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August 28, 2015

8/3/2015
80FR46061
(1)

Ms. Cindy Bladey
Office of Administration
Mail Stop: OWFN-12-H08
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

Subject: Comments on Draft Document *"Testing of Open Secondary Window-Type Current Transformers -Test Plan"* (Federal Register 80FR46061, dated August 3, 2015 - Docket ID NRC-2015-0183)

This letter is being submitted in response to the U.S. Nuclear Regulatory Commission's (NRC's) request for comments concerning the subject draft document *"Testing of Open Secondary Window-Type Current Transformers -Test Plan,"* published in the *Federal Register* (i.e., 80FR46061, dated April 3, 2015).

The NRC is soliciting comments on this draft test plan document. The purpose of the testing is to better understand the following scenario:

> *Will open circuiting of the secondary circuit of a Current Transformer (CT), which is operating within its rated continuous primary current limits, result in an excessively high voltage in the secondary circuit sufficient to start a fire in the form of explosion or arcing in the circuit's insulation at the location of the CT itself or at some other location in the secondary circuit?*

Exelon Generation Company, LLC (Exelon) appreciates the opportunity to comment on the subject draft document and offers the attached comments for consideration by the NRC. Exelon also supports any comments submitted by the Nuclear Energy Institute (NEI) on behalf of the industry related to the subject document.

If you have any questions or require additional information, please do not hesitate to contact Richard Gropp at (610) 765-5557.

Respectfully,

James Barstow
Director, Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Attachment

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Template = ADM – 013
E-RIDS= ADM-03
Add= S. Mehta (Snm2)

Comments on Draft Document *"Testing of Open Secondary Window-Type Current Transformers -Test Plan"*

Exelon Generation Company, LLC (Exelon) offers the comments below for consideration by the U.S. Nuclear Regulatory Commission (NRC).

I. General Comments

1. Review of *"Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE) Volume 1: Phenomena Identification and Ranking Table (PIRT) Exercise for Nuclear Power Plant Fire-Induced Electrical Circuit Failure*" indicates that the question of Current Transformer (CT) open secondary induced fires has been thoroughly vetted. This included CT testing and exhaustive Operating Experience (OPEX) searches for CT secondary induced fires, none of which provided any evidence to support the need for additional research and testing. The draft report appears to leave some doubt that higher ratio CTs above 1200:5 and therefore higher induced secondary open-circuit voltages may be a concern. The information in the report seems somewhat speculative. The references provided in the draft test plan do not appear to suggest that a fire is a potential outcome. Looking at typical CT circuit applications at stations indicates that higher ratio CTs are used in differential relaying circuits. Such circuits would respond immediately to an open secondary and trip the associated power circuit, thereby promptly removing the energy source (i.e., there will not be sustained arcing) and further limiting the likelihood of an induced fire.

   Metering and protection CTs are not unique to nuclear applications, as they are used throughout the utility industry and also at numerous industrial sites. CT manufacturers recommend secondary protection (e.g., Thyrite shunts or arc gaps) for personnel safety reasons and for equipment/asset protection. If open-circuits were prone to inducing fires, this should be discoverable by a thorough literature review.

   If there remains a desire to continue with this testing, it may be prudent to look more closely at the CT applications at various stations to determine where and how the higher ratio CTs are applied and determine if typical applications would provide the sustained arcing to induce a secondary fire in an alternate location.

2. The draft test plan places a significant amount of emphasis on detecting arcing in the affected components, and appears to be using arcing as a surrogate for saying that a fire is possible. This is not supported by the science or theory involved. At high enough voltages, arcs are certainly possible; however, their energy would also be limited by the very low currents available. It is likely that an arc will either jump an air gap or puncture insulation at some place in the circuit (most likely a turn-to-turn short within the CT itself or the winding of a meter/relay); however, it seems very speculative to infer that this arc will cause a fire. Once the insulation is punctured or an air-gap is jumped the phenomenon becomes self-limiting as the CT is no longer open-circuited, and the high voltages have become self-limiting due to the reduction in insulation resistance caused by the puncture.

Per NFPA 921, *"Guide for Fire and Explosion Investigations,"* Section 9.9.4, the energy in a high-voltage, low-current arc is a very poor ignition source. The energy density is low and it is difficult to transfer this energy to nearby solids in a way that raises them to the point of pyrolysis and subsequent ignition. NFPA 921 suggests that only certain materials are susceptible to ignition due to arcing, none of which would normally be present in the vicinity of a CT circuit. As stated in NFPA 921: *"It is noted that fuels with high surface-area-to-mass ratio, such as cotton batting, tissue paper, and combustible gasses and vapors, may be ignited when in contact with an arc."*

It is recommend that the test plan be revised to develop a monitoring strategy that is not based on arc detection, and instead detects thermal overload/overheat that is truly indicative of auto-ignition conditions being reached by some component in the circuit.

3. CT secondary circuits, particularly those associated with protective relaying, are typically provided with shorting links or shorting test switches that allow safe removal and calibration of metering devices. These shorting devices present an ideal location for arc formation as they provide a small gap for an arc to cross; however, they are also of sturdy construction and unlikely to exhibit ignition due to arcs. The draft test plan does not appear to include any shorting links or shorting switches, terminal blocks, circuit grounds, or metering or relaying devices. All of these would be needed for this to be a representative test design.

II. Current Transformer Draft Test Plan Comments

No.	Page #	Line #	Change Text From	Change Text To	Comment Basis
1	7				From a design similarity perspective, does a multi-tap CT provide or induce any non-typical characteristics or capabilities that could influence the results in either the positive or negative direction? Such a configuration does not represent a typical Nuclear Power Plant (NPP) installation.
2	10				1. CT secondary circuits are typically grounded – will the test configuration be grounded? 2. Will the secondary circuit be installed in grounded raceway system (conduit or tray) to represent a typical installation and provide ground plane to test the conductor IR against? 3. Will any additional cables or wires be run in contact with the CT secondary circuit to represent a typical installation?
3	11				Exelon would not necessarily consider ten (10) seconds to be representative of a typical high ratio CT application in a differential relay circuit (instantaneous on the order of cycles). Ten (10) seconds may be appropriate for lower ratio CTs used in metering or other protective relay circuits such as overcurrent. However, based on the discussion contained in JACQUE-FIRE (NUREG/CR-7150) Volume 1, the lower ratio CTs will not result in CT or secondary circuit damage.

No.	Page #	Line #	Change Text From	Change Text To	Comment Basis
4	12				1. What frequency will be used? 2. How will the secondary circuit be configured (conduit, tray, ground path for testing)? 3. What insulation resistance test method will be used? What is it referenced to (ground, other nearby conductors or cables)? a. NUREG-6776: *"Cable Insulation Resistance Measurements Made during Cable Fire Tests"* provides several accurate measurement techniques. b. Use of an ECAD testing system may provide additional data and consistent results. c. FIST 3-1: *"Testing Solid Insulation of Electrical Equipment"* discusses several Insulation Resistance (IR) test methods.
5	13				In consideration of "subsequent tests" - Will the NRC be using a stressed/degraded/potentially damaged CT and wiring for any of the subsequent testing? Typically, components subjected to extreme conditions such as faults would be replaced. Use of any degraded components may not provide an accurate representation of what an unstressed component would provide.
6					1. Two different CTs with differing "turns" ratios are being used. Exelon believes that the testing should provide insights into the impact of "turns" ratio on the testing results. 2. Exelon also believes that the test plan should address the cumulative impact of each open circuit test on the results of the succeeding test.

No.	Page #	Line #	Change Text From	Change Text To	Comment Basis
7	13	1.4.3			In Section 1.4.3, *"CT Subsequent Tests,"* Part b indicates that *if no fire or arcing is observed for conditions which would be expected in a NPP, then additional testing will be done until there is a failure.* The concern here is that testing may then continue outside of the bounds of the objective of the test program, which is to test the CTs within their operating ratings (this may produce some useful/interesting information, but arguably it might not be pertinent for conditions at the power plant).
8					Exelon believes this should be included in the test CTs made by different vendors.
9					Exelon believes that the test should include in the secondary circuit typical relays such as electromechanical, static and microprocessor-based. In addition, it might be helpful to include some typical metering devices and transducers. The location should be such that the devices see the effects of open circuit. This will help to evaluate if their insulation will fail before the secondary circuit cable/wiring. Cable insulation is better than the insulation of these devices.
10					It appears that only wound-type CTs have been included. Shouldn't the bushing-type CTs also be included in the test? Secondary circuit wiring of bushing-type CTs also run inside the plant even if bushing-type CTs are outside the plant.
11	1	1.1.1	"... current carrying capacity..."	"...continuous current carrying capacity..."	Exelon believes that the second sentence should indicate that 1 amp or 5 amps is continuous.
12	4	1.3	"...typically used in the safety systems of nuclear."	"...typically used in the safety systems and applicable non-safety systems of nuclear."	Exelon believes that the test program should not be limited to CTs used in safety systems. For older plants that do not have the same level of circuit separation, there may be CTs in non-safety related systems that could adversely affect safe shutdown systems.
13	13	1.4.3	"If necessary, other tests will be carried out on CTs from several manufacturers and at higher voltage levels up to 4.1 kV."	"If necessary, other tests will be carried out on CTs from several manufacturers and at higher voltage levels up to 13 kV."	Exelon believes that the test program should include 4160V, 6900V, and 13800V CTs or provide further justification as to why these tests are not required.

No.	Page #	Line #	Change Text From	Change Text To	Comment Basis
14					Why test only the Amran CTs? In a typical power plant there could be as many as 25 to 50 different safety-related and non-safety related CTs. If requested, utilities should be able to provide a listing of makes/models of CTs currently in use at their stations.
15					As part of the testing, is the NRC considering the possibility of obtaining CTs from plants that are currently undergoing decommissioning, to support a wider selection of test specimens?
16					In addition to testing, Exelon believes that there should be a literature search that should supplement the testing. For instance, there might be a way to take the list of current transformers from power plants and bin/organize them in such a way (perhaps based on kV) that the potential worst-case performers prior to testing (e.g., based on voltage differences in the secondary circuit windings, or some other parameters) can be determined. One vision/outcome from doing the literature search, is the NRC report will have a list of most of the CTs versus where they are expected to fall based on the way they are binned/organized. Exelon believes that this might provide much more useful information than testing one brand of CT without regards to all the other type of CTs.
17					Exelon suggests that the NRC consider testing more than one type of CT and potentially look at testing several of one type, like the Amran CTs, to ensure that the NRC is getting repeatable test results.

No.	Page #	Line #	Change Text From	Change Text To	Comment Basis
18					The ranges of the test configurations in Section 1.4.1 look good overall, but Exelon believes that the following questions should be addressed: 1) Would it be worth considering varying the number of feet of secondary circuit cable or at least justify why not varying the lengths (50 ft or 75 ft or 100 ft)? Would that provide significant data about the failures for the industry to get some idea how to evaluate potential for failure for some of the other CTs? Note: The NRC is varying lengths for camera cable. 2) Varying the AWG size is good, but what about drain or ground wire? How will the industry be able to tell if drain or ground wire made a difference in the results? 3) How would industry translate the test results to cover the potential for cable with drain or ground wire? Is there a way to do this?
19					Section 1.5 has a good data evaluation. Exelon believes that when documenting the results it would be helpful to consider a few other aspects. In particular, the criteria that determines whether a secondary circuit fire has actually started and the magnitude of the fire is covered at a high level in the procedure with regard to arcing and explosion. However, on the minimum fire end of the spectrum, will flame have to be observed to establish whether a fire occurred or will smoke developed be a criterion? If the fire is self-extinguishing drips, would that count as a fire? One way to document the results would be a detailed description of what was observed.
20					Regarding the cable used on the secondary circuit: Will this be safety-related thermoset cable meeting IEEE-383, *"IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations,"* or will it be thermoplastic cable? The results may vary based on the cable material selected.