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ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STEAM GENERATOR OVERFILL PROTECTION

RESPONSE TO GENERIC LETTER 89-19

ARKANSAS NUCLEAR ONE, UNIT 1

DOCKET NO. 50-313

DISCUSSION:

Steam generator overfill events have been identified by the NRC as potentially significant transients that could lead to unacceptable consequences. Review of how control systems failures contribute to these events was, therefore, a major part of the Unresolved Safety Issue (USI) A-47 program "Safety Implications of Control Systems in LWR Nuclear Power Plants." This program evaluated control system failures that could result in consequences more severe than those previously analyzed in the final safety analysis report (FSAR). Studies identified potentially safety-significant failure scenarios for Babcock & Wilcox (B&W) plants which lead to overfilling the steam generator via the main feedwater system.

Resolution of USI A-47 was documented in Generic Letter (GL) 89-19 "Request for Action Related to Resolution of Unresolved Safety Issue A-47 'Safety Implication of Control Systems in LWR Nuclear Power Plants' Pursuant to 10 CFR 50.54 (f) - Generic Letter 89-19" dated September 20, 1989, which identified staff proposed actions for licensees in order to address steam generator overfill concerns resulting from control system failures. GL 89-19 recommended that pressurized-water reactor (PWR) licensees install automatic steam generator overfill protection systems with associated technical specifications for periodically verifying its operability, and required a licensee response pursuant to 10 CFR 50.54(f) regarding a plan and schedule for implementation of this system. Alternatively, licensees could provide appropriate justification for not implementing the recommended modification.

By letters dated March 19, 1990, and May 29, 1992, Entergy Operations, Inc. the Arkansas Nuclear One, Unit 1 (ANO-1) licensee provided their response to GL 89-19. The licensee took exception to the GL 89-19 recommendations and provided justification for not implementing a steam generator overfill protection system. The justification included alternative assumptions and information to that used by the staff in the cost/benefit analysis done to support the recommended changes described in GL 89-19. This alternative analysis was specific to the ANO-1 plant design.

The licensee evaluated the generic documents upon which the GL 89-19 recommended modifications were based in order to determine their applicability to ANO-1. The recommendation for steam generator overfill protection for B&W plants was based on a probabilistic risk assessment (PRA) of the Oconee Plant performed for the staff by Pacific Northwest Laboratory as documented in NUREG/CR-4386 "Effects of Control System Failures on Transients, Accidents, and Core-Melt Frequencies at a Babcock and Wilcox Pressurized Water Reactor." The ANO-1 licensee provided a comparison of this and related documents to the ANO-1 plant design. This comparison resulted in an alternative cost/benefit result which the licensee stated did not justify the GL 89-19 recommended actions.

Specifically, the licensee indicated that the assumptions and information utilized in the staff's PRA evaluation were outdated or unsupported, and an evaluation assessing the negative impact on safety of the proposed steam generator overfill protection system modification was not performed by the staff. A rereview of major core damage scenarios, the assumptions utilized in the staff's PRA evaluation, and the safety benefit/value impact analysis demonstrates that a steam generator overfill protection system need not be installed at ANO-1.

The licensee essentially duplicated the staff's PRA analysis process on a plant-specific basis in order to provide a sufficient technical and regulatory justification for not installing a steam generator overfill protection system. Of particular importance to the licensee's conclusion was that the documentation supporting the GL 89-19 recommendations did not address the magnitude of increased risk due to inadvertent operation of the overfill protection system which could lead to a loss of feedwater transient. The licensee stated that this shortcoming, coupled with the apparent overstatement of safety benefit from installing such a system leads to a conclusion that the GL 89-19 recommended actions are not warranted for ANO-1.

The licensee stated that the assessment provided in NUREG/CR-4386 made incorrect assumptions with regard to the probability of steam generator tube rupture as a consequence of overfill which artificially increased the public risk calculation. If newer accepted data had been used in the NUREG/CR-4386 analysis, the results would have been significantly different, and would not have justified the GL 89-19 recommended changes to ANO-1.

One area that was investigated by the licensee for ANO-1 was the assumed initiating event frequency in relation to the probability of an operator failing to terminate an overfill scenario. In NUREG/CR-4386, the staff estimated the potential for an operator to fail to terminate a main feedwater (MFW) overfeed to range from 0.7 to 0.1 per demand depending on the rate of overfeed. For ANO-1, MFW overfeed due to control system malfunctions receives special attention in operator training due to the smaller secondary volume of the B&W once-through steam generator compared to Westinghouse and Combustion Engineering plants, and its associated more rapid thermal/hydraulic responsiveness. As a result, the probability that an operator fails to

terminate an overfeed event can be assumed as the lower bound value of 0.1 which produces an initiating event frequency of 0.0009/yr (0.006/yr x 0.1/0.7).

The probability of a main steam line break due to steam generator overfill was also a consideration in the staff's PRA in support of USI A-47 resolution. Assumptions from the Generic Issue (GI) 135 "Steam Generator and Steam Line Overfill Issues" resolution were used to address steam line integrity concerns due to the steam generator being overfed or otherwise filled with water. The resolution of GI-135 showed that steam generator overfill results in only a small risk of core damage. This conclusion was based on analyses which indicate that some main steam line spring hangers may be loaded beyond their design specification due to deadweight loading, but they would not fail. In addition, because the water in the steam lines is at saturated temperature and pressure, the potential for steam line failure due to condensation induced waterhammer is small. Overfills that have occurred under similar conditions have resulted in little or no damage to steam line piping. Therefore, based on the results of the resolution of GI-135 as documented in NUREG-0844 "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding Steam Generator Tube Integrity," a reduction in the probability of a main steam line break due to a steam generator overfill from 0.95 to 0.001 is appropriate.

NUREG/CR-4386 also assumes a probability of 1.0 for a break in the main steam line outside containment in an unisolable location because Oconee has no main steam isolation valves (MSIVs), although it acknowledges that MSIVs are present in the general population of B&W PWRs. The licensee states that this probability for ANO-1 should more appropriately be the ratio of the main steam line piping length outside containment up to the MSIV, to the total length of main steam line piping up to the MSIV. Although this ratio is plant specific, the licensee determined the probability of a main steam line break occurring upstream of the MSIV but outside containment to be 0.16 for ANO-1. The estimated risk would, therefore, be reduced by about a factor of six.

The final conditional probability in the overfill scenario analysis that warrants reconsideration for ANO-1 is the safety benefit and value impact of the recommended steam generator overfill protection system. This reassessment for ANO-1 is difficult since the assumptions made in the generic regulatory analysis of cost/benefit supporting resolution of USI A-47 as described in NUREG-1218 "Regulatory Analysis for Resolution of USI A-47" used the calculations of NUREG/CR-4386 which are based on the Oconee PRA. The feedwater control system at ANO-1 is different from that at Oconee (reference plant), and as a result, the values for cost and benefit of the GL 89-19 proposed upgrades which were used in the regulatory analysis in NUREG-1218 do not apply to ANO-1. Specifically, ANO-1 has made major improvements in the MFW control system, and in the Integrated Control System (ICS) over the past several years which make the actual probability of a MFW overfeed due to control system failures significantly lower than that assumed for Oconee.

NUREG-1218 specified a value of less than $200,000 for the installation of an automatic overfill protection system for PWR plants. The staff used this cost value as a basis of comparison against the licensees cost value in the ANO-1 specific safety/benefit analysis. By incorporating the appropriate conditional probabilities discussed above for the analysis of risk due to steam generator overfill, the risk value shown in NUREG/CR-4386 is reduced from 1360 man-rem to 0.01 man-rem. Using the staff accepted value of $1000/man-rem reduction in public risk as a basis for assessing cost/benefit yields $10.00 (0.01 man-rem x $1000/man-rem) cost/benefit over 30 years (the remaining ANO-1 plant life). This does not consider any potential negative impact on safety from inadvertent overfill protection system actuation. When the $10.00 cost/benefit is compared to the NRC estimated $200,000 installation cost, the overfill protection modification can not be justified.

Consideration of the factors discussed above leads to an estimated risk prediction for the applicable control system failure scenarios well below the point at which the NRC's value/impact guidelines would conclude that hardware changes are an appropriate option. More significantly, when plant specific factors are taken into account, the actual risk reduction due to the installation of a steam generator overfill protection system may actually be less than the risk increase due to spurious operation of the system. Based on the above, the licensee indicated that, for ANO-1, the actual risk due to overfill scenarios is substantially lower than that estimated in the regulatory analysis supporting the GL 89-19 recommended actions. It should be noted that NUREG-1218 incorrectly assumed that all B&W plants (other than Oconee) either had in place, or had committed to modify their designs to include a safety-grade overfill protection system. The safety-grade Emergency Feedwater Initiation and Control (EFIC) system at ANO-1 was originally designed with the capability for automatic steam generator overfill protection, however, this feature was not implemented in the final EFIC system, primarily to avoid inadvertent emergency feedwater pump trips.

CONCLUSION

Based on the licensee's plant specific cost/benefit analysis for ANO-1, the staff concludes that the probability and consequences of a steam generator overfill scenario which results in unacceptable risk are sufficiently low, and the cost sufficiently high such that installation of an automatic steam generator overfill protection system is not justified. The staff, therefore, concludes that the licensee has provided satisfactory justification per the guidance of GL 89-19, and this issue is considered resolved.

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