

## Enclosure Standards and Protection Concepts

### NEMA Enclosure Standards

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

and complete information, NEMA Standards Publication 250-1997, "Enclosures for Electrical Equipment (1000 Volts Maximum)" should be consulted. This Standards Publication, as well as all other NEMA publications, is available from IHS at 1-800-854-7179.

### Standards for Non-Hazardous Locations

**Type 1:** Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection against falling dirt.

**Type 2:** Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment, to provide a degree of protection against falling dirt, and to provide a degree of protection against dripping and light splashing of liquids.

**Type 3:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, and windblown dust; and that will be undamaged by the external formation of ice on the enclosure.

**Type 3R:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, and snow; and that will be undamaged by the external formation of ice on the enclosure.

**Type 3S:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, and windblown dust; and in which the external mechanism(s) remain operable when ice laden.

**Type 4:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, and hose-directed water; and that will be undamaged by the external formation of ice on the enclosure.

**Type 4X:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, hose-directed water, and corrosion; and that will be undamaged by the external formation of ice on the enclosure.

**Type 5:** Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against settling airborne dust, lint, fibers, and flyings; and to provide a degree of protection against dripping and light splashing of liquids.

**Type 6:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water and the entry of water during occasional temporary submersion at a limited depth; and that will be undamaged by the external formation of ice on the enclosure.

**Type 6P:** Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water and the entry of water during prolonged submersion at a limited depth; and that will be undamaged by the external formation of ice on the enclosure.

**Type 12:** Enclosures constructed (without knockouts) for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against circulating dust, lint, fibers, and flyings; and against dripping and light splashing of liquids.

**Type 12K:** Enclosures constructed (with knockouts) for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against circulating dust, lint, fibers, and flyings; and against dripping and light splashing of liquids.

**Type 13:** Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against circulating dust, lint, fibers, and flyings; and against the spraying, splashing, and seepage of water, oil, and non-corrosive coolants.

### Standards for Hazardous Locations (replaced by NEC Hazardous Area Codes)

**Type 7:** Enclosures constructed for indoor use in hazardous locations classified as Class I, Division 1, Groups A, B, C, or D as defined in NFPA 70.

**Type 8:** Enclosures constructed for either indoor or outdoor use in hazardous locations classified as Class I, Division 1, Groups A, B, C, and D as defined in NFPA 70.

**Type 9:** Enclosures constructed for indoor use in hazardous locations classified as Class II, Division 1, Groups E, F, or G as defined in NFPA 70.

**Type 10:** Enclosures constructed to meet the requirements of the Mine Safety and Health Administration, 30 CFR, Part 18.

**Comparison of Specific Applications of Enclosures for Outdoor Nonhazardous Locations**

Provides a degree of protection against the following environmental conditions	Type of Enclosure						
	3	3R*	3S	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X
Rain, snow, and sleet**	X	X	X	X	X	X	X
Sleet ***	...	...	X	...	...	...	...
Windblown dust, lint, fibers, and flyings	X	...	X	X	X	X	X
Hosedown	...	...	...	X	X	X	X
Corrosive agents	...	...	...	...	X	...	X
Occasional temporary submersion	...	...	...	...	...	X	X
Occasional prolonged submersion	...	...	...	...	...	...	X

\* These enclosures may be ventilated.

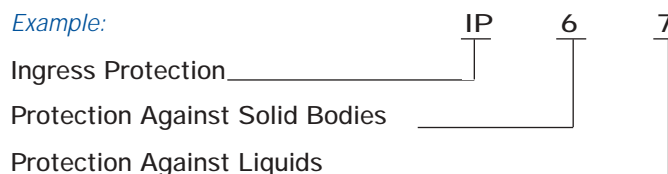
\*\* External operating mechanisms are not required to be operable when the enclosure is ice covered.

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**IEC Enclosure Standards**

The International Electrotechnical Commission has established enclosure standards for protection from environmental contamination as shown below. These standards are used widely in Europe, the Middle East, Africa and parts of Asia.

Example:



**Protection Against Solid Bodies**

- 0: no special protection
- 1: protected against solid objects greater than of 50mm ø
- 2: protected against solid objects greater than 12mm ø
- 3: protected against solid objects greater than 2.5mm ø
- 4: protected against solid objects greater than 1mm ø
- 5: dust protected
- 6: dust-tight

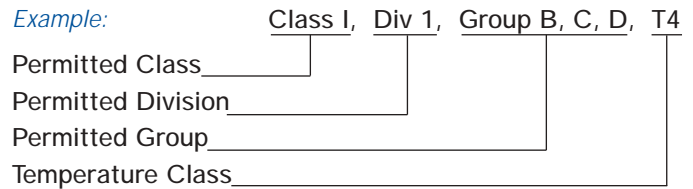
**Protection Against Liquids**

- 0: no special protection
- 1: protected against vertical falling water drops
- 2: protected against vertical falling water drops when enclosure is tilted at 15°
- 3: protected against sprayed water
- 4: protected against splashing water
- 5: protected against water jets
- 6: protected against heavy seas
- 7: protected from the effects of temporary immersion
- 8: protected from the effects of continuous immersion

## Hazardous Area Descriptions

### National Electrical Code (NEC) 500

Traditional standards used in North America.



#### 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 Equivalent

**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)

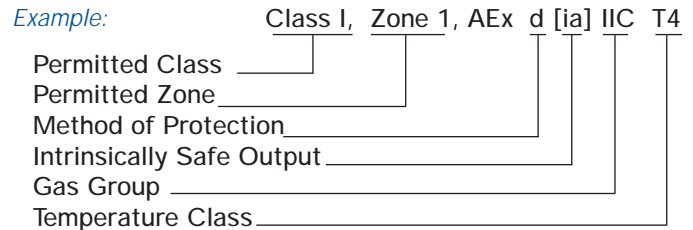
**T5:** 100°C (212°F)

**T6:** 85°C (185°F)

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

### National Electrical Code (NEC) 505

North American Standards developed to harmonize with IEC standards.



#### Permitted Class

**Class I:** Gas Vapors  
**Class II:** Dusts  
**Class III:** Fibers

#### Permitted Zone

**Zone 0:** Gas present continuously

**Zone 1:** Gas present intermittently

**Zone 2:** Gas present under abnormal operation

#### Protection Method

**e:** Increased Safety: no arcs sparks or hot surfaces

**d\*:** Flame proof: contain explosion and quench flame

**m:** Encapsulation, Zone 1: keep flammable gas out

**nA:** Nonsparking equipment

**nC:** Sparking equipment in which the contacts are suitably protected other than by restricted breathing enclosure

**nR:** Restricted breathing

**\*[ia]:** Intrinsically safe, Zone 0, 1, and 2

**\*[ib]:** Intrinsically safe, Zone 1 and 2

#### Gas Group

**IIC:** Acetylene

**IIB + H2:** Hydrogen or equivalents

**IIB:** Ethyl Ether, Ethylene or Cyclopropane

**IIA:** Gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol, lacquer, and natural gas

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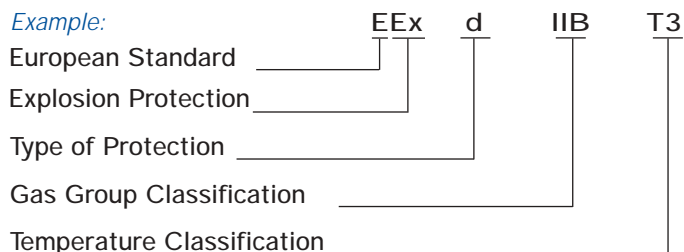
**T5:** 100°C (212°F)

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

### IEC & EU (European) Standards

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



#### 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 nonarcing
- q:** sand-filled
- n:** nonincendive - limited energy
- me:** encapsulation/increased safety

#### Gas Group Classification

- IIC:** Acetylene and hydrogen
- IIB:** Diethyl ether, ethylene, cyclopropane and others
- IIA:** Gasoline, heptane, butane, naphtha propane, isoprene and many others

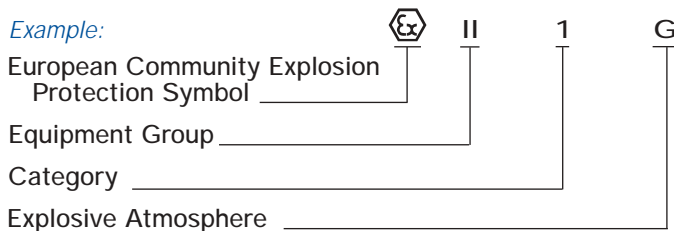
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\* Device may be exposed to gases whose ignition temperature is higher than this value.

### 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.



#### Equipment Group

- I:** Mines
- II:** Other than mines

#### Category

- 1:** Zone 0
- 2:** Zone 1
- 3:** Zone 2

#### Explosive Atmosphere

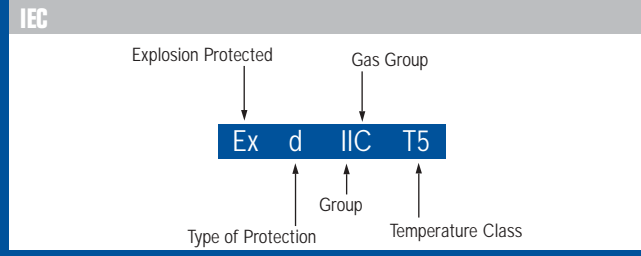
- G:** Gases/Vapors
- D:** Dusts

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

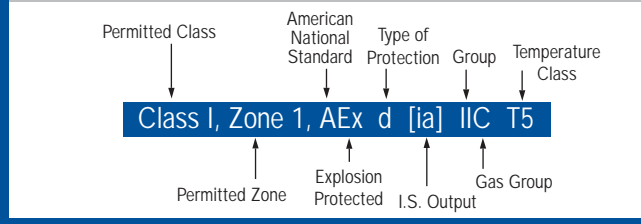
## Expert Guide to Hazardous Locations



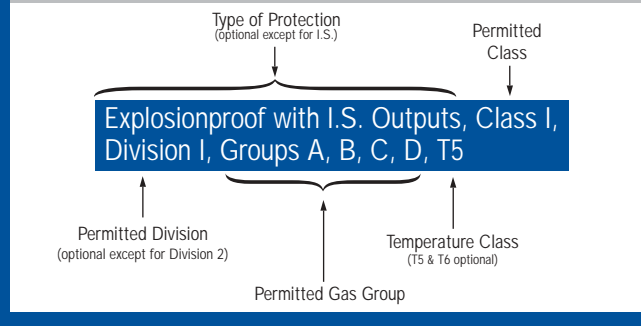
### Ex Marking



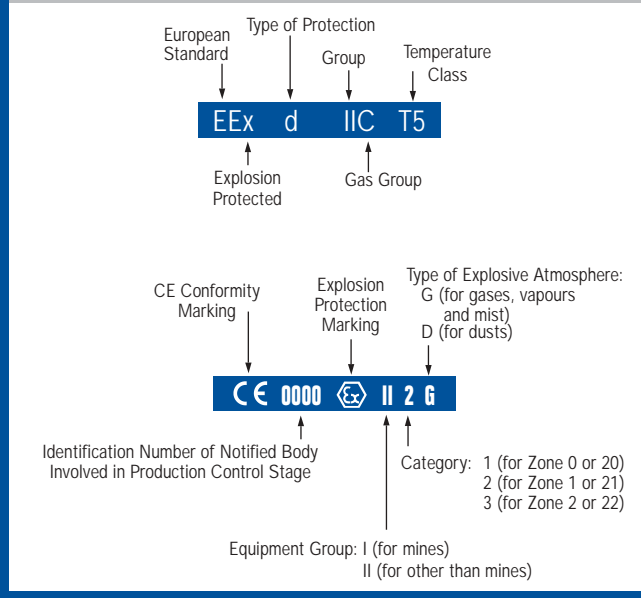
### US (NEC® 505)



### US (NEC® 500)



### EU (Directive 94/9/EC) - ATEX (from July 1, 2003)



### Acronyms

- CENELEC** - European Committee for Electrotechnical Standardization
- EU** - European Union
- IEC** - International Electrotechnical Commission
- I.S.** - Intrinsically Safe
- MSHA** - Mine Safety and Health Administration
- NEC®** - National Electric Code®

### Area Classification

	Flammable Material Present Continuously	Flammable Material Present Intermittently	Flammable Material Present Abnormally
<b>IEC/EU</b>	Zone 0 (Zone 20 - dust)	Zone 1 (Zone 21 - dust)	Zone 2 (Zone 22 - dust)
<b>US NEC® 505</b>	Zone 0	Zone 1	Zone 2
<b>NEC® 500</b>	Division 1		Division 2

IEC classification per IEC 60079-10.  
 EU classification per EN 60 079-10.  
 US classification per ANSI/NFPA 70 National Electric Code® (NEC®) Article 500 or Article 505

### Apparatus Grouping

Typical Gas/Dust/Fiber	US (NEC® 505) IEC EU	US (NEC® 505)
Acetylene	Group IIC	Class I/Group A
Hydrogen	(Group IIB + H <sub>2</sub> )	Class I/Group B
Ethylene	Group IIB	Class I/Group C
Propane	Group IIA	Class I/Group D
Methane	Group I*	Mining*
Metal Dust	None	Class II/Group E
Coal Dust	None	Class II/Group F
Grain Dust	None	Class II/Group G
Fibers	None	Class III

\*Not within scope of NEC®. Under jurisdiction of MSHA.

### Temperature Class

Maximum Surface Temperature	US (NEC® 505) IEC EU	US (NEC® 505)
450° C	T1	T1
300° C	T2	T2
280° C		T2A
260° C		T2B
230° C		T2C
215° C		T2D
200° C	T3	T3
180° C		T3A
165° C		T3B
160° C		T3C
135° C	T4	T4
120° C		T4A
100° C	T5	T5
85° C	T6	T6

## Chemical Compatibility

The chemical compatibility reference guide has been developed to assist you in selecting the best StoneL products and material options for your applications. While this chart should assist you in selecting compatible materials, it is not a substitute for careful testing of a specific product in your operating environment. For additional assistance please contact StoneL technical support.

### Key

- A No effect (Recommended)
- B Moderate effect
- U Severe effect (Not Recommended)
- FC Fusion coating recommended on polycarbonate
- No test data or experience available

Chemical	Aluminum	Polycarbonate	Brass, 360	Stainless Steel	Epoxy
Acetic Acid	A	B	U	A	B
Acetone	A	FC	A	A	U
Acetylene	A	--	A	A	A
Alcohol, Amyl-	B	FC	A	A	A
Alcohol, Butyl-	B	FC	A	A	A
Alcohol, Ehtyl-	B	FC	A	B	A
Ammonia, liquid	A	--	A	A	A
Ammonium hydroxide	B	FC	U	B	A
Beer	A	A	A	A	A
Benzene	B	FC	A	A	B
Boric acid	B	A	A	B	A
Brine	U	B	U	B	--
Bromine	U	FC	A	U	U
Calcium carbonate	U	--	--	B	A
Calcium Chloride	B	A	U	B	A
Carbon tetrachloride	U	FC	A	B	A
Chlorine	B	FC	A	B	--
Chromic acid	U	B	U	U	B
Citric acid	U	B	B	A	A
Creosote	B	FC	B	B	--
Ethyl chloride	--	--	B	A	A
Ethylene	A	--	--	A	--
Ethylene oxide	U	--	--	B	A
Fluorine	B	--	--	A	U
Freon (and other similar refrigerant)	B	--	A	A	A
Gasoline	A	FC	A	A	A
Heptane and hexane	A	B	--	A	A
Hydrochloric acid, 10%	U	A <sup>1</sup>	U	U	A
Hydrogen (gas)	A	--	A	A	--
Hydrogen peroxide	A	A	B	B	B
Hydrogen sulfide	B	A	A	A	A
Isopropyl ether	A	A	--	A	U
Jet fuel (JP 4,5,6)	A	--	--	A	A
Kerosene	A	--	A	A	A
Methane	A	--	--	B	--

Chemical	Aluminum	Polycarbonate	Brass, 360	Stainless Steel	Epoxy
Methyl chloride	U	FC	A	A	A
Methyl ethyl ketone	B	FC	--	A	B
Methylene chloride	B	FC	--	A	A
Naptha	A	FC	--	B	A
Natural gas	A	--	A	A	--
Nickel chloride	U	FC	--	B	A
Nitric acid (10%)	B	A	U	A	A
Nitric acid (80%)	U	B	--	B	U
Nitrous oxide	U	--	--	B	--
Oils (animal)	A	B	--	A	A
Oil (diesel)	A	A	--	A	A
Oil (mineral)	A	B	--	A	A
Phosphoric acid (85%)(air free)	U	B	U	U	B
Potassium chloride	U	A	U	B	A
Potassium hydroxide (10%)	U	FC	B	A	A
Potassium hydroxide (70%)	U	FC	B	A	A
Potassium phosphate	U	---	--	A	--
Propane (LP Gas)	A	A	A	B	A
Soaps and detergents	B	B	A	A	A
Sodium chloride	B	A	U	B	A
Sodium hydroxide (10%) (caustic soda)	U	B	--	A	A
Sodium hydroxide (50%) (caustic soda)	U	FC	-	B	A
Sodium phosphate (monobasic)	U	--	B	A	A
Sulfur dioxide	B	B	B	A	A
Sulfuric acid (7-40%)	U	A	U	U	A
Tannic acid	B	B	A	B	A
Toluol and toluene	A	FC	--	A	B
Turpentine	B	B	A	B	B
Urea	B	A	--	B	--
Vinyl Chloride	B	--	--	B	--
Water, salt	U	--	--	B	A

<sup>1</sup> Temperatures less than 30° C

