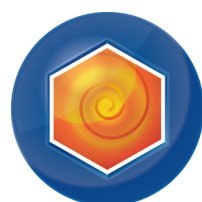




ATEX GUIDE

Basic concepts for protection
in explosive atmospheres



TechnoKontrol™
WHERE YOUR SAFETY IS OUR PRIORITY

Guide to the ATEX directives

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REFINERIES



INTERNAL COMBUSTION SYSTEMS



PETROL-CHEMICAL REFINERY PLANTS



INDUSTRIAL POWER PLANTS



LOGISTICAL MARITIME-BUNKERING FACILITIES



FUELTANKS STORAGE



JUMBO TANK LOGISTICAL STORAGE FACILITIES



SHIP BUILDING



GASIFICATION PLANTS



UPSTREAM-MARITIME OFF SHORE PLATFORMS

> 1. INTRODUCTION

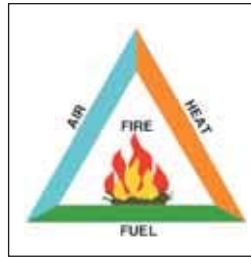
What is ATEX?

“ATEX” is the acronym for “ATmosphere EXplosive”, i.e., explosive atmosphere.

An explosive atmosphere is a mixture of flammable gases, vapours, mists or dusts with air, under specific atmospheric conditions in which, after ignition has occurred, combustion propagates to the flammable mixture.

In order for a potentially explosive atmosphere to form, the flammable substances must be present in a certain concentration. If the concentration is too low (lean mixture) or too high (rich mixture), no explosion occurs; instead there is just a slow combustion reaction or no reaction at all.

Thus the explosion can occur only in the presence of an ignition source and when the concentration is within the explosive range of the substances, i.e., between the lower explosive limit (LEL) and upper explosive limit (UEL). The explosive limits depend on the ambient pressure and the percentage of oxygen in the air.



an explosive atmosphere and specifies the basic criteria by which the equipment is selected within these zones. The ATEX Directive 94/9/EC was implemented in Italy with Legislative Decree 126/98 and applies to products placed on the market and/or in service after 1 July 2003. The ATEX Directive 99/92/EC was implemented in Italy with Legislative Decree 233/03 and came into effect on 10 September 2003. The subsequent Legislative Decree 81/08 of 9 April 2008 (particularly Title XI- Protection from explosive atmospheres) and its update (Lgs.D. 106/2009 of 3/08/09, in effect as of 20 August) have since surpassed Lgs.D. 233/03. The figure below provides a schematic overview of the ATEX Directives and their correlation.

ATEX DIRECTIVES

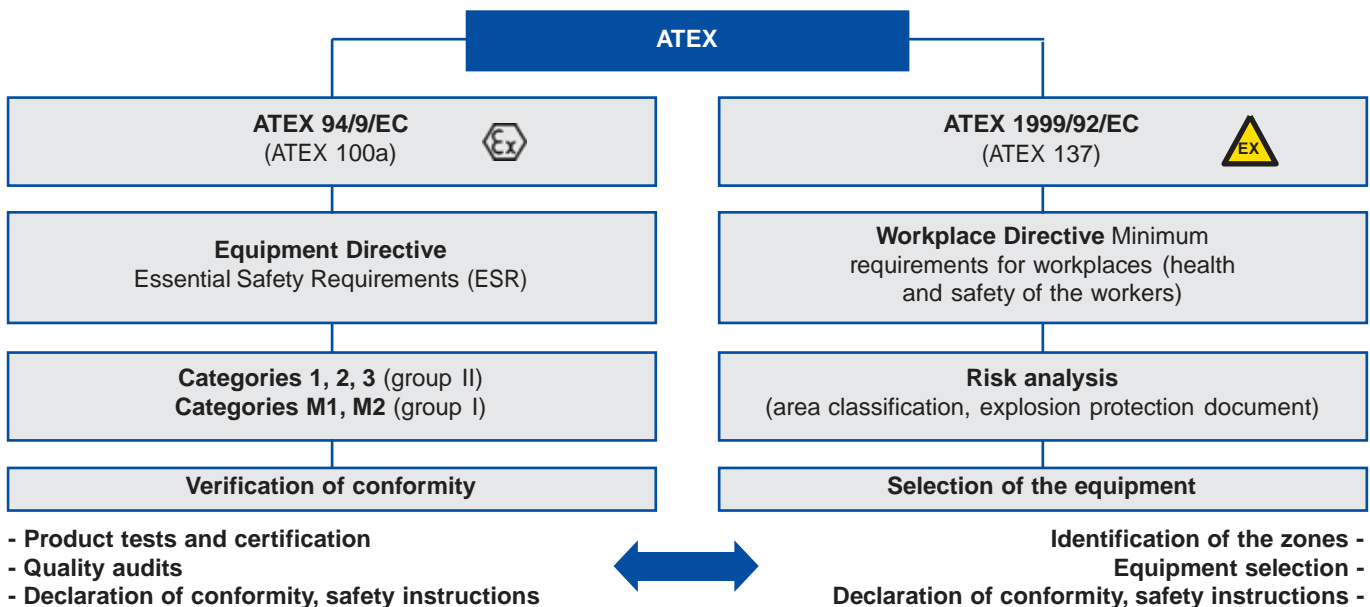
The European Union, regarding the hazard caused a potentially explosive atmosphere, has adopted two harmonized directives on health and safety, known as ATEX 94/9/EC (also ATEX 100a) and ATEX 99/92/EC (also ATEX 137).

The ATEX Directive 94/9/EC sets out the Essential Safety Requirements for products and protective systems intended for use in potentially explosive atmospheres and the respective conformity assessment procedures. The ATEX Directive 99/92/EC, on the other hand, defines minimum health and safety requirements for workplaces with a potentially explosive atmosphere; in particular, it divides the workplaces into zones according to the probability of having

SCOPE OF THE ATEX GUIDE

This document is a simple guide to the ATEX Directives, their meaning and how to select the best products suited for explosion hazard areas.

The scope of the TECHNOKONTROL guide is to support, and not replace, the ATEX Directives by trying to provide valid information about the primary types of installations on which the ATEX Directives have an impact and inform the installer about the criteria for recognizing, selecting and correctly installing the TECHNOKONTROL products and solutions whose characteristics best suit the environment in question.



Guide to the ATEX directives

> 2. ATEX DIRECTIVE 94/9/EC: EQUIPMENT

The ATEX Directive has been effective throughout the European Union since 1 July 2003, replacing the various existing national and European legislations regarding explosive atmospheres; after that date it has been possible to market only those products conforming to the directive and supplied with the ATEX CE marking and EC declaration of conformity. It applies to all the electrical and mechanical equipment intended for use in explosion hazard areas, ranking among the directives that allow free trade of the goods and define the essential safety requirements (ESR) of the equipment which it covers. In particular, the directive defines the product categories and the characteristics the products must satisfy in order to be installed in explosion hazard areas.

It also describes the procedures that must be followed in order to obtain conformity.

The Directive's field of application also extends to safety, control and regulation devices that are installed outside the potentially explosive area, but on which the safety of the products installed in the explosive atmosphere depend.

PRODUCT CLASSIFICATION

The directive includes mining and surface installation materials since the hazard, protective measures and test methods are similar for both materials. The primary distinction is made with the division of the materials into two groups.

- **group I:** products to be used in gassy mines;
- **group II:** equipment intended for use on the surface. Directive 94/9/EC classifies the products in categories, in relation to the level of protection and based on the degree of riskiness of the environment where they will be installed.

GROUP I PRODUCTS

The mining products are divided into 2 categories:

category M1: equipment or protective systems that guarantee a very high level of protection;

category M2: equipment or protective systems that guarantee a high level of protection; they must be able to be disconnected in the presence of the gas.

GROUP II PRODUCTS

The surface equipment (group II) is divided into 3 categories, based on the level of protection (zone of use); the categories are identified by the number 1, 2, 3 followed by the letter G (Gas) or D (Dust).

- **category 1:** equipment or protective systems that guarantee a very high level of protection;
- **category 2:** equipment or protective systems that guarantee a high level of protection;
- **category 3:** equipment or protective systems that guarantee a normal level of protection.

CONFORMITY PROCEDURES

For marking purposes, there are various conformity procedures depending on the product and the category to which it belongs.

All **category 1 and category 2 electrical equipment** must mandatorily be **certified by ATEX Notified Bodies**, i.e., those bodies to which the national authority has assigned the task of verifying conformity with the Directive (in Italy, for example: IMQ, CESI, ICEPI, TUV, etc.).

The updated list of ATEX Notified Bodies (NB) is available on the site:

<http://ec.europa.eu/enterprise/newapproach/nando/>

For companies that manufacture category 1 and category 2 electrical equipment, the notification and monitoring of the quality system through an ATEX NB is also mandatory; the identification number of the body is reported on the plate along with the CE marking.

Self-certification is provided for all category 3 equipment with internal manufacturing control; in TECHNOKONTROL's case, the manufacturing control is fulfilled by the ISO 9001: 2008 company quality certification, issued by CSQ. The manufacturer must prepare the technical documentation that demonstrates the equipment's conformity with the requirements of the Directive; the documentation must remain available for at least 10 years after the last introduction on the market.

All products (category 1, 2 and 3) must mandatorily be accompanied by the written EC declaration of conformity and the instructions for use.

The table below specifies the type of certification required based on the category of the products.

Product category	Product certification by NB	Company certification by NB	Self-certification	Declaration of conformity and instructions for use
M1	YES	YES	NO	YES
M2	YES	YES	NO	YES
1G	YES	YES	NO	YES
1D	YES	YES	NO	YES
2G	YES	YES	NO	YES
2D	YES	YES	NO	YES
3G	Optional	NO	YES	YES
3D	Optional	NO	YES	YES

MARKING





The products must be equipped with the appropriate identification plate which must have, in addition to the CE marking, the specific marking of explosive protection (**Epsilon-x**, in the hexagon) followed by the **group** (I or II) and **category**; for **group II**, the letter **G** is added for equipment for Gas while equipment for dust is identified by the letter **D** (Dust).

In addition to the data required by the ATEX Directive, the plate must also indicate the type of protection as provided for by the standard and the information useful for correct identification and use of the product.

The table below specifies the main information provided on the product plates with relative explanatory notes and their meaning, with reference to the symbol numbers on the example plate (see page 7).

GENERAL INFORMATION

N°	Marking	Meaning	Variants
1	TECHNOKONTROL	Manufacturer	-
2	Via Costa Erta 15 PARRE (BG) – ITALY	Manufacturer's address	-
3	Code 644.xxx-yyy	Product designation	-
4	2007	Year of manufacture	-
5		Conformity mark	For categories 1 and 2 it must be followed by the number of the notified body (*)
6		Specific marking of explosive protection	-
7	II	Equipment group	I: electrical equipment for mines II: electrical equipment for surface installations
8	2	Product category	1 for category 1 2 for category 2 3 for category 3
9	GD	Type of explosive atmosphere	G: gas D: dust GD: gas and dust

(*) Number (4-digit number) of the notified body responsible for ATEX company monitoring (for example: the number 0051 corresponds to IMQ, the number 0722 corresponds to CESI, etc.).

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GAS (SPECIFIC INFORMATION)

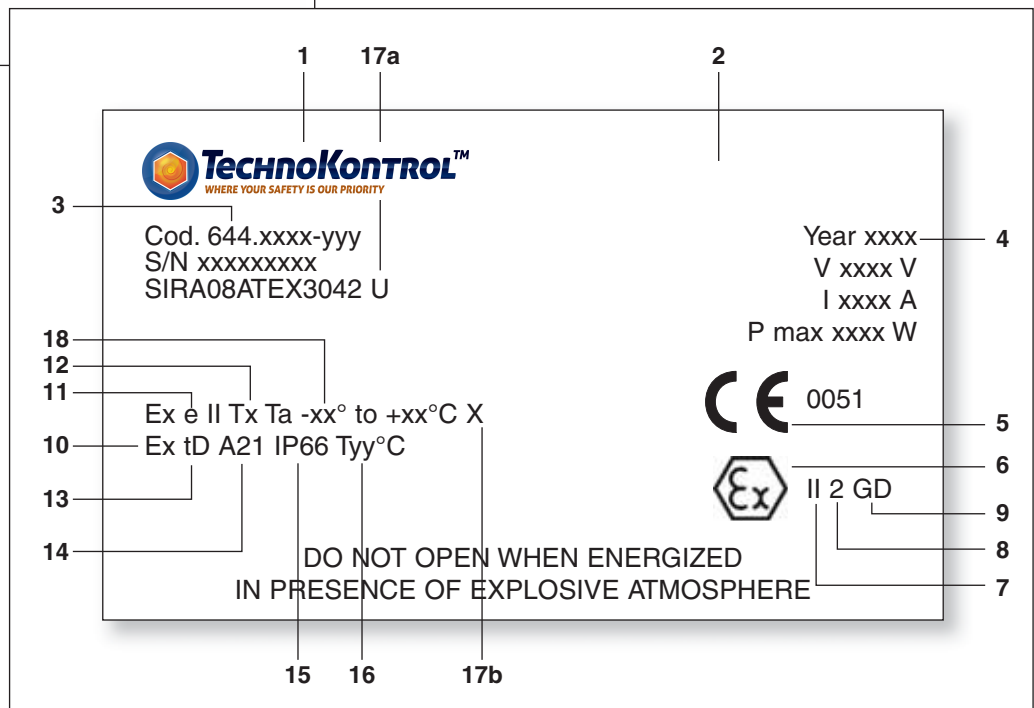
N°	Marking	Meaning	Variants
10	Ex	Conformity with harmonized European standards	-
11	e	Type of protection applied	Types of protection for GAS: - "d": flameproof enclosure - "px" or "py" or "pz": pressurized apparatus, level of protection "px" or "py" or "pz" - "q": powder filling - "o": oil immersion - "e": increased safety - "ia" or "ib" or "ic": intrinsic safety, level of protection "ia" or "ib" or "ic" - "nA": type of protection "nA" - "nC": type of protection "nC" - "nL": type of protection "nL" - "nR": type of protection "nR" - "ma" or "mb": encapsulation, level of protection "ma" or "mb"
12	Tx	Temperature class = maximum temperature that the electrical equipment can reach	Temperature class (Group II): T1 = 450°C T2 = 300°C T3 = 200°C T4 = 130°C T5 = 100°C T6 = 85°C

DUST (SPECIFIC INFORMATION)

13	tD	Type of production applied	Types of protection for DUST: - "tD": protection by enclosure - "pD": type of protection "pD" - "iD": Intrinsic safety protection - "mD": protection with encapsulation
14	A21	Test method (A or B) and installation zone	There are 2 test methods possible in compliance with the standard EN 61242-1: method A or method B, followed by the zone in which the product may be installed
15	IP66	Degree of protection (IP)	IP6X: apparatus suitable for Zone 22 with the presence of conductive dust IP5X: apparatus suitable for Zone 22 with the presence of non-conductive dust
16	Tyy	Maximum surface temperature that the electrical equipment can reach	Tyy°C: maximum surface temperature of the equipment expressed in °C

ADDITIONAL INFORMATION

N°	Marking	Meaning	Variants
17a	U	Indicates the ATEX components	“U”: indicates an EX component
17b	X	Particular additional information	“X”: indicates the presence of special conditions for safe use (to be checked on the certificate or in the instructions for use)
18	Ta -xx°C to +xx°C	Ambient temperature range	If not indicated, the range is: -20°C +40°C

MARKING EXAMPLE


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REFERENCE STANDARDS FOR ELECTRICAL EQUIPMENT

The list below specifies the primary standards applicable for the construction and certification of the equipment, subdivided for gas and dust.

ELECTRICAL EQUIPMENT FOR GAS

IEC Standard	EN Standard	Contents
IEC 60079-0	EN 60079-0	General requirements
IEC 60079-1	EN 60079-1	Construction and testing of flameproof enclosures "d" for electrical equipment
IEC 60079-2	EN 60079-2	Electrical equipment, type of protection "p"
IEC 60079-5	EN 60079-5	Powder filling "q"
IEC 60079-6	EN 60079-6	Oil immersion "o"
IEC 60079-7	EN 60079-7	Increased safety "e"
IEC 60079-11	EN 60079-11	Intrinsic safety "i"
IEC 60079-15	EN 60079-15	Electrical equipment with type of protection "n"
IEC 60079-18	EN 60079-18	Encapsulation "m"

ELECTRICAL EQUIPMENT FOR DUST

IEC Standard	EN Standard	Contents
IEC 61241-0	EN 61241-0	General requirements for equipment for use in atmospheres with the presence of dust. (This will be replaced by the standard IEC 2007/ EN 2009, which will be valid for both gas and dust)
IEC 61241-0	EN 61241-1	Protection by enclosures "tD". (This will be replaced by the standard IEC/EN 60079-31)
IEC 61241-4	EN 61241-4	Protection by pressurization "pD"
IEC 61241-2	EN 61241-11	Protection by intrinsic safety "iD"
IEC 61241-11	EN 61241-18	Protection by encapsulation "mD"

Note: Always check the validity of the current standards on the site: <http://www.ceiweb.it>

> 3. TYPES OF PROTECTION



FLAMEPROOF ENCLOSURE

Marking "Ex d" II 2G,
standard IEC 60079-1, zone 1, 2

Principle

The 'Ex d' type of protection is the only type of protection based on the containment of the explosion.

The electrical components that could ignite an explosive atmosphere are located inside an enclosure which can withstand the pressure of an explosion of the explosive mixture which has formed inside due to the penetration of a flammable gas or vapour (pressure tightness); the enclosure must also prevent the transmission of the explosion to the explosive atmosphere surrounding the enclosure (flameproof).

Applications

Various electrical equipment which, during normal operation, give rise to sparks or high temperatures: switches, disconnectors, lamps, control and signal units, motors, MV/LV transformers, instrumentation, etc.



PROTECTION BY DUST-PROOF ENCLOSURE

Marking "Ex tD" II 2D,
standard IEC 61241-1, zone 20, 21, 22

Principle

The 'Ex tD' type of protection is based on the protection by an enclosure which is sealed to the penetration of dust and limits the surface temperature. The electrical components that could ignite an explosive atmosphere (high temperatures, sparks, etc.) are located inside enclosures with degree of protection IP6X; in zone 22 with non-conductive dust the degree of protection IP5X is allowed. Furthermore, the outer surface temperature of the equipment is kept below the maximum surface temperature T_s , in relation to the maximum temperature for cloud T_{cl} and layer T_l provided for in the installation site.

Applications

Switches, control units, motors, transformers, lamps, instrumentation and generally all the equipment which, during normal operation, could ignite a cloud or layer of combustible dust (e.g., due to arcs, sparks or hazardous temperatures).



PRESSURIZED APPARATUS

Marking "Ex p" II 2G,
standard IEC 60079-2, zone 1, 2
Marking "Ex pD" II 2D,
standard IEC 61241-4, zone 21,22

Principle

The 'Ex p' type of protection, protection by pressurized apparatus, consists in introducing an ignition shield gas into the enclosure in order to keep it at a pressure above that of the external atmosphere, thus preventing the formation of an explosive atmosphere inside the enclosure itself.

The shield gas may be composed of air or inert gas, such as nitrogen; if the overpressure fails, the control unit causes the alarm or shutdown of the pressurized equipment.

The internal overpressure technique may also be applied, essentially with the same characteristics, to the equipment for dust by applying the specific standard; in this case the marking is 'Ex pD'.

Applications

MV/LV transformers, large electrical machinery (as an alternative to the 'Ex e' protection), automation and instrumentation panels, industrial process control systems (chromatograph gases, analyzers), analysis booths and pressurized rooms.



PROTECTION BY INCREASED SAFETY

Marking "Ex e" II 2G,
standard IEC 60079-7, zone 1, 2 2

Principle

The 'Ex e' protection applies to the electrical equipment which does not produce arcs, sparks or hazardous temperatures under normal operation (non-sparking constructions).

Additional protection measures are applied, in order to provide increased safety with a higher safety coefficient, which must prevent the formation of arcs or sparks or the possibility of temperatures that could ignite the explosive mixture; this objective is based on a general oversizing of both insulating materials and the active electrical parts with respect to electrical constructions of normal industrial production, which are already non-initiating in themselves.

Applications

Plant-engineering materials such as enclosures with terminals, electromagnets and coils, motors and generators, lamps, batteries, electric resistance heaters, current transformers, voltage transformers.

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PROTECTION EX n

Standard IEC 60079-15, zone 2

The “n” type of protection actually represents a group of protection types: containment, segregation and prevention, each capable of

preventing ignition of the explosive atmosphere, during normal operation only.

The protection **Ex n** is only applicable for **zone 2**, category 3 G; in zone 2 the probability of the presence of an explosive atmosphere is very low (= 10 h/year) and thus the level of protection required is lower than that of the components for zone 0 and 1 (category 1 and 2).

The ‘Ex n’ protection includes the protection methods which are “simplified”, but not simple in terms of technical / regulatory requirements, each of which is applied preferably to some types of equipment.

The standard considers both the general requirements (metal and plastic materials, mechanical strength and insulation, distance, earthing, IP) applicable to all the equipment, as well as the specific requirements for the type of protection.

The equipment is divided into “non-sparking” equipment and “sparking” equipment, i.e., equipment which produces arcs, sparks or high surface temperatures under normal operation.

An example of non-sparking equipment would be motors and lamps, which have requirements similar to that provided for by the ‘Ex e’ increased safety protection. The sparking equipment category includes other protection techniques such as the “restricted breathing enclosures”, the “closed-cell devices” and the “hermetically sealed devices”; in summary, we can have:

Ex nA: non-sparking equipment;

Ex nC: sparking equipment;

Ex nR: restricted breathing enclosures.

NON-SPARKING EQUIPMENT

Marking “Ex nA” II 3G

Principle

This principle applies to the “non-sparking” equipment, i.e., equipment which does not produce arcs, sparks or hazardous temperatures under normal operation.

Applications

Motors, fuses, lamps, low-power equipment and instruments, current transformers, plant-engineering materials such as terminal boxes, junction boxes and socket-outlets.

RESTRICTED BREATHING ENCLOSURES

Marking “Ex nR” II 3G

Principle

The restricted breathing technique is designed to reduce the possibility of the ingress of a surrounding explosive atmosphere to a low level, in other words to guarantee that the concentration of flammable gas inside the enclosure does not exceed the lower explosive limit of the gas, for the period of time in which the gas is present in the external atmosphere. The ‘Ex nR’ enclosures are designed and built so as to limit the ingress of gas; the tests are carried out by creating a pressure difference between the interior and exterior of the enclosure and verifying that the leaks are less than the predetermined value over a certain time. The equipment installed inside the ‘Ex nR’ enclosures must also have reduced heat dissipation so that the internal temperature does not exceed the exterior ambient temperature by 10°C or more. The restricted breathing enclosures must be equipped with a test connector that allows the breathing properties to be checked and maintained during normal operation, even after installation and maintenance activities.

Applications

This type of protection applies to “sparking” equipment, i.e., equipment which produces arcs or sparks or hot points during normal operation (switches, contactors, relays, measuring instruments, lamps).



ENCAPSULATION

Marking “Ex m” II 2G, standard IEC 60079-18, zone 0, 1, 2

Marking “Ex mD” II 2D, standard IEC 61241-18, zone 20, 21, 22

Principle

In the ‘Ex m’ type of protection the electrical equipment, or its components, that could ignite an explosive atmosphere by means of sparks or heat are “segregated” (encapsulated) so that the explosive atmosphere cannot be ignited. The encapsulation of components which are particularly subject

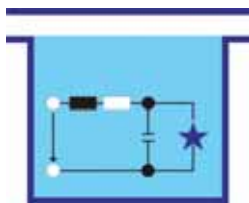
to the environmental factors, particularly the electrical, thermal, mechanical and chemical factors, is achieved by means of resin.

The ‘Ex mb’ equipment is suited for zone 1, while the ‘Ex ma’ protection is also applicable in zone 0.

The ‘Ex mD’ type of protection is based on encapsulation which is sealed to the penetration of dust and limits the surface temperature.

Applications

The ‘Ex m’ protection can be applied to fuses, condensers, windings, transformers, solenoid valves, sensors and electronic devices in general.



INTRINSIC SAFETY

Marking “Ex i” II 2G, standard IEC 60079-11, zone 0, 1, 2

Marking “Ex iD” II 2D, standard IEC 61241-11, zone 20, 21, 22

Principle

The intrinsic safety uses the principle of energy limitation. In a circuit with intrinsic safety there are no sparks or thermal effects, under normal operating conditions and the failure conditions specified by the standards, that are capable of igniting a given explosive mixture, based on the gas group (IIA, IIB and IIC); this is possible if the characteristics of the circuit and its components are such as to limit the energy accumulated and released by the circuit itself.

For intrinsic safety equipment there are 3 levels of protection provided, depending on the constructional characteristics provided for by the standard:

Ex ia: applicable in zone 0;

Ex ib: applicable in zone 1;

Ex ic: applicable in zone 2.

The ‘Ex iD’ type of protection is analogous to the ‘Ex i’ protection provided for explosive atmospheres with gases. The level of energy must be that corresponding to the group IIB. Recall that the ignition energy of gases is less than the ignition energy of dusts.

Applications

The intrinsic safety applies to measurement, control and regulation instrumentation useable in industrial processes, telecommunications systems and portable equipment.

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> 4. ATEX DIRECTIVE 99/92/EC: WORKPLACE

REFERENCE LAWS

- a. ATEX Directive 99/92/EC: Minimum requirements to improve the safety and health of the workers potentially at risk of explosive atmospheres.
- b. Guidelines for the application of the ATEX Directive 99/92/EC.
- c. Lgs.D. 81/2008 of 9 April 2008 – Title XI: Protection from explosive atmosphere.
- d. Lgs.D. 106/2009 of 3 August 2009 – Supplementary and corrective provisions to Lgs.D. 81/2008, on health and safety in the workplace.

In concordance with the requirements of law, the assessment of the explosion risk (classification of the areas, explosion protection document, selection of the installations and respective equipment) must be carried out by personnel with specific expertise in the area.

REFERENCE STANDARDS

The primary reference standards concerning the explosion hazard areas are provided below, subdivided for gas or dust; for installations with the presence of both gas and dust, the cited standards apply jointly.

AREAS WITH THE PRESENCE OF GAS

Classification

IEC EN 60079-10* (CEI 31-30) Electrical apparatus for explosive gas atmosphere. Part 10: Classification of hazardous areas.

Guide CEI 31-35 Electrical apparatus for explosive gas atmosphere. Guide to the application of the standard IEC EN 60079-10 (CEI 31-30). Classification of areas with explosion hazard due to the presence of flammable gas, vapours or mists.

INSTALLATIONS AND MAINTENANCE

IEC EN 60079-14 (CEI 31-33)** Electrical apparatus for explosive gas atmosphere. Part 14: Electrical installations in areas with explosion hazard due to the presence of gas (other than mines).

IEC EN 60079-17 (CEI 31-34) Electrical apparatus for explosive gas atmosphere. Part 17: Electrical installations inspection and maintenance in areas with risk of explosion due to the presence of gas (other than mines).

AREAS WITH THE PRESENCE OF DUST

Classification

IEC EN 61241-10* (CEI 31-66)** Electrical apparatus for use in the presence of combustible dust. Part 10: Classification

of areas where combustible dusts are or may be present.

Guide CEI 31-56 Electrical apparatus for explosive dust atmosphere. Guide for the “Classification of areas where combustible dusts are or may be present”.

IEC 60079-31 Equipment dust ignition protection by enclosure “t”. This Standard applies to electrical equipment protected by means of enclosures and with surface temperature limitation, intended for use in an explosive dust atmosphere.

INSTALLATIONS AND MAINTENANCE

IEC EN 61241-14** (CEI 31-67)** Electrical apparatus for use in the presence of combustible dust. Part 14: Selection and installation.

IEC EN 61241-17 (CEI 31-67) Electrical apparatus for use in the presence of combustible dust. *Part 17: Electrical installations inspection and maintenance in areas with risk of explosion (other than mines).*

Note: Always check the validity of the current standards on the site: <http://www.ceiweb.it>

Classification of areas

This classification has the purpose of identifying the areas where there is the possibility for a potentially explosive atmosphere to form, so as to enable the proper selection and installation of equipment suited for the environment (hazardous area).

The definition of the different areas, within a location with risk of explosion, represents a significantly complex design problem which requires specific knowledge. On a regulatory level, the areas where the risk of explosion is due to the presence of gas and those where it is due to the presence of dust are handled separately; this is the result of the different behaviour of the gases with respect to the dusts in terms of the explosion risks.

• Zones with the presence of gas

The definition of the areas with risk of explosion due to the presence of gas is made based on the frequency and duration of the presence of explosive atmosphere; the standard identifies three different zones:

- **Zone 0:** a place in which an explosive gas atmosphere is present continuously or for long periods.
- **Zone 1:** a place in which an explosive atmosphere is likely to occur during normal operation.
- **Zone 2:** a place in which an explosive atmosphere is not likely to occur during normal operation, but if it does occur, it will persist for a short period only.

* Will be replaced by the standard IEC/EN 60079-10-1 (gas).

** As of 1.07.2011, will be replaced by the standard IEC/EN 60079-14 (gas and dust).

*** Will be replaced by the standard IEC/EN 60079-10-2 (dust).

****As of 1.07.2011, will be replaced by the standard IEC/EN 60079-14 (gas and dust).

SOME DEFINITIONS

Lower explosive limit (LEL)

Concentration of a flammable gas or vapour above which an atmosphere becomes explosive.

Upper explosive limit (UEL)

Concentration of a flammable gas or vapour above which an atmosphere is no longer explosive.

Emission source (ES)

A point or a part of the installation from which it is possible to have the emission of a gas, liquid or vapour which could create a potentially explosive atmosphere.

DEGREE OF EMISSION

The degree of emission represents the probability that an emission source emits gas, liquid or vapour such as to create a potentially explosive atmosphere.

- **Continuous emission:** continuous emission or emission for long periods.
- **Primary emission:** periodic or occasional emission during normal operation.
- **Secondary emission:** emission which is unlikely during normal operation or which occurs only rarely or for short periods.

The type of zone is strictly related to the degree of emission; in general, a continuous emission generates a zone 0, a primary emission generates a zone 1 and secondary emission generates a zone 2.

The ventilation is the element that can change this correspondence, as poor ventilation or lack of ventilation could aggravate the classification of the zone (e.g., a primary emission could then lead to a zone 0 instead of a zone 1).

VENTILATION

Movement of the air or its replacement with fresh air produced by the wind, a thermal gradient or artificial means (fans or extractor units).

The gases or vapours which can create an explosive atmosphere can be diluted in the air, thereby dropping below the minimum hazard levels; thus efficient ventilation allows to obtain a reduction of the hazardous zone. The ventilation can be distinguished based on its efficiency and availability.

The following degrees of ventilation have been identified:

- **High ventilation (HV):** when the ventilation is able to reduce the concentration of hazardous gas below the

lower explosive limit (LEL) almost immediately.

- **Medium ventilation (MV):** when the ventilation is able to affect the concentration of gas in a stable manner, lowering the concentration below the LEL or where the hazardous atmosphere persists for a short period.
- **Low ventilation (LV):** when the ventilation is unable to affect the concentration of gas in a stable manner and is incapable of persistently limiting a hazardous atmosphere. In addition to the degree of ventilation, the efficiency of a ventilation system also depends on its availability; the presence of high ventilation (HV) may be thwarted by its scarce availability (e.g., a faulty fan).

With regard to the availability, we have the following definitions:

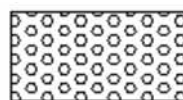
- **Good ventilation:** when the ventilation is present continuously.
- **Adequate ventilation:** when the ventilation is present during normal operation; infrequent interruptions for short periods are allowed.
- **Poor ventilation:** when the ventilation is not able to meet the requirements in order to be considered good or adequate; in any case no long-lasting interruptions are expected.

GAS CLASSIFICATION CRITERIA

The classification of the areas with risk of explosion is a rather complex procedure, but it is essentially based on the identification of the following elements:

- **Number and position of the emission sources (ES)**
- **Type of emission sources:** degree, emission flow rate.
- **Degree of ventilation:** high (HV), medium (MV), low (LV).
- **Availability of ventilation:** good, adequate or poor.

The elements cited above lead, by means of calculations and other assessments, to the definition of the hazardous zones and relative extensions; generally the hazardous zones are represented on the installation designs using the graphic symbols shown below.



Zone 0



Zone 1



Zone 2

Although there is no fixed rule regarding the presence (duration and probability) of explosive atmosphere in relation to the zones (0, 1, 2), the following table represents a useful reference.

Zone	Probability of explosive atmosphere	Overall duration of explosive atmosphere
Zone 0	$P > 10^{-1}$	> 1000 h / year
Zone 1	$10^{-1} > P > 10^{-3}$	from 10 to 1000 h / year
Zone 2	$10^{-3} > P > 10^{-5}$	< 10 h / year

N.B.: In order to apply this rule, however, suitable and reliable statistical data must be available.

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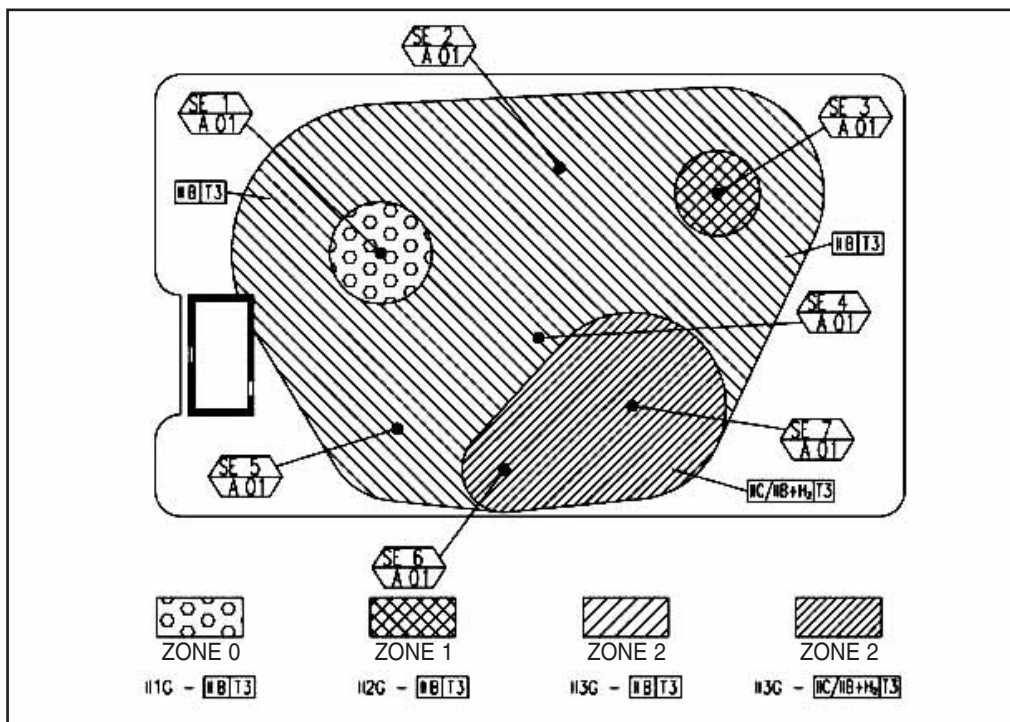
SOME EXAMPLES OF POSSIBLE HAZARDOUS ZONE SITUATIONS FOR GAS AND VAPOURS

Zone	Examples
0	Surfaces of a flammable liquid exposed directly to the atmosphere. Continuous free venting of flammable substance.
1	Opening for filling with a flammable liquid. Single mechanical seal.
2	Connection flange. Pool of flammable liquid which may form infrequently or for short periods.

The points and parts of the installation that may create explosive atmospheres only due to catastrophic failures are not considered to be emission sources:

- the welded piping and containers welded up to standard;

- the containers of flammable substances with tightly closed covers;
- the disabled parts of the installation, in which the flow of flammable substances is prevented by means of valves or similar devices.



Example of a plan with hazardous zones caused by emission sources.

SUITABLE ELECTRICAL EQUIPMENT

The electrical equipment installed in the zones classified for gas must conform to the ATEX Directive 94/9/EC and must

be suitable for the hazardous zones as shown in the table below:

Hazardous zone		Directive 94/9/EC category
Gas and vapours	Zone 0	1G
Gas and vapours	Zone 1	2G or 1G
Gas and vapours	Zone 2	3G or 2G or 1G

ZONES WITH THE PRESENCE OF DUST

The classification of the areas with risk of explosion due to the presence of dust is made in a manner similar to that provided for gas, based on the probability of the presence of an explosive atmosphere.

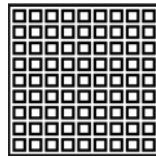
Dust classification

The standard IEC EN 61241-10 defines three zones:

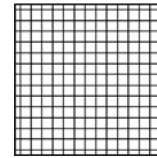
- **Zone 20:** a place in which an explosive atmosphere under the form of combustible dust in the air is present continuously, frequently or for long periods.
- **Zone 21:** a place in which an explosive atmosphere under the form of combustible dust in the air is likely to occur under normal operation occasionally.

- **Zone 22:** a place in which an explosive atmosphere under the form of combustible dust in the air is not likely to occur under normal operation but, if it does occur, it will persist for only a short period of time.

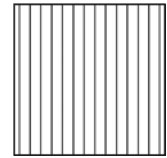
Graphic symbols of the classified zones for dusts:



Zone 20



Zone 21



Zone 22

SOME EXAMPLES OF POSSIBLE HAZARDOUS ZONE SITUATIONS FOR DUSTS

Zone	Examples
20	Filters, cyclones. Dust transport systems, interiors of mixers, mills, dryers, desiccators.
21	Zones outside hoppers. Areas near filling and emptying points.
22	Dust transport systems, interiors of mixers, mills, dryers, desiccators. Areas near equipment that is opened occasionally.

SOME DEFINITIONS

Combustible dusts

Dust capable of burning in air and forming explosive mixtures with air at atmospheric pressure and normal temperatures.

Dust containment

Parts of the process equipment within which the dust is handled, treated, transported or stored, e.g., to prevent the emission of dust into the surrounding atmosphere.

Date emission source

Point or place from which the combustible dust may be emitted into the atmosphere.

Dust classification criteria

The classification for dusts is also a complex procedure that requires the identification of the type, the number and degree of the emission sources. Occasionally, depending on the installation conditions, the introduction of ventilation may allow some areas to be classified as zone 22 which would otherwise be considered as zone 21.

Suitable electrical equipment

The electrical equipment installed in the classified zones must conform to the ATEX Directive 94/9/EC and must be suitable for the hazardous zones as shown in the table below:

Hazardous zone		Directive 94/9/EC category
Dusts	Zone 20	1D
Dusts	Zone 21	2D or 1D
Dusts	Zone 22	3D or 2D or 1D

Guide to the ATEX directives

> 5. EQUIPMENT SELECTION

The equipment must be selected based on the hazardous zone, the substances present, the ignition temperatures and the environmental characteristics of the installation locations.

Hazardous zone

The selection must be made considering the equipment category (ATEX 94/9/EC) which must be SUITABLE for the type of zone (ATEX 99/92/EC).

Hazardous zone		Directive 94/9/EC category
Gas and vapours	Zone 0	1G
Gas and vapours	Zone 1	2G or 1G
Gas and vapours	Zone 2	3G or 2G or 1G
Dusts	Zone 20	1D
Dusts	Zone 21	2D or 1D
Dusts	Zone 22	3D or 2D or 1D

SUBSTANCES

The various substances have different explosive behaviours. The group II electrical equipment, for gas and vapours, is divided into subgroups **IIA, IIB and IIC** in relation to the substance, where the **group IIC** is the **most restrictive** and the **group IIA** is the **least restrictive**. Based on the substance, it is possible to identify the group to which the equipment must belong (see Annex GA of the guide CEI 31-35, or the publication IEC/EN 60079-20-1).

The electrical equipment certified for a certain gas group can

also be used, for safety, in the locations where equipment of a less restrictive group is suitable. In other terms:

- an apparatus of the group IIB can be used in places which require an apparatus of the group IIA;
- an apparatus of the group IIC can be used in places which require an apparatus of the groups IIA and IIB.

Occasionally, an apparatus is indicated as suitable for a gas group (IIB for example) and for a certain gas of the subsequent group, hydrogen for example; in this case the apparatus is marked as **IIB + H₂**.

IGNITION TEMPERATURE

The selection of the equipment based on the ignition temperature of the substances is one of the fundamental aspects for guaranteeing the safety of installations against the risk of explosion.

The selection criteria is different depending on whether the equipment is intended for gas or dust.

Equipment for gas

The surface temperature of the electrical equipment must not exceed the ignition temperature of the hazardous substances present; for group II electrical equipment the maximum surface temperatures are divided into temperature classes from T1 to T6 according to the limits indicated in the table below.

Temperature class	Maximum surface temperature of the equipment	Ignition temperature of the flammable substance
T1	450°C	>450°C
T2	300°C	>300°C
T3	200°C	>200°C
T4	135°C	>135°C
T5	100°C	>100°C
T6	85°C	>85°C

The equipment certified for a certain temperature class can also be used, for safety, in the locations where a class with higher maximum surface temperature is allowed.

For example:

- a T3 apparatus can be used in places which require T1 and T2;
- a T6 apparatus can be used in all the hazardous areas.

THE TABLE BELOW PROVIDES THE CLASSIFICATION (GROUP AND TEMPERATURE CLASS) OF SOME SUBSTANCES COMMONLY FOUND IN INDUSTRIAL INSTALLATIONS:

Gas/Vapour	Group	Temperature class
Acetic Acid	IIA	T1
Acetone	IIA	T1
Acetylene	IIC	T2
Ammonia	IIA	T1
Butane	IIA	T2
Cyclohexane	IIA	T3
Ethanol (ethyl alcohol)	IIA	T2
Ethylene	IIB	T2
Hydrogen	IIC	T1
Kerosene	IIA	T3
Methane (natural gas)	IIA	T1
Methanol (methyl alcohol)	IIA	T2
Methyl Ethyl Ketone (MEK)	IIB	T2
Propane	IIA	T1
Propanol (isopropyl alcohol)	IIA	T2
Tetrahydrofuran (THF)	IIB	T3
Toluene	IIA	T1
Xylene	IIA	T1

EQUIPMENT FOR DUST

In order to prevent the electrical equipment from igniting a **dust cloud** with ignition temperature T_{cl} it is sufficient, in theory, that the maximum surface temperature (T) of the equipment does not exceed T_{cl} ; in practice, the standard introduces a safety coefficient and assumes a maximum temperature $T_{max\ cl} = (2/3) T_{cl}$

Thus the equipment must have a maximum surface temperature (T) = $T_{max\ cl} = (2/3) T_{cl}$

If **dust layers** may form in the area in question, it is necessary to prevent the electrical equipment from igniting the dust layer; for this purpose, the surface temperature of the equipment must be limited in relation to the thickness of the dust layer (generally indicated in the classification of the

areas).

For each type of dust, the minimum ignition temperature is defined for a layer with a thickness of 5 mm T_{5mm} .

The maximum temperature ($T_{max\ l}$) to prevent the ignition of the dust layers must be 75 K (safety margin) less than the minimum ignition temperature of the 5mm-thick layer.

Thus: $T_{max\ l} = T_{5mm} - 75$

The maximum surface temperature (T) of the equipment must not exceed the lower value of the two temperatures $T_{max\ cl} = (2/3) T_{cl}$ and $T_{max\ l} = T_{5mm} - 75$

Guide to the ATEX directives

An example of determining the maximum permissible surface temperature of an electrical apparatus in the presence of flour:

T_{cl} = minimum ignition temperature in cloud = 380°C

$T_{max\ cl} = (2/3) T_{cl} = 253°C$

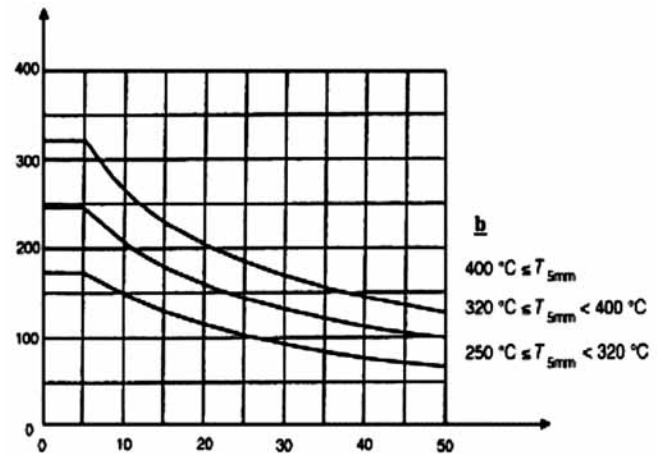
T_{5mm} = minimum ignition temperature in layer = 300°C

$T_{max\ l} = T_{5mm} - 75 = 225°C$

- Minimum value between $T_{max\ cl}$ (253°C) and $T_{max\ l}$ (225°C) = 225°C
- Maximum surface temperature of the apparatus = 225°C

The determination is more complicated if the thickness of the layer exceeds 5 mm (up to 50 mm); in this case the $T_{max\ l}$ is obtained from the curves shown in the figure.

If the layer is thicker than 50 mm, a specialized laboratory must determine the value of $T_{max\ l}$.



THE TABLE BELOW PROVIDES THE IGNITION TEMPERATURE DATA (CLOUD AND LAYER) FOR SOME FLAMMABLE DUSTS

Dust	Typical ignition temperature (°C)	
	Cloud	Layer
Aluminium	560	450
Ground Coal	420	230
Cellulose	520	410
Flour	380	320
Synthetic Rubber	450	220
Wood	410	220
Methyl Cellulose	420	320
Phenolic Resin	530	>450
Polyethylene	420	melts
PVC	700	>450
Toner	530	melts
Starch	460	435
Sugar	490	460

AMBIENT TEMPERATURE

The ambient temperature range for use of the ATEX equipment, for both gas and dust, is usually between -20°C and +40°C, unless specified otherwise.

For values different from the range -20°C / +40°C, the indication

must be specified directly on the plate or by reporting the symbol **X** on the plate and providing the temperature range in the instructions for use.

The following conditions are provided for:

Equipment plate	Conditions to be observed
No indication	-20°C ≤ T ambient ≤ + 40°C
Temperature range or X and temperature range specified in the instructions for use	minimum T ambient MINIMUM Ta declared
	maximum T ambient ≤ MAXIMUM Ta declared

> 6. EVOLUTION OF DUST STANDARDS

EQUIPMENT PROTECTION LEVEL EPL

The ATEX Directive 94/9/CE defines the categories 1,2,3 (group II) based on the level of protection. The standard EN/IEC 60079-0 (Ed.5) introduces the concept of EPL (Equipment protection level).

ATEX CATEGORIES AND EPL

Explosive atmosphere	Zone	ATEX Category	EPL
GAS	0	1G	Ga
	1	1G or 2G	Ga or Gb
	2	1G or 2G or 3G	Ga or Gb or Gc
Dusts	20	1D	Da
	21	1D or 2D	Da or Db
	22	1D or 2D or 3D	Da or Db or Dc

Table 1

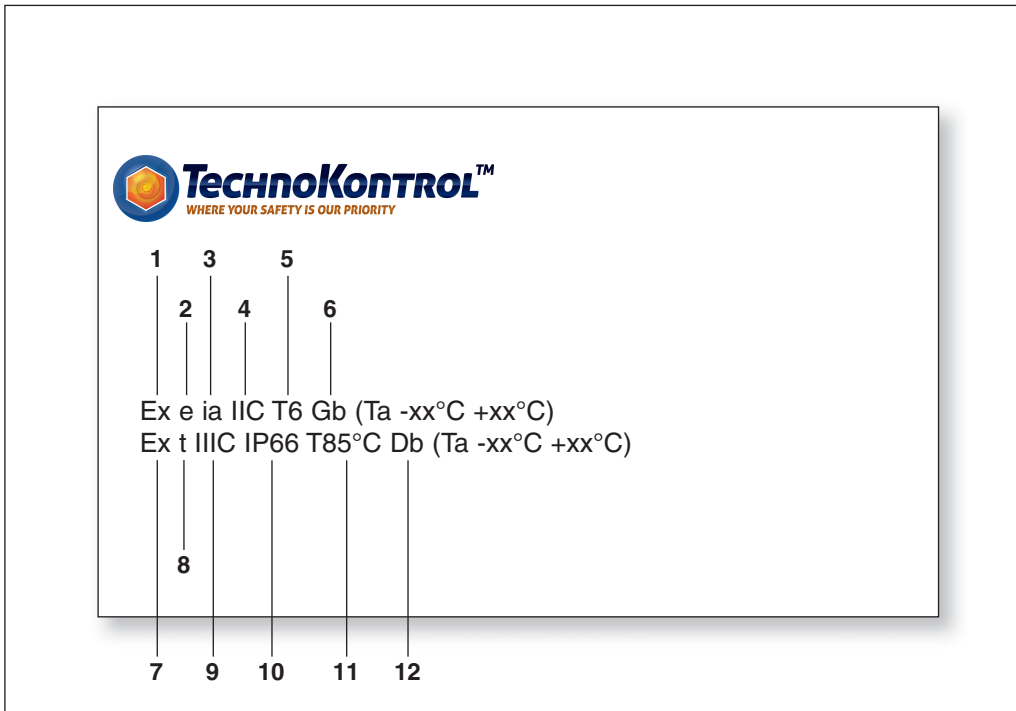
EVOLUTION OF DUST

The standard EN/IEC 60079-0 (Ed.5) introduces group III regarding equipment for dusts. The dusts are divided into 3 subgroups: (IIIA, IIIB, IIIC).

Group	Hazardous substances
IIIA	Combustible volatile substances (fibres)
IIIB	Non-conductive dusts
IIIC	Conductive dusts

Guide to the ATEX directives

EXAMPLE OF NEW MARKING ACCORDING TO THE STANDARD EN/IEC 60079-0 (ED.5)



GAS PROTECTION

- 1 - Ex:** Conforms to the Harmonized European standards
- 2 - e:** Type of protection applied (increased safety)
- 3 - ia:** Intrinsic safety
- 4 - IIC:** Gas Group
- 5 - T6:** T6 = 85°C – temperature class
- 6 - Gb:** Zone 1 Gas (see Table 1)

DUST PROTECTION

- 7 - Ex:** Conforms to the Harmonized European standards
- 8 - t:** Protection by enclosure
- 9 - IIIC:** Conductive dusts
- 10 - IP66:** Degree of protection
- 11 - T85°C:** Maximum permissible surface temperature of the electrical apparatus
- 12 - Db:** Zone 21 Dusts (see Table 1)

> 7. APPLICATION EXAMPLES

The list below provides some examples of general and particular situations associated with the possibility of forming an explosive atmosphere (hazardous zones) and relative characteristics of the installations.

- **CHEMICAL / PETROCHEMICAL / PHARMACEUTICAL INDUSTRIES**
- **GAS HEATING PLANTS**
- **GARAGES**

- **CAR REPAIR SHOPS**
- **FUEL FILLING STATIONS**
- **PAINT BOOTHS (LIQUID)**
- **PAINT BOOTHS (POWDERS)**
- **WOODWORKING AND FURNITURE INDUSTRIES**
- **GRAIN STORES**
- **BAKERIES AND PASTRY SHOPS**

> CHEMICAL / PETROCHEMICAL / PHARMACEUTICAL INDUSTRIES



> GENERAL INFORMATION

The chemical, petrochemical and pharmaceutical industries constitute the majority of installations with potentially explosive atmospheres due to the presence of flammable liquids, gas/vapours and/or dusts.

> HAZARDOUS SUBSTANCES

Considering the substantial variability of the substances which may be present, a specific assessment of the substances and their characteristics is required in order to determine the explosion risk. If there is no data on the substances available in the literature (standards, guides, safety data sheets, etc.), laboratory tests must be carried out in order to characterize the substances.

> PRIMARY REFERENCE LAWS AND STANDARDS

The primary reference laws and standards are cited in the previous paragraphs.

> CHARACTERISTICS OF THE INSTALLATIONS

The type of zone, its shape and dimensions are determined by applying the cited standards and depend essentially on certain variables such as: ventilation, substance, type and degree of the emission source, containment system, etc.

The electrical equipment must conform to the ATEX Directive 94/9/EC and must be suitable for the hazardous zones as summarized in the table below:

Hazardous zone		Directive 94/9/EC category
Gas and vapours	Zone 0	1G
Gas and vapours	Zone 1	2G or 1G
Gas and vapours	Zone 2	3G or 2G or 1G
Dusts	Zone 20	1D
Dusts	Zone 21	2D or 1D
Dusts	Zone 22	3D or 2D or 1D

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> GAS HEATING PLANTS



> GENERAL INFORMATION

This example considers the rooms or group of rooms, if directly communicating with one another, in which a heating plant with a power greater than 35 kW (30000 kcal/h) is installed. The risk of explosion is related to the presence of the gas used for combustion which could leak from the installation.

> INSTALLATION CHARACTERISTICS

For a proper electrical installation, two distinct cases must be considered:

1. Equipment which use devices that are compliant with DPR 661/96.
2. Equipment which use devices that are non-compliant with DPR 661/96.

In the first case, the heating plant uses gas equipment which has the CE marking according to Directive 90/396/EC (DPR 661/96).

Art. 1 of the DPR identifies the equipment that falls within the scope of application; this equipment includes all the devices using gaseous fuel and, if applicable, water with normal temperature less than 105°C, used for: Cooking – Heating, production of hot water - Cooling - Lighting.

DPR 661/96 and the regulations consider these devices to be intrinsically safe, not entailing any risk of leaks and thus explosion; these areas are to be considered as “ordinary”. In the second case the plants do not use devices compliant with DPR 661/96; this category includes all the devices which use hot water with water temperature above 105°C or are used in an industrial process.

The fundamental difference with respect to the previous situation is that in this case the risk of explosion induced by the equipment cannot be excluded a priori. The guide CEI 31-35 applies to methane heating plants provided that:

- the relative operating pressure is not above 4000 Pa
- the emission sources would have an emission hole, due to failure, no larger than 0.25 mm²

The guide CEI 31-35 allows to exclude the risk of explosion if the openings have a free area (in m²) of:

- 0.3 m², heating plants with a nominal operating pressure of up to 2000 Pa.
- 0.5 m², heating plants with a nominal operating pressure of up to 4000 Pa.

These openings will have to be located in the highest part of the outer walls of the building.

> HAZARDOUS SUBSTANCES

Name	Composition	Flash temperature °C	LEL %	UEL %	Specific gravity	Ignition temperature °C	Group and temperature class
Methane	CH ₄	< 0	4.4	17.0	0.55	537	IAT1
LPG	C _x H _x	< 0	2.0	9.0	>1.50	365	(IIB)T2

Among the gases used, natural gas (methane) is lightweight, with specific gravity < 0.8, while LPG is heavy, with specific gravity of > 1.2.

> GARAGES



> GENERAL INFORMATION

This example considers parking garages intended to house more than nine vehicles. The risk of explosion is related to the possible leakage of the fuel contained in the vehicles. The parking of LPG-powered vehicles, with an installation equipped with safety devices compliant with current legislation, is allowed on the floors above ground and the first underground floor of the garages (DM 21/11/2002).

> INSTALLATION CHARACTERISTICS

In light of that provided for by the guide CEI 31-35, the garages are not to be considered as areas with risk of explosion if the following requirements are met:

- a. The fuels used are: petrol, liquefied petroleum gas (LPG), compressed natural gas (CNG); the fuels must not be heated or atomized.
- b. The regulations of DM 1 February 1986 must be implemented, with particular reference to the efficiency of the ventilation

system (natural and/or artificial).

- c. The motor vehicles are normally parked with the motor switched off and the starter motor disconnected.
- d. No other flammable substances are present, other than the fuel contained in the motor vehicles.
- e. The tanks are not filled or emptied on site.
- f. Access is denied to motor vehicles with visible fuel leaks; if necessary, intervene immediately with suitable means of neutralization.
- g. The motor vehicles are homologated and maintained in good working order (overhauled).

The classification of the areas is necessary only in the case in which one or more of the cited requirements are not met. The equipment installed inside the garage must be protected from mechanical impacts caused by the movement of the motor vehicles themselves; in particular, the socket-outlets must be installed at a height of 1.15 meters above the floor.

> HAZARDOUS SUBSTANCES

Name	Composition	Flash temperature °C	LEL %	UEL %	Specific gravity	Ignition temperature °C	Group and temperature class
Petrol	-	< 0	0.70	5.9	≥ 2.50	280	IIAT3
Methane	CH ₄	< 0	4.4	17.0	0.55	537	IIAT1
LPG	C _x H _x	< 0	2.0	9.0	>1.50	365	(IIB)T2

Guide to the ATEX directives

> CAR REPAIR SHOPS



> GENERAL INFORMATION

This example considers the car repair shops where repair work and maintenance operations are carried out on motor vehicles.

> INSTALLATION CHARACTERISTICS

In light of that provided for by the guide CEI 31-35, the car repair shops are not to be considered as areas with risk of explosion if the following requirements are met:

- The fuels used are: petrol, liquefied petroleum gas (LPG), compressed natural gas (CNG); the fuels must not be heated or atomized.
- The regulations of DM 1 February 1986 must be implemented, with particular reference to the efficiency of the ventilation system (natural and/or artificial).
- The motor vehicles are normally parked with the motor switched off and the starter motor disconnected.
- No other flammable substances are present, other than

the fuel contained in the motor vehicles.

- The tanks are not filled or emptied on site.
- Access is denied to motor vehicles with visible fuel leaks; in necessary, intervene immediately with suitable means of neutralization.
- The motor vehicles are homologated and maintained in good working order (overhauled).
- No work is carried out on the carburetor circuits.
- If there are any work pits in the car repair shop, it must have an artificial ventilation system with air extraction (at least 50 exchanges / hour).

The classification of the areas is necessary only in the case in which one or more of the cited requirements are not met. The equipment installed inside the car repair shops must be protected from mechanical impacts caused by the motor vehicles themselves; in particular, the socket-outlets must be installed at a height of 1.50 meters above the floor.

> HAZARDOUS SUBSTANCES

Name	Composition	Flash temperature °C	LEL %	UEL %	Specific gravity	Ignition temperature °C	Group and temperature class
Petrol	-	< 0	0.70	5.9	≥ 2.50	280	IIAT3
Methane	CH ₄	< 0	4.4	17.0	0.55	537	IIAT1
LPG	CxHx	< 0	2.0	9.0	>1.50	365	(IIB)T2

> FUEL FILLING STATIONS



> GENERAL INFORMATION

This example considers the areas where filling stations are installed for the refuelling of motor vehicles.

> INSTALLATION CHARACTERISTICS

An example of the hazardous zones of a filling station is provided below.

Zone 1

- Volumes inside the filling column.
- Zone for positioning the pump nozzle downwards to the ground and horizontally for 10 cm.
- Venting zone of the installation downwards to the ground and horizontally for 10 cm.
- Volume inside the filling trap of the tank.

Zone 2

- Zone for positioning the pump nozzle outside zone 1, for a horizontal extension of 20 cm.
- Venting zone of the installation outside zone 1, for a horizontal extension of 20 cm.
- Zone above the cover of the tank filling trap for a horizontal extension of 20 cm and vertical extension of 10 cm beyond the perimeter of the trap.
- Vent of the balance pipes of the underground tanks within an area with a radius of 75 cm.

In any case, recall that these environments must be classified in concordance with that defined by the standard EN 60079-10.

> HAZARDOUS SUBSTANCES

Name	Composition	Flash temperature °C	LEL %	UEL %	Specific gravity	Ignition temperature °C	Group and temperature class
Petrol	-	< 0	0.70	5.9	≥ 2.50	280	IIAT3
Methane	CH ₄	< 0	4.4	17.0	0.55	537	IIAT1
LPG	CxHx	< 0	2.0	9.0	>1.50	365	(IIB)T2

Guide to the ATEX directives

> PAINT BOOTHS (LIQUID)



> GENERAL INFORMATION

This example considers the environments in which spray painting is carried out with liquid paints containing flammable solvents capable of forming an explosive atmosphere.

> INSTALLATION CHARACTERISTICS

Paint booths have demanding conditions concerning the exposure to explosive atmospheres.

The standard UNI EN 12215 "Spray booths for application of organic liquid coating materials – Safety requirements" specifies the protective measures to adopt in order to prevent the risks of explosion.

The standard requires that the concentration of flammable substances be kept below the LEL by means of forced ventilation. In particular, 2 situations are provided for:

- Concentration within 25% of the LEL (booths with operator presence).

Zone 2: the volume inside the booth (including the air recirculation ducts) and the volume outside the booth up to 1m from the permanent openings.

- Concentration within 50% of the LEL (booths without operator presence).

The booth must be equipped with an LEL control system that blocks the flow of flammable substances upon reaching 50% of the LEL.

Zone 1: the volume inside the booth (including the air recirculation ducts).

Zone 2: the volume outside the booth up to 1m from the permanent openings.

> HAZARDOUS SUBSTANCES

Name	Composition	Flash temperature °C	LEL %	UEL %	Specific gravity	Ignition temperature °C	Group and temperature class
Acetone	C_3COCH_3	< 0	2.5	13.0	2.0	465	IIAT1
Toluene	$C_6 H_5CH_3$	4	1.1	7.1	3.2	480	IIAT1
Xylene	$C_6 H_4(CH_3)_2$	17	1.1	6.4	3.6	464	IIAT1

> PAINT BOOTHS (POWDERS)



> GENERAL INFORMATION

This example considers the environments in which spray painting is carried out with powder coatings capable of forming an explosive atmosphere.

> INSTALLATION CHARACTERISTICS

The standard UNI EN 12981 “Spray booths for application of organic powder coating materials – Safety requirements” specifies the protective measures to adopt in order to prevent the risks of explosion. The standard requires that the concentration of flammable substances be kept below the 50% of the LEL of the dusts, by means of forced ventilation; if the value of the LEL is unreliable, the average concentration must not exceed 10 g/m³.

In particular, the following classification is provided for:

- **Zone 22:** the volume inside the booth (including the air recirculation ducts and the open powder recovery systems);
- **Zone 22:** the volume outside the booth up to 1m from the permanent openings;
- **Zone 20:** the closed powder recovery systems.

> HAZARDOUS SUBSTANCES

The characteristics of the powders used are quite variable and depend highly on the type of product used. Indicatively, the LEL is between 10÷100 g/m³, while the ignition temperatures vary between 350÷400°C (cloud) and 200÷250°C (layer); it is recommended that you always check the data on the product safety data sheets.

Guide to the ATEX directives

> WOODWORKING AND FURNITURE INDUSTRIES



> GENERAL INFORMATION

This example considers the areas used for woodworking (cutting, milling, planing, etc.) with machines provided with aspiration systems to remove sawdust and wood dusts.

> INSTALLATION CHARACTERISTICS

Shavings, sawdust and wood dusts are produced in the furniture and woodworking industries.

The shavings and sawdust usually remain suspended in the air for brief periods due to their dimensions.

The finer wood dusts remain suspended for a longer time

and are more hazardous; these dusts, however, are removed by the aspiration systems.

The hazard of wood dust is marked by its low ignition temperature in layer form; thus in order to limit this risk, thorough cleaning procedures are recommended to prevent the formation of layers.

In general, the classification includes zone 22 with the extension of a few meters around the machines and the areas where the dusts may deposit; hazardous zones also exist inside the dust recovery systems (filters) and the ducts (zone 20 and/or zone 21).

> HAZARDOUS SUBSTANCES

Substance	Average particle size [μm]	LEL [g/m^3]	Cloud ignition temperature T_{ci} [$^{\circ}\text{C}$]	5mm Layer ignition temperature $T_{5\text{mm}}$ [$^{\circ}\text{C}$]	Conductivity of the dust (C / NC)
Sawdust	63	30	490	310	NC

> GRAIN STORES



> GENERAL INFORMATION

This example considers the silos used to store grains (wheat, corn, rice, soy, flours, etc.) in which loading, unloading and other processing operations take place which could generate an explosive atmosphere.

> INSTALLATION CHARACTERISTICS

The grain dusts, due to their low specific weight, can remain suspended in air for long periods, thus generating explosive atmospheres. In the grain storage areas, by way of example, the following classifications are possible:

- **Zone 20:** volume inside the silos;
- **Zone 21:** loading and unloading zone (loaders and hoppers) and adjacent zones;
- **Zone 22:** volume around the zone 21, with an extension of a few meters; it also includes the areas in which the dusts may deposit in layers and the storehouses of packages which may break.

> HAZARDOUS SUBSTANCES

Substance	Average particle size [µm]	LEL [g/m ³]	Cloud ignition temperature T _{cl} [°C]	5mm Layer ignition temperature T _{5mm} [°C]	Conductivity of the dust (C / NC)
Wheat flour	57	60	430	430	NC
Grain	80	60	370	370	NC
Soy flour	59	125	430	430	NC

Guide to the ATEX directives

> BAKERIES AND PASTRY SHOPS



> GENERAL INFORMATION

This example considers the small production businesses, such as bakeries and pastry shops, where flours are handled for the production of food products; large food industries are excluded from this example.

> INSTALLATION CHARACTERISTICS

The classification varies depending on the type of laboratory, the sizes of the rooms and the ventilation; some examples of hazardous zones are provided below.

- **Zone 20:** volume inside the processing machines;
- **Zone 21:** flour loading and unloading zone;
- **Zone 22:** possible in the unlikely event of flour sack breakage.

> HAZARDOUS SUBSTANCES

Substance	Average particle size [μm]	LEL [g/m^3]	Cloud ignition temperature T_{ci} [$^{\circ}\text{C}$]	5mm Layer ignition temperature $T_{5\text{mm}}$ [$^{\circ}\text{C}$]	Conductivity of the dust (C / NC)
Wheat flour	57	60	430	450	NC
Grain	80	60	370	290	NC
Caster sugar	22	60	380	-	NC

> 8. AMERICAN STANDARDS

In North America the installations in hazardous zones (hazardous locations) are governed by various regulations, such as NFPA, NEC, CEC, NEMA, etc.

The National Electrical Code (NEC) is the plant-engineering standard used in USA for the realization of electrical installations in hazardous zones; the Canadian equivalent is the Canadian Electrical Code (CEC).

The hazardous locations based on the substances present are divided into 3 classes:

- **Class I** – Gas or vapours
- **Class II** – Combustible dusts
- **Class III** – Flammable fibres, shavings

Class I substances (gas and vapours) are subdivided into letters (A, B, C, D); the table below provides the comparison between European/IEC procedure (groups IIA, IIB, IIC) and

North American procedure.

For hazardous areas there are 2 divisions, based on the probability that a potentially explosive atmosphere is present.

- **Division 1:** an explosive atmosphere may be present during normal operation.
- **Division 2:** an explosive atmosphere may be present only in case of failure.

Gas	IEC European Group	North American Group
Propane	IIA	D
Ethylene	IIB	C
Hydrogen	IIC	B
Acetylene		A

DIFFERENCES BETWEEN EUROPEAN AND AMERICAN PRACTICE

The American classification uses the method of Classes and Divisions, unlike the European/IEC procedure that uses the method of Zones.

Generally the European/IEC Zone 2 and the American Division 2 can be considered as equivalent, while the American Division 1 includes both Zone 1 and Zone 0; consequently the equipment expressly designed for use in Zone 1 in Europe cannot always be used in Division 1.

In North America the electrical equipment for hazardous locations must be approved for a specified class (Class I, II or III), for the division (Division 1 or Division 2) and must be suitable for the substances: gas (A, B, C, D), dusts (E, F, G) and for the temperature (Temperature Code).

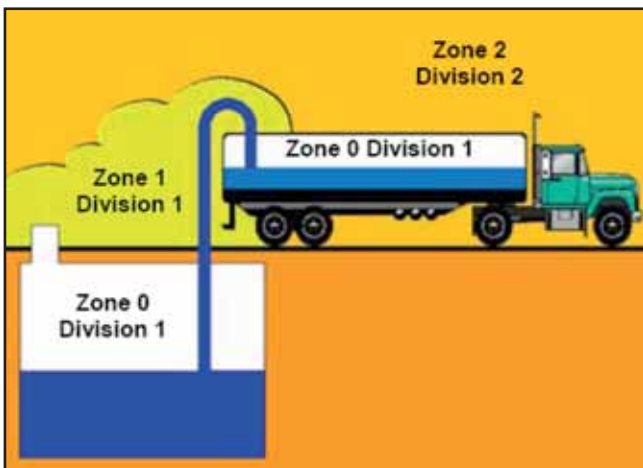
Article 505 of the NEC also provides for the possibility of classification according to the standard IEC 60079-19, i.e.,

with the definition of hazardous zones (0, 1, 2) and the possibility of using products approved according to IEC 60079-x standards for the various protection types (Ex-d, Ex-p, Ex-i, Ex-m, etc.) and equipped with a specific marking. This means that the products can be approved by:

- Either **Class, Division and Substance Group**
For example: Class 1, Division 2, A,B,C,D T3
- Or **Class, Division and Gas Group**
For example: Class 1, Zone 2, IIA, IIB, IIC T3

The table below indicates the differences between the North American classification and the European/IEC classification.

	Continuous hazard	Intermittent hazard	Hazard in abnormal conditions
Europe/IEC	Zone 0	Zone 1	Zone 2
North America	Division 1		Division 2



Although Article 505 also allows the use of products equipped with a marking similar to the European/IEC marking, the presence of different homologations of the equipment for zones or divisions is not always acceptable. For example: The products homologated for Zone 1 do not necessarily meet the requirements for Division 1, which also includes the Zone 0. Even though there is no direct equivalence between the ATEX certifications and the North American certifications, there are many similarities; recently there is growing recognition of the IEC types of protection in North America, in light of the IEC EX certification scheme which is also recognized by North American countries. Underwriters Laboratory (UL), Factory Mutual (FM) and Canadian Standard Association (CSA) are the primary certification bodies in North America.

TECHNOKONTROL ATEX / NFPA ADDITIONAL ANTI-EXPLOSIVE DATA

PLEASE VIEW THESE WEB LINKS FOR FURTHER ADDITIONAL INFORMATION IN ALL "EXPLOSIVE SECTORS" WHICH ARE INCORPORATED IN EU ATEX AND NFPA 68/69 2012. SAFETY DIRECTIVES AND GUIDELINES.

[-http://www.technokontrol.com/en/products/siaps.php](http://www.technokontrol.com/en/products/siaps.php)

[-http://www.technokontrol.com/en/products/tankers.php](http://www.technokontrol.com/en/products/tankers.php)

[-http://www.technokontrol.com/en/products/psaxss.php](http://www.technokontrol.com/en/products/psaxss.php)

[-http://www.technokontrol.com/en/products/valve.php](http://www.technokontrol.com/en/products/valve.php)

[-http://www.technokontrol.com/en/products/valve-es.php](http://www.technokontrol.com/en/products/valve-es.php)

[-http://www.technokontrol.com/en/products/roof.php](http://www.technokontrol.com/en/products/roof.php)

[-http://www.technokontrol.com/en/products/pipelines.php](http://www.technokontrol.com/en/products/pipelines.php)

[-http://www.technokontrol.com/en/products/roof-axspct.php](http://www.technokontrol.com/en/products/roof-axspct.php)

[-http://www.technokontrol.com/en/products/mobile-fuel-tanks.php](http://www.technokontrol.com/en/products/mobile-fuel-tanks.php)

[-http://www.technokontrol.com/en/products/building-fuel-tanks-es.php](http://www.technokontrol.com/en/products/building-fuel-tanks-es.php)

[-http://www.technokontrol.com/en/products/building-fuel-tanks-en.php](http://www.technokontrol.com/en/products/building-fuel-tanks-en.php)

[-http://www.technokontrol.com/en/products/airports.php](http://www.technokontrol.com/en/products/airports.php)

IMAGE: PREPARATION/DEGASIFICATION OF A PETROL STATION FUEL TANK , FUEL TANKERS, STORAGE FACILITIES BEFORE ATEX/NFPA:TK-ANTI-EXPLOSION ALLOYS INSTALLATION.



IMAGE: ATEX/NFPA. SAFETY DIRECTIVES FOR ATMOSPHERIC GAS / PETROL-CHEMICAL RISK-EXPLOSION ZONES

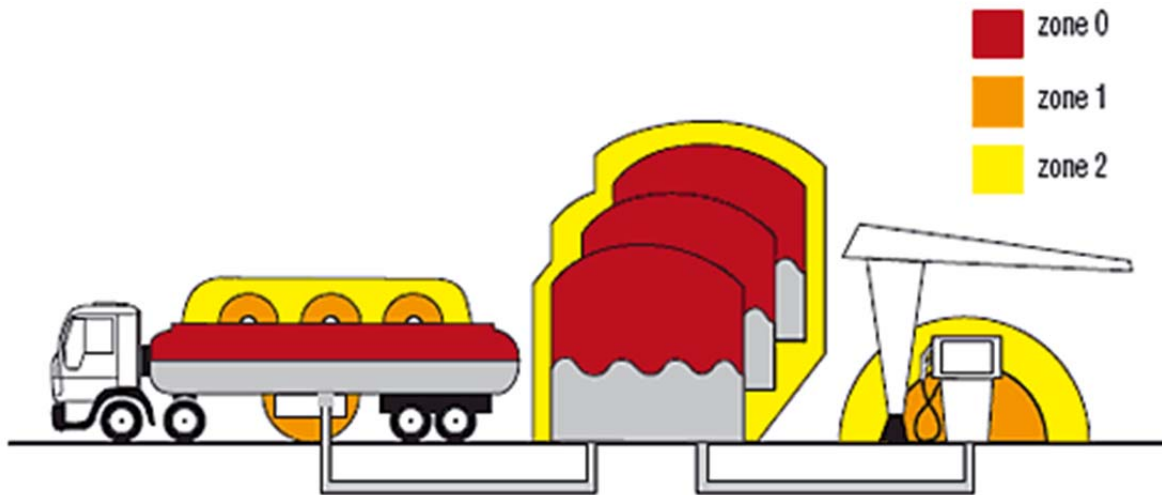
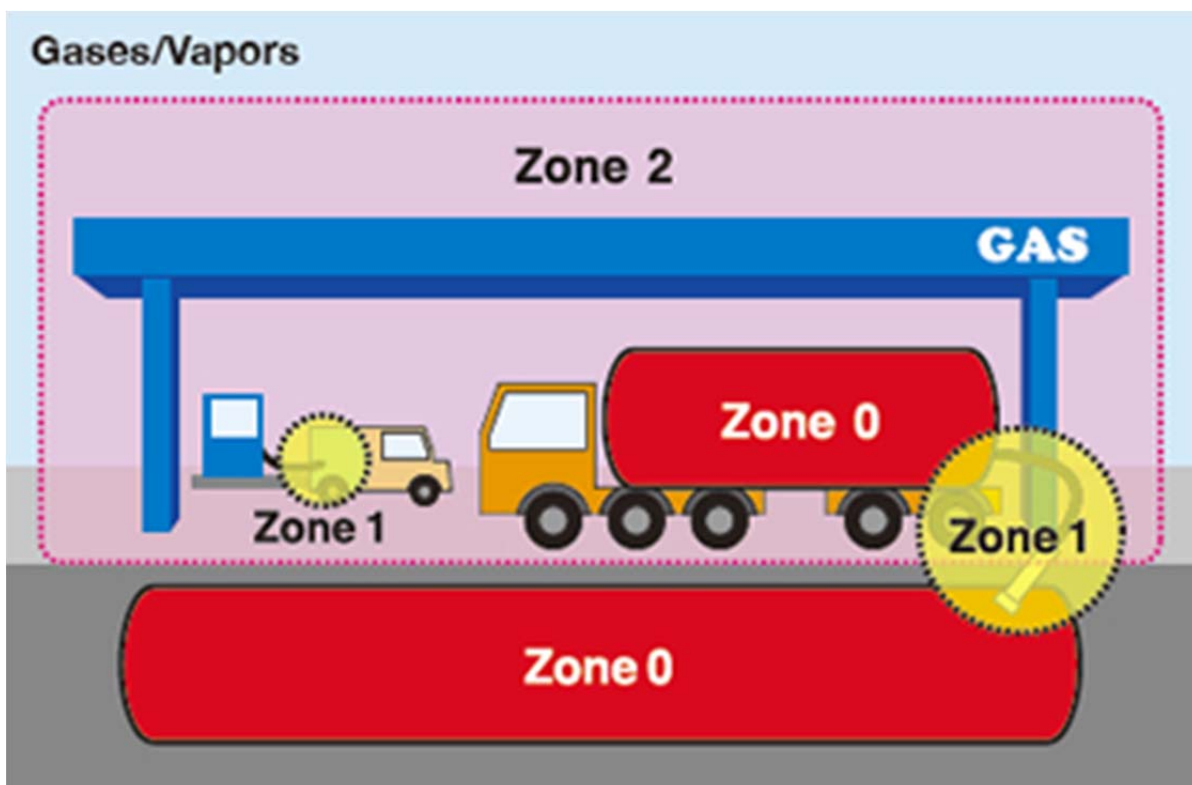


IMAGE:ATEX/NFPA- EXTREME DANGER-DISCHARGING OF EXPLOSIVE GASES/VAPOURS AT PETROL STATIONS, MANHOLES, STORAGE TANKS



TECHNOKONTROL ATEX / NFPA ADDITIONAL ANTI-EXPLOSIVE DATA

IMAGE OF A ATEX / NFPA."PETROL STATION MANHOLE REFUELING POINT WITHOUT TECHNOKONTROL ANTI-EXPLOSION ALLOYS"-

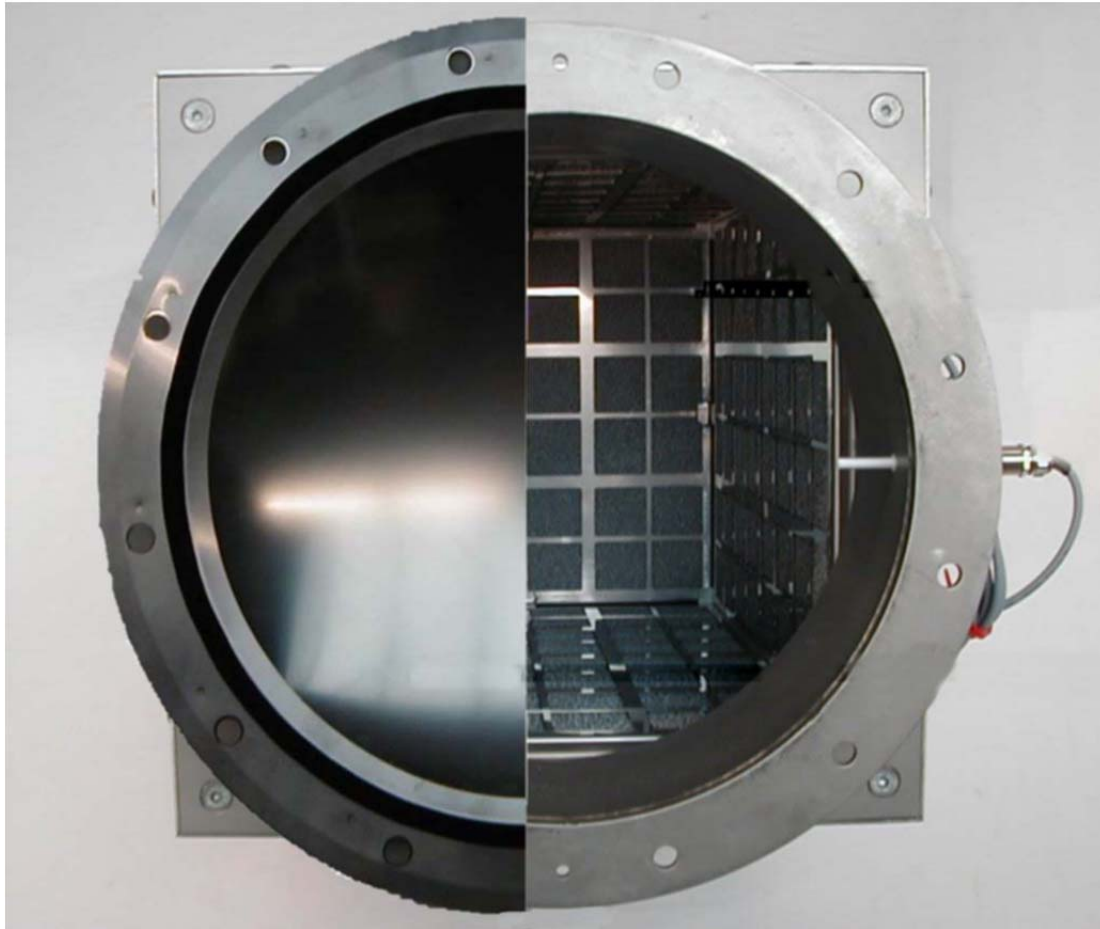


IMAGE: ATEX/NFPA. SAFETY DIRECTIVES FOR ATMOSPHERIC GAS / PETROL-CHEMICAL RISK-EXPLOSION ZONES

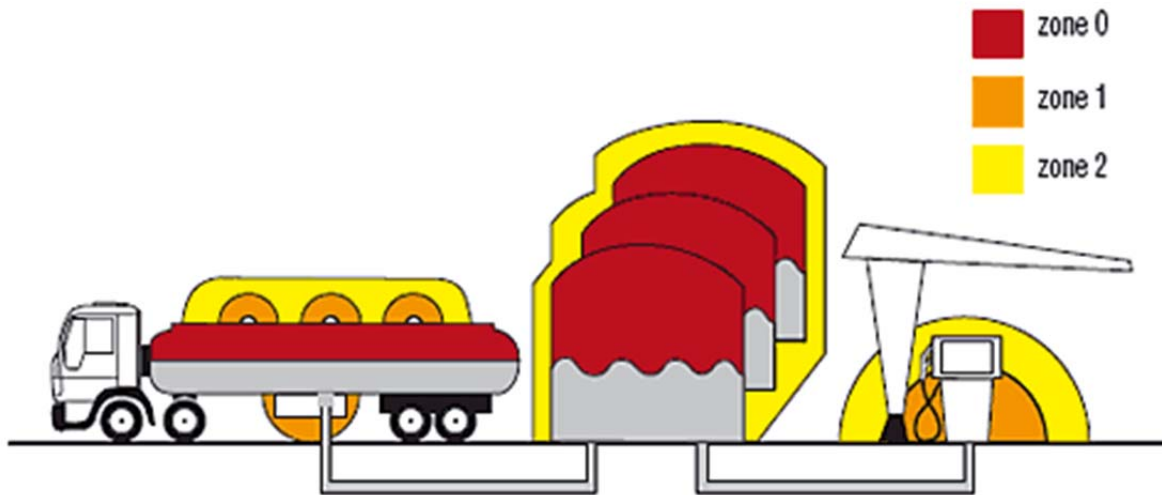
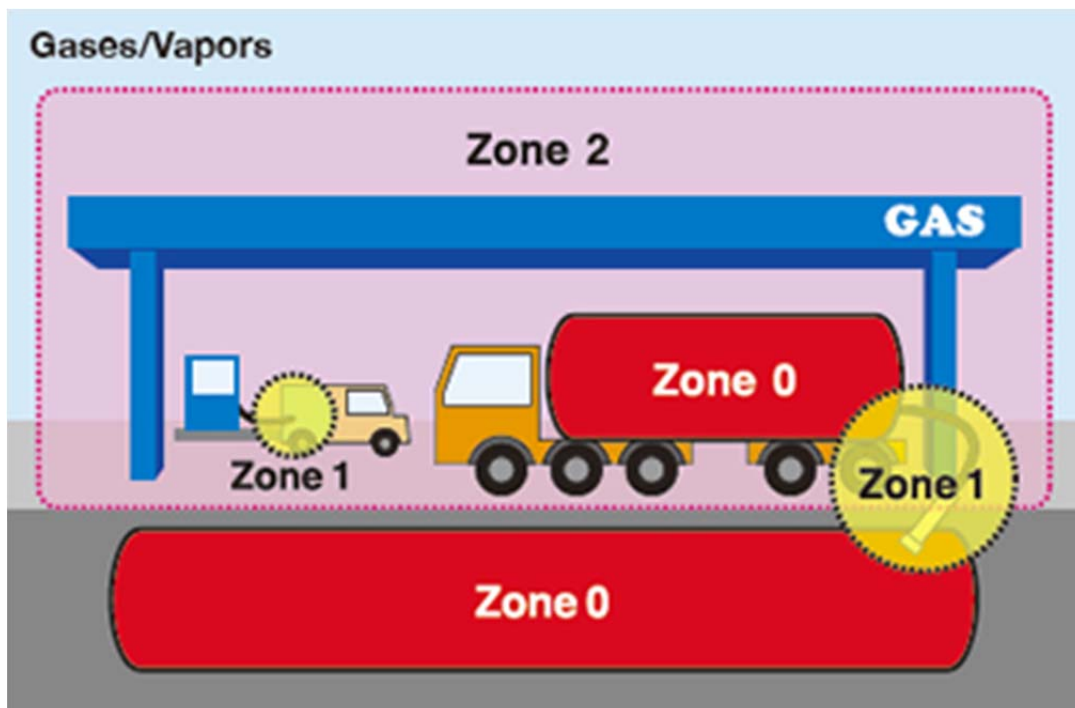


IMAGE:ATEX/NFPA- EXTREME DANGER-DISCHARGING OF EXPLOSIVE GASES/VAPOURS AT PETROL STATIONS, MANHOLES, STORAGE TANKS



TECHNOKONTROL ATEX / NFPA ADDITIONAL ANTI-EXPLOSIVE DATA

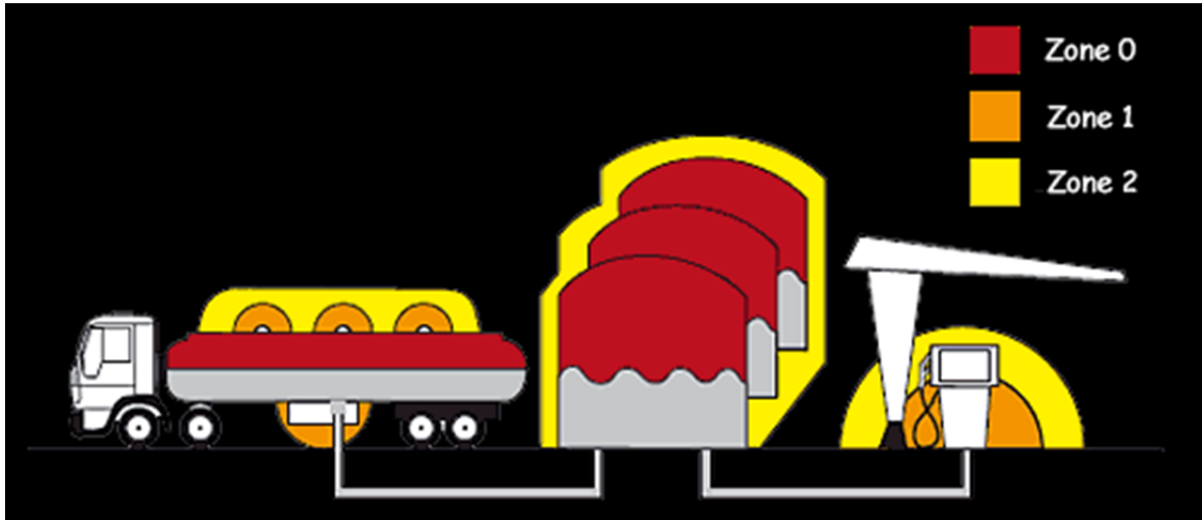
IMAGE: ATEX / NFPA - ANTI-EXPLOSION / SAFETY DISCHARGING - REFUELING VALVES FOR PETROL STATIONS, FUEL DEPOTS, REFINERIES, PETROL- CHEMICAL PLANTS.



IMAGE: ATEX / NFPA- ANTI EXPLOSION, ANTI-ELECTROSTATIC, ANTI-SLOSHING, ANTI-VAPOR SAFETY VALVES "CUSTOM MADE" FOR EACH CLIENT AND TECHNICAL-INSTALLATION REQUIREMENTS.



ATEX/NFPA PETROL STATIONS-MAN HOLES, STORAGE FACILITIES, REFUELING AREAS- ATEX-EU/NFPA EXPLOSIVE ATMOSPHERIC DIRECTIVE DANGER SECTIONS



TK-SIAPS MANHOLES/ARQUETAS



FUEL TANKS SAFETY TECHNOLOGIES

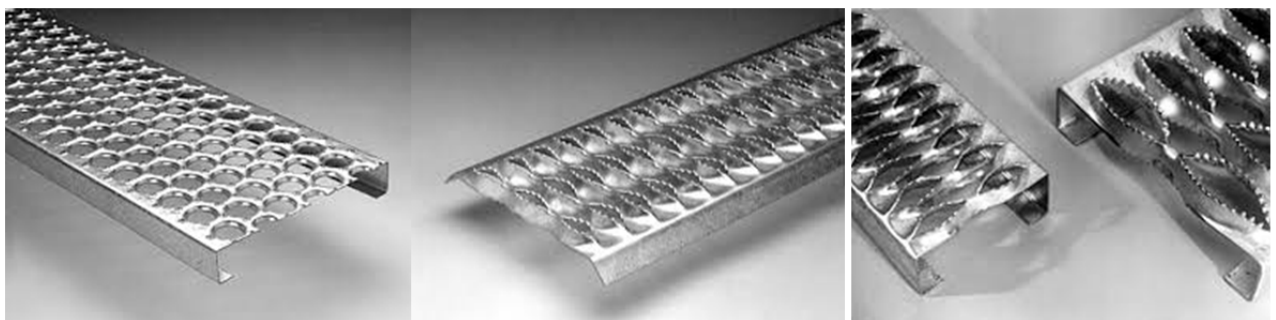


ATEX – TK SAFETY DIRECTIVES

ATEX-NFPA TECHNOKONTROL ANTI-EXPLOSION-SPECIALIST SAFETY TECHNOLOGIES



SPECIALIST UNIQUE PATENTED ALLOY FORMULATIONS & DESIGNS FOR ALL ENGINEERING-TECHNICAL REQUIREMENTS INCLUDING USAGE FROM PROTECTION-SAFETY TECHNOLOGIES TO PETROL-CHEMICAL-ENVIRONMENTAL INDUSTRIES:



TECHNOKONTROL SPECIALIS ANTI-VAPORIZATION, ANTI-THERMAL, & ANTI-ELECTROSTATIC CHARGES ALLOYS FORMULATIONS.



**ANTI-EMPS (ELECTROMAGNETIC PULSES/RADIATION), SPACE/SATELLITE/AVIATION
EXTREME THERMAL HEAT ATMOSPHERIC RE-ENTRY ALLOYS, ETC.**

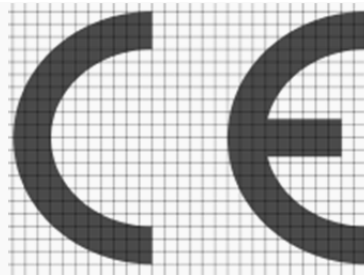


ATEX DIRECTIVE IN EU SAFETY DIRECTIVES, WHAT DOES THIS MEAN FOR MY COMPANY PROTECTION & SAFETY NEEDS?

The ATEX directive consists of two EU directives describing what equipment and work environment is allowed in an environment with an explosive atmosphere

Contents

Directives



The CE mark which should be attached to EU certified equipment



Mark for ATEX certified electrical equipment for explosive atmospheres.

As of July 2003, organizations in EU must follow the directives to protect employees from explosion risk in areas with an explosive atmosphere.

There are two ATEX directives (one for the manufacturer and one for the user of the equipment):

- the ATEX 95 *equipment* directive 94/9/EC, Equipment and protective systems intended for use in potentially explosive atmospheres;
- the ATEX 137 *workplace* directive 99/92/EC, Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

Employers must classify areas where hazardous explosive atmospheres may occur into zones. The classification given to a particular zone, and its size and location, depends on the likelihood of an explosive atmosphere occurring and its persistence if it does.

Areas classified into zones (0, 1, 2 for gas-vapor-mist and 20, 21, 22 for dust) must be protected from effective sources of ignition. Equipment and protective systems intended to be used in zoned areas must meet the requirements of the directive. Zone 0 and 20 require Category 1 marked equipment, zone 1 and 21 require Category 2 marked equipment and zone 2 and 22 require Category 3 marked equipment. Zone 0 and 20 are the zones with the highest risk of an explosive atmosphere being present.

Equipment in use before July 2003 is allowed to be used indefinitely provided a risk assessment shows it is safe to do so.

The aim of directive 94/9/EC is to allow the free trade of 'ATEX' equipment and protective systems within the EU by removing the need for separate testing and documentation for each member state.

The regulations apply to all equipment intended for use in explosive atmospheres, whether electrical or mechanical, including protective systems. There are two categories of equipment 'I' for mining and 'II' for surface industries. Manufacturers who apply its provisions and affix the CE marking and the Ex marking are able to sell their equipment anywhere within the European union without any further requirements with respect to the risks covered being applied. The directive covers a large range of equipment, potentially including equipment used on fixed offshore platforms, in petrochemical plants, mines, flour mills and other areas where a potentially explosive atmosphere may be present.

In very broad terms, there are three preconditions for the directive to apply: the equipment a) must have its own effective source of ignition; b) be intended for use in a potentially explosive atmosphere (air mixtures); and c) be under normal atmospheric conditions.

The directive also covers components essential for the safe use and safety devices directly contributing to the safe use of the equipment in scope. These latter devices may be outside the potentially explosive environment.

Manufacturers/suppliers (or importers, if the manufacturers are outside the EU) must ensure that their products meet essential health and safety requirements and undergo appropriate conformity procedures. This usually involves testing and certification by a 'third-party' certification body (known as a Notified Body e.g. Sira, Intertek, Baseefa, Lloyd's, BAM, TUV) but manufacturers/suppliers can 'self-certify' Category 3 equipment (technical dossier including drawings, hazard analysis and users manual in the local language) and Category 2 non-electrical equipment but for Category 2 the technical dossier must be lodged with a notified body. Once certified, the equipment is marked by the 'CE' (meaning it complies with ATEX and all other relevant directives) and 'Ex' symbol to identify it as approved under the ATEX directive. The technical dossier must be kept for a period of 10 years.

Certification ensures that the equipment or protective system is fit for its purpose and that adequate information is supplied with it to ensure that it can be used safely. There are four ATEX classification to ensure that a specific piece of equipment or protective system is appropriate and can be safely used in a particular application: 1. Industrial or Mining Application; 2. Equipment Category; 3. Atmosphere; and 4. Temperature.

The ATEX as an EU directive finds its US equivalent under the HAZLOC standard. This standard given by the Occupational Safety and Health Administration defines and classifies hazardous locations such as explosive atmospheres.

Technical definitions

What is an explosive atmosphere?

In DSEAR, an explosive atmosphere is defined as a mixture of dangerous substances with air, under atmospheric conditions, in the form of gases, vapours, mist or dust in which, after ignition has occurred, combustion spreads to the entire unburned mixture.

Atmospheric conditions are commonly referred to as ambient temperatures and pressures. That is to say temperatures of -20°C to 40°C and pressures of 0.8 to 1.1 bar.

Zone classification

European and IEC Classification	Definition of zone or division	North American Classification
Zone 0 (gases / Vapors)	An area in which an explosive mixture is continuously present or present for long periods	Class I Division 1 (gases)
Zone 1 (gases / Vapors)	An area in which an explosive mixture is likely to occur in normal operation	Class I Division 1 (gases)
Zone 2 (gases / Vapors)	An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time.	Class I Division 2 (gases)
Zone 20 (dusts)	An area in which an explosive mixture is continuously present or present for long periods	Class II Division 1 (dusts)
Zone 21 (dusts)	An area in which an explosive mixture is likely to occur in normal operation	Class II Division 1 (dusts)
Zone 22 (dusts)	An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time.	Class II Division 2 (dusts)

Effective ignition source

Effective ignition source is a term defined in the European ATEX directive as an event which, in combination with sufficient oxygen and fuel in gas, mist, vapor or dust form, can cause an explosion. Methane, hydrogen or coal dust are examples of possible fuels.

Effective ignition sources are:

- Lightning strikes.
- Open flames. This varies from a lit cigarette to welding activity.
- Mechanically generated impact sparks. For example, a hammer blow on a rusty steel surface compared to a hammer blow on a flint stone. The speed and impact angle (between surface and hammer) are important; a 90 degree blow on a surface is relatively harmless.
- Mechanically generated friction sparks. The combination of materials and speed determine the effectiveness of the ignition source. For example 4.5 m/s steel-steel friction with a force greater than 2 kN is an effective ignition source. The combination of aluminium and rust is also notoriously dangerous. More than one red hot spark is often necessary in order to have an effective ignition source.
- Electric sparks. For example a bad electrical connection or a faulty pressure transmitter. The electric energy content of the spark determines the effectiveness of the ignition source.
- High surface temperature. This can be the result of milling, grinding, rubbing, mechanical friction in a stuffing box or bearing, or a hot liquid pumped into a vessel. For example the tip of a lathe cutting tool can easily be 600 Celsius (1100 °F); a high pressure steam pipe may be above the autoignition temperature of some fuel/air mixtures.
- Electrostatic discharge. Static electricity can be generated by air sliding over a wing, or a non-conductive liquid flowing through a filter screen.
- Radiation.
- Adiabatic compression. Air is pumped into a vessel and the vessel surface heats up.