52-001

September 9, 1992

CC: JD Duncan
CE Buchholz
H Careway
S Visweswaren
L Fredrick

To: R. Palla (NRC))
From: PD Knecht

Subject: Preliminary Draft Responses to NRC Request for Information - Pool Bypass

Reference: FAX to Duncan from Palla, 8/18/92, "Request for Additional Information Regarding Analysis of LOCAs Outside Containment (Q-4)

The basic goal of the Bypass evaluation in Appendix 19E.2.3.3 is to show that Bypass events do not significantly affect the total offsite risk; therefore, consideration in the PRA is not necessary except for paths which can not be excluded. The exceptions are addressed in detail in the PRA. The following responses clarify the information contained in section 19E.2.3.3 and provide a response to the NRC concerns expressed in the referenced FAX. In the interest of brevity, the NRC concerns have been summarized.

Concern 1. Please provide a more comprehensive analysis of the frequency of core damage from LOCAs outside containment using event tree and fault tree techniques. The analysis is to include the effects of instrumentation availability and consequential failure of injection systems.

RESPONSE Simplified event trees of the containment bypass events are shown in Figures 1 and 2. Figure 1 represents the LOCA outside containment events. Figure 2 represents containment bypass situations which occur independently from the initiating event. For both trees the end result is either equivalent full bypass or no bypass. Probabilistic values shown are derived from Table 19E.2-21 of the SAR.

In the trees the following definitions apply:

V_1 The frequency of piping breaks in lines which communicate directly with the reactor vessel. The value used (2.6E-4) is the total estimated frequency for small, medium or large breaks outside of containment. The basis for this estimate is provided in Appendix 19E.2.3.3.3 (2)(k).

Q_1 Conditional probability that required makeup for core cooling is affected by the ex-containment LOCA. It is assumed that such failure results from environmental effects (including flooding). The value Q_1 is discussed in response to concern 3. When isolation is successful core cooling is assumed to be unaffected by the brief period of break flow and a value of 1.0 is assumed.

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Q_o Conditional probability of core cooling failure by all sources of cooling not affected by the ex-containment LOCA. The values used are derived from the event trees in Appendix 19D.4. When used with V_2, the product (Q_o*V_2) is the total core damage frequency calculated in the current PRA (1.5E-7).

X_1 Bypass Fraction - Total conditional probabilities of all ex-containment LOCA paths (from Table 19E.2-21). Conditional probabilities are weighted by a "flow split fraction" to account for different consequences from individual lines. The result is therefore the equivalent full bypass fraction.

The "flow split fraction" compensates for the flow split between flow out of the break in comparison with flow into the suppression pool. An adjustment is made to each line contributing to the total such that an equivalent full flow value is obtained.

X_1 includes the probability that operator action fails due to a lack of instrumentation availability. For most bypass paths considered, no credit for operator action is taken; For ECCS discharge lines the operator is assumed to act to close an open valve, if needed. For these paths, the leak detection system is adequate to alert the operator of a secondary containment break and instrumentation is not considered to provide a strong contribution to the failure probability.

As shown on Table 19E.2-21 and Figure 1, the bypass fraction from ex-containment LOCAs is equal to 2.4E-5.

V_2 The combined frequency of all initiating events exclusive of ex-containment LOCAs. From Appendix 19D.4 this is about 2.0 events per year.

X_2 Bypass Fraction - Total conditional probability from all potential Suppression Pool Bypass paths resulting in complete bypass of the suppression pool. This represents the failure of an isolation barrier in a line communicating with the drywell (excluding vacuum breakers, purge and vent lines). These failures do not initiate transients or core damage sequences. No operator action was assumed for these paths.

To compensate for the flow split between flow out of the bypass path in comparison with flow into the suppression pool, an adjustment is made to each line contributing to the total such that an equivalent full flow value is obtained. As shown on Table 19E.2-21, the bypass fraction from suppression pool bypass paths is equal to 1.5E-5.

Conclusion

Although the consequence from bypass events is greater, the frequency of such events concurrent with core damage is extremely small (2.3E-12/yr). This is well below the criteria of exclusion for consideration in the PRA, regardless of consequence.

The total bypass fraction of 3.9E-5 represents approximately an 18% increase in the offsite exposure risk within 50 miles (see response to Concern 5c). Since significant margin exists between the current PRA results and the safety goals, it can be concluded that the bypass events do not significantly contribute to the offsite exposure risk.

Concern 2. It is not clear that all potential bypass lines were included in accordance with the current ABWR design. Why was the RWCU Line omitted?

RESPONSE The bypass lines identified in Table 19E.2-1 were derived from a systematic review of the ABWR P&IDs available about June, 1988. Significant additions or revisions are not believed to have occurred since that time which would affect the results of this study. A confirmation is planned to verify that no un-evaluated bypass paths have been introduced into the design.

The RWCU Return line to Feedwater was included in Table 19E.2-1 and excluded from further analysis because the bypass path is protected by the feedwater check valves which are already included in the analysis. A break in the discharge line also could result in a bypass pathway through the RWCU suction. This line is included in the analysis.

Concern 3. An systematic evaluation of the environmental and thermal-hydraulic effects of ex-containment LOCAs on the availability of core injection capability should be provided. The effect of unspecified line layout should be addressed.

RESPONSE This concern addresses the assumption in the analysis that the value of Q_1 in the event trees. It is apparent from Figure 1 that these events can not be significant unless the amount of increase in the coolant makeup frequency (Q_0) is greater than the probability that the coolant makeup frequency is affected (Q_1).

A systematic evaluation of potential flooding due to ex-containment breaks was summarized in Appendix 19R, Probabilistic Flooding Analysis. Flooding in the reactor building is noted to disable the system affected and potentially flood the Reactor Building corridor, but not disable other makeup equipment due to the water-tight doors contained in the design. A value of Q_o for flooding events affecting one division was estimated to be about 1.3E-6 which is similar to the value of Q_o without consideration of bypass effects. The conditional makeup failure probability with two systems out of service is estimated to be 2.7E-5.

It can be concluded that although the makeup probability (Q_o) is likely to be slightly higher due to the loss of the flooded system, the value of Q_1 would need to be greater than .2 for this contribution to affect the ex-containment LOCA offsite exposure risk. Based on the flooding analysis, it is judged that Q_1 is likely much less. The net affect on the analysis is that the risk from such bypass initiated events is negligible.

Although line routing are not specified, the analysis assumes a break in the reactor building anywhere outside of the containment isolation valves. This is either inside secondary containment or outside secondary containment and is addressed by the flooding analysis of Appendix 19R. Therefore the results are not sensitive to the final layout.

Concern 4. COL applicant actions to confirm the assumptions in the PRA should be provided. A reassessment of potential bypass paths should be included.

RESPONSE ITAACs were provided for the major assumptions included in Appendix 19E.2.3.3 (See Table 19.8-2). In addition, system interactions which could cause a consequential system failure due to ex-containment LOCAs are already a requirement for the COL applicant (see Appendix 19B.2.3). A systematic evaluation of potential pool bypasses will result from the system interaction review.

Concern 5a The contribution of bypass events which lead to core damage appears to be ignored in the methodology.

RESPONSE Pool bypass events which lead to core damage are encompassed by the ex-containment LOCA event tree (Figure 1). This tree is discussed in more detail in responses to concerns 1 and 2.

Concern 5b The methodology assumes that the bypass event frequency is much less than the non-bypass frequency. This assumption may not be valid if some bypass events have a relatively high probability of causing core damage.

RESPONSE Bypass events do not have a relatively high probability of causing core damage as discussed in response to concern 3.

Concern 5c The SAMDA analysis appears to indicate that the ratio of consequences is non-conservative.

RESPONSE The SAMDA analysis (section 19P) provides the results of the offsite exposures (over a 50 mile radius) for four separate sequences. The consequence ratio in Appendix 19E.2.3.3 was based on the ratio of the site boundary doses for a full release of noble gases 24 hours after the event (suppression pool scrubbing assumed) to that with full bypass and no hold up.

The closest comparison of consequences is provided by comparing "Case 7", a bypass event through the wetwell-drywell vacuum breakers, with "Case 1", core melt with release through the rupture disc. Accounting for the assumed flow split of .26 in the vacuum breaker line yields an approximate consequence ratio of 1.1E-3. This compares with 1.2E-3 assumed in Appendix 19E.2.3.3.

It should be noted that as a result of ACRS questions on the appropriateness of this ratio, GE has concluded that the proper ratio should have been based on the dose from normal containment leakage following core damage rather than the 24 hour rupture disc release.

The ratio of doses indicated in Table 19P.2-1 may be used to estimate the consequence ratio appropriate for the evaluation of suppression pool bypass. "Case 1", adjusted for the assumed flow split, may be used as an approximation of the full suppression pool bypass consequence; "NCL" is the consequence from normal containment leakage. The corresponding ratio is 2.2E-4 which compares with the value of 1.2E-3 indicated in Appendix 19E.2.3.3. This new consequence ratio can be used in the evaluation of pool bypass significance.

Concern 5d Split fractions appear to be non-conservative for large lines and for lines which initiate core damage.

RESPONSE The flow split fractions were determined from first principles calculations of the anticipated pressure drops and flows expected during a severe accident. Two types of flow splits were considered: For ex-containment LOCAs, the pressure drop associated with bypass flow was compared with the pressure drop associated with four open SRVs; for suppression pool bypass paths the bypass pressure drop was compared with that for ten upper drywell vents uncovered about one-fourth of the available opening. As shown on Table 19E.2-19, the calculations indicated that even for the largest lines complete bypass does not occur.

FIGURE 1
LOCA OUTSIDE CONTAINMENT

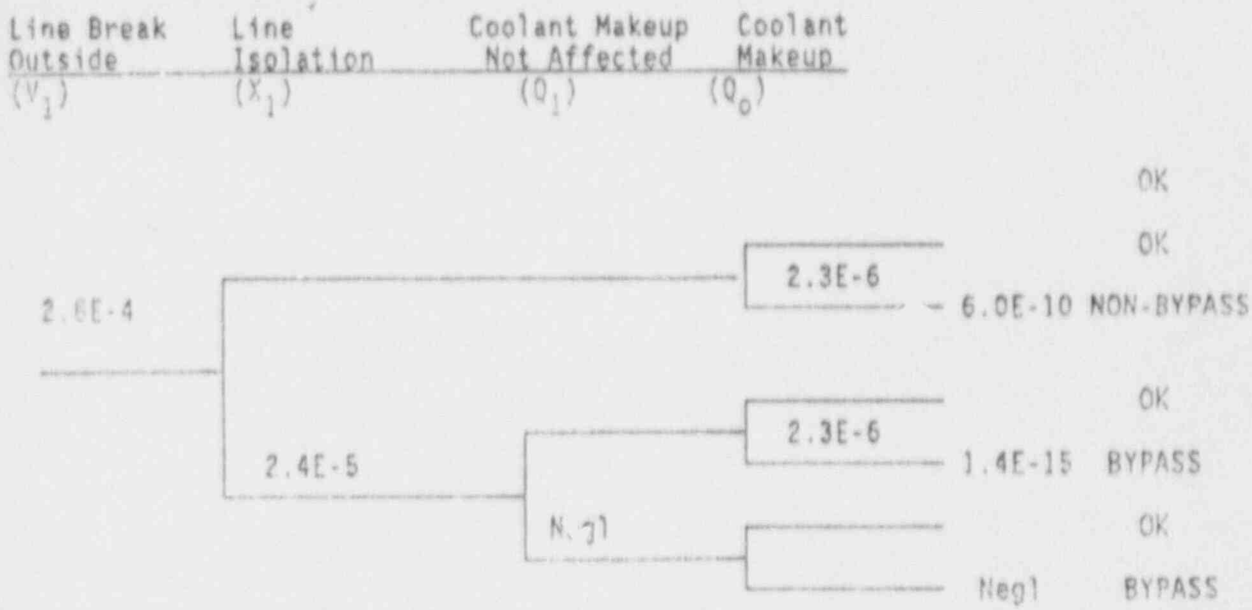
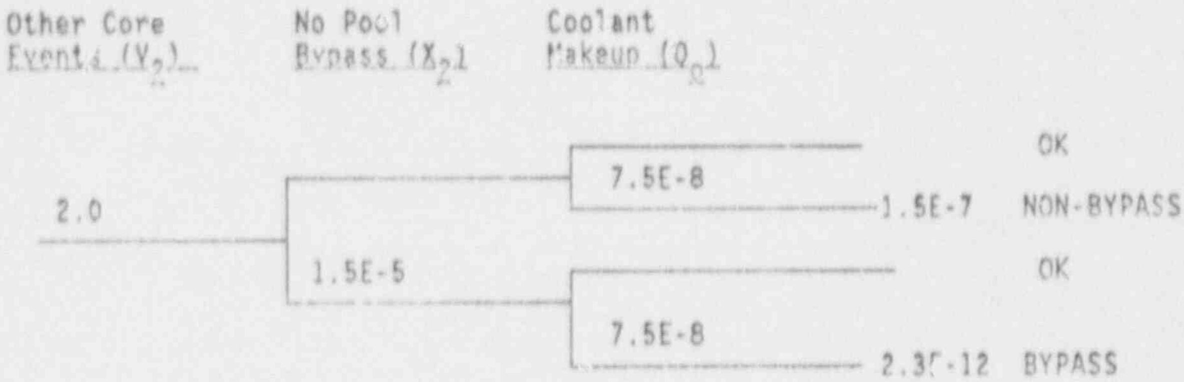


FIGURE 2
SUPPRESSION POOL BYPASS
(NON-INITIATING EVENT)



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				8	0°03'41"		

GE Nuclear Energy

SYSTEMS INTEGRATION ENGINEERING
SAN JOSE, CALIFORNIA
RAPIFAX (408) 925-1289
OR DIAL COMM 8-425-1289

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10E4

DATE: 9/9/92

TO: Glen Kelly NRC - Fairmont Hotel
Bob Palla NRC

FROM: Don Knecht (AR)

THIS TRANSMITTAL INCLUDES COVER SHEET + 7 PAGES

COMMENTS:
Bob - Duncan will call ≈ 11:30 (EST)
to discuss