Mr. C. Randy Hutchinson
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1448 S. R. 333
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April 3, 1998

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION PERTAINING TO INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS (IPEEE) FOR ARKANSAS NUCLEAR ONE, UNITS 1 AND 2 (TAC NOS. M83588 AND M83589)

Dear Mr. Hutchinson:

This is a request for additional information pertaining to the Individual Plant Examination of External Events (IPEEE) submitted for Arkansas Nuclear One, Units 1 and 2. The staff's questions on this matter are enclosed. Please contact me if you have any questions regarding this request for information.

Sincerely,

ORIGINAL SIGNED BY:
William Reckley, Project Manager
Project Directorate IV-1
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-313 and 50-368

Enclosure: Request for Additional Information

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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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ARKANSAS NUCLEAR ONE

Request For Additional Information on IPEEE Submittal

Seismic

(RAIs 1, 2 and 3 apply to both ANO IPEEE submittals for units 1 and 2 while RAI 4 applies only to the Unit 2 submittal. However, if the responses to RAIs 1,2 or 3 differ for the two units, please explain these differences.)

1. Although a table is provided in the IPEEE submittals for the systems "selected for controlling safe shutdown systems" (Table 3.9-1), the submittals do not provide any discussion of the selected systems and the various operating modes of these systems required for a successful shutdown of the plant after a review level earthquake (RLE). Non-seismic failures and human action issues as described in NUREG-1407 are also not provided in sufficient detail. The discussions related to supporting systems are also very brief.

   (a) Please provide, as described in EPRI NP-6041, two plant specific success path logic diagrams (SPLDs) - one for transients wherein the reactor coolant system pressure boundary is intact and the other for a seismically induced small LOCA. Please discuss in some detail the systems and the operating modes of these systems used in the SPLDs. Please include in the discussion the requirement on the recirculation modes of operation of the ECCS and the ways these are met at ANO, and any requirements for feed-and-bleed cooling (or once through cooling) in the success paths. Please identify the needed human actions, including consideration of their failure probabilities, in the selection of the success paths.

   (b) Please address the non-seismic failure issue as described in NUREG-1407. Please include in the discussion the reliance on the turbine-driven emergency feedwater (EFW) system for decay heat removal. The non-seismic failure issue is important if single train systems with recognized poor availability are used in a success path (e.g., the turbine-driven EFW pump is used in one of the selected success paths).

   (c) For the Service Water System the submittals state that "The system takes suction from Lake Dardanelle." Please discuss the effects of an RLE on the availability of the service water system. Please include in the discussion the effects of the RLE on the availability of the lake water (e.g., the effect of the RLE on the dam).

   According to the IPE submittal, the Service Water System can also take suction from the Emergency Cooling Pond. Please discuss whether this water source is considered in the IPEEEs, and if it is, then discuss the operator actions involved and, if the pond is shared by the both units at the site, the multi-unit effect on the capability of the pond (e.g., heat capacity of the pond).

Please describe any differences in the Service Water Systems of the two units which could impact the IPEEE analyses, such as their ability to take suction from Lake Dardanelle in case of dam failure.

(d) Please provide the dependency matrix for the systems used in the success paths and include a description of the support systems listed in the dependency matrix.

2. As stated in both submittals, some steps in the emergency operating procedures (EOPs) were credited if the task could be accomplished using remote or local manual operation. Please identify the EOP steps that involve local manual operation. Please identify and discuss the locations of and the timing allowed for these actions, and provide an assessment of the success rate of these actions (taking into consideration the RLE conditions).

3. As indicated in the ANO IPEEE submittals, a significant number of outliers were identified during the combined IPEEE/USI A-46 seismic walkdown and evaluation effort. Tables 1-2 and 7-1 summarize the "Major Findings" and "Opportunities for Plant Improvements," respectively.

Table 3.5-1 lists the high confidence of low probability of failure (HCLPF) capacity of emergency diesel fuel tanks T-57A and T-57B (2T-57A and 2T-57B for Unit 2) as 0.2g. These tanks control the plant HCLPF capacity and are identified as "Opportunities for Plant Improvement" in Table 7-1.

Please provide an update on the status of the resolution of all outliers, including any plant modifications which have been implemented; any additional plant modifications which are currently scheduled (include implementation schedule); other outlier resolutions and their basis (e.g., structural analysis, systems analysis, etc.); and any currently unresolved outliers. For currently unresolved outliers, please identify the plan and schedule for resolution.

Please update the plant HCLPF capacity to reflect efforts to date to resolve the outliers, and also estimate the plant HCLPF capacity after completion of all planned outlier resolution activities.

4. Please clarify the following items related to the selection of components on the safe shutdown equipment list (SSEL) *(Regarding Unit 2 only)*:

(a) According to the IPE submittal section entitled Success Criteria and Major Assumptions for the Emergency Feedwater (EFW) System, "Operation of the solenoid bypass valve 2SV-0205 is assumed to be required for successful operation of the 2P7A turbine.......Room cooling is assumed to be required for successful operation of either EFW pump. The SW supply valves 2CV-1529-1 and 2CV-1532-1 must open and remain open and the fans 2VUC-6A and 2VUC-6B must start and remain running." Although the fans, 2VUC-6A and 2VUC-6B, are included in the SSEL, the valves mentioned above are not. Please discuss the reasons for not including these valves in the SSEL. Also, discuss the effects of the much longer mission time for IPEEE (than for IPE) on the requirement of pump room cooling and thus the selection of the SSEL.

(b) The ECCS pumps take suction from the refueling water tank (RWT) in the injection mode. There are two RWT discharge valves for the two trains of the ECCS systems, 2CV-5630-1 and 2CV-5631-2. Please discuss why the valve for Train B (2CV-5631-2) is not included in the SSEL while the valve for Train A (2CV-5630-1) is included in the SSEL.

(c) The injection valves for the two high pressure injection (HPI) trains are 2CV-5103-1 and 2CV-5104-2 (for Train A and Train B, respectively). Although the pumps for both trains (2P-89A and 2P-89B) are included in the SSEL, only the injection valve for Train A (2CV-5013-1) is included in the SSEL. Please discuss the effect of the valve on the various operating modes of the system and the reason for not including the valve for Train B (2CV-5014-2) in the SSEL.

Fire

1. It is important that human error probabilities (HEPs) associated with plant recovery actions used in the screening phase of the fire analysis properly reflect the potential effects of fire (e.g. smoke, heat, loss of lighting, etc.). HEPs that are appropriate with respect to internal events may not be appropriate in the context of a given fire scenario. For example, certain recovery actions credited in the internal events analysis may not be possible or credible given certain fires if the action requires access to or passage through the impacted fire area. Such actions should not be credited in the analysis. Also, the likelihood of human error will increase under fire conditions due to increased stress levels, loss of visibility due to smoke, and/or degraded communications.

   Please identify any areas that were screened out of the fire analysis for which the screening assessment included one or more HEPs. For each such area discuss how the effects of fire were considered in the development of the HEPs used in the screening analysis. If fire effects were not considered, then please reassess the contribution of these areas to plant fire risk when the impact of fire on HEPs is included. Given this reassessment, identify any plant areas that would have survived the screening process given modified HEPs and provide an assessment of the contribution of these areas to the plant CDF.

2. NUREG-1407, Section 4.2 and Appendix C, and GL 88-20, Supplement 4, request that documentation be submitted with the IPEEE submittal with regard to the Fire Risk Scoping Study (FRSS) issues, including the basis and assumptions used to address these issues, and a discussion of the findings and conclusions. NUREG-1407 also requests that evaluation results and potential improvements be specifically highlighted. Control system interactions involving a combination of fire-induced failures and high probability random equipment failures were identified in the FRSS as potential contributors to fire risk.

   The issue of control systems interactions is associated primarily with the potential that a fire in the plant (e.g., the main control room [MCR]) might lead to potential control systems vulnerabilities. Given a fire in the plant, the likely sources of control systems interactions could happen between the control room, the remote shutdown panel, and shutdown systems. Specific areas that have been identified as requiring attention in the resolution of this issue include:

   (a) Electrical independence of the remote shutdown control systems: The primary concern of control systems interactions occurs at plants that do not provide independent remote shutdown control systems. The electrical independence of the remote shutdown panel and the evaluation of the level of indication and control of remote shutdown control and monitoring circuits need to be assessed.

   (b) Loss of control equipment or power before transfer: The potential for loss of control power for certain control circuits as a result of hot shorts and/or blown fuses before transferring control from the MCR to remote shutdown locations needs to be assessed.

(c) Spurious actuation of components leading to component damage, loss-of-coolant accident (LOCA), or interfacing systems LOCA: The spurious actuation of one or more safety-related to safe-shutdown-related components as a result of fire-induced cable faults, hot shorts, or component failures leading to component damage, LOCA, or interfacing systems LOCA, prior to taking control from the remote shutdown panel, needs to be assessed. This assessment also needs to include the spurious starting and running of pumps as well as the spurious repositioning of valves.

(d) Total loss of system function: The potential for total loss of system function as a result of fire-induced redundant component failures or electrical distribution system (power source) failure needs to be addressed.

Please describe your remote shutdown capability, including the nature and location of the shutdown station(s), as well as the types of control actions which can be taken from the remote panel(s). Describe how your procedures provide for transfer of control to the remote station(s). Provide an evaluation of whether loss of control power due to hot shorts and/or blown fuses could occur prior to transferring control to the remote shutdown location and identify the risk contribution of these types of failures (if these failures are screened, please provide the basis for the screening). Finally, provide an evaluation of whether spurious actuation of components as a result of fire-induced cable faults, hot shorts, or component failures could lead to component damage, a LOCA, or an interfacing systems LOCA prior to taking control from the remote shutdown panel (considering both spurious starting and running of pumps as well as the spurious repositioning of valves).

3. In the EPRI Fire PRA Implementation Guide, test results for the control cabinet heat release rates have been misinterpreted and have been inappropriately extrapolated. Cabinet heat release rates as low as 65 Btu/sec are used in the Guide. In contrast, experimental work has developed heat release rates ranging from 23 to 1171 Btu/sec.

Considering the range of heat release rates that could be applicable to different control cabinet fires, and to ensure that cabinet fire areas are not prematurely screened out of the analysis, a heat release rate in the mid-range of the currently available experimental data (e.g., 550 Btu/sec) should be used for the analysis.

Discuss the heat release rates used in your assessment of control cabinet fires. Please provide a discussion of changes in the IPEEE fire assessment results if it is assumed that the heat release from a cabinet fire is increased to 550 Btu/sec.

4. The heat loss factor is defined as the fraction of energy released by a fire that is transferred to the enclosure boundaries. This is a key parameter in the prediction of component damage, as it determines the amount of heat available to the hot gas layer. In Fire-Induced Vulnerability Evaluation (FIVE), the heat loss factor is modeled as inversely related to the amount of heat required to cause a given temperature rise. Thus, for example, a larger heat loss factor means that a larger amount of heat (due to

a more severe fire, a longer burning time, or both) is needed to cause a given temperature rise. It can be seen that if the value assumed for the heat loss factor is unrealistically high, fire scenarios can be improperly screened out. Figure A.1 provides a representative example of how hot gas layer temperature predictions can change assuming different heat loss factors. Note that: 1) the curves are computed for a 1000 kW fire in a 10m x 5m x 4m compartment with a forced ventilation rate of 1130 cfm; 2) the FIVE-recommended damage temperature for qualified cable is 700°F for qualified cable and 450°F for unqualified cable; and, 3) the SFPE curve in the figure is generated from a correlation provided in the Society for Fire Protection Engineers Handbook [A.1].

Based on evidence provided by a 1982 paper by Cooper et al. [A.2], the EPRI Fire PRA Implementation Guide recommends a heat loss factor of 0.94 for fires with durations greater than five minutes and 0.85 for "exposure fires away from a wall and quickly developing hot gas layers." However, as a general statement, this appears to be a misinterpretation of the results. Reference [A.2], which documents the results of multi-compartment fire experiments, states that the higher heat loss factors are associated with the movement of the hot gas layer from the burning compartment to adjacent, cooler compartments. Earlier in the experiments, where the hot gas layer is limited to the burning compartment, Reference [A.2] reports much lower heat loss factors (on the order of 0.51 to 0.74). These lower heat loss factors are more appropriate when analyzing a single compartment fire. In summary, (a) hot gas layer predictions are very sensitive to the assumed value of the heat loss factor; and (b) large heat loss factors cannot be justified for single-room scenarios based on the information referenced in the EPRI Fire PRA Implementation Guide.

For each scenario where the hot gas layer temperature was calculated, please specify the heat loss factor used in the analysis. The EPRI FIVE methodology, which was accepted by the USNRC for use in the IPEEE assessments, recommended the use of 0.7 for the heat loss factor (see FIVE Section 10.4, page 10.4-21). For any fire scenario frequency estimates if the analysis is performed consistent with the FIVE methodology that used a heat loss factor larger than 0.7, please assess the impact on core damage frequency.

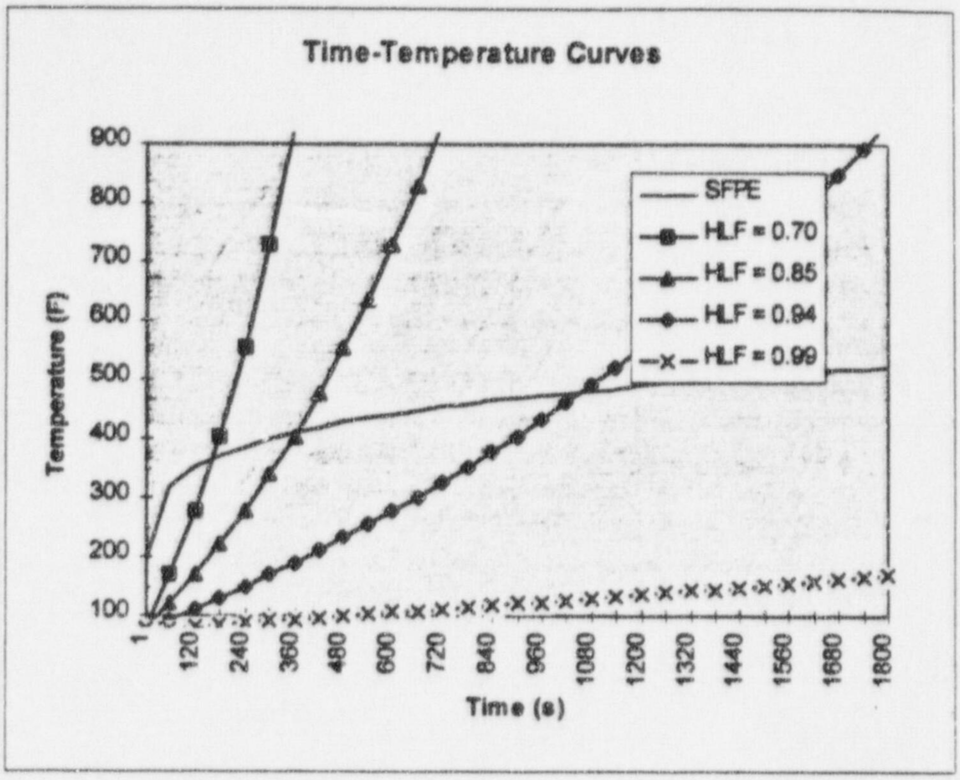

Figure A.1 Sensitivity of the hot gas layer temperature predictions to the assumed heat loss factor.

A.1 P.J. DiNenno, et al, eds., "SFPE Handbook of Fire Protection Engineering," 2nd Edition, National Fire Protection Association, p. 3-140, 1995

A.2 L. Y. Cooper, M. Harkleroad, J. Quintiere, W. Rinkinen, "An Experimental Study of Upper Hot Layer Stratification in Full-Scale Multiroom Fire Scenarios," ASME Journal of Heat Transfer, 104, 741-749, November 1982.

5. The submittal indicates that some fire areas contain elements of both units. For example, Fire Areas B and G appear to be shared by both units. For multi-unit sites, there are three issues of potential interest. Hence, please answer the following:

(a) A fire in a shared area might cause a simultaneous trip demand for more than one unit. This may considerably complicate the response of operators to the fire event, and may create conflicting demands on plant systems which are shared between units. Please provide the following information regarding this issue: (1) identify all fire areas that are shared between units and the potentially risk-important systems/components for each unit that are housed in each such area, (2) for each area identified in (1), provide an assessment of the associated multi-unit fire risk, (3) for the special case of control rooms sharing a common fire area, assess the likelihood of a fire or smoke-induced evacuation with subsequent shutdown of both units from remote shutdown panels, and (4) provide an assessment of the risk contribution of any such multi-unit scenario.

(b) At some sites, the safe shutdown path for a given unit may call for cross-connects to a sister unit in the event of certain fires. Hence, the fire analysis should include the unavailability of the cross-connected equipment due to outages at the sister unit (e.g., routine in-service maintenance outages and/or the potential that normally available equipment may be unavailable during extended or refueling outages at the sister unit). Please provide the following relevant information regarding this issue: (1) identify if any fire response safe shutdown procedures call for unit cross-connects, and (2) if any such cross-connects are called for, determine the impact on fire risk if the total unavailability of the sister unit equipment is included in the assessment.

(c) Propagation of fire, smoke, and suppressants between fire zones containing equipment for one unit to fire zones containing equipment for the other unit also can result in multi-unit scenarios. Hence, the fire assessment for each unit should include analyses of scenarios addressing propagation of smoke, fire and suppressants to and from fire zones containing equipment for the other unit. From the information in the submittal, it is not clear if these types of scenarios are possible. Please provide an assessment of the risk contribution of any such multi-unit scenarios.

6. The submittal assumes that safety-related equipment would not be damaged at room or target temperatures below 700° F. Fire test data published by Sandia in NUREG/CR-4596 and NUREG/CR-4310 indicate that many components have a lower temperature threshold for damage than the 700° F used for qualified cable. Sandia reports failure of relays at temperatures as low as 320° F. Please provide a technical basis for the selection of the temperature threshold or revise the analysis using the temperature of 425° F as specified in FIVE for unqualified cables.

7. Please provide a discussion of how transient fires were assessed in the IPEEE. Include in this discussion the basis for the selection of the transient modeled in each fire area. If the selection is not based on the plant's administrative controls, please revise the analysis to reflect the actual administrative limit.

8. The analysis states that all possible hot shorts were assumed to fail the component. No discussion of hot shorts that could result in a spurious operation of equipment that could affect safe shutdown capability was provided. Please provide the analysis to address spurious actuation of equipment due to hot shorts and the corresponding effect on safe shutdown capability.

9. The analysis assumes that the fire brigade responds and suppresses the fire in 10 minutes for all plant areas. This time appears overly optimistic. The time to effect manual suppression is not based solely on response time. The time required to suppress a fire can involve delays associated with detection time, response time of the fire brigade, size-up and assessment of the fire, time to don protective clothing, and time

for fire suppression. Based on industry historical performance, for most fires that require fire brigade interdiction, the time to provide effective suppression ranges from 30 minutes to several hours. Please revise the analysis for areas that credited manual suppression in 10 minutes to account for the distribution of possible suppression times, and provide a basis for this distribution.

10. Smoke can also cause misdirected manual suppression efforts and hamper the operator's ability to safely shut down the plant. This issue concerns the hampering effects of the potential buildup of smoke on the efforts of the manual fire brigade to promptly and effectively suppress fires. Sensitivity studies in the FRSS showed that prolonged fire-fighting times can lead to a noticeable increase in fire risk.

    Please describe your provisions for smoke control in the event of fires at your facility. For any fire scenario in which manual fire suppression efforts are credited in calculating core damage frequency, please describe how your analysis accounted for smoke control issues. For scenarios in which manual fire suppression is not credited in the analysis, please describe how your analysis evaluated the potential that additional component failures could be caused by misdirected manual fire suppression efforts.

11. The analysis credits a fire watch as a manual suppression system, and assumes it is as reliable as automatic suppression. However, no technical basis is provided for this assumption. The FIVE methodology specifies that the manual fire suppression unavailability ranges from 0.1 to 1.0, whereas the automatic suppression unavailability ranges from .02 to .05. Please revise the analysis using the appropriate values for manual suppression by the fire watch.

12. Several high hazard fire areas such as the clean and dirty lube oil storage tank room, turbine lube oil storage room, and diesel fuel oil storage rooms were screened based on ignition frequency and conditional core damage probability. These areas could present an exposure hazard to adjacent fire areas that contain safe shutdown equipment or cabling. Three-hour barriers may not be sufficient to ensure that fire does not propagate from these high hazard areas. Therefore, a detailed fire compartment interaction analysis is necessary to address these areas. Please provide a detailed fire compartment interaction analysis for the high fire hazard areas considering the potential for failure of active fire barrier components such as doors and dampers.