TVA

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381

MAY 0 8 1995

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

WATTS BAR NUCLEAR PLANT (WBN) - LONG-TERM CABLE BEND RADIUS PROGRAM PLAN

The purpose of this letter is to provide NRC the plan to address the cable bend radius issue for the long-term. TVA committed in letters dated June 5, 1990 and October 11, 1990, to provide such a plan prior to fuel load. This plan is provided in Enclosure 1. The list of commitments for this submittal is provided in Enclosure 2.

If you should have any questions, contact P. L. Pace at (615)-365-1824.

Sincerely,

Raul Baron

Raul R. Baron
Nuclear Assurance
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Enclosures
cc: See page 2

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Enclosures
cc (Enclosures):

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ENCLOSURE 1
WATTS BAR NUCLEAR PLANT (WBN) - UNIT 1
CABLE BEND RADIUS LONG-TERM PROGRAM PLAN

The purpose of this submittal is to provide details which will ensure that mechanisms pertinent to cable performance under small bend radius conditions have been identified and properly evaluated at WBN. TVA committed to provide NRC with details of WBN's Long-Term Cable Bend Radius Program in letters dated June 15, 1990 and October 11, 1990.

BACKGROUND

As a result of internal TVA reviews and NRC inspection findings, potential programmatic bend radius violations and concerns were identified at WBN. Corrective actions required prior to fuel load include testing, field inspection, and rework. As a result, 10 CFR 50.49 cables inside containment and main steam valve vaults will meet industry standard bend radius criteria. For the remaining cable population (located in other harsh and mild areas), TVA will utilize less restrictive bend radius criteria based on test results and analysis previously performed. (See the above referenced letters.) In order to ensure the mechanisms pertinent to cable performance under small bend radius conditions have been properly evaluated for age-related consequences of such bends on normal and accident service, the following long-term cable bend radius program plan has been established and plant procedures are being written/revised to implement this plan. The long-term plan has two salient points:

- Testing - To determine if a synergism exists between physical stress and aging.
- Cable Condition Monitoring - To ensure early identification of adverse trends.

TESTING

In order to substantiate TVA's conclusions that the functionality of the installed cable at WBN under small bend radius conditions is not impaired, (based on previous bending test and cable insulation elongation stress analysis),[1] the following test will be performed:

A fixed elongation will be applied to low voltage power (480V) cable insulation specimens. The "Controlled" and stretched specimen sets will then be subject to accelerated thermal aging. Measurements of ultimate elongation (i.e., elongation at break), will be performed on the aged specimens to identify possible variations of the rate of insulation aging as a function of stress. One of each manufacturer's type of low voltage power cable used in WBN's Environmental Qualification Program (10 CFR 50.49) circuits, that are readily available from TVA's warehouse system, will be used. Thus, the tests will cover two types of insulation materials: cross-linked polyethylene and ethylene propylene rubber. The above test plan is limited to low voltage

[1] TVA Calculation WBPEVAR9004013, "Electrical Cable Bend Radius-Lower Bound."

power cables, due to consideration of the failure mechanisms involved as explained below:

- Potential failure due to over bending is an age related phenomena, which takes into consideration the conductor heating during normal operation, the mechanical stress on the cable due to the bend, and external environmental conditions. Due to the low currents carried, the synergistic condition described above does not apply to control and instrumentation cables.

- Medium voltage (8 kV rated) cables used in WBN's Class 1E applications were reinspected and or reworked such that the final installed radius is equal to or larger than eight times (8X) the cable's outside diameter. The incremental additional stress between the Insulated Cable Engineers Association (ICEA) recommended value of twelve times (12X) versus WBN's 8X multiplier is insignificant. The critical issue for these cables is the insulation-to-shield integrity. Using the same method used by the industry to qualify a cable system design (Load Cycling and Corona Testing), WBN developed and performed a series of tests to address this issue. In contrast to Association of Edison Illuminating Companies (AEIC) protocol, WBN's tests were performed on cable bent to a four times (4X) multiplier and retrained to 8X.

  These tests established the integrity of the insulation-to-shield system for medium voltage cables even when subjected to a moderate bending stress. Therefore, medium voltage insulations may be exempted from the test program described above.

CABLE CONDITION MONITORING

Introduction

TVA has concluded that the periodic testing program, inspection, and upgrade as outlined below meets the recommendations provided in IE Information Notice (IEN) 86-49, "Age/Environment Induced Electrical Cable Failures." Since the scope of IEN 86-49 is much broader than bend radius, the cable condition monitoring aspect of TVA's long-term bend radius program addresses medium voltage power, control voltage, and instrumentation voltage as well as the previously mentioned low voltage power cables. However, the program does emphasize monitoring of feeder cables to large motors (100 hp or larger), because of their consequent higher rate of aging due to their thermal loading and cycling. This results in the routine dielectric examination of the very circuits expected to first display signs of postulated degradation. Additional confidence is provided by implementation of a program that merges test and inspection data to ensure the early identification of undesirable trends.

Periodic Testing

Periodic insulation resistance testing on a random selection of 80 percent of 100 horsepower and larger Class 1E motors shall be performed on an interval not to exceed 2 refueling outages for WBN. This testing will be governed by the plant preventive maintenance program.[2] The specific details of the test and acceptance criteria are addressed on a case by case basis by the governing maintenance instruction.[3]

Testing of Class 1E 6.9kV and 480V motors 100 HP and larger are initially done from the breaker cubicles, with motor connected, and therefore, includes verification of the motor power cables. If results indicate degraded or questionable insulation, and cleaning or drying of the motor windings, etc. is unsuccessful in bringing the motor into compliance with the acceptance criteria, the motor leads are then disconnected from the power feeder cables and each (motor and cables) tested separately. A general description of the test is provided below but may vary, as previously mentioned, depending on the specific load:

1. A megger test to ground using 2,500V direct current (DC) on 6.9kV circuits and 1kV DC on 480V circuits is performed.

2. Insulation resistance readings are recorded at 1 and 10 minutes after initiation of megger testing for 6.9kV and 1 minute for 480V circuits. The minimum acceptable insulation resistance for the 6.9kV circuits is 8 megohms and 1.5 megohms for the 480V circuits. In addition, Polarization Index (PI) is calculated for 6.9kV motors in accordance with site procedures[3] using the following formula: PI= 1 minute/10 minute reading

   With motor and cable connected the acceptable PI is 2. When testing the cable by itself, the minimum acceptable PI is 1. The lower minimum-acceptable PI for the cable by itself is due to station cables having low charging times because of their relatively short lengths.

3. A DC step voltage test is performed on the 6.9kV circuits with the phases (cable conductors) connected together.[3] The test voltage is slowly increased in 1kV DC increments up to and including 13kV. Leakage current readings are taken after 3 minutes at each interval. The test results are then plotted on a graph of voltage versus leakage current. A cable is adequate if the plot is an approximately straight line without a "knee."

The above acceptance criterion are consistent with that recommended by industry standards (e.g., IEEE 141 and IEEE 400).[4] It is noted that consistent with industry thinking, WBN no longer performs DC hipot test on cables which have been subject to submergence, see Electric Power Research

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[2] Site Standard Practice (SSP)-6.02, "Maintenance Management System."

[3] Maintenance Instruction (MI)-57.108, "Insulation Resistance and Continuity Tests for Rotating Machinery, Cables, and Transformers."

[4] IEEE 141-1993, "Recommended Practice for Electrical Power Distribution for Industrial Plants."

IEEE 400-1990, "Guide for Making High-Direct-voltage Tests on Power Cable Systems in the Field."

Institute (EPRI) TR-101245[5] and IEEE Transactions, Volume 7.[6]

Inspection

Each time devices required to mitigate 10CFR50.49 events (which are located in harsh environments) are entered, low voltage control, instrument level, medium voltage, or low voltage power field cables are visually inspected. This inspection provides visible indication of premature cable deterioration inside equipment and is accomplished through the Environmental Qualification[2] and Preventive Maintenance Programs.[2]

Failure Analysis and Trending

In order to identify potential adverse conditions, trending of maintenance history is performed. When an adverse trend is substantiated, (refer to SSP-6.04),[7] a corrective action program document is initiated in accordance with site procedures.[8] Thus, via the corrective action program, the extent of condition and cause (e.g., bend radius, splice, submergence, etc.) are determined and appropriate actions taken.

Ongoing Upgrades

New installations involving Class 1E cables are required to meet the current site procedures,[9] which were revised to reflect industry standards. These procedures also require that during maintenance and modification activities an

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[5] EPRI TR-101245, "Effect of DC Testing on Extruded Cross-Linked Polyethylene Insulated Cables," January 1993.

[6] "Effect of D.C. Testing Water Tree Deteriorated Cable and A Preliminary Evaluation of V. L. F. as Alternate," G. S. Eager, B. Fryszczyn, C. Katz, H. A. Elbadaly and A. R. Jean, IEEE Transactions on Power Delivery, Volume 7, Number 3, July 1992, Pages 1582-1591.

[7] SSP-6.04 - "Equipment History and Failure Trending."

[8] SSP-3.04 - "Corrective Action Program."

[9] General Construction Specification G-38, "Installation, Modification, Maintenance of Insulated Cables Rated Up to 15,000 Volts."

MI-57.113 - "Cable Bend Radius."

Instrument Maintenance Instruction (IMI)-101 - "Instrument Maintenance Planning and Work Activity Guidelines."

IMI-200 - "Periodic Calibration of Plant Instrumentation and Control Equipment."

Modification/Addition Instruction (MAI)-3.2 - "Cable Pulling for Insulated Cables Rated Up to 15,000 Volts."

Modification/Addition Instruction (MAI)-3.3 - "Cable Terminating, Splicing, and Testing for Cables Rated Up To 15,000 Volts."

attempt is to be made to bring the portion(s) of previously installed Class 1E cable being disturbed into compliance with current requirements.

Industry Participation

TVA is currently actively participating in the development of standards and test methodologies relating to cable installation issues. TVA personnel are participating in IEEE working groups responsible for IEEE-422, 690, and 1185 and are members of 383 and 1186.[10] Furthermore, TVA is one of the major sponsors of EPRI Cable Life Program and a member of the peer review group for EPRI Cable Diagnostics Project. As a result, TVA will be cognizant of developments within the industry concerning condition monitoring and bend radius and will incorporate them as appropriate.

Conclusion

It is TVA's conclusion that implementation of the above long-term program plan, which merges test and inspection data with trending for early identification of adverse conditions meets the recommendation of IE Information Notice 86-49 and is consistent with accepted industry practices and standards.

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[10] IEEE 383-1992, "Standard for type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations."

IEEE 422-1986, "Guide for the Design and Installation of Cable Systems in Power Generating Stations."

IEEE 690-1984, "Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations."

IEEE 1185-1994, "Guidelines for Installation Methods for Generating Station Cables."

IEEE-P 1186, "Recommended Practices in Evaluation of Cable Systems for Class 1E Circuits."

ENCLOSURE 2
WATTS BAR NUCLEAR PLANT - UNIT 1
LIST OF COMMITMENTS

1. TVA will perform testing to determine if a synergism exist between physical stress and aging.

2. TVA will write/revise plant procedures to implement the long-term bend program plan.

Item 1 will be completed by the end of the second refueling outage. Item 2 will be completed by September 29, 1995.