



*Gaskets are mechanical devices used to provide a leak-tight seal between two slightly irregular mating surfaces, such as an enclosure and its doors and accessories. In many indoor and outdoor applications, a properly mounted, well-performing gasket is critical to the protection of sensitive electrical and electronic equipment inside the enclosure. While gaskets are primarily used to exclude the external environment from entering an enclosure—such as dust, dirt, water, and Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI)—they can also be used to contain noise or other forms of interference generated from internal components. To ensure proper performance and long service life, specifiers should select a gasket that is specifically designed and rated for an application’s environment.*



## Environments that Require Gaskets

There are several organizations that provide industry standards for electrical enclosures, including the use of gaskets. The four most commonly recognized enclosure standards are the International Electrotechnical Commission (IEC), National Electrical Manufacturer’s Association (NEMA), Canadian Standards Association (CSA) and Underwriters Laboratories® (UL). The IEC 60529 includes a list of codes that are used to identify ingress protection levels. Commonly referred to as the IP rating, these codes reflect an electrical enclosure’s ability to protect against access to electrified parts by people, tools, moisture, dust or dirt. However, IP ratings are often not as stringent as NEMA, CSA and UL ratings. For example, some IP ratings allow a certain amount of water to enter an enclosure through a gasket, as long as the water does not interfere with the performance of electrical and electronic equipment.

NEMA 250 and UL 50, 50E differ from IP ratings because in most cases they do not allow any ingress into an enclosure, and they address design attributes that IP ratings do not. While NEMA and UL ratings address many of the same points, NEMA simply indicates the design intent. Only UL enforces compliance to their standards by third party testing and on-site inspection. To ensure that gaskets provide necessary levels of protection, UL ratings include the following tests:

- Type 12: dripping water and circulation of concrete dust
- Type 13: 2 gallons per minute of a water/wetting agent mix for 30 minutes
- Type 3: concrete dust is circulated around the enclosure and hose tested
- Type 4: 65 gallons per minute of spray for a minimum of 5 minutes from 10-15 feet
- Type 6: temporary submersion in 6 feet of water for 30 minutes
- Type 6P: temporary submersion in 6 feet of water for 24 hours

For indoor applications, a gasket with a UL Type rating of 12 or 13 is typically recommended. Type 3, 4, 4X, 6 and 6P rated gaskets are commonly used for demanding outdoor applications. While they can also be used in indoor applications, these enclosures are typically more expensive than Type 12 or 13 enclosures.



# HOW TO SELECT THE IDEAL ENCLOSURE GASKET



Type 12 Atomized Water Test



Type 4 Test



Type 6, 6P Water Submersion Test



Type 12, 12K and 13 Oil Swell Test



Tensile and Elongation Test

## UL Water Resistance Tests

The levels of water tests range from drip, to hose down, to submersion. To pass each level, UL requires no water to enter the enclosure throughout the entire duration of the tests. For instance, the Type 12 test checks for resistance to dripping water and concrete dust, or atomized water. In the water drip test, the gasket must allow no water to enter the enclosure for 30 minutes, as it is exposed to 20 drops of water per minute. During the concrete dust test, atomized water—which can be substituted for concrete dust—is sprayed at 30 psi at potential leakage points.

The Type 13 test consists of water sprayed at 2 gallons per minute for 30 minutes. The water includes a wetting agent to simulate oil. In the Type 4 and 4X tests, the water is increased to 65 gallons and sprayed directly on the enclosure for a minimum of 5 minutes, depending on the required rating. The highest level, the Type 6, 6P test, requires the enclosure to be completely submersed in water for 30 minutes for Type 6 to 24 hours for Type 6P.

## Other UL-Required Tests

The oil swell test, a UL-required test, determines how the gasket will perform when exposed to oil. Gaskets are immersed in IRM 903 oil for 70 hours and cannot exceed a 25 percent swell or 1 percent shrinkage factor to pass this test required for Type 12, 12K and Type 13.

In the tensile and elongation tests—required for types 2, 3, 3S, 4, 4X, 5, 6, 12, 12K and 13—gaskets are aged at 158°F (70°C) for 1 week. Upon completion of this process, new and aged gaskets are pulled to the breaking point. To pass the test, the aged gaskets must stretch 60 percent of the same length as the new gasket before breaking. Additionally, the tensile strength—the amount of force needed to break the specimen—of the aged gasket must be at least 75 percent of the new gasket.

## Additional Gasket Tests

While it's not required by UL, some manufacturers may perform a water absorption test to ensure that water will not be drawn into the enclosure through the gasket. In this test, the gasket is placed in a chamber with 2 inches of distilled water and submersed for 3 minutes at a negative water column. The gasket then sits at an atmospheric pressure for three minutes and is finally blotted dry and weighed to determine the amount of water the gasket has absorbed. The weight gain must be less than 3 percent to pass this test.

In an optional cold impact test, the gasket material is subjected to -60°F (-51°C) for a minimum of 2 hours. Testers then strike the materials with a 16-ounce hammer and measure it to determine the compression, as well as any permanent impact points. Compression testing is not required by UL, but the American Society for Testing and Materials (ASTM) provides standards for performing this test and evaluating the results. The gasket material is first subjected to 158°F (70°C) for 3 days, and then gaskets are compressed at 20, 30, 40, 50 and 60 percent. Upon returning to room temperature, the compression set is checked. The gasket must return to within 10 percent of its original thickness to pass this test.



Water Absorption Test



Cold Impact Test



Compression Set Test





Adhesion Test

In an adhesion test, testers place foam-in-place or strip gaskets (see the Gasket Designs section below) onto various substrates, including mild steel, stainless steel, painted surfaces and other non-metallic surfaces. The samples undergo a series of tests that include soaking in various chemicals and exposure to multiple environmental conditions. After all of these independent tests are performed, the adhesion level of the gasket is tested. These measures help to ensure that the gasket will not peel off of an enclosure, but adhere so well that adverse elements would actually destroy the gasket before causing it to lose adhesion.

While proper adhesion is necessary for optimal gasket performance, blocking—defined as unwanted adhesion—could cause a gasket to stick to a sealing surface so that an operator cannot open an enclosure door. To test for blocking some manufacturers clamp a gasket to a substrate, which is compressed 50 percent with another substrate, and then soaked at 158°F for 24 hours. The objective is to not have any adhesion to the



Blocking Adhesion Test

clamped on substrate, which represents the enclosure door, at the end of the test.



Chemical Resistance Test

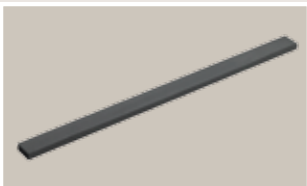
In an optional chemical resistance test, manufacturers may expose gaskets to various chemicals, including strong acids, bases and cleaning substances—which are common to food and beverage, and additional washdown applications. After 7 days of exposure and again after 30 days of exposure, manufacturers check the gasket for visual changes, chemical absorption, swelling and adhesion.

## Gasket Designs

There are three main types of gaskets: strip, foam-in-place (FIP) and die-cut. In the strip-gasket method—the oldest method of gasketing—manufacturers adhere rolls, or strips, of the gasket to the enclosure surface and cut them to exact measurements. Numerous materials can be used for strip gaskets, including neoprene, nitrile, Viton® and silicone. While strip gaskets are usually a cost-effective option, the method creates a seam in each corner which may make the gasket more vulnerable to wear and damage.

FIP gaskets are currently the most popular gasket type. In this method, a polyurethane material is typically applied to an enclosure in liquid form and then allowed to cure to a cellular foam on the enclosure body or cover. The formation process leaves no seams. FIP gaskets offer a good compression set resistance and are typically less expensive than other types of gaskets.

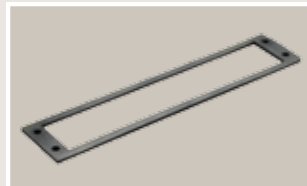
Die-cut gaskets are commonly available in two forms. Regular-cut die-cut gaskets form around the exact perimeter of the surface. Chevron gaskets include two L-shaped matching pieces that equal the surface perimeter. Like FIP gaskets, one-piece die-cut gaskets do not have seams. However, they are typically more expensive.



Strip



Foam-in-place



Die-cut

## MATERIAL OPTIONS

Gaskets can be made out of versatile materials, offering varying service temperature ranges, compression set resistances and other characteristics. Common materials include the following:

### Polyurethane:

- Service temperature range of -40 to 158°F (-40 to 70°C)
- Good compression set resistance
- Easy to create irregularly shaped gaskets

### Neoprene:

- Most common material used for gaskets
- Used to form die-cut and strip gaskets
- Service temperature range of -67 to 250°F (55 to 120°C)
- Offers excellent chemical, abrasion and tear resistance
- Waterproof

### Nitrile:

- Service temperature range of -40 to 250°F (-40 to 121°C)
- Excellent compression set resistance
- Good tear and abrasion resistance
- Poor resistance to ozone, UV and other weather-related elements, unless specifically compounded to resist these elements

### Silicone:

- Service temperature range of -40 to 450°F (-40 to 232°C)
- Excellent compression set resistance
- Good resistance to ozone, UV and other weather-related elements
- Good high temperature resistance
- Manufactured by molding or die-cutting sheet stock
- More expensive than many other materials

### Viton®:

- Fluoroelastomer material
- Service temperature range of -19 to 400°F (-28 to 204°C)
- Good chemical resistance, especially to caustic chemicals
- More expensive than many other materials

# HOW TO SELECT THE IDEAL ENCLOSURE GASKET



Slanted Flange



Hidden

## Design Features that Increase Gasket Performance

EMI and RFI—caused by stray voltages and currents from machines, cell phones, noisy power equipment and more—can negatively affect the performance of the electrical controls in an enclosure. To protect components from EMI and RFI, proper shielding, including a specially designed gasket, should be utilized.

Gaskets used for EMI and RFI shielding should feature metal-to-metal contact, as conductive gaskets provide low-resistance electrical paths. EMI and RFI enclosures must also have an internal conductive plating/coating and shielding at all other entry and exit points.

Gasket effectiveness can additionally be designed into an enclosure to make it especially well suited for certain applications. For example, angled flange gaskets lead water away from the enclosure, protecting them from ingress in washdown applications, such as food and beverage, and pharmaceutical. Hidden gaskets and tongue-and-groove designs protect gaskets from physical damage, as well as UV and chemical exposure.



Tongue and Groove

## Gasket Maintenance

Even gaskets that are properly specified for an application and feature the appropriate Type rating for the environment must be maintained to ensure optimal performance. Gaskets should be checked for physical damage, such as cutting, tearing and gouges.

Aging gaskets can become brittle after prolonged exposure to environmental elements. However, replacing a damaged or aged gasket negates the UL rating of the enclosure.

In certain situations, the UL rating may be maintained by replacing the entire enclosure door. Another option is to replace an old gasket with a pre-cut “ring” gasket that is made specifically for the enclosure. However, this does not maintain the rating, so it shouldn't be used if a UL rating is required.

While gaskets perform a critical task in preventing contaminants and sources of interference from entering an enclosure and, in some cases, sound from exiting an enclosure, the gasket must be properly rated for an environment to ensure reliable performance. Many different tests are conducted to determine the appropriate UL Type rating, and once a gasket is selected, it must be maintained to ensure proper protection.

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