Common Installation Failures: Why Things Go "BOOM" in the Night

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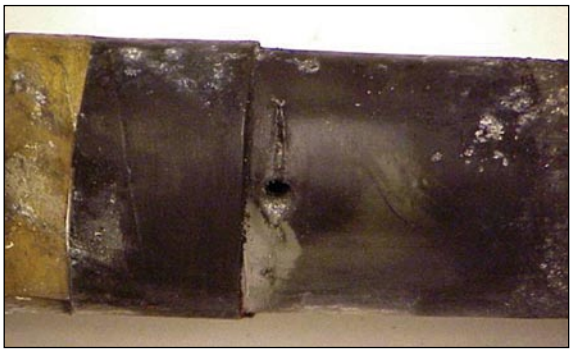
3M

There are only a few things in life that one can firmly state are absolute truths. Though the circumstances may change from time to time, the list below shows some of the "everyday" absolute truths to which some of us can most likely attest:

- Traffic will always be backed up when you are running late or in a hurry to get somewhere.
- Washing and waxing your car by hand will always guarantee that it will either rain only in your neighborhood (directly over your house) or a bird will swoop down out of nowhere and bomb your car.
- All gas stations will cease to appear from your line of sight as soon as the low fuel light comes on in the dash of your car.



Two separate splice installations received from the same customer. One body had failed; the other body had not failed but was cut out for investigative purposes.

Figure 1a — Photo a ring cut just beyond semiconductor step on failed splice installation.

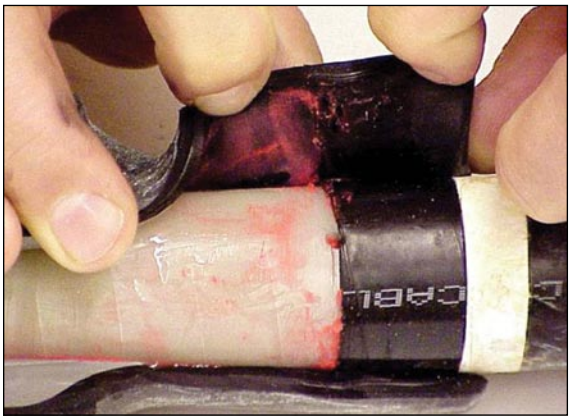


Figure 1b — Photo shows a ring cut on the unfailed splice installation. This installation was in service although it was in the process of failing.

The same holds true for those of us who work in the electrical power industry. As most anyone involved in this field can tell you, if there is any one absolute truth in this industry it is that at some point in time each of us will experience or will be affected by an installation failure. It would be enormously conservative to state that a failure, be it a splice, termination, or modular equipment failure of some type, will occur at least once each day. What is not conservative to state, in any form or fashion, is the fact that the end result of each of these failures is the expense involved not only in cost of replacement kits or equipment for the failed installations but also in man-hours and downtime each and every time an incident such as this takes place.

Though the mode of failure can vary depending on the type of installation involved, the root cause of the vast majority of failures will tend to fall into three general categories:

- Natural/environmental causes
- Animals
- Workmanship

Failures that occur as a result of natural causes are those that might involve such things as lightning strikes, power surges or, perhaps, natural degradation of cable insulation such as in the case of dry paper due to loss of oil in PILC cable. Of

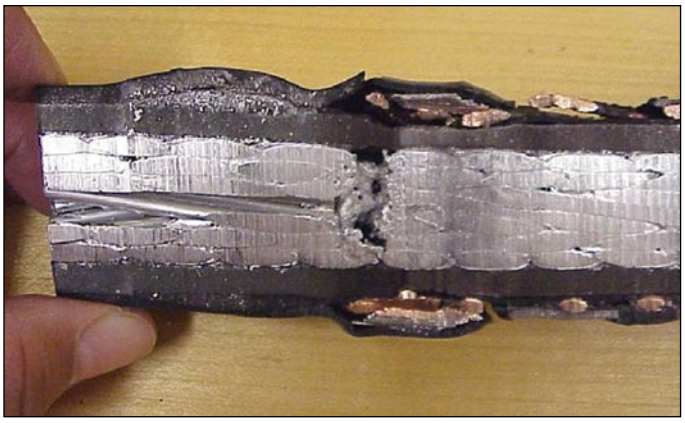


Figure 2 — JCN neutrals were cinched in place beneath the constant force spring portion of the ground strap in a termination installation. The ends of the neutral wires pressed into the cable insulation and created a stress point which eventually created a hole in the insulation and failure upon reaching the conductor.

these items, lightning is obviously the most unpredictable and most destructive element in this category. Its sheer power has the potential to take out a single termination or shut down the power grid for an entire city. In addition, many times it will also initiate a power surge or a series of power surges which could have the potential to further damage an already weakened power system. The unfortunate element in this scenario is that there is little that can be done to truly ward against the forces of nature.

Figure 3 — Poor crimping technique either from using the wrong die or poorly calibrated crimping tool.

Animals and insects can be pesky little creatures, can't they? Failures due to animals are a unique problem and are, by far, some of the most interesting failures to examine. Most of us have probably heard the old cliché, "Curiosity killed the cat." Unfortunately, in the electrical power industry curiosity also killed the bird, the snake, the squirrel, the beaver, the termites, the fire ants, as well as any other unsuspecting creature that inadvertently becomes the catalyst for the failure of that particular electrical installation. In some cases, such as with birds and squirrels, the failure takes place between phases or ground at the top of a pole. In the case of beavers, termites, or fire ants, they will gnaw or tunnel their way through a buried splice body until they have compromised the integrity of the installation which, ultimately, results in a failure. The good news, in this particular case, is that there are quite a number of product offerings that will help to minimize the numbers of failures due to animals or insects.

Workmanship failures, while certainly not unique, represent the types of failures that can be prevented. There are several different types of workmanship related issues that can lead to an installation failure. Some of the most common include:

- Knife or ring cuts in the cable insulation or at the semiconductor step. This type of workmanship issue introduces an air void in the installation which will eventually give opportunity for arcing to take place and degrade the cable insulation as well as the cable accessory to the point of failure.
- Improper cable cutback dimensions. This can cause misalignment of a splice or termination and result in an installation that is not correctly positioned over the cable cutbacks, in the case of a splice, or incorrectly positioned over the semi-con step, in the case of a termination.

Figure 4 — Splice installation that failed due to termites burrowing tunnels through the splice body and into the cable insulation.

- Poor connector crimps. Though a number of different problems can surface as a result of incorrect crimping, one of the most common issues is increased electrical stress on the connector itself. This can cause the connector to produce an increased amount of heat distress and can result in the thermal heating of the cable insulation. Depending on the type of cable, thermal heating can cause the cable insulation to soften and flow, much like candle wax.
- Improper cleaning of the cable insulation. In this case, any foreign substance left on the cable insulation, such as specs of semiconductor material or dust from sanding of the cable insulation, can cause tracking and may eventually degrade the cable to the point of failure.

Figure 5 — Failed splice installation due to beaver damage.

Figure 6 — Evidence of failure due to thermal heating. Cable insulation has melted which led to insufficient contact between cable insulation and interior of splice body. This installation was also misaligned on the cable.

Though this list represents but a few of the most common forms of failure modes for workmanship related issues, the important thing to remember is that these are issues that can be prevented.

That being said, there is honestly not enough that can be said as to the value of proper training. This encompasses proper training on the use of commonly used cable preparation tools and crimping tools as well as familiarity with the types of products being installed on the cable. Though much of this knowledge is acquired over time, the time and money invested in assuring field installation crews are well equipped with the skills necessary to do proper cable accessory installations is an investment in the integrity in the electrical system.

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