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O. J. "Ike" Zeringue
Senior Vice President, Nuclear Operations

MAR 3 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) - NRC JANUARY 18, 1995, REQUEST FOR ADDITIONAL INFORMATION: THERMO-LAG FIRE BARRIER SEISMIC CAPABILITIES (TAC M63648)

The purpose of this letter is to provide TVA's response to the subject request for additional information regarding the seismic capabilities of Thermo-Lag fire barriers. TVA's response to each of the staff's information requests is furnished in the Enclosure.

There are no commitments made in this submittal. If you should have any questions, contact Mr. P. L. Pace at (615)-365-1824.

Sincerely,

O. J. Zeringue

Enclosure
cc: See page 2

MAR 3 1995

Enclosure
cc (Enclosure):

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ENCLOSURE

WATTS BAR NUCLEAR PLANT (WBN) RESPONSE TO
REQUEST FOR ADDITIONAL INFORMATION REGARDING
THERMO-LAG SEISMIC CAPABILITIES[1]

The following provides TVA's response to NRC's January 18, 1995, request for additional information about the seismic capabilities of Thermo-Lag. TVA implementing documents discussed below (e.g., calculations, design standards, procedures, drawings) are available onsite for review.

NRC INFORMATION REQUEST - ITEM 1

"Provide the basis for the required response spectra (RRS) shown in Appendix II (AII) of Enclosure 1 (E1). Provide information as to how they represent critical floor response spectra at Watts Bar Nuclear Plant (WBN)."

TVA RESPONSE

The Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE) RRS curves in Appendix II of Enclosure 1 (Wyle Laboratory Test Report No. 44213-1) were based on enveloping new design and modification floor response spectra for the anticipated locations and orientations of Thermo-Lag 330-1 Electrical Raceway Fire Barrier (ERFBS) enclosure installations at WBN. The RRS curves were broadened in a manner similar to TVA's standard RRS for device testing (e.g., peak acceleration extends over the frequency range from 4.5 to 16 Hertz) to account for potential variations in actual enclosure, raceway, and support natural frequencies. The broadening encompasses and exceeds normal floor response spectra peak broadening which accounts for uncertainties in specific building and subsystem frequencies (reference WBN FSAR Section 3.7.2.5.2).

Support frequency variation was also considered by setting the RRS Zero Period Accelerations (ZPAs) based on bounding case cable tray and conduit support natural frequencies (determined from in-situ tests and adjusted for Electrical Raceway Fire Barrier System enclosure added mass effects) and the applicable WBN floor response spectra. Multi-mode response was directly simulated by the test specimen ERFBS enclosures and test fixtures. Simultaneous tri-axial random input motion was conservatively specified and applied. Thus, compliance with the applicable WBN civil engineering design criteria was assured for the representative Thermo-Lag 330-1 ERFBS enclosure test specimens.

The basis for the RRS curves were summarized in the "Watts Bar Thermo-Lag Enclosures Seismic Testing Plan." The testing plan was made available for NRC review in TVA's Rockville office. The complete basis for the RRS curves is documented in WBN calculation WCG-1-1742 and is available onsite for review.

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1 This information request pertains to TVA's November 11, 1994, letter to NRC that transmitted Thermo-Lag seismic test results.

NRC INFORMATION REQUEST - ITEM 2

"Provide an explanation of the differences in the input ZPAs shown for OBE, SSE in Table 1 (A1, E1) and those of the RRS (A11, E1). Provide information on how the input ZPAs, RRS ZPAs, and the demand spectra at the locations of the cable trays and conduits are correlated."

TVA RESPONSE

The OBE and SSE Test Response Spectra (TRS) simultaneously enveloped the RRS in each orthogonal axis, in accordance with IEEE 344-1975. In order to envelope the respective RRS curves with filtered random input motion per IEEE 344-1975, it was necessary to apply TRS ZPAs greater than the RRS ZPAs. This conservatism is typical for random motion seismic testing to broad banded RRS requirements. For the Thermo-Lag 330-1 tests, the TRS curves enveloped the RRS curves by wide margins for frequencies above 16 Hertz. An example of this is illustrated in the comparative TRS and RRS curves for test series 1 (cable tray/air drop enclosure specimens) and test series 2 (conduit enclosure specimens) in Appendices VI and VII, respectively, of the Wyle Test Report. The TRS curves were generated from control accelerometers mounted directly on the test table. They represent the actual test table input motions which were electronically recorded and analyzed by the test instrumentation.

The support test fixtures, depicted on pages 204 through 213 of the Wyle Test Report, were designed by TVA to be rigid (fundamental frequencies greater than 33 Hertz) with welded connections throughout so that the test table input motion would be directly transferred (without amplification) to the cable tray, air drop, and conduit fixtures to the maximum extent possible. The cable tray, air drop and conduit fixtures were subjected to input motions equal to or greater than the test table motion. To the extent that the test fixture supports were not completely rigid, additional conservatism was introduced by amplified motion at the point of attachment to the cable tray, air drop, and conduit fixtures. Thus, the test input motion and response spectra at the point of support fixture attachment to the cable tray, air drop, and conduit fixtures enveloped both the RRS and TRS curves. Also, as discussed in TVA's response to Information Request Item 1, the TRS curves enveloped the RRS curves which, in turn, enveloped the actual WBN installation requirements.

The cable tray, air drop, and conduit test fixtures were designed by TVA to represent actual WBN installations (e.g., representative cable fill, spans, and support attachments). As a result, the Thermo-Lag 330-1 ERFBS enclosure specimens were subjected to conservative seismic plus deadweight load demands.

NRC INFORMATION REQUEST - ITEM 3

"The test response spectra (TRS) shown in AVI and AVII (E1) are the spectra resulting from the simultaneous three-direction shaking of the test table, while the RRS are the uniaxial demand spectra. Provide justification for determining the adequacy of the TRS based on comparison to the RRS."

TVA RESPONSE

Independent test table motion was applied to each orthogonal axis simultaneously. In each orthogonal axis, the TRS was required to envelope the RRS for that axis, in accordance with IEEE 344-1975. When subjected to the simultaneous tri-axial table inputs, the amplified responses of the test fixtures/specimens ensured compliance with the WBN bi-axial seismic input requirements for qualification of electrical raceway systems. Therefore, multi-mode and multi-directional effects were adequately simulated in the tests. TVA's response to Information Request Items 1 and 2 provides additional justification.

NRC INFORMATION REQUEST - ITEM 4

"Provide a summary of significant differences in the installation procedure for Thermo-Lag implemented at Watts Bar and the installation procedure recommended by the vendor (TSI Technical Note 20684) which enhances the retention capability and reduces the damage potential of Thermo-Lag under the postulated seismic events."

TVA RESPONSE

TVA has not performed a detailed comparison of the WBN installation procedures with any TSI procedure or guideline. The WBN designs and installation procedures were developed independent of TSI Technical Note 20684. WBN designs and installation procedures are available to support a Staff's review of these documents to ascertain the significant differences.

TVA does not use TSI Technical Note 20684 nor any other TSI installation procedure, instruction, or guideline at WBN for installing Thermo-Lag ERFBS'. An understanding of any differences is not important to determining the adequacy of the installation methods being used at WBN. TVA's program of fire, ampacity, and seismic testing was directed specifically at qualifying the Thermo-Lag enclosures and associated installation procedures. This approach obviated the need for a detailed evaluation of TSI procedures. The following provides a summary of the installation controls used at WBN.

The following documents control the installation of Thermo-Lag 330-1 ERFBS enclosures at WBN:

1) General Engineering Specification G-98, "Installation, Modification, and Maintenance Of Electrical Raceway Fire Barrier Systems."
2) 47W243 drawing series of typical Thermo-Lag 330-1 ERFBS enclosures.
3) Design Change Notice (DCN) M-11727.
4) WBN Modification/Addition Instruction (MAI) 3.10, "Application Of Thermo-Lag Fire Barriers On Electrical Raceways."

Seismic adequacy of the WBN Thermo-Lag 330-1 installations is based on compliance with TVA Civil Engineering Design Standard DS-C1.6.16, "Structural Evaluation Of Electrical Raceway Fire Barrier Systems." This design standard defines allowable stresses, attribute comparison (similarity) rules, recommended analysis methods, and guidance for evaluation of enclosed raceways and supports. The design standard is based on Wyle Laboratory Test Report 44213-1 (E1), Singleton Laboratory Test Report 209-041-027A (E2), and supporting TVA calculation CSG-94-CN01.

The seismic capability of WBN Thermo-Lag 330-1 ERFBS enclosure designs is assured by the use of steel components including: external stress skin, heavy gage external tie wires, anchor bolts, tie rods/bolts, nuts, washers, and support braces. Typical steel components used at WBN are shown on the 47W243 series drawings.

NRC INFORMATION REQUEST - ITEM 5

"For the tested configurations of the raceways, the resonance search (AIV and AV, E1) indicated the resonance frequencies of the configurations vary between 12 and 30 Hertz, almost outside the amplified range of the RRS. With relatively flexible configurations (e.g., raceways supported by rod hangers, bolted supports with long support members), the resonance peaks could well be within the amplified range of the RRS. Provide information as to the applicability of the tested configurations to the as-built configurations."

TVA RESPONSE

The RRS ZPA values were adjusted to account for actual bounding case WBN cable tray and conduit support natural frequencies. As discussed above in TVA's responses to Information Request Items 1 and 2, the TRS curves exceeded the RRS curves over the entire frequency range from 1 to 200 Hertz. This ensured conservative results for test fixture/specimen mode responses, especially those modes with natural frequencies above 16 Hertz. The measured post proof test fundamental frequencies of the single cable tray, multiple cable tray, single conduit, and multiple conduit enclosure fixtures/specimens were 9.8 Hertz, 10.0 Hertz, 17.5 Hertz, and 28.0 Hertz, respectively.

The cable tray, air drop, and conduit test fixtures/specimens were representative of actual WBN configurations. Design Standard DS-C1.6.16 provides the basis for qualification of Thermo-Lag 330-1 ERFBS enclosures by attribute comparison (similarity) to items qualified by test (per Wyle Report 44213-1) or generic analysis (per calculation CSG-94-CN01). The design standard also provides the basis for analytical qualification of the other Thermo-Lag 330-1 ERFBS enclosures which do not satisfy the attribute comparison rules.

NRC INFORMATION REQUEST - ITEM 6

"The average material properties of Thermo-Lag material provided in Enclosure 2 are significantly lower than the ones provided by the vendor (TSI Technical Note 12683, etc.). Provide information related to the analysis of the configurations tested (or not tested and used in the plant) using the "as tested" material properties."

TVA RESPONSE

The allowable stresses specified in Design Standard DS-C1.6.16 are based on minimum load/stress capacities determined from Singleton Test Report 209-041-027A (E2) with an appropriate safety factor applied. These values, as well as effective Young's modulus, shear modulus, and panel section modulus and moment of inertia values, were appropriately correlated and justified in TVA calculation CSG-94-CN01. Dynamic test results for the single and multiple cable tray enclosure specimens and the single conduit specimen were also analytically correlated in CSG-94-CN01. The analytical methods in Design

Standard DS-C1.6.16 were developed accordingly. Thus, the "as tested" material properties are being implemented through application of Design Standard DS-C1.6.16. For example, the structural qualification of typical enclosure configurations on the 47W243 series drawings is provided in WBN calculation WCG-1-1751. Calculation WCG-1-1751 was performed in accordance with DS-C1.6.16.

NRC INFORMATION REQUEST - ITEM 7

"Photograph 11 (AIII, E1) indicates that there was minor damage to Thermo-Lag material after the series 2 OBE test. The test procedure requires that the specimens be subjected to SSE testing after 2 cycles of OBE tests. Provide information regarding the condition of damaged material after the SSE test."

TVA RESPONSE

The only damage noted in the seismic test program consisted of superficial surface cracks on the cable tray and air drop specimens (e.g., the minor surface cracking shown in Photograph 12 on page 34 of the Wyle report). The surface cracks were observed after completing the SSE test. None of the test specimens were significantly damaged during the OBE or SSE proof tests. Also, the fire barriers were not breached.

The small piece of Thermo-Lag material shown in Photograph 11 fell from inside the multiple tray enclosure shown in Photograph 1 (page 29 of the Wyle report). The end of the enclosure was intentionally left open so that the inside of the enclosure could be observed during and after seismic testing. The small piece (estimated weight less than 0.1 ounce) fell from the top cable tray at the open end of the enclosure. This small piece of debris was left inside the enclosure during fabrication. It would not have fallen from inside had the enclosure end not been left open for observation. Other similar pieces were also observed inside the trays during the tests. Those were all similarly small fabrication debris pieces which were completely inconsequential relative to their effect on the cables inside the enclosure, during or after the seismic event. None would have fallen from an actual enclosure because an actual enclosure does not have an observation opening.

NRC INFORMATION REQUEST - ITEM 8

"Summary of results indicate that under tested configurations and conditions, the Thermo-Lag panels and conduit wraps retained their position with very little damage. Provide information related to the II over I consideration at Watts Bar based on the test results and analyses to ensure that the as-installed Thermo-Lag will not jeopardize the functioning of the protected cables and nearby structures, systems, and components under the postulated seismic events."

TVA RESPONSE

TVA's testing shows that significant pieces of Thermo-Lag will not fall from the installed WBN enclosures. Also, WBN's enclosures are seismically qualified to the requirements of TVA Design Standard DS-C1.6.16 as described above. Therefore, no damage will occur to safety-related items due to Thermo-Lag 330-1 material falling during design basis seismic events. Small pieces of debris inside the cable tray enclosures would be of no consequence

to the enclosed cables due the ability of the cable jackets to withstand the potential low energy impacts. In addition, unacceptable interactions will not occur because commodity clearances are evaluated for the Thermo-Lag enclosure installations in accordance with WBN Engineering Specification N3C-941.

NRC INFORMATION REQUEST - ITEM 9

"A review of the layers of Thermo-Lag and associated hardware used at the plant (AX, E1) indicates that the installed fire barrier contributes significantly to the total weight of the raceway and cables. Provide information related to the incorporation of these weights in ensuring the seismic adequacy of the raceway supports and their anchorages. Consider the tolerances in the density and thickness of the Thermo-Lag material in your discussion."

TVA RESPONSE

TVA considers the additional weight of Thermo-Lag ERFBS enclosures when determining the seismic adequacy of raceways, raceway supports, and anchorages. Thermo-Lag ERFBS mass effects are evaluated in accordance with the guidance provided in TVA Design Standard DS-C1.6.16. The added Thermo-Lag ERFBS mass effects are considered when ensuring compliance with the applicable WBN civil engineering seismic design criteria (e.g., WB-DC-20-21.1 for cable trays/supports and WB-DC-40-31.10 for conduits/supports).

When performing seismic evaluations, Thermo-Lag 330-1 panel weight/mass is conservatively calculated assuming a nominal thickness (e.g., 5/8 inch) plus the 1/8 inch thickness tolerance permitted by General Engineering Specification G-98. TVA weighed, measured, and analyzed several Thermo-Lag 330-1 ERFBS enclosures to determine an effective density for an ERFBS assembly. TVA's evaluation is documented in calculation CSG-CN-93-001. A density of 72 pounds per cubic foot is used at WBN for a Thermo-Lag 330-1 ERFBS.