Maintenance as a Safety Issue

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There have been a lot of articles, many of them written by us, discussing the changes in Chapter 1 of the new 2009 NFPA 70E. Many of these changes were made to make 70E an easier to read and apply document and others were to eliminate slang terms or to make wording more consistent. Many of the changes add new information, however, and address concerns that were expressed in proposals either made by committee members or by the public.

The maintenance of electrical devices is one such topic. Over and over the subject of inadequate maintenance or complete lack of maintenance surfaced, usually as it was associated with arc-flash hazard studies. One rule-of-thumb often used to describe the relationship between incident energy (the heat from an electric arc) and time is stated as, "Incident energy is proportional to time." In other words, if the time of exposure is doubled, the incident energy a worker would receive during an arc flash is doubled.

Figure 1 is derived from the equations in Annex D of 70E. Note that the graph applies to equipment rated at 600 volt or less. Following the 40 kA (blue) line vertically until it intersects with the 0.1 (green) second line, shows that the incident energy is estimated at 10cal/cm^2. Follow the 40 kA line until it intersects with the 0.2 second (red) line and the incident energy increases to 20cal/cm^2.

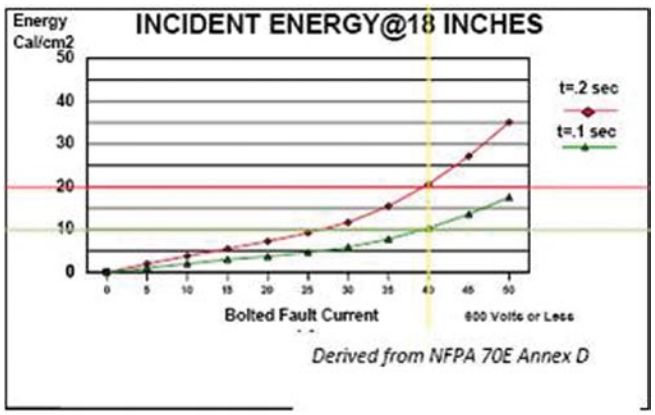

Figure 1 — Incident Energy vs. Time

This aspect of an arc flash makes maintenance a safety-related issue, one that should not be ignored by facility managers and others with budgetary responsibilities. Overcurrent protective devices (OCPD) require regular maintenance in order to function in accordance with the manufacturer's specifications. As current flows through the current-carrying parts (contact assemblies and stabs) heat is produced (copper I^{2}R losses). As current flow increases through a conductor, the heat produced also increases Heavily-loaded equipment will exhibit much higher levels of stress than lightly-loaded equipment of the same ratings, simply because it produces more heat. This heat slowly dries out the lubricants that are applied to moving surfaces, such as the contact assemblies, but it also dries out the lubricants used in the operating mechanism as well, even though no current flows through it. As the lubricants dry they thicken, which slows the circuit breaker down. If no maintenance is performed, the lubricant will begin to flake off and metal-to-metal wear takes place. Figure 2 shows components taken out of a circuit breaker's contact assembly, where the breaker would not close properly.

Figure 2 — Metal-to-Metal Wear Caused by Lack of Maintenance

Many production people believe that no news is good news or don't fix it if it isn't broken. Would these same people run their cars 100,000 miles and not change the oil? Well, maybe some of them would try. They would find out that the blown and seized engine costs much more than what was saved on skipped oil changes. So why do some people have such a difficult time applying that same lesson to electrical equipment?

Here's a list of some of the new additions to the 2009 70E that specifically address maintenance as a safety issue:

- 130.3 FPN - Improper or inadequate maintenance can result in increased opening time of the overcurrent protective device, thus increasing the incident energy.
- 205.3 - General Maintenance Requirements. Overcurrent protective devices shall be maintained in accordance with the manufacturers' instructions or industry consensus standards.
- 210.5 - Failure to properly maintain protective devices can have an adverse effect on the flash-hazard analysis incident energy values.

This concern extends to the arc-flash studies, as well. Any time a change in an electrical system could affect the short-circuit available current, a new short-circuit analysis, coordination study, and arc-flash study needs to be done. Note the 70E wording:

> 130.3 - The Flash-Hazard Analysis shall be updated when a major modification or renovation takes place. It shall be reviewed periodically, not to exceed five years to account for changes in the electrical distribution system that could affect the results of the analysis.

This would include installing a new transformer, upsizing a transformer, installing a transformer that has a lower impedance than the one replaced, installing larger cables, and installing new motors that are larger than 100 horsepower. All of these could increase the short-circuit current, which could exceed the interrupting rating of OCPD's and increase incident energy above what was previously calculated. Paragraph 130.3 only requires a review of the study, if no changes have been made. An arc-flash study is not a static document and should evolve as the electrical system evolves.

Summary

Maintenance is too often viewed as strictly an overhead cost when it should be recognized as a safety requirement. What should be a low-energy event that can be repaired quickly can turn into a major catastrophe, killing or injuring people and destroying parts of the electrical system. Lost production, premium repairs, and lawsuits can quickly follow.

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