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Secretary of the Commission
Nuclear Regulatory Commission
Washington, D.C. 20000

Dear Sir:

Based on my previous experience in the nuclear field in the areas of qualification and cable specification, I feel compelled to respond to the proposed revision to Regulatory Guide 1.131.

I have been knowledgeable in these fields for the past eight years. While employed at Offshore Power Systems (OPS) in Jacksonville, Florida, I was responsible for the specification of all Class 1E cables in the Floating Nuclear Plant. At least eight cable companies were considered as potential suppliers of Class 1E cables. These companies submitted their qualification documents to me for my review and evaluation. It was also my responsibility as cable engineer for OPS to maintain familiarity with the cable field by studying the state-of-the-art in qualification.

I continue to follow the progress in equipment and cable qualification in my present position as a consulting engineer with NUS Corporation. I have been contracted by the Electric Power Research Institute as a technical coordinator and consultant for their equipment qualification program.

I also have retained the function of secretary of IEEE Working Group WG 1.4 which is revising IEEE 384-1977. This document deals with the independence of Class 1E equipment and circuits. Since an important part of any circuit is the cable, it is essential that I be aware of the aspects of Class 1E cable qualification.

My comments have been well researched and are footnoted to allow you to evaluate them quickly. Thank you for your consideration.

Very truly yours,

John W. Wanless

John W. Wanless, P.E.

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COMMENTS ON REGULATORY GUIDE 1.131 - "QUALIFICATION TESTS OF ELECTRICAL CABLES AND FIELD SPLICES FOR LIGHT-WATER-COOLED NUCLEAR POWER PLANTS" - Revision 1.

Background

Regulatory Guide 1.131 entitled "Qualification Tests of Electric Cables and Field Splices of Light-Water-Cooled Nuclear Power Plants" was issued in August, 1979, for comment. The proposed guide adds clarification to the testing parameters of IEEE 383-1974. There is, however, one change to IEEE 383 which could have a significant impact on past and future equipment qualification.

Regulatory Position No. 5 and its corresponding value/impact statement introduces the concept of synergistic effects in the aging process. The regulatory guide requires that investigations be performed to identify these effects, if any. Reference is made to NUREG/CR-0276 (SAND78-0799) "Sandia Laboratories Quarterly Report of January-March, 1978" as a basis for these requirements.

The viability of the entire concept of the use of accelerated aging as a method of predicting life expectancy has been questioned by experts in the field.[1,2,3] Accelerated aging provides only a

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1 Derek R. Augood, "Dielectric Aging-Overview and Comment," IEEE Conference Record of 1978 IEEE International Symposium on Electrical Insulation, 78CH1287-EI, June 12-14, 1978, pp. 17-21.

2 E. E. McIlveen, V. L. Garrison, G. T. Dobrowski, "Class 1E Cables for Nuclear Power Generating Stations," IEEE Transactions Power Apparatus and Systems, PAS-93, No. 4, July/August, 1974, pp. 1121-1129.

3 E. L. Brancato, "Insulation Aging-A Historical and Critical Review," IEEE Transactions on Electrical Insulation, EI-13, No. 4, August, 1978, pp. 308-317.

comparative measure of expected life.[4] The life of a material depends on many stresses including temperature and radiation.

There is indication that radiation and thermal conditions applied simultaneously can actually enhance the properties of some insulations and deteriorate others.[5] This research has been, to date, exploratory in nature and, therefore, has not yielded auditable results.

The chemical reactions produced by aging stresses are complex. It appears unwise to endorse a specific combination of techniques to produce end-of-life conditions. The failure point conditions cannot be predicted accurately at the present time by accelerated techniques. These problems are inherent in state-of-the-art accelerated aging and cannot be solved by ongoing qualification coupled with additional testing.

The relative radiation and thermal hardness of electrical cable insulations has been established.[6] The existing sequential radiation and thermal qualification data with some analytical investigation of radiation and thermal synergisms should indicate acceptable qualification since existing technology can only prove

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[4] Ibid., p. 312.

[5] Ibid., p. 316.

[6] R. B. Blodgett, R. G. Fisher, "Insulations and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations," IEEE Transactions on Power Apparatus and Systems, PAS-88, No. 5, May, 1969, pp. 529-541.

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relative material hardness. Simultaneous testing will produce no greater assurance of operation during a given lifetime. It can only duplicate the current knowledge.

The basis for the Regulatory Guide's concern with synergistic effects is given as NUREG/CR-0276, the Sandia Quarterly Report for January-March, 1978. This report states that "...(insulation) deterioration was caused primarily either by the thermal ambient environment or by extremely important synergistic effects in the combined radiation and thermal environments." Sandia's subsequent research have shown the existence of combined effects. It would be more proper to refer to the more current Quarterly Report of October-December, 1978 (NUREG/CR-0813 (SAND79-0761)).

While subsequent testing has shown the existence of some synergistic effects in accelerated aging testing, Sandia's research has not yet proved a lacked of conservatism in sequential testing. The October-December, 1978, report merely indicates that actual results differ from analytically predicted results for the chloroprene material tested. The data for PVC or PE should not be used as a basis for synergistic effects in nuclear power plant cables since these insulations cannot be used in Class 1E applications. PVC and PE insulated cables will fail both the LOCA and fire tests specified by IEEE 383.

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By using chloroprene as a test material, Sandia's research has proven that the simultaneous application of radiation and temperature stresses produce an end point which is less than that predicted by a mathematical combination of the stresses. This does not mean that the sequential application of temperature then radiation or radiation followed by temperature will cause non-conservative stressing of the material. It is possible that sequential testing may produce an equally or greater stressed material.

In fact, Sandia's results in LOCA testing have shown no apparent differences in the sequential and simultaneous application of stresses. It can be shown by Arrhenius techniques that the LOCA conditions represent just a quickened application of the same accelerated aging stresses that are applied as part of the pre-LOCA age conditioning.

Testing to show that sequential data is non-conservative or invalid is needed before there is a regulatory mandate essentially requiring simultaneous testing for identified synergisms. Since many cable manufacturers have performed sequential radiation-thermal aging tests, it appears prudent to assess the entire industry results rather than adopting a single laboratory observation as the basis for expensive and potentially superfluous requirements for additional testing.

Suggested Changes

It is suggested that Regulatory Position 5 be changed to read as follows: Aging data shall be developed to indicate long-term performance of the cable. Synergistic effects shall be considered in the accelerated aging program. Analytical or experimental investigation shall be performed to determine if there are environmental synergistic effects and, where identified, they shall be addressed in the qualification program. Documentation of the analyses and/or tests shall be provided. Aging stresses may be investigated using the Arrhenius technique. A minimum of 3 data points, including one at 136°C or lower and two or more others at least 10°C apart in temperature shall be used. If accelerated aging techniques indicate potential weaknesses due to aging stresses (such as rapid approach to the chosen end-of-life point during thermal stress), the following ongoing qualification procedure should be used: Ongoing Qualification Procedure--Some types of cables and field splices (hereafter referred to only as cables) may not respond in a representative manner to accelerated aging techniques to indicate end-of-design-life conditions. Consequently, the qualification program may indicate that environmental stresses will cause end-of-life condition before the required design life is met. There are two suggested methods for achieving long-term qualification: (a) After a planned period less than the indicated Arrhenius life of the cable has been reached, representative cables should be replaced with new cables and the removed cables subjected to a qualification evaluation similar to that performed prior to installation to determine the remaining margin of cable life. This margin should be compared to initial test data to ascertain the condition of the cables. Cables having sufficient margin to exceed the design life as determined by the Arrhenius model need not be retested. Cables having insufficient margin should be tested in a manner which duplicates initial testing with accelerated aging equal to the remaining design life. New Class 1E cables should be installed if the representative cables fail the subsequent test. This procedure should be repeated until the indicated Arrhenius life equals or exceeds the required design life.

(b) Additional identical cables should be installed in a nuclear power generating station location or other environmentally equivalent locations where power loading and service conditions equal or exceed those of the cable to be qualified. A cable should be removed after a planned period less than the previously indicated Arrhenius life. The cable properties should be compared to initial test data to ascertain the condition of the cable. A cable having insufficient margin should be retested in a manner which duplicates the initial testing with accelerated aging equal to the remaining design life. If the cable fails the subsequent testing the corresponding Class 1E cables shall be replaced with new cables. Sufficient additional identical cables should be initially installed in order that the above procedure can be repeated until the indicated Arrhenius life equals or exceeds the required design life.

Justification of Changes

1) The Arrhenius model is merely an indication of qualified life. There is no physical law which directly relates elevated stress levels to life of a material or component. Therefore, the term "qualified life" has been replaced by "indicated Arrhenius life." In addition, long-term performance cannot be "established" but only "indicated" by aging data.

2) There is existing preliminary data[7] which may be used in the justification of the conservatism of existing testing methods. Analytical or experimental investigation should be specifically allowed.

3) "Consideration" may be open to interpretation. The aging problem should be "addressed" and "documented" in a qualification program.

4) The Arrhenius technique does not "evaluate" the "effects of temperature" but is an "investigation" of "aging stresses." Many other effects of temperature, such as a change in chemical structure, may occur at levels outside the temperature band investigated by the Arrhenius technique.

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[7] E. L. Brancato, op. cit., p. 315.

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5) Accelerated aging can only give relative strengths of material. It cannot accurately predict the actual aged condition of a material. The important function of accelerated aging techniques is the indication of a rate of degradation not the actual end point. The end point is an arbitrarily chosen value, in any case, which is subject to interpretation. It is correct to say "If accelerated aging techniques indicate potential weaknesses..." rather than "If accelerated aging cannot reliably produce end-of-life conditions..."

6) Qualification "testing" should not be a requirement in ongoing qualification. The main concern is the aged condition of the cable. The remaining life of the cable as indicated in initial testing is the only valid consideration in ongoing qualification. If initial testing is valid, sufficient margin to extend the indicated life past the design life must be valid. Only when an insufficient margin is indicated, should additional testing be required. This criterion is identical to the initial testing criterion which requires additional testing only when the indicated life is less than the design life.

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