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October 26, 1992

JOHN D. SIEBER
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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
3. DLC Letter to the NRC, Generic Letter 88-20, dated September 11, 1992

Please find attached the second 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. The responses from our first submittal (Reference 3) are included herein for convenience.

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

Sincerely,

J. D. Sieber

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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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 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 loading 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.

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

Response 3. The phenomena of greatest interest in the Beaver Valley Unit 2 (BV2) Backend Analysis were the following:

- Induced failures of the hot leg, surge line, and steam generator tubes
- Containment loads at vessel breach resulting from the effects of high pressure melt ejection
- In-vessel hydrogen generation

Induced failures of the Reactor Coolant System (RCS) boundary occur when RCS pressure is maintained at high levels and the components of interest are heated by natural circulation and fission product deposition to temperatures at which their strength is significantly diminished. At these conditions, it is possible that failure of these RCS components could occur before vessel breach occurs, thereby converting a high pressure vessel breach sequence to one that will occur at low pressure. As noted in Section 4.6.2.1, base and sensitivity MAAP cases (using Version 14) for a BV2 fast station blackout event were performed to provide temperature histories for the RCS components of interest. For each of these cases a determination of the time to failure for each of the RCS components of interest, including the reactor vessel, was performed. Except for the reactor vessel, the time to component failure was estimated using Larson-Miller thermal creep rupture data. Probability distributions were generated for each of the component failure times and these distributions were combined using the STADIC program to determine the following mean probabilities of induced component failure after core damage occurs:

- Induced SGTR occurs first $<10^{-3}$
- Hot leg piping or safe end failure occurs first = 0.9
- Vessel melt-through occurs first = 0.1

The Surry analysis for NUREG-1150 cited mean values of 0.018 for induced SGTRs and 0.72 for hot leg failure prior to vessel breach, with the RCS at the system setpoint pressure during core degradation. Because of concerns regarding the "coarseness" of the way that MAAP models the RCS, the NUREG-1150 mean values were used in the BV2 Backend quantification. A "double delta" distribution was used to represent these mean values in the generation of uncertainty distributions for the frequencies of major release category groups.

At the time of the BV2 Backend study, it was judged that the uncertainties in the containment loads at vessel breach, due to high pressure melt ejection, were best represented by the NUREG-1150 distributions generated for Surry by the expert opinion process. Plant specific MAAP analyses performed for BV2, using recommended best estimate input parameters, indicated pressure rises which were less than the median values of the corresponding NUREG-1150 distributions. Hence, because of the similarity between the Beaver Valley and Surry plants, the NUREG-1150 data for Surry was applied to BV2 with first order scaling of the pressure rise due to differences in containment free volume and power level. The containment load distributions were combined with the containment strength distribution in the STADIC program to determine the mean probability of containment failure for various sets of plant damage state parameters (e.g., RCS pressure prior to vessel breach, status of containment sprays, etc.).

Recent experiments (e.g., see Reference 3-1, below) confirm that debris will be trapped in the lower compartment of the containment minimizing the effects of DCH. Thus, it is believed that the approach used in the BV2 Backend Analysis, to assess the probability of containment failure at vessel breach, is somewhat conservative.

The first uncertainty associated with hydrogen involves the quantity of hydrogen generated in-vessel. The BV2 analysis is based on an aggregate of the NUREG-1150 probability distributions for this parameter. MAAP analyses performed for BV2 fast station blackout sequences using the "no blockage option" corresponds to approximately 46% core zircaloy oxidation. As shown in Figure 4.2-1 of the IPE submittal, this fraction of core oxidation corresponds to approximately the 70th percentile of the assumed in-vessel hydrogen distribution. Hence, the assumed distribution was deemed appropriate for BV2 severe accidents.

Reference 3-1.

Allen, M. D., et al, "Experiments to Investigate the Effects of Flight Path on Direct Containment Heating (DCH) in the Surtsey Test Facility," prepared for the U. S. Nuclear Regulatory Commission by Sandia National Laboratories, NUREG/CR-5728 (SAND91-1105), October 1991.

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. The statement made in Section 4.1.4 was more limited in scope than its reference in Question 4 would indicate. The intent of that statement (in Section 4.1.4) was to confirm that no equipment failures resulting from severe accident conditions inside containment had been identified that would, of themselves, "create instances of unusually poor containment performance". That being said, it can also be stated that the overall containment performance for Beaver Valley Unit 2 is judged to be adequate.

The adequacy of the Beaver Valley Unit 2 Containment performance is based on the observation that the mean conditional probability of a large, early containment failure and containment bypass for Beaver Valley Unit 2, given core damage, is less than 5%. This compares to about 13% for Surry, including bypass, and about 4% for Zion, including bypass, as analyzed in NUREG-1150 final summary report dated November 1990. It must also be noted, that the Surry and Zion NUREG-1150 results include <u>all</u> early containment failures, large and small, while the Beaver Valley Unit 2 results are for large failures only. However, it must also be noted further that most of the Surry and Zion early failures are large enough to yield source terms comparable to WASH-1400 PWR4 (i.e., a 10% iodine release), while the early, small containment failures for Beaver Valley Unit 2 are dominated by small isolation failures yielding iodine release fractions, an order of magnitude lower. On this basis, it is judged that the containment performance of Beaver Valley Unit 2, given core damage, is comparable to that of Surry and Zion as analyzed in NUREG-1150 and, therefore, that Beaver Valley Unit 2 does not exhibit unusually poor containment performance.

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. a) Equipment survivability was treated in the IPE process as a means of determining the availability of equipment after core damage has occurred; i.e., beyond the scope of the Level 1 analysis. The Level 1 analyst uses equipment availability and failure rate data as a means of determining the likelihood of core damage, and this information is fed into the Level 2 analysis via the plant damage states. However, equipment that was functioning properly at this endpoint of the Level 1 analysis (or equipment that may have been considered to be restorable in the Level 1 analysis after some time interval) may, in fact, not be available due to conditions created within the containment (or other relevant environment) that result from the core degradation itself, and about which the Level 1 analyst's information is silent. This is the issue of equipment survivability that is dealt with in Section 4.1.4.

The following observations can be made regarding the treatment of equipment survivability in the Beaver Valley Unit 2 IPE:

° The only relevant environment is that within the Containment. Interfacing system LOCAs do not take credit for any equipment potentially affected by the loss of coolant outside Containment.

° Any equipment associated with ECCS is ignored beyond the onset of core damage; in the Beaver Valley Unit 2 IPE all core degradation events are assumed to lead to vessel failure and no recovery actions are currently included in the analysis. Therefore, questions regarding ECCS equipment survivability beyond the onset of core damage are irrelevant.

- There are no containment fan coolers which operate under accident conditions in the Beaver Valley Unit 2 Containment. Containment heat removal is accomplished by Recirculation Spray Coolers. The recirculation sprays are initiated by a timer once the CIB (containment pressure) signal is reached. The CIB signal first actuates the quench sprays and then the recirculation sprays. There is no reliance on containment sump level indication for success of containment recirculation sprays.

- Auxiliary Feedwater is not credited in any analysis beyond the onset of core damage; therefore, questions related to Auxiliary Feedwater control survivability beyond the onset of core damage are irrelevant.

With these observations in mind, the remaining parts of Question 5 can be addressed.

b) An analysis of equipment survivability for severe accident conditions inside Containment was performed for large, dry containment PWRs (as well as for other plant types) by the IDCOR Program and reported in Reference 4-7 of the Beaver Valley Unit 2 IPE. This analysis indicated that for large, dry containment PWRs, cables inside Containment could be vulnerable to temperatures associated with the most limiting (highest atmosphere temperature) severe accidents. Therefore, for any of the accident monitoring and control items mentioned on Table 4.1-3 that involve cable runs inside Containment, survivability was not determined; i.e., there was no prima facie evidence that survival was likely, and no detailed analysis was conducted. However, because of the observations listed in Part a) of this question, the loss of these items would not adversely affect the conclusions of the Beaver Valley Unit 2 IPE.

For the remaining three (3) parameters in Table 4.1-3 (containment pressure, containment area radiation, and containment atmosphere hydrogen sampling), failure due to temperature is viewed as unlikely. Of these only the containment pressure indication was of concern, based on the findings of the IDCOR Report. However, this plant feature is depended upon only during the phase of the accident where the pressure is within design; and, therefore, its survivability (and that of the other two [2] items) is viewed as likely.

c) A comparison of the limiting containment pressure and temperature transients (for Fast Station Blackout or TMBL'), Figures 4.2-2 and 4.2-3 of the Beaver Valley Unit 2 IPE and Figures 3-9 through 3-13, and Figures 3-46 and 3-47 of Reference 4.1-3 for the IDCOR analysis of Zion with and without a global hydrogen burn, confirms that the limiting event for the IDCOR equipment survivability for Zion is as severe than that for Beaver Valley Unit 2. In neither case was a global hydrogen burn calculated to occur, but in the Zion analysis, a global burn was forced soon after vessel failure which produced a 1160°F spike in the containment atmosphere temperature. This spike was then included in the equipment survivability assessment.

d) The response to this part of the question can be found in the response to Part b).

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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......	SF Name...	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-06
11.	MF3	5.6083E-01	1.0487E+00	4.4027E-01	4.8790E-06	9.2000E-01	4.4976E-06
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	3.9509E-06
15.	EAF	4.8792E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9128E-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	1.1057E+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.	ADF	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-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4302E-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.	OOF	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-02	1.6538E+00	9.6582E-01	5.5169E-06	4.9679E-02	3.6091E-07
78.	AO2	4.4506E-02	1.3666E+00	9.5549E-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	9.5677E-01	5.7010E-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	2.6880E-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.	HH1	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	1.9127E-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	0.0000E+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	1.0480E-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.	BP6	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	-1.0821E-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	8.4758E-08
117.	FC2	1.0569E-02	4.0834E+00	9.8943E-01	2.4812E-05	[illegible]4160E-03	8.4758E-08
118.	FB6	1.0569E-02	1.0955E+00	9.8943E-01	8.5056E-07	4.9650E-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.	OI1	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.	FBB	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.	EBB	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	1.5448E-06	3.4285E-02	6.3249E-08
133.	IB4	7.8225E-03	1.1796E+00	9.9378E-01	1.4899E-06	3.3470E-02	6.2732E-08
134.	EA2	7.6983E-03	1.0060E+00	9.9230E-01	5.9123E-07	1.0442E-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	5.3[illegible]04E-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	3.8572E+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	[illegible].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	[illegible]9836E-01	2.1814E-06	6.0449E-03	1.4003E-08
165.	DP2	1.7182E-03	4.3786E+00	9.9[illegible]28E-01	2.7108E-05	5.0830E-04	1.3779E-08
166.	OA2	1.6386E-03	1.0478E+00	9.98[illegible]6E-01	3.9616E-07	3.3170E-02	1.3141E-08
167.	OB1	1.6266E-03	1.3269E+00	9.98[illegible]7E-01	2.6343E-06	4.9480E-03	1.3045E-08
168.	HC2	1.5954E-03	1.1167E+00	9.984[illegible]E-01	9.4825E-07	1.3230E-02	1.2794E-08
169.	IW1	1.5892E-03	2.8063E+01	9.984[illegible]E-01	2.1704E-04	5.8720E-05	1.2745E-08
170.	RE9	1.5818E-03	1.1363E+00	9.984[illegible]E-01	1.1059E-06	1.1470E-02	1.2685E-08
171.	IR1	1.4877E-03	2.5757E+01	9.985[illegible]E-01	1.9855E-04	6.0090E-05	1.1931E-08
172.	RD2	1.4829E-03	1.0618E+00	[illegible]52E-01	5.0755E-07	2.3430E-02	1.1892E-08
173.	SB6	1.4722E-03	1.0155E+00	[illegible]859E-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	[illegible]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.	BPB	1.3006E-03	1.0111E+00	9.9870E-01	9.9536E-08	1.[illegible]479E-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...	Derivative..	SF Value......	Frequency......
181.	RE4	1.1429E-03	1.0071E+00	9.9886E-01	6.6322E-08	1.3820E-01	9.1656E-09
182.	SB3	1.1228E-03	1.0863E+00	9.9934E-01	6.9744E-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	9.9909E-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.	PRB	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	8.8750E-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.	C99	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	1.0005E+00	9.9951E-01	8.0302E-09	4.8760E-01	3.9155E-09
207.	CS2	4.8130E-04	8.9224E-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	9.7931E-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	3.2534E-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	3.7542E-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.[illegible]04E-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	2.5330E-02	2.6[illegible]84E-10
255.	IB2	2.5281E-05	1.0478E+00	9.9997E-01	3.8348E-07	5.287[illegible]E-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	9.99[illegible]8E-01	0.0000E+00	6.7642E-07	1.4607E-10
261.	OD7	1.7420E-05	9.5973E-01	1.0001E+00	-3.2[illegible]4[illegible]E-07	1.6470E-03	1.3970E-10
262.	SBA	1.7203E-05	9.9995E-01	1.0000E+00	-4.0083E-10	3.5820E-02	1.3796E-10
263.	SBC	1.5854E-05	9.9753E-01	1.0000E+00	-2.00[illegible]3E-08	1.3550E-02	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	2.582[illegible]E-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	3.313[illegible]E-04	0.0000E+00
276.	PRK	0.0000E+00	9.9979E-01	1.0000E+00	-1.7016E-[illegible]	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.[illegible]315E-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.	OSD	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	1.2487E-05	0.0000E+00
286.	MSO	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.	OD[illegible]	0.0000E+00	9.7647E-01	1.0001E+00	-1.8755E-07	2.2960E-03	0.0000E+00
289.	C21	0.0000E+00	9.9509E-01	1.000[illegible]E+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.	OD[illegible]	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.	PRO	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	4.5821E-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	9.9490E-01	1.0000E+00	-4.0889E-08	3.2777E-04	0.0000E+00

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......
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.	HH[illegible]	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.[illegible]250E-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.	CD[illegible]	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 4.6-17 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. a) No sensitivity studies relative to ignition limits were performed for the BV2 Backend Analysis. Because Beaver Valley and Surry plants are essentially "sister" plants, the BV2 Backend Analysis relied heavily on the insights obtained from the analyses performed for Surry for NUREG-1150. In addition, plant-specific MAAP analyses performed for BV2 indicated that burns would either be precluded by steam inertion or would occur when the hydrogen concentrations achieved global flammability levels, as determined by the MAAP algorithm for most servere accident scenarios. Thus, either burns did not occur or occurred at relatively low hydrogen concentration. An exception to this observation is when hydrogen is suddenly released into a non-inerted containment. This exception was discussed in our response to RAI Item 2, and will be discussed again later in this response. The burn pressures calculated by MAAP were significantly less than those which would cause a significant probability of containment failure. Hand

calculations for adiabatic burns (deflagrations), up to the limits of detonation limits, indicated that the pressure rises associated with these deflagrations were not likely to result in containment failure. Although the loads associated with detonations (transitions from deflagrations) might be sufficient to cause containment failure, these loads are difficult to calculate and containment strength criteria for these types of loads were not available. As noted in our response to RAI Item 2, the BV2 IPE adopted a conservative treatment for detonations (resulting from transitions from deflagrations) and consequent containment failure. It should be noted that NUREG/CR-4551 did not address detonations for Surry.

As noted on Page 4.2-3 of the IPE submittal, in Reference 8-1, the analysis of hydrogen combustion for the Surry plant for NUREG-1150 assumed that if electrical power were available during the period of hydrogen generation, "the sprays will keep the steam concentration low, and sparks from electrical equipment will cause ignition near the lower deflagrable limit", preventing significant concentrations of hydrogen. Based on the extent of mixing promoted by spray operation and the relatively low ignition energy levels required for ignition, this argument was assumed to be valid for BV2 as well, except for the sudden release of hydrogen into the containment (e.g., vessel blowdown at high pressure after severe core degradation).

The initiation of combustion requires that the temperature of the reactant gases be raised above a "threshold temperature", thereby initiating reaction (see Reference 8-2). This temperature increase can be caused by a flame, spark, arc, hot gas, hot particle (such as core debris)[1], compression, shock waves, adiabatic heating, and the addition of pyrophoric or hypergolic materials. The energy required to initiate combustion decreases as the hydrogen gas temperature increases, until the self-ignition temperature is reached. According to Reference 8-3, stated flammability limits have little meaning at mixture temperatures in excess of approximately 1200°F. At these temperatures, the mixture becomes near-hypergolic (i.e., spontaneously reacting), essentially independent of steam concentrations.

1 It should be noted that the loads associated with high pressure melt ejection include the contribution of hydrogen combustion.

Minimum energies required to ignite various hydrogen-air mixtures are shown in Figure 8A-1 (taken from Reference 8-4). As noted in Reference 8-6, near-stoichiometric mixtures (approximately 30% hydrogen) can be ignited with spark energy levels as low as 0.02 milli-joules. However, the ignition energies required to ignite hydrogen mixtures increase substantially as the mixture concentrations approach the flammability limits. As noted in Reference 8-6, the energy required for ignition increases rapidly as the initial pressure is lowered. Conversely, the minimum spark energy decreases with increasing initial mixture temperatures. Reference 8-6 also notes that there is a degree of uncertainty associated with the magnitude of the available capacitive discharge electrical energy, which is actually expended in heating the gas near the electrodes. Measured ignition energy requirements for mixtures near the flammability limits appear to be very sensitive to the size of the vessel used in the experiment. One reported series of experiments indicated that the required spark energy to ignite a 4.5% hydrogen mixture was in the range of 10 to 100 joules, depending on whether the tests were conducted in a 240 $ft.^3$ vessel or a 10 $ft.^3$ vessel.

The peak pressures associated with detonations are well above the quasi-static pressures associated with deflagrations. However, the energies required for detonation are many orders of magnitude above those required for deflagration. As noted in Reference 8-7, detonation initiation within a range of hydrogen concentration from 18 to 59 volume percent (the approximate range of hydrogen detonability) requires an energetic ignition source, severe confinement, and/or a sufficiently large volume of gas mixture. Reference 8-7 concluded that, "the energy levels required to directly initiate detonation are orders of magnitude greater than those necessary to initiate burning at the same hydrogen concentration", and that "a de facto transition to detonation is highly unlikely in reactor containment buildings, particularly when there are high steam concentrations or hydrogen concentrations below about 18 volume percent". Minimum ignition energies of 4100 joules have been reported (Reference 8-7) for hydrogen-air mixtures. According to Reference 8-7, this energy level is several orders of magnitude higher than would be produced from an electrical spark caused by contact arcing or by electrostatic discharge and approximately eight orders of magnitude higher than the minimum ignition energy required to initiate deflagration.

Figure 8A-2 (taken from Reference 8-8) identifies the energy levels of various potential ignition sources. Based on the ignition energy requirements shown in Figure 8A-2, a match burning for only a fraction of a millisecond would generate sufficient energy to initiate a deflagration in a hydrogen-air mixture near the lower limit of flammability.

If electrical power is not available, the containment sprays will not operate, and the containment is likely to be inerted by high concentrations of steam. When steam inertion prevents combustion, the recovery of electrical power and containment sprays becomes a concern since operation of the sprays will condense the steam and drive the gas mixture towards the flammability range. The Surry analyses performed for NUREG-1150 assumed that hydrogen would be ignited and burned as soon as the gas mixture entered the flammability range, guaranteeing that the burn would occur at low hydrogen concentration. Operation of the containment spray would guarantee substantial mixing.

The recovery of AC power during or after core degradation was not addressed in the IPE submittal. Because of potential deleterious effects (such as containment deinerting), the strategy for recovery of mitigating systems such as containment sprays, must be carefully examined and fully evaluated in the context of an accident management program.

As noted earlier, for scenarios in which the containment sprays are operating, it is likely that hydrogen burns will occur at low concentrations when 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 logic implicit in this assumption is as follows:

1. Containment failure, due to 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 8-9).

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

Figure 4.2-1 of the BV2 IPE submittal (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, and was used as the split fraction value for Top Events C2 and CE when vessel blowdown occurred at high pressure in the absence of HPME.

b) Attached Figures 8-1 through 8-7 provide dimensions of the Beaver Valley Unit 2 containment building. A simplified schematic of the BV2 containment, including compartment locations, compartment junctions, and potential break locations, is given in Figure 8-8. As shown in Table 4.1-1 of the IPE submittal, the total free volume of the BV2 containment is 1.72×10^6 cubic feet. MAAP divides the containment free volume into four compartments. The current MAAP Parameter File for BV2 contains the following volumes for these compartments:

Upper compartment	- 1.02×10^6 cubic feet
Lower (loops) compartment	- 4.30×10^5 cubic feet
Annular/dead end compartment	- 2.55×10^5 cubic feet
Reactor cavity/instrument tunnel	- 7892 cubic feet

During the development of the MAAP parameter file, it was noted that a lot of junction areas existed between compartments relative to the potential hydrogen release points. This was confirmed during the containment walkdown. It was also noted in the MAAP analyses that the hydrogen was well mixed, especially when the containment sprays were functioning. Therefore, no significant hydrogen pocketing is expected for Beaver Valley.

c) As noted in the discussion of Top Event 18 in Section 4.6, detonations were assumed to fail the containment, leading to a large fission product release directly to the environment. No credit was taken for mitigating equipment following a detonation.

d) Top Event 20 addresses containment failure due to late hydrogen burns. As noted earlier, if the containment is not inerted, the only burns of significance are those resulting from sudden releases of hydrogen generated into the containment; however, no such releases are expected in this time frame. Sudden releases at vessel breach were addressed in Top Events C2 and CE. Although MAAP analysis 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 (split fraction C3A).

   If the containment is inerted, operation of containment sprays in this time period could drive the containment atmosphere to flammable mixtures. However, as noted earlier, recovery of sprays after severe core damage was not addressed in this phase of the study.

REFERENCES

8-1 Breeding, R. J., et al. "Evaluation of Severe Accident Risks: Surry Unit 1", NUREG/CR-4551 (SAND89-1309), Volume 3, Revision 1, Parts 1 and 2, October 1990.

8-2 Stull, D. R., "Fundamentals of Fire and Explosion", AIChE Monograph Series, No. 10, Vol. 73, 1977.

8-3 Williams, D. C., et al, "Containment Loads Due to Direct Containment Heating and Associated Hydrogen Behavior: Analysis and Calculations With the CONTAIN Code", NUREG/CR-4896, May 1987.

8-4 Camp, A., et al, "Light Water Reactor Hydrogen Manual", NUREG/CR-2726

8-5 Hertzberg, Martin, "Flammability Limits and Pressure Development in H_2-Air Mixtures", PRC Report No. 4305, Presented at the Workshop on the Impact of Hydrogen on Water Reactor Safety, Albuquerque, New Mexico, January 25-28, 1981.

8-6 Liu, D., et al, "Some Results of WNRE Experiments in Hydrogen Combustion", NUREG/CR-2017, September 1981.

8-7 IDCOR, "Hydrogen Combustion in Reactor Containment Buildings", Technical Report 12.3, September 1983.

8-8 Fauske & Associates, "Technical Support for the Hydrogen Control Requirement for the EPRI Advanced Light Water Requirements Document", DOE/ID-10290, U.S. Department of Energy.

8-9 Sherman, M. P., et al, "FLAME Facility...The Effect of Obstacles and Transverse Venting on Flame Acceleration and Transition to Detonation for Hydrogen-Air Mixtures at Large Scale", NUREG/CR-5275, April 1989.

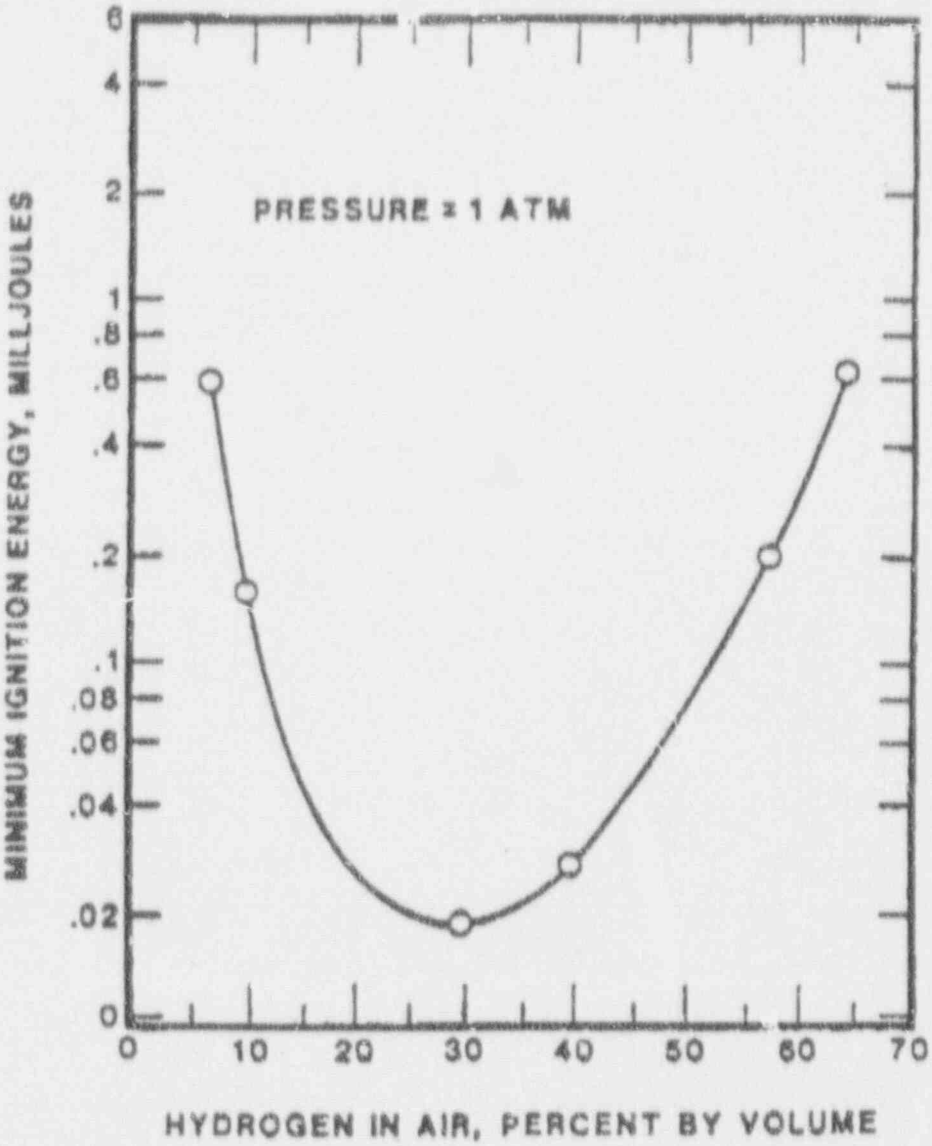

FIGURE 8A-1. MINIMUM IGNITION ENERGY FOR HYDROGEN DEFLAGRATIONS
(Taken from Reference 4)

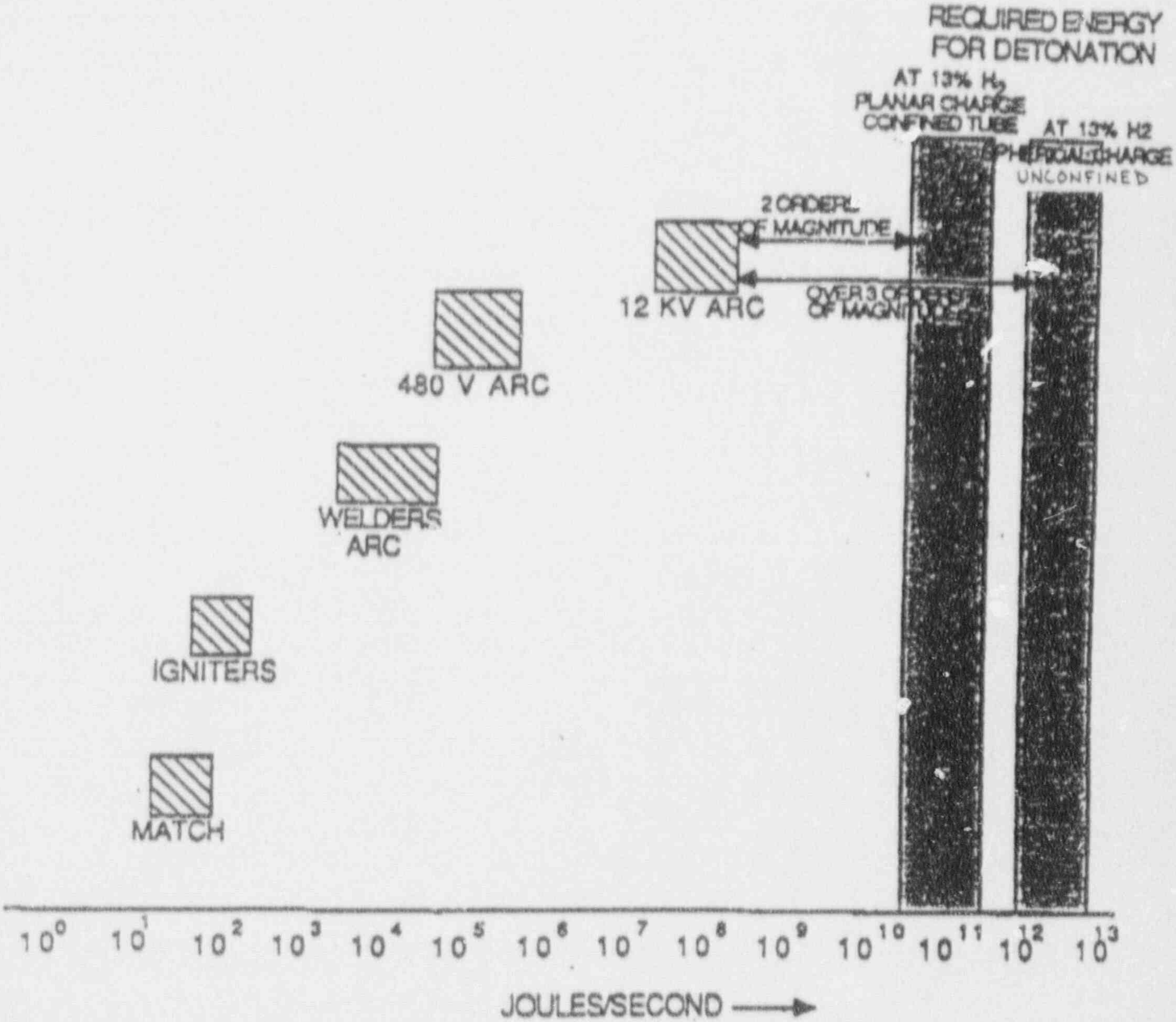

FIGURE 8A-2. IGNITION SOURCE ENERGIES (Taken from Reference 8)

FIGURE 8-1. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 1)

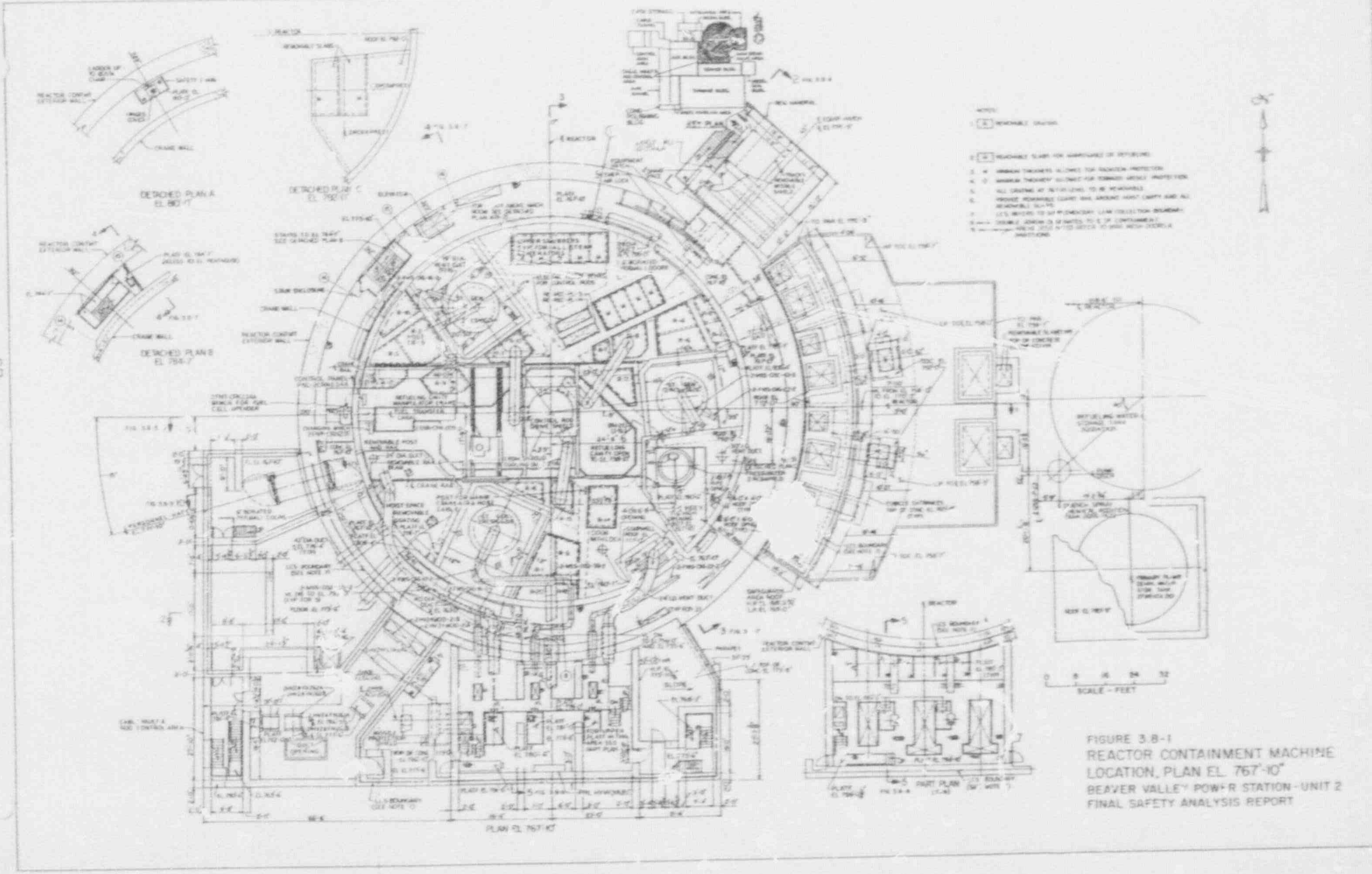

FIGURE 8-2. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 2)

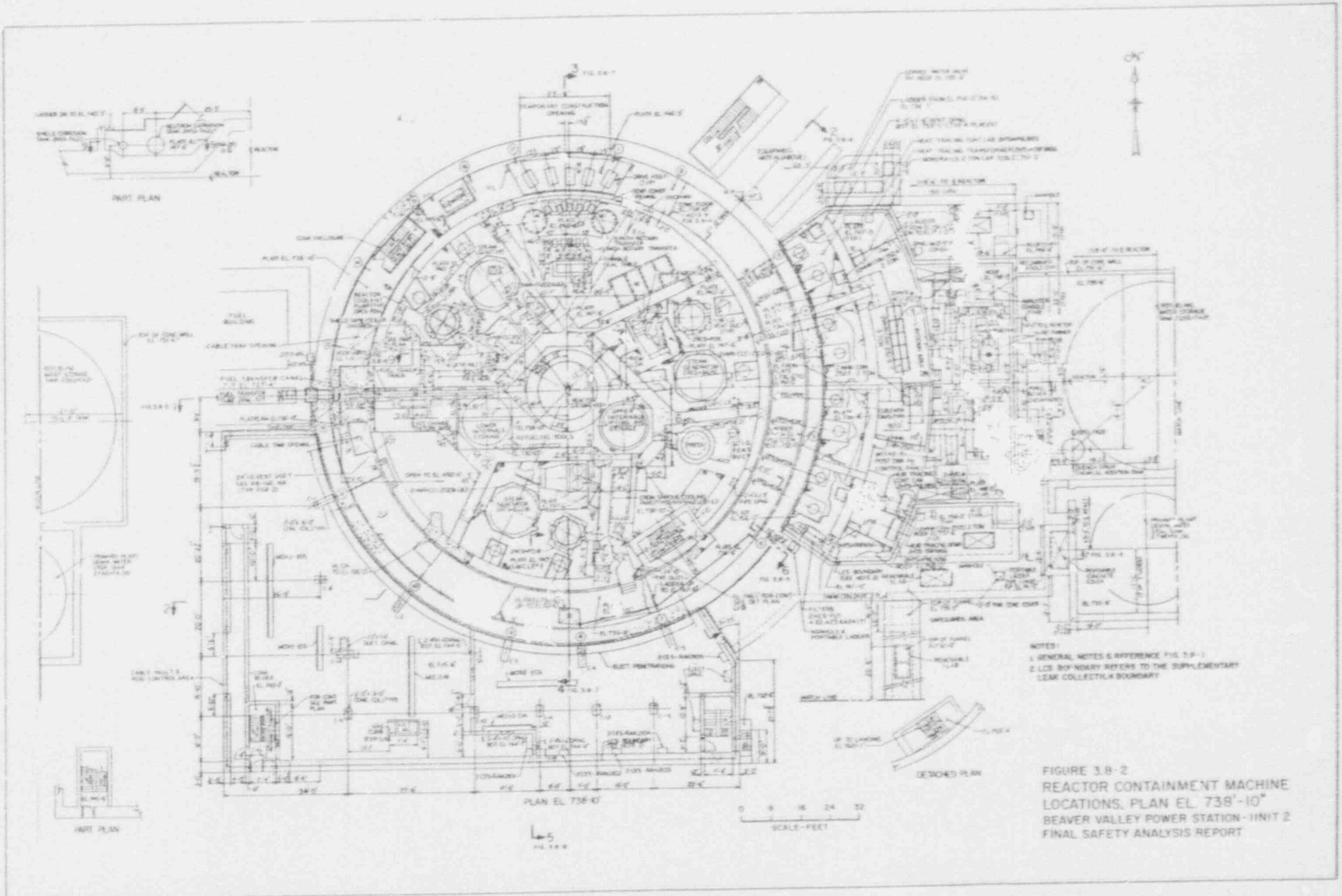

FIGURE 8-3. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 3)

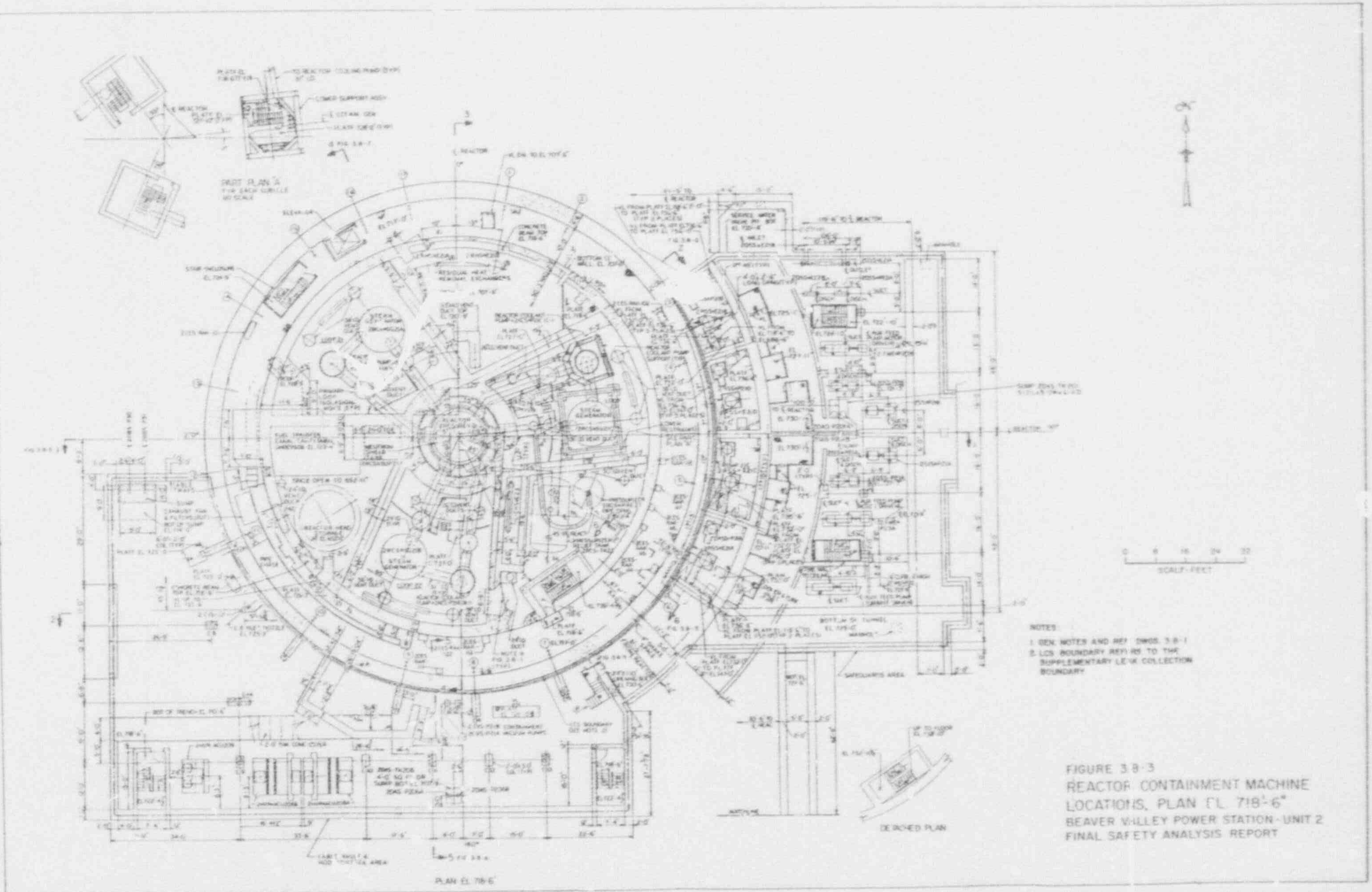

FIGURE 8-4. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 4)

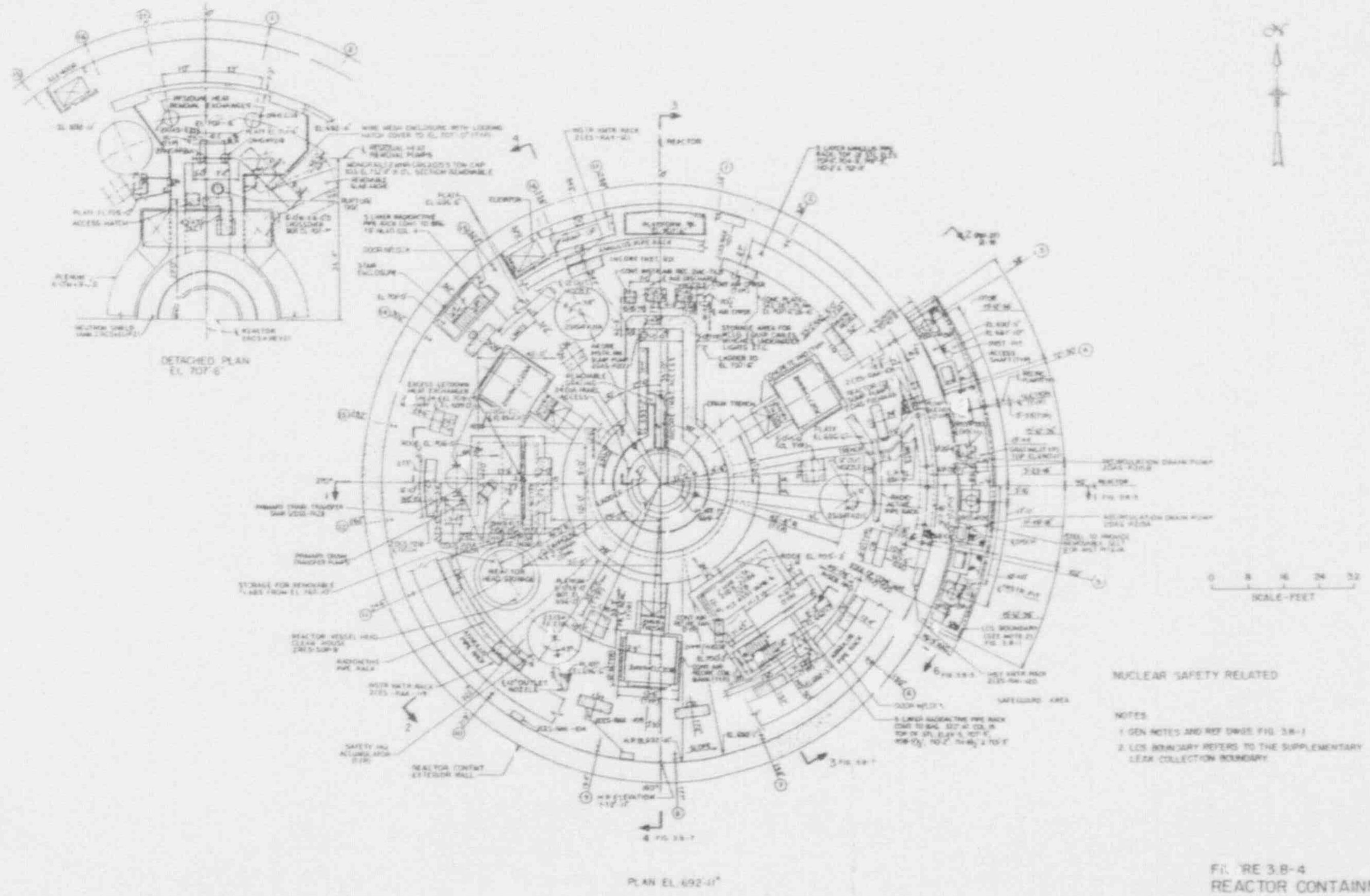

FIGURE 3.8-4
REACTOR CONTAINMENT MACHINE LOCATIONS PLAN EL 692'-11"
BEAVER VALLEY POWER STATION-UNIT 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 8-5. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 5)

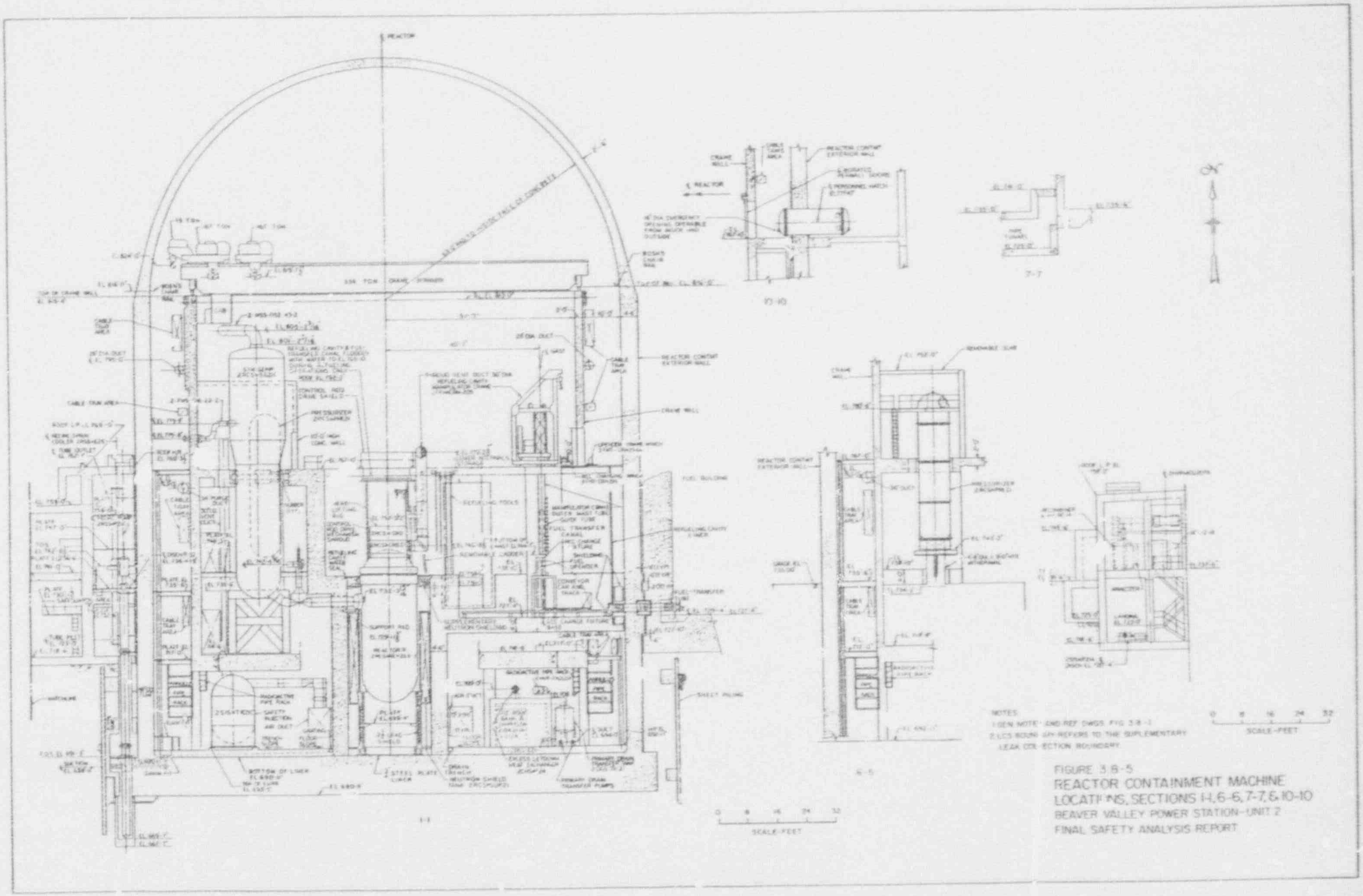

FIGURE 8-6. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 6)

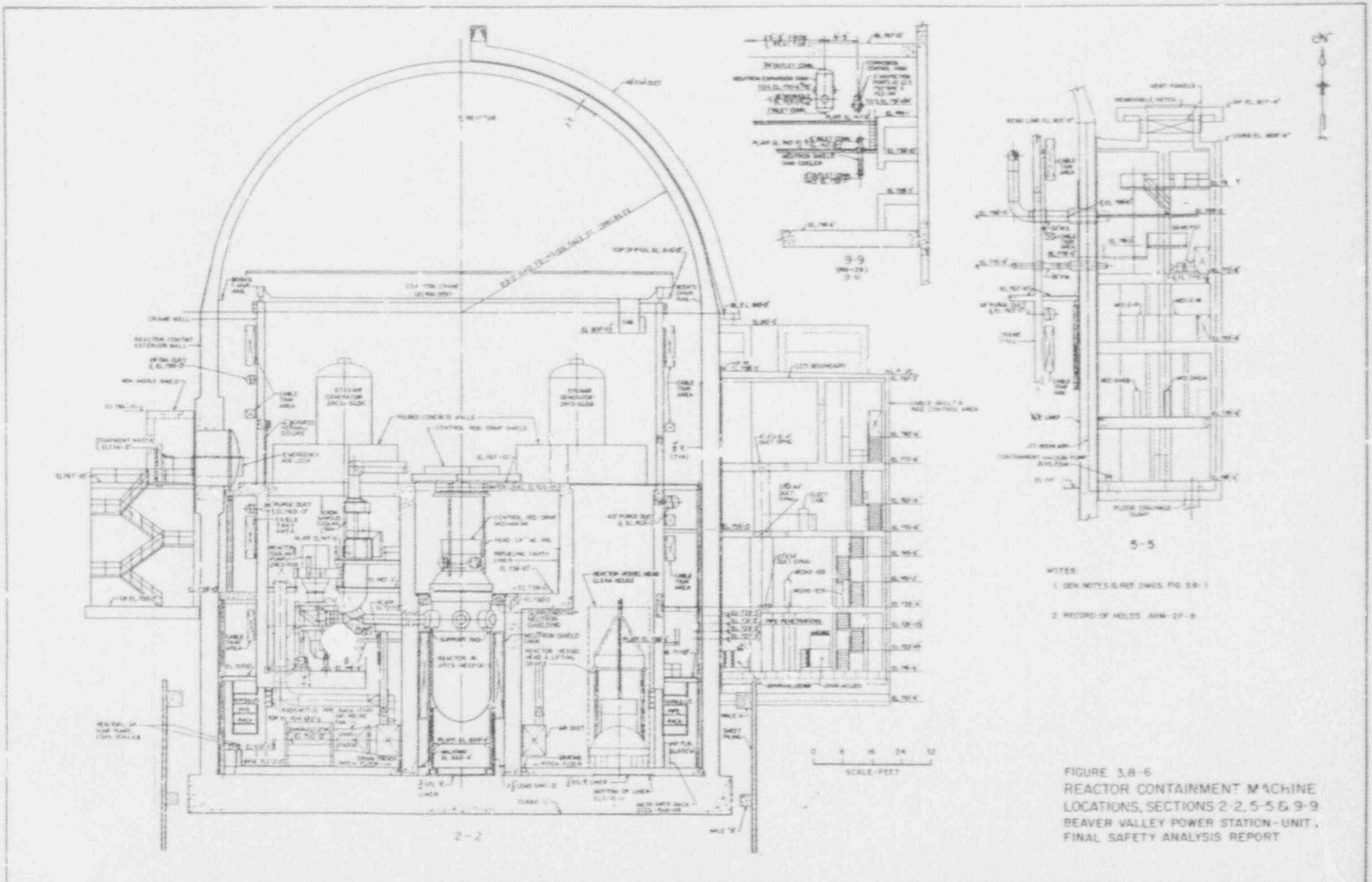

FIGURE 8-7. BEAVER VALLEY UNIT 2 CONTAINMENT BUILDING DIMENSIONS (SHEET 7)

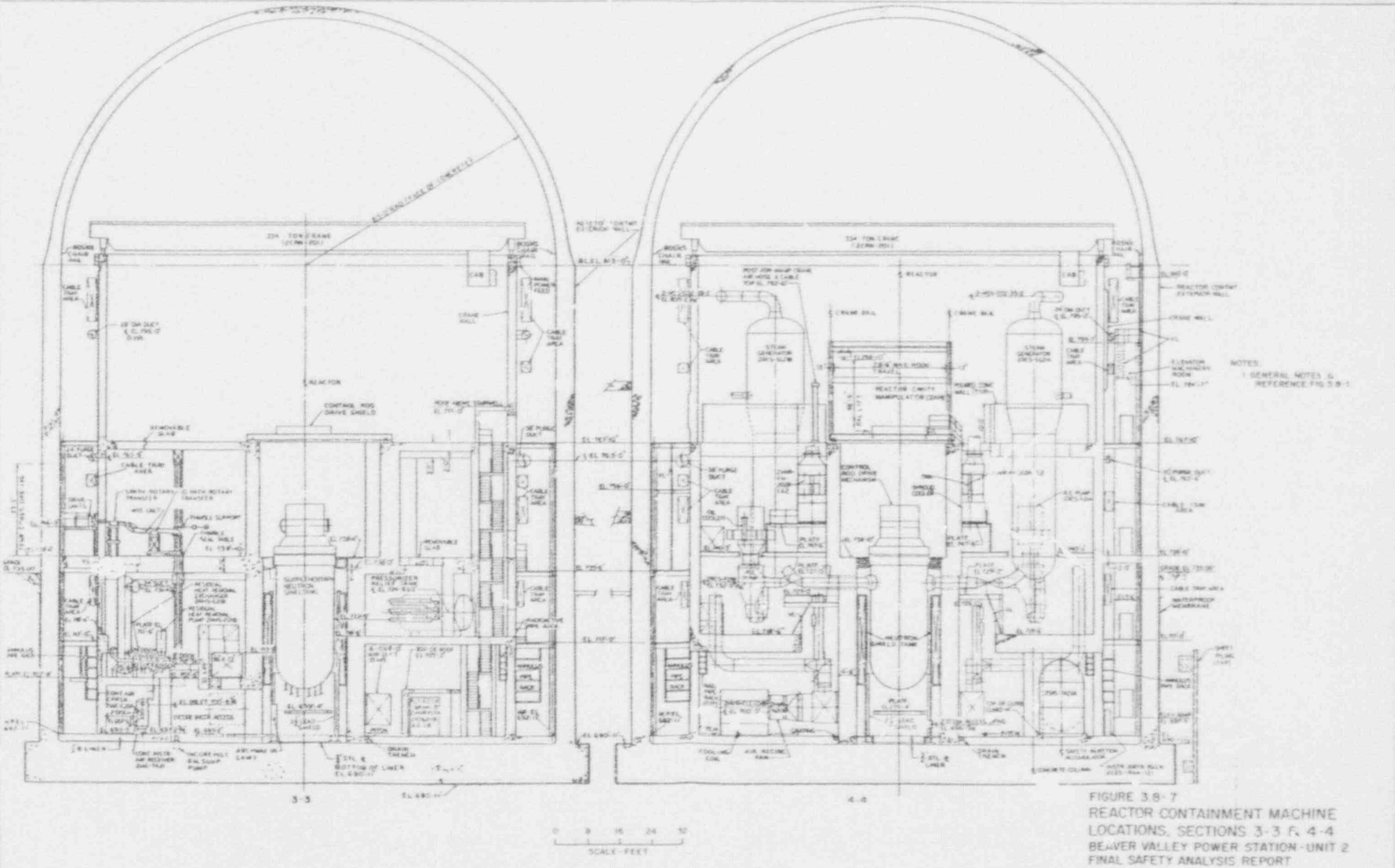

FIGURE 3.8-7
REACTOR CONTAINMENT MACHINE
LOCATIONS, SECTIONS 3-3 & 4-4
BEAVER VALLEY POWER STATION - UNIT 2
FINAL SAFETY ANALYSIS REPORT

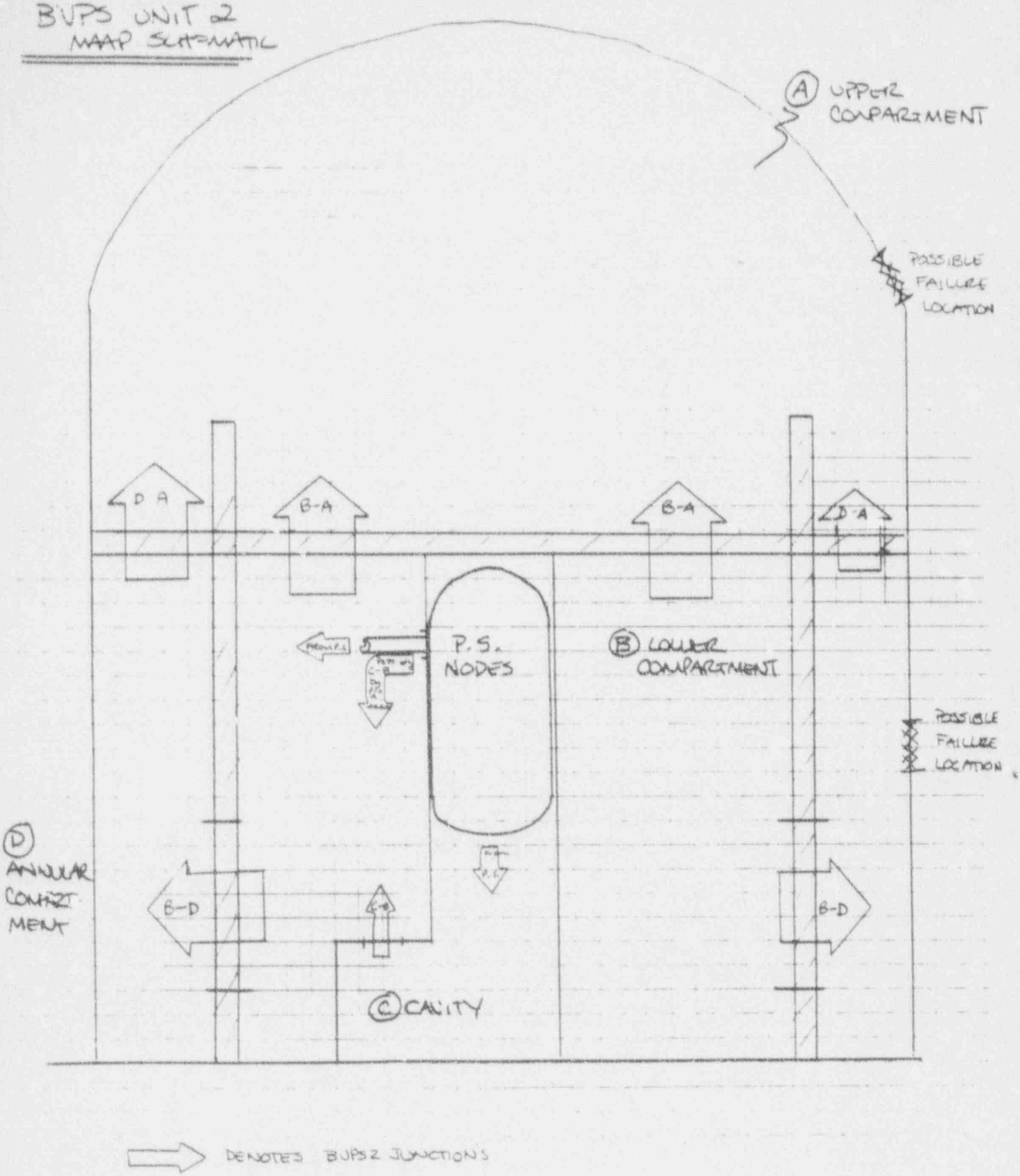

FIGURE 8-8. BEAVER VALLEY UNIT 2 SIMPLIFIED CONTAINMENT SCHEMATIC

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. The containment isolation failure modes which were considered at Beaver Valley Unit 2 consist of the following:

- Small containment bypass; i.e., an SGTR

- Large containment bypass; i.e., large interfacing systems LOCA (V - Sequence)

- Containment not isolated or failed prior to core damage; leak area less than the equivalent of 3 inches in diameter.

- Containment not isolated or failed prior to core damage; leak area greater than the equivalent of 3 inches in diameter.

Due to the subatmospheric design of the Beaver Valley Unit 2 containment building, the last failure mode described above was not included in the PRA models, since preexisting failures of this size would be obvious to the operator inasmuch as he would be unable to maintain subatmospheric pressure. Small containment

bypasses are due to SGTR Initiating Events in the Level 1 Event Trees. These Initiating Events account for 17.0% of the Release Category Group II frequency. Large containment bypasses are due to interfacing system LOCAs in the Level 1 Event Trees, or induced SGTRs in the Level 2 Event Trees. These two types of large containment bypasses account for 9.1% of the Release Category Group I frequency.

As discussed above, any preexisting containment isolation failures were considered to be small in nature and therefore were binned directly into Release Category Group II. Containment isolation failures that were explicitly modeled are:

- Major containment vents and drains; e.g., sump pump discharge lines
- RCS connections; e.g., RCP seal water return line
- Connections to containment atmosphere; e.g., containment vacuum line

The following attached tables are reports generated from the PRA containment isolation model, a brief description for each of these reports is discussed in the following pages. Figure 10-1 shows the fault tree that was used to quantify the containment isolation model.

Table 10-1. This table lists the containment isolation split fractions that were used in the PRA. Included in this table are split fraction descriptions, point estimate (PE) and Monte Carlo (MC/LH) mean split fraction values, and the basic event success/failure states for house events in the fault tree (Figure 10-1). It should be noted that split fraction CI7 only consists of a single basic event (operator action ZHECI3) and hence was not quantified using the fault trees.

MODEL Name: BV2
Split Fraction Report for Top Event CI

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Page 1

Split Fraction CI1 - CONTAINMENT ISOLATION - ALL SUPPORT

PE Mean = 4.9710E-03 Date : 09 AUG 1991 14:16
MC/LH Mean = 5.1670E-03 Date : 28 AUG 1991 00:40

Basic Event Impacts for Split Fraction : CI1

Basic Event	State	Description
XXACPU	S	LOSS OF EMERGENCY AC PURPLE
XXACOR	S	LOSS OF EMERGENCY AC ORANGE
XXSAFF	S	SSPS TRAIN A UNAVAILABLE
XXNOSB	F	NO LOSS OF ALL AC POWER
XXSBFF	S	SSPS TRAIN B UNAVAILABLE

Split Fraction CI2 - CONTAINMENT ISOLATION - LOSS OF AC PURPLE

PE Mean = 1.6790E-02 Date : 09 AUG 1991 14:16
MC/LH Mean = 1.6960E-02 Date : 28 AUG 1991 00:40

Basic Event Impacts for Split Fraction : CI2

Basic Event	State	Description
XXACOR	S	LOSS OF EMERGENCY AC ORANGE
XXACPU	F	LOSS OF EMERGENCY AC PURPLE
XXSAFF	S	SSPS TRAIN A UNAVAILABLE
XXSBFF	S	SSPS TRAIN B UNAVAILABLE
XXNOSB	F	NO LOSS OF ALL AC POWER

Split Fraction CI3 - CONTAINMENT ISOLATION - LOSS OF AC ORANGE

PE Mean = 1.1050E-02 Date : 09 AUG 1991 14:16
MC/LH Mean = 1.1240E-02 Date : 28 AUG 1991 00:40

Basic Event Impacts for Split Fraction : CI3

Basic Event	State	Description
XXACOR	F	LOSS OF EMERGENCY AC ORANGE
XXACPU	S	LOSS OF EMERGENCY AC PURPLE
XXSAFF	S	SSPS TRAIN A UNAVAILABLE
XXSBFF	S	SSPS TRAIN B UNAVAILABLE
XXNOSB	F	NO LOSS OF ALL AC POWER

Split Fraction CI4 - CONTAINMENT ISOLATION - LOSS OF SSPS TRAIN A

PE Mean = 5.1090E-02 Date : 09 AUG 1991 14:16
MC/LH Mean = 5.1390E-02 Date : 28 AUG 1991 00:40

Basic Event Impacts for Split Fraction : CI4

Basic Event	State	Description
XXACOR	S	LOSS OF EMERGENCY AC ORANGE
XXACPU	S	LOSS OF EMERGENCY AC PURPLE
XXSAFF	F	SSPS TRAIN A UNAVAILABLE
XXSBFF	S	SSPS TRAIN B UNAVAILABLE
XXNOSB	F	NO LOSS OF ALL AC POWER

MODEL Name: BV2
Split Fraction Report for Top Event CI

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Split Fraction CI5 - CONTAINMENT ISOLATION - LOSS OF SSPS TRAIN B

PE Mean = 6.2710E-02 Date : 09 AUG 1991 14:16
MC/LH Mean = 6.2720E-02 Date : 28 AUG 1991 00:40

Basic Event Impacts for Split Fraction : CI5

Basic Event	State	Description
XXACOR	S	[illegible] EMERGENCY AC ORANGE
XXACPU	S	[illegible] OF EMERGENCY AC PURPLE
XXSAFF	S	SSPS [illegible] NAVAILABLE
XXSBFF	F	SSPS TRAIN B UNAVAILABLE
XXNOSB	F	NO LOSS OF ALL AC POWER

Split Fraction CI6 - CONTAINMENT ISOLATION - LOSS OF AC ORANGE & PURPLE

PE Mean = 1.1830E-02 Date : 09 AUG 1991 14:16
MC/LH Mean = 1.1880E-02 Date : 28 AUG 1991 00:40

Basic Event Impacts for Split Fraction : CI6

Basic Event	State	Description
XXACOR	F	LOSS OF EMERGENCY AC ORANGE
XXACPU	F	LOSS OF EMERGENCY AC PURPLE
XXSAFF	S	SSPS TRAIN A UNAVAILABLE
XXSBFF	S	SSPS TRAIN B UNAVAILABLE
XXNOSB	S	NO LOSS OF ALL AC POWER

Split Fraction CI7 - CONTAINMENT ISOLATION - LOSS OF SSPS TRAINS [illegible]

PE Mean = 1.0000E-01 Date : 09 AUG 1991 14:16
MC/LH Mean = 1.0270E-01 Date : 28 AUG 1991 00:40

Equation: ZHECI3

Split Fraction CIF - GUARANTEED FAILURE

PE Mean = 1.0000E+00 Date : 09 AUG 1991 14:16
MC/LH Mean = 1.0000E+00 Date : 28 AUG 1991 00:40

Constant Value: 1.0

Table 10-2. This report consists of the containment isolation common cause failure modes, which were developed by using the Multiple Greek Letter (MGL) methodology. Incorporated into this table are the common cause group identifiers, the basic events that are affected in the group, the order of the common cause failure mode modeled, the failure mode, and the database variables that were used to quantify the MGL equations.

MODEL Name: BV2
CCF Model Report for Top Event CI

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Group ID : MVC	Basic Events	Description
	MVFC2CHSMOV381	2CHS*MOV381 FAILS TO CLOSE
	MVFC2CHSMOV378	2CHS*MOV378 FAILS TO CLOSE

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID : CLOSE
Total Failure Rate = ZTVMOD
Beta = ZBVMOD

Group ID : AVC	Basic Events	Description
	AVFC2CHSLCV460A	2CHS*LCV460A FAILS TO CLOSE
	AVFC2CHSAOV200A	2CHS*AOV200A FAILS TO CLOSE
	AVFC2CHSAOV200C	2CHS*AOV200C FAILS TO CLOSE
	AVFC2CHSAOV200B	2CHS*AOV200B FAILS TO CLOSE
	AVFC2CHSLCV460B	2CHS*LCV460B FAILS TO CLOSE
	AVFC2CHSAOV204	2CHS*AOV204 FAILS TO CLOSE

Algebraic Method: MGL
Order = 3 out of 6

Failure Mode ID : CLOSE
Total Failure Rate = ZTVAOD
Beta = ZBVAOD
Gamma = ZGVAOD
Delta = ZDVAOD

Group ID : VSC	Basic Events	Description
	VSFC2CVSSOV151B	2CVS*SOV151B FAILS TO CLOSE
	VSFC2CVSSOV152B	2CVS*SOV152B FAILS TO CLOSE

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID : CLOSE
Total Failure Rate = ZTVSOD
Beta = ZBVSOD

MODEL Name: BV2
CCF Model Report for Top Event CI

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Page 2

Group ID : AV1	Basic Events	Description
	AVFC2DASAOV100B	2DAS*AOV100B FAILS TO CLOSE
	AVFC2DASAOV100A	2DAS*AOV100A FAILS TO CLOSE

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID : CLOSE
Total Failure Rate = ZTVAOD
Beta = ZBVAOD

Group ID : AV2	Basic Events	Description
	AVFC2DGSAOV108A	2DGS*AOV108A FAILS TO CLOSE
	AVFC2DGSAOV108B	2DGS*AOV108B FAILS TO CLOSE

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID : CLOSE
Total Failure Rate = ZTVAOD
Beta = ZBVAOD

Group ID : AV3	Basic Events	Description
	AVFC2VRSAOV109A1	2VRS*AOV109A1 FAILS TO CLOSE
	AVFC2VRSAOV109A2	2VRS*AOV109A2 FAILS TO CLOSE

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID CLOSE
Total Failure Rate = ZTVAOD
Beta = ZBVAOD

Group ID : VS1	Basic Events	Description
	VSFC2CVSSOV153A	2CVS*SOV153A FAILS TO CLOSE
	VSFC2CVSSOV153B	2CVS*SOV153B FAILS TO CLOSE

MODEL Name: BV2
CCF Model Report for Top Event CI

15:30:30 22 SEP 1992
Page 3

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID : CLOSE
Total Failure Rate = ZTVSOD
Beta = ZBVSOD

Group ID : VS2	Basic Events	Description
	VSFC2CVSSOV151A	2CVS*SOV151A FAILS TO CLOSE
	VSFC2CVSSOV152A	2CVS*SOV152A FAILS TO CLOSE

Algebraic Method: MGL
Order = 1 out of 2

Failure Mode ID : CLOSE
Total Failure Rate = ZTVSOD
Beta = ZBVSOD

Table 10-3. This table provides the cause table for each of the containment isolation split fractions that were quantified by using the fault tree on Figure 10-1. The cause tables consist of the quantified minimal cutsets for each particular split fraction. These cutsets are ranked in descending order according to their quantified values. Additionally, this table shows the % Importance, or the percentage that each cutset contributes to the Monte Carlo mean split fraction value, and the % Cumulative, which is the cumulative summation of the % Importance. The cause table reports were generated by using a 99.9% cumulative cutoff for each of the split fractions. The alignment of the system when the cutset was quantified is also provided. These are all shown as being normal, since no maintenance or tests are performed on an unisolated component during plant operation. It should be noted that singleton cutsets, whose basic event identifiers are separated by a comma and enclosed in brackets [ ], are common cause failures of components. Independent failures of common cause components are shown as a single basic event enclosed in brackets.

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI1

PE Value of CI1 = 4.9710E-03 Date : 09 AUG 1991 14:16
MC/LH Value of CI1 = 5.1670E-03 Date : 28 AUG 1991 00:40

15:23:55 22 SEP 1992
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No...	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
1	[VSFC2CVSSOV151A,VSFC2CVSSOV152A]	7.851E-04	15.1945	15.1945	NORMAL
2	[VSFC2CVSSOV151B,VSFC2CVSSOV152B]	7.851E-04	15.1945	30.3890	NORMAL
3	[VSFC2CVSSOV153A,VSFC2CVSSOV153B]	7.851E-04	15.1945	45.5835	NORMAL
4	OPRCI2	4.764E-04	9.2201	54.8036	NORMAL
5	[AVFC2VRSAOV109A1,AVFC2VRSAOV109A2]	4.063E-04	7.8634	62.6669	NORMAL
6	[AVFC2DASAOV100B,AVFC2DASAOV100A]	4.063E-04	7.8634	70.5303	NORMAL
7	[AVFC2DGSAOV108A,AVFC2DGSAOV108B]	4.063E-04	7.8634	78.3937	NORMAL
8	[MVFC2CHSMOV381,MVFC2CHSMOV378]	3.957E-04	7.6582	86.0519	NORMAL
9	[VSFC2CVSSOV151A] * [VSFC2CVSSOV152A]	1.376E-04	2.6631	88.7149	NORMAL
10	[VSFC2CVSSOV153A] * [VSFC2CVSSOV153B]	1.376E-04	2.6631	91.3780	NORMAL
11	[VSFC2CVSSOV151B] * [VSFC2CVSSOV152B]	1.376E-04	2.6631	94.0410	NORMAL
12	CVFR2CVS93 * VSFC2CVSSOV102	6.308E-05	1.2208	95.2619	NORMAL
13	[MVFC2CHSMOV381] * [MVFC2CHSMOV378]	4.540E-05	.8787	96.1405	NORMAL
14	[AVFC2DASAOV100B] * [AVFC2DASAOV100A]	4.049E-05	.7836	96.9241	NORMAL
15	[AVFC2VRSAOV109A1] * [AVFC2VRSAOV109A2]	4.049E-05	.7836	97.7078	NORMAL
16	[AVFC2DGSAOV108A] * [AVFC2DGSAOV108B]	4.049E-05	.7836	98.4914	NORMAL
17	[MVFC2CHSMOV381] * CVFR2CHS173	3.497E-05	.6768	99.1682	NORMAL
18	AVFC2RCSAOV101 * CVFR2RCS6d	3.256E-05	.6302	99.7983	NORMAL

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI2

PE Value of CI2 = 1.6790E-02 Date : 09 AUG 1991 14:16
MC/LH Value of CI2 = 1.6960E-02 Date : 28 AUG 1991 00:40

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No...	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
1	[MVFC2CHSMOV378]	6.091E-03	35.9139	35.9139	NORMAL
2	CVFR2CHS173	5.7[illegible]7E-03	34.003[illegible]	69.9175	NORMAL
3	[VSFC2CVSSOV151A,V SFC2CVSSOV152A]	7.665E-04	4.5195	74.4369	NORMAL
4	[VSFC2CVSSOV151B,V SFC2CVSSOV152B]	7.665E-04	4.5195	78.9564	NORMAL
5	[VSFC2CVSSOV153A,V SFC2CVSSOV153B]	7.665E-04	4.5195	83.4758	NORMAL
6	OPRCI2	5.765E-04	3.3992	86.8750	NORMAL
7	[AVFC2VRSAOV109A1, AVFC2VRSAOV109A2]	4.011E-04	2.3650	89.2400	NORMAL
8	[AVFC2DGSAOV108A,A VFC2DGSAOV108B]	4.011E-04	2.3650	91.6050	NORMAL
9	[AVFC2DASAOV100B,A VFC2DASAOV100A]	4.011E-04	2.3650	93.9699	NORMAL
10	[MVFC2CHSMOV381,MV FC2CHSMOV378]	3.936E-04	2.3208	96.2907	NORMAL
11	[VSFC2CVSSOV151B] * [VSFC2CVSSOV152B]	1.319E-04	.7777	97.0684	NORMAL
12	[VSFC2CVSSOV151A] * [VSFC2CVSSOV152A]	1.319E-04	.7777	97.8461	NORMAL
13	[VSFC2CVSSOV153A] * [VSFC2CVSSOV153B]	1.319E-04	.7777	98.6238	NORMAL
14	CVFR2CVS93 * VSFC2CVSSOV102	6.407E-05	.3778	99.0016	NORMAL
15	[AVFC2VRSAOV109A1] * [AVFC2VRSAOV109A2]	4.036E-05	.2380	99.2396	NORMAL
16	[AVFC2DASAOV100B] * [AVFC2DASAOV100A]	4.036E-05	.2380	99.4775	NORMAL
17	[AVFC2DGSAOV108A] * [AVFC2DGSAOV108B]	4.036E-05	.2380	99.7155	NORMAL

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI3

PE Value of CI3 = 1.1050E-02 Date : 09 AUG 1991 14:16
MC/LH Value of CI3 = 1.1240E-02 Date : 28 AUG 1991 00:40

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No...	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
1	[MVFC2CHSMOV381]	6.303E-03	56.0765	56.0765	NORMAL
2	[VSFC2CVSSOV151A,VSFC2CVSSOV152A]	7.577E-04	6.7411	62.8176	NORMAL
3	[VSFC2CVSSOV151B,VSFC2CVSSOV152B]	7.577E-04	6.7411	69.5587	NORMAL
4	[VSFC2CVSSOV153A,VSFC2CVSSOV153B]	7.577E-04	6.7411	76.2998	NORMAL
5	OPRCI2	4.605E-04	4.0970	80.3968	NORMAL
6	[MVFC2CHSMOV381,MVFC2CHSMOV378]	4.068E-04	3.6192	84.0160	NORMAL
7	[AVFC2VRSAOV109A1,AVFC2VRSAOV109A2]	3.967E-04	3.5294	87.5454	NORMAL
8	[AVFC2DASAOV100B,AVFC2DASAOV100A]	3.967E-04	3.5294	91.0747	NORMAL
9	[AVFC2DGSAOV108A,AVFC2DGSAOV108B]	3.967E-04	3.5294	94.6041	NORMAL
10	[VSFC2CVSSOV151A] * [VSFC2CVSSOV152A]	1.275E-04	1.1343	95.7384	NORMAL
11	[VSFC2CVSSOV153A] * [VSFC2CVSSOV153B]	1.275E-04	1.1343	96.8728	NORMAL
12	[VSFC2CVSSOV151B] * [VSFC2CVSSOV152B]	1.275E-04	1.1343	98.0071	NORMAL
13	CVFR2CVS93 * VSFC2CVSSOV102	6.286E-05	.5593	98.5664	NORMAL
14	[AVFC2VRSAOV109A1] * [AVFC2VRSAOV109A2]	3.884E-05	.3456	98.9119	NORMAL
15	[AVFC2DGSAOV108A] * [AVFC2DGSAOV108B]	3.884E-05	.3456	99.2575	NORMAL
16	[AVFC2DASAOV100B] * [AVFC2DASAOV100A]	3.884E-05	.3456	99.6030	NORMAL
17	AVFC2RCSAOV101 * CVFR2RCS68	3.305E-05	.2940	99.8971	NORMAL

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI4

PE Value of CI4 = 5.1090E-02 Date : 09 AUG 1991 14:10
MC/LH Value of CI4 = 5.1390E-02 Date : 28 AUG 1991 00:40

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No...	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
1	[VSFC2CVSSOV152A]	1.029E-02	20.0234	20.0234	NORMAL
2	[VSFC2CVSSOV152B]	1.029E-02	20.0234	40.0467	NORMAL
3	[VSFC2CVSSOV153B]	1.029E-02	20.0234	60.0701	NORMAL
4	[AVFC2VRSAOV109A2]	5.280E-03	10.2744	70.3444	NORMAL
5	[AVFC2DASAOV100B]	5.280E-03	10.2744	80.6188	NORMAL
6	[AVFC2DGSAOV108B]	5.280E-03	10.2744	90.8932	NORMAL
7	[VSFC2CVSSOV153A,VSFC2CVSSOV153B]	7.640E-04	1.4867	92.3798	NORMAL
8	[VSFC2CVSSOV151B,VSFC2CVSSOV152B]	7.640E-04	1.4867	93.8665	NORMAL
9	[VSFC2CVSSOV151A,VSFC2CVSSOV152A]	7.640E-04	1.4867	95.3532	NORMAL
10	OPRCI2	5.322E-04	1.0356	96.3888	NORMAL
11	[MVFC2CHSMOV381,MVFC2CHSMOV378]	3.942E-04	.7671	97.1559	NORMAL
12	[AVFC2VRSAOV109A1, AVFC2VRSAOV109A2]	3.878E-04	.7546	97.9105	NORMAL
13	[AVFC2DASAOV100B,AVFC2DASAOV100A]	3.878E-04	.7546	98.6651	NORMAL
14	[AVFC2DGSAOV108A,AVFC2DGSAOV108B]	3.878E-04	.7546	99.4197	NORMAL
15	[AVFC2CHSLCV460B,AVFC2CHSAOV204]	6.680E-05	.1300	99.5497	NORMAL
16	CVFR2CVS93 * VSFC2CVSSOV102	6.227E-05	.1212	99.6709	NORMAL
17	[MVFC2CHSMOV381] * [MVFC2CHSMOV378]	4.444E-05	.0865	99.7574	NORMAL
18	[AVFC2CHSLCV460B] * [AVFC2CHSAOV204]	3.887E-05	.0756	99.8330	NORMAL

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI5

PE Value of CI5 = 6.2710E-02 Date : 09 AUG 1991 14:16
MC/LH Value of CI5 = 6.2720E-02 Date : 28 AUG 1991 00:40

15:26:35 22 SEP 1992
Page 1

No..	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
1	[VSFC2CVSSOV151A]	1.002E-02	15.9758	15.9758	NORMAL
2	[VSFC2CVSSOV153A]	1.002E-02	15.9758	31.9515	NORMAL
3	[VSFC2CVSSOV151B]	1.002E-02	15.9758	47.9273	NORMAL
4	CVFR2CVS93	5.782E-03	9.2188	57.1460	NORMAL
5	CVFR2RCS68	5.782E-03	9.2188	66.3648	NORMAL
6	[AVFC2VRSAOV109A1]	5.425E-03	8.6496	75.0143	NORMAL
7	[AVFC2DGSAOV108A]	5.425E-03	8.6496	83.6639	NORMAL
8	[AVFC2DASAOV100A]	5.425E-03	8.6496	92.3135	NORMAL
9	[VSFC2CVSSOV151B,VSFC2CVSSOV152B]	7.481E-04	1.1928	93.5062	NORMAL
10	[VSFC2CVSSOV151A,VSFC2CVSSOV152A]	7.481E-04	1.1928	94.6990	NORMAL
11	[VSFC2CVSSOV153A,VSFC2CVSSOV153B]	7.481E-04	1.1928	95.8917	NORMAL
12	OPRCI2	4.985E-04	.7948	96.6865	NORMAL
13	[MVFC2CHSMOV381,MVFC2CHSMOV378]	3.988E-04	.6358	97.3224	NORMAL
14	[AVFC2VRSAOV109A1,AVFC2VRSAOV109A2]	3.977E-04	.6341	97.9565	NORMAL
15	[AVFC2DASAOV100B,AVFC2DASAOV100A]	3.977E-04	.6341	98.5906	NORMAL
16	[AVFC2DGSAOV108A,AVFC2DGSAOV108B]	3.977E-04	.6341	99.2246	NORMAL
17	[AVFC2CHSLCV460A,AVFC2CHSAOV200A]	6.817E-05	.1087	99.3333	NORMAL
18	[AVFC2CHSLCV460A,AVFC2CHSAOV200C]	6.817E-05	.1087	99.4420	NORMAL
19	[AVFC2CHSLCV460A,AVFC2CHSAOV200B]	6.817E-05	.1087	99.5507	NORMAL
20	[MVFC2CHSMOV381] * [MVFC2CHSMOV378]	4.606E-05	.0734	99.6242	NORMAL
21	[AVFC2CHSLCV460A] * [AVFC2CHSAOV200B]	4.076E-05	.0650	99.6891	NORMAL
22	[AVFC2CHSLCV460A] * [AVFC2CHSAOV200C]	4.076E-05	.0650	99.7541	NORMAL
23	[AVFC2CHSLCV460A] *	4.076E-05	.0650	99.8191	NORMAL

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI5

PE Value of CI5 = 6.2710E-02 Date : 09 AUG 1991 14:16
MC/LH Value of CI5 = 6.2720E-02 Date : 28 AUG 1991 00:40

15:26:42 22 SEP 1992
Page 2

No...	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
	[AVFC2CHSAOV200A]				
24	[MVFC2CHSMOV381] * CVFR2CHS173	3.564E-05	.0568	99.8759	NORMAL
25	[AVFC2CHSLCV460A,AVFC2CHSAOV200A,AVFC2CHSAOV200C,AVFC2CHSAOV200B,AVFC2CHSLCV460B,AVFC2CHSAOV204]	1.001E-05	.0160	99.8919	NORMAL
26	[AVFC2CHSLCV460A,AVFC2CHSAOV200C,AVFC2CHSAOV200B]	4.688E-06	.0075	99.8994	NORMAL

MODEL Name: BV2
Cause Table for Top Event CI and Split Fraction CI6

PE Value of CI6 = 1.1830E-02 Date : 09 AUG 1991 14:16
MC/LH Value of CI6 = 1.1880E-02 Date : 28 AUG 1991 00:40

15.??:30 22 SEP 1992
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No...	Cutsets...........	Value.....	% Importance	% Cumulative	Alignment...
1	OPRCI1	7.316E-03	61.5825	61.5825	NORMAL
2	[VSFC2CVSSOV151A,VSFC2CVSSOV152A]	7.644E-04	6.4343	68.0168	NORMAL
3	[VSFC2CVSSOV153A,VSFC2CVSSOV153B]	7.644E-04	6.4343	74.4512	NORMAL
4	[VSFC2CVSSOV151B,VSFC2CVSSOV152B]	7.644E-04	6.4343	80.8855	NORMAL
5	OPRCI2	5.036E-04	4.2391	85.1246	NORMAL
6	[AVFC2VRSAOV109A1,AVFC2VRSAOV109A2]	3.851E-04	3.2416	88.3662	NORMAL
7	[AVFC2DASAOV100B,AVFC2DASAOV100A]	3.851E-04	3.2416	91.6077	NORMAL
8	[AVFC2DGSAOV108A,AVFC2DGSAOV108B]	3.851E-04	3.2416	94.8493	NORMAL
9	[VSFC2CVSSOV153A] * [VSFC2CVSSOV153B]	1.303E-04	1.0968	95.9461	NORMAL
10	[VSFC2CVSSOV151B] * [VSFC2CVSSOV152B]	1.303E-04	1.0968	97.0429	NORMAL
11	[VSFC2CVSSOV151A] * [VSFC2CVSSOV152A]	1.303E-04	1.0968	98.1397	NORMAL
12	CVFR2CVS93 * VSFC2CVSSOV102	6.213E-05	.5230	98.6627	NORMAL
13	[AVFC2VRSAOV109A1] * [AVFC2VRSAOV109A2]	4.003E-05	.3370	98.9997	NORMAL
14	[AVFC2DGSAOV108A] * [AVFC2DGSAOV108B]	4.003E-05	.3370	99.3366	NORMAL
15	[AVFC2DASAOV100B] * [AVFC2DASAOV100A]	4.003E-05	.3370	99.6736	NORMAL

Table 10-4. This table lists the small, early containment failure or bypass importance, which is the percentage that each containment isolation split fraction contributes to the Release Category Group II frequency.

TABLE 10-4. CONTAINMENT ISOLATION SPLIT FRACTION IMPORTANCE TO SECFBY

Split Fraction	Split Fraction Description	SECFBY Importance	SECFBY Percent Importance
CI1	Containment Isolation - All Support Available	5.45E-03	0.55%
CI2	Containment Isolation - Loss of AC Purple Power	1.40E-03	0.14%
CI3	Containment Isolation - Loss of AC Orange Power	2.51E-03	0.25%
CI4	Containment Isolation - Loss of SSPS Train A	7.86E-05	<0.01%
CI5	Containment Isolation - Loss of SSPS Train B	9.27E-05	<0.01%
CI6	Containment Isolation - Loss of AC Orange & Purple Power	6.94E-03	0.69%
CI7	Containment Isolation - Loss of Both SSPS Trains and OS is Failed	0	0.00%
CIF	Containment Isolation - Guaranteed Failure	7.32E-01	73.21%

FIGURE 10-1. CONTAINMENT ISOLATION FAULT TREE

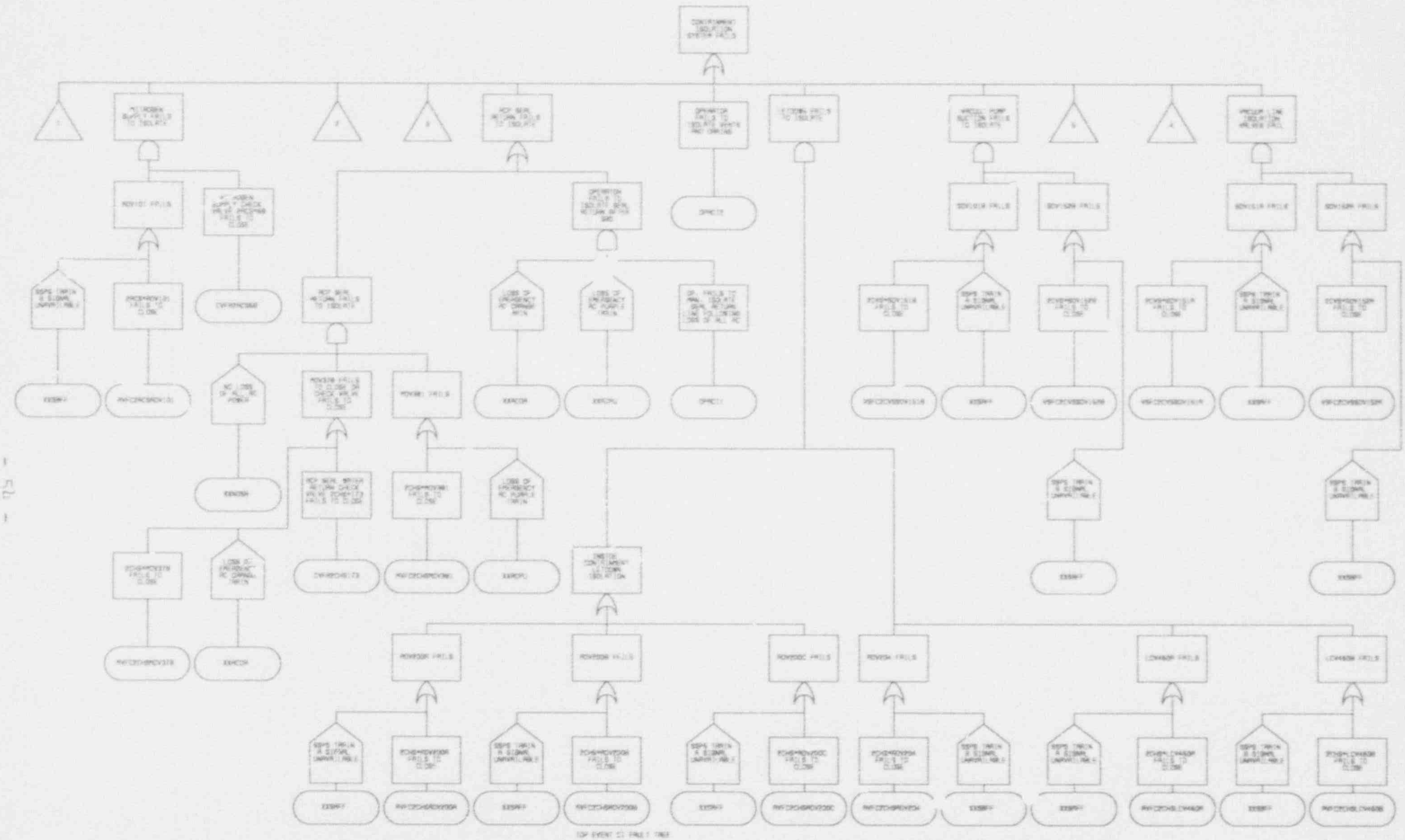
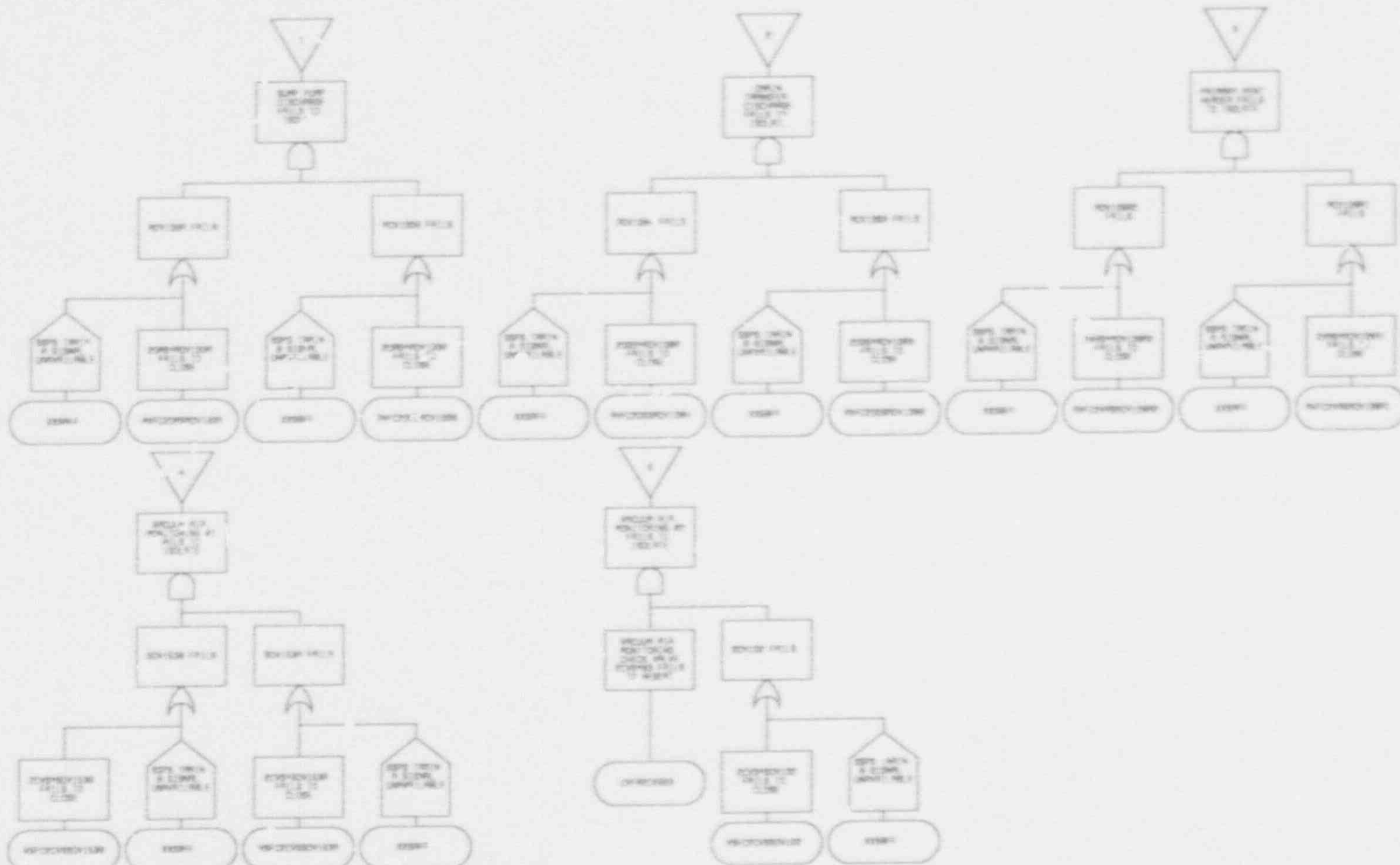


FIGURE 10.1 CONTAINMENT ISOLATION FAULT TREE



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 of 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. Most of the information sources listed in Table 2.4-1 are outputs of the design change process, which Engineering user to control plant modifications. The "FREEZE" date that was used for the PRA/IPE plant configuration was December 31, 1988.

Per DLC procedures, Valve Operating Number Diagrams (VONDs) must be updated and approved prior to any plant modifications being operationally accepted, and these measures ensured that these documents reflected the as-built conditions of the plant at the time of the "FREEZE" date. Since these VONDs were used as the basis for the PRA system fault tree models, all plant design modifications performed and turned over to the Station prior to January 1, 1989 were incorporated into the PRA. Human Actions used in the PRA models were based on the procedure whose revision was in effect at the "FREEZE" date.

Question 12. Duquesne Light Company (DLC) has stated that the PRA for BV-2 was 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. DLC personnel were intimately involved in the development of BV-2 system models, including their quantification; hence this DLC involvement satisfied most of the quantification review process and only minimal additional DLC review was necessary. The update of the BV-2 Model (i.e., development of a plant-specific database, and requantification of system fault tree and event tree models) was performed entirely by DLC personnel. DLC personnel took the lead in the BV-1 PRA and performed the majority of work for all aspects of the PRA.

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 the 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 IPE 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 already 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 59 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 P21A	Reactor Coolant Pumps P21B	Reactor Coolant Pumps P21C	Pressurizer PORV Trains PORV 455C, Block Valve 53C	PORV 455D, Block Valve 537	PORV 456, Block Valve 538	Pressurizer Spray Valves Normal 2RCS*PCV455A 2RCS*PCV455B	Auxiliary 2CHS*MOV310	Main Feed Pumps P21A	P21B	P24	Feedwater Valves	Condensate Pumps	Turbine Trip	MSIVs	Atmospheric Dump Valves 2SVS*PCV 101A, 101B, 101C, 101D	Condenser Dump Valves	Residual Heat Release Valve HCV-104	RCS Letdown
Offsite Grid	X (47)	X (47)	X (47)				(92)		X (82)	X (82)	X (82)		X	(84)			X (86)		
Emergency 4,160V/480V AC Train A (Orange)/Diesel Generator 2-1					(48)	(49)										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)	(37)		X (96)		X (89, 93)
Emergency 125V DC Train B (Purple)/Battery 2-2				X								X (58)		(90)	(67)		X (96)		X (91, 95)
Vital Bus Channel I (Red)	(100)			(80)	(80)	(80)								(49)		X			(94)
Vital Bus Channel II (White)		(100)	(100)	(80)	(80)	(80)								(49)					(94)
Vital Bus Channel III (Blue)				(80)	(51,80)	(51,80)						(85,67)					X (96)		(94)
Vital Bus Channel IV (Yellow)				(51)			(93)					(85,87)							(95)
SSPS Train A (SI, CIA, PWI, SLI)				(58)	(82,58,80)	(87,58,80)			(80)	(80)	(80)	(80)		(50,80)	(59)		(82)		
SSPS Train B (SI, CIA, PWI, SLI)				(82,58,80)	(58)	(58)			(80)	(80)	(80)	(80)		(50,80)	(59)		(82)		
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												(27,71)		(57)					
ERF (Black) Diesel Generator								(92)											
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. Table 3.3.7-2 of the IPE submittal lists the impacted plant systems for all Initiating Event categories, including LOCAs and Steam Line Breaks. The PRA did not take credit for any equipment that was not environmentally qualified for the conditions present following these initiators, e.g., Residual Heat Removal equipment. In addition, Beaver Valley Unit 2 UFSAR Section 3.6 addresses protection against dynamic effects associated with the postulated rupture of piping due to Steam Line Breaks (UFSAR Section 15.1.5) or LOCAs (UFSAR Section 15.6.5).

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., TLh.).

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. Table 18-1 shows the Beaver Valley Unit 2 Initiating Events that were obtained using plant operating experience. Additional information, including a discussion on the loss of bus 2A (Initiating Event LB2A) is addressed in Section 3.3.2.4. Table 3.3.1-4 lists the Initiating Event distributions for all of the initiators that were used in the IPE.

The methodology used to develop the plant specific Initiating Event frequencies that were based on plant operating experience is similar to the two-stage Bayesian approach used for component failure rates, as described in Section 3.3.1.3 of the IPE submittal.

The PRA model was quantified using the same plant-specific data that was submitted in the IPE. This plant-specific data only included information that was collected between 11/87 and 12/88. A specific plan for updating the plant specific database and system models has not been determined. However, we intend to periodically perform these updates, as needed, based upon the significance of plant changes. Any component failures or Initiating Events occurring after 1988 are not expected to have a major impact on the IPE results.

TABLE 18-1. BEAVER VALLEY UNIT 2 INITIATING EVENT FREQUENCY PER CALENDAR YEAR

	NAME OF DISTRIBUTION	GENERIC MEAN	NUMBER OF EVENTS	CALENDAR YEARS	UPDATED PLANT-SPECIFIC DISTRIBUTION MEAN	5TH %ILE	MEDIAN	95TH %ILE
ELOCA	EXCESSIVE LOCA	2.66E-07	0	2.1	2.66E-07	7.59E-09	1.04E-07	7.62E-07
LLOCA	LARGE LOCA	2.03E-04	0	2.1	2.03E-04	7.59E-06	1.08E-04	5.27E-04
MLOCA	MEDIUM LOCA	4.65E-04	0	2.1	4.64E-04	2.28E-05	3.12E-04	1.18E-03
SLOCN	SMALL LOCA, NONISOLABLE	5.63E-03	0	2.1	5.55E-03	1.13E-04	1.77E-03	1.60E-02
SLOCI	SMALL LOCA, ISOLABLE	2.30E-02	0	2.1	[illegible].82E-02	3.94E-04	8.21E-03	4.43E-02
SGTR	STEAM GENERATOR TUBE RUPTURE	2.64E-	0	2.1	2.09E-02	1.96E-04	5.45E-03	5.63E-02
RT	REACTOR TRIP	1.35E+00	2	2.1	1.14E+00	4.55E-01	9.91E-01	1.98E+00
TT	TURBINE TRIP	1.07E+00	1	2.1	8.83E-01	3.21E-01	7.84E-01	1.37E+00
LCV	LOSS OF CONDENSER VACUUM	1.58E-01	0	2.1	1.01E-01	1.79E	7.67E-02	2.19E-01
AMSIV	INADVERTENT CLOSURE OF ALL MSIV'S	1.93E-02	0	2.1	1.83E-02	5.50E-04	1.07E-02	5.22E-02
SLBI	STEAMLINE BREAK INSIDE CONTAINMENT	4.65E-04	0	2.1	4.64E-04	2.29E-05	3.12E-04	1.18E-03
MSV	INADVERTENT OPENING OF MAIN STEAM RELIEF VALVES	4.19E-03	0	2.1	3.81E-03	7.61E-05	7.11E-03	1.10E-02
FRRC	BREAK IN COMMON RHR LINE OUTSIDE CONTAINMENT	1.51E-03	0	2.1	1.48E-03	2.87E-05	5.39E-04	4.20E-03
SLBO	BREAK IN STEAMLINES OUTSIDE CONTAINMENT	4.53E-03	0	2.1	4.26E-03	8.68E-05	1.59E-03	1.17E-02
ISI	INADVERTENT SAFETY INJECTION SIGNAL	2.39E-02	0	2.1	2.22E-02	2.81E-04	7.06E-03	6.12E-02
TLMFW	TOTAL LOSS OF MAIN FEEDWATER	1.62E-01	0	2.1	1.20E-01	1.62E-02	8.16E-02	2.85E-01
PLMFW	PARTIAL LOSS OF MAIN FEEDWATER	1.13E+00	0	2.1	5.53E-01	1.19E-01	4.31E-01	1.05E+00
EXFW	EXCESSIVE FEEDWATER FLOW	1.68E-01	1	2.1	2.41E-01	2.61E-02	1.44E-01	6.25E-01
IMSIV	CLOSURE OF ONE MSIV	8.66E-02	0	2.1	6.96E-02	5.50E-03	4.03E-02	1.73E-01
CPEXC	CORE POWER EXCURSION	2.68E-02	0	2.1	2.39E-02	8.51E-04	1.44E-02	4.77E-02
LPRF	LOSS OF PRIMARY FLOW	1.28E-01	0	2.1	1.07E-01	8.78E-02	5.95E-01	2.70E-01
LB2A	LOSS OF BUS 2A	4.75E-02	2	2.1	1.14E-[illegible]	9.8[illegible]E-03	6.19E-02	2.89E-01
LOSP	LOSS OF OFFSITE POWER*	9.90E-02	1	12.9	7.44E-02	1.15E-02	5.[illegible]8E-02	[illegible].59E-01

* Note: Losses of offsite power can occur even if the plant is not operating. The events that occur while the plant is not at power are not applicable to the PRA, so the frequency shown here must be scaled by the average availability factor for the plant.

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 Table 19-1 lists all of the PLG generic component failure rate distributions used in the IPE. This data was used either directly, when plant-specific data was not available, or as the basis for the plant-specific updated values shown in Table 3.3.2-2.

TABLE 19-1. GENERIC DATA DISTRIBUTION REPORT FOR COMPONENTS

	NAME OF DISTRIBUTION	MEAN	5TH %ILE	MEDIAN	95TH %ILE
ZTBATD	125V DC BATTERY - FAILURE OF OUTPUT ON DEMAND	4.84E-04	7.20E-05	3.30E-04	1.10E-03
ZTBATR	125V DC BATTERY - FAILURE OF OUTPUT DURING OPERATION	7.53E-07	6.36E-08	3.79E-07	1.64E-06
ZTBCHR	BATTERY CHARGER - FAILURE DURING OPERATION	1.86E-05	9.80E-07	8.25E-06	5.38E-05
ZTBS1R	BUS - FAILURE DURING OPERATION	4.98E-07	6.72E-08	3.40E-07	1.13E-06
ZTCB1C	CIRCUIT BREAKER (480 VAC AND ABOVE) - FAIL TO CLOSE ON	1.61E-03	2.68E-04	1.07E-03	3.40E-03
ZTCB1O	CIRCUIT BREAKER (480 VAC AND ABOVE) - FAILURE TO OPEN O	6.49E-04	6.48E-05	3.85E-04	1.40E-03
ZTCB1T	CIRCUIT BREAKER (480VAC AND ABOVE)-TRANSFER OPEN DURING	8.28E-07	5.48E-08	3.79E-07	2.28E-06
ZTCB2C	CIRCUIT BKR(AC OR DC,LT. 480V) - FAILURE TO CLOSE ON DEM	2.27E-04	6.48E-06	8.69E-05	6.52E-04
ZTCB2O	CIRCUIT BKR(AC OR DC,LT. 480V) - FAILURE TO OPEN ON DEM	8.39E-04	2.39E-05	3.28E-04	2.40E-03
ZTCB2T	CIRCUIT BREAKER (AC OR DC ,LT.480V) - TRANSFER OPEN DUR	2.69E-07	2.99E-08	1.28E-07	8.69E-07
ZTCB3D	REACTOR TRIP BREAKER - FAIL TO OPERATE ON DEMAND	1.77E-03	4.14E-04	1.33E-03	3.72E-03
ZTCHLR	CONTROL ROOM VENTILATION CHILLER - FAILURE DURING OPERA	9.45E-05	2.21E-05	7.08E-05	1.99E-04
ZTCHLS	CONTROL ROOM VENTILATION CHILLER - FAILURE TO START ON	8.07E-03	8.25E-04	4.72E-03	2.06E-02
ZTCMPR	AIR COMPRESSOR FAILURE DURING OPERATION	9.31E-05	9.84E-06	4.98E-05	2.40E-04
ZTCMPS	AIR COMPRESSOR FAILURE TO START ON DEMAND	3.29E-03	2.01E-04	1.63E-03	1.12E-02
ZTCRAD	SINGLE CONTROL ROD - FAIL TO INSERT ON DEMAND	3.20E-05	2.00E-06	1.02E-05	9.12E-05
ZTDAOD	PNEUMATIC DAMPER - FAILURE TO OPERATE ON DEMAND	1.52E-03	2.37E-04	1.06E-03	3.32E-03
ZTDAOF	PNEUMATIC DAMPER - FAILURE TO TRANSFER TO FAILED POSITI	2.66E-04	7.57E-06	1.04E-04	7.62E-04
ZTDAOT	PNEUMATIC DAMPER - TRANSFER OPEN OR SHUT DURING OPERATI	2.67E-07	1.50E-08	1.10E-07	8.06E-07
ZTDBDD	BACKDRAFT DAMPER - FAILURE TO OPEN ON DEMAND	2.69E-04	5.33E-05	1.44E-04	6.27E-04
ZTDBDT	BACKDRAFT DAMPER - TRANSFER CLOSED	1.04E-08	2.43E-09	7.80E-09	2.19E-08
ZTDFRI	FIRE DAMPER - INADVERTANT ACTUATION	4.20E-08	1.57E-09	1.30E-08	1.19E-07
ZTDGS1	DIESEL GENERATOR - FAILURE DURING FIRST HR OF OPERATION	1.70E-02	1.07E-03	8.24E-03	5.36E-02
ZTDGS2	DIESEL GENERATOR - FAILURE TO RUN AFTER FIRST HOUR	2.51E-03	2.97E-04	1.49E-03	7.44E-03
ZTDGSS	DIESEL GENERATOR - FAILURE TO START ON DEMAND	2.14E-02	2.50E-03	1.36E-02	6.44E-02
ZTDRYP	AIR DRYER - COMPRESSED AIR SYSTEM - FAIL DUR. OPER.	1.63E-07	2.31E-08	8.08E-08	4.16E-07
ZTFL1P	VENTILATION FILTER	1.07E-06	3.04E-08	4.16E-07	3.05E-06
ZTFL2P	VENTILATION LOUVRE - PLUGGED	1.07E-07	3.04E-09	4.16E-08	3.05E-07
ZTFLXP	FUEL OIL FILTER - PLUGGED	1.07E-06	3.04E-08	4.16E-07	3.05E-06
ZTFN1R	LARGE FANS - FAILURE DURING OPERATION	7.88E-06	1.55E-06	6.23E-06	1.58E-05
ZTFN1S	LARGE FANS - FAILURE TO START ON DEMAND	2.93E-03	3.27E-04	1.66E-03	8.35E-03
ZTFN2R	VENTILATION FAN - FAILURE DURING OPERATION	7.89E-06	1.55E-06	6.23E-06	1.58E-05
ZTFN2S	VENTILATION FAN - FAILURE TO START ON DEMAND	4.84E-04	4.95E-05	2.83E-04	1.24E-03
ZTFU1R	FUSE - FAIL OPEN DURING OPERATION	9.20E-07	2.83E-08	3.16E-07	2.83E-06
ZTHXRB	HEAT EXCHANGER - RUPTURE/EXCESSIVE LEAKAGE DURING OPERA	1.95E-06	2.21E-07	1.32E-06	5.18E-06
ZTINVR	INVERTER - FAILURE DURING OPERATION	1.83E-05	1.60E-06	1.13E-05	5.37E-05
ZTMGSR	MOTOR GENERATOR - FAILURE DURING OPERATION	3.59E-05	9.60E-07	1.10E-05	1.20E-04
ZTPMOR	NORMALLY OPERATED MOTOR DRIVEN PUMP - FAILURE DURING OP	3.36E-05	2.03E-06	1.59E-05	9.83E-05
ZTPMOS	NORMALLY OPERATED MOTOR DRIVEN PUMPS--FAIL. TO START ON	2.31 [illegible]	2.47E-04	1.45E-03	7.38E-03
ZTPMSR	STANDBY MOTOR DRIVEN PUMP - FAILURE DURING OPERATION	3.42E-05	2.88E-06	1.77E-05	9.32E-05
ZTPMSS	STANDBY MOTOR DRIVEN PUMPS--FAILURE TO START ON DEMAND	3.29E-03	2.01E-04	1.63E-03	1.12E-02
ZTPP1B	PIPE ,GREATER THAN THREE INCH, PER PIPE SECTION	8.60E-10	1.96E-12	1.80E-10	2.02E-09
ZTPP2B	PIPE,LESS THAN THREE INCH, PER PIPE SECTION	8.60E-09	1.98E-11	1.80E-09	2.02E-08
ZTPS1R	POWER SUPPLY	1.71E-05	1.03E-06	7.60E-06	4.90E-05
ZTPTSR	TURBINE DRIVEN AUX. FEEDWATER PUMP - FAILURE DURING OPE	1.03E-03	6.53E-05	4.21E-04	3.01E-03
ZTPTSS	TURBINE DRIVEN AUX.FEEDWATER PUMP - FAILURE TO START ON	3.31E-02	6.05E-03	2.45E-	8.25E-02
ZTRL1D	RELAY - FAILURE TO OPERATE ON DEMAND	2.41E-04	1.39E-05	1.10E-04	7.47E-04
ZTRL1R	RELAY - FAILURE DURING OPERATION	4.20E-07	2.39E-08	1.98E-07	1.51E-06
ZTSC1P	SERVICE WATER STRAINER - FAILURE DURING OPERATION	6.22E-06	8.08E-07	3.90E-06	1.58E-05
ZTSC2P	STRAINER OTHER THAN SERVICE WATER - FAILURE DURING OPER	6.22E-06	8.08E-07	3.90E-06	1.58E-05
ZTSC3P	SERVICE WATER TRAVELING SCREEN - FAILURE DURING OPERATI	6.22E-06	8.08E-07	3.90E-06	1.58E-05

TABLE 19-1. GENERIC DATA DISTRIBUTION REPORT FOR COMPONENTS

	NAME OF DISTRIBUTION	MEAN	5TH %ILE	MEDIAN	95TH %ILE
ZTSP P	CONTAINMENT BUILDING S.RAY NOZZLES (TRAIN) PLUG	7.08E-08	2.70E-09	3.02E-08	2.60E-07
ZTSTCD	REACTOR TRIP BREAKER, SHUNT TRIP COIL -FAIL TO OPERATE	1.40E-04	3.27E-05	1.05E-04	2.94E-04
ZTSWPD	BISTABLE FAILURE TO OPERATE ON DEMAND	3.89E-07	5.98E-08	2.58E-07	9.16E-07
ZTSWBI	BISTABLE SPURIOUS OPERATION	2.21E-06	2.56E-09	4.[illegible]1E-07	4.61E-06
ZTSWMT	MOTOR-OPERATED DISCONNECT SWITCH - FAILS OPEN DURING OP	2.67E-07	1.78E-08	1.20E-07	6.71E-07
ZTSWPD	PRESSURE SWITCH - FAIL TO OPERATE ON DEMAND	2.69E-04	1.15E-05	1.09E-04	9.37E-04
ZTTK1B	STORAGE TANK -- RUPTURE DURING OPERATION	2.66E-08	7.59E-10	1.04E-08	7.63E-08
ZTTRFR	FLOW TRANSMITTER - FAIL DURING OPERATION	6.25E-06	6.04E-07	4.39E-06	1.40E-05
ZTTRLR	LEVEL TRANSMITTER - FAILURE DURING OPERATION	1.57E-05	3.96E-06	1.26E-05	3.34E-05
ZTTRPR	PRESSURE TRANSMITTER - FAILURE DURING OPERATION	7.60E-06	5.90E-07	4.70E-06	1.96E-05
ZTUVCD	REACTOR TRIP BREAKER, UNDERVOLTAGE COIL -FAIL TO OPEN O	2.75E-03	6.43E-04	2.06E-03	5.77E-03
ZTVAOD	AIR OPERATED VALVE / FAILURE TO OPERATE ON DEMAND	1.52E-03	2.37E-04	1.08E-03	3.32E-03
ZTVAOF	AIR OPERATED VALVE FAILURE TO TRANSFER TO FAILED POSITI	2.66E-04	7.57E-06	1.04E-04	7.62E-04
ZTVAOT	AIR OPERATED VALVE / TRANSFER OPEN/SHUT DURING OPERATIO	2.67E-07	1.50E-08	1.10E-07	8.06E-07
ZTVCDD	CHECK VALVE / FAILURE TO OPERATE ON DEMAND-GENERIC	5.09E-04	1.00E-05	1.37E-04	1.44E-03
ZTVCOC	SWING CHECK VALVE FAILS TO CLOSE ON DEMAND	8.35E-04	1.65E-05	2.24E-04	2.3[illegible]E-03
[illegible]COD	SWING CHECK VALVE FAILS TO OPEN ON DEMAND	1.83E-04	3.60E-06	4.91E-05	5.18E-04
ZTVCGL	CHECK VALVE (OTHER THAN STOP) - GROSS LEAKAGE DURING OP	5.36E-07	9.[illegible]E-08	3.17E-07	1.26E-06
ZTVCOP	CHECK VALVE(OTHER THAN STOP) TRFR CLOSED/PLUGGED	1.04E-08	[illegible].43E-09	7.80E-09	2.19E-08
ZTVCOR	CHECK VALVE LEAKAGE RATE GREATER THAN 150 GPM (PER HOUR)	7.73E-08	2.71E-09	2.81E-08	2.81E-07
ZTVCSD	CHECK VALVE (STOP) FAILURE TO OPERATE ON DEMAND	9.13E-04	7.07E-05	4.14E-04	2.61E-03
ZTVCSL	CHECK VALVE (STOP) - GROSS LEAKAGE DURING OPERATION	5.36E-07	9.23E-08	3.17E-07	1.26E-06
ZTVCSP	CHECK VALVE (STOP) - TRANSFER CLOSED/PLUGGED	1.04E-08	[illegible].43E-09	7.80E-09	2.19E-08
ZTVE1D	ELECTRO-HYDRAULIC VALVE (EXCEPT TSV,TCV) FAILURE TO OPE	1.52E-03	2.37E-04	1.08E-03	3.32E-03
ZTVE1T	ELECTRO-HYDRAULIC VALVE (EXCEPT TSV,TCV) TRANSFER OPEN/	2.67E-07	1.50E-08	1.10E-07	8.06E-07
ZTVE21	TURBINE STOP/CONTROL VALVE TRANSFER CLOSED DURING OPERA	2.88E-05	8.23E-07	1.13E-05	8.25E-05
ZTVE22	TURBINE STOP/CONTROL VALVE TRANSFER OPEN DURING OPERATI	1.24E-05	3.54E-07	4.85E-06	3.55E-05
ZTVE2D	TURBINE STOP/CONTROL VALVE FAILURE TO OPERATE ON DEMAND	1.28E-04	2.92E-06	9.37E-05	2.63E-04
ZTVHOT	MANUAL VALVE - TRANSFER OPEN/SHUT DURING OPERATION	4.20E-08	1.57E-09	1.30E-08	1.19E-07
ZTVMCX	CHECK VALVE OR MOV DISK RUPTURE	4.53E-08	1.59E-09	1.65E-08	1.65E-07
ZTVMOD	MOTOR OPERATED VALVE - FAILURE TO OPEN/CLOSE ON DEMAND	4.30E-03	7.49E-04	2.84E-03	1.05E-02
ZTVMOE	MOV FAILURE TO CLOSE ON DEMAND WHILE SHOWING CLOSED	1.07E-04	2.10E-05	7.47E-05	3.07E-04
ZTVMOT	M.O.V. / TRANSFER CLOSED OR TRANSFER OPEN DURING OPERAT	9.27E-08	9.65E-09	5.75E-08	2.33E-07
ZTVR1O	SAFETY VALVE - FAILURE TO OPEN ON DEMAND	3.28E-04	1.21E-05	1.19E-04	1.06E-03
ZTVR1S	SAFETY VALVE FAILURE TO RESEAT ON DEMAND	2.87E-03	8.84E-05	1.15E-03	8.21E-03
ZTVR1W	SAFETY VALVE - FAILURE TO RESEAT AFTER WATER RE	1.01E-01	2.88E-03	1.20E-01	2.50E-01
ZTVR2D	RELIEF VALVE (EXCEPT PORV,SAFETY) FAILURE TO OPEN ON DE	2.42E-05	7.58E-07	9.72E-06	6.92E-05
ZTVR2T	RELIEF VALVE (OTHER THAN PORV OR SAFETY) - PREMATURE OP	6.06E-06	9.76E-07	4.01E-06	1.44E-05
ZTVR3C	PWR PORV - FAILURE TO RESEAT ON DEMAND	2.50E-02	5.85E-03	1.87E-02	5.25E-02
ZTVR3O	PWR PORV FAILURE TO OPEN ON DEMAND	4.27E-03	9.95E-04	3.20E-03	8.98E-03
ZTVSOD	SOLENOID VALVE (DIRECT ACTING) FAILURE TO OPERATE ON DE	2.43E-03	7.64E-05	9.79E-04	6.94E-03
ZTVSOT	SOLENOID VALVE / TRANSFER OPEN OR SHUT DURING OPERATION	1.27E-06	5.19E-08	4.91E-07	4.07E-06
ZTVTCD	BUTTERFLY TEMPERATURE CONTROL VALVE - FLT TO OPERATE ON	1.52E-03	2.37E-04	1.08E-03	3.32E-03
ZTVTCF	BUTTERFLY TEMPERATURE CONTROL VALVE - FAIL TO TRFR TO F	2.66E-04	7.57E-06	1.04E-04	7.62E-04
ZTVTCT	BUTTERFLY TEMPERATURE CONTROL VALVE-TRFT OPEN/SHUT DURI	4.20E-08	1.57E-09	1.30E-08	1.19E-07
ZTXR1R	TRANSFORMER (GST,UAT,RAT) - FAILURE DURING OPERATION	1.56E-06	2.83E-07	1.10E-06	3.16E-06
ZTXR2R	TRANSFORMER (STR.SERVICE,4.16KV TO 480V) - FAILURE DURI	6.87E-07	1.05E-07	4.07E-07	1.87E-06
ZTXR3R	TRANSFORMER(INSTRUMENT) (480V TO 120V) - FAILURE DURING	1.55E-06	7.94E-08	7.09E-07	4.87E-06

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 Top 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 describe 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 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 conservatively 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 of 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 DO, 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 3.2.1.9) 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. The emergency 125V DC batteries are designed to last 2 hours based on the licensing design basis discharge. However after evaluating the actual plant operating design, Stone & Webster engineering personnel have estimated an extended battery availability to cope with station blackouts. On the basis of this, it is expected that Battery Number 3 (which provides power to the vital instrument bus that supplies power for control of the auxiliary feedwater pump) will last for at least 8 hours, and Battery Numbers 1 and 2 (which provide power to the buses required to recover the emergency diesel generators) will last for 3.5 hours.

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.

A 480 gpm leak rate per RCP is expected, given the assumption that the low pressure seal leakoff piping ruptures after failure of the #1 RCP seal. On the basis of the analyses performed in the SEALOC code (Reference B.2-5) with the turbine-driven auxiliary feedwater system available, this leak rate would result in core damage (1,200°F) approximately 7 hours after the initiation of the station blackout if operators took action to depressurize the steam generators in 2 hours or less. If the operators depressurize after 2 hours, or completely fail to depressurize at all, core damage would occur approximately 2.9 hours after the station blackout. Using these new core damage times in the electric power recovery model results in a total core damage frequency of 1.95×10^{-4} or approximately a 3 % increase. Reference B.2-5 is as follows:

Maneke, J. A., D. R. Buttemer, and R. K. Deremer, "Reactor Coolant Pump Seal LOCA Analysis during Station Blackout Events at Seabrook Station," prepared for New Hampshire Yankee, Pickard, Lowe and Garrick, Inc., PLG-0724, January 1990.

Table B.2-1. Seal LOCA Flow Rates (GPM) per Pump with and without Primary 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	21	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. The contribution to total core damage frequency for the five Decay Heat Removal Systems of Section 3.4.3, due to loss of electrical and non-electrical support systems, is presented in Table 25-1. As can be seen by Table 25-1, the majority of split fraction failures come from contributions related to the loss of electrical power, CIA/CIB signals, and Initiating Events unrelated to electric power. The largest contribution to core damage frequency due to loss of non-electric power support systems is 16.4%, which is due to the loss of both service water headers to the HHSI/Charging Pumps Lube Oil Coolers. The next two largest contributions to CDF for non-electric support systems are 2.6% and 2.5%, which are RHR failures due to the loss of Primary Component Cooling Water to the RHR pump seals and heat exchangers, and AFW failures associated with the loss of Solid State Protection System signals, respectively. The contribution to core damage frequency for Main Feedwater failures stemming from the loss of non-electric power support systems is less than 0.05%.

TABLE 25-1. BREAKDOWN OF CDF DUE TO GUARANTEED FAILURES OF DECAY HEAT REMOVAL SYSTEMS						
Decay Heat Removal System	Split Fraction	Split Fraction Core Damage Frequency [Percentage of Total CDF]	Core Damage Frequency (Percentage of Split Fraction) [Percentage of Total CDF]			
			Guaranteed Failures Related to Loss of Electric Power	Guaranteed Failures From Non-Electric Power Related Initiating Events	Guaranteed Failures Due to Loss of Non-Electric Power Support Systems	Guaranteed Failures Related to CIA/CIB Signals
HHSI	HHF	1.14E-04 [62.0%]	8.35E-05 (73.6%) [45.6%]	N/A	3.00E-05 (26.4%) [16.4%]	N/A
RHR	RHF	7.63E-05 [41.6%]	2.45E-05 (32.2%) [13.4%]	3.11E-08 (< 0.1%) [< 0.05%]	4.85E-03 (6.4%) [2.6%]	4.69E-05 (61.4%) [25.6%]
AFW	AFF	3.70E-05 [20.2%]	3.21E-05 (86.6%) [17.5%]	3.48E-07 (0.9%) [0.2%]	4.63E-06 (12.5%) [2.5%]	N/A
MFW	MFF	1.78E-05 [9.7%]	1.22E-05 (68.8%) [6.7%]	3.51E-06 (19.7%) [1.9%]	4.82E-08 (0.3%) [< 0.05%]	1.99E-06 (11.2%) [1.1%]
Operator Cooldown	CDF	1.36E-05 [7.4%]	1.36E-05 (100%) [7.4%]	N/A	N/A	N/A

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. Split fraction AFF was mislabeled in Table 3.4.3-1. Its description should read "AFF - Guaranteed Failures of Auxiliary Feedwater", since it consists of all AFW failures, not just those due to Safeguard Area floods. Only one of the many ways of failing AFW consists of a large flood in the north and south Safeguard Areas for a period greater than 20 minutes (i.e., Initiating Event SGFL2). As shown in Table 25-1, this failure mode contributes less than 1% to the total split fraction failure frequency, with the other 99.1% due to the loss of support systems. All the possible ways of guaranteeing the failure AFW are shown in the AFF split fraction rule below:

AFF = (STEAM + AFP22) * AFP23A * AFP23B

where:

STEAM = TT=F * MS=F + INIT=SLBC + INIT=SLBD * MS=F
AFP22 = SA=F * SB=F * OS=F + INIT=SGFL1 + INIT=SGFL2 + INIT=SLBC + INSTRUM
AFP23A = SA=F * OS=F + AO=F + INIT=BVX + DO=F + OG=F * WA=F + INIT=SGFL1 + INIT=SGFL2 + BV=F
AFP23B = SB=F * OS=F + BP=F + INIT=BVX + DP=F + OG=F * WB=F + INIT=SGFL2 + BV=F

and,

INSTRUM = IR=F * IW=F * IB=F * IY=F + BV=F

Therefore, the percentage of core damage frequency shown in Table 3.4.3-1 in which split fraction AFF is present is correct at 20.2%, however, only 0.2% of this is attributed to Initiating Event SGFL2.

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 AFW 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. The probabilistic failure of the operators to realign the MFW pumps only accounts for a core damage frequency of 6.51×10^{-8}, or less than 0.1 % of the total core damage frequency. However, the total core damage frequency would be increased to 2.33×10^{-4}, or a factor of 1.23, if this action is assumed to be a guaranteed failure (i.e., no credit taken for the action). Likewise, the probabilistic failure of the operators to initiate feed and bleed cooling only accounts for 1.76×10^{-7} or less than 0.1 % of the total core damage frequency. The total core damage frequency, however, would increase by a factor of 1.17, or to 2.22×10^{-4} if no credit is taken for this action.

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. DLC is currently evaluating performing a test in order to verify the heat-up rate in the Emergency Switchgear Rooms following a loss of all HVAC.

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. a) The evaluation of contributors to core damage frequency and early release frequency is performed in a top-down systematic manner, working from the general to the specific. First the results are broken down to examine general classes of accident sequences. Several different approaches are followed to define accident sequence classes by a common characteristic. These characteristics include initiating event, plant damage state, split fraction, and combinations of these. Once accident sequences have been classified in this manner, the importance of the group can be evaluated in terms of percentage contribution to CDF or percentage contribution to early release frequency. Next, the results are examined in scenarios as defined by the Initiating Event, split fractions of failed Event Tree Top Events, and the end states of the Level 1 and Level 2 Event Trees. Finally, the causes of each event in the important scenarios are delineated to identify the fundamental contributors to risk. These fundamental contributors to risk are defined as vulnerabilities.

b) The Beaver Valley Unit 2 Containment Building appears to be more vulnerable to early overpressurization failures, which contribute to more than 90% of the Release Category Group I frequency, than it does to large bypass failures, whose failures contribute less than 10% to the group frequency. As shown in the sensitivity studies of Section 4.8.4, severe accident management procedures regarding in-vessel recovery of core damage events and RCS depressurization would significantly reduce the containment early overpressurization failure frequency. Therefore, no design modification to the Containment Building or Containment Spray Systems are currently planned.

c) The potential enhancements to address the identified vulnerabilities are listed in Table 6.3-2 of the Summary Report. This Table lists the percentage contribution to core damage frequency of each vulnerability. The proposed enhancements will reduce the CDF to the extent that they will eliminate the vulnerability. Cost benefit analyses of the potential enhancements will be performed to find the most effective means of reducing the vulnerability and determining a schedule for implementation.

d) Independent failures of the Service Water header flow paths (Top Events WA and WB) are dominated by the conditional probability that the RSS Heat Exchanger supply MOV fails to open, or the CCP/CCS isolation MOV fails to close, on one Train, given that the other Train's MOV has already failed during CIB conditions. These MOV common cause failure-on-demand modes account for greater than 81% of the Top Event failure frequency, with the remainder due to independent failures of the MOVs. Existing Emergency Operating Procedures direct operators to verify that these MOVs have been properly positioned following a CIB signal, and to manually align them if they have not. Since these valves are located inside the Service Water System Valve Pit, operators should not have any problems accessing the area following CIB accident conditions. Hence, taking credit for operator actions to manually align these MOVs would reduce the split fraction failure frequency and, consequently, the Top Event importance to core damage frequency. The failure of the RWST check valve 2QSS-27, common to the suction of the HHSI pumps, currently contributes approximately 2.1% to the total core damage frequency. This vulnerability could be resolved, as addressed in Section 6.4.5, by realigning flow from the LHSI pumps to the HHSI pump suction piping, thus bypassing check valve 2QSS-27, if it fails to open.

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. The PRA/IPE results reflect the normal Station alignment of the PORV block valves at the time that the RCS pressure relief system models were being developed; i.e., two (2) block valves open 100% of the time and one (1) block valve closed 100% of the time, prior to any Initiating Events occurring. The PRA RCS pressure relief models include failures of the safety relief valves (SRVs) to reclose in the event that they open due to PORVs failing to open. These stuck-open safety valves result in failures to the RCS pressure relief models and, consequently, are modeled as small break LOCAs in the existing PRA analysis. Operator actions to open the PORV block valves are modeled in Top Events OB (Bleed and Feed Cooling) and OD (Depressurization of RCS for RHR Entry). The human actions and their mean failure rates associated with these top events are as follows: ZHEOB1 (4.34×10^{-3}), ZHEOB2 (3.65×10^{-2}), ZHEOD1 (1.19×10^{-3}). Failures of these human actions only contribute a total of 0.39% to the core damage frequency.

Based on the above, this is not considered to be a credible failure mode; however, Table 32-1 is provided assuming that it is. Table 32-1 shows a brief analysis of the increase in core damage frequency related to a small break LOCA due to a stuck-open SRV, assuming all three PORV block valves are always closed. This analysis was performed by using the methodology for the third sensitivity case discussed in Section 4.8.4 of the IPE submittal and the following equation:

$$\text{New CDF} = \text{Old CDF} + \sum\left(\frac{\partial(\text{Old CDF})}{\partial \text{PRi}} \times (\text{New SFV} - \text{Old SFV})\right)$$

As seen in the table, core damage frequency would increase by 46.6%, assuming that the PORVs are always isolated. It should be noted, however, that this analysis does not include any increase in core damage frequency due to ATWS events as a result of having only SRVs available to limit the RCS pressure surge during these transients.

TABLE 32-1. CORE DAMAGE FREQUENCY DU[illegible] STUCK-OPEN SRV LOCAS				
CMEI [illegible] Group Frequency = 1.8316E-04 (Old Core Damage Frequency) Stuck-open SRV (NO SI) = 8.6094E-03 (New SFV for PR0 through PR9) Stuck-open SRV (SIS) = 3.0363E-01 (New SFV for PRA through PRW)				
SF Name	Derivative	Old SF Value	New SFV - Old SFV (Delta SFV)	Dervivative * Delta SFV
PR0	0.0000E+00	0.0000E+00	8.6094E-03	0.0000E+00
PR1	1.9243E-03	5.0210E-04	8.1073E-03	1.5601E-05
PR2	-9.5979E-07	5.2240E-04	8.0870E-03	-7.7618E-09
PR3	1.2168E-06	5.1040E-04	8.0990E-03	9.8549E-09
PR4	-4.9595E-08	9.1130E-03	-5.0360E-04	2.4976E-11
PR5	2.1868E-07	2.5930E-02	-1.7321E-02	-3.7877E-09
PR6	4.0825E-07	5.0960E-02	-4.2351E-02	-1.7290E-08
PR7	7.9471E-05	4.9460E-02	-4.0851E-02	-3.2464E-06
PR8	4.6981E-05	[illegible]5070E-02	[illegible]61E-02	-7.7334E-07
PR9	1.3512E-04	[illegible]6710E-02	-[illegible]01E-02	-9.2018E-06
PRA	2.7320E-04	2.0010E-03	[illegible]3E-01	8.2405E-05
[illegible]	0.0000E+00	1.0000E+00	-6.9637E-01	0.0000E+00
[illegible]	2.6781E-06	2.1240E-01	9.1230E-02	2.4432E-07
PRI	2.1459E-06	1.0200E-01	2.0163E-01	4.3268E-07
PRJ	1.3317E-06	3.0340E-01	2.3000E-04	3.0629E-10
PRK	-3.3007E-08	2.0570E-03	3.0157E-01	-9.9540E-09
PRT	-3.3957E-09	2.0020E-01	1.0343E-01	-3.5122E-10
PRU	-3.1080E-09	1.0270E-01	2.0093E-01	-6.2469E-10
PRV	-3.2707E-08	2.9890E-01	4.7300E-03	-1.5470E-10
PRW	0.0000E+00	0.0000E+00	3.0363E-01	0.0000E+00
			Sum of (Derv. * Delta SFV) =	8.5432E-05
			New CDF = Old CDF + Sum of (Derv. * Delta SFV) =	2.6859E-04
			Percent Increase in CDF =	46.64%