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Explosion Proof & Environment



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■ How an Explosion Occurs

An explosion can only occur if there is a combination of the following three factors.

- Source of ignition
- Oxygen
- Combustible substances

Combustible substances can exist in the form of gases, vapor, mist or dust. If one component is missing, no explosion will take place

■ How to minimize an explosion

The followings are protective measures to minimize the risk of an explosion.

- Limit concentration to a safe level
- Avoid combustible substances
- Increase ventilation
- Prevent the ignition
- Restrict explosive effects to a negligible level

■ An explosive environment is categorized in three segments, Zone 0, Zone 1 and Zone 2, depending on the hazardous level of gases and vapors

Zone 0

An area where an explosive atmosphere consisting of a mixture of air containing flammable substances in the form of gas, liquid, or vapor continuously present or is frequently present for a longer period of time.

Zone 1

An area where an explosive atmosphere consisting of a mixture of air containing flammable substances in the form of gas, liquid, or vapor can occasionally occur during normal operating conditions.

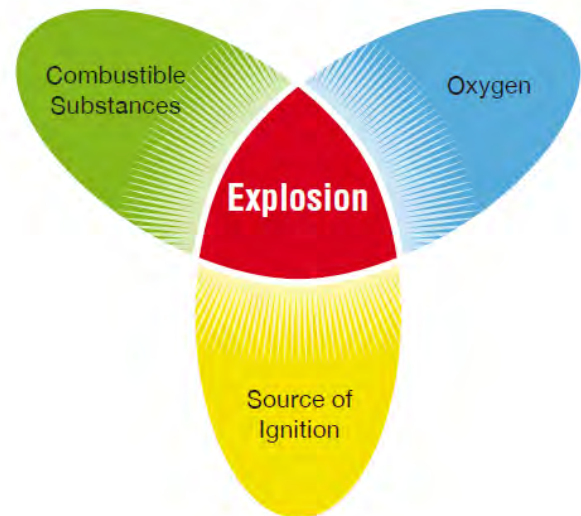


Zone 2

An area where an explosive atmosphere consisting of a mixture of air containing flammable substances in the form of gas, liquid, or vapor is not likely to occur under normal conditions. However, if it occurs, it will only be for short period of time.



Prerequisites for an explosion



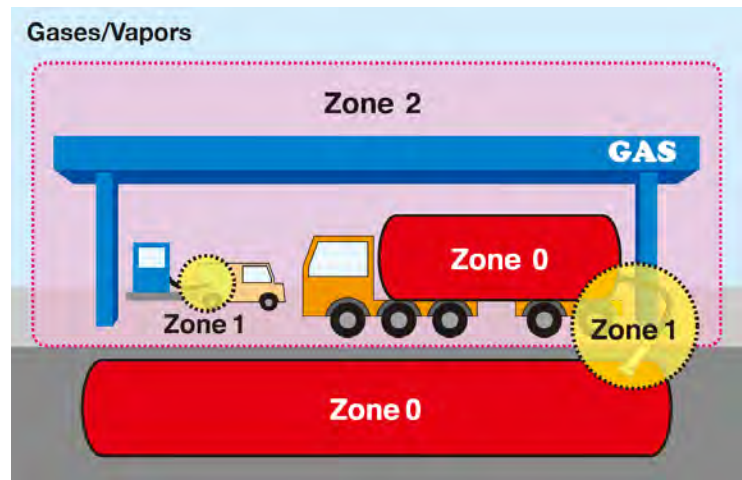
Classification of Hazardous Areas

■ Gases/Vapors

The tank is filled with flammable liquid. The inside of the tank is defined as Zone 0, because the explosive gas/oxygen mixture is continuously present.

Vapor may escape on occasion through the vent on the top of the tank, therefore the area around the vent is categorized as Zone 1.

The vapor may also run down the outside of the tank, developing another explosive environment, so the area around the tank is categorized as Zone 2.



		Constant Exposure	Occasional Exposure	Rare and Temporary
ATEX	EN60079-10	Zone 0	Zone 1	Zone 2
IEC	IEC60079-10	Zone 0	Zone 1	Zone 2
US	NEC505	Zone 0 (Class I)	Zone 1 (Class I)	Zone 2 (Class I)
	NEC500	Division 1 (Class I)		Division 2 (Class I)

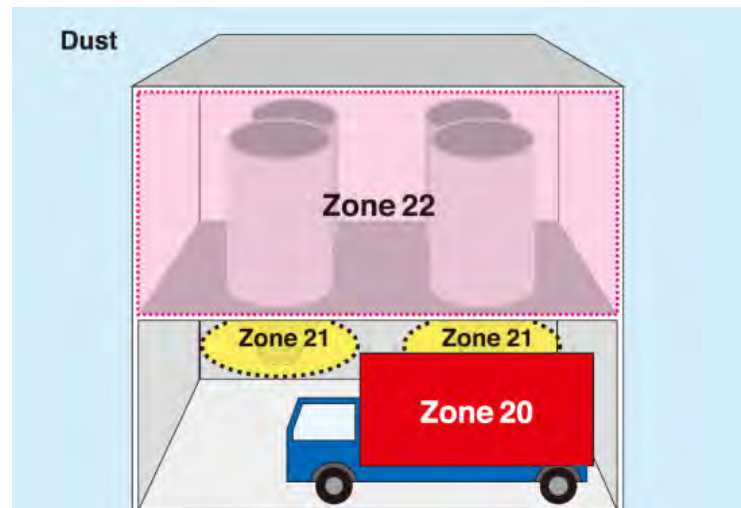
■ Dust

At a mill with a feed hopper and filter: A product, which causes dust particles mixed with air to cause a flammable mixture, is loaded into a hopper.

Inside the feed hopper and filter, it is categorized as Zone 20.

While the product is being loaded, the mixture of dust and air causes a potentially explosive compound in the area where the product is loaded into the hopper, so the area outside the hopper is categorized as Zone 21.

Around the hopper where a potential flammable atmosphere exists temporarily is categorized as Zone 22.



		Constant Exposure	Occasional Exposure	Rare and Temporary
ATEX	EN61241-10	Zone 20	Zone 21	Zone 22
IEC	IEC61241-10	Zone 20	Zone 21	Zone 22
US	NEC505	Zone 20 (Class II)	Zone 21 (Class II)	Zone 22 (Class II)
	NEC500	Division 1 (Class II)		Division 2 (Class II)

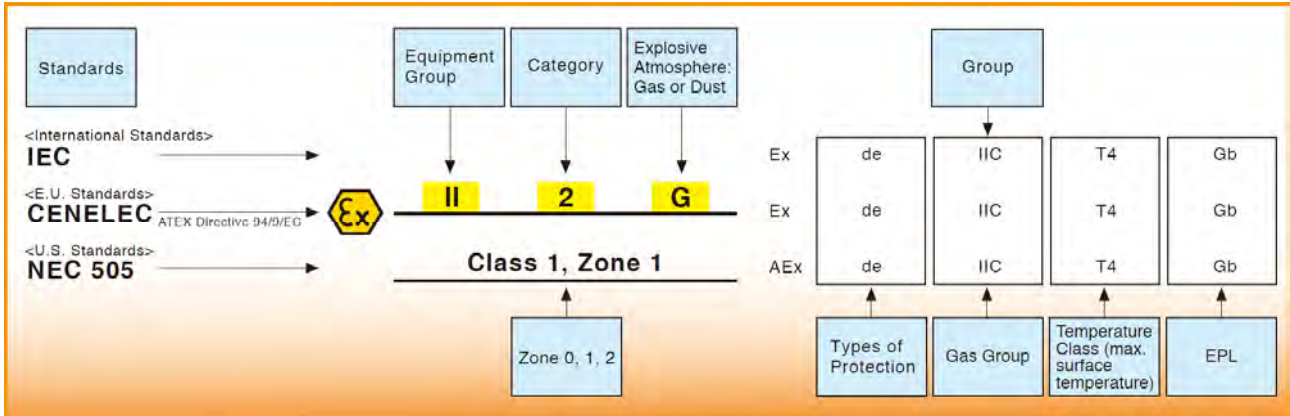
Relationship of IEC, CENELEC, NEC 505 and NEC 500

IEC: International Electrotechnical Commission

CENELEC: European Committee for Electrotechnical Standardization

NEC: National Electrical Code

IEC/CENELEC	Zone 0	Zone 1	Zone 2
USA:NEC 505	Zone 0	Zone 1	Zone 2
USA:NEC 500	Division 1		Division 2
	Explosive Material	Class	Group
	Gas, Vapor or Liquid	I	A, B, C, D
	Dust	II	E, F, G
	Fibers	III	—
			Explosive Material
			Class
			Group
			I
			A, B, C, D
			II
			E, F, G
			III
			—



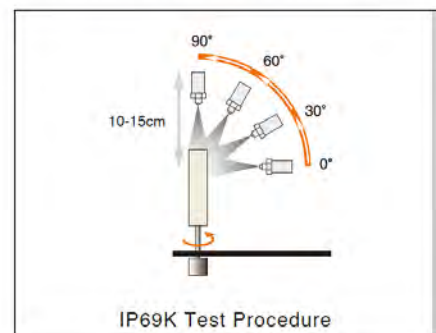
*EPL: Equipment Protection Level

IP Protection Rate: Index of Ingress Protection

IP IEC60529

5	The entrance of dust is not closed completely, but dust may not go into the device in such manner as to impair the optimal operation or safety of the device.	5	No detrimental effect occurs when a jet-stream is applied to the test sample from any direction. (TEST: 12.5 liter/min. of water is sprayed with a jet nozzle, having an internal diameter of 6.3mm, and a distance from the test sample of 2.5m - 3m away)
		6	No detrimental effect occurs when water is sprayed onto the test sample by a jet-stream from any direction. (TEST: 100 liter/min. of water is sprayed with a jet nozzle, having an internal diameter of 12.5mm, with a distance of 2.5m - 4m away from the test sample)
		7	Water must not enter into the device. No detrimental effect occurs when the device is submerged in a depth of 1 meter of water for 30 minutes.
6	No intrusion of dust into the device occurs.	8	Water must not enter into the device. No detrimental effect occurs when the device is continuously submerged. The test conditions are to be mutually agreed upon by the manufacturer and user.

IP69K IP69K is the German DIN 40050 PART9 standard. It is defined as a protection regulation for high temperature and high-pressurized water. Water is heated up to 80 °C and sprayed at a water pressure in the range from 80 to 100 bars at 14 to 16 liters per minute at the test object. The test object is at a distance of 100 to 150 mm from the nozzle and sprayed in all directions at 0, 30, 60, and 90 degrees, then sprayed at a horizontal angle while it is being rotated, all done for a period of 30 seconds without being affected by water penetration.












Types of Protection






According to EN Standard Series EN 60079, explosion protected electrical equipment can have various types of protection according to its construction.

The table below for Gas and Dust shows an overview of the standardized protections and describes its basic principal, as well as its practical applications.

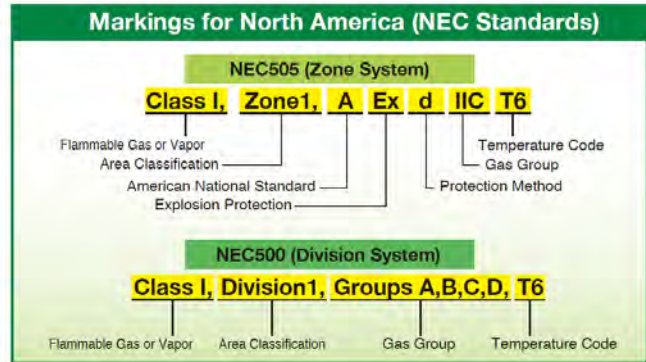
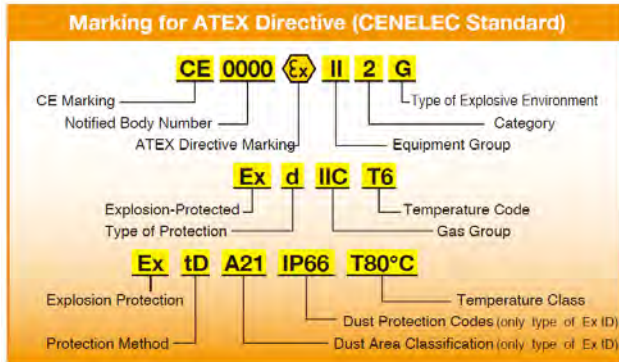
Gas

Type of Protection	Marking	Diagram	Definition	Applications
General requirements EN 60079-0 IEC 60079-0				
Flameproof Enclosure "d" EN 60079-1 IEC 60079-1	Ex d		Parts which can cause ignition while in a potentially explosive environment are encased in an enclosure which can withstand the pressure to contain it when the explosive mixture ignites inside so it is not transmitted into the environment.	Switch Gear, Control Gear, Display Units, Control Systems, Motors, Transformers, Heating Equipment, Light Fittings
Increased Safety "e" EN 60079-7 IEC 60079-7	Ex e		Preventative safety precautions are applied to prevent the possibility of excessive temperatures, the occurrence of sparks or electrical arcing within the equipment enclosure or on exposed parts of the equipment that would not be a hazard in conditions where ignition sources are not present.	Terminal Boxes, Connection Boxes, Control Boxes (for installing Ex-components with different types of protection) Squirrel-cage Motors, Light Fittings
Intrinsic Safety "i" EN 60079-11 IEC 60079-11	Ex ia Ex ib Ex ic		Equipment used in a potentially explosive environment contains intrinsically safe electrical components only. The electric circuit is intrinsically safe when no sparks or internal heat produced under normal operating conditions and specific fault conditions is not capable of causing ignition in a given explosive atmosphere.	Measurement and Control Technology, Communication Technology, Sensors, Actuators. ia = use in Zone 0, 1, 2 ib = use in Zone 1, 2 [Ex ib] = associated equipment - installation in safe areas
Oil Immersion "o" EN 60079-6 IEC 60079-6	Ex o		Electrical equipment or parts are immersed in a protective fluid (such as oil), to prevent the ignition of a potentially explosive atmosphere which may be located over or outside the equipment.	Transformers, Starting Resistors
Pressurized Enclosure "p" EN 60079-2 IEC 60079-2	Ex p		Inside the enclosure, a positive internal pressure in relation to the surrounding atmosphere is maintained with the supply of a constant flow of protective gas (when necessary) to dilute any combustible mixtures.	Switch Gear, Control Cabinets, Analyzers, Large Motors. px = use in Zone 1, 2 py = use in Zone 1, 2 pz = use in Zone 2
Powder Filling "q" EN 60079-5 IEC 60079-5	Ex q		The casing of the electrical equipment is packed with fine granular material to make it impossible for any electric arc created inside the casing under certain operating conditions to ignite the potentially explosive environment outside the casing. Ignition cannot be the result from flames or the raised temperature on the surface of the casing.	Sensors, Display Units, Electronic Ballasts, Transmitters
Encapsulation "m" EN 60079-18 IEC 60079-18	Ex m		Parts which can cause ignition in a potentially explosive environment by sparking or heating are enclosed in a compound to contain and isolate it from the ignition of an explosive environment.	Switch Gear with small breaking capacities, Control and Signalling Units, Display Units, Sensors. ma = use in Zone 0, 1, 2 mb = use in Zone 1, 2
Type of Protection "n" EN 60079-15 IEC 60079-15	Ex nA Ex nR Ex nL		Electrical equipment cannot cause the ignition of a potentially explosive atmosphere (defined under abnormal operating conditions and during normal operation).	All Electrical Equipment for Zone 2 nA = non-sparking equipment nC = sparking equipment in which contacts are conveniently protected nL = energy-limited equipment nR = restricted breathing

Dust

Type of Protection	Marking	Diagram	Definition	Applications
General requirements EN-IEC 60079-0 IEC 60079-0				
Protection by Enclosures "t" EN-IEC 60079-31 IEC 60079-31	Ex t		Dust is incapable of ingressing the enclosure at all or the quantity is at a safe degree, which allows the ignitable equipment to be mounted inside. The surface temperature of the enclosure will not cause ignition to the surrounding explosive atmosphere.	Switch Gear, Control Gear, Connections, Terminal Boxes, Motors, Light Fittings. td A21 = According to Method A for Zone 21 td B21 = According to Method B for Zone 21
Pressurized Enclosure "pD" EN-IEC 61241-4 IEC 61241-4	Ex pD		Inside the enclosure, a positive internal pressure in relation to the surrounding atmosphere is maintained with the supply of a constant flow of protective gas (when necessary) to dilute any combustible mixtures.	Pumps
Intrinsically Safe "i" EN-IEC 60079-11 IEC 60079-11	Ex ia Ex ib Ex ic		Equipment used in a potentially explosive environment contains intrinsically safe electrical components only. The electric circuit is intrinsically safe when no sparks or internal heat produced under normal operating conditions and specific fault conditions is not capable of causing ignition in a given explosive atmosphere.	Measurement and Control Technology, Communication Technology, Sensors, Actuators. iD = use in Zone 20, 21, 22 iB = use in Zone 21, 22 [Ex iB] = Associated Electrical Equipment - Installation in Safe Areas
Encapsulation "m" EN-IEC 60079-18 IEC 60079-18	Ex ma Ex mb		Parts which can cause ignition in a potentially explosive environment by sparking or heating are enclosed in a compound to contain and isolate it from the ignition of a layer of dust or cloud.	Small capacity Switch Gear, Controlling and Signalling Units, Display Units, Sensors. maD = use in Zone 20, 21, 22 mbD = use in Zone 21, 22

Standard Markings



Explosion-Proof Protection

Protection Method	Europe (ATEX Directive / CENELEC) International (IEC)				North America Class I				
	Protection Code	Zone	CENELEC ATEX	IEC IECEx	NEC505		NEC500		
					Protection	Zone	US	Division	US
Flameproof	Ex d	1, 2	EN60079-1	IEC60079-1	AEx d	1, 2	ANSI/ISA 60079-1	1, 2	FM3615 UL1203
Increased Safety	Ex e	1, 2	EN60079-7	IEC60079-7	AEx e	1, 2	ANSI/ISA 60079-7	—	—
Intrinsic Safety (2 faults)	Ex ia	0, 1, 2	EN60079-11	IEC60079-11	AEx ia	0, 1, 2	ANSI/ISA 60079-11	1, 2	FM3610 UL913
Intrinsic Safety (1 fault)	Ex ib	1, 2	EN60079-11	IEC60079-11	AEx ib	1, 2	ANSI/ISA 60079-11	—	—
Purged/Pressurized	Ex p	1, 2	EN60079-2	IEC60079-2	AEx p	1, 2	ANSI/ISA 60079-2	1, 2	FM3620 NFPA496
Encapsulation	Ex m	1, 2	EN60079-18	IEC60079-18	AEx e	1, 2	ANSI/ISA 60079-18	—	—
Non-incendiaries	—	—	—	—	—	—	—	2	FM3611 UL1604
Type-n	Ex n	2	EN60079-15	IEC60079-15	AEx n	2	ANSI/ISA 60079-15	—	—

Zone Classification

	CENELEC IEC	NEC505	Hazardous Area Classification
Gases	Zone 0	Class I Zone 0	An area where the mixture of explosive gas is continuously present or present for long periods.
	Zone 1	Class I Zone 1	An area where the mixture of explosive gas can be present during normal operation.
Vapors	Zone 2	Class I Zone 2	An area where the mixture of explosive gas is not normally present, but if it occurs, it will only be for brief periods of time.
	Zone 20	—	An area where the mixture of incendiary dust is continuously present or present for long periods.
Dust	Zone 21	—	An area where the mixture of incendiary dust can be present during normal operation.
	Zone 22	—	An area where the mixture of incendiary dust is not normally present, but if it occurs, it will only be for brief periods of time.

ATEX Directive (CENELEC)

Equipment Group	Category- Protection Level	Explosive Environment	Flammable Substances	Hazardous Areas
I -mines	M1- Very High Level	Constant Exposure	Methane	—
	M2- High Level	Ocassional Exposure	Coal Dust	—
II -other areas	1- Very High Level	Constant Exposure	Gases	Zone 0 (Gases) Zone 20 (Dust)
	2- High Level	Ocassional Exposure	Vapors	Zone 1 (Gases) Zone 21 (Dust)
	3- Normal Level	Rare and Temporary	Mists Dust	Zone 2 (Gases) Zone 22 (Dust)

ATEX/IEC Classification for Gases & Temperature Coding

	T1 (450°C)	T2 (300°C)	T3 (200°C)	T4 (135°C)	T5 (100°C)	T6 (85°C)
I	Methane	—	—	—	—	—
IIA	Acetone Ethane Propane	Ethyl Alcohol Cyclohexane n-butane	Gasoline Aircraft fuel Diesel fuel	Acetaldehyde	—	—
IIB	Lighting gas Acrylonitrile	Ethylene oxide	Ethylene Glycol Hydrogen sulphide	Ethyl-ether	—	—
IIC	Hydrogen	Acetylene	—	—	—	Carbon bisulfide



■ Markings

