General Information
Standards

Application
The products in this catalog are designed for electrical and electronic enclosure applications in commercial or industrial locations that are classified as non-hazardous. Information on the classification of hazardous and non-hazardous locations appears at the end of this section.

The enclosure products in this publication should be applied, installed and used only by qualified engineers, technicians or electricians knowledgeable of the standards, laws, regulations and ordinances associated with the respective application. The information in this section has been condensed from several references and is provided for guidance in selecting the appropriate enclosure for an application. The original reference must be consulted for detailed information.

Industry Standards
The following information is provided with permission of the respective organizations to assist in the selection of an enclosure:

Enclosure Ratings
What are Ratings?
As a way of standardizing enclosure performance, organizations like NEMA, UL, CSA and IEC use rating systems to identify an enclosure's ability to resist external environmental influences. These influences include falling dirt or liquids, hose directed water to complete submersion and each are broken out by the TYPE rating. While these ratings are intended to assist you in your enclosure selection there are differences among the organizations.

North American Standards Organizations
In North America, NEMA, UL and CSA are the more common recognized standards organizations. Ratings between these organizations are similar in description and performance. UL and CSA both required enclosure testing that is conducted in certified labs. They also conduct site evaluations or field audits to ensure manufacturers adheres to prescribed manufacturing methods and material specifications within the approved UL/CSA files. NEMA publishes a standard for ratings and testing, but does not test or list enclosures.

International Standards Organizations
IEC does not require independent testing, similar to NEMA, but there are differences in the interpretation between the two organizations. For example, under the IEC standards for each level of ingress protection (IP), a certain amount of water is allowed to enter the enclosure. Unlike UL or CSA, water-tight means simply that. Any amount of water ingress regardless of size or amount is considered a failure to the specification.

IEC 60529 IP ratings do not specify construction or degrees or protection, while NEMA type ratings do specify construction and performance requirements for most conditions. Because of these differences in tests and evaluations, the IEC enclosure ratings cannot be directly translated with NEMA enclosure Type ratings.

Reference Documents and Sources
National Electrical Manufacturers Association (NEMA)
1300 North 17th ST, Suite 1847
Rosslyn, VA 22209
www.nema.org
NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum) and NEMA Standards Publication ICS6, Enclosures for Industrial Controls and Systems.

Canadian Standards Association (CSA)
178 Rexdale Blvd.
Etobicoke, Ontario, Canada M9W 1R3
www.csa.ca
CSA Standard C22.2 No. 14 Industrial Control Equipment for Use in Ordinary (Non-Hazardous) Locations; CSA Standard C22.2 No. 40 Cut-Out, Junction and Pull Boxes; and CSA Standard 22.2 No. 94 Special Purpose Enclosures

Underwriters Laboratories (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096
www.ul.com
Underwriters Laboratories of Canada
7 Crouse Road
Scarborough, Ontario, Canada M1R 3A9
UL 50 Enclosures for Electrical Equipment; UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; UL 508 Industrial Control Equipment; UL 870 Wireways, Auxiliary Gutters and Associated Fittings; and UL 746C Polymeric Materials - Use in Electrical Equipment Evaluations

International Electrotechnical Commission (IEC)
1 Rue de Varembei
CH-1211
Geneva 20, Switzerland
www.iec.ch
IEC 529 Classification of Degrees of Protection Provided by Enclosures
IEC 204 Electrical Equipment of Industrial Machines

American National Standards Institute (ANSI)
1430 Broadway
New York, NY 10018
www.ansi.org
ANSI Z55.1 Gray Finishes for Industrial Apparatus and Equipment

National Fire Protection Association (NFPA)
Batterymarch Park
Quincy, MA 02269
www.nfpa.org
NFPA 70 National Electric Code
NFPA 79 Electrical Standard for Industrial Machinery

NEMA, UL, and CSA Ratings

NEMA, UL, and CSA are standard writing organizations commonly recognized in North America. Their ratings are based on similar application descriptions and expected performance. UL and CSA both require enclosure testing by qualified evaluators. They also send site inspectors to make sure a manufacturer adheres to prescribed manufacturing methods and material specifications. NEMA, on the other hand, does not require independent testing and leaves compliance completely up to the manufacturer.

Enclosure Types Non-Hazardous Location

Enclosure Rating	National Electrical Manufacturers Association (NEMA Standard 250) and Electrical and Electronic Mfg. Association of Canada (EEMAC)	Underwriters Laboratories Inc. (UL 50, UL50e and UL 508)	Canadian Standards Association (Standard C22.2 No. 94)
Type 1	Enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment or locations where unusual service conditions do not exist.	Indoor use primarily to provide protection against contact with the enclosed equipment and against a limited amount of falling dirt.	General purpose enclosure. Protects against accidental contact with live parts.
Type 2	Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.	Indoor use to provide a degree of protection against limited amounts of falling water and dirt.	Indoor use to provide a degree of protection against dripping and light splashing of non-corrosive liquids and falling dirt.
Type 3	Enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, and sleet; undamaged by the formation of ice on the enclosure.	Outdoor use to provide a degree of protection against windblown dust and windblown rain; undamaged by the formation of ice on the enclosure.	Indoor or outdoor use; provides a degree of protection against rain, snow, and windblown dust; undamaged by the external formation of ice on the enclosure.
Type 3R	Enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain sleet; undamaged by the formation of ice on the enclosure.	Outdoor use to provide a degree of protection against falling rain; undamaged by the formation of ice on the enclosure.	Indoor or outdoor use; provides a degree of protection against rain and snow; undamaged by the external formation of ice on the enclosure.
Type 4	Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure.	Either indoor or outdoor use to provide a degree of protection against falling rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure.	Indoor or outdoor use; provides a degree of protection against rain, snow, windblown dust, splashing and hose-directed water; undamaged by the formation of ice on on the enclosure.
Type 4X	Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure.	Either indoor or outdoor use to provide a degree of protection against falling rain, splashing water, and hose-directed water; undamaged by the formation of ice of ice on the enclosure; resists corrosion.	Indoor or outdoor use; provides a degree of protection against rain, snow, windblown dust, splashing and hose-directed water; undamaged by the external formation of ice on the enclosure; resists corrosion.
Type 6	Enclosures are intended for use indoors or outdoors where occasional submersion is encountered. limited depth; undamaged by the formation of ice on the enclosure.	Indoor or outdoor use to provide a degree of protection against entry of water during temporary submersion at a at a limited depth; undamaged by the external formation of ice on the enclosure.	Indoor or outdoor use; provides a degree of protection against the entry of water during temporary submersionat a limited depth. Undamaged by the external formation of ice on the enclosure; resists corrosion.
Type 6P	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (hose directed water and the entry of water during prolonged submersion at a limited depth); that provides an additional level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.	Indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during prolonged submersion at a limited depth and damage from external ice formation.	Indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during prolonged submersion at a limited depth and damage from external ice formation.
Type 12	Enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.	Indoor use to provide a degree of protection against dust, dirt, fiber flyings, dripping water, and external condensation of noncorrosive liquids.	Indoor use; provides a degree of protection against circulating dust, lint, fibers, and flyings; dripping and light splashing of non-corrosive liquids; not provided with knockouts.
Type 13	Enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.	Indoor use to provide a degree of protection against lint, dust seepage, external condensation and spraying of water, oil, and noncorrosive liquids.	Indoor use; provides a degree of protection against circulating dust, lint, fibers, and flyings; seepage and spraying of non-corrosive liquids, including oils and coolants.

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General Information

NA Standards continued and International Standards (IP Code)

Comparison of Enclosure Types for Non-hazardous Locations

Provides a Degree of Protection Against the Following Environmental Conditions	Type of Enclosure								
	1	3	3R	4	4X	6	6P	12	13
Incidental Contact with Enclosed Equipment	●	●	●	●	●	●	●	●	●
Indoor	●	●	●	●	●	●	●	●	●
Outdoor		●	●	●	●	●	●		
Falling Dirt	●	●	●	●	●	●	●	●	●
Dripping and Light Splashing Liquids		●	●	●	●	●	●	●	●
Rain, Sleet*, Snow		●	●	●	●	●	●		
Circulating Dust, Lint, Fibers and Flyings		●		●	●	●	●	●	●
Settling Dust, Lint, Fibers and Flyings		●		●	●	●	●	●	●
External Ice*		●	●	●	●	●	●		
Hosedown and Splashing Water				●	●	●	●		
Oil and Coolant Seepage								●	●
Oil and Coolant Spraying and Splashing									●
Corrosive Agents					●		●		
Occasional Temporary Submersion						●	●		
Occasional Prolonged Submersion							●		

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

A Brief Comparison Of NEMA – "Enclosure for Electrical Equipment (1000 Volts Maximum)" and IEC 60529 – "Degrees of Protection Provided By Enclosures (IP Code)"

This publication is intended to provide a brief comparison and explanation of some of the basic differences between NEMA Standard 250, Enclosures for Electrical Equipment (1000 Volts maximum) and IEC Standard 60529, Degrees of Protection provided by Enclosures (IP Code). For a detailed comparison of the differences between the NEMA 250 and IEC 60529 performance specifications, please refer to the respective documents.

What is IEC 60529 and what does it cover?

IEC 60529 is a standard developed through the International Electrotechnical Commission (IEC) that describes a system for classifying the degrees of protection provided by an enclosure. An "enclosure" as used in 60529 is "a part providing protection of equipment against certain external influences and in any direction protection against direct contact".

What is not covered by IEC 60529?

IEC 60529 is NOT a "product standard" and does not cover enclosure requirements other than the "degree of protection" provided. For instance IEC 60529 does not specify the corrosion protection and other environmental operating requirements and tests defined in NEMA 250.

What does "degree of protection" mean in IEC 60529?

"Degree of protection" is a term used in the standard to describe:

1. The protection of persons against access to hazardous parts inside the enclosure.
2. The protection of the equipment inside the enclosure against ingress of solid foreign objects;
3. The protection of the equipment inside the enclosure against harmful effects due to the ingress of water.

What is an "IP Code"?

The IP Code is a designation that indicates the level, or amount, of the protection. The IP Code designation consists of the letters IP (International Protection or Ingress Protection) followed by two numerals. In some instances there may be an optional letter or third digit representing protection against access and mechanical impacts. These two items are beyond the scope of this reference. Please consult additional resources as required.

What does the first numeral of an IP Code indicate?

The first characteristic numeral indicates the degree of protection provided by the enclosure with respect to persons having access to hazardous parts and with respect to solid foreign objects entering the enclosure. See Table 1.

What does the second numeral of an IP Code indicate?

The second numeral indicates the degree of protection provided by the enclosure with respect to the harmful ingress of water. See Table 2.

If a requirement for an enclosure Type is specified, can an equivalent IP rated enclosure be substituted?

No! The IP Code only addresses requirements for protection of people, ingress of solid objects, and ingress of water. There are numerous other requirements covered by the Type designations that are not addressed by the IEC 60529/IP Codes. IEC 60529 does not specify:

- Construction requirements
- Door and cover securement
- Corrosion resistance
- Effects of icing
- Gasket aging and oil resistance
- Coolant effects

The Type designation specifies requirements for these additional performance protections. For this reason, the IEC enclosure IP Codes designations CANNOT be converted to enclosure Type numbers. For general cross reference comparison see See Table 2.

General Information - IP Code

Table 1.

First Number Protection against solid objects.	Second Number Protection against liquids.
0 No Protection	0 No Protection
1 Protected against solid objects up to 50 mm e.g. accidental touch by hands.	1 Protected against vertically falling drops of water.
2 Protected against solid objects over 12 mm. e.g. fingers.	2 Protected against direct sprays of water up to 15° from the vertical.
3 Protected against solid objects over 2.5 mm. e.g. fingers. (tools and small wires)	3 Protected against sprays to 60° from the vertical.
4 Protected against solid objects over 1 mm. e.g. fingers. (tools and small wires)	4 Protected against water sprayed from all directions – limited ingress permitted.
5 Protected against dust – limited ingress permitted (no harmful deposits.)	5 Protected against low pressure jets of water from all directions – limited ingress permitted.
6 Totally protected against dust.	6 Protected against strong jets of water e.g. for us on ship decks – limited ingress permitted.
	7 Protected against the effects of immersion between 15 cm and 1 m.
	8 Protected against long periods of immersion under water.

Table 2.

Assignment of IP Designations to NEMA Type Enclosure Ratings	
NEMA Rating	**IEC Rating**
1	IP23
2	IP30
3	IP64
3R	IP32
4	IP66
4X	IP66
6	IP67
12	IP55
13	IP65

The data contained in the table is provided for information and this table must only be used to apply NEMA ratings to IEC designators; it should not be used inversely. The cross-reference is based on engineering judgment and is not approved by the standards organizations.

Enclosure Selection Guidelines

The Enclosure Selection is designed to enhance enclosure selection by making the process easier, more consistent, accurate and complete. The goal is to assure that factors affecting enclosure selection are considered and the enclosure specification is complete and accurate.

1. Examination of the Application

The requirements of your application must be taken into consideration. Often the application will be associated with the market or product. For example, does the application require a disconnect, does it need to be wall mount or free standing. Each application is different and needs a complete review.

2. Environmental Considerations

Regardless of application - solar field, factory floor, chemical plant, the environment is a critical factor for consideration.
In the proposed environment, what is the highest threat? Based on this threat and the use of NEMA ratings you can determine which enclosure offers the best protection.

3. Material Considerations

Based on the environmental protection that you identify, you will need to define the appropriate material for you application.

- Fiberglass
- Polycarbonate
- PVC
- ABS
- Carbon Steel
- Stainless Steel
- Aluminum

4. Size Considerations

Several factors will need to be evaluated when specifying the size of the enclosure, such as:

- Internal equipment dimensions
- Service connections
- External space restrictions
- Mounting and access
- Climate control requirements
- Aesthetics
- Economics

5. Standards or Ratings

Select an enclosure that has a rating appropriate for your environment and application. Rating types from NEMA, UL, CSA, and IEC determine an enclosures ability to withstand environmental conditions. Keep in mind that there may be multiple enclosures that meet the ratings which may be reduced by material and size considerations.

6. Thermal Considerations

To maximize the life and efficiency of internal components effective thermal management considerations need to be evaluated. One often thinks in terms of dissipating heat build-up, but one must also consider applications that require addition of heat.

General Information
Hazardous Locations

Classification of Hazardous Atmospheres

The NEC classifies areas according to the nature, likelihood and extent of ignitable flammable hazards that could exist where electrical equipment is installed. The intent of area classification is to prevent fires and explosions that could be caused by electrical equipment serving as an ignition source (arc, spark, high temperature, etc.).

The NEC divides the atmospheric explosion hazards into three classes. Considerable skill and judgment must be applied when deciding to what degree an area contains hazardous concentrations of vapors, combustible dusts or ignitable fibers and flyings. Factors such as temperature, barometric pressure, humidity, ventilation, quantity of release, distance from the source, etc. must all be evaluated.

An abbreviated summary of the NEC classifications appears in the table below. For detailed information on specific atmospheres, refer to the NEC, Articles 501-505 and 511-517. For a more complete list of flammable liquids, gases and solids; refer to NFPA 497A and NFPA 497B, Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous (Classified) Locations.

SUMMARY OF HAZARDOUS ATMOSPHERES

Class	Division	Group	Typical Atmosphere, Ignition Temperatures
I Flammable Gases, Vapors Flammable and Combustible Liquids	1 Normally hazardous – Always present in atmosphere	A	Acetylene, 305°C (581°F)
		B	Hydrogen, 520°C (968°F)
		C	Ethylene, 450°C (842°F)
		D	Methane, 630°C (999°F)
	2 Not normally hazardous – May be present in atmosphere	A	Same as Division 1
		B	Same as Division 1
		C	Same as Division 1
		D	Same as Division 1
II Combustible Dusts	1 Normally hazardous – Always present in atmosphere	E	Combustible metal dusts, or other combustible dusts of similar hazardous characteristics
		F	Combustible carbonaceous dusts
		G	Combustible dusts not included in Group E or F, includes flour, grain, wood, plastic & chemicals
	2 Not normally hazardous – Always present in atmosphere	F	Same as Division 1
		G	Same as Division 1
III Ignitable fibers and flyings	1 & 2	No Groups	

General Information – Hazardous Locations

IEC methodology was added to the 1996 NEC in Article 505. The IEC uses area classifications similar to the NEC, but with different terms, groupings, descriptors and temperature range. Article 505 defines only Class I areas; however, the divisions and groupings are different as shown in the following tables:

IEC Group I is for underground mines and is not covered by the NEC. Group IIC combines NEC Groups A and B making the requirements for acetylene the same as for hydrogen and other highly flammable gases.

COMPARISON OF GROUPS

NEC Group	IEC Group
A	IIC
B	IIC
C	IIB
D	IIA

The IEC divides NEC Division 1 into Zone 0 and Zone 1. In Zone 0 the hazard is present at all times or for long periods of time. In Zone 1 the hazard is present during normal conditions, including repair and maintenance activities or leakage, or where operations or processes could result in the release of a flammable mixture or cause a simultaneous failure of electrical equipment.

COMPARISON OF DIVISIONS WITH ZONES

NEC Division	IEC Zone
1	0
1	1
2	2
Non-hazardous	Non-hazardous

CAUTION: These methodologies are mutually exclusive and should not be mixed and matched. Equipment approved for the NEC classifications may be used in the equivalent IEC area, but not vice versa. NEC Article 500-3 requires that the area classification, wiring and equipment selection be under the supervision of a qualified Registered Professional Engineer.

Enclosure ratings for hazardous locations include:

NEMA 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.

NEMA 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.

NEMA 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.

NEMA 10 Enclosures constructed to meet the requirements of the Mine Safety and Health Administration, 30 C. F. R., Part 18.