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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Subject: Waterford 3 SES
Docket No. 50-382
Unresolved Safety Issue A-47
Response to Generic Letter 89-19

Gentlemen:

Generic Letter 89-19 (Reference 1) recommends that CE NSSS PWRs provide automatic steam generator overfill protection (along with associated technical specifications and procedures) and, for plants with low-head high pressure safety injection pumps, the Generic Letter recommends that emergency procedures and operator training be reassessed to ensure adequate handling of SBLOCAs. These recommendations were prompted by the Reference 3 analysis of various transients aggravated by control system failures.

In conjunction with the Combustion Engineering Owner's Group (CEOG), LP&L has reviewed the recommendations of Generic Letter 89-19. Based on the discussions below, LP&L intends to address the steam generator overfill safety concerns raised by References 1, 2 and 3 using the Individual Plant Evaluation (IPE) for Waterford 3, scheduled for completion in March, 1992. We are confident that this approach will provide the necessary technical basis for resolving competing safety concerns while effectively using the IPE process to identify optimum solutions.

The SBLOCA procedural/training questions are inapplicable to Waterford 3.

Plant-Specific Approach to Resolving Overfill Concerns

The Generic Letter 89-19 steam generator overfill recommendations for CE plants are based on a probabilistic risk assessment of Calvert Cliffs Unit I performed by Pacific Northwest Laboratory (PNL) as documented in Reference 3.

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While generic work of this nature may be sufficient for regulatory decision-making, it is clear that each licensee cannot rely solely on the referenced documents as a technical basis for plant-specific implementation.

The basic dilemma faced by any plant in implementing the 89-19 guidance is how to assemble sufficient plant-specific data and analyses to ensure that the new overfill protection system's safety benefit is not over-ridden by the increased risk posed by the system. The licensee's responsibility (e.g. under 10CFR50.59) requires, at a minimum, that the following questions be satisfactorily answered:

1. Are the PNL results a valid basis for resolving overfill concerns?

2. Is the licensee's plant sufficiently similar to Calvert Cliffs to warrant adoption of the PNL results as a technical basis for plant-specific changes?

3. What is the negative impact on safety from installation of an overfill protection system?

4. Will the increased risk from system installation exceed the safety benefit?

5. Are there alternative procedural, training or hardware fixes that would provide increased safety benefit or are more cost-beneficial?

Essentially, the licensee must duplicate the PNL process on a plant-specific basis in order to provide a sufficient technical and legal basis for installation of an overfill protection system. This is particularly important for the issues raised in Generic Letter 89-19 because the Generic Letter and its supporting documents are silent on the magnitude of increased risk due to inadvertent operation of the overfill system (e.g., leading to a loss of feedwater accident). Coupled with the apparent overstatement of safety benefit from installing such a system, detailed plant-specific reviews must be conducted to ensure that safety is not degraded.

The following discussions provide an overview of concerns associated with answering these questions. This is followed by a review of the purpose for IPE and the conclusion that the IPE is the optimum vehicle for resolving the issue of steam generator overfill.

1. <u>Are the PNL results a valid basis for resolving overfill concerns?</u>

LP&L recognizes that there are many sources of uncertainty and numerous judgment calls in any PRA effort, which may have little affect on the ultimate outcome of the analysis. For that reason, we have not engaged in a detailed review of the assumptions, analyses and calculations associated with Reference 3.

Nonetheless, there are several key assumptions/judgments made by the analysts which appear to be unsupported and incorrect, and which significantly affect the outcome of the analyses. Because such judgment would not be acceptable in a plant-specific analysis under 10CFR50.59, the applicability of the PNL results to Calvert Cliffs is questionable. These assumptions fall into 3 areas:

a. The probability of a main steam line break occurring in an unisolable location,

b. The likelihood of operator failure to terminate a potential overfill event, and

c. The probability of water loading on the main steam line leading to a main steam line break.

To place these assumptions in context, it is worthwhile to briefly describe the major core damage scenario analyzed by PNL. (Note: Because of their low contribution to public risk, the Overfill & MSLB, and Transient Shutdown, core damage sequences are not discussed. However, the concerns with the PNL assumptions are also applicable to those sequences.)

The overfill transient begins with one of two control system failure scenarios: 1) the feedwater regulating valve fails to close given a turbine trip signal following a reactor trip, or 2) the turbine trip fails to signal the feedwater valve to close following a reactor trip. In either case, the operator fails to manually terminate or isolate feedwater flow. As the steam generator overfills, water spills into the main steam line, eventually resulting in a main steam line break (MSLB) due to static and dynamic water loads on the piping. The steam generator experiences a pressure transient upon blowdown of the secondary side following MSLB. The pressure differential across the steam generator tubes induces one or more steam generator tube ruptures (SGTRs). High pressure injection into the primary system continues to maintain core cooling as long as a water source (sump or refueling water storage tank) is available. If the MSLB location is outside containment but upstream of the main steam isolation valve (MSIV) sufficient primary water is lost through the ruptured tube(s) to eventually exhaust the refueling water storage tank, at which point core damage is assumed to occur.

In Reference 3, the public risk due to this sequence dominates the total risk associated with the control system failure scenarios. A major contributor to the risk is the assumption that the MSLB occurs with a 50% probability in the location where water would not be collected by containment building sumps for recirculation, always resulting in core damage.

The break location probability is based on the simplified assumption that an MSLB has an equal probability of occurring upstream or downstream of the MSIVs. If the break occurs upstream of the MSIVs, the affected steam generator is assumed to be unisolable and, more importantly, all water exiting the break is assumed to be lost outside containment. For several reasons this assumption is invalid.

In reality, MSIVs are located relatively close to the outside containment wall compared to the length of main steam line piping inside containment. Should an MSLB occur inside containment, the water lost through the break will be collected at the containment sump for recirculation, ensuring an adequate supply for high pressure injection. Far from being a 50% conditional probability of core damage for breaks upstream of the MSIVs, the maximum potential for core damage cannot exceed the product of 50% and the ratio of the main steam line piping length outside containment up to the MSIVs, to the total main steam line piping length up to the MSIVs. For Waterford 3, this value for two steam generators is .16 (i.e., .5 x 117 ft./367 ft.) - a greater than 60% reduction over the 50% assumption in Reference 3.

The basis for the recommendations in Generic Letter 89-19 is discussed in Reference 2. Using the calculations of Reference 3, Reference 2 expected a total risk reduction over 30 years of 570 man-rem, justifying expenditure of $570,000 based on $1000/man-rem. Consequently, the NRC concluded that an estimated cost of approximately $200,000 for installation of an overfill protection system was appropriate.

However, considering only the effects of the MSLB break location probability, the actual estimated risk reduction should be:

570 man-rem x .16/.5 = 182 man-rem

There are other presently unquantifiable factors affecting the probability of an MSLB occurring in an unisolable location and leading to core damage. In the first place, the main steam line piping qualification is different for piping upstream of the MSIVs from that piping downstream of the MSIVs. For Waterford 3, piping upstream of the MSIVs is Safety Class 2 compared to Safety Class 5 downstream of the MSIVs. It is intuitive that the difference in piping pedigree would result in a higher probability of an MSLB downstream of the MSIVs (i.e., an isolable break which could not lead to core damage). Secondly, it is not at all clear that an unisolable MSLB combined with a SGTR leads to core damage in all cases.

The RCS inventory lost should be no more than for a SGTR without an MSLB since the MSLB causes significant cooldown and depressurization of the RCS toward shutdown cooling entry conditions much faster than is assumed in SGTR analyses. Operator action to quickly depressurize the RCS and replenish inventory in the RWSP would prevent core damage.

A further examination of these factors should lead to an estimated risk reduction for the control system failure scenarios well below the point at which the NRC's value/impact guidelines would conclude that hardware changes are a viable option. More significantly, when plant-specific factors are taken into account, the actual risk reduction due to an overfill protection system may actually be less than the risk increase due to spurious operation of the system.

Two other critical assumptions in Reference 3 should be briefly discussed the probability of an operator failing to terminate an overfill scenario, and the probability of an overfill event leading to an MSLB.

The probability of operator failure to terminate the overfill was estimated as .1/demand. In plant-specific PRAs, such overfill scenarios would be assigned an operator failure probability on the order of 0.01 demand (or lower) - resulting in an order of magnitude further reduction in public risk. In this respect, it is worthwhile to quote Reference 3: "In all sequences, a relatively high operator error probability is assumed, because there is considerable uncertainty about this parameter. Operator error probability could be reduced significantly through the use of effective training and emergency procedures, thus lowering the estimates of core-melt frequency and associated risk proportionally. The core-melt potential for these scenarios, as estimated in this report, is thought to be highly conservative."

Given an overfill event, Reference 3 assumed that the probability of inducing an MSLB due to main steam line water loading was .5. This assumption had little basis other than "to be consistent with the approach used in the previous value/impact analyses". In fact, as noted in Reference 3, no MSLBs have occurred as a result of overfill events in the United States. Although there are a couple of instances of steam line damage due to overfill in Europe, those events also did not result in MSLBs. In addition, the steam generator tube integrity program conducted by the NRC used a 1×10^{-3} probability of MSLB for overfill following an SGTR. By all indications, the actual probability of an overfill event leading to an MSLB should be significantly lower than .5 - resulting in a further reduction in public risk.

Based on the above concerns with Reference 3, LP&L believes that the actual risk due to overfill scenarios is substantially lower than estimated in References 1, 2 and 3. Consequently, a plant-specific evaluation under a program such as IPE must be conducted to determine the actual risk associated with overfill issues.

2. <u>Is the licensee's plant sufficiently similar to Calvert Cliffs to warrant adoption of the PNL results as a technical basis for plant-specific changes?</u>

There may be significant plant-specific differences between the reference plant (Calvert Cliffs) and other CE plants responding to Generic Letter 89-19, which would alter the PNL results. Reference 3 recognized this concern and noted that "... the estimates of core-melt frequency are dependent on several factors that may be plant-specific, including basic hardware reliability, operator response to system failures, and plant response to failures. Care must therefore be taken in applying these results to other CE PWRs."

In addition to hardware reliability, operator response and plant response to failures mentioned by PNL in Reference 3, fundamental design differences exist amongst CE plants which may markedly affect the course of an overfill event. For example, the Waterford 3 design incorporates a feedwater isolation valve closure signal on high steam generator level independent from the control system postulated to fail by Generic Letter 89-19. Another example concerns the Reference 3 analysis for core damage frequency given an MSLB (but no SGTR). Reference 3 employed (in Figure 2.1) an MSLB/overcool event tree modified from an earlier study conducted by INPO. This event tree predicted a core damage frequency of 1.1×10^{-5} per reactor year, however half of the core damage contribution is due to a single sequence which involves opening a PORV and subsequent failure of the PORV to close. A significant number of CE plants (including Waterford 3) do not have PORVs.

Given the likelihood of at least some significant design or operational difference from the Calvert Cliffs plant, each licensee will find it necessary to perform a plant-specific evaluation to determine, at a minimum, if the PNL results can be applied to the plant in question.

3. <u>What is the negative impact on safety from installation of an overfill protection system?</u>

References 1, 2 and 3 each recommend installation of an overfill protection system which will ensure that feedwater is isolated to the steam generators. Surprisingly, each reference is silent on the negative impact to safety through implementation of such a system.

An overfill protection system can itself initiate a loss of feedwater accident, regardless of the safety pedigree of the system (Reference 1 allows implementation of a commercial grade system). Spurious actuation of the system during the course of other initiating events may also have adverse safety consequences. Using the same approach as the PNL study including highly conservative failure assumptions, multiple failures, a high probability of operator failure to restore feedwater, etc., the public risk due to installation of the overfill protection system may be significant. At a minimum, it cannot be ignored and must be included in the decision-making process.

4. Will the increased risk from system installation exceed the safety benefit?

As discussed in Items 1 and 2, above, the actual plant-specific public risk due to overfill scenarios is substantially lower than the risk estimated in References 1, 2 and 3. In fact, as discussed in Item 3, the adverse effect on other accident scenarios of installing an overfill protection system may exceed the overfill risk reduction.

In order to proceed with plant-specific implementation of the Generic Letter 89-19 recommendations, each licensee must have a technical basis to resolve this question of competing safety effects. Clearly, the PNL analysis will not represent an adequate basis for plant-specific resolution and there is no technical information available on the down-side risk associated with an overfill protection system. At a minimum, the licensees are required to perform an evaluation under 10CFR50.59 prior to making any plant changes in this area.

Such an evaluation is likely to find an increase in the probability of a loss of all feedwater because of the increased likelihood of the initiating event - a loss of main feedwater. In other words, implementation of the Generic Letter recommendations could be an unreviewed safety question. Should this be the case, 10CFR50.59(c) calls for submittal of a license amendment. Implementation of the Generic Letter recommendations with a license amendment in this case would be a violation of NRC regulations. This would be true even if the safety benefit were to outweigh the increased risk.

5. Are there alternative procedural, training or hardware fixes that would provide increased safety benefit or are more cost-beneficial?

While Reference 3 examined several alternatives for reducing risk associated with overfill events, it did not examine all possibilities. There may be other more risk- and cost-beneficial solutions which a plant-specific review would uncover.

An obvious example of another approach to reducing overfill risk involves operator training and/or procedure changes. It is unclear why this option was not pursued in any of References 1, 2 or 3, particularly since it was the preferred resolution for Generic Letter 89-19 SBLOCA concerns on CE plants. In fact as previously cited, Reference 3 indicated that "Operator error probability could be reduced significantly through the use of effective training and emergency procedures, thus lowering the estimates of core-melt frequency and associated risk proportionally." Any "significant" reduction in operator error probability would remove hardware changes as viable options under the NRC's value/impact criteria.

The IPE process is particularly well-suited for identification of a range of alternative solutions, with a built-in process for evaluating and choosing the best solution.

Individual Plant Evaluation

The Individual Plant Evaluation (IPE) process is underway at Waterford 3. The overall IPE process involves a search for risk-significant sequences coupled with a structured approach to identifying and evaluating a range of possible risk reduction measures.

As discussed above, resolution of the overfill concerns of Generic Letter 89-19 must ultimately be done on a plant-specific basis. No nuclear plant can simply take the analytical results from Reference 3 and conclude that installation of an overfill protection system will increase safety.

By its nature, the IPE presents an ideal solution and framework to resolve the overfill issues raised by Generic Letter 89-19. Because the basis for the Generic Letter is largely PRA-based, PRA techniques should form the core of the plant-specific resolutions. Furthermore, a stated sub-purpose of the IPE is resolution of USIs/GIs on a plant-specific basis.

For these reasons, Waterford 3 has chosen to address this issue using the IPE. The actual methodology to be used is uncertain at this time. In any case, the concerns of Generic Letter 89-19 will be explicitly addressed in the Waterford 3 IPE submittal, documented consistent with the NRC's guidance on plant specific resolution of USIs.

LP&L is convinced that the IPE approach will result in the best safety solution to Generic letter 89-19 while avoiding unforeseen safety concerns which could occur through another, less structured, approach.

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Attachment One

References

(1) Generic Letter 89-19, Request for Action Related to Resolution of Unresolved Safety Issue A-47, "Safety Implications of Control Systems in LWR Nuclear power Plants" Pursuant to 10 CFR 50.54(f)

(2) NUREG-1218, Regulatory Analysis for Resolution of USI A-47

(3) NUREG/CR-3958, Effects of Control System Failures on Transients, Accidents and Core-Melt Frequencies at a Combustion Engineering Pressurized Water Reactor