Hazardous Area Reference, Classifications, and Enclosure Data

This information is provided as simplified guide only, for actual installation use the NEC / CEC code book and IEC / CENELEC approvals and wiring codes as final authority on any installation.

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Hazardous Area Approvals and Standards for North America

The standards in North America are laid out in the following guide lines are:

The NEC (National Electric Code) for the USA
The CEC (Canadian Electric Code) for Canada

In both countries these guides are accepted and used by most authorities as the final standard on installation and use of electrical products. These 2 guides with the issuance of the new NEC standard are almost identical.

These are standards only and equipment is not tested or approved by these national standards. In the USA and Canada the governments have **recognized third party testing and approval agencies**. These agencies are required to test equipment to published standards. The equipment **tested and approved** by these agencies is then suitable for **use under the NEC or CEC installation standards**.

Under NAFTA and other bilateral trade agreements the governments of USA and Canada have recognized the need to harmonize standards. To this end the government agencies responsible for standards have recognized the following third party testing and approval agencies.

In the United States of America the government agency responsible is OSHA (Occupational Health and Safety Administration). OSHA has authorized a group of NRTL (Nationally Recognized Testing Laboratories). At this time the following laboratories are recognized:

CSA (Canadian Standards Association)
ETL Testing Laboratories Incorporated
Factory Mutual Research Corporation
MET Laboratories
UL (Underwriters Laboratories Inc.)
United States Testing Co. Inc.

In Canada the government agency responsible is the Standards Council of Canada. Standards Council of Canada has authorized a group of testing laboratories to certify equipment. At this time the following laboratories are authorized:

CSA (Canadian Standards Association)
ETL Testing Laboratories Incorporated
UL (Underwriters Laboratories Inc.)
ULC (Underwriters' Laboratories of Canada)

In addition to these two government agencies both countries have state, city, county inspectors that may or may not accept the national standards. At the time of this publication, CSA and UL have been accepted in both countries by all inspection authorities.

To confirm compliance to all national standards both countries require an additional indication on products tested an approved. As an example CSA approved product to USA standards must add NRTL/C to the CSA symbol. In Canada UL must add a small c to its label to indicate compliance to all Canadian standards.

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Hazardous Area Approvals and Standards for Europe and all other countries

The standards used in most countries outside of North America:

IEC / CENLEC for all countries that are members of the EC (European Community)
IEC / CEC / NEC depending on country and standards

IEC (International Electrotechnical Commission) has set broad standards for equipment and classification of areas.

CENELEC is rationalizing group that uses IEC standards as a base and harmonizes them with all member countries standards. The CENLEC mark is accepted in all EC countries. All countries with in the EC also have governing bodies that set additional standards for products and wiring methods.

Each member country of the EC has either government or third party laboratories that test and approve products to IEC and or CENELEC standards.

The rest of the countries in world have adopted the following standards:

CEC / NEC (North American)
IEC / CENLEC to British wiring methods (B.S.I.)
IEC / CENELEC to German wiring methods (VDE)
IEC / CENELEC to French wiring methods (NFC)

It should be noted that wiring methods change even under CENELEC this is primarily as to the use of cable, armored cable, type of armored cable or conduit. It should also be noted that standards can change within a country depending on the location or who built a facility.

It also should be noted there is **no CENELEC standard for hazardous dust**. Each country in the EC has either their own standard or adopt the IEC general standard,

The accepted symbol for IEC/CENELEC certification is a “Ex“ followed by the protection standard symbol. The testing agencies in Europe have variety of trade marks and symbols to indicate there approval of listed products.

Area classifications used by IEC are not directly compatible with current CEC / NEC area classification.

The IEC divides hazardous areas into “Zones” and lists product construction style suitable for those zones. CEC/NEC defines an area based on level of the hazard and type. They then together with the approval agencies set minimum construction standards for products to be used in hazardous areas.

The philosophy used to determine a zone area and enclosure acceptability is based on the term: ***normal operation.***

This is why a product that is suitable for Zone 1 in a CENELEC country can not be used in country following CEC/NEC standards.

The CEC/NEC standards assume that ***abnormal conditions can and will occur*** and products must be designed to operate under these conditions.

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The CEC / NEC (North American) Area Classifications

Class I Division I - Product must contain an explosion within its structure. It can cease to operate, but it can not cause any damage external to itself.
Class I Division 2 - Product must not be able to ignite any gas it can come in contact with during operation or when or if it fails. This includes any gas that may enter the interior of the product.
Class II Division 1 - Product must not cause the ignition of any dust that may be deposited on it, or in the surrounding atmosphere. In addition no dust may penetrate the housing and deposit any material on the interior of the product.
Class II Division 2 - Product must not cause the ignition of any dust that may be deposited on it, or in the surrounding atmosphere
Class III product must not cause the ignition of any fiber that may be on it, or in the atmosphere around it. In addition, no fibers may penetrate the housing and deposit any material on the interior of the product.

Class I (Explosive Gases)

Division 1 (Gases normally present in explosive amounts)
Division 2 (Gases not normally present in explosive amounts)

Gas types by group. (See list on following pages for a more complete list.)

Group A	**Acetylene**
Group B	**Hydrogen**
Group C	**Ethylene and related products**
Group D	**Propane and alcohol products**

The basic deciding factor as to which group a gas belongs is the pressure it creates when ignited

Class II (Explosive Dusts)

Division 1 (Dust normally present in explosive amounts)
Division 2 (Dust not normally present in explosive amounts)

Dust types by group. (See list on following pages for a more complete list.)

Group E	**Metal dust**
Group F	**Coal Dust**
Group G	**Grain and non-metallic dust**

Class III (Explosive fibers)

Division 1 areas	(Fibers normally present in explosive amounts)
Division 2 areas	(Fibers not normally present in explosive amounts)
	There are no sub groups for Class III areas

North American device approval rating will normally be expressed in following manner:

Class	**Class I (Explosive gas area)**
Division 1	**(Gases normally present in explosive amounts)**
Group C	**Ethylene and related products**
Temperature Rating	**T6 (Coolest temperature rating)**

(i.e.) Approval would read; **Class I Div.1, Group C (T6 is not required to be shown as it is coolest rating)**

If product is not marked Div.1 or 2 it is approved Div. 1 and suitable for either division.

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The IEC / CENELEC (European) Area Classifications

Explosive Gases

1st Criteria: Ascertain if a gas belongs in Group **I** or **II**

Group I - Products intend for underground mines that are subject to firedamp (Methane Gas)
Group II - Products intend for all other explosive gas atmospheres except for Group I areas

2nd Criteria: Determine type of gas subdivision (see following pages for breakdown of all gas types)

A - Hydrocarbons, Oxygen, Halogen, Sulfur, and Nitrogen (less explosive concentrations and types)
B - Hydrocarbons, Oxygen, Halogen, Sulfur, and Nitrogen (more explosive concentrations and types)
C - Acetylene, hydrogen, carbon disulfide
Note: - A higher letter gas type may be used instead a lower letter gas type.
(i.e.) C & B types can be used instead of A type, C can be used instead of A & B types.

3rd Criteria: Establish Zone.

Zone 0 - Explosive gas is continuously present
Accepted protection standard: **Ex ia** **intrinsically safe**
Zone 1 - Explosive gas is often present
Accepted protection standard: **Ex ib** **intrinsically safe**
Ex d **flame-proof**
Ex e **increased safety**
Ex o **oil immersed**
Ex p **purged and pressurized**
Ex q **powder filled**
Ex m **encapsulated**
Zone 2 - Explosive gas may be accidentally present
Accepted protection standard : **Ex n** **non-sparking and/or non-ignition capable**

4th Criteria: Temperature Rating.

T-Code - Maximum operating temperature of device. (See following pages for ratings.)

IEC / CENELEC device approval rating will normally be expressed in following manner:

Enclosure type (Criteria 3)	**Ex d**	**(Flame-proof)**
Group and Gas (Criteria 1 & 2)	**II C**	**(Standard hazardous area, all gas types)**
Temperature Rating (Criteria 4)	**T6**	**(Coolest temperature rating)**

ie) Approval would read; **Ex d IIC T6**

Explosive Dusts

Zone 21 - Explosive metallic dusts are present
Zone 22 - Explosive non-metallic dusts are present
Accepted protection standard: - **DIP**

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CEC / NEC (North American) Classifications (Material and Ignition Temperatures °C)

Class I (Explosive Gases)					
Group A		**Group D**			
acetylene	305	acetic acid (glacial)	464	mesityl oxide	344
Group B		acetone	465	methane (natural gas)	537
acrolein (inhibited)	220	acrylonitrile	481	methanol (methyl alcohol)	385
arsine	NA	ammonia	651	3-methyl-1-butanol (isoamyl alcohol)	350
butadiene	420	benzene	498	methyl ethyl ketone	404
ethylene oxide	429	butane	287	methyl isobutol keytone	448
hydrogen	500	1-butanol (butyl alcohol)	343	2-methyl-1-propanol (isobutyl alcohol)	415
propylene oxide	449	2-butanol (secondary butyl alcohol)	405	2-methyl-2-propanol (tertiary butyl alcohol)	478
propylnitrate	175	n-butyl acetate	425	petroleum naphta	288
Group C		isobutyl acetate	421	pyridine	482
ethylene	450	sec-butyl alcohol	343	octanes	206
ethylenmine	320	di-isobutylene	391	pentanes	260
ethyl mercaptan	300	ethane	472	1-pentanol (amyl alcohol)	300
ethyl sulfide	NA	ethanol (ethyl alcohol)	363	propane	432
hydrogen cyanide	538	ethyl acetate	426	1-propanol (propyl alcohol)	412
hydrogen sulfide	260	ethylene diamine (anhydrous)	385	2-propanol (isopropyl alcohol)	399
morpholine	310	ethylene dichloride	413	propylene	455
2-nitropropane	428	gasoline (56-60 octane)	280	styrene	490
tetrahydrofuran	321	hexanes	223	toluene	480
unsymmetrical dimethyl hydrazine udmh 1.1-dimethyl hydrazine hydrazine	249	heptanes	204	vinyl acetate	402
		isoprene	395	vinyl chloride	472
		isopropyl ether	443	xylenes (o-xylene)	463

Class II (Explosive Dusts)								
Group E			**Group G**					
Material	**Cloud**	**Layer**	**Material**	**Cloud**	**Layer**	**Material**	**Cloud**	**Layer**
Aluminum	650	760	Alfalfa	460	200	Wheat Flour	380	360
Magnesium	620	490	Cocoa	420	200	Cellulose Acetate	450	390
Titanium	330	510	Coffee	410	220	Ethyl Acetate	450	390
Zinc	630	430	Corn	400	250	Nylon	500	430
Bronze	370	190	Cornstarch	380	200	Polyethylene	450	380
Chromium	580	400	Malt	400	250	Polystyrene	560	---
Tin	630	430	Skim Milk	490	200	Epoxy	540	---
Cadmium	570	250	Rice	440	220	Polyurethane	550	390
Group F			Sugar	350	400	Cork	490	280
Coal (Pittsburgh Seam)	610	180	Wheat	480	220	Wood Flour (White Pine)	470	260

Class III (Explosive Fibers)		
Material	**Cloud**	**Layer**
Cotton Lint	520	---
Flax	430	230
Rayon	520	250

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IEC / CENELEC (European) Material Classifications

Zone 0, 1 & 2 (Explosive Gases)

Subdivision A

Hydrocarbons

Alkanes:
Methane
Ethane
Propane
Butane
Pentane
Hexane
Heptane
Octane
Nonane
Decane
Cyclobutane
Cyclopentane
Cyclohexane
Cycloheptane
Methylcyclobutane
Methylcyclopentane
Methylcyclohexane
Ethylcyclobutane
Ethylcyclopentane
Ethylcyclohexane
Decahydronaphthalene (decaline)

Alkenes:
Propene (propylene)

Aromatic hydrocarbons:
Styrene
Methylstyrene

Benzene and its derivatives:
Benzene
Toluene
Xylene
Ethylbenzene
Trimethylbenzene
Naphthalene
Cumene
Cymene

Mixtures of hydrocarbons:
Industrial methane
Turpentine
Petroleum naphtha
Oil naphtha
Petroleum (including petroleum spirits)
Dry cleaning solvents
Fuel oil
Kerosene
Gas-oil
Benzole for cars

Compounds containing oxygen:

Oxides:
(including ethers):
Carbon monoxide
Dipropyl ether

Alcohols and phenols:
Methanol
Ethanol
Propanol
Butanol
Pentanol
Hexanol
Heptanol
Octanol
Nonanol
Cyclohexanol
Methylcyclohexanol
Phenol
Cresol
Diacetone-alcohol

Aldehydes:
Acetaldehyde
Metaldehyde

Ketones:
Acetone
Ethyl-methyl ketone
Propyl-methyl ketone
Butyl-methyl ketone
Amyl-methyl ketone
2,4-Pentanedione (acetylacetone)
Cyclohexanone

Esters:
Methyl formate
Ethyl formate
Methyl acetate
Ethyl acetate
Propyl acetate
Butyl acetate
Amyl acetate
Methyl methacrylate
Ethyl methacrylate
Vinyl acetate
Ethyl acetylacetate

Acids:
Acetic acid

Compounds containing halogens

Compounds with no Oxygen:
Chloromethane
Chloroethane
Bromoethane
Chloropropane
Chlorobutane
Bromobutane
Dichlorethane
Dichloropropane
Chlorobenzene
Benzyl chloride
Dichlorobenzene
Allyl chloride
Dichloroethylene
Chloroethylene (vinyl chloride)
Benzyl trifluoride
Methylene chloride

Compounds containing Oxygen:
Acetyl chloride
Chloroethanol

Compounds containing Sulphur:
Ethyl mercaptan
Propyl mercaptan
Thiophene
Tetrahydrothiophene

Compounds containing Nitrogen:
Ammonia
Acetonitrile
Nitromethane
Nitroethane

Amines:
Methylamine
Dimethylamine
Trimethylamine
Diethylamine
Triethylamine
Propylamine
Butylamine
Cyclohexylamine
Monoethanolamine
Diaminoethane
Aniline
Dimethylaniline
Amphetamine
Toluidine
Pyridine

Subdivision B

Hydrocarbons
Allylene (Propyn)
Ethylene
Cyclopropane
Butadiene

Compounds containing Nitrogen:
Acrylonitrile
Isopropyl nitrate
Hydrocyanic acide

Compounds containing Oxygen:
Mrthyl ether
Ethylmethyl ether
Ethyl ether
Butyl ether
Ethylene oxide (epoxyethane)
Epoxy-propane
Dioxolan
Dioxin
Trioxin
Butyl hydoxyacetate
Tetrahydrofurfuryl
Methyl acrylate
Ethyl acrylate
Furane
Crotonaldehyde
Acrolien
Tetrahydrofuran

Mixtures:
Gas from a coke furnace

Compounds containing Halogens:
Tetrafluoroethylene
Propane, 1 chloro, 2,3 epoxy (epichlorohydrin)

Subdivision C

Hydrogen
Acetylene
Carbon disulphide

Zone 21 (Explosive metallic dusts)

Magnesium & Aluminum

Metallic dusts with $R \leq 10^5$ Ohms x cm

Zone22 (Explosive non-metallic dusts)

Flour

Non-metallic dusts with $R < 10^5$ Ohms x cm

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Temperature Ratings for North America & IEC / CENELEC (T-Codes and Temperatures)			
Temperature in Fahrenheit	**Temperature in Celsius**	**North American Temperature Code**	**IEC Temperature Code**
842	450	T1	T1
572	300	T2	T2
536	280	T2A	
500	260	T2B	
446	230	T2C	
419	215	T2D	
392	200	T3	T3
356	180	T3A	
329	165	T3B	
320	160	T3C	
275	135	T4	T4
248	120	T4A	
212	100	T5	T5
185	185	T6	T6

Note: Actual temperatures may be shown instead of T-codes.

Maximum External Temperature Allowed in North America		
Area of Use	**Temperature in Fahrenheit**	**Temperature in Celsius**
Class I Groups A,B,C & D	To be determined by gases present at the area of installation, and temperature rating of the product.	
Class I Group C Surgical type fixture only	320	160
Class II, Groups E & F	392	200
Class II, Group G	329	165

North American to IEC / CENELEC Zone comparison chart NOTE: This is not a suggested usage chart, it is a general guide	
North American Area	**Zone Type Area**
Class I, Division 1	Zone 1
Class I, Division 2	Zone 2
North American Gas & Vapor Groups	**Zone Gas & Vapor Classification**
Group A	IIC
Group B	IIC
Group C	IIB
Group D	IIA

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North American Non-Hazardous - Enclosure types

Comparison of Specific Non-hazardous Applications, INDOOR & OUTDOOR Locations														
Provide a Degree of Protection Against the Following Environmental Conditions	Type of enclosure													
	1*	2*	3	3R*	3S	4	4X	5	6	6P	11	12	12K	13
Corrosive agents							✔			✔	✔			
Dust, lint, fibers and flyings**						✔	✔	✔	✔	✔		✔	✔	✔
Falling dirt	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Falling liquids and light splashing		✔				✔	✔		✔	✔	✔	✔	✔	✔
Hosedown and splashing water						✔	✔		✔	✔		✔	✔	✔
Incidental contact with the enclosed equipment	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Occasional temporary submersion									✔	✔				
Occasional prolonged submersion										✔				
Oil and coolant seepage												✔	✔	✔
Oil or coolant spraying and splashing														✔
Rain, snow, and sleet			✔	✔	✔	✔	✔		✔	✔				
Sleet					✔									
Windblown dust			✔		✔	✔	✔		✔	✔				

* Enclosures may be ventilated.

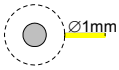
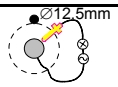
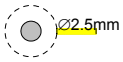
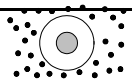
** These fibers and flyings are non-hazardous materials and are not considered Class III type ignitable fibers or combustible flyings. For Class III type ignitable.

IEC Non-Hazardous Enclosure Codes Index of protection = (1st & 2nd Figure)*

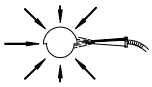
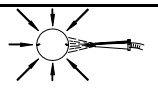
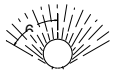
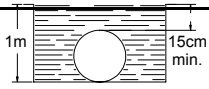
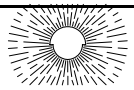
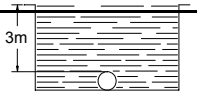
Index of protection is found by putting the first and second figure together. (ie: IP = 64)

Note: A "0" means enclosure has no protection

1st Figure: Protection against solid bodies

IP	Tests	Description	IP	Tests	Description
1		Protected against solid bodies larger than 50mm. (eg. : accidental contact with the hand)	4		Protection against solid bodies larger than 1mm (fine tools, small wires)
2		Protected against solid bodies larger than 12.5mm (eg. :finger of the hand)	5		Protected against dust (no harmful deposit)
3		Protected against solid bodies larger than 2.5mm (tools, wires)	6		Completely protected against dust

2nd Figure: Protection against liquids

IP	Tests	Description	IP	Tests	Description
1		Protected against vertically-falling drops of water. (condensation)	5		Protected against jets of water from all directions
2		Protected against drops of water falling up to 15° from vertical.	6		Completely protected against jets of water of similar force to heavy seas
3		Protected against drops of water falling up to 60° from vertical.	7		Protected against the effects of immersion
4		Protected against projections of water from all directions	8		Protected against prolonged immersion under specified conditions

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Chemicals	Materials Used By NRL Lighting In Fixture Construction										
	Lens Material			Gasket		Fixture Body					
	Glass	Acyrlic (Shhet)	Polycarbonate	Silicone	Neoprene	PBT Glass Reinforced	Polyester Powder Coated	Aluminum	Bronze	Stainless Steel Type 304	Stainless Steel Type 316
Acetic acid	A	D	A	D	D	A	D	D	D	A	D
Acetone	A	D	D	A	D	C	C	A	B	A	A
Aluminum Chloride	A	A	A	A	A	A	D	D	D	A	A
Aluminum Sulfate	A	A	A	A	A	A	D	D	D	A	A
Ammonium Nitrate	A	A	D	A	A	A	D	B	D	A	A
Boric Acid (10 %)	A	A	A	A	A	A	C	B	D	A	A
Brake Fluid	A	D	D	A	D	A	D	A	B	A	A
Calcium Chloride	A	A	A	A	A	A	D	C	B	A	A
Carbon Tetrachloride	A	D	D	D	D	C	D	A	D	A	A
Chlorine Water	A	A	D	A	A	A	A	B	D	A	A
Citric Acid	A	A	A	A	D	A	D	D	D	A	A
Cutting Fluid	A	A	A	A	A	A	A	D	B	A	A
Distilled Water	A	A	A	A	A	A	A	B	B	A	A
Ethyl Alcohol	A	D	A	A	A	A	B	A	B	A	A
Ethylene Glycol	A	A	A	A	A	A	A	A	B	A	A
Hydraulic Oil	A	A	B	A	D	A	A	A	B	A	A
Hydrochloric Acid (25%)	A	A	A	D	B	A	D	D	D	D	D
Isopropyl Alcohol	A	A	A	A	A	A	B	A	B	A	A
Kerosene	A	A	B	D	D	B	A	A	B	A	A
Liquid Soap	A	A	A	A	A	A	C	B	B	B	B
Methylene Chloride	A	D	D	A	D	D	D	A	D	A	A
Mineral Sprits	A	A	B	D	D	A	A	A	B	A	A
Motor Oil	A	A	A	D	D	A	A	A	B	A	A
Nitric Acid	A	A	C	D	D	C	D	D	D	A	A
Phosphoric Acid (25 %)	A	A	A	A	A	A	D	D	D	A	A
Potassium Chloride (25%)	A	A	A	A	A	A	D	C	B	A	A
Sea Water	A	A	A	A	A	A	D	C	B	A	A
Sodium chloride (25%)	A	A	A	A	A	A	D	B	B	A	A
Sulfuric Acid (25 %)	A	A	A	A	D	A	D	D	D	D	A
Tanic Acid (10 %)	A	A	A	D	A	A	D	D	D	C	C
Toluene	A	D	D	D	D	D	B	A	B	A	A
Turpentine	A	A	A	D	D	A	B	A	D	A	A
Unleaded Gasoline	A	A	D	D	D	A	B	A	B	A	A
Xylene	A	D	D	D	D	B	C	A	D	A	A

A. Recommended Material for long term exposure.
B. Satisfactory performance, functional after long term exposure, but cosmetic damage will occur.
C. Short duration exposure only, subject to chemical attack and will deteriorate.
D. Continuous exposure will cause deterioration of material. Cleaning recommended if used in area containing material.

This information is provided as simplified guide only, for actual installation use the NEC / CEC code book and IEC / CENELEC approvals and wiring codes as final authority on any installation.