Selecting the right materials for cable tray use at low temperatures

From the freezing cold of Antarctica to the frigid pipelines of Alaska, reliable power and communications demand properly supported cables. A good understanding of how materials perform at extreme temperatures is critical to avoid serious injuries and expensive down-time.

Some general guidelines on the proper material to specify when dealing with low temperatures are listed below.

Cable tray material	Minimum continuous recommended temperature
Stainless Steel	-300°F (-184°C)
Aluminum	-200°F (-129°C)
Fiberglass	-100°F (-73°C)
Low-Carbon Steel	-20°F (-29°C)

Aluminum, fiberglass, steel, and stainless steel are all readily available materials for cable tray manufacturing. These materials perform very well at ambient temperatures (0°F to 100°F). However, once the confines of these temperatures have been exceeded, the materials start to react differently.

As temperatures decrease, a material's tensile strength typically increases, while its elongation typically decreases. In other words, metals become stronger but less ductile. As far as reliability, the cable tray materials are listed below in order of least effective to most effective.

Steel

As temperature decreases, low-carbon steel products will loose ductility slowly until a certain point where the ductility rapidly decreases by over 50% within a very small temperature range. This point is called the ductile-to-brittle transition and occurs in all unalloyed, low-carbon steel. Depending upon the quality of the steel, the transition can occur anywhere from +32°F to –40°F. These temperatures are hardly arctic but are low enough to require steel cable tray to be over designed by 20 to 50% to compensate for the decreased ductility, especially on long spans. This adds substantial weight and expense to an already heavy system. If the part is not subject to impact loads or vibration, it may perform fine at low temperatures, but it can be very difficult to control this kind of dynamic loading in the field.

Because of this ductile-to-brittle transition phenomenon, it is our recommendation that low-carbon steel clamps not be used below 0°F (-18°C) where impact loads may be present.

The insulation used on stock power cables in frigid temperatures exhibit similar characteristics as low-carbon steel. Many cables can be bent at very low temperature but will shatter under impact at a significantly higher temperature. PVC-covered building wire is a good example. It can be bent, depending on conductor size, from –22 to –40°F before it will crack. The same conductor in a coil dropped from a ladder onto a concrete floor during installation could shatter at +14°F. The ability of a cable to withstand impact at low temperature is a prime factor to consider during application or cable installation

Fiberglass

Although fiberglass does become less ductile as temperatures decrease, it does not exhibit a ductile-to- brittle transition period as low-carbon steel does. Because of this, fiberglass cable tray only requires a minor (10%) increase in design strength making it a much better choice in cold climates.

Aluminum

Aluminum cable trays have a distinct strength advantage over low-carbon steel cable tray in very cold environments. At –121°F aluminum exhibits a 6% increase in yield strength with a 1% increase in elongation. This is a much greater ductility than low-carbon steel with no ductile-to-brittle transition.

The coldest naturally occurring temperature ever recorded on earth was -129°F (-89°C) recorded in 1983 at the Russian Base Vostok in Antarctica. Aluminum cable tray with stainless steel hardware can readily handle this type of environment.

Stainless Steel

Stainless steel is the most effective material for dealing with low temperatures. At -320°F, AISI type 304 and 316 stainless steels gain approximately 9% of their room temperature yield strength with a 46% decrease in elongation. Stainless steel (type 304 or 316) does not exhibit any ductile-to-brittle transition at low temperatures (even down to –400°F), and is an excellent material for frigid temperatures.

There are several considerations in choosing the correct cable tray material for use in low temperatures. With a careful analysis of your environment and the materials available, you are sure to find a cable tray system to meet almost any situation.

For more information, please visit www.eaton.com/cabletray

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