C26 Latent Failures of Type NM Wiring After Ground Energization

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After attending this presentation, attendees will be able to describe the changes in NM leakage characteristics following destructive ground energization that can lead to both immediate and latent fire scenarios.

This presentation will impact the forensic community and/or humanity by demonstrating that catastrophic failure can result from energized type NM cables well after the insult actually occurred.

Article 240 of the NEC generally provides for overcurrent protection of conductors. Overcurrent protection is usually provided by a Molded Case Circuit Breaker (MCCB) meeting the requirements of NEMA AB-1. The underlying criterion for overcurrent protection is that the protective device will always operate before energy dissipated in the wire by resistive heating will damage the wire. The inverse time-current relationship by which MCCBs operate form the usual basis for this prophylactic scheme. While Article 240 does provide protection for the normally operating facility, it is of no use when energization of neutrals or grounds occur. In particular, there is no protection during the scenarios commonly referred to as “floating neutral” and “energized ground” occur. In these scenarios, current flow is unbounded because there is not the usual corresponding increase in hot lead current.

We describe here several fires which have occurred as a result of both the floating neutral and energized ground scenario. Research is then outlined in which type NM cables were intentionally damaged by injecting onto them ground fault currents for varied lengths of time. Temperature rises on the cables were measured by both conventional thermocouple techniques and by thermography. As part of this testing, we measured changes in leakage. By applying AC power across the hot and neutral leads, and then measuring leakage current in vector form (Real + Imaginary), we were able to plot changes in both capacitance and resistive current flows. Instrumentation for our labwork made use of the IEEE488 bus, and a Vitrek dielectric analyzer. This vector analysis is shown to be superior to conventional megger and hipot testing in terms of its ability to predict failures while not violating Kelvin criterion. Field measurement techniques used by maintenance workers during damage assessment never attain the precision offered by vector analysis.

As a result of the type NM testing and from empirical data, we are able to demonstrate that catastrophic failure and arcing ignition can result from energized type NM cables well after the insult has occurred. In one scenario, a fire broke out within 3 weeks of the inducing of current onto the ground. We describe the analytical tools used to show causation, as well as the evidentiary items that should be searched for when examining a structure for this type of fault. The usual source of energization in these fires results when a neutral is accidentally pulled, or when a utility company (during maintenance procedures) injects current onto the ground lead. The most sobering part of this research is that damaged cables can bring about ignition well after the injury has occurred, and well after any open and obvious defects have been repaired.

Fire, Floating Neutral, Dielectric Breakdown

