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THIS TRANSMITTAL INCLUDES COVER SHEET + 5 PAGES

COMMENTS:

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April 27, 1992

To: Charlie Hsu, Brookhaven National Lab

cc: GE: JD Duncan, S Visweswaran, LF Fredrick; NRC: Chet Postlosny, Glen Kelly

From: PD Knecht

Subject: LOCAs Outside Containment in ABWR

References: 1. "Followup on Open Items from the ABWR PRA DFER and the March meeting in San Jose", Letter Kelly to Duncan, April 9, 1992.

2. "Physical Properties of Fluids and Flow Characteristics of Valves, Fittings and Pipe", Crane Engineering Division, 1969

Reference 1 included several questions regarding LOCAs outside of containment and the bypass study included in Section 19E.2.3.3 of the ABWR SSAR. The following responses are provided to these questions. Please note that due to ABWR SSAR revisions Tables "19E.2-12" and "19E.2-13" should refer to Tables 19E.2.20 and 19E.2.21, respectively, and Figure "19E.2-8" should refer to Figure 19E.2-19. The statement of the questions provided below have made these corrections.

Reference 1 Questions "Q-4"

1. Some of the bypass probabilities listed in Table 19E.2-21 appear to have been underestimated because common cause failures do not appear to have been taken into consideration. For example, when calculating the bypass probabilities of feedwater line, SLC injection line or the vacuum breakers, common-cause failure of check valves appears to have been ignored.

RESPONSE

Common causes were considered in the estimate of some failure probabilities listed in Table 19E.2-21. For example P8 was assigned a value of 1.0 to reflect the common cause potential for loss of all AC power during a Station Blackout event; P1 includes consideration of a common cause affecting both MSIVs in a single line. A common cause failure among check valves was not considered.

With regard to check valves, industry failure rate data associated with allowing complete reverse flow was used. Only Feedwater and the SLC paths contain more than one check valve. If common causes are considered for these lines (with a Beta factor of .18), the bypass probabilities for the lines would be increased by a factor of about 21. However, due to the low contribution of these lines to the total the total Bypass fraction would only be increased by about .08%. Therefore such common cause effects can be considered insignificant.

2.. As indicated by Eq. 4, GE's analysis is based on the presumption that a core damage event has occurred. It is not clear, however, whether some of the data such as P13, P14, and P15 shown in Table 19E.2-20 represent the failure probabilities before a core melt or the conditional failure probabilities, given a core melt.

RESPONSE

The values used are conditional probabilities, given a core melt. In general these probabilities are not affected by the core melt. The break failure rates were determined from WASH 1400 which provided a mean break failure rate for a line less than 3" of 8.6E-9/hr-segment. The failure rate of a larger line was given to be a factor of ten lower. For an individual bypass line, the line was assumed to consist of four segments outside of containment. Because it was presumed that an undetected break in an unpressurized line could occur at any time, the conditional probability of a bypass path was then taken to be the same as the failure rate during a one year period (which was estimated to be 7000 hours). This approach of estimating pipe failure probability is judged to be conservative and the consequences of an unisolated LOCA outside containment is considered negligible (see response to question 4, below).

3. It appears that split fractions (a crucial parameter in obtaining GE's results) were calculated using Eq. 12, which was derived from Eq. 10. The detail of how Eq. 12 was actually used to obtain split fractions shown in Table 19E.2-21 is not explained in the SSAR. For example, no information was given regarding the actual numerical values used for the geometry-dependent expansion factors, Y, and the resistance coefficients, K, for the broken area, and the penetration lines. No mention was made of how the differential pressure, dP, which is time dependent, was evaluated for each of the penetration lines including those leading to the suppression pool

RESPONSE

In the evaluation of flow split fractions in Table 19E.2-21, Equation 9 was evaluated using a computer program developed to ease input and calculation. The most significant assumptions (including a discussion of the dP used) were included in notes listed in Section 19E.2.3.3.3 (Page 19E.2-32) of the SSAR. Other values used in the calculation are listed in Table [illegible] ow:

Table 1
Additional assumptions in Flow Split Calculation

Parameter	Assumed Value	Basis
Resistance Coefficient (K=fL/D)		
friction factor (f")	.011 to .014 (Size dependent)	Reference 2 (Pg A-25)
Line length (L)	85 ft/5ft	Note 5
Line Diameter (D)	various	Line size (Table 19E.2-1)
Other resistances (K)		Reference 2 (Pg A-30)
gate valve	13	
check valve	135	
globe valve	340	
Entrance effects	.5	
Exit effects	1.0	
Expansion Factor (Y)	.6 to .9 (dP,K dependent)	Reference 2 (Pg A-22)

4. Since GE has already identified the major bypass paths (See Table 19E.2-21), it should be straightforward to identify those piping systems outside of the pressure boundary whose break can lead to loss of coolant that is not automatically isolable. A simple fault tree analysis can then be performed to estimate the frequency of LOCAs outside of containment. Event trees similar to those shown in Figures 19E.2-19A through 19E.2-19K can also be constructed to estimate the frequency of LOCAs outside containment. Once the frequency of LOCAs outside containment is determined, a LOCA event tree can be constructed to analyze the associated core damage sequences.

RESPONSE

The evaluation of bypass paths in Section 19E.2.3.3 is based on consideration of the relative contribution to offsite risk rather than core damage frequency. The approach used was focused on the relative frequency of releases which would have a high associated source term due to a lack of suppression pool scrubbing. The frequency of LOCAs outside containment can be estimated from the information in Table 19E.2-21, but several considerations make this approach not as useful.

1) Not all bypass paths require a LOCA outside of containment; An open Main Steam line, for instance, can result in condenser failure which is not traditionally considered a LOCA.

2) Bypass paths from the Drywell do not cause a transient and are only of significance following core damage. The evaluation showed that there is more significance to these paths than LOCAs outside containment from the standpoint of risk.

3) Ignoring the effect of flow splitting over estimates the risk of LOCAs outside containment.

If the suggested approach were taken, the initiating event frequency for LOCAs outside containment could be based on the bypass probabilities for Intermediate and Large lines from the RPV indicated on Table 19E.2-21 after adjusting for Common Cause Failures and factors previously introduced for SBO events (see attached markup Table). This approach results in a total initiating event frequency for unisolated LOCAs outside containment of about 3.6E-7/yr. Applying this frequency in an event tree similar to Figures 19D.4-13 and 19D.4-14 yields a core damage frequency for unisolated LOCAs outside containment of about 7E-12/year and orders of magnitude less than the total core damage frequency. This evaluation also ignores the benefit from the flow splitting effect which provides an additional basis for excluding these lines from further consideration.

Table 19E.2-21

Summary of Bypass Probabilities

Lines from the RPV

Pathway	Flow Split Fraction	Bypass Probability Equation	Bypass Probability	Bypass Fraction	Figure 19E.2-19
Main Steam	6.7E-1	4*P1*(P3*P4+P5)	~~1.6E-5~~ 1.2E-7	1.1E-5	A
~~Main Steam Leakage~~ (small)	~~3.2E-5~~	~~4*P2*(P3*P4+P5)~~	~~2.1E-2~~	~~6.4E-7~~	~~A~~
Feedwater	5.2E-1	2*P9*~~P9~~*P15 (CCF → .18)	~~1.1E-9~~ 2.3E-8	5.8E-10	B
~~Reactor Inst. Lines~~ (small)	~~3.1E-5~~	~~30*P13*P9~~	~~6.0E-5~~	~~1.9E-9~~	~~D~~
HPCF Discharge	1.1E-1	2*P9*P10*P14	1.3E-7	1.5E-8*	C
~~HPCF Warmup~~ (small)	~~1.0E-3~~	~~2*P10*P11*P13~~	~~6.7E-8~~	~~7.0E-11*~~	~~C~~
~~SLC Injection~~ (small)	~~3.0E-3~~	~~1*P9*P9*P15~~	~~1.7E-8~~	~~5.0E-11~~	~~B~~
RCIC Steam Supply	6.9E-2	1*~~P6~~*P14 (3.6E-3)(.18)	~~1.6E-5~~ 1.0E-8	1.1E-6	E
RHR LPCI Discharge	1.7E-1	2*P9*P10*P15	6.7E-8	1.1E-8*	C
~~HPCF Warmup Line~~ (small)	~~1.0E-3~~	~~2*P10*P11*P13~~	~~6.7E-8~~	~~7.0E-11*~~	~~C~~
RWCU Suction	1.2E-1	1*~~P6~~*P14 (3.6E-3)(.18)	~~1.6E-5~~ 1.0E-8	2.0E-6	E
~~RWCU Inst. Lines~~ (small)	~~3.1E-5~~	~~4*P13*P9~~	~~8.0E-6~~	~~2.5E-10~~	~~D~~
~~Post-Acc Sampling~~ (small)	~~1.0E-3~~	~~4*P8*P13~~	~~9.6E-4~~	~~9.9E-7~~	~~J~~
~~LDS Instruments~~ (small)	~~3.1E-6~~	~~0*P13*P9~~	~~1.8E-5~~	~~5.7E-10~~	~~D~~
		Total =	3.6E-7		
			Total	1.5E-5	

*These lines may be excluded for station blackout events