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IPMA international project management association

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HAZARDOUS AREAS

International / National Standard Classification

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INMETRO · Ex CQST · JIS · GOST-K · IECEx · CSA · Ex · PCT · nec

HAZARDOUS AREAS

International / National Standard Classification

IECEx Scheme Certificate, IEC based Standards w/o National Deviations

CSA Standards, C22.2 Series,
a/o CAN/CSA 22.2 Series based on IEC with National Deviations

ATEX, EN Series Standards based on IEC with National Deviations

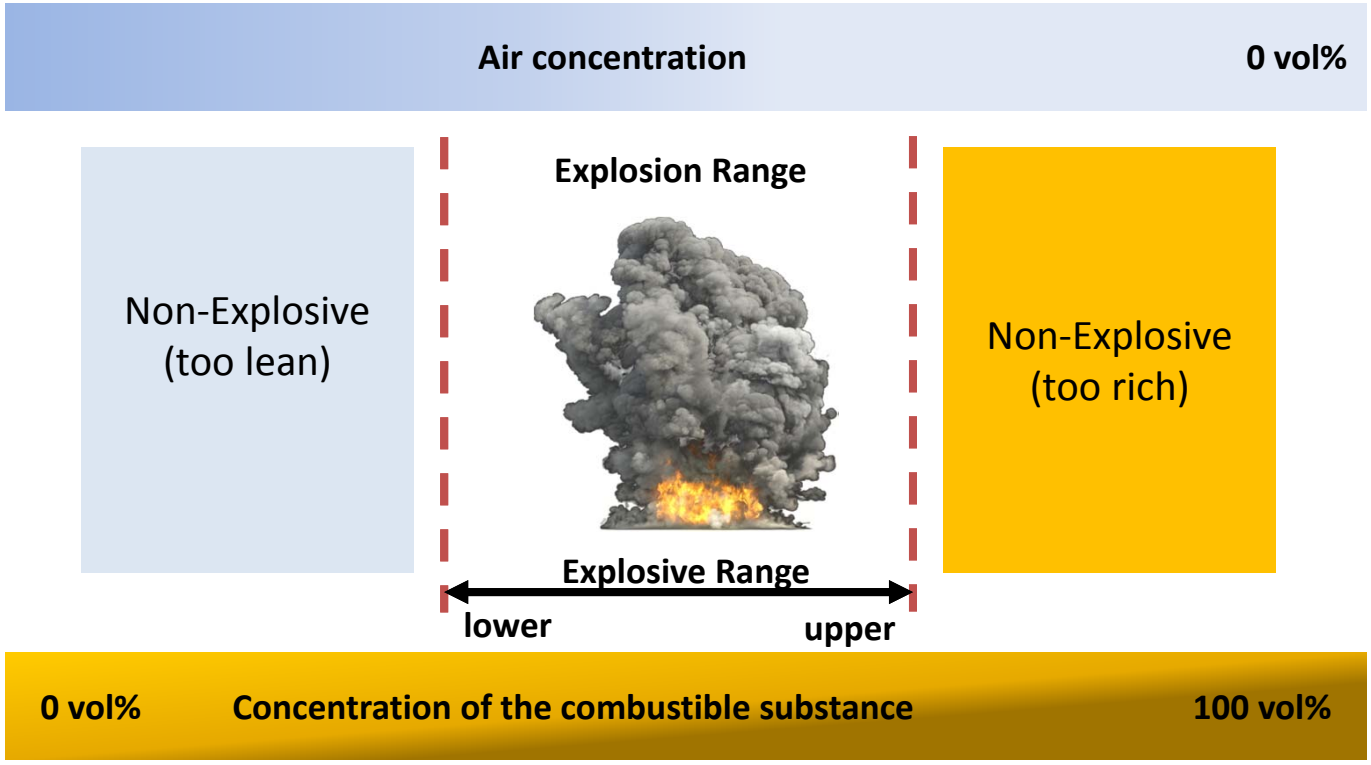
Far East IEC based with National Deviations

Rest of the World IEC based with National Deviations

US (NEC 5050) and CA (CEC Annex J)
ANSI Standards based on IEC with National Deviations

HAZARDOUS AREAS

Explosive Limits



Criteria for combustible liquids:

Category	Criteria	
1	Flashpoint	< 23 °C and boiling point ≤ 35 °C
2	Flashpoint	< 23 °C and boiling point > 35 °C
3	Flashpoint	≥ 23 °C and ≤ 60 °C ([1])

([1]) For the purpose of the CLP Regulation, gas oil, diesel and light heating fuels, which have a flashpoint ranging from 55 °C to 75 °C, may be deemed to belong to Category 3.

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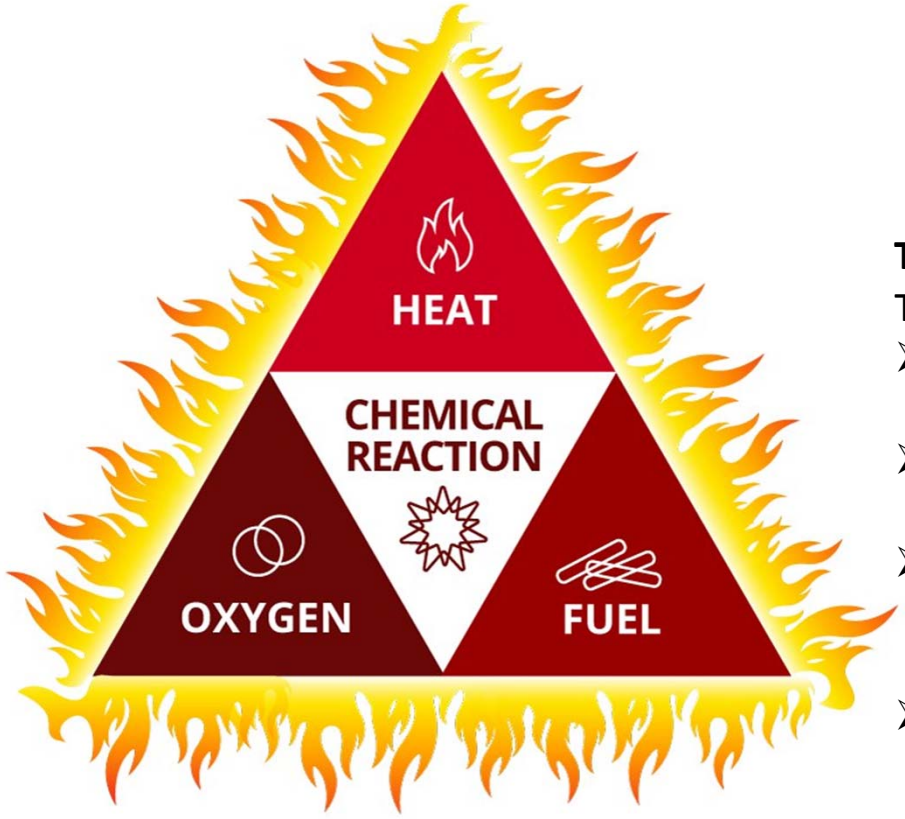
Fire Triangle



FIRE TETRAHEDRON

The stages of fire:

There are four stages of fire, including:

- **Ignition:** At this stage, a fire extinguisher can control the fire.
- **Growth:** Additional fuel ignites, causing the size of the fire to increase.
- **Fully developed:** This is when temperatures reach their peak, causing damage.
- **Burnout:** The fire gets less intense.

Source: https://www.firerescue1.com

HAZARDOUS AREAS

Explosive / Flammability Limits

Substance	Lower Explosive Limit [LEL vol%]	Upper Explosive Limit [UEL vol%]	Flash Point [°C]	Auto ignition Temperature [°C]	Density [kg/m³] (at 1 atm & 0°C)
Acetylene (C_2H_2)	2.5	100 (self decomposing)	Flammable Gas	300	1.1772
Carbon Dioxide (CO)	not combustible	not combustible	not combustible	not combustible	1.977
Carbon Monoxide (CO_2)	12.5	74.2	-191	609	1.250
Hydrogen (H_2)	4	77	not combustible	535	0.0888
Nitrogen (N_2)	4	75	not combustible	not combustible	1.153
Argon (Ar)	not combustible	not combustible	not combustible	not combustible	1.761
Oxygen (O_2)	not combustible	not combustible	not combustible	not combustible	1.411
Methane (CH_4)	5	15	-188	537	0.6
Ethane (C_2H_6)	3	12.4	-135	472	1.0

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Composition of Air and different Off Gas (typical average)

Source	CO	CO_2	H_2	N_2	Other	O_2	Ar
EAF (Electric Arc Furnace)	16 – 18%	11 – 20%	1 – 7%	50 - 60%	CH_4	1 -3%	
BOF (Basic Oxygen Furnace)	50 – 70%	10 – 20%	1 – 2%	15 – 30%			
BF (Blast Furnace)	20 – 35%	20 – 30%	2 – 4%	50 – 60%			
COG (Coke Oven Gas)	5 – 10%	3 – 5%	55%	10%	CH_4 (25%)		
Air		0.03%		78.08%	>0.17% (Ne, He, CH_4, Kr)	20.95%	>0.93%

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European Union Explosion Protection

- **EU Directive 2014/34/EU (ATEX)**
- EN 13463 standard series
- EN 50014 ff series
- EN / IEC 60079 series
- ISO 80079-36 and -37
- EN 1127-1: Explosive atmospheres – Explosion protection – Part 1: Basic principles and methods.
- EN 1127-2: Explosive atmospheres – Explosion protection – Part 2: Basic principles and methods in mines

Explosion protection document must compulsorily contain details on the following aspects:

- ✓ Risk assessment.
- ✓ Protection measures adopted.
- ✓ Zone classification.
- ✓ Observance of minimum requirements. These are divided into organizational measures (e.g. instruction of employees) and technical measures (explosion protection measures).

HAZARDOUS AREAS

United States NEC Explosion Protection

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Gases, vapours or mist Class I classification	Dust Class II classification	Fibres and lint Class III classification
NEC 500 CEC J18	NEC 500 CEC J18	NEC 500 CEC J18
Division 1 Areas in which dangerous concentrations of incendive gases or vapours ❑ may be present in normal operating conditions ❑ may frequently arise during repair and maintenance work ❑ may arise during operational disruptions or fault conditions and at the same time faults occur on electric equipment which lead to a source of ignition.	Division 1 Areas in which dangerous concentrations of explosive dust atmospheres ❑ may be present in normal operating conditions ❑ may arise during operational disruptions or fault situations and at the same time faults occur on electric equipment which lead to a source of ignition and areas with a dangerous quantity of conductive dust Group E).	Division 1 Areas in which flammable fibres and lint occur or are processed.
Division 2 Areas in which dangerous concentrations of incendive gases or vapours are kept in closed containers or systems and which can only be released as a result of fault conditions	Division 2 Areas in which dangerous concentrations of explosive dust atmospheres can only be released in fault conditions.	Division 2 Areas in which flammable fibres are stored or handled differently than in the production process

HAZARDOUS AREAS

IECex / United States NEC Explosion Protection

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Gases and Vapours			
IECex / IEC 60079		**ANSI/NFPA 70 / NEC Article 500**	
Zone 0	flammable atmosphere highly likely to be present - may be present for long periods or even continuously	Class I	hazardous because flammable gases or vapors are present in the air in quantities sufficient to produce explosive or ignitable mixtures
Zone 1	flammable atmosphere possible but unlikely to be present for long periods	Class II	hazardous because combustible or conductive dusts are present
Zone 2	flammable atmosphere unlikely to be present except for short periods of time - typically as a result of a process fault condition	Class III	hazardous because ignitable fibers or flying's are present, but not likely to be in suspension in sufficient quantities to produce ignitable mixtures

Dust			
IECex / IEC 60079		**ANSI/NFPA 70 / NEC Article 500**	
Zone 20	dust cloud likely to be present continuously or for long periods	Division 1	the substance referred to by class is present during normal conditions
Zone 21	dust cloud likely to be present occasionally in normal operation	Division 2	the substance referred to by class is present only in abnormal conditions, such as a container failure or system breakdown
Zone 22	dust cloud unlikely to occur in normal operation, but if it does, will only exist for a short period		

HAZARDOUS AREAS

IECex / United States NEC Explosion Protection

	IECex		NEC / CEC		
Inflammable material	**Zone**	**Group**	**Class**	**Division**	**Group**
Gas and Vapours					
Acetylene	0, 1 or 2	II C	I	1 or 2	A
Hydrogen	0, 1 or 2	II B + H_2	I	1 or 2	B
Propylene oxide, Ethyl oxide, Butadiene	0, 1 or 2	II B	I	1 or 2	B
Cyclopropane, Ethly ether, Ethylene	0, 1 or 2	II B	I	1 or 2	C
Acetone, Benzene, Butane, Hexane, Paint solvents, Natural gas	0, 1 or 2	IIA	I	1 or 2	D
Dust					
Metal Dust		III C	II		E
Coal Dust		III C	II		F
Wood, Paper, Cotton		III A	III		

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IECex / United States NEC Explosion Protection

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Temperature °C	IECex	NEC / CEC
85	T6	T6
100	T5	T5
120	T4	T4A
135	T4	T4
160	T3	T3C
165	T3	T3B
180	T3	T3A
200	T3	T3
215	T2	T2D
230	T2	T2C
260	T2	T2B
280	T2	T2A
300	T2	T2
450	T1	T1

HAZARDOUS AREAS

IECex / United States NEC Explosion Protection

Gas Group / Temperature Class						
Group	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
I	Methane					
IIA	Acetone, Methane, Ethane, Benzene, Methanol, Toluene, Propane, Acetic Acid, Ammonia	Ethanol, Cyclohexane, Propanol 2, N-Butyl alcohol, N-butane	Diesel fuel, Aircraft fuel, Fuel oil, N-Hexane, Heptane, Kerosene	Acetaldehyde		
IIB	Coal Gas	Ethylene, Ethylene oxide, Propanol 1, Methyl Ethyl, Ketone	Ethylene glycol, Hydrogen, Sulphide, Tetrahydrofuran	Ethyl Methyl, Ether		
IIC	Hydrogen	Acetylene				

HAZARDOUS AREAS

IECex / United States NEC Explosion Protection

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Ignition Temperatures for Common Flammable Dusts and Fibers		
	Ignition Temperature	
Material	**Cloud**	**Layer**
Coal Dust	380 °C	225 °C
Polythene	420 °C	(melts)
Methyl Cellulose	420 °C	320 °C
Starch	460 °C	435 °C
Flour	490 °C	340 °C
Sugar	490 °C	460 °C
Grain Dust	510 °C	300 °C
Phenolic Resin	530 °C	>450 °C
Aluminium	590 °C	>450 °C
PVC	700 °C	>450 °C
Soot	810 °C	570 °C

HAZARDOUS AREAS

Technical Principles – ATEC/IECex ZONE CLASSIFICATION

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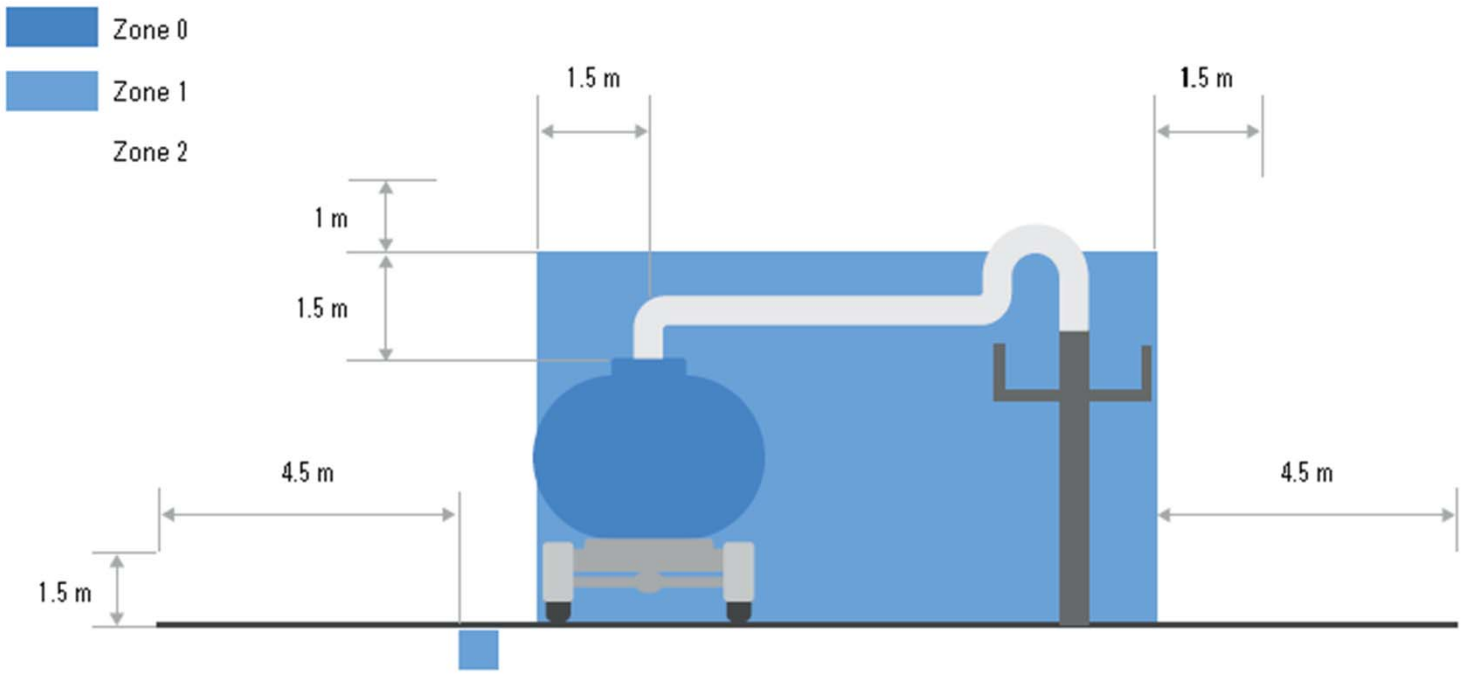
ZONE CLASSIFICATION		
GAS	**Zone 0**	an area in which an explosive gas atmosphere is present continuously or for long periods or frequently.
	Zone 1	an area in which an explosive gas atmosphere is likely to occur periodically or occasionally in normal operation.
	Zone 2	an area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exist for a short period only.
DUST	**Zone 20**	an area in which an explosive dust atmosphere, in the form of a cloud of dust in air, is present continuously, or for long periods or frequently.
	Zone 21	an area in which an explosive dust atmosphere, in the form of a cloud of dust in air, is likely to occur in normal operation occasionally.
	Zone 22	an area rea in which an explosive dust atmosphere, in the form of a cloud of combustible dust in air, is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

HAZARDOUS AREAS

Technical Principles – ATEC/IECex ZONE CLASSIFICATION



source: https://wwww.r-stahl.com

HAZARDOUS AREAS

Technical Principles – ATEC/IECex ZONE CLASSIFICATION

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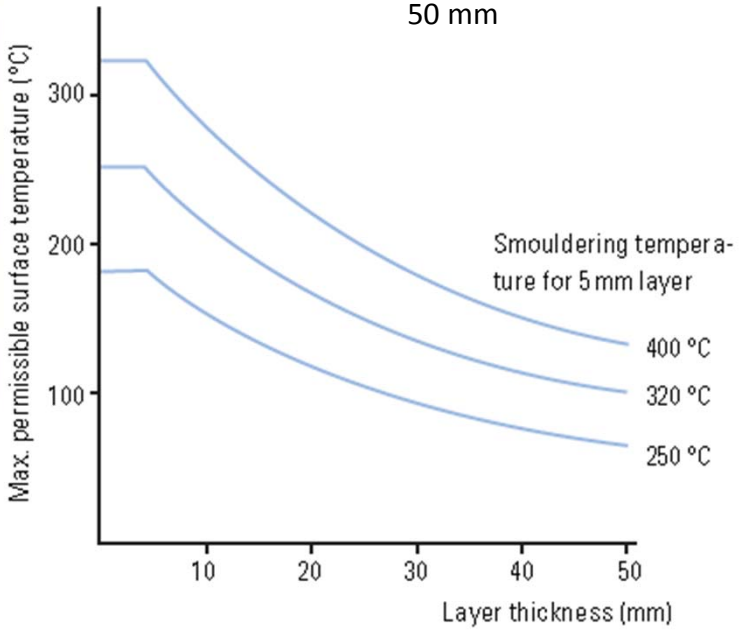
Zone classification and equipment assignment according to their category or EPL protection level				
	Zone	**Duration of the presence of an explosive atmosphere**	**Equipment category**	**Equipment protection level (EPL)**
Gases, vapours, mist	**0**	Constant, long-term, persistent	1G	Ga
	1	Occasionally	2G	Gb
	2	Rarely	3G	Gc
Dust	**20**	Constant, long-term, persistent	1D	Da
	21	Occasionally	2D	Db
	22	Rarely	3D	Dc

HAZARDOUS AREAS

Technical Principles – ATEC/IECex ZONE CLASSIFICATION

TEMPERATURE CLASSES		
Ignition temperature of gases and vapours in °C	**Temperature class**	**Maximum surface temperature of the equipment in °C**
> 450	T1	450
> 300 to 450	T2	300
> 200 to 300	T3	200
> 135 to 200	T4	135
> 100 to 135	T5	100
> 85 to 100	T6	85

Establishment of the max. surface temperature for dust layers of 5 mm to 50 mm



HAZARDOUS AREAS

Electrical equipment protection in explosive gas atmospheres

Protection type acc. to IEC, EN, ISA and UL	Representation (Diagram)	Basic principle	Main application
General requirements IEC 60079-0 EN 60079-0 UL 60079-0		This standard specifies the general requirements for explosion-protected electrical equipment and also details equipment marking.	
Increased safety “e” IEC 60079-7 EN 60079-7 UL 60079-7		Additional measures are adopted in this case to afford a higher degree of safety for preventing impermissible high temperatures and the occurrence of sparks and flashovers inside or on outer parts of electrical equipment that do not occur in normal operation	Terminal and connection boxes, control boxes for installing ex components (with a different protection type), squirrel cage motors, lights eb = use in Zone 1, 2 ec = use in Zone 2
Flameproof enclosure “d” IEC 60079-1 EN 60079-1 UL 60079-1		Parts which can ignite an explosive atmosphere are housed in an enclosure which withstands the pressure of an explosive mixture exploding inside the enclosure and prevents transmission of the explosion to the atmosphere around the enclosure.	Switchgear and control gear, control and display units, control systems, motors, transformers, heaters, lights da = use in Zone 0, 1, 2 db = use in Zone 1, 2 dc = use in Zone 2
Pressurised enclosure “p” IEC 60079-2 EN 60079-2 UL 60079-2		The formation of an explosive atmosphere inside an enclosure is prevented by maintaining a positive internal pressure of inert gas in relation to the surrounding atmosphere and, where necessary, by supplying the inside of the enclosure with a constant flow of inert gas to dilute combustible mixtures.	Switchgear and control cabinets,analysers, large motors pxb = use in Zone 1, 2 and Zone 21, 22 pyb = use in Zone 1, 2 and Zone 21, 22 pyb = use in Zone 2 and Zone 22
Intrinsic safety “i” IEC 60079-11 EN 60079-1 UL 60079-11		Equipment that is used in a hazardous area only contains intrinsically safe electric circuits. An electric circuit is intrinsically safe if no sparks or thermal effects are produced under specified test conditions (which include normal operation and specific fault conditions) which might result in the ignition of a specific explosive atmosphere.	Measurement and control technology, fieldbus technology, sensors, actuators ia = use in Zone 0, 1, 2 and Zone 20, 21, 22 ib = use in Zone 1, 2 and Zone 21, 22 ic = use in Zone 2 and Zone 22 [Ex ib] = associated electrical equipment – installation in safe area
IEC 60079-25 EN 60079-25 UL 60079-25		Intrinsic safety evaluation for defined systems (equipment and cables).	Intrinsically safe systems

HAZARDOUS AREAS

Electrical equipment protection in explosive gas atmospheres

Protection type acc. to IEC, EN, ISA and UL	Representation (Diagram)	Basic principle	Main application
Liquid immersion “o” IEC 60079-6 EN 60079-6 UL 60079-6		Electrical equipment or parts thereof are immersed in a protective fluid (such as oil), so that an explosive atmosphere cannot be ignited above or inside.	Transformers, starting resistors ob = use in Zone 1, 2 oc = use in Zone 2
Powder filling “q” IEC 60079-5 EN 60079-5 UL 60079-		Filling the enclosure of electrical equipment with a fine granular packing material stops flashovers inside during intended operation igniting the explosive atmosphere around the enclosure. Ignition cannot result either from flames or due to increased temperatures on the enclosure surface.	Sensors, electronic ballast, transmitters q = use in Zone 1, 2
Encapsulation “m“ IEC 60079-18 EN 60079-18 UL 60079-18		Parts that may ignite an explosive atmosphere are embedded in sealing compound to stop ignition of the explosive atmosphere.	ma = use in Zone 0, 1, 2 and Zone 20, 21, 22 mb = use in Zone 1, 2 and Zone 21, 22 mc = use in Zone 2 and Zone 22
Protection type “n” IEC 60079-15 EN 60079-15		Electrical equipment cannot ignite a surrounding explosive atmosphere (during normal operation and under defined abnormal operating conditions).	All electrical equipment for Zone 2 nA = non-sparking device nC = devices and components nR = restricted breathing enclosure
Optical radiation “op” IEC 60079-28 EN 60079-28 UL 60079, 28		Appropriate measures prevent ignition of an explosive atmosphere by optical radiation.	Fibre optics / use in gas explosion hazardous areas There are three different methods: Ex op is = inherently safe optical radiation Ex op pr = protected optical radiation Ex op sh = optical radiation with interlock
Protection by enclosure “t” IEC 60079-31 EN 60079-31 UL 60079-31		Thanks to its tightness, dust cannot penetrate the enclosure or reduces it to a negligible degree. Ignitable apparatus can now be mounted in the enclosure. The enclosure temperature must not be sufficient to ignite the surrounding atmosphere.	Switchgear and control gear, control, connection, and terminal boxes, motors, luminaires ta = use in Zone 20, 21, 22 tb = use in Zone 21, 22 tc = use in Zone 22

HAZARDOUS AREAS

Non-Electrical equipment protection in explosive gas atmospheres

Protection type acc. to IEC, EN, ISA and UL	Representation (Diagram)	Basic principle	Main application
General requirements ISO 80079-36 (formerly EN 13463-1)		This standard specifies the general requirements for explosion-protected electrical equipment and also details equipment marking.	
Constructional safety “c” ISO 80079-37 (formerly EN 13463-5)		Proven technical principles are applied to equipment types which do not have any ignition source in normal operation, so that the risk of mechanical faults causing incendive temperatures and sparks is reduced to a negligible degree.	Couplings, pumps, gear drives, chain drives, conveyor belts
Control of ignition source “b” ISO 80079-37 (formerly EN 13463-6)		Sensors are integrated into the equipment to detect imminent hazardous conditions and adopt countermeasures at an early stage before potential ignition sources become effective. The measures can be initiated automatically by means of a direct connection between the sensors and the ignition protection system or manually by issuing a warning to the operator of the equipment.	Pumps, conveyor belts
Liquid immersion “k” ISO 80079-37 (formerly EN 13463-8)		Ignition sources are rendered ineffective by immersion in a protective liquid or by constant moistening with a liquid film.	Submerged pumps, gears
Flameproof enclosure “d” IEC 60079-1 (formerly EN 13463-3)		Parts that can ignite an explosive atmosphere are housed in an enclosure which withstands the pressure of an explosive mixture exploding inside the enclosure and prevents transmission of the explosion to the atmosphere around the enclosure.	Brakes, couplings
Pressurised enclosure “p” IEC 60079-2 (formerly EN 60079-2)		The formation of an explosive atmosphere inside an enclosure is prevented by maintaining a positive internal pressure of inert gas in relation to the surrounding atmosphere and, where necessary, by supplying the inside of the enclosure with a constant flow of inert gas to dilute combustible mixtures.	Pumps
Protection by enclosure “t” IEC 60079-31		Thanks to its tightness, dust cannot penetrate the enclosure or reduces it to a negligible degree. Ignitable apparatus can now be mounted in the enclosure. The enclosure temperature must not be sufficient to ignite the surrounding atmosphere.	Equipment exclusively for dust explosion hazardous areas

HAZARDOUS AREAS

Standards

	Ex ic	Ex nL	NI
Description	**Intrinsic safety**	**Energy-limited circuits**	**“Non incendive field wiring”**
Standard	IEC 60079-11	IEC 60079-15:2005	FM 3611
Fieldbus	IEC 60079-27-FISCO	IEC 60079-27-FNICO:2005	--
Installation	IEC 60079-14	IEC 60079-14	NEC 500
Maintenance	IEC 60079-17	IEC 60079-17	ANSI/ISA 12.12.01
N.B. Ex nL is not replaced by Ex ic. The transition period expired in 2011.			

HAZARDOUS AREAS

Installation & Maintenance

	Ex ic	Ex nL	NI
Application range (gas)	**Zone 2**	**Zone 2**	**Class I, Div. 2**
Application range (dust)	**Zone 22**	**Zone 22**	**Class II + III, Div. 2**
Cables and lines	IEC 60079-14	IEC 60079-14	US standard
Marking	Yes. If coloured, then blue	No special requirements	No special requirements
Distance to normal circuits	50 mm	No (50 mm to Ex i)	Isolation
Proof of energy limiting	Yes	Yes	Yes
Distance to uncoated conductive parts	to non-ex i 50 mm; to other ex i 6 mm; to earth: 3 mm	No special requirements	Isolation
Maintenance*	Yes	Yes	Yes
Upkeep*	Yes	Yes	Yes

* In NEC 500 a distinction is made between maintenance and upkeep. For instance, during upkeep the live replacement of defective “non-incendive” components is not allowed.

HAZARDOUS AREAS

Explosive atmosphere (gas and combustible dust)

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

Recognised IECEx certification bodies (ExCB = certification body) and IECEx test laboratories (ExTLs) exist worldwide and are accredited on the basis of high standard criteria and regularly monitored.
An IECEx certificate is only issued if test sample type testing is successful and an audit verifies that an effective quality management system is in place. However, different regional and national approval procedures currently exist all over the world, including for example the ATEX directive in the European Union or national approvals in the USA (UL, FM).

Business Philosophy

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