Technical Information

NEMA, UL And CSA Standards

Enclosure rating	NEMA National Electrical Manufacturers Association (NEMA 250)	UL Underwriters Laboratories, Inc. (UL 50)	CSA Canadian Standards Association (C22.2 No.94-M91)
Type 1	Enclosures are intended for indoor use primarily to provide a degree of protection against the contact with the enclosed equipment.	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 contact with the enclosed equipment and against a limited amount of falling dirt.	Indoor use to provide a degree of protection against dripping and light splashing of noncorrosive liquids, and falling dirt.
Type 3	Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and damage from external ice formation.	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 to provide 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 rain, sleet, and damage from external ice formation.	Outdoor use to provide a degree of protection against falling rain; undamaged by the formation of ice on the enclosure.	Indoor or outdoor use to provide a degree of protection against rain, snow; undamaged by the external formation of ice on the enclosure.
Type 4	Enclosures are intended for indoor and outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.	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 to provide a degree of protection against rain, snow, and windblown dust, splashing and hose-directed water; undamaged by the external formation of ice on the enclosure.
Type 4X	Enclosures are intended for indoor and outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.	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; resists corrosion.	Indoor or outdoor use to provide a degree of protection against rain, snow, and 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 indoor and outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during occasional temporary submersion at a limited depth, and damage from external ice formation.	Indoor or outdoor use to provide a degree of protection against entry of water during temporary submersion at a 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 limited depth; undamaged by the formation of ice on the enclosure.
Type 12	Enclosures are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping non-corrosive liquids.	Indoor use to provide a degree of protection against dust, dirt, fiber flyings, dripping water, and external condensation of non-corrosive liquids.	Indoor use primarily to provide a degree of protection against circulating dust, lint, fibers, and flyings; dripping and light splashing of noncorrosive liquids; not provided with knockouts.
Type 13	Enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying water, oil and non-corrosive liquids.	Indoor use to provide a degree of protection against lint, dust seepage, external condensation and spraying of water, oil, non-corrosive liquids.	Indoor use primarily to provide a degree for protection against circulating dust, lint, fibers, and flyings; seepage and spraying of noncorrosive liquids including oils and coolants.

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Technical Information

EN60529/IP Environmental Ratings

Degrees Of Protection Against Solid Objects			Degrees Of Protection Against Water		
Description	Definition	First characteristic numeral	Second characteristic numeral	Description	Definition
Non-protected		0	0	No protection	
Protected against solid foreign objects of 50 mm diameter and greater	The object probe, sphere of 50 mm diameter shall not fully penetrate	1	1	Protected against vertically falling water drops	Vertically falling water drops shall have no harmful effects
Protected against solid foreign objects of 12.5 mm diameter and greater	The object probe sphere of 12.5 mm diameter shall not fully penetrate	2	2	Protected against vertically falling water drops when enclosure tilted up to 15 degrees	Vertically falling water drops shall have no harmful effects when the enclosure is tilted at any angle up to 15 degrees on either side of the vertical axis
Protected against solid foreign objects of 2.5 mm diameter and greater	The object probe of 2.5 mm diameter shall not penetrate at all	3	3	Protected against spraying water	Water sprayed at an angle up to 60 degrees on either side of the vertical shall have no harmful effects
Protected against solid foreign objects of 1.0 mm and greater	The object probe of 1.0 mm diameter shall not penetrate	4	4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effects
Dust protected	Ingress of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the apparatus or to impair safety	5	5	Protected against water jets	Water protected in jets against the enclosure from any direction shall have no harmful effects
Dust tight	No ingress of dust	6	6	Protected against powerful water jets	Water protected in powerful water jets against the enclosure from any direction shall have no harmful effects
			7	Protected against the effects of temporary immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under standardized conditions of pressure and time
			8	Protected against the effects of continuous immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and user but which are more severe than for numeral 7

The degree of protection provided by an enclosure is indicated by the IP code in the following way:

IP 2 3

1st characteristic numeral–
e.g. protection against solid foreign objects of 12.5 mm diameter and greater

2nd characteristic numeral–
e.g. protected against spraying water

Technical Information

Certifications & Standards

Reference Documents and Sources

NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum) and NEMA Standards Publication ICS6, Enclosures for Industrial Controls and Systems

National Electrical Manufacturers Association

1300 North 17th Street, Suite 1847
Rosslyn, VA 22209

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

Canadian Standard Association

178 Rexdale Boulevard
Etobicoke, Ontario, Canada M9W 1R3

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

Underwriters Laboratories

333 Pfingsten Road
Northbrook, IL 60062-2096

Underwriters Laboratories of Canada

7 Crouse Road
Scarborough, Ontario M1R 3A9 Canada

IEC 529 Classification of Degrees of Protection by Enclosures; IEC 204 Electrical Equipment of Industrial Machines

International Electrotechnical Commission

1 Rue de Varembei
CH-1211
Geneva 20, Switzerland

ANSI Z55.1 Grey Finishes for Industrial Apparatus and Equipment

American National Standards Institute

1430 Broadway
New York, NY 10018

Information for Comparison of IEC and CSA/NEMA/UL/cUL Ratings

NEMA 250 and UL 50 specify tests for environmental conditions such as falling dirt, ice, corrosion, oil and coolants whereas IEC 529 (EN60529) does not have such requirements. Different rating requirements make comparison difficult and disagreements are common.

The IEC designation consists of the letters IP followed by two numerals. The first number indicates the degree of protection provided by the enclosure with respect to persons and solid foreign objects entering the enclosure. The second number indicates the degree of protection provided by the enclosure with respect to the harmful ingress of water.

The data contained in the following tables are provided for information; however, ***caution is necessary when attempting to equate IEC and NEMA enclosure ratings because an exact equivalence is not possible.*** The table can only be used to convert NEMA designations to IEC, it should not be used inversely. The cross reference is based on engineering judgement and is not approved by any standards organization.

NEMA Enclosure Type	IEC Enclosure Type
1	IP 10
2	IP 11
3	IP 54
3R	IP 14
3S	IP 54
4	IP 66
4X	IP 66
6	IP 67
12	IP 52
13	IP 54

*Comparison ratings in this table are taken from Appendix A, NEMA 250-1997. Test data may change the equivalent rating published by the enclosure manufacturer.

Technical Information

Enclosures & The CE Mark

Background

The CE mark has been a feature of European Community legislation since 1987, but it was actually born out of the New Approach Resolution two years earlier. This resolution aimed to "harmonize" the various national systems of European standards, and prompted various New Approach Directives (NADs). The CE mark applies only to those NADs which include testing or certification requirements.

The precise testing and certification required for CE labeling is spelled out in each individual NAD. These requirements may vary from NAD to NAD. The reason is that, depending on industry or application, a particular NAD may address certain technologies or safety concerns that require special attention.

CE marking on a product or system presumes conformity by the manufacturer or importer that the product complies with one or more directives that relate to the product. As a result, the product may be placed on the European Community market without challenge by national administrations.

The CE mark does not reflect any level of quality or any particular forms of testing or certification. It should not be confused with third-party certification marks like UL, TÜV or VDE. Appearance of the CE mark on a product simply enables that product to be placed on the market within the EC. And it gives confidence to the member national administrations that essential requirements of relevant directives have been met.

Empty Enclosures Are Unaffected

There is no New Approach Directive relating to empty enclosures. Therefore, Rittal Corporation cannot CE label empty enclosures. However, when electrical products and other electronic packages are added, or when the enclosure is used as part of a complete set-up (defined as a "machine" in the New Approach Directives), CE labeling of the complete system may be required.

The following three directives are most likely to apply to electrical related products:

- 89/392/EEC Machinery Directive; applies to both machinery and safety components
- 73/23/EEC Low Voltage Directive; applies to products with 50 to 1000 V AC input
- 89/336/EEC EMC Directive; sets the requirements for the control of emissions and immunity.

Each contains its own specific requirements generally concerning design, manufacture, intended use, test reports, and technical documentation from a Notified Body, as well as supporting schematics and diagrams.

Rittal CE Marked Products

Electrical related products, which cannot function independently, do not need to be labeled, but require a declaration. Upon request, Rittal will supply customers with a declaration of conformity documenting the valid scope of EMC low voltage or machine guideline for the product in question.

CE affected Rittal products–including filter fans, enclosure lights, and door switches–already meet CE requirements and already carry the mark. Rittal air conditioners and air/air heat exchangers have passed all tests for conformity to the relevant guidelines and have been certified by international test laboratories including TÜV and VDE. And Rittal heaters are now moving through the final stages of CE compliance.

Additional Products

Rittal is CE marking the following products affected by the EMC directive:

- Roofmount air conditioners
- Wallmount air conditioners
- Mini-cooling air conditioners
- Air/air heat exchangers
- 1S fan and filter units
- Rackmount 19" fans
- Enclosure lights
- Door switches
- Power distribution products

For Additional Information...

Rittal's product management team is becoming increasingly informed about the CE mark and can help with a variety of questions regarding CE marking requirements. Call (800) 637-4425 for additional information about CE marked Rittal products.

Or ask your Rittal Representative for a complimentary copy of *Understanding and Using Europe's CE Mark*–Rittal's comprehensive white paper on the subject.

EN 50298 Standard

The object of this standard is to specify definitions, classifications, characteristics and test requirements of enclosures to be used as part of switchgear and controlgear assemblies, that do not exceed 1000 V a.c. at frequencies not exceeding 1000Hz, or 1500 V d.c. and suitable for general use for either indoor or outdoor applications. This standard applies to empty enclosures, prior to the incorporation of switchgear and controlgear components by the user, as supplied by the enclosure manufacturer. Compliance with the safety requirements of the applicable product standard is the responsibility of the final assembly manufacturer.

Enclosures meeting this standard were type tested according to clauses written in the standard. These type tests include: static load, lifting, impact code, environmental code, thermal stability, heat, abnormal heat and fire, dielectric strength, continuity of protective circuit, weathering, corrosion and marking.

Technical Information
Enclosure Materials

Specifications for Construction Materials Used in Rittal Enclosures

Rittal offers **Aluminum**, **Galvanized Steel**, **Painted Steel**, **Polycarbonate**, **Stainless Steel** and **Fiberglass** Enclosures. The choice of material is dependent on the concentration of various corrosives present in the application environment and other physical properties necessary to meet the design specifications. Although NEMA 4X is the only enclosure fabricated and rated for resistance to corrosive agents, other enclosure materials and ratings offer a degree of corrosion resistance in less harsh environments.

To begin the selection process, one must consider all the corrosive agents which can be present in an application, but determining the concentration and corroding agents may be a complex process. Usually several corrosive elements are present and interactions are not always well documented.

Water is the most common corrosive and is usually present to some extent in every enclosure application. Adjacent processing operations or other intermittent activities such as industrial cleaning or road salt may expose the enclosure to a variety of corrosive agents and temperatures. Each environment is unique and all possible corrosive agents should be identified for the intended enclosure application.

Once the corrosive agents and concentrations are identified, information in this section can be used to select the enclosure material. Metal corrosion is influenced by surface finish, surface treatment such as painting or galvanizing, and use of materials such as stainless steel, fiberglass, polycarbonate or aluminum which are naturally corrosion resistant.

To select the best enclosure material for an application; chemical resistance, physical strength and economic data are presented in several tables beginning on the next page. In Table 1 enclosure materials are rated on a continuum from “Recommended” to “Limited or Unacceptable” in three broad categories of chemicals. Since the chemical resistance categories in the table are extremely broad, some materials may perform well in specific corrosive environments within a general category and it is best to consult the detailed Chemical Resistance Information provided in Table 3.

Besides the enclosure material, the corrosion resistance of features such as windows, gaskets, latches, etc. must also be considered. Table 4 provides the chemical resistance information which can be used to select the commonly used materials for these features.

Much of the chemical resistance information in Tables 3 and 4 is based on total immersion testing in the chemical for a minimum of 30 days at 72°F. The information in these tables is intended as a guide only. Total immersion testing is considered quite severe and **the results may not necessarily reflect the performance under actual field conditions.** The user assumes responsibility for selection of the material based on the characteristics of the application environment.

Cold Rolled Steel
A low carbon, cold finished steel, produced by passing bar stock through a set of rolls. Cold rolled sheets have less thickness variation and a better finish than hot rolled steel.

Galvanized Steel
A zinc coated steel which is hot dip galvanized, metal sprayed or electroplated to provide corrosion resistance. Galvanizing provides a sacrificial coating and cathodic protection.

Hot Rolled Steel
A low carbon, hot finished steel, produced by passing bar stock through a set of rolls at a temperature above the re-crystallization temperature. Hot rolled steel sheet has a poorer finish than cold rolled steel.

Pickled and Oiled Steel Sheets
Hot rolled steel sheets which have had the scale removed by means of a hot, weak sulfuric acid bath after which an oil film has been applied for corrosion resistance.

Polycarbonate
Thermoplastic polymer which becomes solid when temperature falls below its melting point. Can be recycled and reused. Has excellent electrical properties and high impact strength.

Stainless Steel
A highly corrosion resistant iron alloy containing between 12% and 25% chromium. For superior corrosion resistance, Rittal fabricates enclosures from both Type 304 and 316 Stainless Steel which are non-magnetic. Type 316, a low carbon stainless steel, is harder and more corrosion resistant; it is an excellent material for marine application.

Aluminum
A lightweight metal which quickly forms a natural oxide layer to resist corrosion. Rittal fabricates enclosures from Type 5052 aluminum, the highest strength non-heat treatable aluminum alloy recommended for marine applications.

Galvaneal
A hot-dip zinc coated sheet which has been heated after coating to allow interdiffusion of zinc and iron to form an alloy coating.

Fiberglass
Enclosures are molded under heat and pressure with fiberglass reinforced polyester resin to produce superior chemical resistance in corrosive applications. The glass fiber reinforcement increases enclosure strength to withstand physical loads such as unexpected impacts or additional tensile loads.

TECHNICAL APPENDIX

Technical Information
Enclosure Materials

Table 1. Broad Categories Of Enclosure Material Chemical Resistance

CONTINUUM OF USE	GENERAL CATEGORY OF CHEMICALS		
	Acids	Alkalines	Solvents
⬇			Stainless Steel
⬇	Stainless Steel	Stainless Steel	Fiberglass
Recommended		Fiberglass	Aluminum
⬇	Fiberglass		Powder Coated Steel
⬇			
Acceptable			
⬇		Galvanized Steel	Galvanized Steel
⬇	Powder Coated Steel	Powder Coated Steel	
Limited or Unacceptable			
⬇	Aluminum		
⬇	Galvanized Steel	Aluminum	

Detailed material strength information is beyond the scope of this catalog and should be obtained from a materials reference or Rittal; however, Table 2 provides some relative data to help with this selection.

Table 2. Relative Material Strength And Cost Comparison Of Commonly Used Enclosure Materials

MATERIAL	RELATIVE PHYSICAL STRENGTH	RELATIVE COST	APPLICATION CONDITIONS	TEMPERATURE LIMITATIONS
Aluminum	Average	Average	Indoor and outdoor, marine, solvents, petrochemical sulfates, nitrates and specific acids.	None for enclosure applications
Mild Steel: Galvanized Painted	High	Average Low	Indoor and outdoor where the respective coating provides acceptable protection in a mildly corrosive environment.	None for enclosure applications
Stainless Steel	High	Average-High	Indoor and outdoor in highly corrosive applications. Food and dairy processing or marine.	None for enclosure applications
Acrylic	Average	Low	Enclosure windows. Weatherable, scratch resistant. Good resistance to solvents.	-31°F(-35°C) to 180°F(82°C)
Poly-carbonate	Average	Low-Average	Enclosure windows. Not recommended for direct sunlight, exposure to organic solvents and concentrated alkalis.	-31°F(-35°C) to 248°F(120°C)
Nylon	Average	Low	Cord grip, hinges, latches.	-22°F(-30°C) to 212°F(100°C)
Fiberglass	Average	Low-Average	Indoor and outdoor for continuously damp and highly corrosive environments. Petrochem, water treatment, food processing, coating, salts and chemicals.	-40°F(C) to 250°F(121°C)
Gaskets:				
Neoprene	Low	Low	Oil resistance. Seams may be a problem.	-40°F(C) to 225°F(107°C)
Silicone	Low	Average	Oil resistance temperature and chemical resistance.	-40°F(-40°C) to 350°F(175°C)
Urethane	Low	Average	Water and oil resistance, chemical resistance.	-40°F(C) to 200°F(93°C)

For more information, contact the Rittal Technical Hotline 1-800-637-4425.