TVA

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

DEC 2 3 1994

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

Gentlemen:

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

WATTS BAR NUCLEAR PLANT (WBN) - RESPONSE TO NRC QUESTIONS REGARDING THE USE OF THERMO-LAG FIRE BARRIER SYSTEMS AT WBN (TAC M63648)

The purpose of this letter is to provide additional information in response to NRC questions that were discussed during an August 30, 1994, meeting between TVA and NRC regarding the use of Thermo-Lag fire retardant material at WBN. Specifically, the meeting was held to discuss ongoing TVA testing to determine ampacity derating factors when Thermo-Lag fire barrier systems are used. During the meeting, TVA agreed to provide additional information to address the following requests:

1. Provide a best estimate list of the non-standard power circuit raceway configurations expected to be protected by a Thermo-Lag fire barrier system.

2. Provide an explanation of why the non-standard configurations currently included in the WBN test program are appropriate for determining derating factors for the configurations expected to be used.

3. Explain what provisions were taken during the tests to ensure that the wall temperature did not differ significantly from the ambient air temperature which was maintained at $40°\pm2°C$, or provide an evaluation of the potential effects of variations in the wall temperature of test enclosures on the derating factors derived from tests.

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TVA's response to the staff's request is provided in the enclosure. It should be noted that TVA's response describes current plans for installing and testing Thermo-Lag. This response is provided to supply information about the design, testing, and installation, and should not be construed to contain commitments. The specific design, test, and installation procedures are available for NRC review. Accordingly, there are no commitments contained in this submittal. If you have any questions, please contact Mr. P. L. Pace at (615) 365-1824.

Sincerely,

Dwight E. Nunn
Vice President
New Plant Completion
Watts Bar Nuclear Plant

Enclosure
cc (Enclosure):

NRC Resident Inspector
Watts Bar Nuclear Plant
Rt. 2, Box 700
Spring City, Tennessee 37381

Mr. P. S. Tam, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

ENCLOSURE

ADDITIONAL INFORMATION REGARDING WBN AMPACITY
TESTING ASSOCIATED WITH USE THERMO-LAG FIRE BARRIERS

NRC REQUEST

Provide a best estimate list of the non-standard power circuit raceway configurations expected to be protected by a Thermo-Lag fire barrier system.

TVA RESPONSE

TVA does not yet know where the "non-standard" configurations (i.e., those that do not exactly match an approved, tested configuration) will be located in the plant. The location of "non-standard" configurations to be protected will not be known until immediately prior to each protected raceway's pre-construction walkdown. The pre-construction walkdowns will be ongoing during the installation of Thermo-Lag, which is expected to continue through early 1995.

The type of Thermo-Lag installation will be specified on a list which is developed as pre-construction walkdowns are conducted. The walkdowns are conducted by several individuals, including a knowledgeable engineer. The engineer determines the appropriate type of Thermo-Lag enclosure and specifies the correct configuration. If the installation does not match an approved, pre-existing configuration, a new design output document is generated. The design output document is approved in accordance with TVA design control practices, ensuring that each configuration design is bounded by an approved, tested configuration. TVA does not intend to separately track those configurations which can be considered to be "non-standard."

Expected cable tray and conduit configurations are described below. The final configuration details for each Thermo-Lag installation will be available on-site for review.

Standard Tray or Special Tray Fittings (Double Cross and "Tee")

- Tray with 5/8" Thermo-Lag
- Tray with cover and 5/8" Thermo-Lag
- Tray with extended cover (side rail clips) and 5/8" Thermo-Lag
- Tray with solid bottom[1] and 5/8" Thermo-Lag
- Tray with solid bottom[1], cover, and 5/8" Thermo-Lag
- Tray with solid bottom[1], extended cover (side rail clips), and 5/8" Thermo-Lag
- Boxed trays[2] with 5/8" Thermo-Lag

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[1] True solid bottom. Removable bottom covers will be removed before installing Thermo-Lag on power trays.

[2] A vertical stack of up to three trays or two side-by-side trays may be enclosed by a common box type fire barrier. One or two could be power trays.

Conduits

- Single conduit with 5/8" or (5/8" + 3/8") Thermo-Lag (depending upon conduit size)
- Two conduits wrapped together (encased in Thermo-Lag - no air spaces)
- Multiple conduits[3] within a 5/8" Thermo-Lag box

NRC REQUEST

Provide an explanation of why the non-standard configurations currently included in the WBN test program are appropriate for determining derating factors for the configurations expected to be used.

TVA'S RESPONSE

At the completion of the tests currently underway, TVA's ampacity correction factors (ACFs) will have been developed as a result of extensive programs conducted by both Texas Utilities (TU) and TVA at Omega Point Laboratories (OPL) in San Antonio, Texas, and by TVA at its own Central Laboratories Services Department (CLSD) laboratories in Chattanooga, Tennessee. The ACFs used by TVA for individually wrapped open-top ladder trays and wrapped air drops is based on the results of the TU-sponsored tests. The ACFs used by TVA for individually wrapped conduits are based on the results of the CLSD tests.

The results of the TU tray tests are also being used to represent the common enclosure of trays which are horizontally adjacent (i.e., run side-by-side). This arrangement is consistent with the Stolpe model on which tray ampacities (given in ICEA P-54-440) are derived. The model considers that heat is dissipated out the top and bottom surfaces only (and not out the sides). The TU tests (which were performed on ladder-type trays) will also be used to represent solid bottom trays. This application is conservative in that true solid bottom trays do not have an air gap between the cables and the Thermo-Lag barrier as a result of the presence of the tray rungs.

The TVA sponsored tests at OPL address the enclosure of ladder type trays over which a sheet steel cover has been applied prior to the application of any barrier material (test plan assembly 1). Those tests also include a vertical stack of trays within a common Thermo-Lag enclosure (assembly 3). The stack includes two power trays and one control tray, with the latter tray on the bottom. The ACF developed for the latter arrangement will also be used for cases where just the two power trays are in the common enclosure. The application of this ACF is conservative since the two tray arrangement affords more direct heat dissipation for the lower power tray than the tested three tray enclosure.

The test program includes assemblies to evaluate multiple conduits encased within common Thermo-Lag panel enclosures. Two types of Thermo-Lag panel enclosures are used: 1) flat panels mounted directly on the surface of the conduits with no intentional peripheral air gap, and 2) flat panels attached to a Unistrut frame installed around (but not touching) the conduits. The

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[3] Two or more conduits within a common fire barrier; maximum number is expected to be no more than 6; arrangement is unknown. Concrete walls or ceiling may provide one or two sides of the Thermo-Lag box.

first type will be used on three- and four-sided boxes. The second type will be used where the conduits to be protected are routed such that only two sides of the box will be protected by Thermo-Lag. For both types of enclosures, the sides not protected by Thermo-Lag will be a concrete wall or ceiling. As discussed during the TVA/NRC meeting, the substantial heat capacity of the concrete and rebar, coupled with its low thermal resistivity compared to Thermo-Lag, ensures that two- and three-sided enclosures are not limiting. Therefore, the four-sided assemblies used during testing are conservative.

There is no specific guidance in P-848 for the performance of testing when concrete walls form one or two sides of the enclosure. Thus, TVA identified the key parameters regarding such arrangements and selected the key variables in a manner to ensure conservative results. The key parameters are conduit size, number of conduits (and their arrangement into rows and/or columns), conduit spacing (where multiple conduits are used), and box size (in the case of two-sided boxes on Unistrut frames). The parameters are addressed for each construction type in the following manner:

1. Enclosures constructed of panels mounted directly to the conduit.

    a. The air gaps (between adjacent conduits) tend to vary in accordance with the enclosed conduit size. With small conduits, the correspondingly small air gaps result in the heat transfer across the gap being a function of radiation and conduction only, rather than a combination of radiation, convection and conduction. Thus, the ACF derived using "small" conduits would be conservative. In keeping with the P-848 philosophy, TVA uses 1" conduits since they are the smallest conduits in which power circuits are typically routed.

    b. For enclosures constructed of panels mounted directly to the conduit, the surface area is lowest for low numbers of small conduits. A single conduit would provide for the lowest surface area but does not include any internal air gap since TVA's method of application is to use preformed sections coated with trowel grade material. While a two conduit encasement would result in an air gap, each conduit has an adjacent "end wall" from which to radiate. Thus, a set of three conduits in a row provides the least surface area, while still including a conduit which is not adjacent to one of the enclosure end walls. Such an arrangement, using 1" conduits, has been included as assembly 4. When conduits are banked in multiple rows, an additional air gap occurs between the rows. In order to assess that effect, TVA has developed test assembly 5 to include a double row of three 1" conduits.

    The presence of multiple conduits in close proximity to one another (even without a barrier) results in mutual heating and the introduction of what Neher and McGrath described as an "interference temperature rise." This effect is typically accounted for through the use of a grouping factor, such as provided in P-46-426. The tendency of the effect to dominate the corrective factor when many conduits are wrapped together further contributed to TVA's decision to use small conduit banks (1x3 and 2x3) as described above.

c. A spacing between conduits of one-half their nominal diameter has been used. Lesser spacings would result in a greater interference temperature rise effect (as described above, these appear to minimize the effect of the barrier) and are not feasible below one-fourth of the nominal diameter because of the physical interference of couplings and supports and as a result of the need for tool clearances. Larger spacings would generally support individual wrapping of the conduits.

2. Enclosures constructed of panels mounted on a Unistrut frame.

   a. In contrast to the boxes formed by Thermo-Lag panels in direct contact with multiple conduits (which were necessary to assess the resultant dead air spaces between conduits), panels mounted on a Unistrut frame potentially results in a large gap between the conduit surface and the inner wall of the panels. Free air exchange will exist between that larger space and the small conduit-to-conduit gaps, rendering the latter insignificant. Tests to assess the effect of the large gap and the Thermo-Lag enclosure will be conducted using a single conduit, thus avoiding the concern for "interference temperature rise" mentioned above.

   b. Tests are being conducted using 1" conduits, given that its thermal resistance to the surrounding air is higher than that of a 4" (due to the smaller surface area of the former). As noted earlier, this is the smallest size conduit in which power circuits are typically routed.

   c. For a given size conduit, the minimum box size (and therefore the minimum air gap thickness) is established by the diameter of the conduit, the thickness of the Unistrut, and the gap between the conduit and the Unistrut. For a single 1" conduit with Thermo-Lag mounted over 1.625" P1000 Unistrut, the smallest possible box would be approximately 4.75" x 4.75" (as measured over the Unistrut).

   In order to assess the effect of large enclosures, with their correspondingly large air gaps, the same cable and conduit set are being tested within a 30" x 30" enclosure.

   The ACF applied at WBN will be the most conservative of the two determined by the above tests, after adjustment for the appropriate grouping factor. Consistent with IEEE P-848, both assemblies will be 12' in length.

NRC REQUEST

Explain what provisions were taken during the tests to ensure that the wall temperature did not differ significantly from the ambient air temperature which was maintained at 40°±2°C, or provide an evaluation of the potential effects of variations in the wall temperature of test enclosures on the derating factors derived from tests.

TVA'S RESPONSE

TVA did not take any special provisions to monitor wall temperature or ensure that wall temperature did not differ significantly from the ambient air temperature. In this regard, TVA followed the guidance of P-848, which does not require maintenance or measurement of the enclosure wall temperature. Also, TVA is not aware that potential wall temperature variation effects have been monitored or evaluated during any previous ampacity tests (including those unrelated to Appendix R).

TVA believes that the effect of wall temperature variations has been minimized where the test enclosures have been fabricated using a good insulating material and the room ambient temperature has been maintained for a substantial period of time. Under these conditions, TVA considers that any minimal wall temperature variations during testing will have no significant impact on the test results.

The TVA ampacity tests at CLSD utilized an enclosure (8' wide by 8' high by 28' long) fabricated from two layers of a foil-backed 3/4" thick Celotex "Tough-R" insulating sheathing placed over 2" by 4" studs (which did not breach the enclosure). The presence of the foil, with its low emissivity, minimizes the transfer of radiant energy between the test specimen and the enclosure. Due to the extensive nature of the sequentially-performed TVA test program (multiple thicknesses of TSI, 1" and 4" specimens, multiple baseline conduits and multiple conductor arrangements), ambient temperature would have been maintained for weeks, ensuring that the wall temperatures were in equilibrium with the ambient temperature.

The test enclosure currently in use at OPL (which is approximately 19' long by 19' wide and 12' high) has two walls which are fabricated using 1-1/2" extruded polystyrene insulating boards ("Styrofoam" manufactured by Dow) applied over conventional metal studs (which do not breach the insulation). The remaining two walls, which are a permanent part of the OPL facility's climate-controlled "conditioning room," are insulated with 6" of fiberglass and covered with sheetrock. The test facilities are climate-controlled and do not undergo significant temperature variations, ensuring that the wall temperatures were in equilibrium with the ambient temperature.

In order to provide supporting data, TVA has been measuring test enclosure wall temperatures during ampacity tests performed since the August 30, 1994, TVA/NRC meeting. Surface temperature measurements are being taken on the wall near both ends of the test specimen and near its mid-point. A review of the data taken to date shows that the average wall temperature variation during testing is insignificant (e.g., temperatures taken during the final hour of the baseline runs for a one-inch, three-hour conduit test was within 1/2°C of the average ambient temperature). TVA considers that such minor temperature differences are of minimal impact on the measured ACF and that the magnitude of the impact is insignificant.