April 6, 2001

Mr. Gary J. Toman
Chairman
IEEE/NPEC/SC2
Plant Supporting Engineering
Science and Technology Division
EPRI
1300 W.T. Harris Blvd.
Charlotte, NC 28262

Dear Mr. Toman:

I raised several technical issues related to environmental qualification of safety-related electric equipment at the IEEE Nuclear Power Engineering Committee (NPEC) meetings in November 2000 and March 2001. These issues are documented in the Enclosure 1.

Consistent with the NPEC directive, I request that your subcommittee, SC2, should discuss these issues at your next meeting and develop IEEE position on these issues, specifically on Issues # 2 and 3.

Please do not hesitate to contact me if you need additional information on (301) 415-6005.

Sincerely,

**/RA/ by Satish Aggarwal**

Satish Aggarwal
Senior Program Manager
Office of Nuclear Regulatory Research

Enclosure: As stated

cc: Neil Smith, IEEE/NPEC

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| NAME | S. Aggarwal | | N. Chokshi | | | | | | | | |
| DATE | 04/06/01 | | 04/06/01 | | | | | | | | |

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**ROUTING AND TRANSMITTAL SLIP** **DATE: April 6, 2001**

| TO: | INITIALS | DATE |
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| 1. S. Aggarwal - initial/signature/concur | | |
| 2. F. Cherny - initial/concur | | |
| 3. N. Chokshi - initial/concur | | |
| 4. R. Lambert - Dispatch | | |
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LETTER TO: G. Toman, EPRI
FROM: Satish Aggarwal

RE: Technical issues related to Environmental Qualification

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| ***FROM:*** *R. Lambert* | *Room No.*<br>*T-10-E-6*<br>*Phone No.*<br>*x5686* |

# TECHNICAL ISSUES RELATED TO ENVIRONMENTAL QUALIFICATION

## 1. Need for Monitoring Plant Environments & Condition Monitoring

Background: The overall EQ process provides reasonable assurance that, when qualified in accordance with the NRC regulations, cables will perform their intended safety function during their qualified life. Specifically, 10 CFR 50.49(e)(5) contains provisions for aging that require, in part, consideration of all significant types of aging degradation that can affect the component's functional capability. Compliance with 10 CFR 50.49 ensures that the cables will perform the intended function during accident conditions after exposure to the effects of service aging. Failures of Okonite, Rockbestos, and Samuel Moore cables in recent Wyle tests and Sandia tests, raise concerns about the long-term performance of these cables.

The licensees were expected to provide assurance that safety-related equipment will perform its intended function throughout its installed life and operating environmental conditions will not exceed those assumed during preaging. It is expected that the licensees will monitor environments (temperature and radiation) in operating plants, at least in certain areas, so that they know where the "hot-spots" are. The licensees were encouraged to consider surveillance, maintenance, and condition monitoring. The staff does not have current information about what steps the licensees are taking to assure compliance with 10 CFR 50.49 throughout the service-life of safety-related equipment. A "feed back mechanism" is missing. Further, the operating experience at several power plants indicates failure of cables and problems with splices.

Thus, the combination of insufficient information about licensee programs for assuring compliance with the NRC regulations, the research data identifying several cable types and designs where the original qualifications have been challenged, and operating experience identifying problems with previously qualified splices, lead the staff to conclude some additional regulatory action is required.

Are some of the low-voltage I&C cables thermally overrated?

Inspection, surveillance, condition monitoring, and trending of selected parameters for any installed safety-related equipment can potentially increase knowledge regarding aging effects and confidence in equipment reliability and performance.

**ISSUE: For maintaining qualification throughout the qualified life of I&C safety-related cables, should the licensees provide information on the environments are monitored to detect localized hot-spots and that the original test conditions are not exceeded in operating nuclear power plants?**

**Is it prudent to perform some kind of condition monitoring of I&C cables, that may include walkdowns to look for any visible signs of anomalies attributable to cable aging?**

**What are the industry initiatives?**

2. **Testing of Single Prototype**

Background: Based on IEEE standards, single prototype testing has been used for many applications and will almost certainly be used in future applications. However, based on recent research results, the staff believes that the use of a single cable specimen for environmental qualification warrants further discussion with the nuclear industry.

The analysis of test failures into random and common-mode categories is significantly enhanced by testing multiple specimens. If one of these specimens fails but the others perform throughout the program, the justification that the failure was random becomes significantly more sound.

**ISSUE: Shouldn't the IEEE standards be revised to require testing of multiple specimens?**

3. **Post-LOCA Submerged Voltage-withstand Test**

Background: IEEE standards require a submerged voltage-withstand test (80V/mil ac or 240V/mil dc) for 5 minutes. This is a post-LOCA test. For a 30 mil thickness, the test voltage is 2400 V. The industry has vigorously argued that this is an extremely severe test and I&C cables would never be exposed to this voltage. According to IEEE standard (IEEE Std. 383-1974), the post-LOCA simulation test demonstrates an adequate margin of safety. It should be noted that several test specimens, which were preaged to 40 and 60 years of equivalent service life, in NRC tests failed submerged voltage-withstand test .

**ISSUE: What are the technical bases for this post-LOCA test? Should this requirement be changed?**

4. **Testing of I&C cables for 60 years service life**

Background: If one uses the Arrhenius equation to calculate thermal aging conditions, the ratio of accelerated aging time to simulated service time remains constant as long as there is no change in activation energy, aging temperature, and service temperature. Therefore, one can clearly obtain the 60-year aging time by multiplying the 40-year aging time by 1.5.

This was the technical basis for choosing 60-year accelerated aging time. Of the twelve cables preaged and tested, eight experienced failures during the post-LOCA submerged voltage withstand tests. The results indicate that some low-voltage I&C cables may not have sufficient margins beyond the 40 years of their qualified life. If the service environmental conditions are assumed to be those used in the original qualification, then these cables may not perform their intended functions at the end of the 60-year service life, and subjected to LOCA conditions. The staff has concluded that many I&C cables, at their existing ratings, will not have sufficient margins for 60 years of their service life.

**ISSUE: Should the cable aging be addressed as part of an aging management program for detecting aging degradation of safety-related I&C cables, for licensees seeking to renew their operating licences?**

**How to ensure that the service environmental conditions will not exceed the environmental conditions assumed in the analysis for demonstrating requalification to 60 years for license renewal?**