

STRITT & PRIEBE INC.

Hazard Protection Equipment Enclosure Comparisons

Type of Enclosure	European - Area of use Designation Standard	IEC - Area of use Designation Standard	USA - Area of use Designation Standard
Flameproof Enclosure – An enclosure used to house electrical equipment, which when subjected to an internal explosion will not ignite a surrounding explosive atmosphere.	Zones 1 & 2 EExd EN50018	Zones 1 & 2 Exd IEC60079-1	Class 1 Divisions 1 & 2 UL1203
Intrinsic Safety – A technique whereby electrical energy is limited such that any sparks or heat generated by electrical equipment is sufficiently low as to not ignite an explosive atmosphere.	Zones 0, 1 & 2 EExi EN50020	Zones 1 & 2 Exi IEC60079-11	Class 1 Divisions 1 & 2 UL913
Increased Safety – This equipment is so designed as to eliminate sparks and hot surfaces capable of igniting an explosive atmosphere.	Zones 1 & 2 EExe EN50019	Zones 1 & 2 Exe IEC60079-7	
Purged and Pressurized – Electrical equipment is housed in an enclosure which is initially purged to remove any explosive mixture, then pressurized to prevent ingress of the surrounding atmosphere prior to energization.	Zones 1 & 2 EExp EN50016	Zones 1 & 2 Exp IEC60079-2	Class 1 Divisions 1 & 2 NFPA496
Encapsulation – A method of exclusion of the explosive atmosphere by fully encapsulating the electrical components in an approved material.	Zones 1 & 2 EExm EN50028	Zones 1 & 2 Exm IEC60079-18	
Oil Immersion – The electrical components are immersed in oil, thus excluding the explosive atmosphere from any sparks or hot surfaces.	Zones 1 & 2 EExo EN50015	Zones 1 & 2 Exo IEC60079-6	Class 1 Division 2 UL698
Powder Filling – Equipment is surrounded with a fine powder, such as quartz, which does not allow the surrounding atmosphere to come into contact with any sparks or hot surfaces.	Zones 1 & 2 EExq EN50017	Zones 1 & 2 Exq IEC60079-5	
Non-sparking – Sparking contacts are sealed against ingress of the surrounding atmosphere, hot surfaces are eliminated.	Zone 2 EExn EN50021	Zone 2 Exn IEC60079-15	
Special Protection – Equipment is certified for use in a Potentially Explosive Atmosphere but does not conform to a type of protection listed above.	Zones 0, 1 & 2 *Exs	Zones 0, 1 & 2 Exs	

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Hazard Protection Certified Testing Agencies for Hazardous Location Equipment

Approval	Agency Used	Approvals Accepted By
ATEX	BASEEFA – British Approvals Service for Electrical Equipment in Flammable Atmospheres	European Union
	KEMA – NV tot Keuring van Elektrotechnische Materialen	
	LCIE – Laboratoire Central des Industries Electriques	
BASEEFA	British Approvals Service for Electrical Equipment in Flammable Atmospheres	Great Britain
GENELEC	European Committee for Electrotechnical Standardization	European Union
CSA	Canadian Standards Association	Canada
FM	Factory Mutual Research	North America
FSETAN	Federal Service on Ecological, technical and Nuclear Supervision	Russia
GB	National Safety Certification	China
GOST-R	GOST-GOSSTANDART	Russia
IECEX	International Electrotechnical Commission on Explosion Protected Equipment	International
INMETRO	National Institute of Metrology, Standardization and Industrial Quality	Brazil
NEPSI	National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation	China
PTB	Physikalisch-Technische Bundesanstalt	Germany
SAA	Standards Association of Australia	Australia
SCS	Sira Certification Service	England
TIIS	Technology Institution of Industrial Safety	Japan
TIS	National Product Certification	Thailand
UL	Underwriters Laboratories	North America

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Hazard Protection NEMA Enclosure Protection Standards

NEMA (National Electrical Manufacturers' Association) has established standards for enclosures to provide protection from environmental contamination. Descriptions of the more common standards are listed below. Type definitions are from NEMA 250-1997.

NEMA Enclosure Type ^{2,3}	Intended Use
1	Indoor use, limited amounts of falling dirt
2	Indoor use, limited amounts of falling water and dirt
3	Outdoor use, rain, sleet, windblown dust, external formation of ice
3X	Outdoor use, rain, sleet, windblown dust, corrosion, external formation of ice
3R	Outdoor use, rain, sleet, external formation of ice
3RX	Outdoor use, rain, sleet, corrosion, external formation of ice
3S	Outdoor use, rain, sleet, windblown dust, external mechanisms operable when ice laden
3SX	Outdoor use, rain, sleet, windblown dust, corrosion, external mechanisms operable when ice laden
4	Indoor or outdoor use, windblown dust and rain, splashing water, hose directed water, external formation of ice
4X	Indoor or outdoor use, windblown dust and rain, splashing water, hose directed water, corrosion, external formation of ice
5	Indoor use, settling airborne dust, falling dirt, non-corrosive liquids
6	Indoor or outdoor use, hose directed water, temporary submersion, external formation of ice
6P	Indoor or outdoor use, hose directed water, prolonged submersion, external formation of ice
7	Indoor use, Class I, Division 1, Groups A, B, C, and D hazardous locations, air-break equipment (NFPA 70)
8	Indoor use, Class I, Division 1, Groups A, B, C, and D hazardous locations, oil-immersed equipment (NFPA 70)
9	Indoor use, Class II, Division 1 Groups E, F, and G hazardous locations, air-break equipment (NFPA 70)
10	Mining applications
11	Indoor use, oil immersed, corrosive liquids & gases
12	Indoor use, circulating dust, falling dirt, dripping noncorrosive liquids
12K	Indoor use, circulating dust, falling dirt, dripping noncorrosive liquids, provided with knockouts
13	Indoor use, lint, dust, spraying of water, oil, and noncorrosive coolant

Note:

- 1 Numbers can be replaced by 'X' when the characteristic number is not required
- 2 Enclosure Types for US only
- 3 Enclosure Type can be converted to IP code rating; however, IP classified enclosures cannot be converted to Enclosure Type

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Hazard Protection
NEMA Enclosure Types

Comparison of Specific Applications of NEMA Enclosures for Indoor Nonhazardous Locations

Provides a Degree of Protection Against the Following Conditions	Type of Enclosure									
	1*	2*	4	4X	5	6	6P	12	12K	13
Access to hazardous parts	X	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (falling dirt)	X	X	X	X	X	X	X	X	X	X
Ingress of water (Dripping and light splashing)	---	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (Circulating dust, lint, fibers, and flyings **)	---	---	X	X	---	X	X	X	X	X
Ingress of solid foreign objects (Settling airborne dust, lint, fibers, and flyings **)	---	---	X	X	X	X	X	X	X	X
Ingress of water (Hosedown and splashing water)	---	---	X	X	---	X	X	---	---	---
Oil and coolant seepage	---	---	---	---	---	---	---	X	X	X
Oil or coolant spraying and splashing	---	---	---	---	---	---	---	---	---	X
Corrosive agents	---	---	---	X	---	---	X	---	---	---
Ingress of water (Occasional temporary submersion)	---	---	---	---	---	X	X	---	---	---
Ingress of water (Occasional prolonged submersion)	---	---	---	---	---	---	X	---	---	---

* These enclosures may be ventilated.

** These fibers and flyings are nonhazardous materials and are not considered Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the National Electrical Code, Article 500.

Comparison of Specific Applications of Enclosures for Outdoor Nonhazardous Locations

Provides a Degree of Protection Against the Following Conditions	Type of Enclosure									
	3	3X	3R*	3RX*	3S	3SX	4	4X	6	6P
Access to hazardous parts	X	X	X	X	X	X	X	X	X	X
Ingress of water (Rain, snow, and sleet **)	X	X	X	X	X	X	X	X	X	X
Sleet ***	---	---	---	---	X	X	---	---	---	---
(Windblown dust, lint, fibers, and flyings)	X	X	---	---	X	X	X	X	X	X
Ingress of water (Hosedown)	---	---	---	---	---	---	X	X	X	X
Corrosive agents	---	X	---	X	---	X	---	X	---	X
Ingress of water (Occasional temporary submersion)	---	---	---	---	---	---	---	---	X	X
Ingress of water - Occasional prolonged submersion	---	---	---	---	---	---	---	---	---	X

* These enclosures may be ventilated.

** External operating mechanisms are not required to be operable when the enclosure is ice covered.

*** External operating mechanisms are operable when the enclosure is ice covered.

Comparison of Types 7, 8, 9, 10 Enclosures

In Hazardous Locations, when completely and properly installed and maintained		
Designed to contain an internal explosion without causing an external hazard.	7	Type 7 Enclosures constructed for indoor use in hazardous (classified) locations classified as Class I, Division 1, Groups A, B, C, or D as defined in NFPA 70.
Designed to prevent combustion through the use of oil-immersed equipment	8	Type 8 Enclosures constructed for either indoor or outdoor use in hazardous (classified) locations classified as Class I, Division 1, Groups A, B, C, and D as defined in NFPA 70.
Designed to prevent the ignition of combustible dust.	9	Type 9 Enclosures constructed for indoor use in hazardous (classified) locations classified as Class II, Division 1, Groups E, F, or G as defined in NFPA 70.
Designed to contain an internal explosion without causing an external hazard.	10	Type 10 Enclosures constructed to meet the requirements of the Mine Safety and Health Administration, 30 CFR, Part 18.

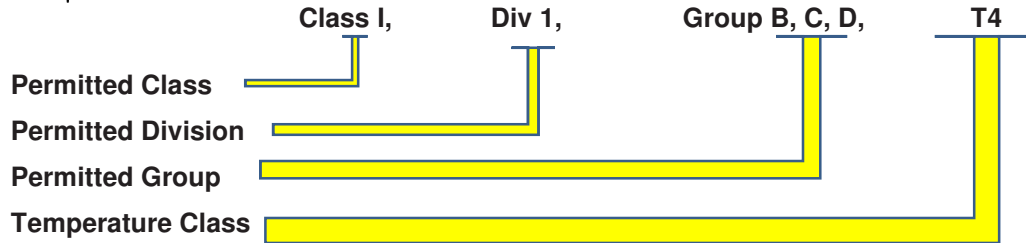
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Hazard Protection Hazardous Area Descriptions

National Electrical Code (NEC) 500

Traditional standards used in North America.

Example:



Permitted Class

Class I: gas vapors
Class II: dusts
Class III: fibers

Permitted Division

Division 1: gasses or vapors exist under normal conditions
Division 2: gasses or vapors are present but are normally contained and can escape only through accident or abnormal operation

Permitted Group

Group A: acetylene
Group B: hydrogen or equivalents
Group C: ethyl ether, ethylene or cyclopropane
Group D: gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol, lacquer, and natural gas
Group E: metal dust
Group F: carbon black
Group G: flour, starch, grain dusts

Temperature Class*

T1: 450°C (842°F)
T2: 300°C (572°F)
T3: 200°C (392°F)
T4: 135°C (275°F)
T5: 100°C (212°F)
T6: 85°C (185°F)

* Device may be exposed to gases whose ignition temperature is higher than this value.

Temperature Code Comparison

A mixture of hazardous gases and air may ignite in contact with a hot surface. The condition for ignition depends on several factors as surface area, temperature and concentration of gas. Equipment approved receives a temperature code indicating the maximum surface temperature of the equipment.

Classification		Maximum Surface Temperature	
Europe	USA/Canada	°F	°C
T1	T1	842	450
T2	T2	572	300
	T2A	536	280
	T2B	500	260
	T2C	446	230
	T2D	420	215
T3	T3	392	200
	T3A	356	180
	T3B	329	165
	T3C	320	160
T4	T4	275	135
	T4A	248	120
T5	T5	212	100
T6	T6	185	85

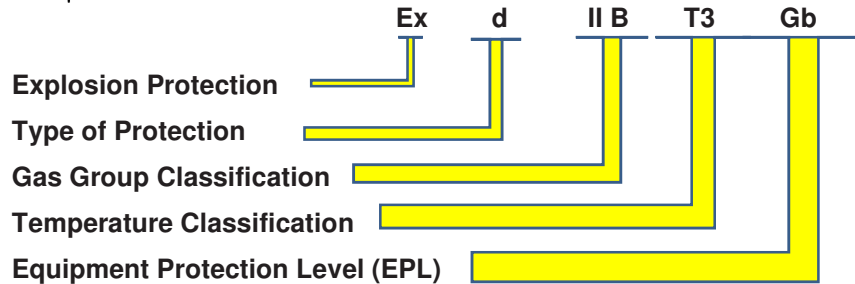
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Hazard Protection Hazardous Area Descriptions

IEC & EU (European) Standards

The IEC (International Electrotechnical Commission) markings are as follows:

Example:



Equipment Protection Level (EPL)

	Applicable Zone
Gas	Ga: 0
	Gb: 1
	Gc: 2
Dust	Da: 20
	Db: 21
	Dc: 22

Type of Protection

- d: flameproof enclosure - contain explosion and quench flame
- p: pressurized enclosure - fill with inert gas
- ia: intrinsically safe for Zone 0 - limit energy
- ib: Intrinsically safe for Zone 1 - limit energy
- o: oil immersion
- s: special protection
- e: increased safety - no arcing, sparking or hot surfaces
- m: encapsulation - sealed arcing devices or non-arcing
- q: sand-filled
- nL: nonincendive - limited energy
- nA: nonincendive - non sparking
- me: encapsulation/increased safety

Gas Group Classification

- IIC: acetylene and hydrogen
- IIB: diethyl ether, ethylene, cyclopropane and others
- IIA: gasoline, hexane, butane, naphtha propane, isoprene and many others

Temperature Class*

- T1: 450 °C (842 °F)
- T2: 300 °C (572 °F)
- T3: 200 °C (392 °F)
- T4: 135 °C (275 °F)
- T5: 100 °C (212 °F)
- T6: 85 °C (185 °F)

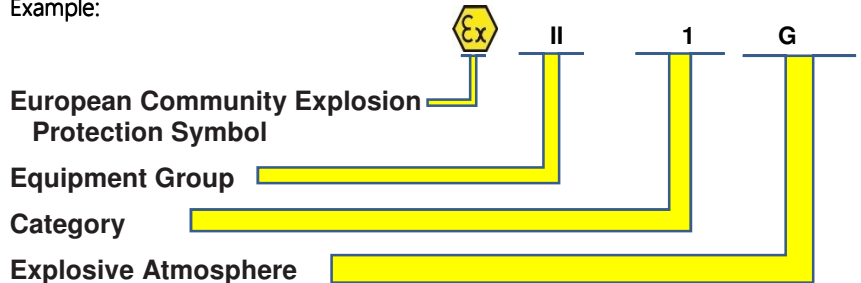
* Device may be exposed to gases whose ignition temperature is higher than this value.

ATEX Marking (94/9/EC)*

European requirements centered around the safety of hazardous area equipment that became mandatory on July 1, 2003. All equipment exported into European member countries must meet the ATEX hazardous and essential health and safety requirements for acceptance.

*The ATEX markings are in addition to the standard Zone markings and indicate compliance to the new directives.

Example:



Equipment Group

- I: mines
- II: other than mines (surface)

Category

- 1 = Zone 0 or 20 Very High protection in area in which an explosive gas-air mixture is continuously present or present for long periods.
- 2 = Zone 1 or 21 High protection in area where combustible or conductive dusts are present. Area in which an explosive gas-air mixture is likely to occur in normal operation.
- 3 = Zone 2 or 22 Low protection in area in which an explosive gas-air mixture is not likely to occur, and if it occurs it will only exist for a short time.
- M1 Very High protection from Methane & Dust
- M2 High protection from Methane & Dust

Explosive Atmosphere

- G: gases/vapors
- D: dusts

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Hazard Protection European Ingress Protection

Two numbers indicate the level of ingress protection of an instrument or apparatus.
The first is the level of protection against solid objects and the second against liquids.

	Solids		Liquids
0	No protection.	0	No protection.
1	Protected against solid objects up to 50mm, e.g. hands.	1	Protected against vertically falling drops of water.
2	Protected against solid objects up to 12mm, e.g. fingers.	2	Protected against water spray up to 15 degrees from vertical.
3	Protected against solid objects up to 2.5mm, e.g. tools.	3	Protected against water spray up to 60 degrees from vertical.
4	Protected against solid objects over 1mm, e.g. wires.	4	Protected against water sprays from all directions.
5	Protected against dusts. (No harmful deposits).	5	Protected against water jets from all directions.
6	Totally protected against dust.	6	Protected against strong water jets from all directions, e.g. Offshore.
		7	Protected against immersion between 15cm and 1m in depth.
		8	Protected against long immersion under pressure.

Note: IP54 is the minimum protection allowed for Hazardous Area Equipment.

European Zone Classification and Equipment Protection Level

Hazardous mixture	Period of presence of the flammable substances	Zone classification	Necessary marking for the equipment		Protection group	EPL Equipment protection level	Protection Level
			according 94/9/EC	according IEC 60079-0			
			Equipment group	Category			
Gas, Vapor, Mist	Continuously for long periods or frequently	Zone 0	II	1G	II	Ga	very high
	Occasional occurrence	Zone 1	II	2G	II	Gb	high
	Not likely, but if it does occur only rarely and for a short period	Zone 2	II	3G	II	Gc	increased
Dust	Continuously for long periods or frequently	Zone 20	II	1D	III	Da	very high
	Occasional occurrence	Zone 21	II	2D	III	Db	high
	Not likely, but if it does occur only rarely and for a short period	Zone 22	II	3D	III	Dc	increased
Methane		Mining	I	M1	I	Ma	very high
Coal Dust		Mining	I	M2	I	Mb	high

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Hazard Protection Hazardous Area Classification

Hazardous Areas are locations where the potential for fire or explosion exists because of gases, dust, or easily ignitable fibers or flyings in the atmosphere.

In **North America**, hazardous area classification is separated by classes, divisions, and groups to define the level of safety required for equipment installed in these locations. Classes define the general form of the flammable materials in the atmosphere. Divisions define the probability of the presence of flammable materials. Groups classify the exact flammable nature of the material.

Classifications Inside North America (NEC – National Electric Code)

SUMMARY OF CLASS I, II, III HAZARDOUS LOCATIONS				
CLASSES	GROUP	DIVISIONS		Typical Locations
		1	2	
		The substance referred to by class is present during normal conditions.	The substance referred to by class is present only in abnormal conditions, such as a container failure or system breakdown.	
I Gasses, Vapors and Liquids (Art. 501)	A. Acetylene B. Hydrogen, etc. C. Ether, etc. D. Hydrocarbons, Fuels, Solvents, etc.	Normally explosive and hazardous.	Not normally present in an explosive concentration (but may accidentally exist).	Petroleum refineries, and gasoline storage and dispensing areas; Dry cleaning plants where vapors from cleaning fluids can be present; Spray finishing areas; Aircraft hangars and fuel servicing areas; and Utility gas plants, and operations involving storage and handling of liquified petroleum gas or natural gas
II Dusts (Art. 502)	E. Metal Dusts (conductive* and explosive) F. Carbon Dusts (Some are conductive* and all are explosive) G. Flour, Starch, Grain, Combustible Plastic or Chemical Dust (explosive)	Ignitable quantities of dust that is normally or may be, in suspension or conductive dust may be present.	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.	Grain elevators; Flour and feed mills; Plants that manufacture, use or store magnesium or aluminum powders; Producers of plastics, medicines and fireworks; Producers of starch or candies; Spice-grinding plants, sugar plants and cocoa plants; and Coal preparation plants and other carbon handling or processing areas
III Fibers and Flyings (Art. 503)	Textiles, Woodworking, etc. (easily ignitable, but not likely to be explosive)	Handled or used in manufacturing.	Stored or handled in storage (exclusive of manufacturing).	Textile mills, cotton gins; Cotton seed mills, flax processing plants; and Plants that shape, pulverize or cut wood and create sawdust or flyings.

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Hazard Protection Hazardous Area Classification

Classification Outside North America (ATEX)

In **Europe and countries outside of North America**, classification of hazardous areas is accomplished differently.

Zones are used to define the probability of the presence of flammable materials.

Zones	
Zone 0	Area in which an explosive gas-air mixture is continuously present or present for long periods.
Zone 1	Combustible or conductive dusts are present. Area in which an explosive gas-air mixture is likely to occur in normal operation.
Zone 2	Area in which an explosive gas-air mixture is not likely to occur, and if it occurs it will only exist for a short time.

Protection Types denote the level of safety for the device.

Protection Types		
		Zone
d	Flameproof (Explosion proof) Enclosure	1,2
e	Increased Safety	1,2
ia	Intrinsic Safety	0,1,2
ib	Intrinsic Safety	1,2
o	Oil Immersion	2
p	Pressurized Apparatus (Purged Apparatus)	1,2
q	Powder Filling (Sand Filling)	2
m	Encapsulation	1,2
n	Normally Nonsparking and/or Nonincendive Circuits)	2

Groups classify the exact flammable nature of the material. These groups are separated differently than North American Groups.

Groups	
Group I	For application in below ground installations (mines) where methane (firedamp) and coal dust may be present.
Group IIA	For application in above ground installation where hazards due to propane may exist. This group most closely matches the North American Group D.
Group IIB	For application in above ground installations where hazards due to ethylene may exist. This group most closely matches the North American Group C.
Group IIC	For application in above ground installations where hazards due to hydrogen or acetylene may exist. This group most closely matches the North American Groups A and B.

Temperature Identifications convey the maximum surface temperature of the apparatus based on 104° F (40° C) ambient. These temperature codes are selected carefully not to exceed the ignition temperature of the specific gas or vapor to be encountered in the application

Temperature Codes		
	°F	°C
T1	842	450
T2	572	300
T3	392	200
T4	275	135
T5	212	100
T6	185	85