

SPECIFYING THE CORRECT ENCLOSURE MATERIAL

Thirty years ago, specifying an enclosure involved three steps: ordering the appropriately sized gray box, installing sensitive electronic equipment and hoping the enclosure would withstand its environment. Today, choices have increased exponentially, as there are a wide variety of enclosure types. While many different attributes affect an enclosure's performance, selecting the correct enclosure material is a key element in ensuring long enclosure life. The following tips and integrated Project Assessment Tool will assist in determining the correct enclosure material for the application at hand.

ENVIRONMENTAL CONSIDERATIONS

From airborne debris and temperature variations to ultraviolet (UV) rays, environmental elements can have a significant impact on how an enclosure will perform over years of operation. For example, a fiberglass enclosure exposed to direct sunlight for several years will likely experience fiberbloom, whereas a mild steel enclosure will exhibit rust in wet or corrosive environments. To prevent problems such as these, specifiers must take into consideration whether the enclosure will be located indoors or outdoors; in washdown, UV or other challenging environments; or near harsh chemicals such as chlorine or sodium. Specifiers must also remember stainless steel is not "stain-free," meaning while it can offer exceptional performance in some environments, it is not totally immune to rust or staining. For example, in an area where salt spray is present, mild and stainless steel enclosures are susceptible to

rust to varying degrees, while a non-metallic enclosure will not rust.

Specifiers should also consider if the enclosure will be located in a high-traffic environment, such as one containing forklifts or other heavy equipment, or if personnel will need to frequently access the enclosure. Different materials offer varying degrees of impact resistance, and both metallic and non-metallic enclosures are available with several latching options to provide easier access and security to the enclosed components.

MODIFICATIONS

Specifiers must often evaluate the modification flexibility of an enclosure material, since almost all enclosures will need to be modified with holes or cutouts. Thermoplastics and other non-filled non-metallics are highly suitable for jobsite modifications. Fiberglass is more difficult to modify, since the glass

Disclaimer: The statements made in this paper apply only to the materials from which enclosures are constructed. The statements do not apply to gasketing, latching or other enclosure components.

PROJECT ASSESSMENT

STEP 1: ENVIRONMENTAL CONSIDERATIONS

Identify environmental chemicals:

Will the enclosure be placed in a washdown environment?

☐ Yes ☐ No

Will the enclosure be located indoors or outdoors?

☐ Indoors ☐ Outdoors

If outdoors, will sunlight be:

☐ Direct ☐ Indirect

Are Rating requirements needed?

☐ Yes, Type

☐ No

Traffic around the enclosure:

☐ High ☐ Medium

☐ Low

How often will the enclosure be accessed?

☐ Frequently

☐ Occasionally

☐ Rarely

STEP 2: MODIFICATIONS

Custom size or shape required?

☐ Yes ☐ No

In-field cutouts or holes required?

☐ Yes ☐ No

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contained is highly abrasive and not conducive to clean cutouts. Mild steel is a viable option—with the correct metalworking tool, holes can easily be added in the field. Stainless steel, due to its hardness, is very difficult to cut and far more challenging to modify on-site.

If modifications such as custom sizes or shapes are required, mild and stainless steel are suitable candidates. Both materials are fabricated from a flat sheet of steel, making them easier to form to custom specifications in the fabrication process. Non-metallics are available in several sizes, but due to tooling limitations, specifiers can only select the sizes manufacturers have available.

PRICE

Different enclosure material types provide different price points, helping project managers stay within their budget, while providing the required protection from environmental elements. If the project budget is tight, there may be more than one material option that can help maintain costs. For example, an enclosure manufactured from Type 304 stainless steel performs well in some harsh surroundings, such as where chlorine is present. Fiberglass or polyester can also prove to be cost-effective options in this environment. However, specifiers must carefully evaluate all environmental factors to ensure an enclosure made of a less expensive material will withstand its intended environment and application.

AESTHETICS

An increasing number of customers are requesting enclosures that are highly designed, branded with company colors, or finished to blend in with their environment. Both metallic and non-metallic materials

offer modification capabilities in these areas. As mentioned above, if a custom size or shape is needed, metallic enclosures can be fabricated accordingly; non-metallics may require new tooling.

THERMAL ISSUES

Specifiers must evaluate both the temperature of the environment in which the enclosure will be located, as well as the expected temperature of its enclosed electrical components. Plastics such as polycarbonate are superior insulators, while metallics such as stainless steel absorb and conduct heat. If heat dissipation is a concern, a metallic enclosure will typically dissipate heat better than a non-metallic enclosure. Several thermal solutions are available to address heat concerns, including: color, fans, louvers, heat exchangers and air conditioners.

WEIGHT CONSIDERATIONS

Depending on the application at hand, a lightweight enclosure may be preferable. Lightweight materials such as aluminum or plastic are easier to lift and work with, especially when the enclosed components are of significant weight or when the enclosure will be wall- or pole-mounted. Most non-metallic materials weigh less than metallics, and there are different material options and thicknesses available to address weight concerns. For example, if a polycarbonate object weighs one pound, a fiberglass object of the same size may weigh 1.5 pounds. The object might weigh 2 pounds if made of aluminum and 6.5 pounds if fabricated from steel. When designing, take both the weight of the electrical components and the expected mounting configuration into consideration when selecting an enclosure material.

PROJECT ASSESSMENT

STEP 3: PRICE

Target price _____

STEP 4: AESTHETICS

Customer specifications: _____

STEP 5: THERMAL ISSUES

Ambient temperature range: _____

Component temperature range: _____

Heat dissipation required:
☐ Yes ☐ No

STEP 6: WEIGHT CONSIDERATIONS

What is the total weight of the components?

Will the enclosure be:
☐ Floor-mounted
☐ Wall-mounted
☐ Pole-mounted

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MATERIAL REFERENCE CHART

Material	Metals					Non-Metallics					Finishes		
	Mild Steel	304 SS	316 SS	Aluminum Die Cast	Aluminum Sheet	Poly-carbonate	Fiberglass*	Fiberglass**	Polyester	ABS	Powder Coat	Plated	Exotic Finish
Cost	2	4	5	3	3	2	3	3	2	1	3 or 4		
Weight	5	5	5	3	3	1	3	3	1	1	—		
Chemicals	Specific to chemical and environment mix					Specific to chemical and environment mix					Gaskets must be protected from chemicals		
EMC	Needs a conductive gasket					Requires special coating and gasket					Masking in gasket contact areas		
Heat Dissipation	3	3	3	5	5	1	1	1	1	1	—		
Heat Absorption	3	3	2	1	1	5	5	5	5	5	Changing finishes can change heat effect		
Aesthetics	Dependent upon enclosure customization options					Dependent upon enclosure customization options					—		
Impact Resistance	3	2	2	1	1	4	3	3	5	4	—		
Conductivity/ Grounding	3	4	4	5	5	1	1	1	1	1	Plating can improve conductivity on metals		
Available Sizes	No constraints on sizes; easily modified to meet specifications					Must select available sizes; tooling limits meeting specific size needs					—		
Modifications	No constraints in fabrication process; some constraints on modifications in the field					Limited to holes with some color options					—		

Ratings: 1 = Low 5 = High

* Spray-up ** Compression molded

Disclaimer: This is a general guide. The specific environment should be taken into consideration when selecting an enclosure.

MATERIAL OVERVIEW

Many additional design factors may come into play due to customer-requested modifications and application-specific needs, but knowing the traits and limitations of each enclosure material can assist specifiers in determining the best selection for the most common applications.

MILD STEEL

Most mild steel enclosures are manufactured from hot- or cold-rolled steel. Hot-rolled steel is produced from low-carbon, hot bar stock, elevated above the recrystallization temperature and passed between rollers set to the desired thickness. A hot, weak sulfuric acid bath is then used to remove scale, and

an oil film is applied. Cold-rolled steel is also low-carbon and produced by passing bar stock through rollers, but in this process the material temperature is not elevated. Enclosures fabricated from either type of mild steel are acceptable for many indoor and outdoor environments, but, they are not considered corrosion resistant materials. The performance of mild steel is enhanced with a powder paint finish.

STAINLESS STEEL

Stainless steel's ability to resist corrosion comes from its chemical composition. Type 304 stainless steel (18-8) was named to reflect its 18% chromium and 8% nickel composition. Type 316 stainless steel, a higher grade version, has a 10% nickel, 16% chromium and 2% molybdenum content. Nickel and molybdenum provide increased corrosion resistance to chlorides and many

common industrial chemicals, while chromium provides a protective surface film. Stainless steel can cost up to three times as much as mild steel, and since the cost of stainless steel is directly related to its chemical composition, an increase in nickel content equals an increase in material cost.



Type 316 stainless steel enclosures offer superior resistance to many corrosive environments and can be designed to deliver ATEX-certified component protection.

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NON-METALLICS

Non-metallic enclosure options have been available since the early 1970's. Non-metallic popularity has recently increased with greater understanding of the benefits these materials provide. Generally, non-metallic enclosures are easily modified at the jobsite, weigh far less than both mild and stainless steel, and provide low solar heat absorption.

In addition, despite the common industry misperception, non-metallics provide security and tamper resistance levels similar to metallic enclosures when properly locked. Common material options in this category are fiberglass, polycarbonate, ABS and polyester.

Fiberglass, a thermoset polyester material reinforced with glass fibers, is the most widely used non-metallic material in the industry. Fiberglass enclosures are typically produced in one of two ways: compression molding, using a large press and tools, or a spray-up process of glass and resin that provides a heavy outer layer gel coating that provides protection and is available in

many colors. This material demonstrates high impact strength and rigidity, a wide working temperature range (-31 to 300 F), excellent dimensional stability and electrical properties, and excellent moisture and chemical resistance. Fiberglass is a cost-effective alternative for many corrosive environments.

Polycarbonate is a high-performance thermoplastic resin processed by injection molding or sheet extrusion. It exhibits excellent impact resistance, a fairly wide temperature range (-31 to 180 F), and good dimensional stability and electrical properties. Plus, polycarbonate can be formulated to provide superior fire resistance and UV stable properties. Clear polycarbonate material is available and used to provide transparent covers. Polycarbonate offers good corrosion resistance in some acidic environments, but is not suitable for environments with strong alkalis and organic solvents. Most polycarbonate enclosures meet Type 4X requirements and have low to moderate prices.



Polyester enclosures are lightweight and can provide exceptional flame resistance, UV protection and resistance to a broad range of solvents, alkalis and acids.

ABS (or ABS blends) is another thermoplastic option. ABS material may offer better chemical resistance to some acids and alkalis than polycarbonate material and offers a slightly narrower temperature range than other non-metallic materials (0 - 125 F). ABS enclosure constructions may meet NEMA 4X requirements but are not UL/CSA certifiable. ABS is a good low-cost alternative for indoor and moderately corrosive environments where a UL rating is not required.

Polyester (PBT) was recently introduced as an additional non-metallic enclosure material option, and while it is not as widely available as the other non-metallic materials, it offers a broad range of benefits at a moderate price. This lightweight, high-performance unfilled thermal plastic is processed using injection molding and delivers high impact resistance, excellent electrical properties, and superior chemical and moisture resistance. It has a slightly narrower temperature range than fiberglass (-40 to 248 F) and provides less impact resistance in cold weather than polycarbonate. Polyester can provide sufficient protection in numerous indoor and outdoor applications, but direct sunlight might cause a slight yellowing of the material.

CHEMICAL RESISTANCE CHART

	Solvents	Alkalis	Acids
Recommended	Type 304 stainless steel Type 316 stainless steel Fiberglass (compression molded) Aluminum Polyester	ABS Polyester Type 304 stainless steel	ABS Polyester Polycarbonate Fiberglass (spray-up) Type 304 stainless steel Type 316 stainless steel
Satisfactory	Steel (polyester powder coat) Fiberglass (spray-up) Polycarbonate ABS	Type 316 stainless steel Polycarbonate Fiberglass (compression molded) Fiberglass (spray-up)	Fiberglass (compression molded)
Limited Use		Steel (polyester powder coat) Aluminum	Aluminum Steel (polyester powder coat)

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