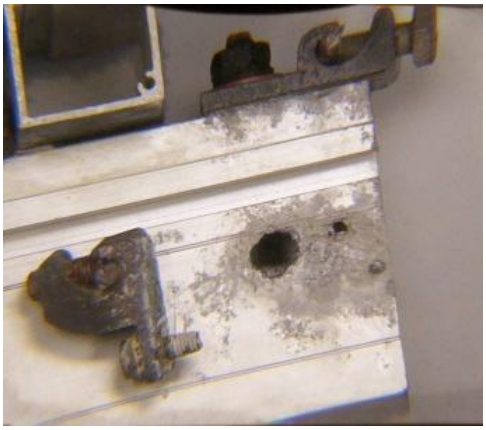
June 26, 2012

WEEBs and Corrosion in Solar PV Grounding and Bonding

Corrosion in outdoor environments is an issue that has been getting more and more attention in the solar industry, and rightfully so. Simple oxidation, galvanic, and crevice corrosion are mechanisms by which metals deteriorate when exposed to the elements. The rate and extent of corrosion depends on several factors, including environmental conditions such as moisture, temperature and pH. Galvanic action is also a common accelerator of corrosion, caused by dissimilar metals in contact with each other in the presence of an electrolyte (such as salt water). The impact of corrosion depends on the item being attacked – a large steel beam, or a small electrical connection. With regards to solar PV grounding and bonding, small electrical connections are the targets of corrosion, and the impact of such failed connections could be extensive.

Galvanic corrosion between stainless steel and aluminum is a well-documented phenomenon. In many corrosive environments the combination of stainless and aluminum is avoided, whether the materials are used for mechanical or electrical connections. In some solar installations the two materials are used together in direct contact (for both mechanical and electrical connections), with little to no negative results. The same connections can deteriorate rapidly in environments where the PV array is constantly exposed to moisture, salt spray and heat.



Nearly all grounding devices used to establish a ground bond to aluminum module frames incorporate a stainless steel to aluminum connection. Proper installation of these devices makes a huge difference in their long-term performance. Selecting the right device for use in a corrosive environment can make a large impact on the longevity of the system.

Many grounding lay-in lugs, even when installed properly, still damage the protective anodized coating on aluminum module frames and rails. In some cases the electrical connection is created by scraping, gouging or cutting through the anodizing. Without sealing or otherwise treating the connection they create, raw aluminum becomes exposed to the environment and increases the rate of oxidation and galvanic corrosion. This leads to an increase in the connection's resistance, and eventual failure of the ground bond. Even if a lay-in lug does not rely on the stainless to aluminum electrical connection, the stainless mounting hardware still damages protective

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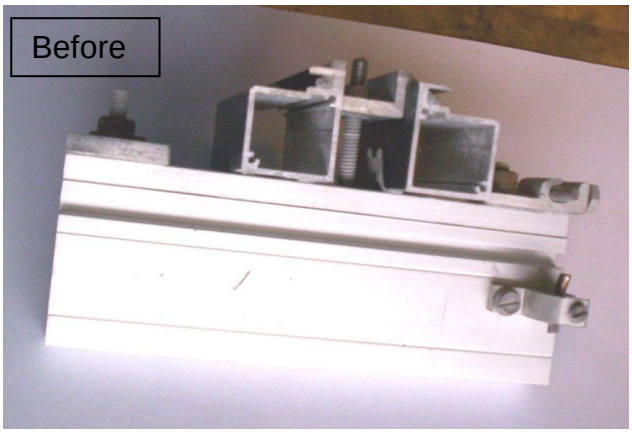
anodizing and exposes the mechanical connection to corrosion. Such corrosion is just as dangerous, since the lug can eventually dislodge from the module frame or mounting rail.

The Washer Electrical Equipment Bond (WEEB) teeth (the features that create the electrical connection) are specifically designed to mitigate this common occurrence of corrosion. The teeth do not scrape or otherwise remove the protective anodized layer. They embed into the aluminum, self-seal, and self-retain to form a connection that is highly resistant to oxidation and galvanic corrosion. The action of the WEEB teeth embedding and deforming to create such a connection necessitates that the WEEBs be a one-time use part. The same degree of protection cannot be reached by a device that is allowed to be used multiple times.

Beyond being UL 467 listed, UL 1703 listed, and UL 2703 recognized, the WEEBs have undergone a battery of non-standard tests since their inception. After completing the UL 1703 tests on the WEEBs (which include the Temperature Cycling test for 200 cycles, Humidity Freeze test for 10 cycles, and the Bonding Path Resistance tests) the WEEBs were subjected to the UL 467 High Current test. This test successfully passed 1530 Amps of current (the requirement for a #6 AWG copper wire) through the environmentally tested WEEB connections.



Corrosive atmosphere tests are an absolutely crucial part of evaluating grounding and bonding devices. The ASTM B117-09 salt fog test is a good starting point for corrosion testing of grounding and bonding connections. To truly test the corrosion resistance of the WEEBs, a more rigorous test was performed as part of their development. This test subjected a WEEB, a WEEB Lug, and a traditional lay-in lug (installed

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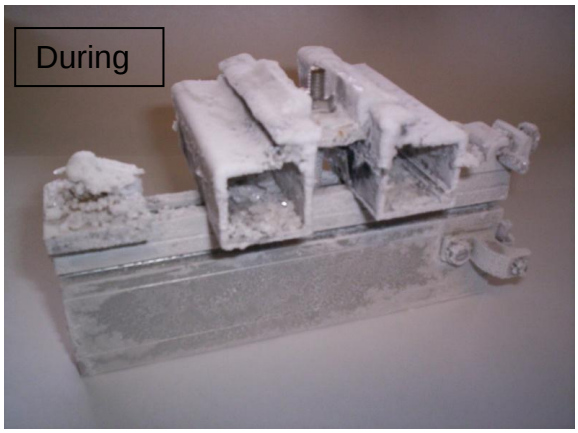
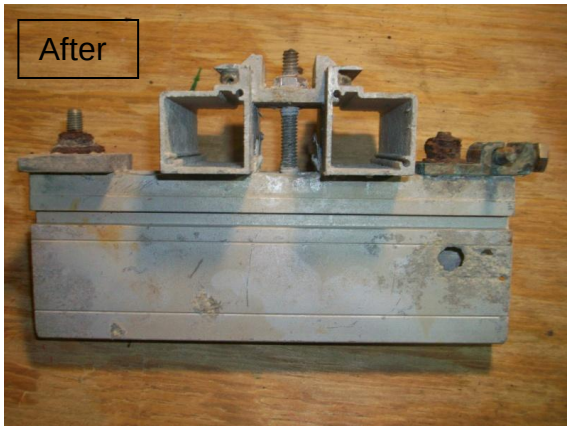
with a stainless thread-cutting screw) to 200 cycles of saturated salt water bath at 105°C. The samples shown here were submerged in this salt bath for a period of 8 hours, then removed and allowed to oxidize at room temperature for 16 hours. 200 cycles at 24 hours per cycle is more than 6 months of regular exposure to conditions that no other electrical bonding connection has been exposed to. The results speak for themselves. The stainless steel screw used to install the traditional lay-in lug failed after 95 cycles, in both its electrical and mechanical capacities.





The Salt Bath test shows the shortcomings of stainless connections that scrape, gouge, or otherwise remove the protective anodizing on aluminum module frames or mounting rails. On the other hand, the WEEB's method of creating an electrical connection shows significant corrosion resistance. After cleaning and disassembly, the WEEB tooth marks and the raw aluminum they protected are clearly visible.

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Electrical grounding and bonding connections used in PV installations must be able to withstand decades of harsh environmental exposure. While the current standards are only starting to reflect the challenges of real-world applications, WEEBs have already exceeded the most rigorous testing requirements. WEEBs have been proven to be reliable, low impedance, corrosion resistant bonding devices that perform extremely well in the harshest of environments.

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