the base methods and requirements for the hazard assessment of mechanical equipment. The aim here is to prevent the formation of mechanical ignition sources. If this is not possible by applying constructional measures, other measures shall be applied to ensure that these ignition sources cannot become effective. In addition, measures are applied to prevent the coming into contact of effective ignition sources with the explosive atmosphere. Another measure is to confine a possible explosion in such a way that it cannot spread to the outside. This standard can be applied on its own for a testing and assessment, but in some parts it also refers to EN 60079-0, the general requirements for electrical equipment.



#### ISO 80079-37: Types of protection constructional safety "c", control of ignition source "b" and liquid immersion "k" (Previous standards in Europe: EN 13463-5, -6 and -8)

In the case of Protection by constructional safety the equipment is dimensioned and designed in such a way (e.g. by a special tightness and over-dimensioning) that no ignition sources can form during the service life of the equipment or in the event of any malfunctions that are to be expected. This type of protection is used, for example, for bearings and couplings.

With the type of protection Control of Ignition Sources it is assumed that many types of non-electrical equipment for use in explosive atmospheres do not feature effective ignition sources during normal operation. However, there is a risk of the formation of an ignition source if there is a malfunction in the moveable parts or if a process is not carried out correctly. In order to prevent potential ignition sources from becoming effective during normal operation, a malfunction or a rare malfunction, it is possible to fit sensors in the equipment. These detect any imminent hazardous conditions and counter-measures can be initiated at an early phase of the malfunction before potential ignition sources become effective.

The measures applied can be initiated automatically by direct connections between the sensors and the protective system or manually after a warning has been given to the operator of the equipment (with the aim that the operator carries out the protective measure e.g. by shutting down the equipment).

Equipment in the type of protection Liquid Immersion features potential ignition sources that are either rendered ineffective by submersing it in a protective liquid or by continuously coating it with a flowing film of protective liquid, e.g. oil-immersed disc brakes or oil-filled gearboxes where the gear wheels are partially immersed, but continuously coated by a viscous film of oil.

#### ISO 80079-38: Equipment and components in underground mines (Group I) This part specifies the requirements for equipment with an equipment protection level "Ma" and "Mb".

The fundamental requirements according to 60079-0 (if cited) and 80079-36 apply. This standard describes additional requirements that take special hazards due to the hybrid mixture of coal dust and firedamp into consideration. The marking corresponds to that for mechanical equipment, e.g. Ex h I Mb.

EN 50495  
Safety devices for the safe operation of equipment with regard to explosion risks

Scope

This standard specifies the safety requirements for electrical safety devices used for monitoring ignition hazards with equipment in explosive atmospheres. This also includes safety devices operated outside the explosive atmospheres to ensure the safe functioning of equipment or protective systems by monitoring explosion risks.

Electrical equipment intended for use in explosive atmospheres are dependent on the correct functioning of the safety devices, such as, for example, devices for ensuring adherence to given characteristics of the equipment within permissible limits.

Examples of safety devices include motor protection devices (limitation of the rise in temperature if the motor blocks) and control devices for the protection of the pressure compensation. Ignition sources can be avoided with the aid of control or monitoring devices. For this reason, these devices shall carry out the respective measures within the appropriate reaction time, for example, the activation of an alarm or an automatic switch-off.

Safety devices where the safety function cannot be adequately specified with the existing standards of the series EN 60079 shall also meet the requirements of this standard.

Definitions

Safety device

Safety devices, control and regulating devices lead to the safe functioning of equipment with regard to explosion risks. Safety devices provide explosion protection by carrying out a safety function that operates independently of the normal function of the equipment.

Safety instrumented system (SIS)

System for carrying out one or more safety-related functions. An SIS system consists of sensor(s), logic solver and actuator(s).

Safety component

Part of the system or device for specific safety functions.

Equipment under control (EUC)

Equipment, machinery, apparatus or components that contain a potential ignition source and are monitored by a safety device.

Table 1:  
Minimum requirements for safety devices for risk reduction

	Group IIIC	Group IIIB	Group IIIA
EUC	Equipment suitable for EPL Ga / Da where an ignition source can become effective in the event of rare faults	Equipment suitable for EPL Ga / Da where an ignition source can become effective in the event of faults to be expected	Equipment suitable for EPL Gb / Db where an ignition source can become effective in the event of faults to be expected
Minimum risk reduction factor of safety device	10	100	10
EPL of the combined equipment	Ga	IP5X	IP5X

Safety function

Function performed by a safety device to ensure the safe state of the EUC and, by doing so, provide explosion protection.

General requirements  
General concept

During the ignition source risk analysis of electrical equipment, it is necessary to assess all potential ignition sources, including the faults to be considered, in relation to the EPL. By applying the types of protection of the series of standards EN 60079 ff, the ignition risks covered by these standards are minimized. EN 50495 provides solutions for ignition risks that cannot be eliminated by applying the classic types of protection.

General requirements

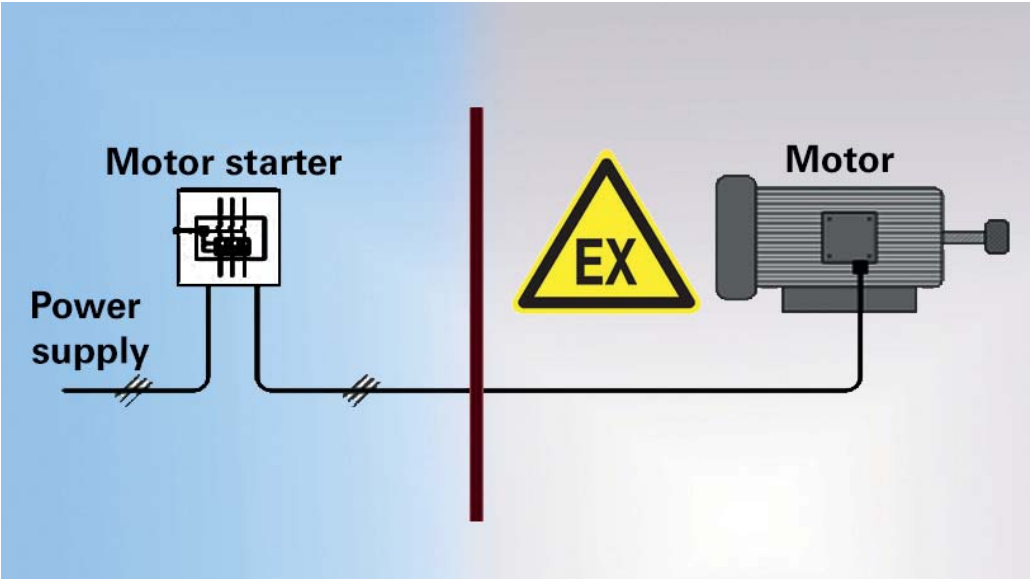
When specifying (selecting) a safety device, the EUC, including the potential ignition source to be monitored, shall be taken into consideration.

The safety device shall satisfy the level of operational safety dependent on the reduction of the ignition source risk for the equipment under control (EUC) subject to the EPLs.

Example of an application:

According to EN 60079-7, the rise in temperature of a motor in EPL "Gb" shall also be limited under fault conditions (blocked rotor). This can be achieved by using a current measuring device that can be installed outside the explosive atmosphere. The safety function comprises the monitoring of the current and the switching off of the motor in the event of an inadmissibly high current under the fault condition to be expected (blocked rotor). To ensure the required level of safety for EPL "Gb", the minimum risk reduction factor of the safety device shall be 10 (see table).

Working group 42 of IEC TC 31 is currently preparing a new standard that, once completed, (not to be expected before 2019), will replace the previous European standard.





### Marking of electrical equipment for use in potentially explosive atmospheres due to flammable gases, vapours and mists as well as dusts

The requirements for the marking of explosion-protected equipment are laid down in the European Directive 2014/34/EU and the standard EN 60079-0.

#### Directive 2014/34/EU

All the applicable directives for the respective product shall be observed when marking electrical equipment. In the case of explosion-protected equipment, Directive 2014/34/EU is mainly applied.

This directive contains several articles (e.g. Article 6, 15 and 16) and Annex II (1.0.5) where the minimum requirements for the marking of explosion-protected equipment are outlined explicitly.

#### CE marking

„CE marking“ shall mean a marking by which the manufacturer indicates that the product is in conformity with the applicable requirements set out in Community harmonisation legislation providing for its affixing.

This CE marking indicates the conformity of a product and is the visible result of a complete process that includes the conformity assessment in the broader sense. The general principles for the CE marking are laid down in Regulation (EC) 765/2008. The C marking according to Directive 2014/34/EU shall only be applied for equipment and not components.

#### Rules and conditions for affixing the CE marking and other markings

Article 16: Excerpts

(1) The CE marking shall be affixed visibly, legibly and indelibly to the product or to its data plate. Where that is not possible or not warranted on account of the nature of the product, it shall be affixed to the packaging and to the accompanying documents.

(3) The CE marking shall be followed by the identification number of the notified body, where that body is involved in the production control phase (for Category I and Category II electrical equipment)

(4) The CE marking and, where applicable, the identification number of the notified body shall be followed by the specific marking of explosion protection, the symbols of the equipment-group and category and, where applicable, the other markings and information referred to in point 1.0.5 of Annex II.

#### Marking in accordance with Annex II, No.1.0.5

The directive requires a special and clear marking of this equipment and these protective systems that identifies their suitability for use in explosive atmospheres and goes above and beyond the CE marking.

#### 1.0.5. Marking

All equipment and protective systems must be marked legibly and indelibly with the following minimum particulars:

- name, registered trade name or registered trade mark, and address of the manufacturer,
- CE marking (see Annex II to Regulation (EC) No 765/2008),
- designation of series or type,
- batch or serial number, if any,
- year of construction,
- the specific marking of explosion protection followed by the symbol of the equipment-group and category,
- for equipment-group II, the letter 'G' (concerning explosive atmospheres caused by gases, vapours or mists),

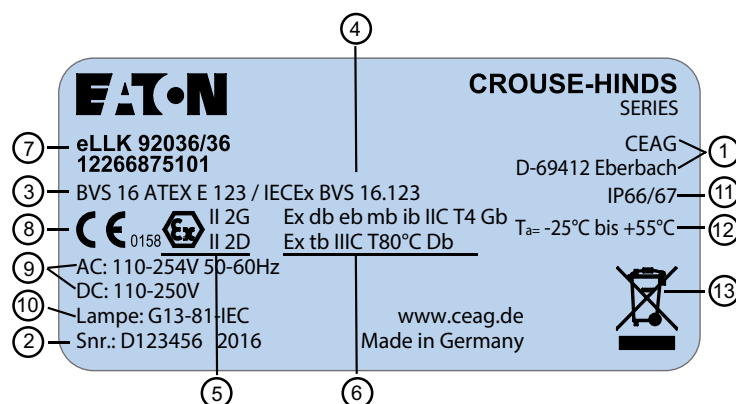
and/or

- the letter 'D' (concerning explosive atmospheres caused by dust).

Furthermore, where necessary, they must also be marked with all information essential to their safe use.

#### Example of marking according to the Directive

- ① Name or registered trade mark (CEAG) and address of the manufacturer
- ② Serial number including year of manufacture
- ③ Certificate number, may end with "X" or "U" - "X" indicates that special conditions for safe use apply "U" is used for component certificates
- ④ Additional IECEx certification
- ⑤ Marking according to directive: Equipment group (II) and equipment category 2); type of explosive atmosphere G (Gas, vapour or mist) – D (dust)
- ⑥ Marking according to standard: IEC/EN
- ⑦ Equipment name/type
- ⑧ CE marking and number of the "notified body" responsible for monitoring the quality system (0158 = EXAM Germany)
- ⑨ Electrical parameters
- ⑩ Other essential information (depends on the standard, e.g. lamp)
- ⑪ Other optional information (e.g. degree of protection)
- ⑫ Permissible ambient temperature (-25°C to +55°C); no marking required for temperatures from -20°C to 40°C (standard values for all equipment)
- ⑬ Marking according to EU-directive 2002/96/EC (WEEE-directive: Waste of Electrical and Electronic Equipment)



Example of marking according to the Directive

### Marking according to EN 60079-0

In addition to the marking according to the directive, equipment shall also be marked with the marking specified in EN 60079-0, to ensure a safe selection and a safe use of the equipment. This marking shall be clearly legible and affixed to the "main part" of the equipment.

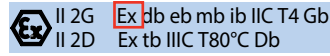
With the exception of enclosures that have only been issued with a component certificate (U certificate) where the Ex marking may only be affixed to the interior, the marking shall be affixed to the exterior. Further requirements for the marking are laid down in Clause 29 of the standard named above.

### General

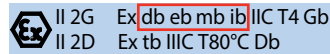
The marking shall include the following:

- the name of the manufacturer or his registered trade mark;
- the manufacturer's type identification;
- a serial number, except for
  - connection accessories (cable glands, blanking element, thread adaptor and bushings);
  - very small electrical equipment on which there is limited space;
- the name or mark of the certificate issuer and the certificate reference
- if it is necessary to indicate specific conditions of use, the symbol "X" shall be placed after the certificate reference. An advisory marking may appear on the equipment as an alternative to the requirement for the "X" marking;
- the specific Ex marking for explosive gas atmospheres, see 29.3, or for explosive dust atmosphere. The Ex marking for explosive gas atmospheres and explosive dust atmospheres shall be separate and not combined;
- any additional marking prescribed in the specific standards for the types of protection

### Marking for explosive gas atmospheres:



- the symbol Ex, which indicates that the electrical equipment corresponds to one or more of the types of protection;
- the symbol for the type of protection used



- „da“: Flameproof Enclosure (for EPL Ga or Ma)
- „db“: Flameproof Enclosure (for EPL Gb or Mb)
- „dc“: Flameproof Enclosure (for EPL Gc)
- „eb“: Increased Safety (for EPL Gb or Mb)
- „ec“: Increased Safety (for EPL Gc)
- „ia“: Intrinsic Safety (for EPL Ga or Ma)
- „ib“: Intrinsic Safety (for EPL Gb or Mb)
- „ic“: Intrinsic Safety (for EPL Gc)
- „ma“: Encapsulation (for EPL Ga or Ma)
- „mb“: Encapsulation (for EPL Gb or Mb)
- „mc“: Encapsulation (for EPL Gc)

„nA“: Type of Protection n, type nA (for EPL Gc)

„nC“: Type of Protection n, type nC (for EPL Gc)

„nR“: Type of Protection n, type nR (for EPL Gc)

„ob“: Liquid Immersion (for EPL Gb)

„oc“: Liquid Immersion (for EPL Gc)

„pxb“: Pressurization (for EPL Gb or Mb)

„pyb“: Pressurization, (for EPL Gb)

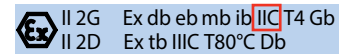
„pzc“: Pressurization (for EPL Gc)

„q“: Powder Filling (for EPL Gb or Mb)

„op is“: Inherently safe optical radiation (for EPL Ga or Ma)

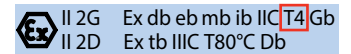
„op pr“: Protected optical radiation (for EPL Gb or Mb)

„op sh“: Optical system with interlock (for EPL Ga or Ma)

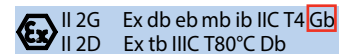


c) the symbol for the group:

- I for electrical equipment for mines susceptible to firedamp
- IA, IIB or IIC for electrical equipment for places with an explosive gas atmosphere other than mines susceptible to firedamp



d) for Group II electrical equipment, the symbol indicating the temperature class.



e) the equipment protection level, "Ga", "Gb", "Gc", "Ma", or "Mb" as appropriate

**EAT•N**

**eLLK 92036/36  
12266875101**

**BVS 16 ATEX E 123 / IECEx BVS 16.123**

**CE 0158 Ex II 2G Ex db eb mb ib IIC T4 Gb Ex tb IIIC T80°C Db**

**AC: 110-254V 50-60Hz**

**DC: 110-250V**

**Lampe: G13-81-IEC**

**Snr.: D123456 2016**

**CROUSE-HINDS  
SERIES**

**CEAG**

**D-69412 Eberbach**

**IP66/67**

**T<sub>a</sub> = -25°C bis +55°C**

**www.ceag.de  
Made in Germany**



Example for a Gas-Ex marking

### Marking for explosive dust atmospheres:

II 2G Ex db eb mb ib IIC T4 Gb  
II 2D Ex tb IIC T80°C Db

a) the symbol Ex, which indicates that the electrical equipment corresponds to one or more of the types of protection

II 2G Ex db eb mb ib IIC T4 Gb  
II 2D Ex tb IIC T80°C Db

b) the symbol for each type of protection used:

„ta“: Protection by enclosure (for EPL Da)

„tb“: Protection by enclosure (for EPL Db)

„tc“: Protection by enclosure (for EPL Dc)

„ia“: Intrinsic safety (for EPL Da)

„ib“: Intrinsic safety (for EPL Db)

„ic“: Intrinsic safety (for EPL Dc)

„ma“: Encapsulation (for EPL Da)

„mb“: Encapsulation (for EPL Db)

„mc“: Encapsulation (for EPL Dc)

„pxb“: Pressurization (for EPL Db),

„pyb“: Pressurization (for EPL Db),

„pzc“: Pressurization (for EPL Dc),

„op is“: Inherently safe optical radiation (for EPL Da)

„op pr“: Protected optical radiation (for EPL Db)

„op sh“: Optical system with interlock (for EPL Da)

II 2G Ex db eb mb ib IIC T4 Gb  
II 2D Ex tb IIC T80°C Db

c) the symbol for the group IIIA, IIIB or IIC for electrical equipment for places with an explosive dust atmosphere

II 2G Ex db eb mb ib IIC T4 Gb  
II 2D Ex tb IIC T80°C Db

d) the maximum surface temperature in degrees Celsius and the unit of measurement °C preceded with the letter „T“, (e.g. T 90 °C)

II 2G Ex db eb mb ib IIC T4 Gb  
II 2D Ex tb IIC T80°C Db

e) the equipment protection level, „Da“, „Db“, or „Dc“, as appropriate

The Ex marking for explosive gas atmospheres and explosive dust atmospheres must not be combined, but shall be indicated separately.

### „Ga“ equipment using two independent „Gb“ types of protection

Where two independent types (or levels) of protection with EPL Gb, are employed for the same piece of electrical equipment in order to achieve EPL Ga, the Ex marking shall include the symbols for the two types (or levels) of protection employed with the symbols for the types (or levels) of protection joined with a „+“ (See EN 60079-26).

### Alternate marking of equipment protection levels (EPL)

The currently valid standard EN 60079-0 contains an alternate marking that has scarcely been used. As the use of this marking caused problems with regard to the differentiation between the level of protection of the type of protection and the overall equipment protection level, it will be deleted in the future.

# EATON

eLLK 92036/36  
12266875101

BVS 16 ATEX E 123 / IECEx BVS 16.123

CE 0158 Ex II 2G Ex db eb mb ib IIC T4 Gb  
II 2D Ex tb IIC T80°C Db

AC: 110-254V 50-60Hz

DC: 110-250V

Lampe: G13-81-IEC

Snr.: D123456 2016

# CROUSE-HINDS

SERIES

CEAG

D-69412 Eberbach

IP66/67

Ta= -25°C bis +55°C

www.ceag.de  
Made in Germany



Example of Dust-Ex marking



## Requirements for the erection, operation, maintenance and repair of electrical installations in explosive atmospheres

### Rules, regulations and ordinances

The following shall be observed for the erection and operation of electrical installations in hazardous areas:

- Ordinance on protection against hazardous substances (Gefahrstoffverordnung – GefStoffV)
- Ordinance governing the health and safety aspects of the provision of work equipment and use of materials at work, the operation of equipment requiring supervision and the organisation of occupational health and safety precautions (Betriebssicherheitsverordnung- BetrSichV)
- Ordinance concerning the placing on the market of equipment and protective systems intended for use in hazardous areas – Explosion protection decree (ExVO)
- Directive on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (2014/34/EU)
- Directive on the minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (1999/92/EC)
- Explosion protection rules (EX – RL) with examples from the “BG-Chemie” (Employers’ Liability Association for the Chemical Industry)
- Rule for the avoidance of ignition hazards due to electrostatic charges issued by the Confederation of the Insurance Liability Associations
- Accident prevention regulations of the Employers’ Liability Association DGUV, Regulation 4 “Electrical installations and equipment”

- The relevant technical rules – Operational Safety (TRBS) and Hazardous Substances (TRGS)
- On principle, the following VDE regulations apply for the erection of electrical installations:  
VDE 0100, 0101, 0107, 0113, 0141, 0185, 0190, 0800 Parts 1 – 4.
- In addition, the following VDE regulations shall be taken into consideration for hazardous areas:  
VDE 0165 and VDE 0170 (all parts).
- The following applies for the operation and servicing of existing installations  
VDE 0105 Operation of electrical installations – Part 1: General stipulations

## Design, selection and erection of electrical installations according to EN 60079-14

### Explosive atmospheres – Part 14: Electrical installations design, selection and erection

This standard contains the specific requirements for the design, selection, erection and initial inspection of electrical installations in explosive atmospheres. Where the equipment is required to meet other environmental conditions, e.g. against the ingress of water and resistance to corrosion, additional protection requirements may be necessary. If additional protective measures are applied, they shall not have an adverse effect on the suitability of the enclosure.

The requirements of this standard only apply to the use of equipment under normal or almost normal atmospheric conditions. For other conditions, additional precautions may be necessary.

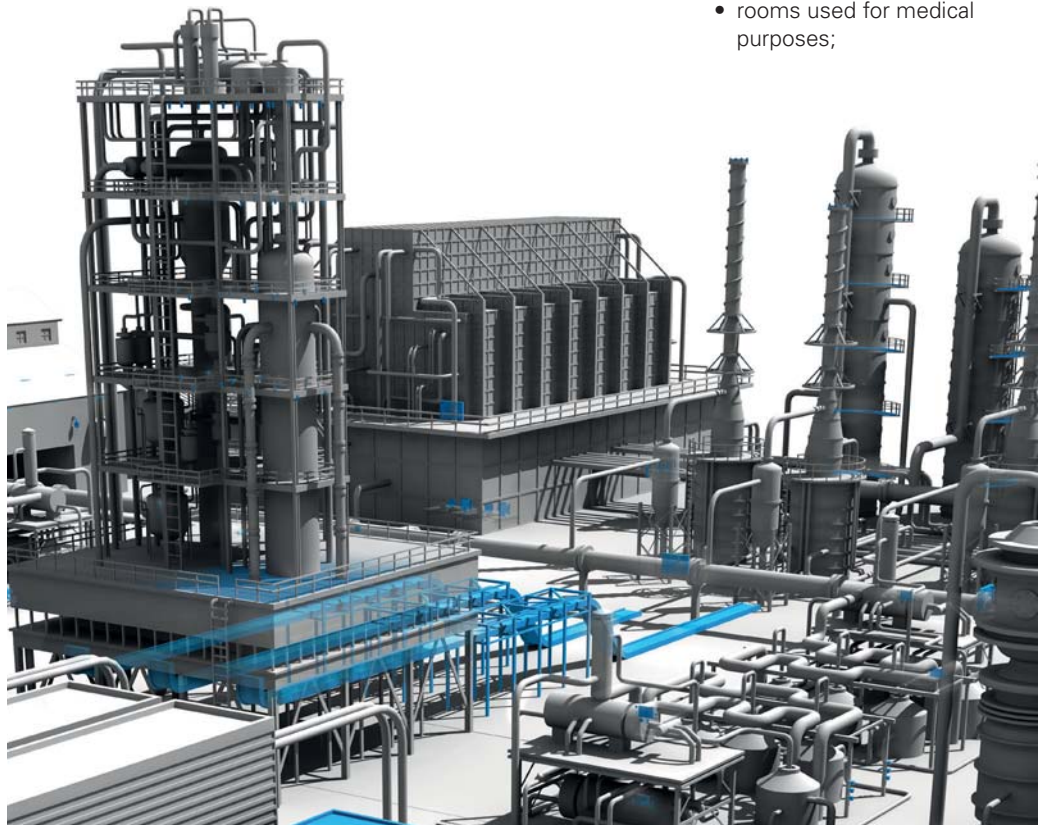
For example, most flammable materials and many materials which are not normally regarded as non-flammable might burn vigorously under conditions of oxygen enrichment. Further precautions might also be necessary for the use of electrical equipment under conditions with extremely high temperatures and extreme pressure. Such measures are not within the scope of this standard.

As part of the risk assessment these additional measures as well as the requirements for hybrid mixtures must be determined.

This EN 60079-14 standard applies to all electrical equipment, including fixed, portable, transportable and personal equipment, and permanent or temporary installations. It applies to installations for all voltages.

This EN 60079-14 standard does not apply to:

- electrical installations in mines susceptible to firedamp;
- inherently explosive situations, e. g. the manufacture and processing of explosives;
- rooms used for medical purposes;



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- 1 Scope
- 2 Normative references
- 3 Terms and definitions
- 4 General
  - 4.1 General requirements
  - 4.2 Documentation
  - 4.3 Initial inspection
  - 4.4 Assurance of equipment conformity
  - 4.5 Qualification of personnel
- 5 Selection of electrical equipment
  - 5.1 Information requirements
  - 5.2 Zones
  - 5.3 Relationship between Equipment Protection Levels (EPLs) and zones
  - 5.4 Selection of equipment according to EPLs
  - 5.5 Selection according to equipment group
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  - 5.11 Rotating electrical machines
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- 6 Protection from dangerous (incendive) sparking
  - 6.1 Light metals as construction materials
  - 6.2 Danger from live parts
  - 6.3 Danger from exposed and extraneous conductive parts
  - 6.4 Potential equalization
  - 6.5 Static electricity
  - 6.6 Lightning protection
- 6.7 Electromagnetic radiation
- 6.8 Cathodically protected metallic parts
- 6.9 Ignition by optical radiation
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- 8 Switch-off and electrical isolation
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- 22 Additional requirements for the type of protection "op" – Optical radiation
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- Annex A (normative) Knowledge, skills and competencies of responsible persons, operatives/technicians and designers
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- Annex C (normative) Initial inspection – Equipment-specific inspection schedules
- Annex D (informative) Electrical installations in extremely low ambient temperatures
- Annex E (informative) Restricted breathing test for cables
- Annex F (informative) Installation of electrical trace heating systems
- Annex G (normative) Potential stator winding discharge risk assessment – Ignition risk factors
- Annex H (normative) Verification of intrinsically safe circuits with more than one associated apparatus with linear current/voltage characteristics
- Annex I (informative) Methods of determining the maximum system voltages and currents in intrinsically safe circuits with more than one associated apparatus with linear/current /voltage characteristics (as required by Annex H)
- Annex J (informative) Determination of cable parameters
- Annex K (normative) Additional requirements for the type of protection "op" – Optical radiation
- Annex L (informative) Examples of dust layers of excessive thickness
- Annex M (informative) Hybrid mixtures



## Brief information on selected points

### Potential equalization

Potential equalization is required for installations in hazardous areas to avoid incendive sparking. All conductive parts of the construction or installation where a hazardous potential shift is to be expected shall be incorporated in the equipotential bonding system.

Examples where additional potential equalization measures may be required:

- via compensators (non-conductive)
- insulated conduit
- insulated gaskets

The following need not be incorporated in the equipotential bonding system:

- conductive window frames
- conductive door frames

Enclosures need not be additionally connected to the equipotential bonding system if they are mounted in such a way that they have reliable contact to parts of the installation that are incorporated in the equipotential bonding system.

### Electrostatic charges

Parts of the construction shall also be designed in such a way that no dangerous charges can occur when they are used for their intended purpose. For the limitation of surface areas, it is necessary to take both the surrounding zone and the explosion group into consideration. Further useful requirements can be found in TRGS 727.

### Lightning protection

A functioning lightning protection system is required in hazardous areas according to the zone. The individual requirements can be found in VDE 0185. EN 60079-14 only states the objective of reducing the effects of lightning strikes to a non-hazardous level. A surge protector is only required for intrinsically safe circuits leading into Zone 0.

### Emergency switch-off

For emergencies where the spreading of a hazard is to be expected, devices for switching off the electrical supply of the

hazardous area shall be installed outside the hazardous area.

### Electrical isolation

In addition, to allow work to be carried out safely, a suitable means of isolation with a label to identify the respective circuit shall be provided for each circuit (or each group of circuits).

### Cables and wiring systems

Wiring systems shall always be selected so as to ensure that they withstand the mechanical, electrical, chemical and thermal stresses that are to be expected. Cables that are not laid in earth or in sand-filled cable trenches/ducts shall be protected against flame propagation.

Unused cores of multi-core cables shall be connected safely to the earth potential or adequately isolated by using a suitable connected terminal.

Bushings for cables into non-hazardous areas shall be adequately sealed (e.g. sand seals or mortar sealing). Where cables are subject to particular stresses, they shall be specially protected (e.g. by conduit). However,

closed conduit systems must not be laid unless, due to their specific design, they are suitable for hazardous areas.

The transmission of gases or liquids through cables shall be prevented by applying suitable measures (e.g. potting, completely filled cables, etc.).

### Additional requirements

In addition to the basic requirements already described, depending on the type of protection and/or equipment, the standards also contain further requirements.

### Commissioning of electrical installations in hazardous areas

After erection, in accordance with §15 of BetrSichV, the operator shall have the proper state of an installation inspected by an authorized person in accordance with Annex 2, Clause 3, No. 3.3 or a notified monitoring body prior to commissioning or after modifications requiring testing.





## Operation of installations in hazardous areas

After an installation has been erected correctly, it shall be operated in accordance with the state of the art technology.

In accordance with §6 GefStoffV, (Ordinance on Protection against Hazardous Substances) the responsible operator shall observe the following important principles and document them before operation:

1. Hazards during operations with hazardous substances
2. Result of a test for the substitution of the hazardous substance and for the forgoing of a possible technical substitution with protective measures.
3. Safety measures to be carried out
4. Reasons for deviation from the known rules and findings
5. Verification of the effectiveness of the protective measures

Subject to the development of a hazard due to explosive mixtures, the hazards shall be stated specifically in the explosion protection document. Determination and assessment of an explosion hazard

1. Appropriate measures for achieving the explosion protection goals
2. Zone classification
3. Areas for which explosion protection measures have been taken
4. Measures for the safe collaboration with various companies
5. Tests for explosion protection in accordance with the health and safety ordinance (BetrSichV)

After commissioning, it is necessary to ensure that the proper state is maintained. For this the installations shall be inspected at given intervals on a recurrent basis according to §16 of BetrSichV, at the least every 3 years. EN 60079-17/VDE 0165 Part 10 can be referred to for details relating to the execution of these inspections.

When work is being carried out in hazardous areas, the safety of persons and installations is dependent to a large degree on the strict adherence to all safety regulations.

The company management and the operating and maintenance personnel shall work together in an optimal way to ensure the maximum possible degree of safety. Thus, the maintenance staff that works in such installations bears a special responsibility.

## Maintenance

Maintenance encompasses all measures (inspection, servicing and repair) for maintaining and restoring the required state and for determining and assessing the actual state. Inspections or the supervision of installations helps to prepare for upcoming maintenance tasks and to identify trends with regard to possible damages.

A visual inspection shows the experienced specialist, e.g. due to the formation of droplets on switch cabinets, whether more intensive inspections are necessary.

## Special safety measures

Whenever work is carried out in hazardous areas, it is necessary to ensure that neither incendive sparks nor hot surfaces occur that, in combination with an explosive atmosphere, can lead to an explosion.

On principle, work on live electrical installations and equipment is strictly forbidden. By way of exception, work on intrinsically safe circuits and, in certain cases, on other electrical installations is permitted.

In this case, the company management shall issue a safe work permit to confirm in writing that no explosion hazard exists at the worksite for the duration of the work in hand (e.g. monitoring by a gas detector).

The absence of voltage may only be measured with explosion-protected measuring instruments. The two special cases named above are the only exceptions.

## Avoidance of formation of sparks

With the electrical equipment used, the respective types of protection ensure that no incendive sparks or hot surfaces come into contact with the explosive atmosphere.

If no further organizational measures have been taken, only explosion-protected measuring instruments may be used to measure electrical values.

Sparks capable of causing ignition may also occur when connecting or disconnecting cables, even though no voltage source is connected.

The reasons for this can be stored energy in electrical installations or external influences such as induction of electromagnetic fields. The electrician shall, at all times, be aware of whether or not sparks capable of causing ignition are to be expected.

A possible spark formation shall also be taken into account when using hand-operated tools.

Here a distinction is made between two types of tools, tools where only single sparks occur during use, e.g. screwdrivers or spanners, and tools that give off a shower of sparks during use, e.g. grinders. The use of tools that may give off sparks is generally not permitted in Zones 0 and 20.

According to EN 1127, only those steel tools that might give off a single spark can be used in Zones 1 and 2 if no Group IIC substances are present. The use of steel tools that give off single sparks is permitted in Zones 21 and 22.

On principle, tools that give off sparks may only be used together with a "safe work permit" if the location has been assessed to ensure that an explosive atmosphere is not present for the duration of the work in hand. The requisite safety measures shall be specified in the safe work permit.

Erlaubnisschein für explosionsgefährdete Bereiche			
Zutreffendes ankreuzen. Nichtzutreffendes in angekreuzten Zeilen streichen			
Erlaubnis für Schweiß-, Brenn- und andere Funken erzeugenden Arbeiten, für Bohren, Schleifen, Schlag- und Stemmarbeiten, für den Einsatz nicht explosionsgeschützter Geräte.			
A 1. Auftraggeber: _____		Bau: _____	Meister: _____
2. Arbeitsstelle und Art der Arbeit _____			
3. Erlaubnis von _____ Uhr, bis _____ Uhr, für die Zeit _____			
4. Für Werkstatt/Fa. _____		Meister _____	
<b>B Gefahrenstellen in der Umgebung</b>			
der Arbeitsstelle, Bauten, Apparate usw.		Zuständiger	Bau
1. _____			Telefon _____
2. _____			
3. _____			
4. _____			
<b>C Sicherungsmaßnahmen</b>		durchzuführen von: _____	erledigt _____
<input type="checkbox"/> 1. Prüfen auf Dichtheit von Rohrleitungen u. Apparaten in der Umgebung der Arbeitsstelle _____			<input type="checkbox"/>
<input type="checkbox"/> 2. Lösch- und andere Sicherungsmaßnahmen _____			<input type="checkbox"/>
a. Bereitstellen von Löschwasser, Feuerlöscher an der Arbeitsstelle _____			<input type="checkbox"/>
b. Feuerwehrausgang anschließen _____			<input type="checkbox"/>
c. Sicherungsposten aufstellen _____			<input type="checkbox"/>
<input type="checkbox"/> Handwerker <input type="checkbox"/> Betriebsangehöriger <input type="checkbox"/> Aufsichtsführender <input type="checkbox"/> Feuerwehrmann _____			<input type="checkbox"/>
d. Beseitigen von brennbaren Stoffen, Dämpfen, Gasen oder Staubaablagerungen _____			<input type="checkbox"/>
e. _____			<input type="checkbox"/>
f. _____			<input type="checkbox"/>
<b>3. Kennzeichnung der Arbeitsstelle</b> (Straße, Gleisanlage usw.) _____			<input type="checkbox"/>
a. Durch rote Flaggen (20 m beidseits der Arbeitsstelle) _____			<input type="checkbox"/>
b. Durch Schilder (z.B. Feuerarbeiten auf Rohrbrücke) _____			<input type="checkbox"/>
c. Absperrung, Umlenkung für Tankfahrzeuge, Sperrung für Gleisfahrzeuge _____			<input type="checkbox"/>
<b>4. Sicherung der Umgebung gegen Schweißfunke</b>			<input type="checkbox"/>
a. Abdecken der benachbarten Leitungen _____			<input type="checkbox"/>
b. Schutzwand anbringen, Dachhaut schützen, evtl. feucht halten _____			<input type="checkbox"/>
c. Bei Zugverkehr Arbeiten einstellen _____			<input type="checkbox"/>
d. Von feuergefährlichen Kesselwagen, Tanklagern usw. Mindestabstand von _____ m halten _____			<input type="checkbox"/>
e. Abdecken bzw. Abdichten von Rohrdurchbrüchen, Gitterrosten, Licht- und Kanalschächten _____			<input type="checkbox"/>
f. _____			<input type="checkbox"/>
<b>5. Für Arbeiten in und an Behältern, Apparaten, Gruben, Rohrleitungen, an ausgebauten Anlagenteilen, in engen Räumen usw. Zusätzliche Maßnahmen auf:</b>			<input type="checkbox"/>
a. Befehl-Erlaubnis _____ Nr. _____ vom _____			<input type="checkbox"/>
b. Arbeitserlaubnis _____ Nr. _____ vom _____			<input type="checkbox"/>
c. Sicherungsschein für elektrische Betriebsmittel Nr. _____ vom _____			<input type="checkbox"/>
d. _____			<input type="checkbox"/>
<b>6.</b>			<input type="checkbox"/>
a. Vor Beginn der Arbeit täglich melden bei B 1, 2, 3, 4. _____			<input type="checkbox"/>
b. Ende der Arbeit täglich melden bei B 1, 2, 3, 4. _____			<input type="checkbox"/>
<b>7.</b>			<input type="checkbox"/>
a. Kontrolle der angekreuzten Sicherungsmaßnahmen durch (Name) _____			<input type="checkbox"/>
b. Kontrolle der Arbeitsstelle nach Beendigung der Arbeiten durch (Name) _____			<input type="checkbox"/>
<b>C Einverständnis der Zuständigkeiten</b>		Arbeitsbeginn gemeldet am: _____ bei: _____	
Für B 1 Maßnahmen C Ziffer _____			
Für B 2 Maßnahmen C Ziffer _____			
Für B 3 Maßnahmen C Ziffer _____			
Für B 4 Maßnahmen C Ziffer _____			
Datum _____		Unterschriften _____	
Erlaubnisschein ausgestellt _____		Datum _____	
		Unterschrift des Betriebsleiters oder dessen Beauftragte _____	

Example of a safety work permit

## EN 60079-17 Explosive atmospheres - Part 17: Electrical installations inspection and maintenance

Electrical installations in explosive atmospheres feature special characteristics that allow their correct operation in these areas. For safety reasons it is essential for these special characteristics to remain effective throughout the service life of such installations. Additional to an initial inspection this requires regular periodic inspections during plant operation.

This standard, which is directed at the operator, only deals with aspects directly related to the inspection and maintenance of electrical installations

It does not include:

- other fundamental installation and inspection requirements for electrical installations
- the verification of electrical equipment
- the repair and reclamation of explosion protected equipment (see EN 60079-19)

It does not apply to:

- underground mining areas,
- areas in which a hazard can occur due to the presence of hybrid mixtures ,
- dusts of explosives that do not require atmospheric oxygen for combustion,
- pyrophoric substances.

## Contents of standard (excerpt)

- 1 Scope
- 2 Normative references
- 3 Terms and definitions
- 4 General requirements
  - 4.1 Documentation
  - 4.2 Qualification or personnel
  - 4.3 Inspections
  - 4.4 Periodic inspections
  - 4.5 Continuous supervision by skilled personnel
  - 4.6 Maintenance requirements
  - 4.7 Environmental conditions
  - 4.8 Isolation of equipment
  - 4.9 Earthing and equipotential bonding
  - 4.10 Specific conditions of use
  - 4.11 Movable equipment and its connections
  - 4.12 Inspection schedules (Tables 1 to 3)

## Terms and definitions

### Visual inspection

Inspection which identifies, without the use of access equipment or tools, those defects, such as missing bolts, which will be apparent to the eye.

### Close inspection

Inspection which encompasses those aspects covered by a visual inspection and, in addition, identifies those defects, such as loose bolts, which will be apparent only by the use of access equipment, e.g. steps and, (where necessary), tools.

Note:

Close inspections do not normally require the enclosure to be opened, or the equipment to be de-energized.

### Detailed inspection

Inspection which encompasses those aspects covered by a close inspection and, in addition, identifies those defects, such as loose terminations, which will only be apparent by opening the enclosure, and/or using, where necessary, tools and test equipment.

## Continuous supervision

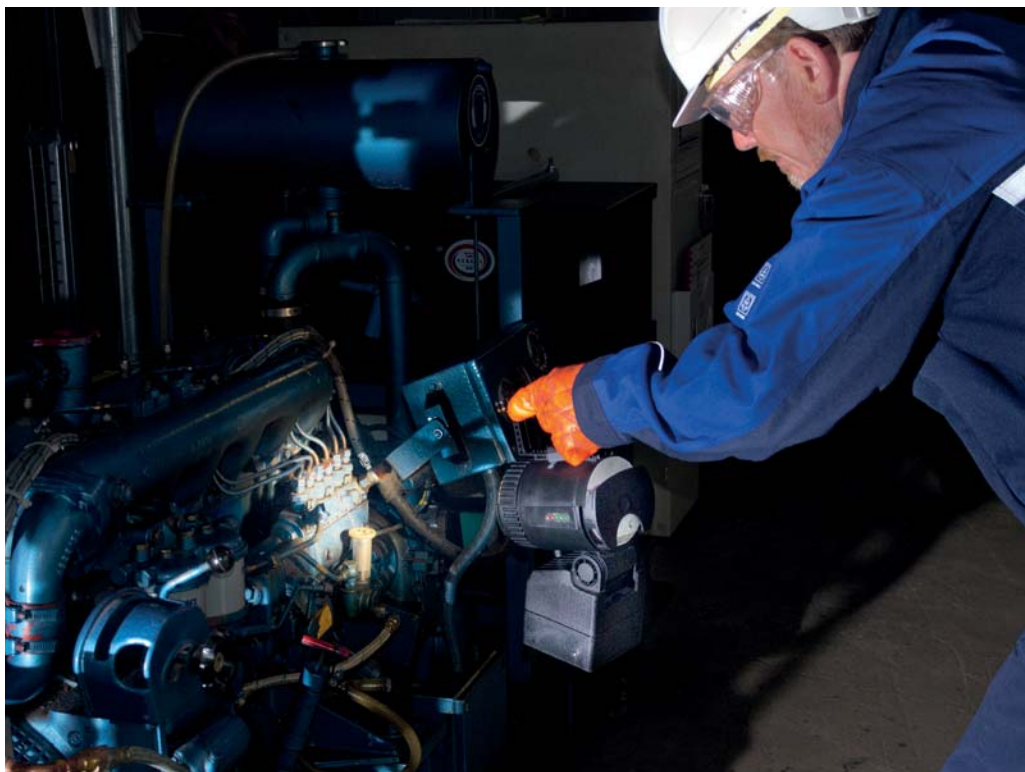
Frequent attendance, inspection, service, care and maintenance of the electrical installation by skilled personnel who have experience in the specific installation and its environment in order to maintain the explosion protection features of the installation in a satisfactory condition.

## Skilled personnel

Persons whose training has included instruction on the various types of protection and installation practices, the requirements of this standard, the relevant national regulations/company rules applicable to the installation and on the general principles of area classification.

## Documentation

For the purposes of inspection and maintenance, an up-to-date documentation for the following items shall be available:



*Explosion-protected handlamps ensures a flexible and safe illumination of the working area for inspection and maintenance work*

- a) zone classification of areas and, if included, the equipment protection level (EPL) required for each location (see EN 60079-10); In Europe the respective equipment categories apply
- b) for gases: equipment group (IIA, IIB or IIC) and temperature class requirements for the equipment used
- c) for dusts: equipment group (IIIA, IIIB or IIIC) and maximum surface temperature requirements for the equipment used
- d) equipment characteristics e.g. temperature ratings, type of protection, IP rating, corrosion resistance
- e) records sufficient to enable the explosion protected equipment to be maintained in accordance with its type of protection (for example list and location of equipment, spares, certificates, technical information)
- f) copies of previous inspection records
- g) copy of the initial inspection records according to EN 60079-14

## Inspections

Before an installation or equipment can be put into service, it shall be subjected to an initial inspection. These initial inspections are carried out following the erection according to EN 60079-14. The inspection requirements are specified in this standard.

To ensure that the installations in the hazardous area are maintained in the state required for their further operation, according to this standard it is necessary for

- a) regular periodic inspections
- b) or continuous supervision by skilled personnel and, if necessary, maintenance and repair work to be carried out

The Annex to EN 60079-17 contains information on tests for the implementation of these inspection requirements.

## Continuous supervision

*"Continuous supervision"* is the frequent attendance, inspection, service, care and maintenance of electrical installations by skilled personnel with experience in the environment to ensure the fast detection and immediate elimination of any faults that may occur and the early recognition of any changes and the initiation of appropriate countermeasures.

For the realization of a continuous supervision, the responsible operator of the installation shall permanently employ qualified personnel and allow them sufficient freedom to supervise the installation. Here training as a skilled electrician is the minimum requirement. In addition, it is necessary to have an adequate knowledge of the field of explosion protection.

So that possible weak points can be identified at an early stage, it is necessary to have a specific knowledge of the installation and the demands on it.

In the course of their normal work, for example, control operations, inspections, maintenance work, cleaning work, checking for faults, switching operations, making terminal connections and disconnections, setting and adjustment work, alterations and erection work, skilled personnel shall detect faults or changes at an early stage so that the necessary maintenance measures can be carried out in good time.

Continuous supervision shall be carried out by a technical person with executive function (responsible engineer). With regard to the qualification of this responsible engineer, importance is placed on the functional description and not the educational background. Here the person in question is a responsible person with an executive function that, for example, can be performed by a trained technician with the necessary expertise. Based on this expertise, he controls the qualification of skilled personnel and the execution of the continuous supervision by specifying appropriate operational procedures, and analyses changes in environmental conditions, the feedback from maintenance measures and results of random individual tests, so that necessary measures for the adaptation of electrical installations can be carried out at an early stage.

**Table : Testing plan for Ex „d“, „e“ and „n“**  
(D = Detailed inspection; N = Close inspection; S = Visual inspection)

Folgendes ist zu prüfen		Zundschutzart „d“			Zundschutzart „e“			Zundschutzart „n“		
		Prüftiefe								
		D	N	S	D	N	S	D	N	S
A	Gerät									
1	Gerät entspricht EPL/Zonenanforderungen des Einbauortes	•	•	•	•	•	•	•	•	•
2	Gerät ist richtig	•	•	•	•	•	•	•	•	•
3	Geräte Temperaturklasse ist richtig	•	•	•	•	•	•	•	•	•
4	Geräte-Stromkreisbezeichnung ist richtig	•	•	•	•	•	•	•	•	•
5	Geräte-Stromkreisbezeichnung ist vorhanden	•	•	•	•	•	•	•	•	•
6	Gehäuse, Glasscheiben und Glas-Metall-Abdichtungen und/oder Verbindungen sind ordnungsgemäß	•	•	•	•	•	•	•	•	•
7	Keine unzulässigen Änderungen	•	•	•	•	•	•	•	•	•
8	Keine sichtbaren Beschädigungen (direkt und indirekt),	•	•	•	•	•	•	•	•	•
9	Sichtprüfung der Schutzart ist ausreichend (direkt und indirekt),	•	•	•	•	•	•	•	•	•
10	Spezielle Betriebsbedingungen (falls zutreffend) sind eingehalten	•	•	•	•	•	•	•	•	•
11	Fehlerschleifen-Impedanz (TN-System) oder Erdungswiderstand (IT-System) ausreichend	•	•	•	•	•	•	•	•	•
12	Isolationswiderstand ist ausreichend	•	•	•	•	•	•	•	•	•
13	Die Automatische elektrische Schutzeinrichtung spricht in zulässigen Grenzwerten an	•	•	•	•	•	•	•	•	•
14	Die Automatische elektrische Schutzeinrichtung ist richtig eingestellt, automatische Rückstellung nicht möglich	•	•	•	•	•	•	•	•	•
15	Spezielle Betriebsbedingungen (falls zutreffend) sind eingehalten	•	•	•	•	•	•	•	•	•
16	Kabel und Leitungen, die nicht benutzt werden, sind richtig abgeschlossen	•	•	•	•	•	•	•	•	•
17	Hindernisse in der Nähe von zünddurchschlagsicheren Verbindungen sind in Übereinstimmung mit IEC 60079-14	•	•	•	•	•	•	•	•	•
18	Installationen mit veränderbarer Spannung/Frequenz in Übereinstimmung mit der Dokumentation	•	•	•	•	•	•	•	•	•
C	Umgebungseinflüsse									
1	Das Gerät ist ausreichend gegen Korrosion, Wetter, Schwingungen und andere Störfaktoren geschützt	•	•	•	•	•	•	•	•	•
2	Keine Übermäßige Staub oder Schmutzansammlung	•	•	•	•	•	•	•	•	•
3	Elektrische Isolierung ist sauber und trocken	•	•	•	•	•	•	•	•	•
<b>ANMERKUNG 1</b> Allgemeines: Die Überprüfung an Geräten mit den beiden Zundschutzarten „d“ und „e“ stellen eine Kombination beider Spalten dar.										
<b>ANMERKUNG 2</b> Positionen B7 und B8: Man sollte bei der Verwendung von elektrischen Prüfgeräten die Möglichkeit in Betracht zu ziehen, dass in der Nähe des Gerätes eine explosionsfähige Atmosphäre sein kann										

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Marking of degree of protection  
of electrical equipment for  
use in explosive atmospheres

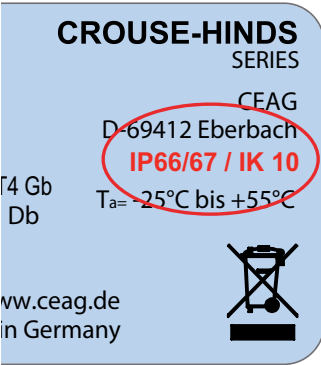
In the relevant IEC(EN)  
standards distinction is made  
between

IEC 60529

Degree of protection by encl-  
sure (IP Code) and

IEC 62262

Mechanical protection by  
enclosure (IK Code)



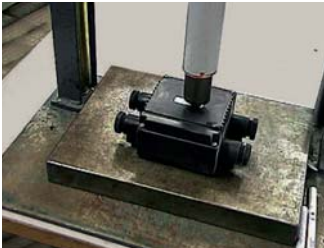
IP-Code - Degrees of protection  
to IEC/EN 60529

This standard describes a system  
with fixed gradations and test  
methods for classifying the de-  
grees of protection provided by  
enclosures of electrical equip-  
ment against the ingress of solid  
foreign objects and the ingress  
of water (see Table 1). The  
specified test is a type test and  
is carried out on clean and new  
equipment at temperatures  
ranging from 15°C to 35°C. The  
first digit of the IP Code descri-  
bes the protection of persons  
against access to hazardous  
parts and, at the same time,  
the protection of the enclosure  
against the ingress of foreign bo-  
dies. The second digit specifies  
the protection of the enclosure  
with regard to harmful effects  
due to the ingress of water. With  
the second number, numbers  
up to 6 indicate that the require-  
ments for all the lower numbers  
are met. With numbers > 6 the  
protection for lower numbers is  
not necessarily given. The code  
number for the lower degrees  
of protection need not be stat-  
ed in the code. If an enclosure  
meets the requirements for  
both areas, this shall be indicat-  
ed using a combined marking  
(see Table 2).

Table 1: IP-Code according to IEC/EN 60529			
FIRST NUMBER Protection against the ingress of foreign bodies		SECOND NUMBER Protection against the ingress of water with adverse effect	
No protection	0	0	No protection
≥ 50 mm diameter	1	1	Vertically dripping water
≥ 12,5 mm diameter	2	2	Dripping water 15° angle
≥ 2,5 mm diameter	3	3	Sprayed water
≥ 1,0 mm diameter	4	4	Splashed water
Dust-protected	5	IP56	5 Water jets
Dust-tight	6		6 Powerful water jets
			7 Temporary immersion
			8 Continuous immersion
			9 High pressure & high temp. of water jets

IK Code - Mechanical degree  
of protection to IEC/EN 62262

This standard describes a sys-  
tem with fixed gradations and  
test methods for classifying the  
mechanical degree of protec-  
tion (resistance to impact) pro-  
vided by enclosures. The speci-  
fied test is a type test and is  
carried out on clean and new  
equipment at temperatures  
ranging from 15 °C to 35 °C.



Impact test of an explosion  
protected junction box

Table 3: Impact piece and test to IEC 62262	
Impact energy (J)	IK Code
--	IK 00
0.14 J	IK 01
0.2 J	IK 02
0.35 J	IK 03
0.5 J	IK 04
0.7 J	IK 05
1 J	IK 06
2 J	IK 07
5 J	IK 08
10 J	IK 09
20 J	IK 10

Table 2: Combined designation if requirements for several applications are met			
Enclosure passes test for:		Designation and marking	Range of application
Water jets second character- istic numeral	Temporary/conti- nuous immersion second charac- teristic numeral		
5	7	IPX5/IPX7	Versatile
5	8	IPX5/IPX8	Versatile
6	7	IPX6/IPX7	Versatile
6	8	IPX6/PX8	Versatile
9	7	IPX7/IPX9	Versatile
9	8	IPX8/IPX9	Versatile
5 and 9	7	IPX5/IPX7/IPX9	Versatile
5 and 9	8	IPX5/IPX8/IPX9	Versatile
6 and 9	7	IPX6/IPX7/IPX9	Versatile
6 and 9	8	IPX6/IPX8/IPX9	Versatile
-	7	IPX7	Restricted
-	8	IPX8	Restricted
9	-	IPX9	Restricted

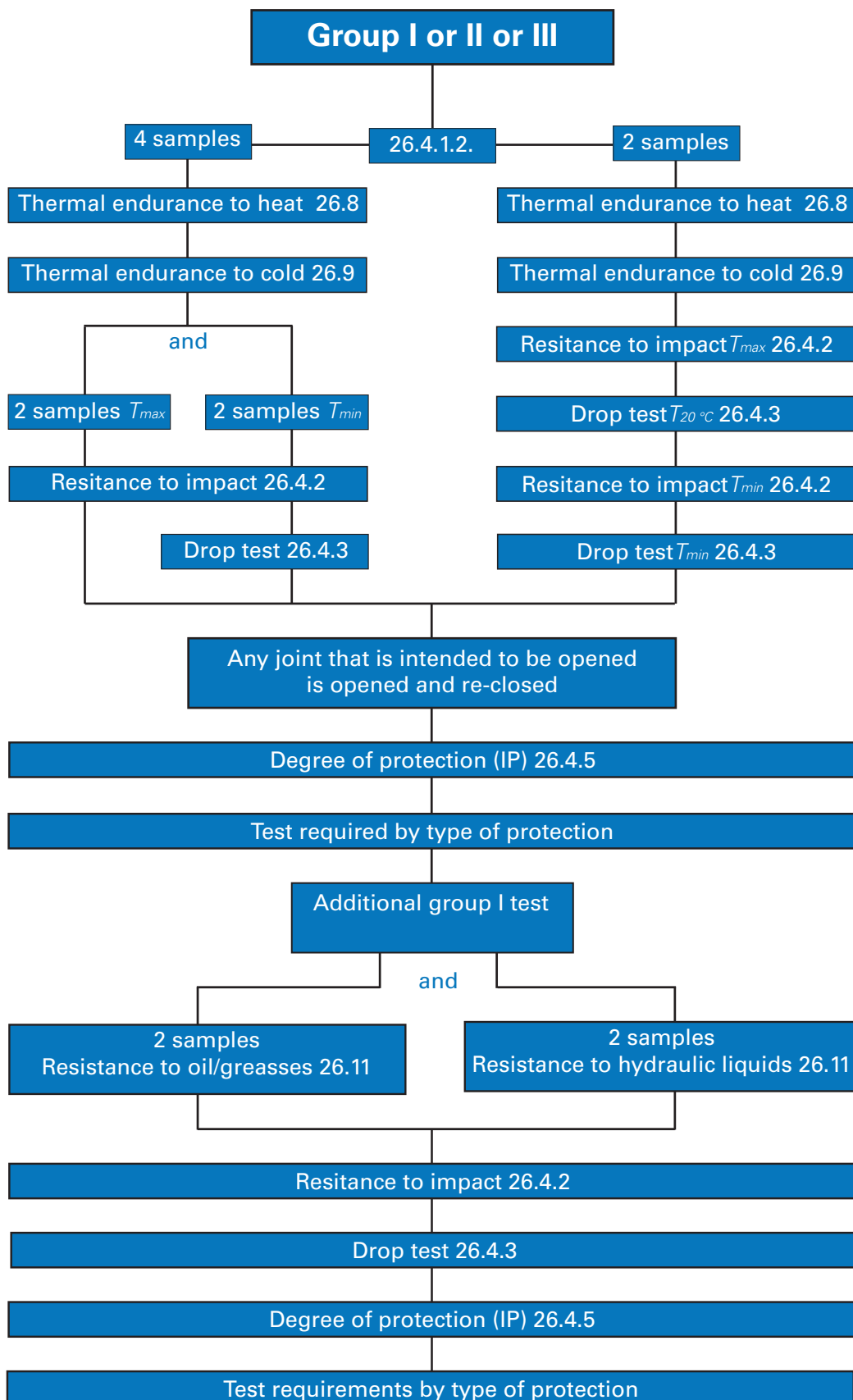
Degree of protection of explo-  
sion-protected equipment

Unlike industrial equipment  
where testing of the degree of  
protection may be carried out  
on new test sample, with explo-  
sion-protected equipment, if the  
degree of protection is a con-  
stituent element of the type of  
protection, tests shall be carried  
out on "aged" and mechanically  
stressed test samples.

EN 60079-0 specifies this aging  
process where, among other  
things, the aging of plastics and  
the resistance to aging of seals  
is tested. This is followed by a  
mechanical test that simulates  
a prolonged use of the equip-  
ment for the application and is  
fundamentally different to the  
tests for equipment for industri-  
al applications only.

The following chart shows that  
the test for the degree of pro-  
tection comes at the end of the  
test chain. An impact piece with  
a considerably smaller diameter  
is used for the mechanical test  
to EN 60079-0.

Flow chart for tests on equipment for use in explosive atmospheres



## The IECEX Conformity Assessment System

In the early 1990s an IEC working group, the WGEx, was formed. This was the starting point for the investigation of a possible implementation of a global certification system for the field of explosion protection based on the IEC standards for equipment for use in explosive atmospheres, which were in existence worldwide. The first official meeting for the establishment of a new IEC conformity assessment system (IECEX) took place in June 1996.

When it was established, in line with the IECEx System, the IECEX System only focussed on the drafting and mutual acceptance of test reports for equipment that had been tested for use in explosive atmospheres (IECEX test Reports (ExTRs)) of the participating IECEX testing organisation.

The basis for this Certificate of Conformity (CoC) issued by an IECEX certification body (ExCB) was the test report (ExTR) of an IECEX test laboratory (ExTL), and, as an added element, an audit of the manufacturer's quality management system.



However, it was not long before the IECEX Conformity Assessment System was extended to allow the preparation of full approvals. The first IECEX Certificate of Conformity (CoC) for Ex equipment was issued in 2002.

Each CoC contains a test report (ExTR), the associated Quality Assessment Report (QAR) with detailed information on the results of the assessment and testing of a product and its manufacture by an IECEX certification body (ExCB) and test laboratory (ExTL).

Unlike the existing national and regional approvals systems, where the paper original of the approval certificate is the decisive document, the IECEX System used an EDP supported approvals system from the outset.

Only the document shown in the system is the original.

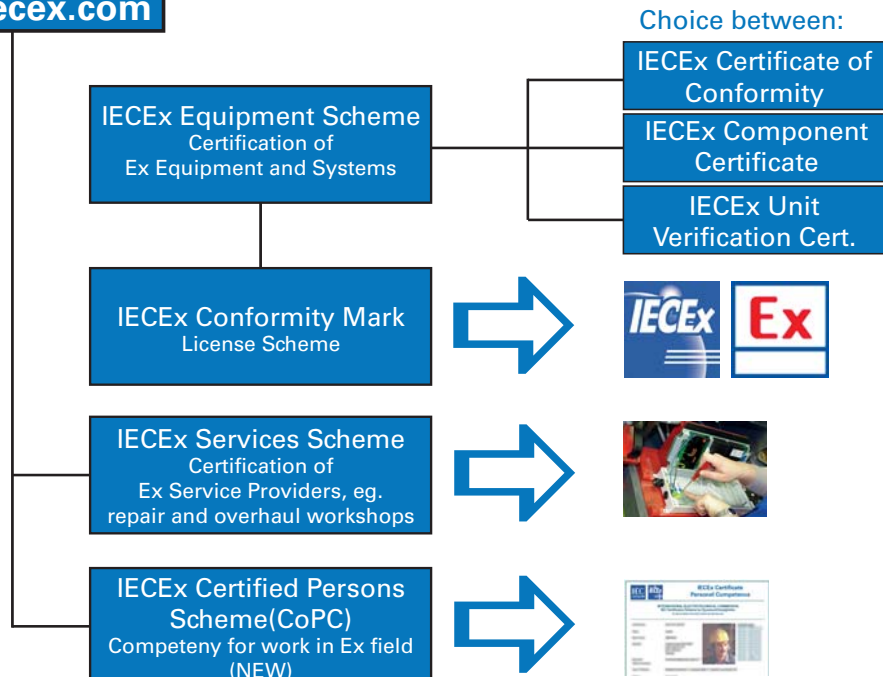
In the meantime the IECEX Conformity Assessment System not only a system for the testing and approval of electrical equipment for use in explosive atmospheres, but it has extended its activities to include international services or systems.

The rulings now cover:

- the certification of Ex equipment ,
- the certification of Ex service providers and
- the certification of Ex personnel competence.



## IECEX System [www.iecex.com](http://www.iecex.com)





## UNECE

### Formation

The Economic Commission for Europe (UNECE) was set up nearly two years after the end of the Second World War by the Economic and Social Council of the United Nations. The aim was to aid economic reconstruction in Europe, in particular the economic relations amongst themselves and worldwide. On the same day the Economic and Social Commission for Asia and the Pacific was set up with the same aim.

The Economic Commission for Latin America and the Caribbean, the Economic Commission for Africa and the Economic and Social Commission for Western Asia followed later. Based on the objectives of the ECE and the situation at that time with regard to economic force and power, it was almost inevitable that the USA and the Soviet Union were among the founder members.

### Structure

The Commission is made up of an Executive Committee and Sectoral Committees:

- Economic cooperation and integration
- Competitiveness, entrepreneurship, market regulation
- Environmental protection
- Forests and forest industry
- Housing and town planning
- Sustainable energy
- Norms, standards, trade barriers
- Inland waterways, railways, roads
- Statistics



### Explosion protection

The United Nations, through the United Nations Economic Commission for Europe (UNECE), is a multilateral platform that facilitates greater economic integration and cooperation among Member States and promotes sustainable development and economic prosperity

The UNECE Working Party on Regulatory Cooperation and Standardization Policies (WP. 6) has worked in close cooperation with the International Electro-technical Commission (IEC) and the IEC System for Certification to Standards relating to Equipment for Use in Explosive Atmospheres (IECEx) to develop a model for legislation in the sector of equipment used in environments with an explosive atmosphere. After the model was adopted in the first step, the text was published. The model provides for adequate risk mitigation, without creating excessive costs or red tape for business.

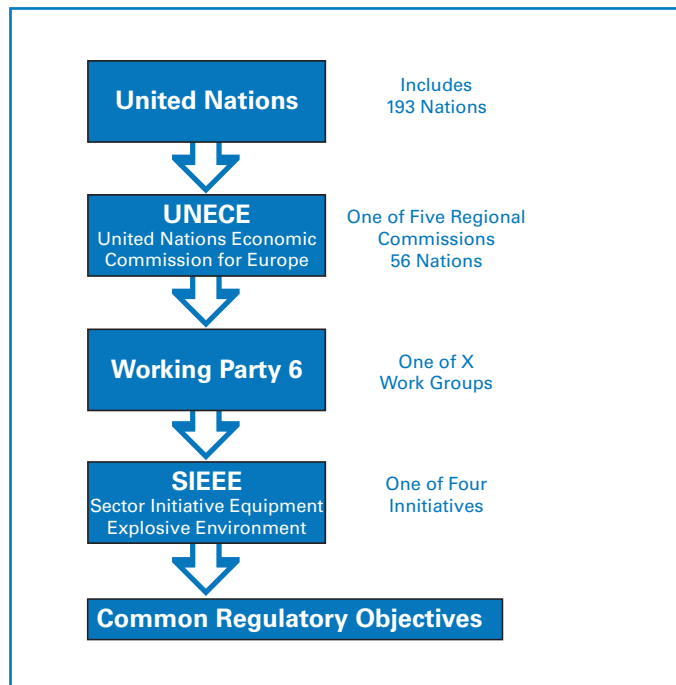
Any Member State that has no regulatory framework in the explosive equipment sector can use the model as a blueprint for legislation. If countries already have such a framework, they could consider gradually converging towards this international model.

### Objectives

The UNECE Working Party 6 established a "sectoral initiative" to tackle existing challenges in this sector.

Specifically, the project aimed at:

- Fostering the use of relevant IEC and ISO International Standards by the industry.
- Promoting a globally harmonized legislation.
- Ensuring mutual acceptance of test procedures and test results among the test houses.
- Striving for comparable installation, maintenance and repair procedures of the equipment.



## Global Reference Guide on the Marking of Electrical Equipment for Use in Explosive Atmospheres: NEC/CEC Reference

Typical NEC/CEC Class/Division marking of electrical apparatus in USA and Canada:  
Marking according to NEC 500 / CEC J18

### Class I Division 1 Groups A, B, C & D

Class I ..... Hazard category  
Division 1 ..... Area classification  
Groups A, B, C & D ..... Hazardous atmosphere category (gas or dust grouping)  
T1 ..... Temperature classification

#### Method of explosion protection

Type of protection	Description of protection	Permitted for use in USA	Permitted for use in Canada	Protection concept
a	Increased safety	2	1, 2	No arcs, sparks or hot surfaces
b	Non-incendive	2	2	2
d	Flameproof	2	1, 2	1, 2
e	Explosion-proof	1, 2	1, 2	1, 2
q	Powder filled	2	1, 2	1, 2
is	Intrinsic safety	1, 2	1, 2	1, 2
is	Intrinsic safety	1, 2	1, 2	1, 2
psb	Pressurized (surge)	1, 2	1, 2	1, 2
pyb	Pressurized (surge)	1, 2	1, 2	1, 2
m	Encapsulation	2	1, 2	1, 2
mb	Encapsulation	1, 2	1, 2	1, 2
o	Oil immersion	2	1, 2	1, 2

#### Area classification

Continuous hazard	Intermittent hazard	Hazard under abnormal conditions
North America / NEC 500-503/CEC J18	Division 1	Division 2
NEC 500-503/CEC J18	Zone 0 (Zone 20 dust)	Zone 1 (Zone 21 dust)

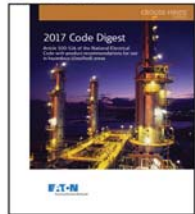
#### Temperature classification according to NEC/CEC

Maximum surface temperature	US Zone concept	US Division / Canada Zone and Division concept
450 °C (842 °F)	T1	T1
300 °C (572 °F)	T2	T2
280 °C (536 °F)	T2A	T2A
260 °C (500 °F)	T2B	T2B
230 °C (446 °F)	T2C	T2C
215 °C (419 °F)	T2D	T2D
200 °C (392 °F)	T3	T3
180 °C (336 °F)	T3A	T3A
160 °C (320 °F)	T3B	T3B
150 °C (302 °F)	T3C	T3C
135 °C (275 °F)	T4	T4
120 °C (248 °F)	T4A	T4A
100 °C (212 °F)	T5	T5
85 °C (185 °F)	T6	T6

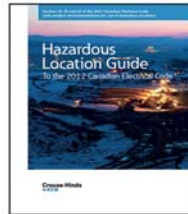
#### Committees and directives

NEMA (National Electrical Manufacturers Association) NEMA 250 series standards for enclosure types covers both hazardous areas (potentially explosive atmospheres) and non-hazardous areas.  
NEC - National Electrical Code (USA)  
CEC - Canadian Electrical Code (Canada)

#### NEC Code Digest



#### CEC Code Digest



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## Global Reference Guide on the Marking of Electrical Equipment for Use in Explosive Atmospheres (EU/ATEX/IECEX/CSA)

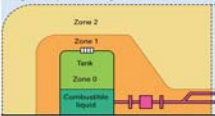
Typical marking of electrical equipment for use in explosive gas atmospheres (EU/ATEX/IECEX):

Marking according to Directive 2014/34/EU (previously 94/9/EG) (ATEX)  
Marking according to IEC/CENELEC/CSA standard 60079-0

**CE** **Ex** **II** **2** **G** **Ex** **db** **eb** **IIC** **T4** **Gb**

CE: CE-marking and number of the notified (monitoring) body (0158 = DEKRA EXAM GmbH) (not for equipment category 3)  
II: Explosion protection symbol (Electrical equipment group II, subgroup IIC (hydrogen), intended for use in areas where an explosive gas atmosphere is to be expected, other than mines susceptible to fire/damp)  
2: Equipment category (category 2)  
G: Explosive atmosphere (gas, vapour or mist)  
Ex: Explosion protection marking  
db: Type of protection (flameproof enclosure, level of protection „db“)  
eb: Type of protection (increased safety, level of protection „eb“)  
IIC: Equipment group (Electrical equipment group II, subgroup IIC (hydrogen), intended for use in areas where an explosive gas atmosphere is to be expected, other than mines susceptible to fire/damp)  
T4: Temperature class (max. surface temperature 135 °C)  
Gb: Equipment protection level (EPL Gb; equipment with high protection level)

Example of classification of explosive gas atmospheres into zones  
Ex gas atmosphere according to IECEN 60079-10-1



#### Explosion group

Explosion classification		Typical conducting material	Group	Maximum surface temperature
Gas, vapour or mist		Acetylene	IC	450 °C
		Hydrogen	IC / (StbH2)	450 °C
		Ethylene/Propylene	IIA	300 °C
		Methane/Ethane	IIA	200 °C
Dust	Conductive	Alkal dust	IC	150 °C
		Coal dust		
	Non-conductive	Grain dust	III	150 °C
	Fibres & Pyrolys	Other paper or textile processing	IIA	85 °C



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