Overview of Ingress Protection

Overview of Ingress Protection for electrical enclosures

In manufacturing, there are two standards used to measure the different grades of electrical enclosures and how resistant they are to the ingress of certain materials. NEMA ratings and IP ratings both define degrees of protection against substances such as water and dust, but use different test methods and parameters to define their enclosure types (NEMA 250 and IEC standard 60529).

NEMA, refers to the National Electrical Manufacturers Association, a trade association whose membership is comprised of electrical equipment manufacturers in the United States, and is responsible for publishing a wide range of standards, including not only enclosure integrity but also electrical connections.

For example, a device with a NEMA 4 rated enclosure must provide a degree of protection against the following:

- Access to hazardous parts
- Ingress of solid foreign objects (e.g. falling dirt, circulating dust, lint, fibres, etc.)
- Ingress of water from splashing water or a hose-down.

IP ratings are a part of the International Electrotechnical Commission (IEC). "IP" stands for "international protection" but is commonly referred to as "ingress protection." There are dozens of IP standards, but some of the most common ones are:

- IP54 - "limited dust tight" and protected against water spray in any direction
- IP65 - "dust tight" and protected against water projected from a nozzle
- IP67 - "dust tight" and protected against water immersion up to 1m in depth
- IP68 - "dust tight" and protected against immersion.

The first digit represents the degree of protection against solid objects, while the second digit covers protection against water.

NEMA is geared towards industrial applications and is primarily used in North America, whereas IP ratings cover a broad set of applications worldwide. IP ratings cover protection only against the ingress of water and solid objects while NEMA includes supplementary protection standards against corrosion resistance and icing. NEMA ratings also include distinctions between hazardous and non-hazardous environments.

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NEMA, While there is no direct conversion between NEMA and IP they can be compared as shown in the table below.

NEMA rating	IP Equivalent	NEMA definition
1	IP10	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.
2	IP11	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.
3	IP54	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 external formation of ice on the enclosure.
3R	IP54	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 external formation of ice on the enclosure.
3S	IP54	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.
4	IP66	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 failing dirt, rain, sleet, snow, windblown dust, splashing water, hose-directed water, and corrosion; and that will be undamaged by external formation of ice on the enclosure.
5	IP52	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.
6	IP67	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.
6P	IP67	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to the personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water and te entry of water during prolonged submersion at a limited depth; and that will be damaged by external formation of ice on the enclosure.

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NEMA rating	IP Equivalent	NEMA definition
12 and 12K	IP52	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 flying; and against dripping and light splashing of liquids.
13	IP65	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.

Ingress protection requirements for enclosures are defined in the codes and standards for various explosion protection options as follows:

Purge & pressurization (Ex p): BS/EN 60079-2: Minimum IP40; NFPA496 (2021) NEMA 3,3S, 4, 4X, 6, 6P, 12, 13 (X-Purge only)

Increased safety (EX e): BS/EN 60079-7: Minimum IP54

Type n protection (Ex nR): BS/EN0079-15 Minimum IP66 (plus breathing test).

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