Introduction

Explosion Protection

The process of harmonisation of regulations in the field of explosion protection within the member states of the European Union was initiated in 1996. One of the main reasons for harmonisation is that the different regulations existing in the individual member states present a trade barrier. The transitional period, during which both the new and the previous regulations are applicable, has been extended until 30 June 2003. The new harmonised regulations will take effect in all member states of the European Union from 1 July 2003.

In the following, please find a brief comparison between the new and the „old“ regulations. Our more detailed brochure „Explosion Protection - A Practical Guide“ can be provided on request. Nevertheless, the user is obliged to know the presently applicable regulations and directives.

1 Directives and Standards

History

Until the end of 1975, numerous national directives covering the field of explosion protection existed in the individual European states. On 18 December 1975, the first framework directive on explosion protection (mining excluded) came into effect, applying in the member states of the European Union: 76/117/EWG.

Until 1990 there were frequent amendments of this directive. This directive referred to the characteristics and structure of the equipment at issue and was directly related to standards. It applied exclusively to electrical equipment and explosion protection (except mining).

The fact that national directives were still in effect restricted free trade in this area.

In the beginning of 1994, the „Framework Directive 94/9/EC of the European Parliament and Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres“ was passed. This directive has regard to the „European Treaty“ of 1985, in particular article 100a (amendment of 2 February 1992), establishing the European Community.

To find a general abbreviation for this new directive it was agreed to use the name ATEX 100a. ATEX is an abbreviation of the French translation of „explosive atmosphere“ (atmosphère exploisable) and 100a refers to the article 100a. Apart from the article 100a, there are further articles which have not yet been fully transposed into according directives. TÜRCK catalogues always use the term ATEX to relate to the new directives on explosion protection conforming to ATEX 100a.

Within the member states of the European Union the ATEX 100a was translated into national legislation, e.g. in the Federal Republic of Germany by the „Gerätesicherheitsgesetz (§11 GSGV)“ and the „Explosionsschutzverordnung (EXVO)“.

The presently valid regulations on explosion protection will have effect until 3 June 2003. Even though the new regulations have come into effect in 1996, a transitional period was created to adopt the new regulations complying with ATEX.

The System Specifiers who must meet safety requirements according to IEC 31 (CO) 43, ATEX137, EN 60079-14.

The Manufacturers of Components bound by constructional requirements set forth by EN 50014...20, 28 and 39 and ATEX 100a.

EN 60079-14 Installation of Intrinsically Safe Systems in Explosion Hazardous Areas

This standard includes the safety requirements that must be observed (e.g. identification and classification of explosion hazardous locations, temperature classes, cabling and wiring, requirements for the installation of electrical devices in zones 0 and 1).

Contrary to the standards described, which are primarily for manufacturers, this standard applies to maintenance, operators and test personnel. As EN 60079-14 this standard also complies with the requirements of ATEX. Please note that the former exemption clause for components is no longer included. Partly an approval for individual components is now required.

ElexV – Regulations on Electrical Equipment in Explosion Hazardous Locations (old) /Areas (new)

As a national directive, the ElexV is addressed to those responsible in Germany for the technological causes of the formation of explosive mixtures.

The former ElexV of 1980 related to European regulations on explosion protection of industrial electrical equipment. This „old“ version constituted the legal basis for almost the entire field of explosion protection of electrical equipment. By defining explosion hazardous areas and especially by dividing these into specific zones, ElexV gained major importance as a standard for explosion protection measures. Since the introduction of the ATEX directive in 1996 a lot has changed.

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Definitions relating to the non-electrical aspects of new electrical equipment are now covered by the new „Explosion Protection Directive“ (ExVO). The amended version of ElexV of 1996 refers only to those parts which have not yet been translated into national regulations.

ATEX 137 - Directive for System Operators

The directive 1999/92/EC of the European Parliament and Council of 16 December concerning the essential health and safety requirements is intended to guard workers against the potential hazards of an explosive atmosphere. It is addressed to system operators and employers and contains binding regulations. Among other things, it requires to assess the risks resulting from a potentially explosive atmosphere, to classify areas exposed to potentially explosive atmospheres and to keep an explosion protection document.

The Explosion Protection Directive – (ExVO)

The ExVO determines the placing on the market of devices, protective systems and components intended for use in potentially explosive atmospheres and is the German transposition of the directive 94/9/EC. It describes the essential health and safety requirements and mandatory conformity assessment procedures. The ExVO is mainly aimed at manufacturers of devices, maintenance and test personnel.

In compliance with the directive 94/9/EC, ExVO excludes the following equipment from its scope (summarised): medical devices, explosive substances, or unstable chemicals, personal protection equipment, seagoing vessels, offshore systems and products for military purposes.

EN 50014 – Electrical Apparatus for Use in Potentially Explosive Atmospheres – General Requirements

EN 50014 contains general requirements for the construction and testing of any electrical apparatus to be used in hazardous areas.

EN 50015...20, 28 and 39 describe the technical requirements of different methods of protection:
- oil immersion (EN 50015)
- pressurised apparatus (EN 50016)
- powder filling (EN 50017)
- flameproof enclosure (EN 50018)
- increased safety (EN 50019)
- intrinsic safety (EN 50020)
- encapsulation (EN 50028)
- intrinsically safe electrical systems (EN 50039)

With this protection method, all or parts of the electrical apparatus are immersed in oil so that the explosive atmosphere above the oil level or outside the enclosure cannot be ignited.

EN 50020 – Protection Type „Intrinsic Safety (i)“

All other methods of protection attempt to contain an explosion to the inside of the housing and to prevent penetration of an ignitable gaseous mixture.

The method of „Intrinsic Safety“ is based on a different approach. It limits the electrical energy to such an extent, that elevated temperatures, sparcis or arcs are incapable of generating the energy needed to ignite an explosive atmosphere. Due to the limitation of electrical energy, these circuits are especially suited to application in the field of measuring, control and instrumentation. The method of „intrinsic safety“ has some significant advantages over other protection methods, e.g. maintenance and wiring of live circuits. These systems are easy to handle and cost effective due to inexpensive intrinsically safe components.

2 Definitions of Terms

Explosion

An explosion is an exothermic reaction of a material (such as gas, fumes, or dust) occurring at a high reaction speed.

The risk of an explosion exists whenever there is the probability of an explosive atmosphere containing flammable gases or vapours, flammable liquids, combustible dust, or ignitable flyings due to handling, processing, using and storing of these materials.

Such hazardous atmospheres can be present for instance in chemical industries, gas stations, refineries, power plants, paint shops, vehicles, sewage plants, grain mills, airports, grain silos and filling plants.

Explosion Hazards

Explosion hazards exist in locations:
- in which ignitable concentrations of flammable gases or vapours can exist under normal operating conditions, or because of repair or of leakage, and when these conditions provide the probability that a dangerous fuel to air mixture will occur;
- where the explosive or ignitable mixtures can come in contact with a source of ignition and they continue to burn after ignition.

Explosive (flammable) Mixtures (general term)

A combustible (flammable) mixture is an atmosphere containing substances that when mixed with air, gases or vapours, propel a reaction after ignition.

Explosive (flammable) Atmospheres

An explosive atmosphere contains gases, vapours or dust mixed with air as well as the usual filler materials that can explode spontaneously under atmospheric conditions.

Dangerous Explosive Atmospheres

A dangerous explosive atmosphere is a mixture containing concentrations of flammable gases or vapours that, when ignited, can cause damage to persons directly or indirectly through an explosion.

Explosion Hazardous Location

An explosion hazardous area is a location where potentially explosive atmospheres may exist due to local operating conditions.
Introduction

Explosion Protection

Ignition Triangle

In order to have an explosion, the following three components must be present simultaneously:

- oxygen
- ignition source
- fuel

Possible sources of ignition:
- hot surfaces
- flammable or explosive gases
- electrically generated sparks
- electrical installations
- transient currents
- static electricity
- lightning, ultrasonic energy...

Oxidizers:
- air (21% Oxygen)
- pure Oxygen
- oxygen releasing compounds
  (i.e. potassium manganate)

Fuels (flammable substances):
Flammable concentrations of gases and powders from liquids or solids which have the potential for igniting an explosion.

Explosive Limits

A mixture is only explosive when its concentration falls within certain material specific limits. These limits are called the upper and lower explosive limits and are listed in according tables.

Flash-point Temperature

The flash-point is the lowest temperature at which a liquid releases sufficient vapours that are ignitable by an energy source and extinguish when the energy source is removed.

An explosive atmosphere cannot occur when the flash-point of a material is not exceeded during storage or handling. Flammable liquids, which do not dissolve in water, constitute a source of danger and are in Germany classified according to VbF (directive for the installation and operation of plants where flammable liquids are stored and handled). Further parameters to evaluate the danger are the glow temperature, the minimum ignition energy and the ignition temperature. These values are listed in according tables.

Primary and Secondary Methods of Protection

Basically there are two methods used to prevent an explosion.

Primary Method of Protection

The primary method prevents formation of a dangerous atmosphere by one or more of the following measures:

- avoiding the use of flammable liquids
- increase of flash point
- limiting the concentration to safe levels
- through natural and technical ventilation
- monitoring the concentration

The primary method of protection is not described in this brochure. Please refer to the explosion protection regulations of the professional association of the chemical industry in Germany (Ex-RL) and EN 1127-1.

Secondary Method of Protection

The secondary method comprises measures to prevent ignition of an explosive mixture to prevent ignition. Here, constructive or electrical techniques are used to

- segregate the electrical parts of the equipment, which could ignite a dangerous mixture, by keeping the explosive atmosphere away from the ignition source
- prevent an explosion by impeding the propagation to the surrounding explosive atmosphere.

The secondary protection method is frequently used, if primary protection does not provide adequate protection.

3 Electrical Equipment Featuring Protection Type „Intrinsic Safety“

The term „intrinsic safety“ implies that the electrical energy of an intrinsically safe circuit is limited to such an extent that a thermal effect or spark is incapable of igniting an explosive atmosphere under specified conditions.

TURCK devices for use in explosion hazardous locations comply with protection type „intrinsic safety“. The devices are divided into two different kinds of electrical equipment: intrinsically safe equipment and associated equipment. Marking of the devices enables clear distinction between the two types of apparatus (see point 5). Further there are devices defined as „simple equipment“ which maintain an exceptional position within this field.

Intrinsically Safe Electrical Apparatus

is any apparatus in which all circuits are intrinsically safe. Direct installation in hazardous locations is permitted, provided that all related requirements are met. An example is a NAMUR sensor approved according to EN 50227 or a transmitter.

Associated Electrical Apparatus

is any equipment which may incorporate both intrinsically safe and non-intrinsically safe circuits. Intrinsically safe devices may be connected to associated electrical equipment, provided that all essential conditions for this kind of interconnected assembly are fulfilled.

Associated electrical apparatus must generally be installed outside the hazardous areas. If installed within the hazardous location, additional types of protection must be provided.

All TURCK devices, type multisafe®, multimodul and multiset® with intrinsically safe circuits, are classified as associated electrical apparatus.
Groups and Temperature Classes

Electrical apparatus for use in the hazardous area is classified into groups and classes based on the likelihood of explosion danger. This is of great importance from a safety aspect as well as an economical aspect because it determines the requirements that must be met by the electrical apparatus.

Definition of Groups is based on the location in which the apparatus is going to be used.

- Group I classified apparatus may be used in mines susceptible to firedamp and must conform to European standards EN 50014...50020 and 28.
- Group II classified apparatus may be used in all other potentially explosive atmospheres.

Group II classified apparatus is used in all hazardous (classified) areas except mining applications where methane may be present. Depending on the application, different flammable materials with different ignition energy ratings are needed. From a practical point of view, subdividing Group II is therefore necessary and makes sense, not only for economical reasons.

Subdivision of Group II equipment is determined by the different ignition energy of the flammable materials. The different groups are classified by capital letters in ascending alphabetical order according to the hazard risk of the associated material. Materials belonging to group C require less ignition energy than Group A materials (see table 1).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Temperature Class</th>
<th>Ignition Temperatures of Flammable Materials (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Methane</td>
<td>Acetone Ethyl alcohol Gasolines Acetadehyde Ethyl ether</td>
</tr>
<tr>
<td>II A</td>
<td>Ethane Ethanol Ammonium Benzol Acetic acid Carbon monoxide Methanol Propane Toluene</td>
<td>n-Butane i-Amylacetate n-Butyl alcohol Aircraft fuel Fuel oils n-Hexane</td>
</tr>
<tr>
<td>II B</td>
<td>City gas</td>
<td>Athylene*</td>
</tr>
<tr>
<td>II C</td>
<td>Hydrogen</td>
<td>Athylene*</td>
</tr>
</tbody>
</table>

*) no authorized regulations

Tab. 1 Flammable materials - temperature classes and groups

<table>
<thead>
<tr>
<th>Temperature Class</th>
<th>Maximum Surface Temperature of Apparatus (°C)</th>
<th>Ignition Temperatures of Flammable Materials (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>450</td>
<td>&gt; 450</td>
</tr>
<tr>
<td>T2</td>
<td>300</td>
<td>&gt; 300</td>
</tr>
<tr>
<td>T3</td>
<td>200</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>T4</td>
<td>135</td>
<td>&gt; 135</td>
</tr>
<tr>
<td>T5</td>
<td>100</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>T6</td>
<td>85</td>
<td>&gt; 85</td>
</tr>
</tbody>
</table>

Tab. 2 Surface and ignition temperatures
Introduction

Explosion Protection

Temperature Class

The temperature class specifies the maximum allowable surface temperature of an apparatus. In this category, the explosion protected apparatus can be approved for different temperature classes - a decision which depends on technical and economical considerations.

In the majority of cases, explosion proof equipment for the lowest temperature can be very expensive to buy and install. By comparison, using products featuring protection type “intrinsic safety” is more efficient and cheaper. Intrinsic safe equipment for direct installation in hazardous areas requires temperature classification. For associated apparatus temperature classification is not needed.

Ignition Temperature

The ignition temperature (defined as the temperature at which a mixture self-ignites during testing) directly relates to the temperature class. The temperature class indicates the maximum surface temperature of an apparatus and must be lower than the minimum ignition temperature of the flammable material (see table 2 - page A-9) to prevent an ignition.

Device Groups and Categories According to the ATEX Directive

The ATEX directive includes a new kind of device marking which describes the application and the constructional level of safety.

This new marking per ATEX does not replace standardised marking including temperature class, explosion group and protection type.

Marking according to ATEX contains information on the area of application and the safety level achieved by the device. Marking according to EN 50020 provides detailed information on how the protection measures were realised and which applications are permitted. EN 50020 and ATEX use similar terms but the information provided may be essentially different.

The first criterion is the Equipment Group. This classification accords to the groups described on page 11 and defines the location in which a device may be installed.

- Device Group I: for mining underground with a potential hazard due to firedamp and/or combustible dusts.
- Device Group II: for all other locations in which a potentially explosive atmosphere exists.

The second criterion is the Equipment Category, defining the level of safety:

1: very high level of safety: devices featuring two independent means of protection; even in the event of rare device disturbances, the device remains functional and maintains the requisite level of protection
2: high level of safety: devices featuring one means of protection. Even in the event of frequently occurring device disturbances or equipment faults which normally have to be taken into account the device provides the requisite level of safety
3: normal safety; the device ensures the requisite level of protection during normal operation.

Equipment classified as Group I (underground mining susceptible to firedamp) uses the prefix M, e.g. M1, in addition to the category classification.

The third and last criterion is the Substance Group which characterises the application of devices in particular atmospheres:

G: explosion protection in explosive atmospheres due to gases, vapours or mists (G: gas)
D: explosion protection in explosive atmospheres due to dusts (D: dust)

The equipment category also determines whether the device is an associated apparatus or an intrinsically safe apparatus. If it is an associated apparatus the equipment category is put into round brackets, e.g. II (I) G.

4 Zone Classification

According to EN 60079-10 and EN 1127-1 explosion hazardous areas are divided into zones such as flammable gases, vapours, mists and combustible dust. The classification is based on the likelihood that a dangerous explosive atmosphere occurs. The ATEX directive has re-defined the zone division as follows:

- zones 0, 1 and 2 for gases and vapours
- former zones 10 and 11, now zones 20, 21 and 22 for dusts
- zones G and M for locations used for medical purposes

<table>
<thead>
<tr>
<th>Zone classification</th>
<th>Likelihood of an explosive atmosphere</th>
<th>Compliance with safety requirements by</th>
<th>Requirements fulfilled by related equipment group</th>
<th>Equipment category</th>
<th>additional equipment category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0 (gas, ...)</td>
<td>continuously, for long periods or frequently</td>
<td>2 independent means of protection</td>
<td>II 1 G (for gas, ...) 1 D (for dust)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zone 20 (dust)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone 1</td>
<td>occasionally</td>
<td>1 independent means of protection</td>
<td>II 2 G 2 D</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Zone 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone 2</td>
<td>unlikely or infrequently - for a short period only</td>
<td>normal operation</td>
<td>II 3 G 3 D</td>
<td>1 or 2</td>
<td></td>
</tr>
<tr>
<td>Zone 22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Zone classification - equipment category
Gases and Vapours

Zone 0

Zone 0 is a location in which ignitable concentrations of flammable gases or vapours are continuously present, or present for long periods. The example shows a gas station with zone 0 locations.

According to the previous national regulations any apparatus or parts thereof used in a zone 0 location had to be specially certified and approved for use in zone 0 locations. Further, the certificate of conformity had to mention explicitly that the equipment and parts thereof were permitted for use in zone 0. When using intrinsically safe and associated equipment as an interconnected assembly, both parts used to require a system approval.

This restriction is not included to the ATEX directive. If both parts of equipment meet the regulations for installation in zone 0, it is permitted to use the equipment accordingly without an extra approval. When electrical equipment approved by both previous and new regulations is used as an interconnected assembly, it is required to meet all requirements set forth by both directives. Additionally a system approval is needed.

Intrinsically safe apparatus designed for use in zone 0 must meet category “ia” safety standards and must have no live contacts. Galvanic isolation between intrinsically safe and non-safe equipment is the method of choice. If earthing of the intrinsically safe circuit is required for functionality, this must be done outside zone 0, but as close as possible to zone 0.

Zone 1

Zone 1 are locations in which an explosive air/gas mixture is likely to occur under normal operation. Here ATEX does not incorporate any changes. The example identifies the area near the gas pump during refuelling as a zone 1 location.

Generally the following areas in industrial plants are considered to be zone 1 locations:

- in the vicinity of zone 0
- close to inspection openings
- near filling and draining devices
- inside of machinery

Any equipment certified for zone 1 must be Group IIA, IIB or IIC and at least category "ib".

Zone 2

Zone 2 comprises areas in which an explosive and dangerous atmosphere is unlikely to occur, but, if it does, only for a short period. The ATEX definition of zone 2 differs slightly: An explosive atmosphere should not occur, but, if it does, only infrequently and for a short period.

- any areas near zone 0 and 1
- areas near flange seals whenever standard flange joints are used
- areas near pipe lines in closed rooms

Unlike apparatus for zones 0 and 1, equipment for use in zone 2 does not require a test certificate by an authorised body. Devices for zone 2 must conform to category 3 and must meet the following criteria (EN 50021):

- restricted breathing enclosures (10 K overtemperature only)
- sealed enclosures (various test methods/requirements)
- simple pressurized enclosure (like „p” without purging)
- limited energy (intrinsic safety without safety factor)
- encapsulated switching devices (simple „pressurized enclosure“)
- lower requirements for equipment in zone 1, e.g.
  - clearances and creepages
  - housing impact test
  - plastic materials
  - construction of lamp holders and starters

Installation of Devices in Zone 0 to 2

For installation in zones 0 to 2 (gas, vapour) it is required that intrinsically safe and associated equipment must meet at least those requirements applying to the zone in which the intrinsically safe apparatus is to be installed. If the equipment meets higher requirements, operation is obviously permitted. The national regulations apply to interconnected assembly and installation of devices. Please refer to point 7 for further information.
**Combustible Dusts**

Explosion protection regulations applying to combustible dusts differ from those relating to gases and vapours due to the different hazard points. Here, ATEX also determines new regulations. Transposition into new directives and standards has not yet been completed, so that it is likely that there will be various amendments and complications.

The previous zone classification and the new division into zones according to ATEX differ in many respects. Following please find a comparison.

Previous zones 10 and 11 will be replaced by the zones 20, 21 and 22. Here the zone classification is similar to that of gases and vapours.

### Previous Zone 10 - New Zone 20

According to the previous regulations, zone 10 comprises areas in which a dangerous explosive atmosphere is constantly present or prevails for a long period.

According to ATEX, zone 20 is classified as an area in which a dangerous explosive atmosphere in form of a dust cloud is continuously present, or occurs frequently, or for a long period. The possibility of a dust deposit with a known or excessive thickness is given. The presence of dust deposits as a single event does not constitute a zone 0 classification.

As a rule, these conditions can only prevail inside an enclosure, pipes and instruments. Areas, in which dust deposits occur, but where clouds of dust are not present constantly, frequently, or for a long term, do not belong to this zone.

### Previous Zone 11, New Zone 21 and Zone 22

Zone 11 comprises areas in which it is likely that a dangerous explosive atmosphere occurs occasionally due to whirling up of dust. According to ATEX, zone 11 is subdivided into two zones, i.e. zones 21 and 22.

**Zone 21:**
Areas in which, during normal operation, a potentially explosive atmosphere in form of a dust cloud can occur occasionally. Dust deposits or layers of combustible dust will usually be present.

These can be areas in the close vicinity of filling or dust extraction stations, where dust deposits are present and explosive concentrations of flammable dust mixed with air may occur during normal operation.

**Zone 22:**
An area in which it is unlikely that a potentially explosive atmosphere in form of a dust cloud occurs during normal operation. If such an atmosphere occurs, then only for a short period, or in the event of dust accumulation, or in layers of combustible dust.

### Devices for Use in Zone 20 to 22

The ATEX regulations covering combustible dusts are still in preparation. Installation and operation of devices in zone 20 to 22 are subject to the national regulations (pr EN50281-1-2). Associated equipment does not require an approval for flammable dusts, an approval for gases and vapour is sufficient. It must be ensured that the limit values of intrinsic safety of the EC type examination certificate are met in case of an interconnected assembly. Then it is permitted to mark the intrinsically safe equipment, for instance as II 1 D and the associated apparatus as II (1) G.

During installation it is required to observe the special conditions of dust protection. E.g. simple apparatus for use in zone 20 to 22 must have an approval, whereas this is not necessary for simple equipment in zones 0 to 2.

### Medical Environments

According to the previous regulations, medical environments, e.g. all equipment used for anesthesia or for artificial respiration, were subdivided into zones M and G. ATEX no longer includes medical equipment in the scope of its explosion protection regulations. The applicable legislation covering the protective aspects associated with medical products do not relate to explosion protection so that there is a juridical insecurity in this field.
5 Marking of Devices

Equipment for explosion protected areas must be clearly marked. There are two different types of marking. According to CENELEC marking of an apparatus conforming to EN 50014/20 must provide the following information:

- manufacturer’s name or trademark
- part number
- EEx-symbol
- ignition category (e. g. „ia“)
- designated group together with the respective subdivision (e. g. IIC)
- temperature class or maximum surface temperature (for group II devices only)
- serial number (may be omitted if space is restricted)
- test authority, date and file number
- „x“ after the test certificate number indicates that special conditions must be met (see certificate for special conditions)

An intrinsically safe apparatus could have the following marking:

**EEx ia IIC T6**

- temperature class
- explosion group
- type of protection
- conform to European standard

An associated apparatus could have the following marking:

**[EEx ia] IIC**

- explosion group
- type of protection
- acc. to European standard
- associated apparatus

To date, the test certificate number of the test authority used to contain the generation number of the applicable standard to indicate the amendment status, e.g.:

**PTB Nr. Ex-85.B.2128X**

- PTB Nr. authorized body
- Ex- explosion protected apparatus
- 85. year of issue
- B. generation indicator
- 2128 serial certificate number
- X special conditions

Associated equipment is identifiable by round brackets enclosing the device category:

**II (1) G**

- **may not be installed in hazardous areas**

6 Manufacturer Obligations

Certificates of Conformity and EC Type Test Certificates

An authorised body is entitled to test and certify that devices are suited for use in explosion hazardous areas and comply with the relevant regulations and standards.

Previous regulations required the manufacturer to submit a test sample to the test body and to ensure compliance with existing regulations. The authorised test body then issued the certificate of conformity and passed it on to the manufacturer. The certificate of conformity contains all relevant data associated with explosion protection.

Here, the ATEX directive also implements a change. The manufacturer is requested to supply a type test sample to an authorised inspection body, which draws up a test report to be submitted to the notified body entitled to issue the EC type examination certificate after verifying conformity. Notified bodies and external inspection bodies are registered centrally. The EC type examination certificate contains all data relevant for explosion protection.

The obligation to keep a copy of this certificate is the responsibility of the manufacturer of the device. Along with the certificate, the manufacturer provides an instruction manual with all relevant Ex data. In addition, the manufacturer issues a declaration of conformity, stating that all applicable standards and directives are met. The user needs these documents to document compliance of the system installation correctly.
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CE Marking of Equipment

Devices for use in explosion hazardous area are equipped with the CE marking and the identification code of the testing authority. The assessment procedure for CE marking is clearly defined and depends on the device category. The example shown relates to device category 1, featuring the highest safety level. The applicable annexes of the directive 94/9/EC are also shown.

Assessment of the Quality Assurance System

The manufacturer of intrinsically safe devices, categories 1 and 2, must have an approved quality management system. This approval is needed to ensure that the manufacturer produces the devices according to the test type sample and that conformity to relevant protection regulations is given. Assessment of the quality assurance system is carried out by a notified body. Assessment can be achieved in two different ways:

1. Assessment of the Quality Assurance System

   The following illustration shows both possibilities:

   - Category 1
     - EC type test examination (module B, annex III)
     - Testing of products (module F, annex V)
     - Manufacturer’s declaration of conformity
     - Certification of the QM system according to directive 94/9/EC by notified body
   - TURCK’s manufacturing sites for explosion protected devices are certified according to ISO 9001 and have a quality system approval.

2. CE Marking of Equipment

   The following illustration shows both possibilities:

   - Quality management system according to ISO 9000ff implemented
   - An “Ex” auditor is involved in the QM system certification assessment procedure
   - Additional audit for product-specific aspects of explosion protection

7 Guidelines for Use of Devices with Intrinsically Safe Circuits

The national regulations and standards are the basis for use of devices with intrinsically safe circuits. These must be strictly observed and followed. The user is obliged to inform himself on all revisions. The following guidelines relate to the ATEX (94/9/EG) directive of the member states of the European Union, especially to the field of explosion protection in areas exposed to hazards by gas.

If the device is classified as an associated apparatus equipped with intrinsically safe and non-intrinsically safe circuits it may not be installed in explosion hazardous areas. It is permitted to connect intrinsically safe devices located in the hazardous area to the intrinsically safe connections of this device. With the TURCK devices, series multisafe®, multimodul and multicart®, these connections are marked in blue. When interconnecting devices within such an assembly it is mandatory to provide a proof of intrinsic safety (EN 60079-14). It is required to verify that all data related association to explosion protection of the devices allow mutual operation. Verification must include the internal capacitances and inductances of the cables used. Please refer to section 8.1 on page A-19 for further information.

Intrinsically safe circuits should never be interconnected with non-safe circuits. Even if only interconnected once, it is possible that essential protective elements are damaged without the user being aware of this fact. A simple function test is not suited to verify a damage of this kind. Once intrinsically safe circuits have been connected to the non-intrinsically safe circuit, it is not permitted to use the device subsequently as intrinsically safe equipment.

The governing regulations cover installation of intrinsically safe circuits, mounting to external connections, cable characteristics and cable installation. Cables and terminals with intrinsically safe circuits must be marked and separated from non-intrinsically safe circuits or feature appropriate isolation (> 1.500 VAC). Following an excerpt from the requirements according to EN 60079-14:

- protection against external electrical or magnetic fields (e.g. power current cables)
- prevent conductor splicing of fine wires through wire sleeves
- min. cross section of 0.1 mm (also single wires of a conductor)
- protection against damaging (mechanical, chemical, thermic...)
- armouring, metal cladding, shielding of cables and lines
- common use of single-core non-sheathed cables of intrinsically and non-safe circuits in one line is not permitted
- separate error assessment when using multi-conductor cables and lines
- when marking cables by colour, light-blue must be used.

It is required to observe the specified clearances between the intrinsically safe connections of this device and the earthed components and connections of other devices. If intrinsically safe TURCK devices, style multimodul or multisafe® are used, these may be mounted directly next to each other. The required safety distance of 6 mm between intrinsically safe connections is ensured by the terminal design. It is further required to observe a safety distance of 3 mm (EN50020, chapter 6.3, table 4) to earthed components, such as covers or side panels of mounting cabinets. A thread measure of 50 mm must be observed between intrinsically safe connections and non-safe connections.
Due to the open construction and the special wiring of Eurocard style devices, the following regulations must be followed when installing multicart\textsuperscript{\textregistered} switching amplifiers:

- According to IEC publication 60529, multicart\textsuperscript{\textregistered} style devices require a protection of at least IP20. Generally, this is achieved by installing special partition barriers or special enclosures in the mounting rack.

- Connections for intrinsically safe and non-intrinsically safe circuits must either be separated by a physical barrier so that they are at least 50 mm (thread measure) apart from each other, or each connection must be provided with cable sleeves which cannot slip off and ensure covering of all bare parts. These safety measures are not necessary if crimp snap-in type edge connectors are used.

- All edge connectors on the multicart\textsuperscript{\textregistered} devices must be coded by a pin/plug coding to avoid insertion of the wrong module. The coding is prepared by the manufacturer by means of coding pins and holes on the contact strips according to a coding plan.

- Within the mounting rack, the safety distances must also be observed.

A thread measure is defined as the distance between circuits separated by an partition barrier. The reason for this regulation is that it possible to work with live intrinsically safe circuits; thus it must be avoided that these come into contact incidentally with any non-safe connection components.

This distance is only required for external connections which can be accessed by the user. The minimum distance between two intrinsically safe circuits must be 6 mm and separation from other (earthed) metal parts must be 3 mm.

The approval expires, if the device is repaired, altered or opened by a person other than the manufacturer or an expert unless the device-specific instruction manual explicitly permits such interventions. Only an expert disposes of the information on protection measures needed to assure that the device is still in accordance with the applicable regulations after such an intervention. Visible damages of the device’s housing (e.g. black or brown discolouration due to heat accumulation, perforation or deformation) indicate a serious error and the device must be turned off immediately. It is required to check the connected equipment too.

Intrinsically safe circuits with galvanic isolation - as is the case with TURCK devices - should not be earthed, unless not absolutely necessary from a functional point of view.

Circuits without galvanic isolation, e.g. Zener barriers, always require earthing. EN 60079-14 includes the relevant earthing regulations. Within zone 0 earthing of a circuit is not necessary. If earthing is necessary for functional reasons, then it must be carried out in close vicinity of zone 0.

Prior to every initial set-up or after any change of the device interconnection within the assembly, it must be ensured that all applicable regulations, directives and framework directives are met, that all safety regulations are fulfilled and that the device is functioning properly. Only then operation is permitted.

Mounting and connection of the device should only be carried out by qualified and trained staff familiar with the relevant national and international regulations of explosion protection to ensure correct operation.

The system operator must ensure that the system is always in the required safe condition. The system must be inspected continuously and necessary maintenance work must be carried out immediately while observing the safety regulations. The system must be tested in case of need, latest every three years.

Accidents

The operator must report any explosion which could have been caused by the electrical equipment to the supervisory body. The supervisory body is entitled to order an investigation by an expert.
Introduction

Explosion Protection

Safety Barriers

Safety barriers are considered protection devices and their function is to avoid possible errors and faults by preventing the transfer of unsafe levels of energy to the hazardous area. Possible faults are:

- excessive voltage in the hazardous area
- high current levels in the hazardous area (short-circuit)

Because barriers have no galvanic isolation, they require connection to the equipotential connection (PA) leading into the hazardous area to prevent potential variances between conducting constructional parts and the intrinsically safe circuit.

The following parameters must be observed when using safety barriers:

- Zener voltage $U_Z$
- short-circuit current $I_k$
- maximum current $I_m$

In cause of fault, these maximum energy values could reach the hazardous area.

The safety parameters of the barrier are:

- the supply voltage of the barrier should always be lower than the maximum input voltage indicated on the barrier, otherwise any leakage currents occurring during normal operation could flow through the Zener diodes
- total series resistance $R$ of the barrier
- maximum voltage $U_m$ on the hazardous side
- maximum allowable external inductances $L_a$ and capacitances $C_a$

Section 12.2.4 of EN 60079-14 generally requires intrinsically safe circuits to be earth-free, but for safety and functional reasons earthing is permitted. Due to an earth fault between two different potentials of remote system components, compensation currents may flow in the intrinsically safe circuit. These currents can counteract intrinsic safety, e.g. by causing excessive heat within a cable which originally was rated correctly for the intrinsically safe circuit.

The safest method is an isolated (earth-free) design of intrinsically safe circuits. As a rule, earthing is usually not necessary for functional reasons. Earthing of an intrinsically safe apparatus at one point is permitted and in many cases needed to prevent disturbances. Metal housings of intrinsically safe equipment do not require earthing. Further details on Zener barriers are included in the data sheets available from the respective manufacturers.
8 Proof of Intrinsic Safety

According to EN 60079-14 a proof of intrinsic safety must be provided to confirm that equipment interconnected within an assembly accords to the requirement of intrinsic safety. In this context there is a clear distinction between two basically different circuits:

1. simple intrinsically safe circuit with a single associated apparatus and at least one intrinsically safe apparatus without additional supply
2. more than one associated apparatus which is capable of supplying electrical energy to the intrinsically safe circuit not only during normal operation but also in a fault condition.

8.1 Simple Circuits

The first definition of a simple intrinsically safe circuit requires to observe all electrical limit values stated in the EC type examination certificate and the power characteristics. If these conditions are met, the user is entitled to keep a proof of intrinsic safety. Inductances and capacitances of the installed cables must be taken into account.

Intrinsic safety of a simple circuit is given, if the limit values are maintained according to the following conditions:

\[ U_0 \leq U_i \]
\[ I_0 \leq I_i \]
\[ P_0 \leq P_i \]
\[ L_0 \geq L_i + L_C \]
\[ C_0 \geq C_i + C_C \]

The cable characteristics provided by the manufacturer should be used. Should these not be available, it is recommended to use the following typical values (BASEEFA newsletter no. 3, October 1980):

\[ L_C = 1 \text{ mH/km} \quad \text{and} \quad C_C = 110 \text{ nF/km} \]

The connection of proximity switches to isolating switching amplifiers, or 2-wire transmitters to isolating transducers, or solenoid valves to a valve control module can be considered as simple circuits.

Example of a "Proof of intrinsic safety"