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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STEAM GENERATOR OVERFILL PROTECTION

RESPONSE TO GENERIC LETTER 89-19

CRYSTAL RIVER UNIT 3

DOCKET NO. 50-302

DISCUSSION

Steam generator (SG) overfill events have been identified by the Nuclear Regulatory Commission (NRC or the staff) 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 SG via the main feedwater (MFW) 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 licensee actions to address SG overfill concerns resulting from control system failures. GL 89-19 recommended that PWR licensees install automatic steam generator overfill protection systems with associated technical specifications (TS) for periodically verifying their operability. Alternatively, licensees could provide appropriate justification for not implementing the recommended modification.

By letters dated March 19, 1990, and July 6, 1993, Florida Power Corporation (the licensee) provided its response to GL 89-19. The licensee took exception to the GL 89-19 recommendations and provided justification for not implementing an SG overfill protection system. The justification included alternative assumptions and information to that used by the staff in its cost/benefit analysis for supporting the GL 89-19 recommendations. The licensee's alternative analysis was specific to the CR-3 plant design.

The licensee evaluated the generic documents which provided the basis for the GL 89-19 recommended modifications to determine their applicability to CR-3. The staff recommendation for SG 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 licensee provided a comparison of this and related documents to the CR-3 plant design. The licensee stated that its alternative cost/benefit analyses did not justify the GL 89-19 recommended actions.

The licensee essentially duplicated the staff's PRA analysis process on a plant-specific basis to provide technical and regulatory justification for not installing an SG 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 CR-3.

The licensee stated that the NUREG/CR-4386 assumptions relating to the probability of an SG tube rupture as a consequence of overfill unduly 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 CR-3.

The licensee investigated 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 an MFW overfeed to range from 0.7 to 0.1 per demand depending on the rate of overfeed. For CR-3, this MFW overfeed scenario 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.

The probability of a main steam line break due to SG overfill was also a consideration in the staff's PRA in support of USI A-47 resolution. The staff used assumptions from the Generic Issue 135 "Steam Generator and Steam Line Overfill Issues" resolution to address steam line integrity concerns due to the SG 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 CR-3 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 CR-3. 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 CR-3 is the safety benefit and value impact of the recommended steam generator overfill protection system. The staff's generic regulatory cost/benefit analysis supporting resolution of USI A-47 as described in NUREG-1218 "Regulatory Analysis for Resolution of USI A-47" is based on the Oconee PRA calculations documented in NUREG/CR-4386. 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 for comparing the licensee's cost value in its plant-specific safety/benefit analysis. By incorporating the appropriate conditional probabilities discussed above for the analysis of risk due to SG 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 CR-3 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 cannot 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 an SG 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 CR-3, 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.

CONCLUSION

Based on the licensee's plant-specific cost/benefit analysis for CR-3, 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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