April 15, 1998

Mr. Lew W. Myers
Vice President - Nuclear, Perry
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P.O. Box 97, A200
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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING IPEEE SUBMITTAL - PERRY NUCLEAR POWER PLANT, UNIT NO. 1 (TAC NO. M83659)

Dear Mr. Myers:

The staff and its contractors have reviewed the Individual Plant Examination of External Events for Severe Accident Vulnerabilities (IPEEE) for the Perry Nuclear Power Plant, Unit No. 1. Based on our review, we have developed the enclosed requests for additional information (RAI). The RAIs are related to the seismic and fire analyses in the IPEEE. There are no RAIs for the review of high winds, flood, and other external events (HFO) in the IPEEE. The RAIs in the seismic area were developed by our contractor, Brookhaven National Laboratory, and the RAIs in the fire area were developed by our contractor, Sandia National Laboratories. All of the RAIs were reviewed by the "Senior Review Board" (SRB). The SRB is comprised of RES and NRR staff and RES consultants (Sandia National Laboratories) with probabilistic risk assessment expertise in external events.

In order to best accomodate the review schedules for both the staff and contractors, we request that you provide a response within 60 days of receipt of this letter

Sincerely,

Original signed by:

Douglas V. Pickett, Senior Project Manager
Project Directorate III-3
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-440
Enclosure: As stated
cc: See next page

DOCUMENT NAME: G:\PERRY\PER83659.RAI

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

April 15, 1998

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Centerior Service Company
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Request for Additional Information
Perry IPEEE

A. Seismic

1. The IPEEE submittal states that since flat-bottom metal fluid storage tanks were not included in the success paths, their seismic capacities were not evaluated by the Seismic Review Team. These tanks were only reviewed for possible rupture during an earthquake. To cope with seismic-induced flooding issues, the plant relies on dikes that surround these tanks to contain the fluids if the tanks do rupture. Since these dikes serve as the last barriers to contain fluids from flooding the plant safety equipment if a rupture occurs, it is important to quantify the seismic capacities of these dikes to resist a Review Level Earthquake (RLE).

   a. ***Please describe the functions for which these dikes were originally designed. Was their original purpose to contain fluid from the tanks, or was their primary function to act as protective barriers for the tanks?***

   b. ***Please also describe how the quantification of the seismic capacities of these dikes to resist an RLE was carried out, and provide the capacities.***

2. Nonseismic failures are not discussed in the IPEEE submittal. According to EPRI NP-6041, non-seismic-caused component or system unavailability should be evaluated for single-train systems with recognized poor availability. An example provided in EPRI NP-6041 is the use of both Reactor Core Isolation Cooling (RCIC) and High Pressure Coolant Injection (HPCI) for high pressure injection in a success path. However, in the Perry IPEEE, only High Pressure Core Spray (HPCS) is included in Success Path A for high pressure injection. This may not be consistent with the EPRI NP-6041 recommendations. According to the data presented in NUREG/CR-4550, the probabilities of nonseismic failures are very similar for a turbine-driven pump (used in RCIC and HPCI) and a diesel generator (used to provide electric power for HPCS).

   The reliability of the HPCS system at Perry is further affected by the performance of the low-ruggedness relays used in the HPCS diesel generator control circuitry. According to the IPEEE submittal, chatter of some of these relays in a review level earthquake (RLE) may result in a lock out of HPCS diesel generator operation or a trip of the HPCS 4.16 kV bus diesel generator breaker, and manual reset is subsequently required for HPCS recovery.

   a. ***Please describe how the nonseismic failure issue was treated in the Perry analysis, in keeping with the request in NUREG-1407, Section 3.2.5.8, which states that "success paths are chosen based on a screening criterion applied to nonseismic failures and needed human actions. It is important that the failure modes and human actions are clearly identified and have low enough probabilities to not affect the seismic margins evaluation."***

   b. ***Please describe in more detail the effect of nonseismic failure of the HPCS system on the seismic margins evaluation.***

   c. ***Please discuss the combined effect of nonseismic failure and relay chatter on the availability of the HPCS system in an RLE. Please include in the discussion a more detailed description of the procedures (e.g.,*** *whether procedures are in place and what they are), operator actions (in and out of control room operations), and operator availability for HPCS recovery after relay chatter. The time available for recovery actions and the effect of seismic conditions on operator actions need to be addressed in the discussion.*

3. Although many elements in the success paths require human actions, human actions are not discussed in the submittal. For example, containment venting is used in both success paths of the Perry IPEEE and is the sole source of containment overpressure protection for Success Path A. However, the human actions involved in containment venting and their failure probabilities are not discussed. Section 3.2.5.8 of NUREG-1407 requests that "human actions be clearly identified and have low enough probabilities to not affect the seismic margins evaluation."

   a. Please address human action issues related to the success paths in accord with the statements in NUREG-1407 cited above.

   b. Please describe the human actions involved in containment venting. Please include in the discussion the procedures used and detailed operator actions involved in the venting. The time available for operator actions and the effect of seismic conditions on operator actions need to be addressed in the discussion.

B. Fire

1. In Table 4-3 of the submittal, 18 fire areas are identified as not being screened out by the FIVE methodology Phase I and Phase II Step 2 screenings. However, fire area 1ABE which contains RHR Train A elements is missing from Table 4-10 which lists the fire areas which did not initially screen along with their screening and final fire induced CDFs.

   Please provide the results of the detailed analysis of fire area 1ABE and discuss its effect on CDF, including, in particular, whether the analysis showed that the area screened out or remained above the 10^{-6} screening value.

2. In general, credit was not taken for one-hour-rated raceway barriers, i.e., the ability of Thermo-Lag material to reduce temperatures or impede fire damage. However, in two fire compartments, DG1d and CC2/4, circuits from each of the Appendix R Safe Shutdown divisions pass through these areas. Credit was taken for a one-hour-rated raceway barrier for one of the divisions in one of the compartments.

   Please determine the conditional core damage probability (CCDP) if it is assumed that no Thermo-Lag is present in the subject compartments. Also, identify any other areas where Thermo-Lag was credited and the effect on CCDP if no credit is taken.

3. 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 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).

4. Fire severity factors were used for analyses involving pump motor and compressor fires apparently based on NSAC-178L. The severity factors were apparently used in scenarios involving compartments which contain such components. Some of the compartments which were analyzed in detail have automatic fire suppression systems. As a result, the severity factors could have been used where automatic fire suppression was also credited. Since the

potential for a large fire is dependent upon fire suppression, such cases would result in double counting suppression efforts.

> ***Please describe the fire scenarios in which automatic fire suppression was credited in conjunction with the fire severity factors used in the Perry fire assessment. For each case explain why such credit does not constitute double counting for suppression.***

5. The Perry Plant has an exemption for station transformers which are located less than 50 feet from the Turbine Building wall which has less than a three-hour fire rating. In addition, the area has no automatic fire suppression. This exemption was not discussed in the submittal nor analyzed in terms of a potential fire scenario. According to the submittal, the Turbine Building has a CCDP of 7.4×10^{-4}. Since FIVE specifies a fire ignition frequency for the transformer of 1.5×10^{-2}, it appears that the risk may be significant.

> ***Please assess the risk (CCDP) of a transformer fire that spreads after breaching the barrier separating the transformer and the Turbine Building.***

6. The probability of manual non-suppression for a Control Room fire which would result in critical component damage was based on the estimated time available for suppression and a model contained in Appendix J of the Fire PRA Implementation Guide. The unavailability value provided by the model could not be verified. Also, it was unclear how the value for the fire scenario which would require evacuation of the Control Room due to smoke was determined. This scenario was also based on an estimated available suppression time. This approach is not consistent with the FIVE methodology.

> ***Please describe the process and models used to obtain the non-suppression probabilities required for the analysis of Control Room fires. Compare the results to those which would have been obtained using the FIVE methodology.***

7. 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 being 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 R.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 [R1].

   Based on evidence provided by a 1982 paper by Cooper et al. [R2], 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 [R2], 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

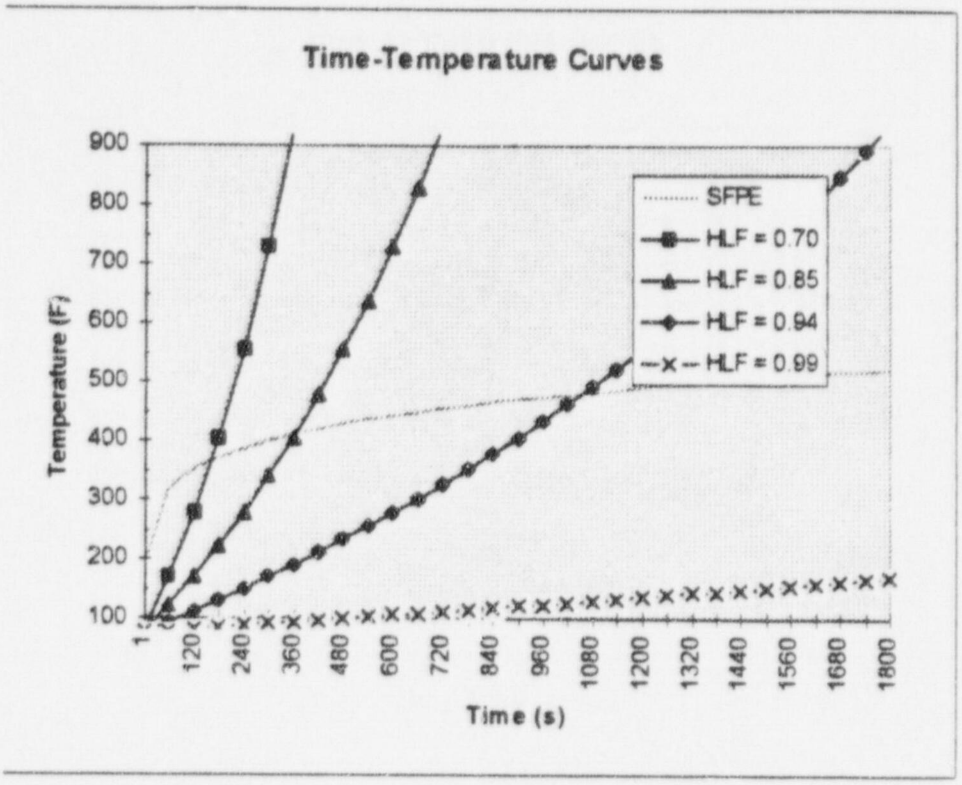

Figure R.1 Sensitivity of the hot gas layer temperature predictions to the assumed heat loss factor

from the burning compartment to adjacent, cooler compartments. Earlier in the experiments, where the hot gas layer is limited to the burning compartment, Reference [R2] 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*.

The Perry IPEEE fire study discusses heat loss factors only in conjunction with the detailed analysis of electrical cabinets in one fire compartment (1CC3a). No hot gas layer (HGL) temperature is estimated and HGL effects are apparently not considered important based on test data and referenced information that could not be verified. HGL effects were apparently also considered in other detailed compartment analyses.

For each scenario where the hot gas layer temperature was calculated, please specify the heat loss factor value used in the analysis. In light of the preceding discussion, please either: a) justify the value used and discuss its effect on the identification of fire vulnerabilities, or b) repeat the analysis using a more justifiable value and provide the resulting change in scenario contribution to core damage frequency.

References for Fire RAIs

R1. P.J. DiNenno, et al, eds., "SFPE Handbook of Fire Protection Engineering," 2nd Edition, National Fire Protection Association, p. 3-140, 1995.

R2. 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.

C. High winds, flood, and other external events

There are no RAIs in this area.