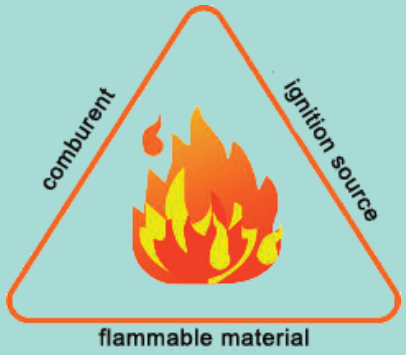
PRINCIPLES of EXPLOSION PROTECTION



An explosion is a rapid chemical reaction between a combustible substance and the oxygen with the consequent release of energy (in the form of heat and light).
An explosion can occur ONLY IF the following three factors are present simultaneously:

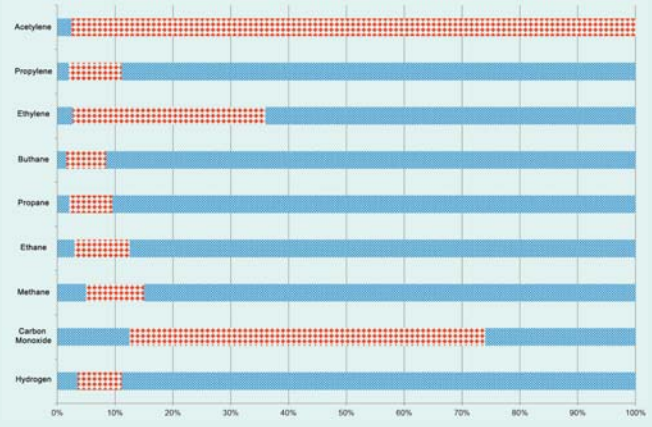
1. **Flammable material** (in the right amount);
2. **Comburent agent** (it is usually the oxygen present in the atmosphere);
3. **Ignition source.**

If one of these three factors is missing, than explosion cannot occur.

Some characteristics of flammable materials shall be taken into account to understand how a potentially explosive atmosphere is formed.
The ignition temperature (flash point T_{FL}) of a flammable liquid is the minimum temperature at which a liquid releases vapor in such a concetration that it forms a flammable mixture with air near the surface of the liquid itself (at atmospheric pressure). If the flash point is much greater than maximum temperature that can be reached, the explosive atmosphere will not be created. However, it must be considered that flash point of a mixture of more substances may be lower than the value of the components alone. The flash point, together with boiling point, is used to classify liquids into three different categories: extremely flammable, highly flammable and flammable.

TYPE OF FLAMMABLE LIQUID	FLASH POINT T_{FL}	BOILING POINT
EXTREMELY FLAMMABLE	$T_{FL} < 0°C$	< 35°C
HIGHLY FLAMMABLE	$T_{FL} < 21°C$	> 35°C
FLAMMABLE	$21°C < T_{FL} < 55°C$	

In order to create a potentially explosive atmosphere, the flammable substances must be in a given concentration. If the concentration is too high or too low, the explosion may not occur.
The **L.E.L.** (Lower Explosive Limit) and the **U.E.L.** (Upper Explosive Limit) state the concentration range where a given substance dissolved in the air can produce an explosion. In fact, a mixture can be ignited only if the concetration of substance in the air is between the L.E.L. and the U.E.L.



The ignition temperature is the lowest temperature at which the mixture air/gas or air/vapour spontaneously ignites in normal atmosphere conditions.

SUBSTANCE	IGNITION TEMPERATURE
HYDROGEN	500°C
ACETONE	465°C
ETHYLENE OXIDE	435°C
BUTANE	372°C
ETHANOL	363°C
PETROL	280°C

The last aspect concerns the ignition source.
A potentially explosive atmosphere needs a source of ignition to explode and the most commons are the following:

- hot surfaces
- flames and hot gases
- mechanically generated sparks
- electrical equipment
- static electricity
- electromagnetic waves (high frequency)
- optical radiations
- ionizing radiations
- ultrasounds
- adiabit compression and shock waves.

TEMPERATURE CLASS and MAXIMUM SURFACE TEMPERATURE

The chosen of equipment according to ignition temperature of the substances is one of the fundamental aspects in order to ensure the safety of the plants againt the risk of explosion.

The choice criterion is different depending on whether the equipment is used in gas or dust atmospheres.

Equipment for gas

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

TEMPERATURE CLASS	IGNITION TEMPERATURE OF GAS					MAXIMUM SURFACE TEMPERATURE OF EQUIPMENT
T1			T	≥	450°C	450°C
T2	300°C	≤	T	<	450°C	300°C
T3	200°C	≤	T	<	300°C	200°C
T4	135°C	≤	T	<	200°C	135°C
T5	100°C	≤	T	<	135°C	100°C
T6	85°C	≤	T	<	100°C	85°C

Equipment for combustible dust

Unlike for what happens for the gases, when combustible dusts are present we shall distinguish between two different cases:

1. Dust cloud;
2. Dust layers.

1. To prevent ignition of dust clouds, maximum surface temperature (T) of electrical equipment shall not exceed the ignition temperature of dust cloud (indicated with T_{cl}). In the calculation phase a safety coefficient equal to $T_{cl,max} = 2/3 \cdot T_{cl}$ is introduced, therefore the maximum allowable temperature of the equipment shall be (T) ≤ $T_{cl,max}$.

2. To prevent ignition of dust layers, surface temperature of equipment shall be limited in relation to the thickness of dust layer.
   In fact, for each type of dust a minimum ignition temperature value for a 5 mm thickness dust layer T_{5mm} is defined. The maximum surface temperature that can be reached by the equipement ($T_{max,l}$) avoiding ignition of dust layers shall be less than 75 K compared to T_{5mm}, that is: $T_{max,l} = T_{5mm} - 75$.
   Maximum surface temperature (T) of equipment shall not exceed the lowest value between $T_{cl,max}$ and $T_{max,l}$.

Example:

Choice of maximum surface temperature of an electrical equipment in the presence of sugar powder.

T_{cl} = minimum ignition temperature in cloud = 350°C

$T_{cl,max} = 2/3 \cdot T_{cl}$ = 233°C

T_{5mm} = minimum ignition temperature in layer = 490°C

$T_{max,l} = T_{5mm} - 75$ = 415°C

lowest value between $T_{cl,max}$ (233°C) and $T_{max,l}$ (415°C) = 233°C

Surface temperature of equipment ≤ 233°C

ZONE with PRESENCE of GAS

GAS		
ZONE 0	**ZONE 1**	**ZONE 2**
Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas or vapour is present continuously or for long periods or frequently.	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas or vapour is likely to occur in normal operation occasionally.	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas or vapour is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
> 1000 h/year	10 ÷ 1000 h/year	< 10 h/year

GAS SUBDIVISION		
IIA	**IIB**	**IIC**
A typical gas is propane	A typical gas is ethylene	A typical gas is acetylene
NOTE: Equipment marked IIB is suitable for applications requiring Group IIA equipment. Similarly, equipment marked IIC is suitable for applications requiring Group IIA or Group IIB equipment.		

TABLE OF SOME REPRESENTATIVE GASES

NAME	FORMULA	L.E.L. (vol %)	U.E.L. (vol %)	M.I.T. (°C)	M.I.E. (µJ)	GROUP	TEMPERATURE CLASS
Acetylene	CH=CH	2,30	100,00	305	19	IIC	T2
Acetone	$(CH_3)_2CO$	2,50	14,30 (100°C)	539		IIA	T1
Ammonia	NH_3	15,00	33,60	630		IIA	T1
Ethanol	CH_3CH_2OH	3,10	19,00 (60°C) 27,70 (100°C)	400		IIB	T2
Diethyl ether	$(CH_3CH_2)_2O$	1,70	39,20	175		IIB	T4
Ethylene	$CH_2=CH_2$	2,30	36,00	440	82	IIB	T2
Firedamp		4,40	17,00	595	280	I	T1
Hydrogen	H_2	4,00	77,00	560	16	IIC	T1
Methane	CH_4	4,40	17,00	600	280	IIA	T1
Metanolo	CH_3OH	6,00	36,00 (60°C) 50,00 (100°C)	440		IIA	T2
Propane	$CH_3CH_2CH_3$	1,70	10,90	450	250	IIA	T1
Propanol	$(CH_3)_2CHOH$	2,00	12,70	399		IIA	T2
Carbon disulphide	CS_2	0,60	60,00	90		IIC	T6
Tetrahydrofuran	$OCH_2CH_2CH_2CHCH_2OH$	1,50	9,70	280		IIB	T3
LEGEND	L.E.L. = Lower Explosive Limit; U.E.L. = Upper Explosive Limit;			M.I.T. = Minimum Ignition Temperature; M.I.E. = Minimum Ignition Energy.			

ZONE with PRESENCE of COMBUSTIBLE DUSTS

COMBUSTIBLE DUSTS		
ZONE 20	**ZONE 21**	**ZONE 22**
Area in which an explosive atmosphere in the form of a cloud of dust in air is present continuously, or for long periods or frequently.	Area in which an explosive atmosphere in the form of a cloud of dust in air is likely to occur, occasionally, in normal operation	Area in which an explosive atmosphere in the form of a cloud of dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
> 1000 h/year	10 ÷ 1000 h/year	< 10 h/year

COMBUSTIBLE DUSTS SUBDIVISION		
IIIA	**IIIB**	**IIIC**
Combustible flyings: *solid particles, included fibers, whose nominal size is > of 500 µm*	**Non-conductive dust**: *finely divided solid particles, whose nominal size is ≤ 500 µm, with electrical resistivity greater than 10^3 Ωm*	**Conductive dust:** *finely divided solid particles, whose nominal size is ≤ 500 µm, with electrical resistivity equal to or less than 10^3 Ωm*
NOTE: Equipment marked IIIB is suitable for applications requiring Group IIIA equipment. Similarly, equipment marked IIIC is suitable for applications requiring Group IIIA or Group IIIB equipment.		

TABLE OF SOME REPRESENTATIVE COMBUSTIBLE DUSTS

Combustible Dusts	Granulometry	Explodibility L.E.L.	M.I.T.		M.I.E.	K_{st}
			T_{cl}	T_{5mm}		
	(µm)	(g/m³)	(°C)	(°C)	(mJ)	(°C)
Aluminum	29	40	700	320	50	415
Coke	15	80	---	---	80	47
Wheat Flour	57	60	430	450	50	87
Lactose	23	125	450	fonde	10	81
Wood	70	40	440	325	20	128
Magnesium	28	30	600	490	120	508
Polyehylene	< 10	25	450	---	80	156
Rise	45	60	490	---	80	101
Zinc	< 10	480	680	460	650	176
Sugar	35	200	350	490	30	138
Legend	L.E.L.: Lower Explosive Limit; M.I.E.: Minimum Ignition Energy; M.I.T.: Minimum Ignition Temperature;			K_{st}: specific parameter that depends on dusts and test method; T_{cl}: ignition temperature for dust clouds; T_{5mm}: ignition temperature due to dust layers on surfaces (layer thickness reference equal to 5 mm).		

GROUPS, CATEGORIES and EPLs

GROUPS	
GROUP I	**GROUP II**
comprises equipment intended tfor use in the underground mines, which are subsceptible to firedamp and/or to coal dust.	comprises equipment intended for use in places with an explosive atmosphere other than mines subsceptible to firedamp (tipically atmospheres with presence of gas and/or combustible dusts).

CATEGORIES				
GROUP I		**GROUP II**		
CATEGORY M1	**CATEGORY M2**	**CATEGORY 1**	**CATEGORY 2**	**CATEGORY 3**
Equipment in this category is required to remain functional in the presence of an explosive atmosphere and ensures a very high level of protection.	This equipment is intended to be de-energised in the event of an explosive atmosphere and ensures a high level of protection.	Comprises equipment designed to ensure a very high level of protection for use in areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dust mixtures are present continuously, for long periods or frequently.	Comprises equipment designed to ensure a high level of protection for use in areas in which explosive atmospheres caused by gases, vapours, mists or air/dust mixtures are likely to occur occasionally.	Comprises equipment designed to ensure a normal level of protection for use in areas in which explosive atmospheres caused by gases, vapours, mists, or air/dust mixtures are unlikely to occur or, if they do occur, are likely to do so only infrequently and for a short period only.
PROTECTION LEVEL				
Very high	High	Very high	High	Normal
LEVEL OF PROTECTION				
Either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection, or the requisite level of protection is assured in the event of two faults occurring independently of each other.	The means of protection assure the requisite level of protection during normal operation and also in the case of more severe operating conditions, in particular those arising from rough handling and changing environmental conditions..	Either, in the event of one means of protection failure, at least an independent second means provides the requisite level of protection, or the level of protection is assured in the event of two faults occurring independently of each other.	The means of protection ensure the requisite level of protection, even in the event of frequently occurring disturbances or equipment faults which normally have to be taken into account.	Equipment in this category ensures the requisite level of protection during normal operation.
OPERATING CONDITIONS				
Equipment remains functional, even in the event of rare incidents relating to equipment, with an explosive atmosphere present.	Equipment is intended to be de-energised in the event of an explosive atmosphere.	Equipment remains functional (see table category-zone correlation).	Equipment remains functional (see table category-zone correlation	Equipment remains functional (see table category-zone correlation

CATEGORY-ZONE CORRELATION FOR GROUP II						
	G			D		
	Zone 0	Zone 1	Zone 2	Zone 20	Zone 21	Zone 22
1	1G	1G	1G	1D	1D	1D
2	X	2G	2G	X	2D	2D
3	X	X	3G	X	X	3D

CATEGORY and PROTECTION LEVEL (EPL) CORRELATION								
	M		G			D		
	M1	M2	1G	2G	3G	1D	2D	3D
1	Ma	Ma	Ga	Ga	Ga	Da	Da	Da
2	X	Mb	X	Gb	Gb	X	Db	Db
3	n.a.	n.a.	X	X	Gc	X	X	Dc

MODE of PROTECTION

There are several applicable mode of protection for **gas atmospheres**, which are divided into four different types:

1. CONTAINMENT: the idea is not to avoid in anyways the explosion, but to make it occur within an enclosure that it may contain and limit it. the mode of protection Ex d is made on this criterion.
2. PREVENTION: the idea is to manufacture more sophisticated electrical apparatuses that, in their normal use, do not create explosion causes (i.e. low surface temperature, non sparking equipment, etc.) and thus the ignition source is eliminated. Mode of protections based on this criterion are Ex e and Ex n.
3. LIMITATION: electrical components are designed and made with a limited power so that in every operating condition the explosion cannot be ignited in anyway. Mode of protection Ex i is based on this criterion.
4. ISOLATION: the idea is to isolate the electrical equipment, that can cause the ignition of combustible mixture due to sparkings or high temperature, so that the explosion cannot be possible to ignite at any time. Several mode of protections such as Ex m, Ex p, Ex q an d Ex o take advantage of this criterion.

MODE OF PROTECTION	ZONE CLASSIFICATION			CALSSIFICATION ACCORDING TO ATEX DIRECTIVE 2014/34/EU			
				GROUP		CATEGORY	
	ZONE 0	ZONE 1	ZONE 2	MINES	SURFACE	MINES	SURFACE
Ex d	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2G
Ex e	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2G
Ex n	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3G
Ex ia	SUITABLE	SUITABLE	SUITABLE	I	II	M1	1G
Ex ib	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2G
Ex ic	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3G
Ex ma	SUITABLE	SUITABLE	SUITABLE	I	II	M1	1G
Ex mb	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2G
Ex mc	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3G
Ex pb	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2G
Ex pc	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3G
Ex q	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2G
Ex o	FORBIDDEN	SUITABLE	SUITABLE	N.A.	II	N.A.	2G

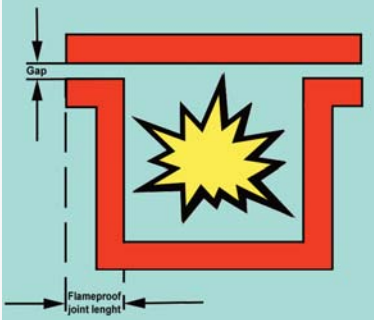
There are several applicable mode of protection for **dust atmospheres**, which are divided into three different types:

1. CONTAINMENT: the idea is to prevent the ingres of combustible dust inside the enclosure thanks to an adequate degree of protection (IP). Mode of protection Ex t is based upon this criterion.
2. LIMITATION: electrical components are designed and made with a limited power so that in every operating condition the explosion cannot be ignited in anyway. Mode of protection Ex i is based on this criterion.
3. ISOLATION: the idea is to isolate the electrical equipment, that can cause the ignition of combustible mixture due to sparkings or high temperature, so that the explosion cannot be possible to ignite at any time. Mode of protections such as Ex m and Ex p take advantage of this criterion.

MODE OF PROTECTION	ZONE CLASSIFICATION			CALSSIFICATION ACCORDING TO ATEX DIRECTIVE 2014/34/EU			
	ZONE 20	ZONE 21	ZONE 22	GROUP		CATEGORY	
Ex ta	SUITABLE	SUITABLE	SUITABLE	I	II	M1	1D
Ex tb	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2D
Ex tc	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3D
Ex ia	SUITABLE	SUITABLE	SUITABLE	I	II	M1	1D
Ex ib	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2D
Ex ic	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3D
Ex ma	SUITABLE	SUITABLE	SUITABLE	I	II	M1	1D
Ex mb	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2D
Ex mc	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3D
Ex pD	FORBIDDEN	SUITABLE	SUITABLE	I	II	M2	2D
Ex pD	FORBIDDEN	FORBIDDEN	SUITABLE	N.A.	II	N.A.	3D

MODE of PROTECTION

EXPLOSIONPROOF ENCLOSURES “d”



Group	I	II
Category	M2	2G
Zone	N.A.	1, 2
EPL	Mb	Gb

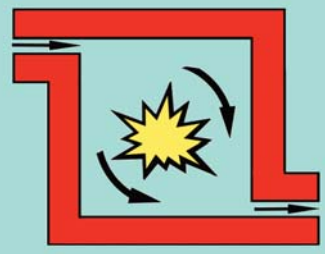
Principle

Mode of protection Ex d is based on the principle of containing the explosion inside the enclosure.
In this way every electrical equipment is installed within metallic enclosures that are able to withstand pressures which are generated in case of a possible internal explosion due to the ingress of gas or vapour (overpressure resistence). In addition, enclosures are made with flameproof joints of such dimensions as to prevent the transmission of the explosion to the outside amosphere (flameproof resistence).

Applications

Electrical equipment in general, including switches, circuit breakers, deviators, command and/or signalling units, motors, transformers, instruments, etc.

PROTECTION by PRESSURIZED ENCLOSURES “p”



Group	N.A.	II	
Category	N.A.	2G 3G	2D 3D
Zone	N.A.	1 2	21 22
EPL	N.A.	Gb Gc	Db Dc

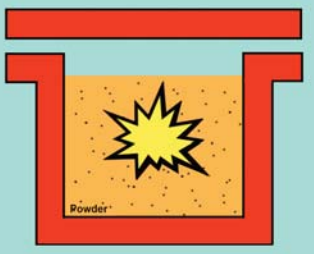
Principle

Mode of protection Ex p is based on the principle of inserting an inert gas with a greater pressure than the atmospheric in an enclosure. In this way the external potentially explosive atmosphere can not penetrate inside.
Air or nitrogen are normally used as inert gases. Obviusly, in case of malfunctioning of the circuit which pumps in pressurized gas, a control unit provides to switch off all electrical equipment.
Mode of protection Ex p can be used also for ambient with presence of combustible dusts; in this case the relative mode of protection will be indicated with Ex pD.

Applications

Transformers, electrical machineries, automation panels, analysis cabins etc.

PROTECTION by POWDER FILLING “q”



Group	I	II
Category	M2	2G
Zone	N.A.	1, 2
EPL	Mb	Gb

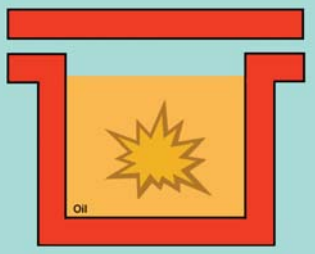
Principle

Mode of protection Ex q (also called “powder filling”), completely similar to mode Ex o, considers that parts likely to ignite an explosive atmosphere are embedded in a filling material (typically quartz or glass particles). This, contrary to the mode Ex o, cannot be used for moving machineries.
With powder filling the gas can entere inside the enclosure but the explosion is estinguished through the propagating path into the filling material.

Applications

In particular for low voltage equipment (1000 V is the maximum admitted voltage), typically power factor correction capacitors.

PROTECTION by LIQUID IMMERSION “o”



Group	N.A.	II
Category	N.A.	2G
Zone	N.A.	1, 2
EPL	N.A.	Gb

Principles

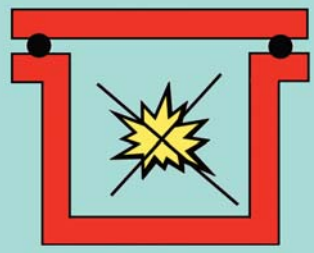
Mode of protection Ex o, using the same principle of mode of protection Ex q, provides that parts likely to ignite an explosive atmosphere are submerged in a protective liquid (typically oil) so that the potentially explosive atmosphere, located above the liquid, could not be ignited.
Mode Ex o, contrary to the mode Ex q, can be used for moving machineries.
Obviously, this method presents many problems during maintenance and/or control phases (i.e. to keep oil level and pressure to acceptable level, for problems in the event of emptying of the enclosure, etc.).

Application

Transformers.

MODE of PROTECTION

PROTECTION by INCREASED SAFETY "e"

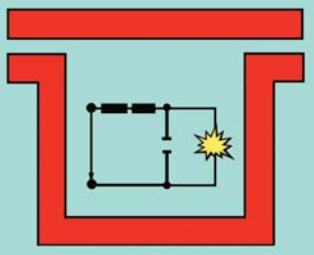


Group	I	II
Category	M2	2G
Zone	N.A.	1
EPL	Mb	Gb

Principles
Mode of protection Ex e uses additional measures in order to ensure an increased safety level against the possibility of excessive temperatures and the formation of arcs and sparks. Therefore, the mode Ex e has a narrow scope of application than Ex d, since all increased safety equipment shall avoid the ignition causes (arc, spark or excessive temperature). This can be achieved by constructive means (as the equipment overdimensioning)to limit extreme temperatures, the strengthen of insulation to avoid arc frmation, the increase of distances between mechanical parts to avoid spark and a greater care to the used material resistance and to degree of protection IP.

Applications
Rotating electrical machines (asynchronous motors with squirrel-cage rotor), lighting fittings, batteries, junction boxes, resisance heaters.

PROTECTION by INTRINSIC SAFETY "i"

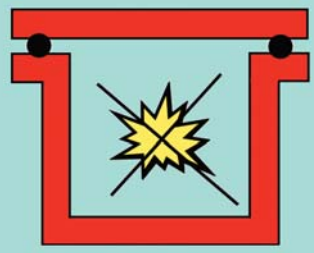


Group	I	II	
Category	M1 M2	1G 2G 3G	1D 2D 3D
Zone	N.A.	0 1 2	20 21 22
EPL	Ma Mb	Ga Gb Gc	Da Db Dc

Principio
Mode of protection Ex i uses the principle of energy limitation. So, in an intrinsic safety circuit no sparks and/or thermal effect, both under normal conditions and under fault conditions, can cause the ignition of a given potentially explosive atmosphere. For each gas group characteristics of the circuit and used components are designed in order to limit the energy stored and released by the circuit itself.
Mode of protection Ex i can be also used for cobustible dust explosive atmospheres.

Applications
Measuring, control and regulation instruments, telecommunication systems and portable equipment.

PROTECTION "n"



Group	N.A.	II
Category	N.A.	3G
Zone	N.A.	2
EPL	N.A.	Gb

Principles
Mode of protection Ex n includes a set of different modes of protection: containment, segregation and prevention each one able to prevent the ignition of explosive atmosphere only under normal conditions. Therefore, mode Ex n is applicable only to zone 2 and provides simplified protection methods.
More in particular equipment are divided into not sparking equipment (lighting fittings, motors, etc.) and sparking equipment (restricted breathing enclosure, closed-cell devices and sealed)or which produces arcs, sparks or excessive surface temperatures under the normal conditions. So, it could be the following:
Ex nA: non-sparking equipment;
Ex nC: sprarking equipment
Ex nR: restricted breathing enclosures.

NON-SPARKING EQUIPMENT "na"

Principles
This mode of protection applies to non-sparking equipment, i.e. that under normal conditions does not produce arcs, sparks or overheating.

Applications
Motors, fuses, lighting fittings, instruments and low-power equipment, transformers, plant material such as terminal boxes, junction boxes, plugs and sockets.

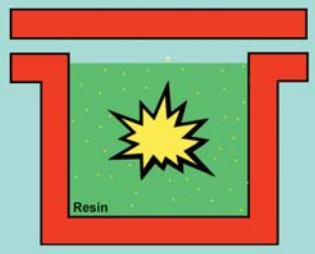
RESTRICTED BREATHING ENCLOSURES "nR"

Principles
Restricted breathing technique tries to reduce the possibility of surrounding explosive atmosphere ingress inside the enclosure so as not to exceed the lower limit of explosivity of the gas.
On Ex nR enclosures are carried out tests by creating a pressure difference between inside and outside and it is verified that leakage is lower than a predetermined value in a certain period. In addition equipment installed inside Ex nR enclosure shall have a reduced heat dissipation in order that the internal temperature does not exceed the outdoor temperature of 10°C. Finally, the enclosures shall be equipped with a test connection that allows the control of breathing properties during operation.

Applications
It applies to sparking equipment that under normal conditions creates arcs, sparks or hot spots (switches, contactors, relays, measuring instruments, lighting fittings).

MODI di PROTEZIONE

PROTECTION by ENCAPSULATION "m"



Group	I	II	
Category	M1 M2	1G 2G 3G	1D 2D 3D
Zone	N.A.	0 1 2	20 21 22
EPL	Ma Mb	Ga Gb Gc	Da Db Dc

Principle

Mode of protection Ex m consists of encapsulating the electrical equipment, or their components, inside a resin compund so that the explosive atmosphere cannot be ignited.
The encapsulated component, however, needs a connection with the rest of the plant and there is a problem of how to connect the cable without altering the protection. A bare conductor of at least 5 mm section is generally left into the compound.
Mode of protection Ex mD is based on the encapsulation with sealing requirements to the ingress of dust and limitation of the surface temperature.

Applications

Printed circuits, single small sizecomponents such as capacitors, transistors, relays, sensors, batteries, fuses, power supply circuits for lighting fittings and all the static components in general.

DUST IGNITION PROTECTION by ENCLOSURE "t"

Group	I	II
Category	M1 M2	1D 2D 3D
Zone	N.A.	20 21 22
EPL	Ma Mb	Da Db Dc

Principle

Mode of protection Ex t is based on the protection by an enclosure with sealing requirements against dust ingress and limitation of surface temperature. Electrical components that can ignite the ambient (high temperatures, sparks, etc.) are installed inside enclosures with degree of protection IP6X. In addition, temperatures of equipment external surfaces is kept below the maximum surface temperature T, in relation with the maximum temperature for dust cloud T_{Cl} and dust layer T_{5mm} provided at the installation site.

Applications

Switches, cmmand and control units, motors, transformers, lighting fittings, instrumentations and all equipment that under normal operation can cause the ignition of a dust cloud or the combustible dust layer (e.g. due to arcs, sparks, or excessive temperatures).

PROTECTION "s"

Principle

Mode of protection Ex s, actually not covered by any standards, is called mode of protection special. It is used whenever the protection solution are not regulated by any standards and the product must be tested by a Notified Body. If the tests verify the safety requirements a certificate will be issued and the equipment marked with mode of protection Ex s.

COMPOSED MODE of PROTECTION

Principle

It often happens that an electric equipment uses more than one of the mode of protection listed above. The typical example is a motor protected by an Ex d explosionproof enclosure and an Ex e increased safety terminal strip, or a lighting fitting protected by an Ex d enclosure and an Ex e increased safety terminal block.

These cases are usually called composed mode of protection and the marking will present after Ex the codes of the modes of protection concerned.

REFERENCE STANDARDS

It follows the list of the main applicable standards of products:

IEC STANDARD	EN STANDARD	TITLE
IEC 60079-0	EN 60079-0	Part 0: Equipment - General requirements
IEC 60079-1	EN 60079-1	Part 1: Equipment protection by flameproof enclosures "d"
IEC 60079-2	EN 60079-2	Part 2: Equipment protection by pressurized enclosure "p"
IEC 60079-5	EN 60079-5	Part 5: Equipment protection by powder filling "q"
IEC 60079-6	EN 60079-6	Part 6: Equipment protection by liquid immersion "o"
IEC 60079-7	EN 60079-7	Part 7: Equipment protection by increased safety "e"
IEC 60079-11	EN 60079-11	Part 11: Equipment protection by intrinsic safety "i"
IEC 60079-15	EN 60079-15	Part 15: Equipment protection by type of protection "n"
IEC 60079-18	EN 60079-18	Part 18: Equipment protection by encapsulation "m"
IEC 60079-31	EN 60079-31	Part 31: Equipment dust ignition protection by enclosure "t"

It follows the list of the main applicable standards of plants:

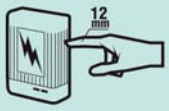
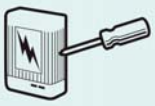
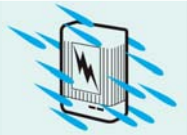
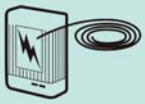
IEC STANDARD	EN STANDARD	TITLE
IEC 60079-10-1	EN 60079-10-1	Part 10-1: Classification of areas - Explosive gas atmospheres
IEC 60079-10-2	EN 60079-10-2	Part 10-2: Classification of areas - Explosive dust atmospheres
IEC 60079-14	EN 60079-14	Part 14: Electrical installations design, selection and erection
IEC 60079-17	EN 60079-17	Part 17: Electrical installations inspection and maintenance
IEC 60079-19	EN 60079-19	Part 19: Equipment repair, overhaul and reclamation

DEGREE of PROTECTION IP

The degree of protection IP, as defined in EN IEC 60529, is a code that summarizes the level of protection of electrical equipment against accidental or intentional contact with the human body or objects and the protection agiansct contact with water. The code is applicable to systems with rated voltages up to 72.5 kV.

Coding

International Protection	1st digit	2nd digit	Additional letter (optional)	Supplementary letter (optional)
IP	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6, 7, 8	A, B, C, D	H, M, S, W

1st DIGIT - SOLIDS			2nd DIGIT - LIQUIDS		
LEVEL	DEFINITION		LEVEL	DEFINITION	
IP0X		Non protected	IPX0		Non protected
IP1X		Protected agiansct solid foreign objects of 50 mm and greater	IPX1		Protected against vertically falling water drops
IP2X		Protected agiansct solid foreign objects of 12 mm and greater	IPX2		Protected against vertically falling water drops when enclosure tilted up to 15°
IP3X		Protected agiansct solid foreign objects of 2.5 mm and greater	IPX3		Protected against spraying water
IP4X		Protected agiansct solid foreign objects of 1 mm and greater	IPX4		Protected against splashing water
IP5X		Dust-protected	IPX5		Protected against water jets
IP6X		Dust-tight	IPX6		Protected against powerful water jets
			IPX7		Protected against the effects of temporary immersion in water
			IPX8		Protected against the effects of continuos immersion in water

ADDITIONAL LETTER (OPTIONAL)		SUPPLEMENTARY LETTER (OPTIONAL)	
LEVEL	DEFINITION	LEVEL	DEFINITION
A	Protected agiansct access with the back of the hand	H	High-voltage apparatus
B	Protected agains access with finger	M	Tested for harmful effects due to the ingress of water with movable part are in motion
C	Protected against access with a tool	S	Tested for harmful effects due to the ingress of water with movable part are stationary
D	Protected against access with a wire	W	Suitable for use under specified weather conditions

ATEX DIRECTIVE

The new **ATEX Directive 2014/34/EU** (on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres), published on Official Journal of the European Union (no. OJ EU L96) of 29 March 2014 and entered into force on 30 March 2014, has repealed the previous Directive 94/9/EC on 20 April 2016 in accordance with art. 43.
It is applied to all products, electrical and mechanical, inteded for use in potentially explosive atmospheres, it finds place among directives that allow the freedom of movement of goods and it defines the essential health and safety requirements (ESHR) of products that shall comply with. In particular, the Directive defines the characteristics that products shall comply to be installed in potentially explosive atmospheres and defines the different assessments to follow to obtain the conformity.
The scope of the Directive also applies to safety, control and regulation devices that are installed outside the potentially explosive atmosphere, from which depends the safety of equipment placed inside the hazardous area. Categories of excluded products from the scope of the directive are as follows:

- medical devices intended for use in a medical environment;
- gas equipment intended for use in domestic and non- commercial environments;
- equipment and protective systems used in environments with the presence of explosive substances;
- personal protective equipment;
- means of transport by land, sea, river and air (aside from vehicles that can cause an explosive atmosphere during loading and unloading phases or that are used in explosive atmosphere).

PRODUCTS CLASSIFICATION
The directive considers equipment for surface plants and for mines plants, because the hazards, the protective measures are similar for both; the first distinction concerns the subdivision into two groups:

- group I: equipment intended for use in underground mines;
- group II: equipment intended for use in surface plants.

Directive 2014/34/EU categorizes the products in relation to the protection level and to the environment grade of dangerousness where they will be installed.

GROUP I PRODUCTS
The equipment for undergorund mines are divided into 2 categories:

- category M1: equipment or protective systems that ensure a very high level of protection;
- category M2: equipment or protective systems that ensure a high level of protection; they shall be de-energised in the event of an explosive atmosphere.

GROUP II PRODUCTS
The equipment for surface plants (group II) are divided into 3 categories, depending on the level of protection (zone of use); categories are identified by the digits 1, 2, or 3 followed by the letter G (for gas) or D (for dust).

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

CONFORMITY ASSESSMENT PROCEDURES
Several conformity assessment procedures depending on equipment and category are performed for the purpose of marking. All electrical equipment of category 1 and category 2 must be compulsorily certified by an ATEX Notified Body, i.e. a conformity assessment body whose notifying authority of the Member State gave the task of carrying out verification of compliance with the Directive. The updated list of ATEX Notified Body is available at the following link: http://ec.europa.eu/enterprise/newapproach/nando/.
Notification and surveillance of quality management system by an ATEX Notified Body is mandatory for companies manufacturing electrical equipment of category 1 and category 2; the identification number of the NB is affixed on marking plate together with EC marking.
For the equipment of category 3 is sufficient only the self-certification, with the internal production control.
Manufacturer must prepare technical documentations to demonstrate that the equipment conforms to the requirements of the Directive; documentation shalll be kept at disposal for at least 10 years after the last product has been placed on the market. It is compulsory that all the products (category 1, 2 or 3) are delivered together with EU declartion of conformity and instruction for use.

Directive 99/92/EC, transposed in Italy by the Legislative Decree no. 233/03 and mandatory starting from the 1st of July 2003, unlike directive 2014/3/EU (ATEX) concerning products and their use in hazardous areas, is a social policy directive, which examines people and their own safety when they have to operate and to work in potentially explosive atmospheres. Very briefly, it is possible to say that is a sort of sub-directive of 89/391/EEC (transposed in Italy by the wellknown Legislative Decree 626/94 and currently in force with D.Lgs. 81/08 and subsequent amendments), that deals with specific regulations to follow in areas subjected to potentially explosive atmospheres.
This directive shall apply to same areas where the ATEX directive is applied, except for the mines; therefore it is a directive valid only for surface plants, both for gas and for dust atmospheres.
Directive 99/92/EC considers the zone classification of working places where an explosive atmosphere may occur made by the employer and latter decides groups, categories of equipment ot be used in each zone.
This classification - recalled by standard IEC/EN 60079-10-1 (for gas) and IEC/EN 60079-10-2 (for dust) - is carried out based on frequency and duration of explosive atmosphere presence.

Ex MARKING

Each electrical devices intended for use in potentially explosive atmospheres must present a minimum marking in accordance with Directive 2014/34/EU (only for European market) and products technical standards.

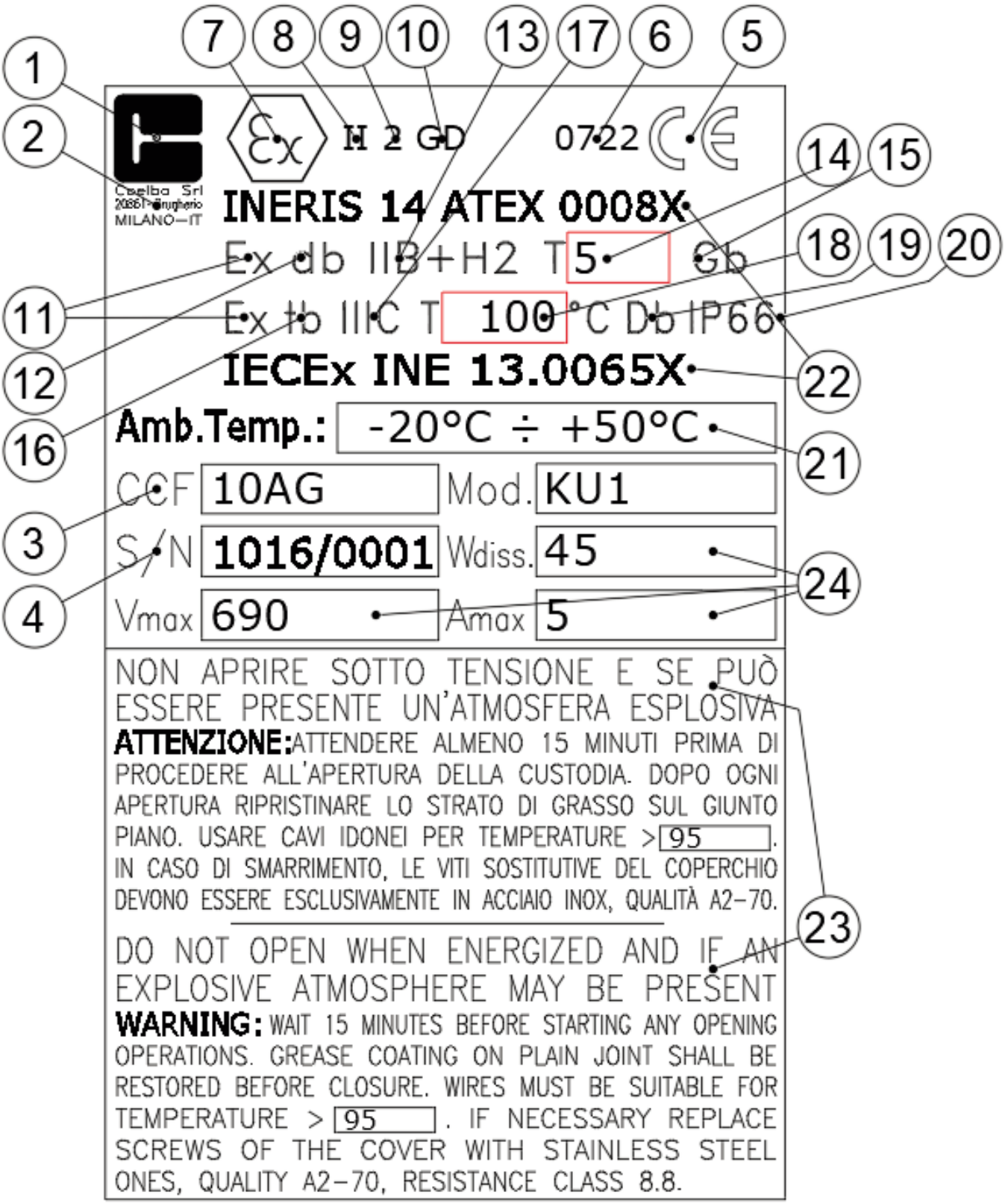
In compliance with the **Directive 2014/34/EU ATEX**, all equipment intended for use in potentially explosive atmospheres must provide indication of the following minimu information (EC marking):

- Name and address of the manufacturer;
- EC marking;
- Equipment identification by a product code and traceability with a serial number;
- The specific markin of protection against explosion according to Directive 2014/34/EU (ATEX);
- The indication of equipment group and the relevant category (see page A13).

In accordance with **IEC/EN 60079-0** standard, all equipment intended for use in potentially explosiveatmospheres must provide indication of the following minimu information (Ex marking):

- Name of the manufacturer or trademark;
- Product code;
- Community trademark;
- Ex logo (product conforming to IEC/CENELEC standards);
- Mode or modes of protection used (e.g. “d”, “t” or “de”, etc.);
- Indication of apparatus group (see page A13);
- Symbols of gases and/or dusts of subgroups (see pages A11 and A12);
- Temperature class and/or maximum surface temperature (see page A10);
- Number of the certifcate of conformity with the addition of some suffixes for particular cases (X = specific conditions of use, U = Ex component not intended to be used alone)
- classic rating plate data required for the equipment, such as voltage, current, degree of protection, ambient temperature, etc.

Ex MARKING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0722
INERIS 14 ATEX 0008X
Ex db IIB+H2 T5 Gb
Ex tb IIIC T 100°C Db IP66
IECEx INE 13.0065X
Amb.Temp.: -20°C ÷ +50°C
CCF 10AG
Mod. KU1
S/N 1016/0001
Wdiss. 45
Vmax 690
Amax 5
NON APRIRE SOTTO TENSIONE E SE PUÒ ESSERE PRESENTE UN'ATMOSFERA ESPLOSIVA
ATTENZIONE: ATTENDERE ALMENO 15 MINUTI PRIMA DI PROCEDERE ALL'APERTURA DELLA CUSTODIA. DOPO OGNI APERTURA RIPRISTINARE LO STRATO DI GRASSO SUL GIUNTO PIANO. USARE CAVI IDONEI PER TEMPERATURE > 95 . IN CASO DI SMARRIMENTO, LE VITI SOSTITUTIVE DEL COPERCHIO DEVONO ESSERE ESCLUSIVAMENTE IN ACCIAIO INOX, QUALITÀ A2-70.
DO NOT OPEN WHEN ENERGIZED AND IF AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT
WARNING: WAIT 15 MINUTES BEFORE STARTING ANY OPENING OPERATIONS. GREASE COATING ON PLAIN JOINT SHALL BE RESTORED BEFORE CLOSURE. WIRES MUST BE SUITABLE FOR TEMPERATURE > 95 . IF NECESSARY REPLACE SCREWS OF THE COVER WITH STAINLESS STEEL ONES, QUALITY A2-70, RESISTANCE CLASS 8.8.

Ex MARKING

No.	Marking	Descrizione	Possible Variants
1		Manufacturer's logo	----
2	Coelbo S.r.l. 20861 Brugherio MILANO-IT	Manufacturer's address	----
3	CCF 10AG	Equipment code	----
4	1016/0001	Serial number	----
5		Conformity mark	It must be followed by Notified Body number encharged of surveillance for equipment of category 1 and 2 (see 6).
6	0722	Number of Notified Body encharged of surveillance of Quality Assurance Notification	----
7		Specific marking of explosion protection	----
8	II	Equipment group	I = equipment for underground mines II = equipment for surface plants
9	2	Category group	1 for category 1 2 for category 2 3 for category 3
10	GD	Type of explosive atmosphere	G = for gas D = for dust
11	Ex	Compliance with International and European harmonized	----

12	db	Mode of protection for gas used	Mode of protection for GAS:
			d = flameproof enclosure;
			e = increased safety equipment;
			i = intrinsic safety equipment;
			de = equipment protected by a flameproof enclosure "d" together with a part protected by an increased safety "e";
			d [ia Ga] = equipment protected by a flameproof enclosure "d" which contains internally an intrinsic safety "i" apparatus (typically a barrier);
			nA = equipment built to minimize the risk of arcs and sparks that can ignite the explosive atmosphere under normal operation;
			nR = equipment designed to limit gas and vapours ingress;
			p = protection by pressurized enclosure;
			q = protection by powder filling;
			o = protection by liquid immersion;
			m = protection by encapsulation.

13	IIB+H2	Gas group	IIA, IIB, IIC (+ characteristics gas, if any)
14	T5	Temperature class	T1 = 450°C T2 = 300°C T3 = 200°C T4 = 135°C T5 = 100°C T6 = 85°C
15	Gb	EPL for gas	Ga = category 1G Gb = category 2G Gc = category 3G
16	tb	Mode of protection for dust used	Mode of protection for DUST: t = dust ignition protection by enclosure with means to limit surface temperatures; i = intrinsic safety equipment; t [ia Da] = equipment protected by a fdust ignition protection by enclosure "t" which contains internally an intrinsic safety "ia" apparatus (typically a barrier); p = protection by pressurized enclosure; m = protection by encapsulation.
17	IIIC	Dust group	IIIA, IIIB, IIIC
18	T100°C	Maximum surface temperature	Maximum surface temperature of equipment stated in °C
19	Db	EPL for dust	Da = category 1D Db = category 2D Dc = category 3D
20	IP66	Degree of Protection IP	"IP6X": states protection against solids "IPX6": states protection against liquids
21	-20°C÷+50°C	Ambient temperature range	To be specified if different from standard range (-20°C÷+40°C)
22	INERIS 14 ATEX 0008X IECEx INE 13.0065X	EC certificate number (ATEX) CoC certificate number (IEC-Ex)	"X": states the presence of specific conditions of use "U": states an Ex component
23	NON APIRIRE ...	Warning and precaution markings	----
24	W_{diss} / V_{max} / A_{max}	Electrical ratings	----

MATERIALS

ALUMINUM LIGHT ALLOYS

Aluminum light alloy is the most used materails to make flameproof enclosures all over the world.
Its excellent corrosion resistance characteristics make this material to be recognized as the most efficient and versatile for most kinfd of applications. It has the advantage of being much more lighter than cast iron, facilitating thus both assembly and maintenance of plants, and in addition it has a very good resistance to corrosion without the need to be surface protected (unlike cast iron that needs a galvanic protection and painting). Compared to stainless steel then, the aluminum has a hugely lower cost.
Mechanical characteristics of light alloy aluminum castings are highly satisfactory for uses in explosion proof equipment.
In the past either aluminum-copper alloys (with a poor corrosion resistance) or aluminum-magnesium alloys (though it offer a greater corrosion resistance, they showed the limit of magnesium presence that was able to cause sparks with energy values capable to ignite an explosion if mechanically hit - techincal standards nowadys limit magnesium quantity by weight in alloys) were used.
Currently most used alloys are aluminum-silicon ones where the copper content is in very low quantities and present the following characteristics:

- good mechanical strength;
- sufficient ductility;
- good compactness;
- corrosion resistance.

Most used aluminum alloy are AlSi10Mg(b) (EN AB 43100) and AlSi12(b) (EN AB 44100) whose chemical compositions in accordance with standard EN 1706 are shown in the following table:

ALLOY	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb	Sn	Ti	Impurities
EN AB 43100	9.0÷11.0	0.45	0.08	0.45	0.25÷0.45	-	0.05	0.10	0.05	0.05	0.15	0.05 - single 0.15 - global
EN AB 44100	10.5÷13.5	0.55	0.10	0.55	0.10	-	0.10	0.15	0.10	-	0.15	0.05 - single 0.15 - global

STAINLESS STEEL

Stainless steel are alloys made from iron, carbon and chromium that combine the typical mechanical properties of carbon steels to the corrosion resistance characteristics, due to a thin and transparent surface layer called "passivation layer" that it is formed by the contact between chemical elements constituting the alloy (tiypically chromium) and the oxygen.
Stainless steel are traditionally divided into three major categories, according to their microstructure: martensitic, ferritic and austenitic.
In the last years market has requested more and more materials that were able to resist corrosion due to chloirde and, for this reasons, our range of products are made in stainless steel AISI 316L (X2 CrNiMo 1712), belonging to austenitc group. Its special features are:

- excellent resistance to corrosion;
- ease of cleaning and excellent hygienic coefficient.

On the contrary, it should be noted that:

- corrosion resistance decreases at low temperatures: the acid breaks the oxyde film leading to general corrosion;
- into the slots and in protected areas, the amount of oxygen may not be sufficient to preserve passivation layer, resulting in crevice corrosion;
- halides ions, in particular the anion (Cl^-), break the passivation film causing the so-called pitting corrosion.

It follows chemical composition, in accordance with standard EN 10888:

ALLOY	C	Mn	P	S	Si	Cr	Ni	Mo	N
AISI 316L	<0.03	<2.0	<0.045	<0.03	<1	16.5÷18.5	10.0÷13.0	2.0÷2.5	<0.11

NICKEL PLATED BRASS

This type of material (CuZn39Pb3), which presents a good corrosion resistance, is mostly used to make Ex cable entries systems (typically cable glands). Besides the typical binary alloy composed by Copper (Cu) and Zinc (Zn), a low percentage of lead (Pb) is added to simplify machining.
Subsequently, the item is subjected to electrolytic surface treatment in order to improve both aesthetic appearance and corrosion protection against external agents.
It follows chemical composition, in accordance with standard EN 12164

ALLOY	Cu	Zn	Pb	Sn	Fe	Ni	Al	Altri
CuZn39Pb3	5,0÷59,0	Rem.	2,5÷3,5	<0,3	0,3	<0,2	0,05	<0,2

ZINC PLATED STEEL

Zinc plated steel is an iron (Fe) carbon (C) alloy and, as for the nickel plated brass, is used to make fittings elements.
It is a mild alloy steel for general purpose with small quantities od lead, bismuth, tellurium and sulfur. To improve corrosion resistance characteristics is subjected to galvanizing process after machining.

GLASS

Soda lime tempered glass is used in all applications where it is necessary to observe something without being in contact or as protection, with operating temperature up to +250°C.

GASKETS

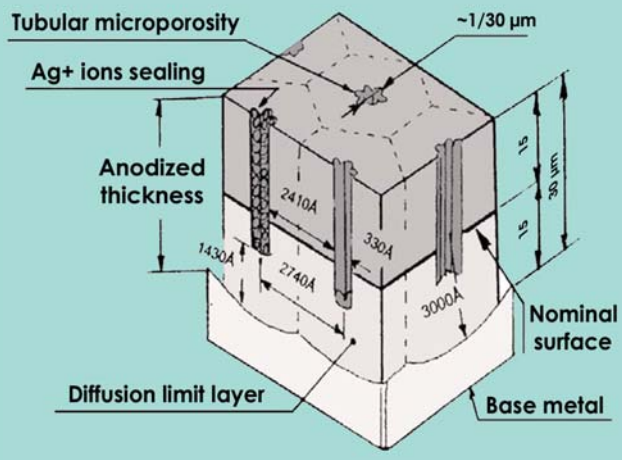
For our gaskets the following elastomers are used:
EPDM (Ethylene-Propylene Diene Monomer) rubbers are a synthetic rubbers family of the group M, that show a satisfactory compatibility with hydraulic fluids, incombustible, ketones, hot and cold water and alkalis and an unsatisfactory compatibility with most of the oils, gasoline, kerosene, hydrocarbons, halogenated solvents and concentrated acids.
The main properties of EPDM are its strong resistance to heat, ozone and weathering. It has excellent properties of electrical insulation.

Silicones are inorganic polymers based on a silicon-oxygen chain and functional organic groups (R) bound to the silicon atoms.
The **liquid silicone rubbers** (or LSR), polymeric masses made with addition of the appropriate catalyst, have the characteristics to be remarkably resistant to the temperature, chemical and corrosion attacks, and are excellent electrical insulators. In addition they present excellent non-stick behaviour, flexibility, resistance to aging and high temperatures.

ALUMINOX

What's ALUMINOX®?

ALUMINOX® is a combination of Aluminium alloy used for all Coelbo's products with a final surface treatment which involves the exclusive GHA technology (Golden Hard Anodizing).
The Aluminium alloys, because of their low hardness, present an extremely vulnerable surface (scratches, wear). Moreover, their natural bent to get oxidized, quickly triggers dangerous corrosion processes either locally (pitting) or diffused. This is why aluminium items are protected by painting, chrome, nickel or anodic oxidation coatings.
The Anodic Oxidation represents the most suitable and safe surface treatment among any others as it cannot be removed: the aluminium surface becomes Aluminium Oxide (Al2O3), creating a hard not removable protective layer. The Aluminium Oxide crystals present a very hard and compact hexahedron structure with a capillary hole on its centre, that severely limits its application especially when the surfaces are subject to frictions or to corrosive environments.
Scientists of M/s SOUKEN (Japan) have developed the process for sealing the porosities of the Al2O3 by a special galvanic process using Ag+ ions, transforming the porosity (which was a real defect) into a new material.



The technological characteristics lead by this process make extremely convenient and competitive any Aluminium alloys item Vs. the equivalent solution based on most valuable materials such as Stainless Steel, Titanium alloys or Steel coatings involving TIN, PVD, CVD, Hard Chrome, Chemical Nickel, etc.

Which are the advantages of ALUMINOX®?

ALUMINOX® preserves all the advantages of the Aluminium alloys with the addition of characteristics normally belonging to Stainless Steel as well as to other advanced materials:

- Unparalleled corrosion resistance in Marine/Saline environment;
- High antibacterial and anti-mildew capability;
- Extreme surface hardness (resistance to wear);
- Elevate thermal conductivity;
- Superior fire and heat resistance;
- Non stick and Antistatic properties (less dirt/easy cleaning and electrically safer);
- Self-lubricating surfaces (i.e. non-seizing threading).

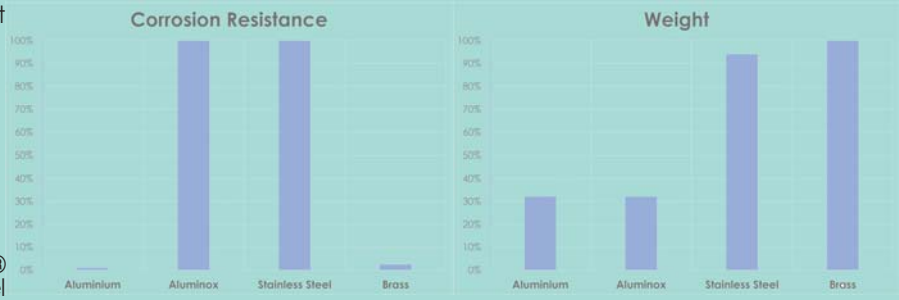
MATERIAL	HARDNESS (Hv)	Melting Point (°C)	Coefficient of Friction	Bacteriostatic capacity	Corrosion resistance (NSS)	Resistance to wear
Aluminum alloy	70÷100	680°C	0,44	None	50÷100 hours	10^2 hours
ALUMINOX®	500÷550	2100°C	0,025	Very High	10000 hours	10^5 hours
Hard anodizing	500÷550	2100°C	0,15	None	200÷500 hours	10^3 hours

When and where using ALUMINOX®?

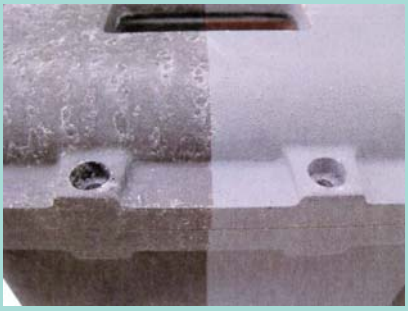
All the listed characteristics let the ALUMINOX® to be suitable where there is a particularly aggressive environment and in many different industrial areas such as:

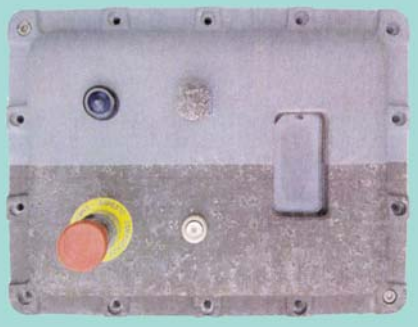
- Off-Shore platforms;
- Coastal Oil & Gas Exploration;
- Coastal Oil & Gas Drilling;
- Petrochemical Industries
- Ferrtilizers Production Plants;
- Food;
- Beverage;
- Pharmaceutical Industries;
- Etc.

The graphs below shows how the ALUMINOX® has the same behaviour as the Stainless Steel regarding corrosion resistance but at one third of the weight. This leads to some saving s aspects, because less weight means minor costs of transportation and even smaller frameworks on site of installation.



All the extraordinary characteristics of ALUMINOX® have been scientifically tested and proven by independent laboratories.
For example, as far as the resistance to corrosion is concerned, these laboratories have exposed a number of our enclosures to ACCELERATED CORROSION TESTS, lasting 600 hours in a Saline Atmosphere Chamber (Heraeus Votsch GmbH). The test report no. 10661/2009 dated January 30th 2009, indicates that "the enclosures and their covers present an uniform downgrading localized to some small circular corrosion hotbeds (see picture below). No invasive damages such as rising of surface layers or craters (pitting) occurred".





PLANTS

PLANTS WITH CONDUIT

Making a plants with conduit means placing all the conductors in metallic threaded conduits.

The most obvious adavantage is that it is made evidently a plant with a very high mechanical protection level, therefore suitable in those places where this is a very real problem (e.g. oil and chemical industries).
On the contrary, such kind of plant is totally rigid and therefore really low adaptable to wiring changes, installation is expensive and conduits tend to rust over time.

To prevent that a a possible explosion may propagate through the conduit system, between one enclosure and the other, technical standards request that a "sealing nipple or a sealing joint" (an element filled with resin that does not allow the transmission of the explosion) is placed before the conduit.

This sealing joint shall be installed at a distance lesser than 45 cm from the enclosure. Indeed, it shall be installed every time that the conduit passes from an hazardous area to an ordinary one.
The filling of joint with the blocking resin is a delicate operation which must be carried out with several precautions necessary to prevent the creation of empty zones ehich could void the flame arrest.

Eventually, when three or more cables are used in conduits, the total section of cables, including insulating material, shall not be greater than 40% of conduit section.
Conduits are normally rigid, but there are situations where it could be useful and reasonable to use flexible conduits, for example when it is necessary to connect a control panel with a vibrating equipment such as a motor.

PLANTS WITH DIRECT ENTRY OF CABLE INTO ENCLOSURES

This type of plants is much more similar to traditional plant, because the cables are not inserted into rigid metallic conduits, but are installed with normal modes.
In case of direct entry, the cable goes directly into the enclosure by a cable gland with sealing ring that prevents the propagation of a possible explosion outside the enclosure.
Used cable glands shall be certified in accordance with standards IEC/EN 60079-0 and IEC/EN 60079-1 (at least) and are divided into two different categories:

- cable glands where the seal is made only by the inner sealing ring;
- sealing cable glands where the seal is made both by the inner sealing ring and by the blocking resin.

Sealing ring of cable gland (or the blocking resin) shall have a certain lenght such as to ensure flameproof characteristics.
For the correct choice of ceble glands see following page.

In addition, cable glands are suitable for use with:

- armoured cables (cables with an armour that ensures a certain mechanical resistance with grounding continuity);
- not armoured cables (suitable when risk of mechanical damages is limited and grounding continuity is not mandatory).

Whether armoured cables or not armoured cables are used, obviusly, it is necessary to respect some different installation requirements as not to insert morethan one cable in the same cale gland and using cable glands with internal diameter equal to cable diamter.

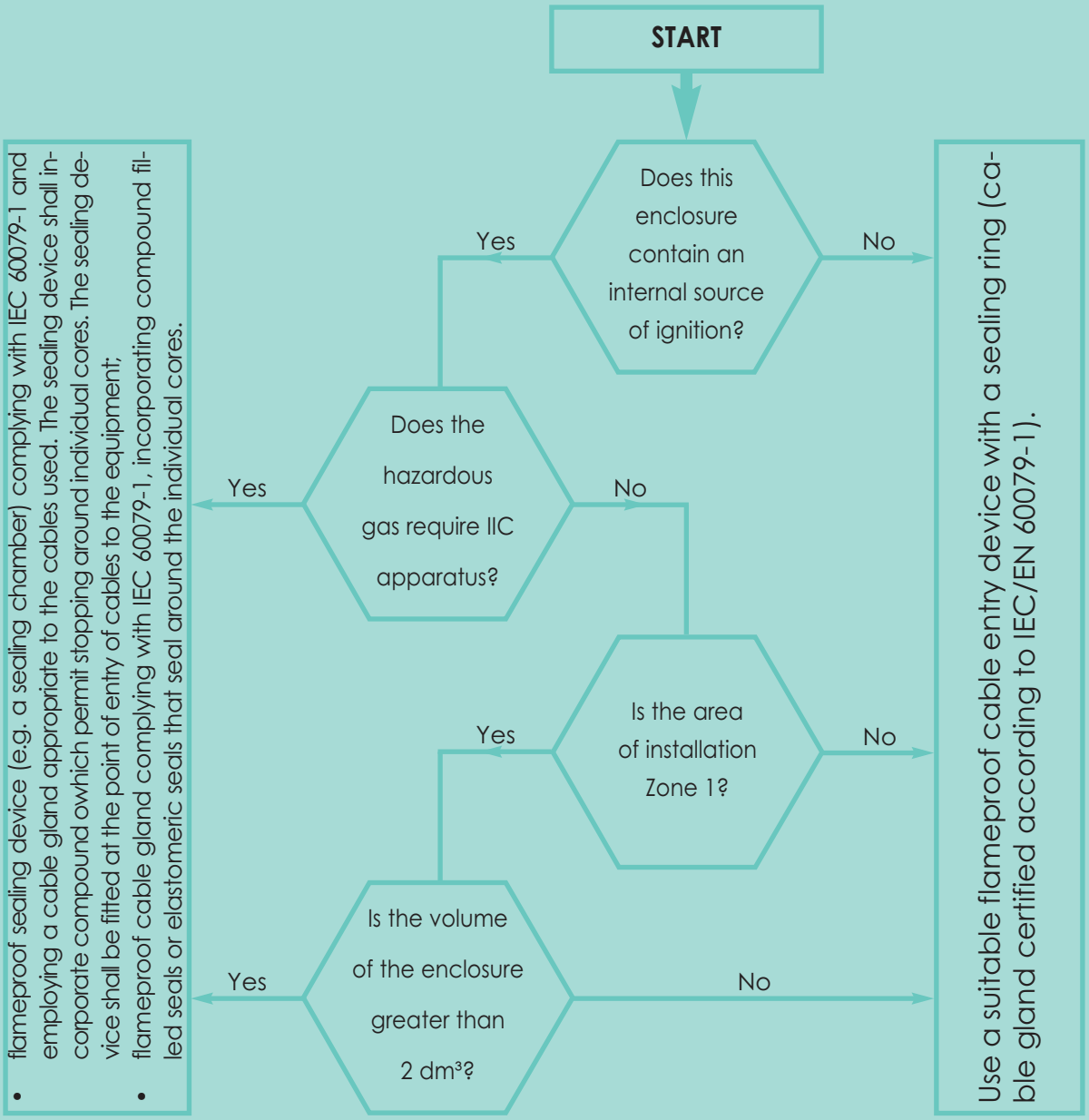
PLANTS WITH INDIRECT ENTRY OF CABLE INTO ENCLOSURES

In this type of plants cable does not enter directly into explosion proof enclosure Ex d, but pass through an increased safety enclosure Ex e, where are present terminal strips.
The cables then continue and arrive through sealed passages in the Ex d enclosure which contains equipment that could cause sparks.

CABLE ENTRIES SELECTION

CABLE ENTRIES SELECTION

In accordance with paragraph 10.4.2. of IEC 60079-14:2007 and EN 60079-14:2008 the cable entry system shall comply with the following diagram:



NEW STANDARD

Starting from 02/01/2017 la IEC/EN 60079-14:2015 will supersede the previous edition of the standard.
This will cause the application of the new paragraph (10.6.2.) concerning the selection of cable entries, that will no longer use the diagram above, but the following choices:

a) Cable glands sealed with setting compound (barrier cable glands) in compliance with IEC 60079-1 and certified as equipment;
b) Cables and glands meeting all of the following:
   - cable glands comply with IEC 60079-1 and are certified as equipment,
   - cables used comply with 9.3.2(a),
   - the connected cable is at least 3 m in length;
c) Indirect cable entry using combination of flameproof enclosure with a bushing and increased safety terminal box;
d) Flameproof sealing device (for example a sealing chamber) specified in the equipment documentation or complying with IEC 60079-1 and employing a cable gland appropriate to the cables used. The sealing device shall incorporate compound or other appropriate seals which permit stopping around individual cores. The sealing device shall be fitted at the point of entry of cables to the equipment.