ATEX INTRODUCTION

M.A.M.

EXPLOSION PROOF ENCLOSURES

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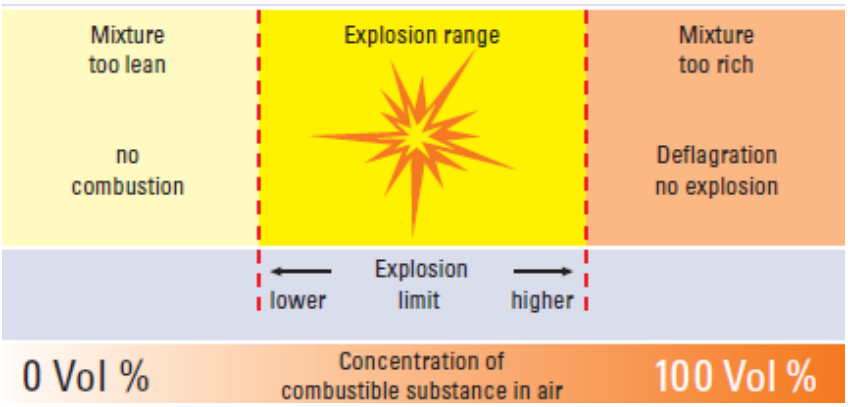
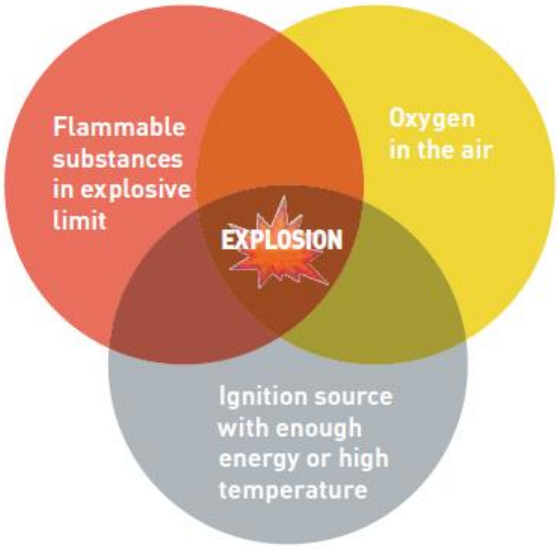
1. GENERAL INFORMATION

Atex is the acronym of **Atmosphere Explosive**, explosive atmosphere, that is a mixture of flammable substances in form of gas, vapours, mist or dust, where combustion, after ignition, propagates through all the flammable mixture.

A potentially explosive atmosphere is an atmosphere that is not explosive under normal operating condition, but can become such in case of unpredictable events, like gas leaks, equipment failure, temperature or pressure

To obtain the formation of an explosive atmosphere it is necessary that flammable substances are present in a determined concentration, otherwise a reaction of combustion will take place only or no reaction at all. This concentration range is defined for each flammable substance by the lower explosion limit (LEL) and the upper explosion limit (UEL), that is the minimum and maximum concentration, between which a given substance may be ignited, when given an ignition source.





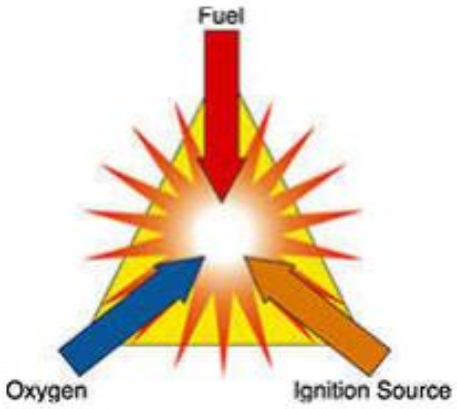


Fig. 1 - Triangolo della combustione.

2. REGULATION IN FORCE

Explosive atmospheres can arise in several industrial fields (oil&gas, chemistry, pharmaceutical, feed industry, metallurgic) during transport, manufacturing or storage processes and if ignited they can lead to harmful or catastrophic events for people and the environment. **ATEX directive**, in the **European Union** countries, aims to uniform the different legislations of its members with respect to the risk given by the presence of potentially explosive atmosphere: it is divided in 2014/34/UE and ATEX 99/92/CE.

ATEX directive 2014/34/UE defines the essential safety requirements and protection systems intended to be used in potentially explosive atmosphere. It applies for manufacturers and require the certification of their products.

ATEX directive 99/92/CE defines the minimum requirements for safety and health in working environments in potentially explosive atmospheres, where plants and certificated equipment are employed. It applies for final users.

IECEx Certification

The ATEX compliance is mandatory in UE countries for equipment installed in explosive atmospheres. At international level instead it is widespread the IECEx certification, that is a certification scheme that testifies conformity to Ex standard (issued by IEC – International Electrotechnical Commission) for electrical equipment. IECEx certification was derived from representatives, industries and laboratories with the common aim to ease the **international commerce** of Ex equipment, ensuring the required safety levels and avoiding to pass conformity tests for each single market. A list of countries that currently accept the IECEx certification are reported in the table below.

Ex-TR-CU Certification

To trade Ex products in the Doganal Union formed by Russia, Armenia, Kirghizistan and Kazakistan it is mandatory the Ex-TR-CU certification.

3. ATEX DIRECTIVE

3.1 GROUPS AND CATEGORIES

According to ATEX directive, products are divided into categories based on the level of protection required and depending on the degree of danger of the environment I which they will be installed.

Group I: equipment intended for use in mines above and below ground. It is divided into two categories depending on the required protection level.
M1: equipment in this category is required to remain functional with an explosive atmosphere present. Level of protection *"very high".*
M2: this equipment is intended to be de-energised in the event of an explosive atmosphere forming. Level of protection *"high".*

Group II: : equipment intended for use in location, other than mines (surface industries). It is divided into three categories depending on the required protection level. For gaseous atmosphere categories are identified by the letter G, while for dusty atmospheres by the letter D.
1G o **1D**: an explosive atmosphere is present continuously or for long periods. Level of protection *"very high"*.
2G o **2D**: an explosive atmosphere is occasionally present. Level of protection *"high".*
3G o **3D**: an explosive atmosphere is not likely to occur of if it does, it will be only for short periods. Level of protection *"normal".*

All electric equipment falling in categories 1 and 2 must be certified by an ATEX notified body and manufacturing companies have to undertake a quality surveillance system. For equipment falling in category 3, an auto-certification is sufficient. All product, whichever their group or category, must be CE certified and must be provided with the instruction manual.

3.2 DEGREE OF PROTECTION EPL

At international level, the Equipment Protection Level EPL was introduced in 2007 for the equipment classification. EPLs identify products according to the explosion risk they can cause, easing in this way the risk evaluation and component selection.

EPL Ma: equipment for installation in mines with level of protection "*very high":* no risk of ignition in case of predictable or rare malfunctions during normal operation, even in case of gas leaks.

EPL Mb: equipment for installation in mines with level of protection "*high":* no risk of ignition in case of predictable malfunctions during normal operation, even during the period between a gas leak and shut down.

EPL Ga or **Da**: equipment for installation in explosive atmosphere with level of protection "*very high*": no risk of ignition in case of predictable or rare malfunctions during normal operation.

EPL Gb or **Db:** equipment for installation in explosive atmosphere with level of protection "*high*": no risk of ignition in case of predictable or rare malfunctions during normal operation.

EPL Gc or **Dc**: equipment for installation in explosive atmosphere with level of protection "*augmented*": no risk of ignition during normal operation. Additional protection measures are implemented to ensure equipment to remain inactive as ignition source in case of predictable or rare malfunctions.

3.3 ZONES CLASSIFICATION

According to ATEX 99/92/CE, explosive atmosphere are divided in zones by the employer by applying EN 60079-10.

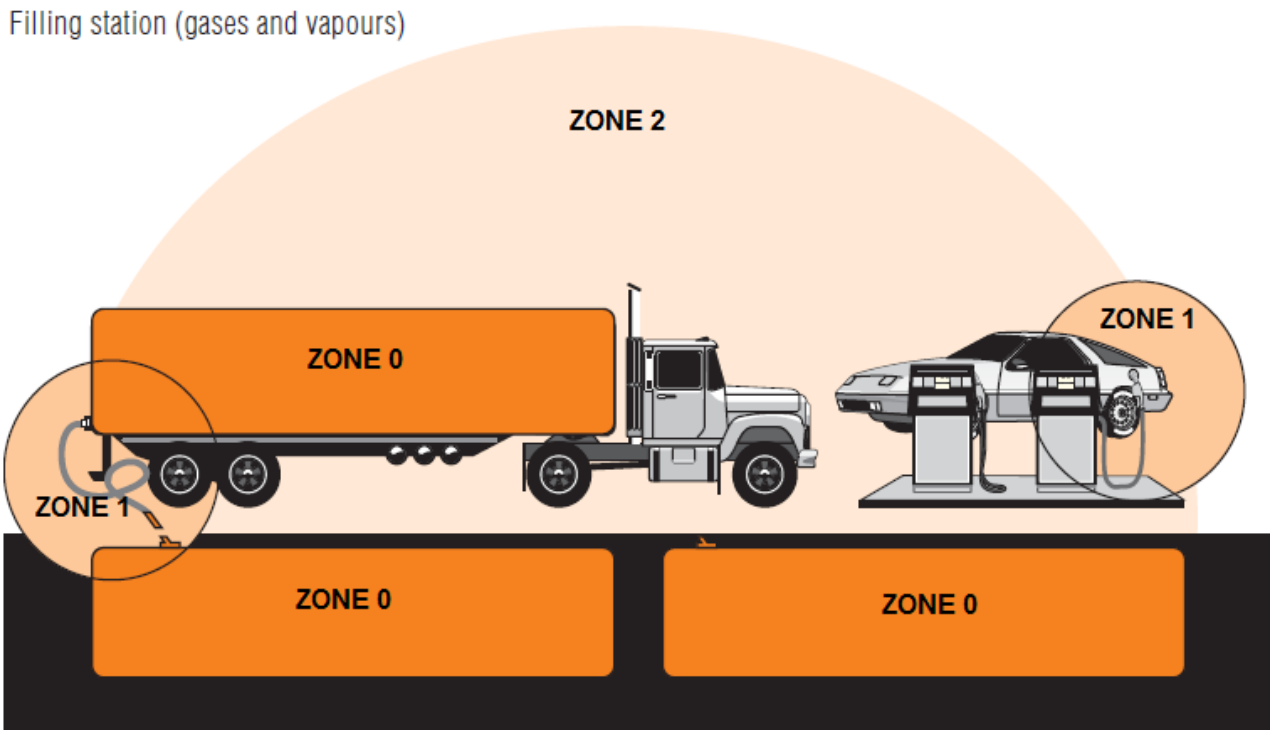
Zona 0: an explosive atmosphere consisting of a mixture of air and flammable substances in form of gas, vapours or mists is present continuously or for long periods.
Zona 20: an explosive atmosphere consisting of a mixture of air and flammable substances in form of dusts is present continuously or for long periods.

Zona 1: an explosive atmosphere consisting of a mixture of air and flammable substances in form of gas, vapours or mists is occasionally present under normal operating conditions.
Zona 21: an explosive atmosphere consisting of a mixture of air and flammable substances in form of dusts is occasionally present under normal operating conditions.

Zona 2: an explosive atmosphere consisting of a mixture of air and flammable substances in form of gas, vapours or mists is never present, or if it occurs, it will be only for short periods.
Zona 22: an explosive atmosphere consisting of a mixture of air and flammable substances in form of dusts is never present, or if it occurs, it will be only for short periods.

The correspondence between EPL and ATEX categories in their respective installation zones is shown in the table below. Next figure shows instead an example of zones subdivision.

ATEX category	EPL degree of protection	Zona di installazione	Atmosphere
1G	Ga	0	GAS
2G	Gb	1	
3G	Gc	2	
1D	Da	20	DUST
2D	Db	21	
3D	Dc	22	
M1	Ma	MINING	COAL DUST METHANE
M2	Mb		



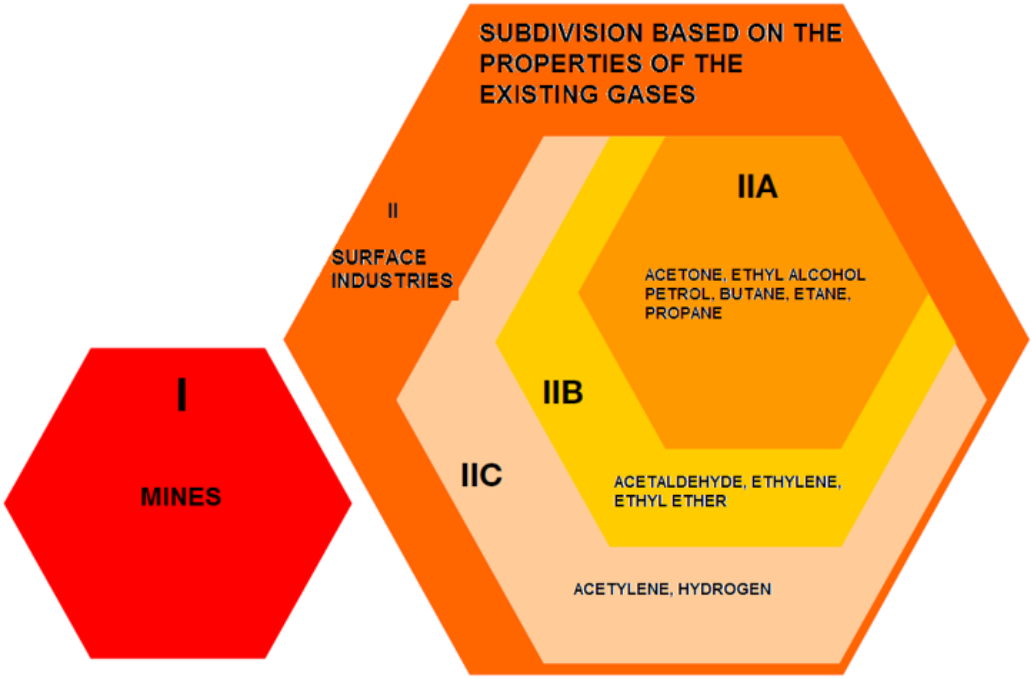
3.4 ATMOSPHERE GROUPS

The choice of the equipment is to be made according to the zone it will be installed into, the present substances and their ignition temperatures. Electric equipment of group II are divided into subgroups IIA, IIB and IIC for gas and IIIA, IIIB and IIIC for dust.

Group C is more restrictive than group B, that in turns in more restrictive than group A in terms of danger and safety regulation. Therefore, equipment designed for group IIC or IIIC can be used for application IIB or IIIB but not vice versa.

Gas group	Representative Gas
IIA	Propane
IIB	Ethylene
IIC	Hydrogen / Acethylene

Dust group	Representative dust
IIIA	Combustible shavings
IIIB	Non-conductive
IIIC	Conductive



3.5 TEMPERATURE CLASS

The **ignition temperature** of the substances constituting the explosive atmosphere is another fundamental aspect to be considered. This value, defined as the lowest temperature at which an explosive mixture ignites spontaneously, must be higher than the maximum superficial temperature of the different components.

For gas, electric components are divided into 6 temperature classes from T1 to T6 according to the limits reported in table

Temperature class	Equipment maximum surface temperature	Flammable substance ignition temperature
T1	450 °C	> 450 °C
T2	300 °C	> 300 °C
T3	200 °C	> 2000 °C
T4	135 °C	> 135 °C
T5	100 °C	> 100 °C
T6	85 °C	> 85 °C

Component classified as T3 may be used in zones, which require T1 or T2, but a component classified as T4 must not be used in zones, which require T5. In the following table some examples of most commonly used substances in ATEX sectors are reported.

Gas	Group	Temperature class	Ignition temperature
Hydrogen	IIC	T1	560 °C
Propane	IIA	T1	470 °C
Ethylene	IIB	T2	425 °C
Acethylene	IIC	T2	305 °C
Kerosene	IIA	T3	280 °C
Diethyl ether	IIB	T4	160 °C
Carbon disulphide	IIC	T6	95 °C

For combustible dusts a distinction is mad between clouds and layers of dusts.
In case of **cloud of dust** with ignition temperature T_{cl}, regulation states that the highest superficial temperature must be $T \leq 2/3\ T_{cl}$.

In case of **layer of dust** instead, the higest permissible temperature is $T = T_{5mm} - 75\ °C$ (there are special table to evaluate the highest temperature for layers of dust thicker than 5mm).

Dusts	Typical ignition temperature [°C]	
	Cloud	Layer
Aluminum	560	450
Ground coal	420	230
Cellulose	520	410
Flour	380	320
Wood	450	220
Phenolic resin	530	450
PVC	700	450
Sugar	490	460

4. PROTECTION METHODS

Explosion protected electrical equipment can have different types of protection depending on its construction. In this paragraph a short explanation of the more widespread and principally used methods in ATEX sectors is reported.

Explosion proof enclosure Ex-d

Parts that can cause ignition while in an explosive atmosphere are confined in an enclosure, which can withstand the pressure generated by an explosion and prevent its transmission into the environment.

Reference standard IEC 60079-1

Aumented safety Ex-e

Additional safety precautions are applied to prevent the possibility of excessive temperature, sparks or arcs.

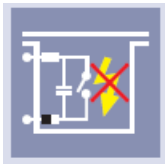
Reference standard IEC 60079-7

Pressurized enclosure Ex-p

The formation of a potentially explosive atmosphere inside the enclosure is prevented by applying a positive pressure gradient between the inside and outside of the enclosure.

Reference standard IEC 60079-2

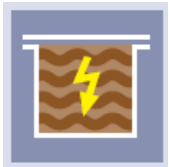
Intrinsic safety Ex-i



Intrinsically safe electrical components only are used: sparks or high temperatures are not able to ignite the surrounding explosive atmosphere. Energetic Limitation.

Reference standard IEC 60079-11

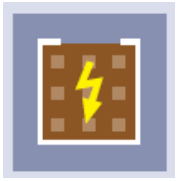
Oil immersion Ex-o



Parts are immersed in a protective fluid (such as oil) to prevent the ignition of a potentially explosive atmosphere outside its surface.

Reference standard IEC 60079-6

Encapsulation Ex-m



Parts that can ignite a potentially explosive atmosphere by sparking or heating are enclosed in a compund to isolate them from the surrounding environment.

Reference standard IEC 60079-18

5. IP CODE

A further information about the protection level of the electrical equipment is given by the IP code, defined in IEC standard 60529: it is defined by the code *"IP XY"* where the first digit X denotes the protection from solid particles, while the second digit Y denotes the protection from liquid penetration. For example M.A.M. products are classified IP 66 meaning that they are completely protected from dusts and powerful water jets (see tables below).

IP	First digit meaning – solid particle
0	no protection
1	effective against solid particles with dimension > 50 mm
2	effective against solid particles with dimension > 12 mm
3	effective against solid particles with dimension > 2,5 mm
4	effective against solid particles with dimension > 1 mm
5	dust protected (no harmful deposit)
6	completely dust protected

IP	Second digit meaning – liquid penetration
0	no protection
1	protected from vertically dripping drops
2	protected from dripping drops titlted up to 15°
3	protected from dripping drops titlted up to 60°
4	protected from splashing water from any direction
5	protected from water jet
6	protected from powerful water jet
7	protected from temporary immersion
8	protected from continous immersion

6. MARKING

The last section of this guide provide an overview on the marking of Ex-d equipment: figures reported below show an example of ATEX certification usually applied on Ex-d enclosures. Particularly in the scheme are highlighted the explation of the differents terms.