December 1, 1995

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

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION - INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS - SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 (TAC NOS. M83674 AND M83675)

Dear Mr. Kingsley:

Based on our ongoing review of the Sequoyah Individual Plant Examination of External Events (IPEEE) submittals dated December 23, 1991, September 18, 1992, and June 29, 1995, and associated documentation, we have developed the attached request for additional information (RAI). The RAI is related to the external events analysis in the IPEEE, including the seismic analysis, the fire analysis, and the analysis of effects of high winds, floods, and others. It was developed by our contractor, Energy Research, Inc., and reviewed by the "Senior Review Board" (SRB). The SRB is composed of personnel from the Offices of Research and Nuclear Reactor Regulation, and consultants (Sandia National Laboratory) with probabilistic risk assessment expertise for external events.

We request that you provide your response to the questions contained in the RAI within 120 days.

Sincerely,

Original signed by

David E. LaBarge, Sr. Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket Nos. 50-327 and 50-328

Enclosure: Request for Additional Information

cc w/enclosure: See next page

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SEQUOYAH NUCLEAR PLANT

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REQUEST FOR ADDITIONAL INFORMATION

INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2

I. Seismic

1. NUREG-1407, page 11, states that the seismic margin evaluation should utilize the NUREG/CR-0098 median rock or soil spectrum anchored at 0.3g or 0.5g, depending on the g-level and the primary condition at the site. It further states that the ground motion should be considered at the surface in the free field. Additionally, if secondary conditions such as shallow soil conditions are being considered, appropriate procedures should be used to determine the free-field motion in the vicinity of those affected structures, and the capacity evaluation should take into account the effects of soil-structure interaction. Inasmuch as SQN is a predominately rock site, with most safety related structures founded on rock, it should have used 0.3g specified at the rock outcrop instead of at the top of the soil. The method used, which resulted in 0.3g at the soil surface, effectively reanalyzed the plant at the SSE ground motion, which is inconsistent with the intent of the IPEEE program. Discuss the impact on results and insights if the analysis were performed in accordance with NUREG-1407 (i.e., 0.3g at the rock outcrop).

2. NUREG-1407 (Section 3.2.5.8, page 14) suggests that human actions are to be clearly identified and that the seismic IPEEE assessment assure that they are low enough in probability so that they do not compromise the seismic margins. Typically, some of the more risk significant human actions for an ice condenser plant include (among others): connect ERCW as an auxiliary feedwater source, feed and bleed, RCS cooldown and depressurization following LOCA, reduce containment spray pump flow, room cooling recovery, and establish cold leg recirculation. The statements that all paths are twofold redundant, written procedures provide guidance, and technical specifications exist, do not provide assurance that human actions can be accomplished after a seismic margin earthquake (SME) and that success paths will be available after an SME. Provide a list of human actions required for the safe shutdown path and the plant locations at which these actions will be performed.

3. The submittal lists walkdown anomalies (pages 3-7 through 3-11) which are a compilation of "unsatisfied caveats" in the screening and evaluation worksheets (SEWS). The categories of these anomalies include: potential functional failures, inadequate anchorage and load path, Category II to I proximity issues, and inadequate clearance. The submittal noted these items were addressed by means of maintenance or work requests. It is not clear, however, if the equipment capacity assessments used the as-found condition, or the prospective fixed condition, when screening out and evaluating equipment. Describe how the walkdown, screening, and seismic margins assessment accounted for the anomalous conditions of the equipment listed on Pages 3-7 through 3-11 of the submittal.

ENCLOSURE

4. The submittal states that a relay may be considered non-essential (i.e., pre-screened) if it does not prevent success of the associated desired function and does not cause the occurrence of an undesired event. The example is cited that battery chargers and associated relays are not essential because ample residual capacity is available to start diesels. However, once diesels are operating, battery chargers are essential to maintaining DC power for the full 72 hour success criterion. Provide an assessment of the need for battery chargers for the success paths over 72 hours and, if found to be needed, provide the HCLPF of battery chargers and an assessment of the adequacy of the associated relays.

5. Page 4-79 of the submittal states that fires in the turbine building indirectly affect auxiliary feedwater. The auxiliary feedwater system is one of the safe shutdown systems, yet the effect of turbine building structural or masonry wall seismic failures on auxiliary feedwater (or any other system) were not evident from the submittal. Provide an explanation of how turbine building failures could affect the auxiliary feedwater system. If the effect could be significant, then provide the turbine building failure modes, locations, and screening results or HCLPFs.

6. Provide walkdown notes and fragility calculations notes (as applicable) for the following components: ice condenser, auxiliary building roof diaphragm, ERCW MCC anchorage, lowest capacity masonry block wall affecting safe shutdown equipment list components, and RWST.

II. Fire

1. The control room was screened out using the qualitative argument that it is continuously occupied, the transient combustible control program is effective, combustibles are separated from ignition sources and restrained from falling onto cabinets, and unit shutdown is available from the alternate shutdown panel. This is considered to be an insufficient basis to screen out the control room. The ability to suppress a fire and achieve safe shutdown from another location does not mean that it will certainly be done. For example, the argument ignores the potential effects of cabinet-initiated fires, which are an important fire source in the control room, that might force a control room evacuation. In all fire PRAs, in which the frequency of cabinet fires, the potential for suppression, and the conditional probability of successful operator actions and remaining equipment for a realistic selection of scenarios are analyzed in detail, the control room emerges as a significant contributor to the overall core damage frequency.

   Describe the change in the screening status of the control room and the total estimated core damage frequency of unscreened compartments owing to quantitative analysis of the following: (1) frequency of cabinet fires, (2) probability of control room evacuation, (3) the probability of non-suppression, and (4) the conditional probability of safe shutdown, including hardware and operator actions within and outside of the control room. Identify and describe vulnerabilities that may emerge from these considerations.

2. The relay room is separated from the cable spreading room in Sequoyah. Because the cable spreading room has no cabinets, it was understandably screened out. However, the fire frequency of the relay room (which contains cabinets) was also screened out on the basis of a fire initiator frequency being low in comparison with other similar plants and with what would be expected from the FIVE database used in this study. Furthermore, the manual suppression failure probability of 0.1 was justified on the basis that this room is continuously manned. It is not typical for a relay room to be continuously manned. Given the numerous potential scenarios that can occur owing to relay room fires, the conditional core damage frequency of approximately 1×10^{-3} appears low in comparison to comparable rooms, such as the 125V Battery Board Room.

   Provide a description of analyses performed for the relay room that shows the following: (1) derivation of the fire frequency, with consideration of all fire sources in the compartment; (2) fraction of time the relay room is manned, the fire protection training of those occupying the room, the fire protection equipment available within the room, and the fire brigade response time for that room; and (3) derivation of the conditional core damage frequency that accounts for all sources and scenarios in the relay room, including the potential for abandonment and use of the Auxiliary Shutdown Panel.

3. The separation of Thermo-Lag wrapped cables into a separate, virtual compartment, in effect, assumes that the wrap is effective in precluding fire damage of the cable from any fire in the original compartment. A fire in the original compartment, therefore, is treated as not being able to damage wrapped cables within it no matter where the source fire is. This assumption is contrary to FIVE guidance which suggests that 1 hour fire barriers are not to define the boundaries of compartments. Therefore, this assumption is not considered to be an acceptable approach. Furthermore, the basis for the extremely low fire initiator frequency assigned to each wrapped cable (3.1×10^{-7} per year) was not stated in the submittal. Other studies allow damage to occur to these cables if a fire propagation analysis concludes that the cable damage criterion has been reached. The concern is that the assumption of isolation of Thermo-Lag wrapped cables coupled with the low assigned fire initiator frequency has understated the fire risk associated with compartments that contain these cables.

   Describe the change in the list of screened and unscreened compartments, and the change in the estimated core damage frequency of unscreened compartments, obtained from consideration of an approach that considers fire propagation from nearby sources (e.g., transformers, transient combustibles) to wrapped cable. Identify and describe vulnerabilities that may emerge from this consideration.

4. The FIVE methodology requires an estimate of the Critical Combustible Loading that would be necessary for a target/source combination to exceed the damage threshold of the target. If a Critical Combustible Loading is present, then a time to damage, t_{crit}, is calculated. The

probability of non-suppression depends on the relationship between t_{crit} and the time demonstrated for automatic and/or manual suppression. The Sequoyah fire study employed a simplification of the FIVE method in that it did not base its manual and automatic non-suppression probability estimates on the calculation of a Critical Combustible Loading. Instead, it assumed blanket screening values for non-suppression probability. The study claimed that the use of a 0.3 screening value for manual non-suppression in untended rooms is conservative. Plant fire drill data, shown in submittal Tables 4.9-1 and 4.9-2, indicates that 0.3 corresponds to the likelihood of the fire brigade failing to arrive at the scene within 10 minutes after detection. A true suppression time that includes detection and extinguishment is not provided. The value of 0.3, therefore, is clearly not conservative for those compartments (at least 30% of them) for which the total suppression time exceeds ten minutes. The treatment of automatic suppression also underestimates the potential for fire damage because it assumes that the detectors are well placed and detection time is zero. The automatic suppression unavailability used in the submittal assumes full compliance with NFPA standards. Such compliance has not been demonstrated for Sequoyah. The failure of automatic suppression, employed in the study, is simply the system unavailability.

Describe the change in the list of screened and unscreened compartments, and the change in the estimated core damage frequency of unscreened compartments, obtained from consideration of either: (1) use of compartment-by-compartment suppression probabilities that take into account the competition between fire growth and manual and/or automatic suppression response times, or (2) use of a blanket non-suppression probability that is clearly conservative for all compartments. Identify and describe vulnerabilities that may emerge from these considerations.

5. Table 4.9-2 (which appears to use Table 4.9-1) is not a valid analysis. First, the analysis does not use a sufficiently large or diverse sample of plant locations. Second, the non-suppression probability reaches zero at 30 minutes (which is an insufficient duration). Third, the analysis does not include the detection and suppression times (after arrival). Describe the effect on compartment screening, CDF, and vulnerabilities using a statistical approach that does not have these shortcomings. Consider the modified approach when responding to Question (4).

6. The initiating events and systemic or functional sequences identified for each fire source location in a compartment are crucial to the evaluation of conditional core damage probability. The selection influences both the complement of equipment and the human actions that are assumed to be required to prevent core damage. A review of the reasonableness of the quantitative screening calculations in the Sequoyah fire IPEEE cannot be made because initiating events, accident sequences, a list of analytical assumptions, sources of uncertainties, the functional/systemic event trees associated with fire-initiated sequences, and human actions have not been provided in accordance with NUREG-1407, page C-4, Items 9, 10, and 11.

Provide the following for each unscreened compartment: (1) the initiating events analyzed, (2) the accident sequences and a word description of the accident sequences that does not rely upon knowledge of the top event identifiers in the event trees, (3) a list of key analytical assumptions used in the development of the conditional probability of core damage, (4) the functional or systemic event trees used in the fire analysis with a description of the top events, and (5) the key human actions of each sequence. Also, provide a general description of the sources of uncertainty in the fire IPEEE.

7. The potential for fires to induce a small LOCA was not mentioned in the submittal. In particular, it is not clear how the potential for the fire-induced opening of pressurizer PORVs, or how seal LOCAs derived from loss of seal injection and cooling, were treated. In addition, the submittal states that pressurizer PORVs were walked down to determine if a potential fire could affect them. However, the results or insights of this walkdown were not provided in the submittal. If the potential for fires to induce LOCAs was considered, provide a list of compartments and fire scenarios that included fire-induced LOCAs. If fire-induced LOCAs were not considered, describe the change in the list of screened and unscreened compartments, and the change in the estimated core damage of unscreened compartments, obtained from consideration of fire-induced LOCAs. Also provide the results of the pressurizer PORV walkdown.

8. The study used three methods to obtain the conditional probability of core damage given a fire. Two were based on the IPE event tree/fault tree models, and one was based on a Risk Achievement Worth model. None of the methods were explained as requested in NUREG-1407, Page C-4, Items 7 and 9. Describe each method, including assumptions, and provide example applications of each method for the following zones:

· 6.9 kV Shutdown Board Rooms	734-A02FS1
· Heating and Ventilation	714-A03FS2
· Relay Room	732-C13

Also include the following information for each of the above zones: (a) list of components and systems affected by the fire, and (b) other components and systems that are failed in the assessment of core damage.

9. The effect of fires on failure of decay heat removal, per USI A-45, does not appear to have been addressed in an analytical manner. For example, some IPEEEs have performed a risk assessment resulting in a core damage frequency for fire-induced loss of decay heat removal scenarios. Other IPEEEs have explicitly reviewed the IPE models for loss of decay heat removal to determine the effect of fire on decay heat removal availability. Provide an explanation and the analytical basis for the statement on Page 4-91 that no significant findings were identified that impact the decay heat removal system at Sequoyah. The explanation should include the following: (1) the compartments that contain decay heat removal systems, and their support systems, as identified in Section 3.4.4 of the Sequoyah IPE, (2) the potential of fire-induced damage of decay heat removal systems in these compartments, (3) the

scenarios (with descriptive text) in each of the identified compartments that include decay heat removal systems, and (4) the fraction of fire-induced core damage frequency associated with loss of decay heat removal equipment or a similar measure of the importance of the effect of fire on decay heat removal equipment.

10. The study assumes that passive fire-barrier elements (e.g., walls, floors, ceilings, and penetration seals) are 100% reliable. Such an analysis is not valid unless the assumption is adequately justified and it can be demonstrated that there are no paths through the barrier for the spread of damage. Provide such justification and demonstration for high-hazard fire areas, such as: the turbine building, diesel generator rooms, cable spreading rooms, switchgear rooms, and lube oil storage areas.

11. The fire compartment interaction analysis (FCIA) is based on the assumption that fire barriers are effective as rated. For active fire barriers (e.g., a normally open fire door that gets closed by fusible link), the failure probability can be significantly high. Provide a list of compartments with active fire barriers, a description of the active barriers, and a discussion regarding qualitative screening of these (and their adjacent) compartments.

12. The submittal states that some mercoid switches remain at the plant. One aspect of the seismic-fire interaction issue is the potential for CO_2 system controller low-ruggedness mercoid slave relays to trip diesel generators or isolate room cooling. The submittal discussion did not address this aspect of the issue. Provide the location and identify the function of the mercoid relays and an assessment of the potential interactions caused by seismic activation of these mercoid relays.