How to avoid over specifying enclosures

When electronic equipment is installed outdoors, security, reliability and performance all depend upon the design and construction of its enclosure. The first step in enclosure selection is establishing an appropriate specification, and that's not always a straightforward process.

Enclosures for electronic equipment must offer simultaneous protection from multiple threats. They need to keep water, dust, and vermin out, for example, and resist the efforts of casual vandals or determined criminals. They must permit easy access to authorised users for installation, maintenance, and upgrade work.

And they need to ensure that equipment within can maintain a safe operating temperature, regardless of the weather outside. Some enclosures need to protect the environment from the equipment too, for example by supressing noise or preventing harmful electromagnetic emissions. And some parts of the world have even more demanding requirements, for example the need to cope with seismic activity or even to resist damage by small-arms fire.

The cost of the enclosure is likely to be relatively low compared to the through-life costs of operating critical equipment, and to the value generated by that equipment. That can encourage owners to "gold plate" their enclosure specifications, but this approach doesn't always lead to the best solutions. Let's see why.

Conflicting needs

The enclosure attributes needed to deliver different types of protection can work in opposition to each other. The most obvious example of this is thermal management. To keep equipment cool, designers want to facilitate airflow through the interior of the enclosure. That airflow can be generated by passive convection, or through the installation of fans.

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Either way, the air must enter and leave the enclosure via vents, creating additional challenges for ingress protection and noise suppression and electromagnetic shielding. Most of those challenges have technical solutions, such as the use of water-resistant filters or specially shaped grilles that reduce the transmission of radio waves, but such solutions can mean additional purchase and maintenance costs.

Enclosure designers seek to balance these competing requirements when they develop new solutions for their customers. They have the best chance of achieving a reliable and cost-effective design if the specifications are set at the right level to offer real-world protection to the equipment. Here are some examples of areas where customers can run the risk of over-specification:

Water resistance

The water-resistance of an enclosure for low voltage electrical equipment is defined by part of EN 60529 (British Standard BS EN 60529:1992), the international standard for the ingress protection of electrical equipment. The water ingress protection offered by an enclosure is explained by the second number in its IP rating.

Enclosures designed to meet IPX2 standards offer protection against vertical or nearly vertical water sprays, which in practical terms means rainfall. IPX3 and IPX4 standard enclosures offer additional protection against water sprays and splashes from directions other than the vertical. IPX5 and higher standards are used in applications where equipment may be exposed to high pressure water jets or total immersion.

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For most exterior enclosures designed for outdoor deployment, IPX4 enclosure provides all the protection the customer needs for real-world conditions, even in today's world of heaver rains and more frequent storms. Some users are now taking steps to give their equipment some protection against temporary shallow flooding, for example by installing pumps in enclosures sited in at-risk locations. A flood event that results in total immersion of an enclosure is likely to be a catastrophic one, however, with impact on infrastructure that goes far beyond the contents of the enclosure. IPX8 ratings, which we sometimes see on enclosure specification sheets, are more appropriate for portable equipment that might experience immersion during regular use.

Thermal load

The heat load in an enclosure comes from two sources: the external environment, and the equipment within the enclosure that generates heat. The maximum acceptable temperature is defined by the manufacturer(s) of the equipment. The enclosure should be designed to manage the internal temperature below the maximum in an agreed "worst-case" scenario. In the UK, that scenario is often an ambient temperature of 35°C, with an additional allowance for solar load of up to 1120 W/m² on the exterior of the enclosure. As temperatures rise, some UK organisations are now using an ambient temperature of 40°C.

Determining the thermal load imposed by the equipment in this worst-case scenario can be tricky, however. Some customers simply use the rated capacity of the equipment's power supply as a proxy for thermal load. This can result in high numbers that demand expensive cooling systems or even the use of air conditioning to reduce the temperature inside the enclosure to below ambient.

In practice, however, the thermal load generated by the equipment is likely to be significantly lower. Peak electrical power dissipation may only occur during transient events lasting a few seconds, for example. And not all the power entering the equipment will be dissipated as heat. Thermal data collected from equipment operating in the field or under realistic test conditions is likely to yield a more useful baseline. Sometimes, it makes sense to take a critical look at the temperature limits specified by the equipment manufacturer.

Thermal load on an enclosure is determined by 3 factors:

1. Ambient air
2. Heat from direct or reflected sunlight
3. Heat generated by equipment.

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We know of one telecoms operator whose RFP specification required an expensive and energy-hungry cooling system in their cabinet to keep the equipment below 25°C all year. A closer look at the equipment specifications revealed that the temperature-sensitive component was a single battery costing just a few pounds, and that the limit was there simply to maximise the working life of the battery. In this case, improved monitoring of battery condition or more frequent replacement intervals would have been the simpler and more cost-effective solution.

Emissions

The potential impact of an enclosure on its environment is another area where overly stringent specification can have a significant impact on complexity. One potential concern is electromagnetic emissions, either from the equipment in the in the enclosure or upon that equipment. Fully screening an enclosure to prevent the transmission of such emissions is a complex job, but it's rarely necessary. Almost all modern electronic equipment is designed to be compliant with electromagnetic compatibility regulations, which limits the need for external screening to exceptional cases.

Acoustic noise is most often associated with cooling systems, such as fans and air conditioning systems. This can be minimised by good design, for example using large fans running at low speed combined with effective control systems that keep air flows to the minimum required for the conditions.

Many enclosures are sited in remote locations or places where ambient noise is already high – close to railway lines or busy roads, for example. Where the location is noise-sensitive, such as on the roofs of residential buildings, the addition of acoustic insulation and other attenuation measures may be required.

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Standardisation

If setting the optimum specification for a single enclosure is tricky, establishing a standard for a large fleet of them is even more complex. Yet modern infrastructure often involves hundreds or thousands of enclosures housing multiple types and combinations of equipment.

Operators naturally want to standardise the design of these enclosures as much as they can. That allows them to benefit from economies of scale in purchasing and simplifies installation and maintenance. Yet adopting a single enclosure design that works for the most demanding installations in the fleet means that the vast majority will be over specified and expensive.

One way to balance the desire for standardisation with the varying requirements of different enclosures is with modular designs. In this approach, the user settles on a common basic design for its enclosure fleet, and makes changes to the specification where required, for example by adding larger cooling fans in enclosures that generate higher thermal loads or extra acoustic insulation for those installed in quiet areas. Such systems also make it easier to update the enclosure during its working life, as equipment or use patterns change.

Talk to the experts

At Rainford, we have been manufacturing enclosures for more than 40 years. For some customers, we build enclosures to exacting specifications that have been refined through decades of field experience. For others, our work begins with a blank sheet of paper, and we apply our own experience and expertise to help them develop a solution that meets their technical and commercial needs. Wherever you are on that continuum, a conversation with us just might reveal a few ways to maximise equipment protection without unnecessary cost or complexity.

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