UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
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EA-03-016

DRAFT

Craig G. Anderson, Vice President,
Operations
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S.R. 333
Russellville, Arkansas 72801-0967

SUBJECT: ARKANSAS NUCLEAR ONE - NRC TRIENNIAL FIRE PROTECTION INSPECTION REPORT 50-313/01-06; 50-368/01-06 - PRELIMINARY GREATER THAN GREEN FINDING

Dear Mr. Anderson:

On August 20, 2001, the NRC issued the subject triennial fire protection report, which discussed a finding concerning the acceptability of your use of operator actions to remotely operate equipment necessary for achieving and maintaining hot shutdown, in lieu of providing protection to the cables associated with that equipment, as a method of complying with 10 CFR Part 50, Appendix R, Section III.G.2. This finding was unresolved pending further NRC review of your licensing basis and determination of the risk significance of the finding. By letter dated April 5, 2002, in response to your backfit claim, the NRC informed you that this finding was not a backfit, and reclassified the unresolved item as an apparent violation, pending NRC's assessment of the risk.

Using the Significance Determination Process described in NRC Inspection Manual Chapter 0609, this finding was preliminarily determined to be greater than green (i.e., a finding whose safety significance is greater than very low), which may result in additional NRC inspection and potentially other NRC action. As indicated in the enclosed Significance Determination Process Phase 3 Summary, the significance of this finding may be greater than GREEN (very low) due to the number of safe shutdown components that may be affected as a result of fire (e.g., main feedwater, high pressure injection, emergency AC power, and emergency feedwater) and the uncertainty regarding the timing and synergistic impact that potential failures may have on the operator's ability to accomplish required shutdown functions in time to prevent core damage. Specifically, the significance of the finding was attributed to a failure of emergency feedwater and feed and bleed capability, assuming no credit for operator recovery actions.

In discussions held with your risk analysts, there appear to be some differences between your risk analysis and the significance determination performed by the NRC. These differences include the method for determining fire duration and severity, heat release rates, the fire ignition frequency, and operator recovery of critical shutdown functions. Your analysts used the FIVE (fire-induced vulnerability evaluation developed by the Electric Power Resource Institute) methodology, whereas NRC analysts used the CFAST model to assess fire duration and fire severity. The NRC analysts assumed higher heat release rates (200-500 KW vs. 70-200 KW).

Consequently, in the NRC analysis, the time to reach critical temperatures was quicker; therefore, the likelihood for success of manual suppression capabilities was reduced. In addition, the heat release rates used by the NRC analysts resulted in an increased likelihood that both the emergency feedwater and high pressure injection functions would be affected by a fire. Finally, the NRC considered the added risk from other fire areas affected by this finding which may warrant an increase in the final significance of the finding. A more detailed discussion of the NRC's risk determination is included in the enclosure.

By letter dated February 3, 2003, you provided additional technical information that you requested be considered prior to our making a final decision on the risk significance of this finding. In addition, you indicated that you may have updated information, and requested the opportunity to review the NRC's risk evaluation, in order to permit the inclusion of this updated information. The additional information in Attachment 1 to your letter, included a list of cables whose failure temperatures appear to be 700 degrees, F, the layout of ignition sources in Fire Zone 99M, and raceway locations in Fire Zone 99M. **In response to your request of February 3, 2003, to review the NRC's risk evaluation, a summary of the NRC's Phase 3 significance determination is enclosed.**

Before we make a final decision regarding the significance of this finding, we are providing you the opportunity to present to the NRC your perspectives concerning the facts and assumptions used by the NRC in its significance determination at a Regulatory Conference or through the submittal to the NRC in writing. In addition, you may present any new technical information that you deem pertinent to the significance determination of the finding. If you chose to request a Regulatory Conference, it should be held within 30 days of the receipt of this letter and we encourage you to submit supporting documentation at least one week prior to the conference in an effort to make the conference more efficient and effective. If a Regulatory Conference is held, it will be open for public observation. If you decide to submit only a written response, such submittal should be sent to the NRC within 30 days of the receipt of this letter.

This finding does not represent a current safety concern, because the licensee posted fire watches in all fire areas affected by this finding, in accordance with their fire protection program.

The finding is also an apparent violation of NRC requirements and is being considered for escalated enforcement action in accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions" (Enforcement Policy), NUREG-1600. The current Enforcement Policy is included on the NRC's website at www.nrc.gov/OE.

Please contact Charles Marschall at 817-860-8185 within 10 business days of the date of this receipt of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision and you will be advised by separate correspondence of the results of our deliberations on this matter.

Since the NRC has not made a final determination in this matter, no Notice of Violation is being issued for these inspection findings at this time. In addition, please be advised that the characterization of the apparent violation may change as a result of further NRC review.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at XXXXXXXXXXXXX(the Public Electronic Reading Room).

Sincerely,

Dwight D. Chamberlain, Director
Division of Reactor Safety

Dockets: 50-313
50-368
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NPF-6

Enclosure: SDP Phase 3 Summary

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Entergy Operations, Inc.

Significance Determination Process
Phase 3 Summary

A. Overview of Issue

The installed configurations of equipment and cabling in the ANO Unit 1 diesel generator corridor (Fire Zone 98J) and the north electrical switchgear room (Fire Zone 99M) did not ensure that cables associated with redundant trains of safe shutdown equipment was free of fire damage as required by 10 CFR Part 50, Appendix R, Section III.G. In lieu of providing this protection from fire damage, the licensee credited manual actions to remotely operate equipment necessary for achieving and maintaining hot shutdown. In addition, the licensee did not have adequate procedures for the manual actions necessary to achieve safe shutdown.. The licensee credited a symptom-based approach which relied on the operator's ability to detect each failure or mis-operation as it occurred and then perform manual actions as necessary to mitigate the effects. Due to the number of components that may be affected as a result of fire and uncertainty regarding the timing and synergistic impact that potential failures may have on the operator's ability to accomplish required shutdown functions, the NRC determined that the strategy for implementing manual actions to mitigate a postulated fire were inadequate.

B. Results of Phase 3 Risk Analysis

A Phase 2 risk analysis using NRC Manual Chapter 0609, "Significance Determination Process," Appendix F, "Determining Potential Risk Significance of Fire Protection and Post-fire Safe Shutdown Inspection Findings," was required, because the issue involved fire protection defense in depth. Depending on the assumptions, the results of the Phase 2 analysis varied between very low safety significance and high safety significance. Therefore, a Phase 3 analysis was required.

The NRC's senior reactor analyst reviewed the licensee's risk analysis, which was performed using the Fire-Induced Vulnerability Evaluation (FIVE) methodology developed by the Electric Power Research Institute (EPRI) for the determining fire duration and severity. The licensee's analysis resulted in an increased time for reaching temperatures at which cables could be damaged. Because the time to reach critical temperatures was more than 20 minutes, the licensee assumed that manual fire suppression would be successful. However, the licensee did not credit manual suppression capability in the determination of the conditional core damage probability (CCDP) results. In addition, the licensee's risk analysts used heat release rates of 70-200 KW in assessing the potential for fire damage in the affected fire zones, which resulted in a determination by the licensee that a fire in Fire Zone 99-M would not simultaneously affect the emergency feedwater (EFW) and high pressure injection (HPI) functions. Source documents used by the licensee included EPRI TR-105928, "EPRI Fire PRA Implementation Guide," EPRI TR-10043, "Methods of Quantitative Fire Hazards Analysis," and EPRI Report SU-105928, "Supplemental to EPRI Fire Implementation Guide (TR-105928)."

The NRC risk analyst used higher heat release rates (200-500 KW) to assess the potential for fire duration and severity. As a result, the time to reach critical temperatures was quicker and the likelihood for success of manual suppression capabilities was reduced. Additionally, the higher heat release rates resulted in an increased likelihood that both the EFW and HPI functions would be affected by a fire in Zone 99-M.

The NRC utilized the CFAST model to develop a fire hazards analysis, using as input, licensee-provided information concerning the ignition frequencies and the CCDP for a fire with and without operator recovery actions. A human reliability screening analysis for the manual operator actions was performed using INEEL/EXT-99-0041, "Revision of the 1994 ASP HRA Methodology (Draft)," dated January 1999. The NRC risk analyst also completed a qualitative assessment of similarly affected fire areas, in which they determined that the added risk from the other similarly-affected fire areas may warrant an increase in the final significance determination process result.

The NRC analyst determined that multiple redundant trains of mitigating equipment (main feedwater, high pressure injection, emergency AC power, and emergency feedwater) could potentially be affected by a fire in Fire Zone 99M. In reviewing the results of each accident sequence, it was concluded that the significance of the finding was primarily attributed to a failure of emergency feedwater and feed and bleed capability, assuming no credit for operator recovery actions.

The more significant influential assumptions involved: (1) the human error probability for successful recovery of failed equipment due to the symptomatic operator response to a fire in the affected areas and the large number of operator actions, and (2) the heat release rate associated with the fire and corresponding failure probability associated with manual fire suppression.

Lowering the human error probability directly impacted the core damage frequency (CDF) calculation; therefore, several sensitivity analyses were completed using a wide spectrum of human error probability (HEP) values. Additionally, the NRC analyst noted that the licensee's human reliability analysis (HRA) values were derived for a non-fire event; therefore, increased the base HEP values for the affected recovery actions. The net increase in the CDF was attributed to the failure to provide adequate alternate shutdown procedures given a fire in Zone 99-M.

A reduction in the heat release rate would extend the time required to reach critical temperatures. An extension in the time to reach critical temperatures to beyond 20 minutes could result in fewer affected components and lower the failure probability for manual fire suppression. Nevertheless, the NRC risk analyst determined that a reduction in the heat release rate was not appropriate given the data collected from industry events which involved energetic switchgear fires.

The sensitivity analyses were completed using licensee-calculated CCDP values which corresponded to various combinations of HEPs. The NRC analyst determined that the calculated increase in CDF for Fire Zone 99-M was in the range of 7E-6/year to 2E-5/year. The analyst qualitatively determined that an additional increase in the CDF

was warranted due the existence of additional fire zones at the facility which also credited the use of operator recovery actions. The increase in the CDF from these additional fire zones warranted a proposed significance determination of "Yellow".

C. Human Reliability Screening Analysis

The team determined that the licensee had not implemented appropriate procedural controls for a fire in Fire Zones 99-M (north electrical switchgear room) and 98-J (diesel generator corridor). Specifically, the licensee relied solely on a symptomatic response to a fire in these areas. For example, if a control room operator became aware of a loss of feedwater condition, then operators would respond by aligning EFW from either the control room or locally. This approach differed from other alternate shutdown areas of the plant. For these areas, specific procedural guidance (Procedure 1203.002, "Alternate Shutdown") existed to direct the operators to isolate and then restore potentially affected components.

The following four broad classes of operator actions were evaluated:

1. Manual alignment of EFW to the steam generators.

2. Restoration of service water to the affected diesel generators.

3. Isolation of letdown flow and inventory control.

4. Local start of an diesel generators without DC control power.

For each of the above classes, an operator would be required to successfully diagnose the system failure, determine the appropriate procedure, and then take the appropriate series of operator actions to mitigate the failure. There were several complicating factors in completing the analysis because the operator actions would be required during or following a major fire. Specifically, the fire could result in: (1) inaccurate indications associated with critical plant parameters, (2) spurious actuation of plant equipment which could be detrimental to the event, (3) failure of plant equipment to respond automatically, (4) inability to remotely operate plant equipment from the main control room, and (5) previously implemented operator actions could become over-ridden by subsequent operator actions through the use of multiple procedures in lieu of a single prioritized procedure.

An "Extreme Stress" classification was used for each class of operator actions. This level of stress is likely to occur when the onset of the stressor is sudden and the stressing situation persists for long periods.

An "Available, But Poor" classification was used for the procedural actions necessary to recover failed or degraded mitigating equipment. This classification is used for conditions where a procedure is available but inadequate. This classification level was chosen because the licensee planned to utilize symptomatic operator response to fire-damaged equipment, in lieu of having a pre-planned shutdown procedure. If properly diagnosed, procedures existed for operators to implement the individual system

recovery actions. However, there may be dependencies between the procedures which are not accounted for. Specifically, to recover AC power, the operators may need to open the individual breakers on various switchgear. This activity could affect other operator actions that may be required to restore mitigating systems. A single pre-planned procedure would account for the dependencies between procedures such that subsequent recovery actions do not adversely affect previously-performed required recovery actions.

A "Barely Adequate Time" classification was used for diagnosing a loss of flow to the steam generators and establishing EFW flow. This classification level was chosen based on the potential for indications and controls not being available in the control room. The timing associated with initiating EFW flow is dependent on operator actions to secure reactor coolant pumps. In addition, the flow rate to the steam generators must be controlled to prevent over-cooling and shrinkage of the reactor coolant system.

A "Barely Adequate Time" classification was used for diagnosing a loss of service water to the diesel generators, and for securing the affected diesel generators. The diesel generators without service water flow must be secured within 7 minutes to prevent overheating and mechanical damage. The failure to secure the diesel generators could potentially prevent recovery of an emergency AC power source.

A "Barely Adequate Time" classification was used for diagnosing the failure of letdown to isolate, and taking manual action to secure letdown. If letdown is isolated within 4 minutes, then inventory control may not be required for 40 minutes. The failure to isolate letdown directly impacts the time available to initiate inventory control.

A "Highly Complex" classification was used for a local start of the diesel generators without DC power. This procedure is infrequently performed, requires a high degree of skill, and includes multiple steps to complete.

A "Moderately Complex" classification was used for a local manual start of an EFW pump and for local manual control of EFW flow to a steam generator. This activity is infrequently performed and would require constant communication with personnel monitoring important plant parameters to ensure the appropriate heat removal rate was maintained.

Limited personnel would be available during the first hour following a fire. Two individuals would be available for field operations (1 main control room reactor operator and 1 auxiliary operator). The remaining personnel would be assigned other functions. Specifically, the shift manager would be assigned emergency response organization duties, the control room supervisor and one reactor operator would remain in the main control room, the waste control operator and 1 auxiliary operator would be assigned to the fire brigade. The shift engineer would be available to provide assistance where necessary, **but cannot operate equipment.** A Unit 2 operator could be dispatched to start the alternate diesel generator; however, the licensee did not credit the use of Unit 2 operators in the performance of Unit 1 plant manipulations.

The analyst determined that 1 operator would need to be dedicated to the restoration of EFW and the operation of the EFW flow control valves. The remaining operator would be required to complete all other evolutions (Isolate letdown, local start of the diesel generator, and all breaker manipulations). In contrast, the alternate shutdown procedure requires four operators, as a minimum, for successful completion. The analyst determined that the majority of actions specified in the alternate shutdown procedure could potentially be required for a major fire in Fire Areas 99-M or 98-J.

Recovery Action	Diagnosis Failure Probability	Action Failure Probability		Task Failure Probability Without Formal Dependence	
		Without Procedure	With Procedure	Without Procedure	With Procedure
Establish emergency feedwater	0.5	0.5	0.1	1.0	0.6
Secure diesel generator without service water	0.5	0.25	0.05	0.75	0.55
Local diesel generator start	0.05	0.125	0.025	0.18	0.075
Isolate Letdown and Inventory Control	0.5	0.25	0.05	0.75	0.55

D. Sensitivity Analysis

A wide spectrum of sensitivity analyses were completed using the licensee's CCDP values which corresponded to various combinations of HEPs. The NRC analyst determined that the calculated increase in CDF for Fire Zone 99-M would, most likely, be in the range of 7E-6 to 2E-5 : The analyst qualitatively determined that an additional increase in the CDF was warranted due the existence of other fire zones at the facility in which the licensee credited the use of operator recovery actions in lieu of meeting 10 CFR Part 50, Appendix R, Section III.G.2 separation. The increase in the CDF from these additional fire zones warranted a proposed significance determination of Yellow.

The licensee's HRA was completed for non-fire conditions. The dominate recovery actions for a fire in Zone 99-M involved the establishment of EFW, the restoration of electrical power, and the establishment of feed and bleed capability. The associated non-fire human error probabilities for these recovery actions were 1.86E-1 for EFW, 1.0E-1 for electrical power, and 6E-3 for feed and bleed. The revised HRA estimate from the licensee included HEP values of 2.6E-1 for EFW, 1E-1 for electric power, and 3.2E-1 for feed and bleed.

The NRC analyst completed a simplified HRA screening analysis using INEEL/EXT-99-0041, "Revision of the 1994 ASP HRA Methodology (Draft)," January 1999. The HEP values, assuming that procedures were available but poor, were 1.0 for

EFW, 7.5E-1 for electric power, and 7.5E-1 for feed and bleed. The HEP values using the assumption that procedures were adequate were 6E-1 for EFW, 5.5E-1 for electric power, and 5.5E-1 for feed and bleed.

The NRC analyst selected multiple combinations of NRC and licensee derived HEP values for the sensitivity analysis. The range of results was typically between 7E-6/year and 2E-5/year.

E. Qualitative Assessment of Other Fire Areas

A qualitative analysis of similarly-affected fire zones in Unit 1 and Unit 2 was performed by the NRC analyst. The analyst compared 15 fire zones in Unit 1 which required manual recovery actions for safe shutdown to Calculation 85-E-0053-47, "Individual Plant Examination of External Events/Fire," Revision 2, to determine which fire zones were unscreened as part of the FIVE analysis. The analyst also compared the 21 fire zones in Unit 2 which required manual recovery actions for safe shutdown to Calculation 85-E-0053-48, "Individual Plant Examination of External Events/Fire," Revision 2, to determine which fire zones were unscreened as part of the FIVE analysis. **Those fire zones that did not screen out in the licensee's FIVE analysis were considered further as described below.**

The remaining fire zones affected by this finding were reviewed for the presence of automatic suppression capability. The NRC's quantitative analysis of Fire Zones 98J and 99M determined that the finding in Fire Zone 98-J was of low safety significance partially due to the availability of automatic suppression capability. The analysis of Fire Zone 99-M determined that the finding in Fire Zone 99M was of low to moderate or substantial safety significance partially due to the lack of automatic suppression capability. **Based on this, the NRC analyst determined that for other fire zones affected by this finding, the significance would be reduced for those having automatic suppression.**

The NRC analyst determined that Fire Zones 98-J and 99-M had ignition frequencies between 2E-3 and 4E-3 and that both fire zones included multiple redundant trains of safe shut down equipment. The analyst determined the significance of a fire in a particular fire zone would be reduced if multiple redundant trains of equipment were not affected, or if the fire zone had a relatively low ignition frequency (less than 1E-3).

Accordingly, fire zones were qualitatively removed from further consideration if any of the following conditions existed: the ignition frequency was less than 1E-3, the affected area had automatic suppression capability, or multiple redundant trains of safe shutdown equipment were not affected by a postulated fire. The NRC analyst qualitatively determined that 2 additional fire zones in Unit 1 (Fire Zones 104-S and 100-N) had either low to moderate or substantial safety significance. The analyst also qualitatively determined that 4 fire zones in Unit 2 (Fire Zones 2100-Z, 2096-M, 2091-BB, and 2040-JJ) had low to moderate safety significance. Based on this, the NRC determined that escalation of a quantitative result of low to moderate to substantial safety significance may be warranted.