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SUBJECT: Comments on Suppl to GL 86-10, "Fire Endurance Acceptance Criteria for Fire Barrier Sys Used to Separate Redundant Safe Shutdown Trains Within Same Fire Area."

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Florida Power & Light Company, P.O. Box 14000, Juno Beach, FL 33408-0420

FPL

August 23, 1993
L-93-207

Chief, Rules and Directives Review Branch
U.S. Nuclear Regulatory Commission
Washington, DC 20555

RE: Supplement #1, to Generic Letter 86-10, "Fire Endurance Acceptance Criteria For Fire Barrier Systems used to Separate Redundant Safe Shutdown Trains within the Same Fire Area"

On July 23, 1993, the Nuclear Regulatory Commission (NRC) published for public comment the referenced draft generic letter supplement. The letter disseminates to licensees the NRC position on fire endurance test acceptance criteria for fire barrier systems used to separate redundant safe shutdown trains within the same fire area. These comments are submitted on behalf of the Florida Power and Light Company (FPL). FPL is an investor-owned utility serving over three (3) million customers in the State of Florida. FPL is a licensed operator of two nuclear power plant units in Dade County, Florida and two units in St. Lucie County, Florida.

Comment 1)
In the event that a barrier does not meet the acceptance criteria for a specific fire rating only one option is discussed in the referenced document. This option requires qualification of the cable to the higher temperature seen in the enclosure at the completion of the fire endurance test. We propose that an additional option be provided consistent with Interpretation #4 of Generic Letter 86-10.

The licensee should be allowed to perform an evaluation of the adequacy of the fire barrier to protect the redundant safe shutdown equipment and components (cable) from a design basis fire in a particular plant area. The evaluation would then be retained by the licensee for subsequent NRC audits. This is an extremely viable option, given the fire modelling techniques available in the industry today, and the inherently low combustible loading in most plant areas. One specific modelling method (FIVE) has already been accepted by the NRC for PRA's.

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Comments 2 through 8 apply to the functional testing requirements discussed in Attachment 1 to Enclosure 1 to Generic Letter 86-10, Supplement 1:

Comment 2)

The proposed supplement discusses cable insulation testing as it relates to engineering analyses that would be performed by the licensee to demonstrate functionality of the protected cable should the cable under test not meet the acceptance criteria under existing regulations. Paragraph c of the proposed supplement states in part that "Insulation resistance (Megger) testing provides an indication of the cable insulation resistance, whereas the high potential (Hi-Pot) test provides assurance that the cable has sufficient dielectric strength to withstand the applied rated voltage...."

In general, both of these tests are used to determine the condition of the insulation. The insulation resistance test is generally a non-destructive test used to determine the condition of the cable insulation; however, it does not give an indication of the total dielectric strength of the insulation. It may also reveal contamination present on the cable in the form of moisture, dirt, or carbonization. (Note, that after the proposed testing the presence of dirt or other contaminants, particularly on the terminations, caused by testing could cause the cable to fail electrical tests leading to an erroneous conclusion that the cable would not have been operable in an actual installation.) The applied voltage during insulation resistance testing is generally low (e.g., 500 to 2500 V dc depending on the equipment being tested). Therefore, it has historically been a practice to proof-test medium voltage shielded power cable using high-potential testing.

High-potential (both ac and dc) testing is generally used to detect gross imperfections in the cable insulation, perforations of the insulation, or improper practices/materials used in splicing/terminating the cable. High-potential testing of cables is only recommended for shielded power cables (these are generally cables rated ≥ 5000 V); however, based upon tests currently being performed by EPRI on aged cables, it appears that dc high-potential testing may significantly accelerate aging of the cable such that it may no longer be recommended as a test method. (Currently, there are at least two manufacturers of shielded power cable that state that dc high-potential tests shall not be performed on any cable that is 5 or more years old without their concurrence.)

High-potential testing of non-shielded power cable is not recommended (including medium voltage non-shielded power cable) since it could cause the failure of an otherwise good cable (even a brand new piece of cable). Guidance for making high-potential tests on shielded power cable is provided in IEEE Std 400-1991. (Note, this standard is currently under revision to reflect the EPRI test findings as they relate to dc high-potential testing. It is likely that the revision to this standard will include alternative test methods such as low frequency e.g., 0.1 Hz testing. Once approved, it may no longer recommend dc high-potential testing of cable.) The test voltages recommended in the standard are based upon principles which relate to the cable's basic impulse level (BIL) rather than to the type and thickness of the insulation. This would then account for not only the operating voltage impressed on the cable during operation, but the surges that may be experienced by the system (and therefore the cable) during operation e.g., switching

surges. In addition, the AEIC is proposing to eliminate dc high-potential testing for factory testing of cables in the draft revision of AEIC Std CS5, currently ready for ballot.

It is FPL's position that of the two tests described, only insulation resistance testing would be applicable to testing the functionality of a cable that has not met the acceptance criteria after a test of a fire barrier. (This assumes that the test setup allows for proper and safe performance of the insulation resistance test. It is not clear that insulation resistance testing during the fire test can be done safely.) High-potential testing, even at reduced voltage levels, would more than likely fail a cable that would have otherwise passed the test had it been subjected to only operating voltage during the test. Additionally, when examining a fire barrier or the performance of a cable during a test of the fire barrier, it is assumed that the cable will be subject to only the maximum operating voltage.

Comment 3)

The proposed supplement, again in paragraph c., discusses the minimum acceptable insulation resistance in Mohms and then goes on to state "In addition, AC or DC high-potential (Hi-Pot) test for power cables greater than 1000 volts shall be performed after the post-fire megger tests to assess the dielectric strength. This test provides assurance that the cable will withstand the applied voltage during and after a fire...."

The high-potential test is inappropriate for this purpose as previously stated under Comment 2. In general, the thickness of insulation on a power cable is far in excess of that necessary for the normal operating voltage applied to the cable. Mechanical strength of the insulation (e.g., that necessary to withstand handling during installation and termination) is the overriding consideration for determining the thickness. For example, based upon Table B1 in AEIC Stds CS6-87 and CS5-87, the minimum average insulation thickness for an 8 kV rated cable, 1000 kcmil or less would be 115-140 mils for ethylene propylene rubber (EPR), thermoplastic, or crosslinked polyethylene (XLPE). Each of these insulating materials has a dielectric strength of at least 400 V/mil (based upon ASTM Std D 149). Using these numbers, the dielectric strength of the cable insulation based solely upon its minimum average thickness would range from 46- to 56-kV. It is this level of insulation that the high-potential test is designed to detect failure in, rather than whether the cable would withstand its operating voltage (i.e., the intent of the testing to be conducted under the proposed supplement).

Similarly, Table 3-1 of NEMA Std WC 7-1988 (ICEA S-66-524), and NEMA Std WC 8-1988 (ICEA S-68-516) specifies an insulation thickness of 30-45 mils, 55-80 mils and 65-95 mils for 14-9 AWG, 1-4/0 AWG and 225-500 kcmil cable rated 0-600 V. Again, considering the insulation has a dielectric strength of at least 400 V/mil, these levels of insulation would correspond to 12-18 kV, 22-32 kV and 26-38 kV.

Comment 4)
The proposed supplement in paragraph c. presents a table of cable type, operating voltage and tests (including test voltages). The table recommends that insulation test voltages for insulation resistance testing of power cable (≥ 1000 Vac), power cable (< 1000 Vac) and instrument and control cable (≤ 250 Vdc, ≤ 120 Vac) are 2500 Vdc, 1500 Vdc and 500 Vdc, respectively. Additionally, there is a note that states that an insulation resistance test voltage of 1000 Vdc is acceptable for power cable (< 1000 Vac), provided a high potential test be performed after the insulation resistance test. The proposed supplement states "The table below summarizes the megger and Hi-Pot test voltages which, when applied to power, control and instrumentation cables, would constitute an acceptable cable functionality test."

FPL disagrees with both the table and statement. For the reasons discussed in other comments high-potential testing of the cables should not be performed. In addition, recommending such tests for non-shielded low voltage power cable (i.e., < 1000 V ac) is contrary to all industry standards, even for newly installed cable. The use of a high-potential test for cables that have already sustained some damage during the fire barrier test to evaluate whether or not they would have been functional would be inappropriate.

Additionally, the test voltage for the insulation resistance measurements are too high. For example, the three industry standards that describe this testing for newly installed cable at generating stations and substations are IEEE Std 422-1986, IEEE Std 690-1984 and IEEE 525-1992. Each of these standards recommend that insulation resistance tests for low-voltage power and control cable be at a minimum of 500 V dc. Recommendations vary on the need to insulation resistance test instrumentation cable. For example IEEE 690-1984, Appendix A, clause A10.1 (4) states "Insulation resistance measurements should be performed on instrumentation cables if circuit performance is dependent upon level of insulation resistance. Cable manufacturers' recommendations should always be considered." If manufacturing standards are considered, both NEMA Std WC 7-1988 (ICEA S-66-524), and NEMA Std WC 8-1988 (ICEA S-68-516) recommend a test voltage of 100 to 500 V dc for insulation resistance testing of new cable at the factory.

The discussions above describe industry standards used to test new or newly installed cable. It would then seem reasonable that test voltages for the evaluation of cables that did not meet the acceptance criteria after the test of the fire barrier, be no more severe than those applied to newly installed cable.

FPL proposes the following test voltages for insulation resistance testing for the various cables tested (additionally, it is proposed that no testing be performed during the fire test unless it can be demonstrated that this testing can be done safely):

Cable Type	Operating Voltage	Megger test Voltage
o Power Cable	≥1000 V ac	2500 V dc
o Power Cable	1000 V ac 600 V ac	1000 V dc 500 V dc
o Power Cable	≤300 V dc	500 V dc
o Control Cable	≤240 V ac ≤ 300 V dc	500 V dc 500 V dc
o Instrumentation Cable[1]		300 V dc

Comment 5)
The high temperatures in the vicinity of the fire test chamber requires that the ends on of the cables under test be long enough to enable them to be in a satisfactory location for electrical testing (i.e., an area cool enough for the test instruments and the test personnel). These longer cable ends may be subjected to mechanical damage, e.g., as the cable under test is moved about, which may alter test results due to damage unrelated to the specific purpose of the test. Additionally, the use of test equipment in a high ambient temperature environment will affect the accuracy of the measurements taken as will the alternate of using long test leads (i.e., to allow the instrument to be in a normal environment.).

Comment 6)
In paragraph c, the fourth paragraph discusses the need to "immediately" megger test all cables. Performance of the megger test takes time, thus adding to the 1 or 3 hour testing time since the test assembly would remain in the oven at or near test temperature (the assembly and cable would see 1+ or 3+ hours of elevated temperatures). The additional time, at temperature, could cause a test failure. If high-potential testing as described in the proposed supplement, is also performed in the "oven" then the time of temperature exposure of the test assembly would be further increased. If the electrical cable testing is to be performed, it is more logical to complete the fire test, perform the hose stream test, then, if necessary, perform any electrical cable testing.

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[1] If the instrumentation cable's circuit performance is not dependent upon the level of insulation resistance, the ANS circuit integrity test shall be used as the acceptance criteria (i.e., a test voltage of 8 to 10 V dc).

Comment 7)
Ideally, all terminations for the cable under test should be made before the fire test, however, due to the specific configuration of the test assembly this may not be possible. If the cable terminations are made after the test, this may also lead to misleading results. Movement of the tested cable to enable proper termination can subject it to mechanical forces that could damage the cable, causing it to fail.

Comment 8)
The proposed electrical tests used to determine functionality if the tested cable fails to meet acceptance criteria are new to the industry and should be reviewed for feasibility and personal safety implications. This process should include appropriate industry review (e.g., cable manufactures, IEEE, AEIC, ICEA, etc.).

Summary
FPL considers that the cable circuit integrity and cable insulation testing described in Attachment 1 to Enclosure 1 to the proposed Generic Letter 86-10, supplement 1, will not properly demonstrate cable functionality. Instead it will demonstrate cable failure. Based on the proposed testing criteria for cables that require an engineering analysis to be performed to demonstrate functionality, few, if any cables would pass. In addition, the supplement, by omission appears to disallow engineering analysis previously acceptable for fire barriers in Generic Letter 86-10. The testing proposed in the supplement is not consistent with, nor has it been approved by, the electrical cable engineering and fire test facility communities and lacks the appropriate industry review process. For the reasons presented above, FPL requests that the cable functional testing requirements discussed in the proposed Generic Letter be revised to better test for cable functionality utilizing these and other industry comments.

FPL appreciates the opportunity to comment on the proposed Generic Letter supplement.

Should you have any questions, please contact us.

Very truly yours,

W. H. Bohlke
Vice President
Nuclear Engineering and Licensing