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Docket: NRC-2018-0040
Aluminum High Energy Arc Fault (HEAF) Particle Size Characterization; Proposed draft test plan

Comment On: NRC-2018-0040-0001
Aluminum High Energy Arc Fault Particle Size Characterization

Document: NRC-2018-0040-DRAFT-0002
Comment on FR Doc # 2018-04341

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General Comment

The attached comments are submitted on behalf of the FirstEnergy Nuclear Operating Company - Beaver Valley Nuclear Power Station, for NRC-2018-0040.

Attachments

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FirstEnergy pubcomments NRC-2018-0040

Beaver Valley Power Station Comments; Draft Test Plan; Aluminum High Energy Arc Fault
Particle Size Characterization: SAND2018-0706 O; NRC Contract NRC-HQ-60-15-D-0005

Re: NRC Request For Comments: Monday April 2, 2018

Beaver Valley Power Station's comments are submitted in this document as it pertains to Draft Test plan entitled "Aluminum High Energy Arc Fault (HEAF) Particle Size Characterization Test Plan – DRAFT" SAND2018-0706 O; NRC Contract NRC-HQ-60-15-D-0005:

In the overall general context of HEAF, prior industry experience has indicated that single-phase arcing faults are much more difficult to sustain than three-phase arcing faults. Experimental results in this area have indicated that arcing line to ground faults are characterized as a discontinuous sinusoidal waveform. Additionally, these tests have confirmed that single-phase arcing faults pass through a current zero twice a cycle during which time they produce no ionized arc plasma, which is required to maintain the arc current flowing. Comparatively, three-phase arcing faults, produce a constant source of arc plasma that can more easily maintain the arcing fault. However, evolving faults have been shown to manifest themselves originally as single-phase faults which subsequently develop into multiple-phase faults. Based upon known evidence of fault evolution that involves different combinations of faulted phases, it is proposed that test sequence objectives be reviewed in the context of ultimately applying the results, or findings, to help identify what steps the industry should pursue that would improve methods to limit the energy of the postulated HEAF at its origination.

Another dynamic that is an extremely important aspect of HEAF involves magnetic forces created by induced currents. These magnetic forces have been demonstrated to have impelled wires upstream of the HEAF with enough force to damage insulation or tear the conductors from their terminations, creating additional short circuits. This sequence has been proven by means of stage fault testing in the industry which utilized high-speed film recording technologies that captured the progression. Therefore, a correlation is desired to be quantified based on HEAF experimentation objectives with respect to these magnetic forces and resultant ejected particle emission and physical movement. The Zone Of Influence implications involving induced current magnetics is sought to be more formally addressed by means of HEAF test experimentation which would capture and record these magnetic field forces (magnitudes and direction over time) with additional monitoring of consequential multiple short circuit events as a likely or credible manifestation, throughout the conduct of the testing. It is proposed that magnetic field monitoring instrumentation would thereby enable a more precise identification of specific switchgear design attributes that can be enhanced to address subsequent fault occurrences due to an originating HEAF.

Historically there has been considerable experimental verification of only a minimal rise in conductor temperature with respect to HEAFs involving bare copper bus as correlated with the monitored arc travel rate. Moreover, with regards to prior insulated bus testing, the voltage gradients are well within the dielectric withstand capability of the bus's insulation system. It is desired that HEAF experimentations be designed that would deliver results to the industry that more precisely characterizes the performance insofar as the manner in which insulated bus structures extinguish the arc and therefore possibly minimize damage. That is, in the design of the HEAF test experimentation, it is desired that results afford more specific determination of the relationships between voltage level, insulation type, and construction where bus insulation may help extinguish or sustain an arc once established. At present, as applied specifically to the scenario of an arc "blast," (nomenclature borrowed from page 2 of SAND2018-0706 O) versus an arching "fault," there is an opportunity to expand present-day industry knowledge and understanding as to the degree that existing insulated bus in the 600-Volt class of equipment appears to provide significant safety advantages over non-insulated bus.

A more detailed elaboration or description of specific individual key test plan parameters should be itemized in the test plan in an organized format. Information is desired as to the HEAF parameter significance to be addressed as part of the overall test plan. For each HEAF parameter categorized in terms of its significance, there should be established the documented test plan steps to address each of the individual HEAF parameters. Such an identified HEAF parameter-specific significance or ranking would focus more directly upon the importance of the correlation between each of the separate test parameters (i.e., measured quantities, monitored components, etc.) with respect to the overall stated objective of the test plan. Along with this, and in association with each of the parameters identified by significance, a summary of test plan steps designed to address each of the parameters individually would then establish the effectiveness of how thorough the test configurations and actions would be in contributing to support the final test plan results or findings.

Therefore, supplementary HEAF test plan information and data would be broken down in an itemized format addressing stated test objectives in terms of the specific HEAF test parameter identification, and in association with this, the HEAF test parameter significance (or ranking in terms of its importance). Further insight would then be advantageous if test sequences are correlated and then summarized for each of the identified and ranked HEAF test parameters.

Aligned with the preceding recommended approaches, subsequently are presented what are intended to be suggested "templates" as a starting point for development of more specificity in the test plan, but utilizing (for the sake of exemplification) what can only be projected (or surmised) parameter significance categories (or rankings) and corresponding test sequences:

Bus and Enclosure Orientation / Spacing: Significance Category: Very High: Test sequence summary: A selected arrangement of a set of vertical and horizontal physical routings reflecting the most common industrial bus bar designs and electrical cabinet construction will be configured in the test. Further testing of additional cable bend radii and bus bar lengths and spacings will be implemented based on the results of the initial tests.

Arc Intensity / Duration: Significance Category: High: Test sequence summary: Heat Release Rates (HRR) are to be monitored among tests. The intent is to analyze plume and hot gas layer temperatures associated with the corresponding HRRs. The ability to track these heat release rates is a function of several factors including test chamber size. These factors may limit the HRR. The design of each test may vary to prevent hot gas layer temperature from becoming excessive.

Arc Impingement: Significance Category: High: Test sequence summary: Impingement to be tracked with respect to the tests of the proximity of electrical enclosures, as well as aluminum bus bar specimens in relation to heat release rates. The simulations are also intended to capture both plume and hot gas layer effects on proximate electrical cabinets and bus ducts.

It is intended that the preceding suggested "templates" would afford a more organized format that captures the desired detailed test parameter itemization with corresponding significance and test sequence summarization. The goal would be to better convey in a logical manner, for all the specific HEAF focus areas, how particular aspects of the experiments are designed to individually correlate to the overall stated test plan objectives. This will ensure that detailed characterization of such attributes as thermal conditions, pressure environments, nearby surface deposits created by HEAFs, etc., will comprehensively be achieved utilizing state-of-the-art monitoring equipment and instrumentation.

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