April 27, 1995

Mr. Oliver D. Kingsley, Jr.
President, TVA Nuclear and
Chief Nuclear Officer
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: WATTS BAR UNIT 1, AUDIT REPORT REGARDING THERMO-LAG SEISMIC ADEQUACY (TAC NO. M63648)

Dear Mr. Kingsley:

On April 11, 1995, the staff performed an audit of the various documents regarding seismic adequacy of Thermo-Lag materials as used at Watts Bar Unit 1. A report of that audit is enclosed for your information.

The staff's review of application of Thermo-Lag materials is ongoing as part of the Watts Bar Unit 1 fire protection review. We appreciate your site staff's support during the April 11, 1995 audit.

Sincerely,

ORIGINAL SIGNED BY:

Peter S. Tam, Senior Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosure: NRC Staff Report

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NRC STAFF REPORT ON WATTS BAR SITE AUDIT

THERMO-LAG FIRE BARRIER SEISMIC ADEQUACY

Background: Recognizing a need to address the seismic adequacy concern related to the Thermo-Lag fire-barrier material, TVA had performed shake-table testing of some typical cable tray and conduit configurations; and had tested Thermo-Lag specimens to determine their mechanical properties. The applied shake-table loading was calibrated to envelop the expected maximum vibratory motions to the test configurations. The staff had reviewed the reports related to the seismic testing and material testing and requested additional information (RAI) to clarify some of the issues related to the tests. TVA had provided brief responses to the questions raised, but had made reference to a number of related TVA-developed documents for detailed responses. The staff planned this site audit to review some of these documents and to observe the field installations of Thermo-Lag material on the raceway systems at Watts Bar Nuclear Station (WBN).

The planned agenda for the meeting and lists of attendees during the entrance and exit parts of the meeting are enclosed as Attachments 1, 2, and 3.

During the morning of the April 11th meeting, some of the issues raised (in the RAI) and their responses were clarified with an identification of the documents that the staff planned to audit in the afternoon. Some of the generic information obtained during the morning meeting is summarized below.

- Considerable differences were noticed in the installation procedure and the attachment hardware at Watts Bar and those recommended in TSI's (vendor) documents.

- TVA is also reviewing the existing Thermo-Lag material installations at Sequoyah and Browns Ferry.

- TVA has completed the installation of Thermo-Lag 330-1 on 75% of the conduits, and 10% of the cable trays which were identified to require fire barriers. The basic reason for the intentional delay in the installation of the Thermo-Lag material on cable-trays is to plan for rerouting of some of the essential cables from the cable trays and putting them into the protected conduits.

- At WBN, Thermo-Lag has been installed on the raceways and their supports. It has not been used on HVAC ducts or other equipment.

- The newly-developed (by TSI) Thermo-Lag 770-1 material is more pliable, and could be wrapped around the existing 330-1 material. However, its chemical and mechanical properties are not known. TVA plans to test the essential properties of this material, and use it in limited areas where 3-hour fire rating is needed.

ENCLOSURE

- The TVA staff showed a video clip of the fire-test in which the Thermo-Lag 330-1 material was subjected to a fire for 1 hour with sustained flame temperature of 1005°F and an end temperature of up to 1700°F. The temperature of the cable insulation was recorded as 250°F above its normal temperature.

During the walkdown, the TVA staff showed some of the installed Thermo-Lag material on a single conduit, ganged conduits, junction boxes and cable air-drops. The TVA staff also showed some of the difficult-to-access cable-tray areas where TVA is seriously thinking about rerouting some of the essential cables for which Appendix R fire protection is needed. Most of the raceways requiring fire protection are located in the Auxiliary Building, and the Diesel Generator Building. Most of the cable-tray installations (including their supports) appear to be relatively rigid (i.e., their natural frequencies are higher than 10 Hz). Some of the conduit air-drops could be flexible. However, our later audit indicated that TVA has identified each and every installation to differentiate it from the tested configurations.

The following TVA documents were audited in the afternoon for resolving the staff's concerns related to the seismic adequacy, installation procedure, and uncertainties in the weight (density) of the installed Thermo-Lag:

- WGC-1-1742 to assess whether the required response spectra (RRS) and the enveloping test response spectra enveloped the demand spectra at the highest location of the raceways, where Thermo-Lag is or will be installed.

- Four documents related to the installation of Thermo-Lag to assess the differences between the TVA-developed installation procedure and the one recommended by the vendor and presumably used at other nuclear power plants.

- TVA's Civil Engineering Standard (DS-C1.6.16), supporting calculations, and relevant set of drawings to ascertain that the test interpretations are logical, the Standard's criteria are well justified, and the actual calculations of WBN raceway installations are consistent with the Standard's criteria.

- Documents related to Thermo-Lag weight calculations.

- The TVA staff also showed a video clip of the seismic testing performed at Wyle Laboratories. Two cycles of triaxial shaking simulating the amplified OBE followed by one cycle of amplified SSE were applied to the test specimens. The simulated OBE consisted of ZPAs; H1 - 2.4g, H2 - 2.0g, and V - 1.4g, with the maximum spectral accelerations of H1 - 4.2g, H2 - 3.2g, and V - 2.6g between the frequencies of 4 to 30 Hz. The simulated SSE consisted of ZPAs; H1 - 4.0g, H2 - 3.2g, and V - 3.0g, with the maximum spectral accelerations of H1 - 6.5g, H2 - 5.2g, and V - 5.0g between the frequencies of 4 and 30 HZ. The simulated test response spectra enveloped the required response spectra by significant margins. The installed Thermo-Lag suffered only minor damage.

The NRC staff raised two issues during the audit process:

(1) The resonance search of the tested configurations indicated that their natural frequencies were in the range of 12 to 30 Hz. Though the test response spectra indicated adequate amplifications, the damage potential for such relatively rigid configurations would be low compared to more flexible configurations. The TVA staff stated that the tested configurations represented typical installations of raceways in the plant. Moreover, the TVA staff has performed detailed calculations to confirm that the stresses in all configurations were below the conservatively established acceptance criteria (based on the tested material properties).

(2) During the review of the parameters associated with the testing of the mechanical properties of the Thermo-Lag material, the NRC staff noted that some of the specimen thicknesses recorded were higher than the maximum thicknesses allowed; that is, a 5/8 in. Thermo-Lag panel can have thickness ranging between 1/2 in. and 3/4 in. Some of the specimens used in the tests had thicknesses as high as 0.9 in. The TVA staff is going to look into this issue and provide a response.

In general, however, the audit indicated that TVA has expended significant resources to assure itself that the Thermo-Lag installations at WBN do not pose undue hazard to the plant's safety systems under the postulated seismic events at WBN. Copies of a few of the documents that are necessary as references for the safety evaluation had been requested by the staff. The TVA staff committed to transmit them within a week.

Upon review of these documents, the Civil Engineering and Geosciences Branch will provide an input to the Plant Systems Branch safety evaluation related to the adequacy of the Thermo-Lag fire barriers installed at WBN.

Principal contributors: Hans Ashar, Robert Rothman

Attachment 1

AGENDA
MEETING & WALKDOWN
SEISMIC ADEQUACY OF THERMO-LAG FIRE BARRIER

▪ Background, Objective	TVA, NRC	8:30a
▪ Discussion of Responses to NRC's RAI	NRC, TVA	9:00a
▪ Walkdown of T-Lag Installations	TVA, NRC	10:00a
▪ Lunch		12:00a
▪ Audit of Documents	NRC, TVA	1:00p

1. WGC-1-1742	Required Response Specta
2. WBN	T-Lag installation procedures (4 documents)
3. DS-C1.6.16	TVA's Civil-Engineering Standards
4. CSG-94-CN01	Supporting Calculations
5. 47W243	Relevant Set of Drawings
6. WCG-1-1751	Qualifications of Enclosure Configurations
7. Spec. N3C-941	Evaluations of Commodity Clearances
8. WB-DC-20-21.1	Calculations of Cable-Tray Supports
9. WB-DC-40-31.1	Calculations of Conduit Supports
10. CSG-CN-93-001	Variation in T-Lag Weight Calculations

▪ Relevant Discussions	NRC,TVA	4:00p
▪ Exit Remarks	NRC, TVA	5:00p

ATTENDANCE ROSTER
Page of

INTERVIEW TOPIC: Thermolag Seismic Test Audit - Audit of documents related to Thermolag Seismic Analysis.

DATE: April 11, 1995

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INTERVIEW TOPIC: THERMO-LAG SEISMIC TEST AUDIT

Attachment 3

(Audit of documents related to Thermo-Lag Seismic Test)

DATE: April 11, 1995

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