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Vice President - Nuclear Group

September 11, 1992

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
Generic Letter 88-20 (TAC No. M74379)

References:
1. NRC Letter to Duquesne Light Company (DLC), Generic Letter 88-20 Individual Plant Examination (IPE) For Severe Accident Vulnerabilities - Request For Additional Information (TAC No. M74379), dated July 15, 1992
2. DLC Letter to the NRC, Generic Letter 88-20, dated August 17, 1992

Please find attached the first submittal of Duquesne Light Company's responses to the NRC's Request for Additional Information (RAI), Reference 1. Our plan to provide two submittals in response to the RAI is stated in Reference 2. However, not all of the responses scheduled for this submittal are included herein primarily because key personnel have been engaged longer than anticipated in completing the Beaver Valley Power Station Unit No. 1 IPE Summary Report. Therefore, those responses will be provided with the second submittal.

Should you have any questions regarding this submittal, please contact Ed Coholich at (412) 393-5224.

Sincerely,

J. D. Sieber

Attachment

cc: Mr. L. W. Rossbach, Sr. Resident Inspector
Mr. T. T. Martin, NRC Region I Administrator
Mr. A. W. De Agazio, Project Manager
Mr. R. R. Janati, Pennsylvania Department of Environmental Resources
Mr. M. L. Bowling (VEPCO)

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DELIVERING QUALITY ENERGY

ADDITIONAL INFORMATION FOR

BEAVER VALLEY UNIT 2 INDIVIDUAL PLANT EXAMINATION

Question 1. a) Describe briefly the peer review performed on the Individual Plant Examination (IPE) to help assure the analytic techniques used in the back-end analysis were correctly applied. Identify specific areas reviewed, expertise of the reviewers, and characterize the peer review findings and any significant comments.

b) As an example of the internal review performed, provide a copy or summary of peer review comments and resolutions (as appropriate) for aspects of the Probabilistic Risk Assessment involving the "Emergency Switchgear Ventilation" from system analysis through event tree quantification, plant improvements and conclusions.

Response 1. a) The analytical techniques used in the back-end analysis of the Beaver Valley Unit 2 IPE were developed by PLG, Inc., and applied using results from previous NRC and industry analyses. Particularly heavy emphasis was placed on the Surry analysis in NUREG-1150, since Beaver Valley and Surry are similar plants. The back-end analysis was reviewed within Duquesne Light by the Radiological Engineering group and Nuclear Engineering group to assure that the parameters used in the input appropriately described the Beaver Valley plant. The analysis was also reviewed with Sandia, the principle contributors to the back-end analysis for the NUREG-1150 analysis of Surry. Their comments were to include provisions within the model to reduce the Reactor Coolant System pressure prior to vessel break by way of stuck open PORVs and Reactor Coolant Pump seal leaks. We had previously only modeled induced steam generator tube ruptures and induced hot leg failures, as pressure reducing mechanisms.

b) The internal review focused mainly on system design and operation, and on Emergency Operating Procedures. There were no specific comments on the Emergency Switchgear Ventilation System in the formal internal review, however, the system model, and the success criteria, were discussed with plant personnel during the development of the system analysis. Proposed plant improvements were discussed with the Unit 2 Operations Manager and General Manager.

Question 2. Describe how containment loading was assessed for each of the Containment Event Tree (CET) end-states. Discuss the development of plant-specific probability distribution functions of failure likelihood for the range of failure pressures.

Response 2. As discussed in Section 4.4, "The Beaver Valley Unit 2 containment is very similar in design to the Surry Unit 1 containment", which was analyzed extensively in NUREG-1150. Both containments were designed and constructed by the Stone & Webster Engineering Corporation (SWEC), a member of the BV-2 back-end analysis team. Based on a detailed review of the BV-2 containment design and a comparison to the Surry Unit 1 design, it was concluded "with a high degree of confidence that the failure distributions for Beaver Valley Unit 2 and Surry Unit 1 containments would be similar, and that use of the Surry distribution would be somewhat conservative for the Beaver Valley Unit 2 containment". Based on this conclusion, the NUREG/CR-4551 Surry Unit 1 distributions for containment failure pressure and conditional probability that the failure would be large were utilized without modification in the BV-2 study.

As shown in Figure 4.5-1, the CET has 12,463 end states. Therefore, it is assumed that this request is directed at the broad categories of end state discriminators as related to CET Top Events C1, AP, C2, CE which address early containment failures, and Top Events C3 and C4 which address late containment failures.

No pressure load considerations are addressed for Top Event C1 which addresses containment failure prior to vessel breach. In the BV-2 IPE, this top event addresses only whether the containment is isolated. It was assumed, as it was in NUREG/CR-4551, that containment threats (blowdown or hydrogen burns) prior to vessel breach could be ignored.

CET Top Event AP addresses containment failures due to in-vessel steam explosions. Containment loading was not evaluated for this top event. For the failure branch of this top event, it was assumed that the containment would fail. Containment failures, resulting from in-vessel steam explosions, were assumed to be large.

CET Top Event C2 addresses the containment loading at vessel breach. Because of the similarity between the Surry plant analyzed in NUREG/CR-4551 and BV-2, the containment pressure rise distributions developed for the former were adapted to BV-2, with minor adjustments to account for slight differences in the containment volume and power ratings. These loads distributions were compared to the failure of various CET paths.

No specific containment loads were calculated for Top Event CE which addresses containment failure within four (4) hours of vessel breach, due to hydrogen burns within that time period, including those that occurred at vessel breach in the absence of HPME. MAAP analysis performed for BV-2 indicated that the amount of hydrogen generated in-vessel for most BV-2 sequences was typically of the order of 700 lbm (equivalent to the oxidation of approximately 40% of the core Zircaloy). MAAP also indicated that the quantity of hydrogen generated ex-vessel in this time period was relatively small. Therefore, the primary source of hydrogen in this four (4) hour time frame is that which is produced in-vessel. Furthermore, the concern regarding significant hydrogen burns during this time period applies only to scenarios in which the steam concentrations in the containment atmosphere are low (i.e., when containment sprays are in operation).

For scenarios in which the containment sprays are operating, it is likely that hydrogen burns will occur at low concentrations if hydrogen is "slowly" released into the containment. Only when the hydrogen is suddenly released into the containment (e.g., due to an induced failure of the hot leg or at vessel breach) will the hydrogen concentrations achieve significant values. When vessel breach is accompanied by HPME, the containment loads discussed for Top Event C2 include the contribution of hydrogen burns. However, for "pour" type vessel breaches at high pressure, there could be a sudden release of hydrogen into the reactor cavity and then into the containment. For those scenarios in which there was a sudden release of hydrogen into a non-steam inerted containment atmosphere, it was assumed that if the global concentration exceeded 12%, a burn would occur which would, in turn, fail the containment. The intermediate logic implicit in this assumption is as follows:

1. A deflagration at a 12% hydrogen concentration, is not likely to fail the BV-2 containment (based on peak containment pressures determined using the adiabatic burn assumption).

2. Although MAAP simulations showed that the containment was well mixed when sprays were in operation, it was assumed that local concentrations could be 20% higher than the global concentration.

3. Although the BV-2 containment configuration is not necessarily amenable to a Deflagration to Detonation Transition (DDT), it was assumed that a DDT would occur if local concentrations exceeded a value of 15% (minimum value reported in Reference 4-8).

4. It was assumed that DDT would result in a large containment failure.

Figure 4.2 (based on the in-vessel hydrogen generation distributions reported in Volume 2 of NUREG/CR-4551) was used to determine the probability that the amount of hydrogen generated in-vessel would exceed a level necessary to produce a global concentration of 12%. This probability was estimated to be 0.38.

Top Event C3 addresses late hydrogen burns. If sprays are in operation, the only late burns of significance are those resulting from sudden releases of hydrogen generated in-vessel into the containment. These releases were addressed in Top Event CE. At the time that the MAAP analysis was performed for BV-2, the MAAP program indicated that for scenarios in which there was uncooled debris in the cavity, hydrogen would recombine in the reactor cavity, or burn as it exited the reactor cavity as a hydrogen-laden jet. In the absence of containment heat removal, the deposition of the energy associated with these burns, along with decay heat and noncondensible gases generated from the decomposition of concrete, containment overpressurization would eventually occur. While the timing of such failure is certainly influenced by the rate of containment pressure and temperature rise, there is considerable uncertainty as to the failure pressure, especially when there are potentially multiple failure modes, some of which are sensitive to temperature. Industry practice is to assume that the time of containment failure corresponds to the median failure pressure. In fact, however, there is a finite probability of containment failure at any pressure which exceeds the test pressure. Hence, there is significant uncertainty in the time of failure, even if the containment loading was known precisely.

Top Event C4 addresses slow, long-term overpressurization of the containment. In the absence of containment heat removal, the containment atmosphere is likely to continuously pressurize until some mode of containment failure occurs. MAAP analysis performed for BV-2 provides containment pressure and temperature histories. The same considerations regarding the timing of containment failure that were discussed above for Top Event C3, apply to Top Event C4 as well.

Question 3. Describe how phenomenological uncertainties were accounted for during the quantification of Containment Event Trees.

Response 3. (LATER)

Question 4. Section 4.1.4, "Equipment Survivability" (Page 4.1-6) of the IPE states that, "survivability of equipment for BV-2 is such that equipment failures under severe accident conditions would not create instances of Unusually Poor Containment Performance (UPCP), given a severe accident."

a) State the definition of UPCP, and discuss the basis for this definition.

b) Was the conditional and absolute probability of UPCP for internal events only estimated? If so, please provide the estimates.

Response 4. (LATER)

Question 5. a) Provide a concise discussion of how the IPE process treated equipment survivability during a severe accident scenario.

b) Was any essential equipment identified which would fail as a result of severe environmental effects? How is it determined which equipment (qualified for Design Basis Accident [DBA] environments), will be usable and assumed to operate in severe accidents? How was credit for such equipment taken in the PRA?

c) Section 4.1.4.1 of the BV-2 IPE (Page 4.1-6) states that the containment response reported in Reference 4-7 for the Zion Plant can be taken as representative of that for BV-2. Discuss the applicability of the Zion analysis to BV-2.

d) Explain how the information in Table 4.1-3 was used in the BV-2 IPE process.

Response 5. (LATER)

Question 6. Describe briefly the plant-specific insights obtained from the BV-2 back-end analysis, and discuss how the BV-2 back-end insights were or will be used to enhance plant safety.

Response 6. As noted in Section 1.7, the BV-2 containment configuration is not conducive to flooding of the reactor cavity, either before or after vessel breach (except for vessel injection following vessel breach). The QSS provides only limited flow to the cavity while it is operating, and the RSS spray coverage pattern is such that none of its flow reaches the cavity. The cavity does not communicate with the sump, and it cannot be flooded (without an external source of water) due to spillover from the remainder of the containment. The cost-benefit aspects of design changes to provide water to the cavity will be examined during the accident management phase of the BV-2 IPE.

The BV-2 CDF contains a relatively high percentage (approximately 27%) of SBO Events. Thus, a relatively high fraction of vessel breaches occur at RCS pressures, at which the effects of forced ejection of debris from the vessel must be considered. As noted in Section 1.5, "for sequences involving Station blackout and no steam generator cooling, current procedures (ECA 0.0) preclude RCS depressurization via the PORVs, as would otherwise be directed for other sequences per FR-C.1." As also noted, consideration will be given to extending existing procedural provisions for RCS depressurization to cover Station blackout sequences where appropriate.

Core damage scenarios involving SGTRs, and a stuck open secondary side relief valve, have the potential for significant off-site releases. If low pressure injection is available, depressurization could extend the time to core damage, thereby providing a much larger time window for recovery actions, and significantly reduce the source term if core damage cannot be prevented. Existing procedures are being reviewed and updated to more explicitly instruct the operators to perform the depressurization for sequences in which all high head safety injection is also failed. Procedures and training are also being reviewed to ensure that a stuck-open main steam safety/relief valve would be locally gagged, thereby isolating the faulted steam generator.

Question 7. Discuss the considerations given to in-vessel steam explosion as a contributor to early containment failure probability.

Response 7. In-vessel steam explosions were addressed in Containment Event Tree Top Event 12 - In-vessel Steam Explosion Fails Containment (AP). As noted in Section 4.6.3 of the IPE Summary Report, the failure fractions for this Top Event were taken directly from Volume 3 of NUREG/CR-4551 (0.008 for low RCS pressure melts and 0.0008 for high pressure melts). All in-vessel steam explosion caused failures were considered as large, early containment failures. The contribution of in-vessel steam explosions to the frequency of large, early containment failures can be determined by examining the importance of CET split fractions APL and APH in the split fraction importance table for Release Category Group I (see Table 7-1 attached to this response). The table is the basis for Table 4.8-3 of the IPE submittal, which is an abbreviated version of the attached table. The sum (0.0465) of the importance of split fractions APL and APH represent the fractional contribution of in-vessel steam explosions to the frequency of Release Category Group I. This represents approximately 5% of the Release Category Group I frequency. In terms of absolute frequency, in-vessel steam explosions account for 3.7×10^{-7} per reactor year, or approximately 0.2% of the total CDF of 1.9×10^{-4} per reactor year.

TABLE 7-1. Split Fraction Importance for Large, Early Containment Failures and Bypasses

MODEL Name: BV2LVL2
Split Fraction Importance for Group : LECFBY
Sorted by Importance
Group Frequency = 8.0195E-06

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......	S[illegible]...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.......	Frequency......
1.	SSF	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0195E-06
2.	CP1	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0195E-06
3.	ICF	9.3516E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.4995E-06
4.	NRF	9.1380E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3282E-06
5.	NMF	9.0300E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.2415E-06
6.	TBF	7.8958E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3320E-06
7.	REF	7.3647E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9061E-06
8.	CCF	7.2410E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8069E-06
9.	HHF	6.7296E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.3968E-06
10.	SP2	5.9243E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7510E-[illegible]
11.	ME3	5.6083E-01	1.0487E+00	4.4027E-01	4.8790E-06	9.2000E-01	4.4976E-[illegible]
12.	WAF	5.2172E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.1839E-06
13.	FAF	4.9575E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9757E-06
14.	LCF	4.9391E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9609E-06
15.	EAF	4.8792E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9[illegible]8E-06
16.	SEF	4.7874E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8392E-06
17.	WBF	4.7689E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8244E-06
18.	LHF	4.5477E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6470E-06
19.	QSF	4.5419E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6424E-06
20.	SMF	4.5389E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6400E-06
21.	FBF	4.1475E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3261E-06
22.	RRF	4.0851E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2760E-06
23.	EBF	4.0696E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2636E-06
24.	VLF	3.8451E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0836E-06
25.	C2S	3.5658E-01	2.5452E+00	6.4342E-01	1.5251E-05	1.8750E-01	2.8596E-06
26.	L2S	3.5658E-01	1.2488E+00	6.4342E-01	4.8550E-06	5.8900E-01	2.8596E-06
27.	RCF	3.1569E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.5316E-06
28.	RDF	3.1298E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.5100E-06
29.	ME2	2.9400E-01	1.1087E+00	7.0600E-01	3.2298E-06	7.3000E-01	2.3577E-06
30.	RPR	2.8011E-01	1.4057E+00	8.3430E-01	4.5822E-06	2.9000E-01	2.2464E-06
31.	RSF	2.4861E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9937E-06
32.	OBF	2.2324E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7903E-06
33.	AOF	2.1992E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7636E-06
34.	C2J	2.0425E-01	1.8909E+00	7.9575E-01	8.7827E-06	1.8650E-01	1.6380E-06
35.	L2J	2.0425E-01	1.1443E+00	7.9575E 01	2.7952E-06	5.8600E-01	1.6380E-06
36.	SAF	1.9609E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5726E-06
37.	SBF	1.9520E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5654E-06
38.	HCF	1.9118E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5332E-06
39.	BPF	1.8441E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4789E-06
40.	AFF	1.7834E-0[illegible]	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.[illegible]02E-06
41.	C22	1.7787E-01	2.2227E+00	8.2213E-01	1.1232E-05	1.2700E-01	1.4264E-06
42.	L22	1.7787E-01	1.1534E+00	8.2213E-01	2.6563E-06	5.3700E-01	1.4264E-06
43.	IRF	1.7669E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4170E-06
44.	IWF	1.7597E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4112E-06
45.	CIF	1.7454E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3997E-06
46.	OFF	1.7436E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3983E-06
47.	ODF	1.6435E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3180E-06
48.	RPQ	1.6037E-01	1.6226E+00	8.7248E-01	6.0157E-06	1.7000E-01	1.2861E-06
49.	OSF	1.5418E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2365E-06
50.	RPP	1.5195E-01	9.8012E-01	1.0229E+00	-3.4287E-07	5.3500E-01	1.2185E-06
51.	WB4	1.4736E-01	2.7702E+00	8.5264E-01	1.5378E-05	7.6850E-02	1.1818E-06
52.	WC2	1.4714E-01	1.4854E+02	8.5286E-01	1.1843E-03	9.9630E-04	1.1800E-06
53.	RPT	1.4572E-01	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-01	1.1686E-06
54.	VL1	1.4211E 01	1.3850E+02	8.5823E-01	1.1038E-03	1.0300E-03	1.1396E-06
55.	OGF	1.3956E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1192E-06
56.	DPF	1.3784E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1054E-06
57.	C12	1.3753E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1029E-06
58.	DOF	1.2541E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0057E-06
59.	IYF	1.1830E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4869E-07
60.	IBF	1.1820E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4786E-07

TABLE 7-1. Split Fraction Importance for Large, Early Containment Failures and Bypasses

MODEL Name: BV2LVL2
Split Fraction Importance for Group : LECFBY
Sorted by Importance
Group Frequency = 8.0195E-06

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......	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.......	Frequency......
61.	BVF	1.1798E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4611E-07
62.	L2A	1.1613E-01	1.1081E+00	8.8387E-01	1.7979E-06	5.1800E-01	9.3130E-07
63.	C2A	1.1613E-01	2.7185E+00	8.8387E-01	1.4712E-05	6.3300E-02	9.3130E-07
64.	SE4	1.1151E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.9428E-07
65.	RE5A	1.0747E-01	1.7691E+00	8.9253E-01	7.0299E-06	1.2260E-01	8.6186E-07
66.	BX2	9.4989E-02	6.7834E+00	9.0501E-01	4.7142E-05	1.6159E-02	7.6176E-07
67.	BP5	9.4989E-02	1.5412E+00	9.0501E-01	5.1022E-06	1.4930E-01	7.6176E-07
68.	LS2	9.3145E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.4697E-07
69.	IAF	8.2166E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.5893E-07
70.	MFF	8.1625E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.5459E-07
71.	LS3	7.8341E-02	9.3155E-01	1.0684E+00	-1.0978E-06	5.0000E-01	6.2826E-07
72.	RP5	7.7523E-02	9.2248E-01	0.0000E+00	0.0000E+00	1.0000E+00	6.2169E-07
73.	AO1	6.5877E-02	6.9952E+01	9.3412E-01	5.5348E-04	9.5450E-04	5.2830E-07
74.	CS4	5.9120E-02	9.5379E-01	1.0059E+00	-4.1824E-07	1.1391E-01	4.7411E-07
75.	ISS	5.0757E-02	3.6731E+00	9.5100E-01	2.1830E-05	1.8000E-02	4.0705E-07
76.	TB3	4.8377E-02	2.5341E+00	9.5294E-01	1.2680E-05	2.9760E-02	3.8796E-07
77.	AF4	4.5004E-07	1.6538E+00	9.6582E-01	5.5169E-06	4.9679E-02	3.6091E-07
78.	AO2	4.4506E-02	1.3666E+00	9.5547E-01	3.2971E-06	1.0825E-01	3.5692E-07
79.	RPK	4.4122E-02	9.5588E-01	0.0000E+00	0.0000E+00	1.0000E+00	3.5384E-07
80.	FB7	4.3226E-02	8.1779E+00	9.567[illegible]-01	5.7910E-05	5.9860E-03	3.4665E-07
81.	BY2	4.2890E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4396E-07
82.	LB2	4.2890E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4396E-07
83.	APL	4.1645E-02	6.1590E+00	9.5839E-01	4.1706E-05	8.0000E-03	3.3397E-07
84.	CDF	4.1086E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2948E-07
85.	EB7	4.0771E-02	2.8477E+00	9.5923E-01	1.5144E-05	2.1590E-02	3.2696E-07
86.	RE1	4.0293E-02	8.9512E+00	9.5971E-01	6.4088E-05	5.0420E-03	3.2313E-07
87.	PRF	4.0204E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2241E-07
88.	PR9	3.9416E-02	1.3703E+00	9.6923E-01	3.2164E-06	7.6710E-02	3.1610E-07
89.	BP7	3.4879E-02	4.1041E+01	9.6512E-01	3.2139E-04	8.7033E-04	2.7971E-07
90.	RE2	3.3518E-02	1.2430E+00	9.6648E-01	2.2178E-06	1.2120E-01	[illegible].6880E-07
91.	DP1	3.0516E-02	3.6002E+02	9.6948E-01	2.8794E-03	8.4990E-05	2.4472E-07
92.	PL1	2.9792E-02	1.0152E+00	9.7021E-01	3.6089E-07	6.6200E-01	2.3891E-07
93.	RT1	2.9502E-02	3.0227E+02	9.7055E-01	2.4163E-03	9.7730E-05	2.3659E-07
94.	HR1	2.6935E-02	4.6758E+01	9.7310E-01	3.6717E-04	5.8751E-04	2.1600E-07
95.	RPS	2.4401E-02	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-01	1.9568E-07
96.	BV2	2.3826E-02	4.5071E+02	9.7617E-01	3.6066E-03	5.2979E-05	1.9107E-07
97.	CD7	2.2985E-02	9.7579E-01	1.0019E+00	-2.0933E-07	7.2680E-02	1.8433E-07
98.	OAF	2.2490E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8036E-07
99.	RPW	2.2153E-02	9.7785E-01	0.0000E+00	0.0000E+00	1.0000E+00	1.7766E-07
100.	CD8	2.1797E-02	9.9737E-01	1.0005E+00	-2.4796E-08	1.4950E-01	1.7480E-07
101.	CSF	2.0659E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6567E-07
102.	RE3	1.9570E-02	1.2210E+00	9.8043E-01	1.9290E-06	8.1360E-02	1.5694E-07
103.	BX1	1.9164E-02	0.[illegible]000E+00	9.8084E-01	0.0000E+00	5.6635E-06	1.5368E-07
104.	BP3	1.9164E-02	4.2108E+00	9.8084E-01	2.5903E-05	5.9330E-03	1.5368E-07
105.	IPS	1.8508E-02	9.2967E-01	1.1808E+00	-2.0142E-06	7.2000E-01	1.4842E-07
106.	BP4	1.7778E-02	2.1523E+01	9.8222E-01	1.6472E-04	8.6550E-04	1.4257E-07
107.	OS1	1.5939E-02	2.5027E+00	9.8408E-01	1.2179E-05	1.0[illegible]80E-02	1.2782E-07
108.	OT1	1.3486E-02	1.0412E+01	9.8769E-01	7.5579E-05	1.3060E-03	1.0815E-07
109.	SA1	1.3425E-02	2.1994E+00	9.9081E-01	9.6920E-06	7.6010E-03	1.0766E-07
110.	BF6	1.3314E-02	1.1206E+00	9.8669E-01	1.0742E-06	9.9390E-02	1.0677E-07
111.	BK1	1.2398E-02	9.8773E-01	1.0012E+00	-1.0021E-07	9.0492E-02	9.9427E-08
112.	RE7	1.2288E-02	1.5069E+00	9.8771E-01	4.1633E-06	2.3670E-02	9.8546E-08
113.	CD6	1.1994E-02	1.4725E+00	9.9057E-01	3.8649E-06	1.9560E-02	9.6182E-08
114.	MUF	1.0674E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5600E-08
115.	EB6	1.0569E-02	1.0031E+00	9.8943E-01	1.0999E-07	7.7060E-01	8.4758E-08
116.	EC2	1.0569E-02	1.1208E+00	9.8943E-01	1.0534E-06	8.0458E-02	8.475[illegible]-08
117.	FC2	1.0569E-02	4.0834E+00	9.8943E-01	2.4812E-05	3.4160E-03	8.4758E-08
118.	FB6	1.0569E-02	1.0955E+00	9.8943E-01	8.5056E-07	9.9650E-02	8.4758E-08
119.	EB4	1.0563E-02	1.2650E+00	9.8944E-01	2.2101E-06	3.8330E-02	8.4712E-08
120.	VL2	1.0143E-02	1.6501E+00	9.9124E-01	5.2838E-06	1.3300E-02	8.1339E-08

TABLE 7-1. Split Fraction Importance for Large, Early Containment Failures and Bypasses

MODEL Name: BV2LVL2
Split Fraction Importance for Group : LECFBY
Sorted by Importance
Group Frequency = 8.0195E-06

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......	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.......	Frequency......
121.	RTF	9.7628E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.8292E-08
122.	OG1	9.7213E-03	8.6148E+00	9.9028E-01	6.1145E-05	1.2750E-03	7.7959E-08
123.	VL3	9.5258E-03	1.6959E+00	9.9083E-01	5.6543E-06	1.3000E-02	7.6392E-08
124.	OA1	8.6959E-03	3.3314E+00	9.9130E-01	1.8767E-05	3.7160E-03	6.9737E-08
125.	RI1	8.3581E-03	1.3815E+00	9.9164E-01	3.1263E-06	2.1440E-02	6.7027E-08
126.	HC1	8.3197E-03	1.5088E+01	9.9168E-01	1.1305E-04	5.8990E-04	6.6720E-08
127.	SB2	8.2634E-03	1.3408E+00	9.9183E-01	2.7987E-06	2.3400E-02	6.6268E-08
128.	FB8	8.1626E-03	1.2029E+00	9.9184E-01	1.6923E-06	3.8680E-02	6.5460E-08
129.	EC1	8.1405E-03	9.2960E+00	9.9186E-01	6.6595E-05	9.8029E-04	6.5282E-08
130.	EB8	7.9913E-03	1.0728E+00	9.9201E-01	6.4766E-07	9.8950E-02	6.4086E-08
131.	AF6	7.9353E-03	4.1938E+01	9.9208E-01	3.2837E-04	1.9343E-04	6.3637E-08
132.	FA2	7.8870E-03	1.2222E+00	9.9211E-01	1.8448E-06	3.4285E-02	6.3249E-08
133.	TB4	7.8225E-03	1.1796E+00	9.9378E-01	1.4899E-06	3.3470E-02	6.2732E-08
134.	EA2	7.6983E-03	1.0660E+00	9.9230E-01	5.9123E-07	1.3442E-01	6.1736E-08
135.	FA1	7.5622E-03	6.8149E+00	9.9244E-01	4.6693E-05	1.2988E-03	6.0644E-08
136.	BV4	7.4571E-03	5.6300E+01	9.9254E-01	4.4354E-04	1.3483E-04	5.9802E-08
137.	EA1	7.3946E-03	1.2818E+00	9.9261E-01	2.3188E-06	2.5574E-02	5.9301E-08
138.	RW1	5.7550E-03	0.0000E+00	9.9424E-01	0.0000E+00	4.7860E-05	4.6152E-08
139.	CEF	4.8911E-03	1.0080E+00	9.9511E-01	1.0322E-07	3.8000E-01	3.9224E-08
140.	LEF	4.8911E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9224E-08
141.	HEA	4.8911E-03	1.0002E+00	9.9562E-01	3.6413E-08	9.6500E-01	3.9224E-08
142.	APH	4.8695E-03	6.2271E+00	9.9581E-01	4.1952E-05	8.0000E-04	3.9051E-08
143.	RC1	4.8665E-03	1.1921E+00	9.9513E-01	1.5794E-06	2.4709E-02	3.9027E-08
144.	OR1	4.3360E-03	1.3040E+01	9.9566E-01	9.6590E-05	3.6000E-04	3.4772E-08
145.	PR7	4.1252E-03	1.0633E+00	9.9671E-01	5.3404E-07	4.9460E-02	3.3082E-08
146.	PRV	3.7277E-03	9.9652E-01	1.0015E+00	-3.9817E-08	2.9890E-01	2.9894E-08
147.	DO3	3.4900E-03	7.0798E+00	9.9651E-01	4.8785E-05	5.7370E-04	2.7988E-08
148.	DP3	3.4519E-03	7.0760E+00	9.9655E-01	4.8754E-05	5.6780E-04	2.7682E-08
149.	REA	3.2324E-03	1.0205E+00	9.9677E-01	1.9060E-07	1.3600E-01	2.5922E-08
150.	AF3	3.0641E-03	1.0417E+00	9.9774E-01	3.5263E-07	5.1502E-02	2.4572E-08
151.	OS6	2.9872E-03	3.6572E+00	9.9714E-01	2.2936E-05	1.0000E-03	2.3956E-08
152.	RD1	2.6511E-03	1.1044E+00	9.9735E-01	8.5819E-07	2.4774E-02	2.1261E-08
153.	HH2	2.5193E-03	3.9055E+00	9.9749E-01	2.3321E-05	8.6265E-04	2.0204E-08
154.	BV1	2.4611E-03	0.0000E+00	9.9754E-01	0.0000E+00	1.7241E-07	1.9737E-08
155.	SB1	2.3399E-03	8.2941E-01	1.0012E+00	-1.3780E-06	7.2320E-03	1.8764E-08
156.	BPA	2.2671E-03	1.4333E+01	9.9773E-01	1.0694E-04	1.7000E-04	1.8181E-08
157.	DO2	2.2559E-03	5.6244E+00	9.9774E-01	3.7103E-05	4.8760E-04	1.8092E-08
158.	BV5	2.2309E-03	1.0711E+00	9.9777E-01	5.8789E-07	3.0431E-02	1.7890E-08
159.	SA2	2.1838E-03	1.0089E+00	9.9990E-01	7.1919E-08	1.1470E-02	1.7513E-08
160.	HC3	2.0751E-03	1.1521E+00	9.9798E-01	1.2356E-06	1.3090E-02	1.6641E-08
161.	RI2	1.9922E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5977E-08
162.	HH4	1.7802E-03	4.0789E+00	9.9822E-01	2.4705E-05	5.7782E-04	1.4276E-08
163.	OR3	1.7493E-03	1.1500E+00	9.9825E-01	1.2167E-06	1.1530E-02	1.4028E-08
164.	CCB	1.7461E-03	1.2704E+00	9.9836E-01	2.1814E-06	6.0449E-03	1.4003E-08
165.	DP2	1.7183E-03	4.3786E+00	9.9828E-01	2.7108E-05	5.0830E-04	1.3779E-08
166.	OA2	1.6386E-03	1.0478E+00	9.9836E-01	3.9616E-07	3.3170E-02	1.3141E-08
167.	OB1	1.6266E-03	1.3269E+00	9.9837E-01	2.6343E-06	4.9480E-03	1.3045E-08
168.	HC2	1.5954E-03	1.1167E+00	9.9844E-01	9.4825E-07	1.3230E-02	1.2794E-08
169.	IW1	1.5892E-03	2.8063E+01	9.9841E-01	2.1704E-04	5.8720E-05	1.2745E-08
170.	RE9	1.5818E-03	1.1363E+00	9.9842E-01	1.1059E-06	1.1470E-02	1.2685E-08
171.	IR1	1.4877E-03	2.5757E+01	9.9851E-01	1.9853E-04	6.0090E-05	1.1931E-08
172.	RD2	1.4829E-03	1.0618E+00	9.9852E-01	5.0755E-07	2.3430E-02	1.1892E-08
173.	SB6	1.4722E-03	1.0155E+00	9.9859E-01	1.3566E-07	8.3210E-02	1.1806E-08
174.	VIF	1.3668E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0961E-08
175.	SE2	1.3510E-03	1.2535E+00	9.9865E-01	2.0434E-06	5.3020E-03	1.0834E-08
176.	PR1	1.3394E-03	3.6514E+00	9.9867E-01	2.1274E-05	5.0210E-04	1.0741E-08
177.	BP8	1.3006E-03	1.0111E+00	9.9870E-01	9.9536E-08	1.0479E-01	1.0430E-08
178.	OS2	1.2926E-03	1.0723E+00	9.9873E-01	5.9005E-07	1.7220E-02	1.0366E-08
179.	IR2	1.1804E-03	4.4797E+00	9.9882E-01	2.7915E-05	3.3910E-04	9.4660E-09
180.	OS4	1.1696E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3798E-09

TABLE 7-1. Split Fraction Importance for Large, Early Containment Failures and Bypasses

MODEL Name: BV2LVL2
Split Fraction Importance for Group : LECFBY
Sorted by Importance
Group Frequency = 8.0195E-06

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......	SF Name...	Importance.....	Achievement..	Reduction...	Derivati	SF Value.......	Frequency......
181.	RE4	1.1429E-03	1.0071E+00	9.9886E-01	6.6322[illegible]	1.3820E-01	9.1656E-09
182.	SB3	1.1228E-03	1.0863E+00	9.9934E-01	6.974[illegible]-07	7.6060E-03	9.0046E-09
183.	AF2	9.7147E-04	2.9590E+00	9.9905E-01	1.5718E-05	4.8585E-04	7.7907E-09
184.	RE6A	9.6348E-04	1.0049E+00	9.9904E-01	4.6714E-08	1.6540E-01	7.7266E-09
185.	RT2	9.1242E-04	1.5134E+00	9.9907E-01	4.1242E-06	1.7740E-03	7.3171E-09
186.	IW2	9.0358E-04	3.6404E+00	9.9910E-01	2.1182E-05	3.4210E-04	7.2462E-09
187.	RWF	9.0258E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.2382E-09
188.	MF1	8.6533E-04	1.2825E+00	9.9913E-01	2.2726E-06	3.0536E-03	6.9395E-09
189.	PR6	8.4700E-04	9.6934E-01	1.0016E+00	-2.5906E-07	5.0960E-02	6.7925E-09
190.	RT3	8.3793E-04	0.0000E+00	9.9916E-01	0.0000E+00	3.5780E-06	6.7197E-09
191.	RIF	8.3793E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.7197E-09
192.	SE5	8.2849E-04	1.1605E+00	9.9917E-01	1.2941E-06	5.1340E-03	6.6440E-09
193.	OB2	8.2332E-04	1.1386E+00	9.9923E-01	1.1180E-06	5.5180E-03	6.6026E-09
194.	FR8	7.7929E-04	1.0182E+00	9.9953E-01	1.4972E-07	2.5070E-02	6.2495E-09
195.	AF1	7.5750E-04	0.0000E+00	9.9925E-01	0.0000E+00	1.0720E-05	6.0748E-09
196.	SB4	7.4990E-04	8.8755E-01	1.0013E+00	-9.1202E-07	1.1210E-02	6.0138E-09
197.	TB1	7.4687E-04	1.4517E+00	9.9935E-01	3.6274E-06	1.4460E-03	5.9895E-09
198.	PA1	7.3445E-04	1.0448E+00	9.9927E-01	3.6515E-07	1.6130E-02	5.8899E-09
199.	PR4	6.6156E-04	9.5462E-01	1.0004E+00	-3.6729E-07	9.1130E-03	5.3053E-09
200.	CI6	6.5774E-04	1.0547E+00	9.9934E-01	4.4400E-07	1.1880E-02	5.2747E-09
201.	HR2	6.3433E-04	1.0957E+00	9.9937E-01	7.7286E-07	6.5820E-03	5.0870E-09
202.	DO1	6.0988E-04	8.3007E+00	9.9939E-01	5.8553E-05	8.3530E-05	4.8909E-09
203.	SB9	5.4355E-04	9.9738E-01	1.0000E+00	-2.1247E-08	1.1810E-02	4.3589E-09
204.	SA4	5.2846E-04	9.9615E-01	1.0000E+00	-3.1223E-08	1.1660E-02	4.2380E-09
205.	LH2	4.9623E-04	1.0422E+00	9.9950E-01	3.4241E-07	1.1622E-02	3.9795E-09
206.	PA2	4.8825E-04	1.0605E+00	9.9951E-01	8.0302E-09	4.8760E-01	3.9155E-09
207.	CS2	4.8130E-04	8.9324E-01	1.0004E+00	-8.6748E-07	3.8348E-03	3.8598E-09
208.	HMF	4.1034E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2907E-09
209.	PRJ	3.6480E-04	9.9931E-01	1.0003E+00	-7.9407E-09	3.0340E-01	2.9255E-09
210.	AF5	3.5564E-04	1.5125E+00	9.9965E-01	4.1131E-06	6.8198E-04	2.8520E-09
211.	RDA	3.4825E-04	1.0041E+00	9.9965E-01	3.5837E-08	7.7930E-02	2.7928E-09
212.	RX1	3.4825E-04	1.1805E+00	9.9965E-01	1.4503E-06	1.9257E-03	2.7928E-09
213.	FC1	3.4687E-04	0.0000E+00	9.9965E-01	0.0000E+00	2.4771E-05	2.7817E-09
214.	FB4	3.4687E-04	1.0178E+00	9.9965E-01	1.4587E-07	1.9070E-02	2.7817E-09
215.	HH3	3.4665E-04	1.5740E+00	9.9966E-01	4.6056E-06	5.8975E-04	2.7800E-09
216.	LH1	3.3198E-04	1.4810E+00	9.9967E-01	3.8604E-06	6.8966E-04	2.6623E-09
217.	HH5	3.0278E-04	1.4054E+00	9.9970E-01	3.2538E-06	7.3718E-04	2.4281E-09
218.	MU2	3.0248E-04	1.0148E+00	9.9970E-01	1.2129E-07	2.0000E-02	2.4257E-09
219.	BK2	2.8812E-04	7.2190E-01	1.0001E+00	-2.2313E-06	5.0316E-04	2.3106E-09
220.	FB3	2.4799E-04	1.1901E+00	9.9975E-01	1.5263E-06	1.3030E-03	1.9887E-09
221.	CS3	2.4156E-04	8.9129E-01	1.0009E+00	-8.7930E-07	8.5727E-03	1.9372E-09
222.	WA2	2.3946E-04	1.0182E+00	9.9976E-01	1.4806E-07	1.2970E-02	1.9203E-09
223.	OB3	2.3171E-04	1.0144E+00	9.9978E-01	1.1692E-07	1.5200E-02	1.8582E-09
224.	BV3	2.3102E-04	0.0000E+00	9.9977E-01	0.0000E+00	1.2627E-06	1.8527E-09
225.	OR2	2.2900E-04	1.1276E+00	9.9977E-01	1.0248E-06	1.7920E-03	1.8365E-09
226.	HM1	2.2848E-04	1.3977E+00	9.9977E-01	3.1916E-06	5.7410E-04	1.8323E-09
227.	ASF	2.2653E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8166E-09
228.	SM2	2.2525E-04	1.0040E+00	9.9977E-01	3.3764E-08	5.3500E-02	1.8064E-09
229.	QS2	2.2525E-04	1.0363E+00	9.9977E-01	2.9322E-07	6.1605E-03	1.8064E-09
230.	WB3	2.0532E-04	1.0166E+00	9.9979E-01	1.3474E-07	1.2220E-02	1.6466E-09
231.	OD6	2.0087E-04	8.1042E-01	1.0003E+00	-1.5224E-06	1.3560E-03	1.6109E-09
232.	HLF	1.7963E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4405E-09
233.	PRA	1.7682E-04	9.0528E-01	1.0002E+00	-7.6117E-07	2.0010E-03	1.4180E-09
234.	MSF	1.7061E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3682E-09
235.	RE8	1.6108E-04	1.0078E+00	9.9984E-01	6.3792E-08	2.0250E-02	1.2918E-09
236.	OR5	1.5710E-04	1.4181E+00	9.9984E-01	3.3542E-06	3.7560E-04	1.2598E-09
237.	AFA	1.5682E-04	1.0369E+00	9.9984E-01	2.9694E-07	4.1872E-03	1.2576E-09
238.	CI2	1.4977E-04	1.0087E+00	9.9985E-01	7.0816E-08	1.6960E-02	1.2010E-09
239.	OA3	1.4745E-04	1.0345E+00	9.9985E-01	2.7751E-07	4.2610E-03	1.1825E-09
240.	PA3	1.4410E-04	1.0002E+00	9.9986E-01	2.8337E-09	4.0780E-01	1.1556E-09

TABLE 7-1. Split Fraction Importance for Large, Early Containment Failures and Bypasses

MODEL Name: BV2LVL2
Split Fraction Importance for Group : LECFBY
Sorted by Importance
Group Frequency = 8.0195E-06

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......	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.......	Frequency......
241.	CI1	1.4177E-04	1.0273E+00	9.9986E-01	2.2004E-07	5.1670E-03	1.1369E-09
242.	AW1	1.3909E-04	1.2989E+00	9.9986E-01	2.3981E-06	4.6512E-04	1.1154E-09
243.	PRH	1.3640E-04	1.0004E+00	9.9989E-01	4.0486E-09	2.1240E-01	1.0938E-09
244.	SA7	1.2098E-04	1.0077E+00	9.9991E-01	6.2205E-08	1.1740E-02	9.7019E-10
245.	SBJ	1.2098E-04	1.0033E+00	9.9988E-01	2.7791E-08	3.4910E-02	9.7019E-10
246.	C2T	9.5981E-05	1.0959E+00	9.9990E-01	7.6972E-07	1.0000E-03	7.6972E-10
247.	L2T	9.5981E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.6972E-10
248.	AS1	7.9922E-05	1.0079E+00	9.9992E-01	6.4093E-08	1.0000E-02	6.4093E-10
249.	OF1	6.9267E-05	9.9520E-01	1.0000E+00	-3.8578E-08	1.2100E-03	5.5549E-10
250.	SA5	6.3032E-05	1.0008E+00	9.9999E-01	6.7637E-09	1.3910E-02	5.0548E-10
251.	IA1	5.1323E-05	3.6870E-01	1.0002E+00	-5.0645E-06	3.4241E-04	4.1158E-10
252.	SBE	4.9633E-05	1.0006E+00	9.9995E-01	5.2345E-09	7.4390E-02	3.9803E-10
253.	FB5	3.8598E-05	1.0012E+00	9.9996E-01	9.6309E-09	3.2140E-02	3.0954E-10
254.	EB3	3.5644E-05	1.0014E+00	9.9996E-01	1.1285E-08	2.53[illegible]-02	2.8584E-10
255.	IB2	2.5281E-05	1.0478E+00	9.9997E-01	3.8348E-07	5.2870E-04	2.0274E-10
256.	TT2	2.1019E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6856E-10
257.	L3C	1.8478E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4818E-10
258.	C3C	1.8478E-05	1.0000E+00	9.9998E-01	3.8996E-10	3.8000E-01	1.4818E-10
259.	H3C	1.8478E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4818E-10
260.	HH6	1.8215E-05	0.0000E+00	9.9998E-01	0.0000E+00	6.7642E-07	1.4607E-10
261.	OD7	1.7420E-05	9.5973E-01	1.0001E+00	-3.2349E-07	1.6470E-03	1.3970E-10
262.	SBA	1.7203E-05	9.9995E-01	1.0000E+00	-4.0083E-10	3.5820E-0[illegible]	1.3796E-10
263.	SBC	1.5854E-05	9.9753E-01	1.0000E+00	-2.0053E-08	1.3550E-[illegible]	1.2714E-10
264.	CCG	1.5537E-05	1.0371E+00	9.9999E-01	2.9778E-07	2.8030E-04	1.2460E-10
265.	RT4	1.5175E-05	0.0000E+00	9.9999E-01	0.0000E+00	4.3000E-06	1.2170E-10
266.	SL1	0.0000E+00	9.9372E-01	1.0002E+00	-5.1975E-08	3.0970E-02	0.0000E+00
267.	CC1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8563E-05	0.0000E+00
268.	AF7	0.0000E+00	9.9963E-01	1.0000E+00	-2.9978E-09	2.2947E-04	0.0000E+00
269.	MS1	0.0000E+00	9.9381E-01	1.0000E+00	-4.9671E-08	7.1010E-04	0.0000E+00
270.	AFC	0.0000E+00	9.9972E-01	1.0000E+00	-2.2749E-09	4.8675E-04	0.0000E+00
271.	PRI	0.0000E+00	9.9987E-01	1.0000E+00	-1.1944E-09	1.0200E-01	0.0000E+00
272.	CC7	0.0000E+00	9.9994E-01	1.0000E+00	-4.9264E-10	2.5825E-04	0.0000E+00
273.	CC4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.0554E-05	0.0000E+00
274.	CC2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.1228E-05	0.0000E+00
275.	OF2	0.0000E+00	9.9983E-01	1.0000E+00	-1.3919E-09	3.3130E-04	0.0000E+00
276.	PRK	0.0000E+00	9.9979E-01	1.0000E+00	-1.7016E-09	2.0570E-03	0.0000E+00
277.	LS1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
278.	TT3	0.0000E+00	9.9996E-01	1.0000E+00	-2.9063E-10	1.6640E-02	0.0000E+00
279.	TT1	0.0000E+00	9.8300E-02	1.0000E+00	-7.2315E-06	5.0560E-05	0.0000E+00
280.	BY1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
281.	OS0	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
282.	TTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
283.	ME1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
284.	SP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
285.	AFB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.2482E-05	0.0000E+00
286.	MS0	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
287.	C11	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
288.	OD8	0.0000E+00	9.7667E-01	1.0001E+00	-1.8755E-07	2.2960E-03	0.0000E+00
289.	C21	0.0000E+00	9.9509E-01	1.0000E+00	-3.9380E-08	2.0000E-04	0.0000E+00
290.	IA2	0.0000E+00	8.6336E-01	1.0001E+00	-1.0964E-06	5.8650E-04	0.0000E+00
291.	OD1	0.0000E+00	9.9960E-01	1.0000E+00	-3.2138E-09	1.1950E-03	0.0000E+00
292.	PIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
293.	PR0	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
294.	PR2	0.0000E+00	9.9298E-01	1.0000E+00	-5.6298E-08	5.2240E-04	0.0000E+00
295.	CS6	0.0000E+00	9.9987E-01	1.0000E+00	-1.0699E-09	3.5740E-02	0.0000E+00
296.	PI2	0.0000E+00	8.4886E-01	1.0040E+00	-1.2438E-06	2.5470E-02	0.0000E+00
297.	DC3	0.0000E+00	9.9998E-01	1.0000E+00	-1.5598E-10	5.0000E-02	0.0000E+00
298.	CS5	0.0000E+00	9.9994E-01	1.0000E+00	-4.8821E-10	4.7728E-04	0.0000E+00
299.	PR5	0.0000E+00	9.9905E-01	1.0000E+00	-7.7924E-09	2.5930E-02	0.0000E+00
300.	IC2	0.0000E+00	9.9[illegible]0E-01	1.0000E+00	-4.0889E-08	3.2777E-04	0.0000E+00

MODEL Name: BV2LVL2
Split Fraction Importance for Group : LECFBY
Sorted by Importance
Group Frequency = 8.0195E-06

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......	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.......	Frequency......
301.	IC1	0.0000E+00	9.4026E-01	1.0000E+00	-4.7919E-07	1.8347E-04	0.0000E+00
302.	PR3	0.0000E+00	9.9321E-01	1.0000E+00	-5.4508E-08	5.1040E-04	0.0000E+00
303.	HH7	0.0000E+00	9.7979E-01	1.0000E+00	-1.6228E-07	1.3939E-03	0.0000E+00
304.	IP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
305.	SBI	0.0000E+00	9.9748E-01	1.0000E+00	-2.0446E-08	1.2250E-02	0.0000E+00
306.	CD3	0.0000E+00	9.9857E-01	1.0000E+00	-1.1526E-08	6.4980E-03	0.0000E+00
307.	CD1	0.0000E+00	9.9522E-01	1.0000E+00	-3.8356E-08	9.1230E-04	0.0000E+00
308.	CDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
309.	L12	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
310.	CCD	0.0000E+00	9.9994E-01	1.0000E+00	-4.9267E-10	2.7463E-04	0.0000E+00
311.	CCJ	0.0000E+00	9.9455E-01	1.0000E+00	-4.3740E-08	3.4410E-04	0.0000E+00
312.	OD9	0.0000E+00	9.9944E-01	1.0000E+00	-4.5324E-09	1.6030E-03	0.0000E+00
313.	PI1	0.0000E+00	7.4574E-01	1.0000E+00	-2.0394E-06	1.8120E-04	0.0000E+00
314.	IS1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
315.	RTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
316.	RT5	0.0000E+00	8.8190E-01	1.0001E+00	-9.4756E-07	5.1510E-04	0.0000E+00
317.	OD3	0.0000E+00	9.9786E-01	1.0000E+00	-1.7213E-08	1.2900E-03	0.0000E+00
318.	OTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
319.	CS1	0.0000E+00	9.5622E-01	1.0000E+00	-3.5115E-07	5.4721E-05	0.0000E+00

Question 8. a) Provide a discussion of the ignition sources and limits used in the hydrogen combustion analyses. Were sensitivity studies performed to evaluate the impact on the IPE results, due to the uncertainties of the ignition limits used?

b) Provide the information requested in NUREG-1335 (Section 2.2.2.1), i.e., accurate but simple representations of the containment showing the instrument tunnel, reactor cavity compartment, loop compartment(s), annular compartment(s) and upper compartment, with specific identification of potential reactor release points and vent paths indicated. Estimates of compartment free volumes and vent path flow areas should also be provided. Please address specifically how this information is used in the assessment of hydrogen pocketing and detonation.

c) Discuss the plant-specific effects on containment integrity and equipment survivability due to local detonations. The discussion should cover likelihoods of local detonation and potentials for missile generation as a result of local detonations.

d) In Page 4.6-19 on Top Event 20 - Late Burn of Combustible Gases, the IPE states that, "If the containment is not inerted..., hydrogen burns are assumed to be assured in this time period; however, these burns are not expected to challenge the containment." Please discuss briefly the reasons for not expecting the hydrogen burns to challenge the containment.

Response 8. (LATER)

Question 9. NUREG-1335 recognizes the importance of considering uncertainties in the accident progression and CET quantification. EPRI recommends that sensitivity studies be performed by MAAP users, which could provide qualitative insight into understanding uncertainties. Please specify what specific revision(s) of the MAAP-3.0B Code were used for the BV-2 PRA. Address the Gabor Kenton & Associates report prepared for EPRI ("Recommended Sensitivity Analyses for an Individual Plant Examination Using MAAP-3.0B"). In particular, with respect to Appendix A of the report, indicate for each of the 78 indicated parameters:

a) If the recommended value(s) were used,

b) If value(s) other than the recommended value(s) were used, and the basis for the choice; or

c) If the sensitivity study indicated was not performed, provide the reasons for omitting the recommended analyses.

Response 9. Calculations were performed with MAAP-3.0B, Revisions 14 and 16. The analysis for Surry described in NUREG-1150 was used as the basis for the PRA quantification and no sensitivity studies were performed by DLC.

Question 10. Discuss briefly the quantification results for each containment isolation failure mode (including common-mode failure).

Response 10. (LATER)

Question 11. The Table on Pages 2.4-1 and 2, identifying walk-throughs, does not explicitly identify any specific system walkdowns by analysts to account for the impact of plant modifications prior to walk-throughs, or modifications conducted during the time frame of the IPE. In addition, in the list of information sources (Table 2.4-1), there is no mention of Engineering documents used to control plant modifications.

What is the "FREEZE" date used for the plant configuration analyzed in the IPE?

Since there is usually a lag time between documents that request plant modifications and revision to documents that were used to base the models on, were any modifications incorporated in the plant that were being done just before the freeze date that were not incorporated in the model?

Response 11. (LATER)

Question 12. Duquesne Light Company (DLC) has stated that the PRA for BV- s originally performed by Pickard, Lowe and Garrick, Inc. (PLG, and Stone & Webster Engineering Corporation (S&W), and that DLC personnel incorporated plant-specific data and requantified the model. However, Table 5.3-1 shows minimal involvement of the DLC organization in reviewing the quantification.

Since expertise in the methods is important to ensure that the techniques are correctly applied, please discuss DLC personnel participation in the update of the BV-2 Model and the completion of the Beaver Valley Unit 1 (BV-1) PRA.

Response 12. (LATER)

Question 13. Section 5.4 resolution of comments indicates that the review comment/resolutions were documented in accordance with the PLG-0223, "Quality Assurance Program". Does conformance with this program comply with the DLC in-house requirements for documentation?

Will comment/resolution for BV-1 use PLG's program or DLC's?

Response 13. The PLG Quality Assurance Program requirements for documentation meet or exceed the DLC program requirements. BV-1 Comment resolutions will be documented per the DLC program.

Question 14. Table 3.1.1-2 identifies Instrument Air as being captured under Initiating Event "TLMFW". However, there is no discussion in Section 3.1.1 (Initiating Events) which indicates that the frequency of this event was added to the "TLMFW". Please identify the frequency of Loss of Instrument Air (LOIA), and the source, i.e., whether the frequency was obtained from generic or plant-specific data.

Response 14. Loss of Instrument Air (LOIA) was not explicitly added to the Total Loss of Main Feedwater (TLMFW) Initiating Event frequency because the frequency of LOIA is a small percentage of TLMFW. The frequency of LOIA from generic sources reported in IL3 Reference 3.3.1-3 is 2.0×10^{-3} per year. This frequency corresponds to total Losses of Instrument Air. It is seen to be very small compared to the Total Loss of Main Feedwater frequency of 0.12 per year. Partial losses of air to individual components (e.g., MFW valves) are alr_ y accounted for in the frequencies assigned to such initiating events, i.e., such events are included in the derivation of initiating event frequencies for partial and total losses of Main Feedwater.

Question 15. Discuss the impact of LOIA on front line and support systems designed to mitigate the effects of failures sustained during or after a trip, and the rationale used in combining the event with TLMFW as opposed to treating it as a unique Initiating Event.

Response 15. The impact of LOIA on systems is described in IPE Section 3.2.2, dependency tables. Both the intersystem dependencies associated with instrument air and the containment instrument air systems are identified. The first page of the Support-to-Frontline System Dependency Table, Table 3.2.3-2, was inadvertently omitted from the submittal. This first page of the table is attached as Page 18 of this submittal.

The loss of containment instrument air would cause the air-operated containment isolation valves inside containment to fail to the "fail-safe" position. As indicated in Table 3.1.1-2, this would cause the CCP isolation valves for the RCP thermal barrier cooling to fail closed, but RCP seal injection and RCP motor cooling would remain available. Therefore, loss of this system would not cause a plant trip.

The immediate impact on the plant of a loss of Instrument Air would be closure of the feedwater control valves, the condenser steam dump valves, the isolation of letdown, and the loss of control for normal pressurizer spray. The MSIVs will eventually close when their accumulators are exhausted; i.e., after approximately thirty (30) minutes.

The most significant impact of a loss of Instrument Air on systems designed to mitigate a plant trip is the loss of Main Feedwater and the Main Condenser. The TLMFW Initiating Event includes the same impact on main feedwater and the condenser as the LOIA. Treating LOIA as a unique Initiating Event would add a minor contribution to the total core damage frequency. This conclusion is based on the fact that the Auxiliary Feedwater flow valves and the pressurizer PORVs are not dependent on compressed air at Beaver Valley Unit 2, as they are at some other plants.

Table 3.2.3-2 (Page 1 of 9). Support-to-Frontline System Dependency Table

Support System Failed / Frontline System Effected	Reactor Coolant Pumps			Pressurizer PORV Trains			Pressurizer Spray Valves		Main Feed Pumps			Feedwater Valves	Condensate Pumps	Turbine Trip	MSIVs	Atmospheric Dump Valves 2SVS*PCV 101A, 101B, 101C	Condenser Dump Valves	Residual Heat Release Valve HCV-104	RCS Letdown
	P21A	P21B	P21C	PORV 455C, Block Valve 535	PORV 455D, Block Valve 537	PORV 456, Block Valve 536	Normal 2RCS*PCV455A 2RCS*PCV455B	Auxiliary 2CHS*MOV310	P21A	P21B	P24								
Offsite Grid	X (47)	X (47)	X (47)				(93)		X (82)	X (82)	X (83)		X	(84)			X (86)		
Emergency 4,160V/480V AC Train A (Orange)/Diesel Generator 2-1					(48)	(48)										X			
Emergency 4,160V/480V AC Train B (Purple)/Diesel Generator 2-2				(48)														X (70)	
Emergency 125V DC Train A (Orange)/Battery 2-1					X	X								(90)	(67)		X (96)		X (89, 91)
Emergency 125V DC Train B (Purple)/Battery 2-2				X								X (58)		(90)	(67)		X (96)		X (91, 93)
Vital Bus Channel I (Red)	(100)			(90)	(80)	(80)								(40)		X			(84)
Vital Bus Channel II (White)		(100)	(100)	(90)	(80)	(90)								(49)					(84)
Vital Bus Channel III (Blue)				(80)	(51,80)	(51,80)						(85,87)					X (98)		(84)
Vital Bus Channel IV (Yellow)				(51)			(93)					(85,87)							(89)
SSPS Train A (SI, CIA, FWI, SLI)				(58)	(52,56,80)	(52,56,80)			(80)	(80)	(80)	(80)		(50,60)	(59)		(62)		
SSPS Train B (SI, CIA, FWI, SLI)				(52,56,80)	(58)	(58)			(80)	(20)	(80)	(80)		(50,60)	(59)		(63)		
SSPS Train A (CIB)	(102)																		
SSPS Train B (CIB)		(102)	(102)																
Instrument Air/Containment Instrument Air	(100,102)	(100,102)	(100,102)				X				(76)	X (75)			(67)		X (75)		X (94)
Service Water Header A																			
Service Water Header B																			
Primary Component Cooling Water Header A	X (38)																		
Primary Component Cooling Water Header B		X (38)	X (38)																
Reactor Trip Breakers												(57,71)		(57)					
ERF (Black) Diesel Generator								(93)											
Secondary Component Cooling Water									X	X	X		X						
Normal DC Supply, Batteries 2-5 and 2-6	(73)	(73)	(73)						(74)	(74)	(74)		(74)				X (97)		X (95)
AMSAC System														(99)					

Question 16. Discuss the technical basis, or provide a reference for "assuming" that "very small LOCAs" (less than 1/2 in. equivalent diameter) are within the makeup capacity of the normal charging system and, therefore, these events could be "conservatively" included with "small LOCA" Initiating Events (Page 3.1-7 in Section 3.1.1).

Response 16. The reference to conservatively include very small LOCAs within the small LOCA Initiating Event category refers to only those events which lead to an immediate plant trip. The accident sequence model for small LOCAs is conservative for such cases, because it assumes that recirculation from the containment sump will eventually be required. By contrast, in the analysis for Surry in NUREG/CR-4550, for very small LOCAs, credit was taken for cooling down and going on closed loop RHR as an alternative success path to that of recirculation from the sump. The omission of this success path makes the current analysis conservative for very small LOCAs. The PRA Team at Duquesne Light Company is unaware of any small or very small LOCA events at a U.S. nuclear plant, which resulted in the need for recirculation from the containment sump. Instead, all such LOCAs which have occurred to date, have been successfully mitigated by RCS depressurization and successful closed loop RHR cooling.

For very small LOCAs which do not lead to an immediate plant trip, the leak rate must be within the capacity of normal charging; otherwise, the net loss of inventory would lead to a plant trip. Normal charging is designed for mitigation of RCS breaks up to 3/8" in diameter. For very small LOCAs, less than this size, the operators would initiate a controlled, manual plant shutdown, which is not considered a plant initiator.

Question 17. Discuss the impact of LOCAs or Steam Line Breaks on mitigating systems as Initiating Events.

Response 17. (LATER)

Question 18. Unlike the information provided for component data, there is no discussion or identification of plant-specific data used in the "updating process" for Initiating Events.

a) Provide a listing of the frequency of Initiating Events (e.g., Turbine Trip, Reactor Trip, Loss of Offsite Power/Main F.W./Instrument Air) that were obtained from plant operating experience, as opposed to those arrived at through system analysis.

b) Include a discussion of the updating process for the Initiating Events and a discussion of the frequency of those events whose total frequency is made up of multiple events (e.g., TLMFW).

Section 1.1 states that in 1991 DLC developed a plant-specific database and used it to requantify the Unit 2 PRA model. However, Section 3.3.2.1 indicates that the plant-specific data presented and discussed in Section 3.3.2 was collected between 11/87 and 12/88.

c) Has the data presented been captured through 1988 or 1991?

d) Is the PRA model quantified using plant-specific data different from what is presented in the IPE?

e) If the PRA model has been quantified using plant-specific data through 1988, please provide a discussion of any plans to update the database and the PRA model, and any component failures or Initiating Events occurring since 1988, which would impact the IPE results.

Response 18. (LATER)

Question 19. Generic Letter 88-20 and NUREG-1335 request that the IPE submittal provide a list of all generic plant data for equipment and Initiating Events, including origin and method of analysis.

Since Section 3.3.1 indicates that for a majority of components the generic component failure rates were taken from "Database for PRA of Light Water Nuclear Power Plants", PLG-0500, 1989, and since this document is not in the public domain, please provide a listing of the generic component failure rates used for the BV-2 IPE (or the PLG database used in the analysis). This list should include those generic values used as a basis for updated values.

Response 19. (LATER)

Question 20. In verifying that the submittal contained a listing of Initiating Event frequencies, it was noted:

That the system Initiating Event frequencies in Table 3.1.1-3 were different from the values provided in Table 3.3.5-2.

A constant value is displayed for all parameters of the distribution for Initiating Events WAX, WBX, and WXB.

Explain these apparent discrepancies, and provide a discussion regarding any possible impacts on the results presented in the IPE, due to these discrepancies.

Response 20. Table 3.3.5-2 used Beaver Valley Unit 2 plant-specific data for obtaining the Initiating Event frequencies derived from system models, while Table 3.1.1-3 used PLG generic component failure rates. The values from Table 3.3.5-2 are correct and were the ones used to quantify the Event Trees. Table 3.1.1-3 should have been updated to reflect these values.

When developing the Service Water System models for Riskman, it was necessary to break the system up into several different smaller Top Events in order to generate the cutsets. The values for the WAX, WBX, and WXB initiators were derived from equations that used mean values from the initiating uncertainty distributions for these smaller Top Events, and are, therefore, only point values based on the means of the smaller Tops Initiating Event frequencies. This, however, has no effect on the core damage frequency, since Riskman only uses the mean values of the Initiating Event distributions to quantify the Event Trees.

Question 21. The Internal Flooding Analysis indicated that mitigating features such as redundancy and separation were considered. However, actual operating experience has demonstrated that separate rooms do not necessarily provide protection because of drain systems that are plugged or allow backflow, unsealed doors, or maintenance actions or situations. Discuss how consideration was given to these conditions in the flooding analysis, and how they impacted the choice or quantification of Initiating Events.

Response 21. The choice, quantification and impact of internal flood Initiating Events is based on evaluation of actual flood sources at each location, as well as potential propagation into the location. In considering propagation, the number and size of drains was considered, whether there are seals on the door was considered, and whether the door opens out of the room or into the room was considered. In addition, backflow through drains was reviewed. These considerations were checked in the field during walk-throughs. In general, if there were several drains in a room, it was assumed that most were functional (unplugged) and a large flood source was required to impact equipment. Maintenance actions were considered with regard to flood Initiating Events and are included in the Initiating Event database. Maintenance was not explicitly considered with regard to open doors or plugged drains. Most doors are fire doors which require frequent inspections or fire watches when open. Door seals were qualitatively considered with regard to the most likely propagation path for smaller floods. However, door seals alone were not the basis for screening out propagation to an adjoining location.

As an example, the Cable Vault Flood Initiating Event (CVFL) is based on a flood that occurs in Room CV-2 where there is only one (1) floor drain. The flood collects in this room, failing one train of MCCs, and eventually fails the door that opens into Room CV-1. The flood is assumed to fail redundant MCCs in CV-1. A potential flood event in CV-1 is assumed to be enveloped by the initiator in CV-2 because there are several drains in CV-1, there is less flood potential in CV-1, the area is much larger in CV-1, and the more likely propagation path is into stairwells and to the pipe tunnel There are doors that open into CV-1 from the Emergency Switchgear Room, however, the drains and floor areas in the Switchgear rooms were judged to be sufficient to handle leakage into the rooms.

Question 22. Sections 1.4 (Summary of Major Findings), 3.3.8 (Interior Flooding Analysis), and 4.8 (Back-End Results) do not characterize the impact of internal flooding events, either as important or not significant. However, Figure 4.8-1 shows that Control Building Flood (CBFL) events contribute approximately 6.6% of the "small early containment failures or bypasses", which is the third largest contributing initiator.

Provide a discussion of the flooding analysis addressing whether the process yields non-conservative, realistic or conservative estimates, and DLC's assessment of the IPE conclusions in light of this, especially with regard to CBFL.

Response 22. Section 1.4 is a brief executive summary of the major findings which did not include a summary of internal flood contributions. However, Section 1.4 does describ the dominant core damage sequences (Level 1) and early large release sequences (Level 2), which indicate that internal floods are not dominant sequences. Section 3.4 summarizes the Level 1 results, and as shown in this section, internal floods provide a minor contribution to core damage frequency.

Section 3.3.8 provides a qualitative summary of the internal flood analysis, the resulting initiators identified from the study, and insights from the study. The final results from including the initiators in the overall accident sequence model are included in Sections 3.4 and 4.8.

Section 4.8 indicates that internal floods contribute, but do not dominate releases. CBFL's contribution to small early containment failure is based on a service water flood in the Fan Room next to the Main Control Room, and a fire water flood in the Cable Tunnel. Both floods are assumed to propagate to Elevation 707 of the Control Building which houses process racks and other electrical equipment. This will likely cause a plant trip and could spuriously operate equipment. A detailed analysis of the impact was not performed. It was assumed that solid state protection would fail after the plant trip and, if the operators fail to initiate safety injection, they would also fail to isolate containment (small early release in Level 2), resulting in core damage. There are potential conservatisms in that the service water flood would most likely propagate through double doors in the Fan Room to the outside. However, it was cons vatively assumed that the flood would push the stairwell door open to Elevation 707. Credit was given to operator detection and isolation for the service water flood. This was not the case for the fire water flood. Another potential conservatism could be the human error rate used for responding to this flood. As mentioned above, a detailed analysis the impact of the flood was not performed, and a detailed analysis of the timing of operator response was not performed. The conditional probability of operator failure to initiate safety injection and isolate the containment used for this Initiating Event was 1.04×10^{-2}. This process is considered to be conservative since the guaranteed failure of operators to isolate containment after failure of SSPS results in a large percentage of its end-states to be assigned to the small containment bypass release group. Therefore, CBFL shows minor contribution to core damage frequency, but indicated some importance to the Release Category Group II frequency.

Question 23. It is noted that in the discussion of Top Events DG, DP, IE, IB, IW and IY, the time that power is specified to be available is dependent on "How Long The Batteries Last", and is identified as either 3.5 or 8 hours. However, the system's description for DC Electric Power (Section 3.2.1.2.9) states the assumption that following a loss of AC power DC power is evaluated for a mission time of just 2 hours. The BV-2 FSAR Chapter 8 also indicates that the life of the batteries under design loads is 2 hours.

Discuss the technical basis, or provide a reference for the assumption of battery life longer than 2 hours, as relates to the Top Events above.

Response 23. (LATER)

Question 24. In Section 3.1.3.1 (General Transient/Small LOCA Tree) under the description provided for Top Event CI (Containment Isolation), a discussion is provided which relates to the Seal LOCA Model. However, the discussion and Section 3.3.3 (Human Failure Data), which is referred to therein as containing the Seal LOCA Model, do not explicitly describe the Model used for the IPE submittal.

Provide a discussion of the Seal LOCA Model, as used in the BV-2 submittal including the various leak rates, timing of seal failure, and the probability of their occurrence with and without the seal return line isolated.

In addition, discuss the impact on Core Damage Frequency (CDF), if the assumption is incorrect that the low pressure seal leakoff pipe will withstand high pressure on failure of the number one seal.

Response 24. The General Transient/Small LOCA Event Trees are described in Section 3.1.3.1. Section 3.3.3 provides a summary of the electric power recovery approach. The electric power recovery results are also summarized in Table 3.3.3-11.

The seal LOCA model is described in Reference 3.3.3-5, Appendix B, Section B.2. The specific seal LOCA leak rates, used as a function of time after loss of seal cooling, are provided in Table B.2-1, copy attached. The model for the pump seal leak rates was based on the four-loop RCP seal LOCA study of Reference B.2-4 for Westinghouse RCPs with the old style O-rings that existed in the Beaver Valley RCPs at the time of the study, and scaled by the number of loops at Beaver Valley to reflect the leak rates per pump. The flow rates listed in GPM define the effective flow area, assuming an RCS pressure of 2250 psig. The time to core uncovery for a given leak rate, which varies with time, was computed accounting for the decrease in RCS pressure as the accident progresses and includes the effects of the operator action to depressurize the Steam Generators. Reference B.2-4 is as follows:

NUREG-11560, Report Reactor Coolant Seal LOCA, "Results of Expert Opinions Elicitation on Internal Event Front-End Issues for NUREG-1150: Expert Panel", NUREG/CR-5116, Volume 1, Sandia 88-0642, April 1988.

Table B.2-1. Seal LOCA Flow Rates (GPM) per Pump with and without Pri[illegible]ry Depressurization							
Probability	Cumulative Probability	Time after Station Blackout (hours)					
		0-1.0 (gpm)	1.0-1.5 (gpm)	1.5-2.5 (gpm)	2.5-3.5 (gpm)	4.5-5.5 (gpm)	5.5+ (gpm)
0.2712	.2712	21	21	21	21	21	21
0.0151	.2863	21	2[illegible]	21	61	61	61
0.0161	.3024	21	21	61	61	61	61
0.0181	.3205	21	61	61	61	61	61
0.0120	.3325	21	61	108	108	108	108
0.0059	.3384	21	61	108	108	120	175
0.1120	.4504	21	61	250	250	250	250
0.0136	.4640	21	120	250	250	250	250
0.5302	.9942	21	250	250	250	250	250
0.0016	.9958	21	308	308	308	308	308
0.0042	1.0000	21	480	480	480	480	480

Question 25. Section 3.4.3 of the submittal provides information on the importance of the five (5) systems that perform Decay Heat Removal (DHR) functions, and indicates that no particular vulnerabilities have been found. However, the values provided in Table 3.4.3-1 as the "percentage of CDF in which event is failed", show a non-negligible contribution for some Top Events due to loss of support (e.g., MFF 9.7% and AFF 20.2%). A value for HHF (High Head Safety Injection Pumps, Support Unavailable) is not provided; however, Table 3.4.2-1 shows the percentage of CDF with this split fraction as 62%.

Generic Letter 88-20 and Appendix 5 therein, indicate that support systems are important to the DHR Function and suggests that they be considered in the search for DHR related vulnerabilities. Therefore, please discuss the impact of support systems on these five (5) systems, differentiating between the contribution from Loss of Power (LOSP and BVX), and other supports such as Service Water, Primary Component Cooling Water and Instrument/Containment Instrument.

Response 25. (LATER)

Question 26. Table 3.4.3-1 shows the percentage of CDF in which the Event AFF is failed as 20.2% (3.84E-5) identifying it as due to Large Flood in Safeguards Area. However, Figure 3.3.8.2 (comparative contributions to core damage from floods) shows that only 16.6% of the CDF from all floods (7.32E-6 x 0.166 = 1.22E-6) is due to safeguards floods. Provide a discussion of this apparent discrepancy and other values in the table which may likewise impact the results of the IPE

Response 26. (LATER)

Question 27. As indicated in the paragraph on Feed and Bleed Cooling, the BV-2 design "minimizes the frequency of sequences involving failure of AFW and Bleed and Feed Cooling, relative to other PWRs previously studied", because of credit taken for realigning the electric motor-driven MFW pumps. It would appear that this capability is of significant benefit to BV-2.

Discuss the benefit derived from this capability in terms of CDF with and without this capability. In concert with this, please provide the benefit derived from the capability to feed and bleed upon loss of all secondary cooling (i.e., MF and AF) in terms of CDF with and without this capability.

Response 27. (LATER)

Question 28. Provide a list of the types of Initiating Events identified as "other" in Figure 3.4.0-2, and the breakdown of their contributions to CDF.

Response 28. See attached Table 28-1 for the breakdown on all of the Beaver Valley Unit 2 Initiating Event contributions to the total core damage frequency.

TABLE 28-1. Beaver Valley Unit 2 Initiating Event Contributions

Initiator	Initiator Core Melt Frequency	Percentage of Total Core Melt Frequency	Initiator	Initiator Core Melt Frequency	Percentage of Total Core Melt Frequency
LOSP	2.86E-05	14.84	SGFL2	3.81E-07	0.20
BVX	2.35E-05	12.17	LCVA	3.45E-07	0.18
SLOCI	2.15E-05	11.18	VSX	3.44E-07	0.18
SLOCN	2.06E-05	10.69	TLMFW	3.37E-07	0.17
AOX	1.48E-05	7.67	SLBD	3.34E-07	0.17
BPX	9.31E-06	4.83	VPFL	2.90E-07	0.15
IRX	7.24E-06	3.76	MSV	2.84E-07	0.15
IWX	7.23E-06	3.75	LCV	2.84E-07	0.15
SGTR	7.21E-06	3.74	ELOCA	2.65E-07	0.14
IMSIV	4.81E-06	2.50	AOXA	2.29E-07	0.12
TT	4.56E-06	2.37	LPRF	2.23E-07	0.12
LB2A	4.25E-06	2.21	LB2AA	1.90E-07	0.10
CBFL	4.05E-06	2.10	DPXA	1.85E-07	0.10
WBX	3.55E-06	1.84	DOXA	1.82E-07	0.09
DPX	2.88E-06	1.49	IBXA	1.70E-07	0.09
RT	2.52E-06	1.31	LOSPA	1.49E-07	0.08
MLOCA	2.12E-06	1.10	BPXA	1.37E-07	0.07
SGTRA	2.01E-06	1.05	SLBC	1.35E-07	0.07
PLMFWA	1.90E-06	0.99	CX1	1.22E-07	0.06
PLMFW	1.56E-06	0.81	CPEXC	1.21E-07	0.06
ISI	1.53E-06	0.79	LPRFA	1.01E-07	0.05
WXB	1.29E-06	0.67	IYXA	9.08E-08	0.05
AMSIV	1.26E-06	0.66	IRXA	8.15E-08	0.04
DOX	1.25E-06	0.65	IWXA	8.10E-08	0.04
WAX	1.20E-06	0.62	IYX	5.03E-08	0.03
ISFL	1.13E-06	0.58	IBX	4.97E-08	0.03
TTA	8.89E-07	0.46	TBFL	4.72E-08	0.02
LLOCA	8.52E-07	0.44	CVFL	4.32E-08	0.02
SGFL1	8.37E-07	0.43	WXBA	1.09E-08	0.01
EXFWA	8.26E-07	0.43	WAXA	1.09E-08	0.01
EXFW	6.78E-07	0.35	CX1A	8.13E-09	0.00
ABFL1	5.36E-07	0.28	ABFL2	1.75E-09	0.00
SLB1	5.10E-07	0.26	WBXA	3.35E-10	0.00
TLMFWA	4.10E-07	0.21			

Question 29. The submittal identified core damage as having occurred when loss of core heat removal progressed beyond the point of core uncovery, **and** core exit temperatures exceed 1200°F.

How many sequences were screened out because of this double criteria? Discuss the impact on the resultant CDF obtained using this criteria.

Please address the following:

- The basis for the temperature chosen (1200°F).

- Do all sequences with the core uncovered go to core damage, or was there recovery prior to reaching 1200°F?

- Would the CDF be significantly different without the 1200°F core exit temperature criterion?

Response 29. There were no sequences screened out by application of the 1200°F criterion. The use of this criterion only marginally impacts the time available for recovery actions. If the 1200°F criterion was replaced by just core uncovery, some sequences would increase in frequency by a slight amount to reflect the incremental effects of recovery between the time of core uncovery and the time of core exit temperatures reaching 1200°F. For typical sequences in which the 1200°F criterion was applied, there would only be about fifteen (15) minutes after core uncovery until core exit thermocouple readings in the Control Room would reach 1200°F. This estimate is based on MAAP analyses performed for Seabrook Station, as documented in the following reference:

Fleming, K.N., et al, "Risk Management Actions to Assure Containment Effectiveness at Seabrook Station", PLG-0550, prepared for New Hampshire Yankee Division of Public Service Company of New Hampshire, July 1987, Table 6-3.

While the use of the 1200°F criterion does not appreciably impact the core damage frequency in comparison with core uncovery, this value was selected for consistency with the Functional Restoration Guidelines that form part of the Emergency Operating Procedures. At Beaver Valley, Functional Restoration Guideline FR-C.1, Inadequate Core Cooling, is entered when core exit thermocouple temperatures exceed 1200°F. See, for example, Part 12 of Figure 3.1.1-2, the Event Sequence Diagram for Beaver Valley Unit 2. The actions in FR-C.1 were not credited in reducing the frequency of core damage.

Because of the small incremental time between core uncovery and 1200°F core exit temperatures, the use of this criterion has no significant impact on the estimation of the CDF.

Question 30. The BV-2 submittal has identified loss of Emergency Switchgear Room HVAC as a significant contributor to CDF, due to the relatively rapid rise in room temperatures that will exceed the qualification temperature of equipment in the room. However, experiences of other plants have indicated that temperature rise determined by test on loss of HVAC is not as rapid as determined by calculation.

The possible prediction by calculation of temperature rise significantly more rapidly than might be experienced and could cause a distortion in the identification of contributors to CDF and subsequent misapplication of resources. Is DLC giving consideration to verification of the rate of temperature rise determined for the Emergency Switchgear Room on loss of HVAC, to establish if the contribution from this event is appropriate?

Response 30. (LATER)

Question 31. Section 6.1 indicates that the two (2) risk factors of merit that have been considered are CDF and early release frequency. In addition, Section 6.3.1 states that in order to determine vulnerabilities the major accident "CATEGORIES" were evaluated along with top ranking sequences.

a) Provide the definition of vulnerability, and describe the process used in conjunction with the above to identify the vulnerabilities as requested by NUREG-1335.

b) Discuss the findings related to identifying potential vulnerabilities with respect to containment failure or by-pass, and assessing any associated plant modifications.

c) Discuss the anticipated benefit (decrease in CDF or impact on release category), the rationale by which the listed option was chosen from the potential options, and the respective timing, if implementation for those "under review".

d) Discuss the consideration given to independent failure of the Service Water Headers (WA and WB involved in 13.7% CDF, and in top ranking sequences involving small LOCAs which contribute 21% to CDF), and the common check valve in the suction of the HHSI pumps (VL-1, involved in approximately 15% CDF, and also in top ranked sequences involving loss of vital bus and small LOCA) as vulnerabilities.

Response 31. (LATER)

Question 32. Discuss briefly the IPE results (including the contributions to CDF) of any analysis related to a small break LOCA due to a stuck-open safety valve event if the PORVs are blocked off to stop any leakage. The discussion should address the percentage of time the PORVs are blocked off due to leakage and failures of operator actions to open the PORV block valve during accident conditions.

Response 32. (LATER)