UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION OF
GE METHOD OF SIMILARITY TESTING
FOR
USE IN CABLE QUALIFICATION AT
TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT UNITS 1, 2 AND 3
DOCKETS NOS. 50-259/260/296

BACKGROUND:

On April 29, 1986, TVA and GE made a presentation to the NRC concerning the environmental qualification of certain electrical cables installed in the Browns Ferry Nuclear Plant (BFN) for which TVA did not have sufficient records to provide adequate identification and traceability to ensure proper environmental qualification of the cables. During the presentation, a method of generic cable qualification was proposed by TVA and GE based on the GE method of similarity testing. On September 2, 1986, TVA formally submitted the proposed cable qualification methodology to the NRC for approval for use in certain cable qualification applications at BFN. The evaluation of this cable qualification methodology is the subject of the discussions in the following paragraphs.

DISCUSSION:

A. The TVA submittal states that the similarity methodology would be used to qualify a small number (recent information indicated approximately 160 or less) of the total cables in the plant. Enclosure 1 to the cover letter states that no credit will be taken for cable jackets and the methodology will not be used to qualify cables in the primary containment, steam vault, or reactor water cleanup rooms. This essentially restricts the methodology to qualification of cables in the reactor building (RB) at BFN. The enclosure states that the similarity methods may be applied to the following two cases.

   1. Case 1 uses the method to establish similarity between samples of cable with the same insulation type that were purchased on different contracts from various manufacturers.

   2. Case 2 uses the method to establish similarity from sample cable with the same insulation type from the same manufacturer.

   In the proposed cable qualification method, described in NEDE-31302P-1, "General Electric Cable Similarity Program for the Browns Ferry Nuclear Plant" Revision 1, dated June 1986, similarity between type-tested Class 1E cables and non-type-tested Class 1E cables which are located in the RB is established. Once similarity between the cables is established, BFN would base qualification of the non-tested cables on the fact that the tested cables passes type-testing for environmental conditions equal to or more severe than the accident environments which the non-tested cables would be exposed in their inplant installations (RB-outside containment).

Conditions inside the RB are identified in Table 2-1 of the GE report and consist of worst case conditions of 180 degrees Fahrenheit (F) for temperature, 17 Mrads total integrated dose of radiation, 4 psig of pressure, and 100% humidity.

B. Based on our evaluation of the information presented in the report, it is concluded that the similarity methodology is acceptable for use in establishing qualification of cables within the restrictions identified in the TVA letter, its enclosure, and the report. Additionally, the use of this method is restricted for use in cases where non-type-tested cables are bounded on both sides by qualified type-tested cables manufactured both before and after the non-tested cables. This restriction applies to cables of the same insulation types manufactured by the same manufacturer and/or different manufacturers. Acceptance of this similarity methodology is based on the following:

1. The cables to be qualified are required to be qualified to DOR guidelines as cited in 10 CFR 50.49. While the guidelines state that type testing is the preferred method of qualification of electrical equipment inside containment, section 5.3 states that certain analysis methods are acceptable which may be reviewed and accepted on a case-by-case basis. Since the cables are located outside containment where the environmental conditions are less severe, this analysis method is considered acceptable.

2. The worst environmental conditions as identified in paragraph A above are not severe relative to typical cable capability (see paragraph 3. below) and the duration of the steam transient is given as a maximum of 80 seconds. Therefore, time for heat transfer and moisture penetration (considering the peak pressure of 4 psig) is minimal.

3. Cable used in nuclear power plant service is generally rated at a minimum of 90 degrees Centigrade (C) (194 degrees F) continuous conductor temperature. For wet locations, the cables are usually derated to a 75 degree C continuous conductor temperature. However, since most cables are used below these values in actual plant applications and most Class 1E power cables (the ones with potential for significant conductor temperatures) are de-energized until an accident occurs, much of the rated conductor temperature rise can be considered to be caused by the ambient environment.

   Additionally, cables are generally aged at significantly higher temperatures, typically 121, 136, and often 150 degrees C. Although these are dry temperatures with no cable loading, they do indicate general insulation survivability at elevated temperatures for extended periods of time.

Since cables with the same insulation materials as the cables that are being qualified at BFN have been successfully type-tested to environments (including saturated and superheated steam conditions) more severe than the RB, typical cable capabilities are generally considered within the expected BFN cable capability requirements, and the severity and duration of the accident conditions in the RB are minimal, this similarity method is considered acceptable for use in establishing qualification of certain cables in the RB.

4. Functional performance for cables consists of carrying voltage and current and maintaining acceptable insulation resistance. Since the BFN temperatures are not that severe in the RB, carrying rated current is not considered the major problem. The problem is the insulation resistance of the cables, which also relates to ability to carry voltage. Insulation resistance varies with the circuits the cable is used in; however, for the short (80 seconds) duration transient, even for instrumentation circuits, accuracy is not likely to be a significant concern, as long as circuits continue to function properly after the transient. Consequently, the major concern reduces to essentially avoiding "short circuit" conditions, i.e., low enough insulation resistance to cause fuses or breakers to open. In actuality, based on a large number of tests, insulation resistances of cables at the RB temperatures in a steam environment are expected to remain high and are not expected to cause any problems, even with short term instrument accuracy considerations.

C. While the use of this similarity method is acceptable for the conditions in the reactor building at BFN, use of this method to establish qualification of cable at higher environmental levels is not approved. Concerns with its use are identified below:

1. The method provides no demonstration of cable similarity in steam and/or radiation environments. It was noted that the report claimed the capability to assess radiation behavior in conjunction with the thermo-galvometric analysis (TGA); however, details were not discussed.

2. The report presents no clear acceptance criteria. The report appears to make the acceptance criteria the fact that certain values fall within a standard deviation of the mean of a group of samples or values are greater than or less than certain established values; however, no technical basis to support the apparent acceptance criteria is provided. For example, no evidence exists that exceeding some established industry standard (not specific to or even necessarily intended for nuclear grade cable) for two different kinds of cable implies anything about the similarity of the cables.

3. The report is not clear as to what size populations are used to establish standard deviations. If only small populations are used being within a standard deviation of some mean value may not be significant with regard to establishing cable similarity.

4. The report deals with cables which have passed type-testing and establishes values which are considered adequate to demonstrate cable similarity; however, the report does not address where cables that have not passed type-testing would fit into the method. If cables that have failed type-testing fall within the values which are established as acceptable for proving cable similarity, the question can be asked as to how does the establishment of cable similarity relate to demonstrating cable performance in severe accident environments.

SUMMARY:

Based on evaluation of information presented in the report, it is concluded that the similarity methodology is acceptable for use in establishing qualification of cables within the restrictions identified in the TVA letter, its enclosure, and the report. These restrictions include worst case conditions of 180 degrees F for temperature, 17 Mrads total integrated dose of radiation, 4 psig of pressure, and 100% humidity. Additionally the use of this method is restricted for use in cases where non-type-tested cables are bounded on both sides by qualified type-tested cables manufactured both before and after the non-tested cables. This restriction applies to cables of the same insulation types manufactured by the same manufacturer and/or different manufacturers.

While the use of this similarity method is acceptable for the conditions in the RB at BFN, use of this method to establish qualification of cable at higher environmental levels is not approved. If BFN wants to use this methodology to qualify cables in applications outside the above constraints, then NRC approval should be obtained for any new applications.

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