8 CONTAINMENT PERFORMANCE

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8 CONTAINMENT PERFORMANCE

8.0 INTRODUCTION

A spectrum of potential containment failure modes has been evaluated for the ESBWR. In Section 7, the potential for a break outside of containment was evaluated. In Section 21, potential ex-vessel steam explosion, direct containment heating and basemat penetration challenges were evaluated. In this section, the focus is on the containment challenges associated with potential combustible gas deflagration, overpressurization and bypass. The potential for containment failure due to these challenges is addressed by considering physical characteristics of the containment, notably the inerted condition and containment structural capability, as well as the reliability of passive systems engineered to perform the containment functions of "isolation", "vapor suppression" and "heat removal".

Containment failure due to combustible gas deflagration is shown to be unrealistic considering the inerted containment and time period required to generate enough oxygen to create a combustible gas mixture. The probability of containment failure due to overpressure or bypass requires consideration of the reliability of engineered systems used to isolate the containment and mitigate containment pressurization associated with a severe accident. As will be seen, the containment capability and system reliability are such that the calculated probability of containment bypass and overpressurization can be considered to be negligible.

Consistent with the NRC design certification policy for advanced reactors discussed in Reference 8.0-1, the containment response has been evaluated for a 24-hour period following the onset of core damage. To provide additional insight on the containment performance objective discussed in the reference, containment effectiveness will be quantified to demonstrate that the containment provides a reliable barrier to radionuclide release after a severe accident.

Section 8.1 discusses the potential for combustible gas deflagration. Section 8.2 evaluates the probability of containment overpressurization and bypass. Section 8.3 presents the computer simulation results of containment response to overpressurization challenges. Section 8.4 summarizes key insights from the evaluation. Appendix A.8 quantifies the frequency of all release categories discussed in this section as well as those in Section 21. Appendix B.8 presents the analysis of containment ultimate strength. Appendix C.8 provides the screening analysis to support quantification of the containment isolation system probability.

The results developed in this section, as well as from Section 21, are used to develop conservative source terms in Section 9 for use in the offsite consequence analysis. The offsite consequence analysis is presented in Section 10.

Table 8.0-1 summarizes acronyms and terminology used in this section.

Table 8.0-1 Acronyms and Terminology	
General	
ADS	Automatic Depressurization System
BiMAC	Basemat Internal Melt Arrest and Coolability (Device)
CCI	Core Concrete Interaction
CSET	Containment System Event Tree
FAPCS	Fuel and Auxiliary Pools Cooling System
GDCS	Gravity Driven Cooling System
ICS	Isolation Condenser System
PCCS	Passive Containment Cooling System
VB	Vacuum Breaker
Sequence Nomenclature	
MLi	Medium LOCA (GDCS injection line)
T	Transient (e.g., MSIV closure, loss of AC)
T-AT	Transient with failure to insert negative reactivity
nCHR	no Containment Heat Removal
nD	no Deluge
nDP	no Depressurization
nIN	no core Injection
nVB	no Vacuum Breaker (vacuum breaker failure to close)
Containment Release Categories	
BOC	Break Outside of Containment (Connecting RPV to environment)
BYP	Containment Bypass (Connecting containment to environment)
FR	Filtered Release (Through controlled suppression pool venting)
OP	Overpressure (General category)
OPW1	Overpressure due to failure of short-term containment heat removal
OPW2	Overpressure due to failure of long-term containment heat removal
OPVB	Overpressure due to failure of Vacuum Breaker
TSL	Technical Specification Leakage

8.1 POTENTIAL FOR FAILURE DUE TO COMBUSTIBLE GAS DEFLAGRATION

Because the ESBWR containment is inerted, the prevention of a combustible gas deflagration is assured in the short term following a severe accident. In the longer term there would be an increase in the oxygen concentration resulting from the continued radiolytic decomposition of the water in the containment. Because the possibility of a combustible gas condition is oxygen limited for an inerted containment, it is important to evaluate the containment oxygen concentration versus time following a severe accident to assure that there will be sufficient time to implement severe accident management (SAM) actions. It is desirable to have at least a 24-hour period following an accident to allow for SAM implementation. This section discusses the rate at which post-accident oxygen will be generated by radiolysis in the ESBWR containment following a severe accident, and establishes the period of time that would be required for the oxygen concentration in containment to increase to a value that would constitute a combustible gas condition (5% oxygen by volume) in the presence of a large hydrogen release, thus de-inerting the containment in the absence of mitigating SAM actions.

8.1.1 Background

The rate of gas production from radiolysis depends upon the power decay profile and the amount of fission products released to the coolant. Appendix A of Standard Review Plan (SRP) Section 6.2.5 (Reference 8.1-1) provides a methodology for calculation of radiolytic hydrogen and oxygen generation. The analysis results discussed herein were developed in a manner that is consistent with the guidance provided in SRP 6.2.5 and Regulatory Guide 1.7 (Reference 8.1-2).

There are unique design features of the ESBWR that are important with respect to the determination of post-accident radiolytic gas concentrations. In the post-accident period, the ESBWR does not utilize active systems for core cooling and decay heat removal. As indicated earlier, for a design basis loss-of-coolant accident (LOCA), the ADS would depressurize the reactor vessel and the GDCS would provide gravity driven flow into the vessel for emergency core cooling. The core would be subcooled initially and then it would saturate resulting in steam flow out of the vessel and into the containment. The PCCS heat exchangers would remove the energy by condensing the steam. This would be the post-accident mode and the core coolant would be boiling throughout this period.

A similar situation would exist for a severe accident that results in a core melt followed by reactor vessel failure. In this case, the GDCS liquid would be covering the melted core material in the lower drywell, with an initial period of subcooling followed by steaming. The PCCS heat exchangers would be removing the energy in the same manner as described above for a design basis LOCA.

In order to prevent non-condensable related termination of steam condensation, the PCCS heat exchangers are provided with a vent which will transfer any non-condensable gases which accumulate in the heat exchanger tubes to the suppression pool vapor space, driven by the drywell to suppression pool pressure differential. In this way, the majority of the non-condensable gases will be in the suppression pool. The calculation of post-accident

radiolytic oxygen generation accounts for this movement of non-condensable gases to the suppression pool after they are formed in the drywell.

The effect of the core coolant boiling is to strip dissolved gases out of the liquid phase resulting in a higher level of radiolytic decomposition. This effect was accounted for in the analysis.

8.1.2 Analysis Assumptions

The analysis of the radiolytic oxygen concentration in containment was performed consistent with the methodology of Appendix A to SRP 6.2.5 and Regulatory Guide 1.7. Some of the key assumptions are as follows:

Reactor power was 102% of rated

$G(O_2)$ = 0.25 molecules/100eV

Initial containment O_2 concentration = 4%

Allowed containment O_2 concentration = 5%

Stripping of drywell non-condensable gases to wetwell vapor space

Fuel clad-coolant reaction up to 100%

Iodine release up 100%

Adequate gas mixing throughout containment

8.1.3 Analysis Results

The analysis results show that the time required for the oxygen concentration to increase to the de-inerting value of 5% is significantly greater than 24 hours for a wide range of fuel clad-coolant interaction and iodine release assumptions up to and including 100%. Thus, the potential for containment failure due to combustible gas deflagration will not be discussed further.

8.2 FREQUENCY OF OVERPRESSURE AND BYPASS RELEASE CATEGORIES

The containment bypass (BYP) failure mode represents the failure to isolate containment before or during a severe accident, thus allowing a radionuclide barrier to be breached. The containment overpressure (OP) failure mode represents the potential for containment pressurization from stored energy and decay heat to exceed the ultimate containment strength. The likelihood of these failure modes was evaluated with "Containment System Event Trees" (CSETs). The end state of a CSET is one of the following potential release categories. The first group depicts containment failure:

- Containment bypass (BYP) represents the condition in which the containment has been bypassed due to failure of the Containment Isolation System. With this failure mode, the containment is assumed to be unavailable as a radionuclide barrier from the start of the severe accident, i.e., the containment isolation function has failed. As a result, there is a direct path from the containment atmosphere to the environment.
- Overpressurization (OPW) represents the condition in which the vapor suppression capability has functioned, but there has been a failure to remove energy from the containment, i.e., the containment heat removal function has failed. Two modes of containment heat removal failure are considered. Short term failure (within 24 hours of accident initiation) is defined as "OPW1" category; long term failure (after 24 hours) is defined as "OPW2".
- Overpressurization due to vacuum breaker failure (OPVB) represents the condition in which a vacuum breaker is open or fails to reclose, which is assumed to defeat the containment's vapor suppression function. In such a situation, containment overpressure occurs earlier than in the OPW failure mode.

Also shown on the CSETs are two end states, which are not considered containment failure because they do not result in the loss of control of the containment boundary:

- Technical Specification Leakage (TSL) represents the condition in which the containment pressure boundary is intact and the only source term is that associated with the allowable leakage rate, as defined by the Technical Specifications.
- Filtered release (FR) is an end state depicting containment venting under operator control. Such a release results in a much lower radionuclide source term than containment failure because the radionuclide pathway is through the suppression pool, which provides filtering of the radionuclides.

The CSETs are discussed in more detail in Section 8.2.1.

8.2.1 Containment System Event Trees

The Level 1 analysis, described in earlier sections, evaluated severe accident sequences with the potential to cause core damage. The core damage frequency associated with each of these sequences is discussed in Appendix A.8. In that appendix, the core damage sequences were grouped according to their similarity and potential containment challenge so that a manageable number of sequences could be evaluated in terms of the containment response.

The class definition and contribution of each accident class to the core damage frequency is summarized as follows:

Accident Class	CDF contribution (per year)	Percentage CDF contribution	Class summary
Class I	2.87 E-8	98.23	Sequences with RPV failure at low pressure
Class II	0.0	0.0	Sequences with containment failure preceding core damage
Class III	3.29 E-10	1.13	Sequences with RPV failure at high pressure
Class IV	1.83E-10	0.63	Sequences involving failure to insert negative reactivity
Class V	4.27E-12	0.01	Sequences involving containment failure due to interfacing systems LOCA (Break outside of containment)

To evaluate the containment response to a severe accident, two types of containment event trees were used to evaluate the complete spectrum of potential challenges to containment integrity. The "Containment Phenomenology Event Trees" (CPETs) were found to be most useful for the phenomenology, as discussed in Section 21. The "Containment System Event Trees" (CSETs) were found to be most useful for evaluating the containment response to bypass and overpressurization events. The CSETs relate the entry event to the containment systems designed to mitigate such an event. The containment is evaluated with a CSET for failure due to overpressurization or bypass if failure by other mechanisms can be ruled out. The low probability of failure from other mechanisms indicates that most of the core damage frequency translates to the entry event of the CSET.

The number of CSETs needed to evaluate the overpressurization and bypass failure modes for the Level I accident classes, was established with the following considerations:

- Class II sequences, by definition, ultimately result in containment failure prior to core damage; thus, an event tree is not required to evaluate the probability of containment failure. Indeed, Class II events do not require evaluation because they do not result in core damage within the mission time, as illustrated in Section 8.3.2.2.
- Class V sequences involve direct communication between the RPV and environment which renders containment systems, and associated event tree modeling, irrelevant.

Thus, containment event trees were required only to evaluate the containment response to Class I, Class III and Class IV events.

The CSETs were developed by establishing the functions and containment systems that were relevant to mitigating the overpressure and bypass challenges. The CSETs were then constructed using appropriate logic to account for mitigating system success or failure by

establishing the logically possible containment responses. Finally, the end states of the CSETs, which are termed "release categories", were defined. The release categories may indicate containment failure or may indicate that the containment has successfully functioned to limit the radionuclide release. These release categories represent meaningfully different outcomes to the containment challenge and are used in the source term evaluation discussed in Section 9.

Review of the CSETs indicates that that there is a common structure to the trees, irrespective of the initiating event. This structure is indicated in Figure 8.2-1. Because of this common tree structure, quantification of different accident classes was unique only because of differing entry event and branch probabilities. Determination of the CSET entry event probabilities is discussed in Section 8.2.1.1. The containment systems evaluated in the CSETs are summarized in Section 8.2.1.2 with the associated top events being discussed in Section 8.2.1.3. The end states of the trees, which become the release categories for the consequence evaluation, are discussed in Section 8.2.1.4. The frequencies associated with the release categories are presented in Section 8.1.1.5. Appendix A.8 provides additional detail on the release category quantification.

8.2.1.1 CSET Entry Events

Quantification of the CPETs indicates that it is very unlikely that containment failure will occur due to the type of containment challenges addressed in the containment phenomenology event trees. Thus, the total probability of all of the CSET entry events is very close to the calculated frequency of a core damage event. The difference lies in the small probabilities of containment failure that were assigned to the core-concrete interaction, ex-vessel steam explosion and direct containment heating events. As illustrated in Appendix A.8, the probability of transferring from the CPET to the CSET becomes the entry, or "initiating" event frequency for each CSET.

The CSET entry event frequencies are summarized in Table 8.2-1. Note that each accident class is divided into two subclasses. The subclasses were necessary to reflect system dependencies on whether or not site power was available. For example, accident Class I was divided into Class IL (RPV failure at low pressure and loss of preferred power) and Class IN (RPV failure at low pressure without loss of preferred power). Class III was similarly subdivided. From the Level 1 analysis presented in Section 7, the probability of a Class IV event resulting in RPV failure at high pressure is negligible. Thus, the subclasses for Class IV are IVL (ATWS with RPV failure at low pressure and loss of preferred power) and IVN (ATWS with RPV failure at low pressure without loss of preferred power).

8.2.1.2 Mitigating Systems

The ESBWR includes systems with the capability to prevent or mitigate containment bypass and overpressurization. The systems considered in the evaluation of containment response are summarized below.

Containment Isolation System

The containment isolation system provides for monitoring and isolation of the containment boundary to prevent unacceptable radiological releases during normal, abnormal and accident conditions.

Isolation Condenser System

The isolation condenser system (ICS) provides the capability to remove decay heat from the RPV. Because the heat exchangers are external to the containment, removal of heat from the RPV also removes energy from the containment. The isolation condensers would be effective primarily when the RPV is at an elevated pressure. The isolation condensers do not condense a significant amount of steam after RPV depressurization and thus, provide little mitigation of a severe accident after RPV depressurization. For conservatism, the ICS was not credited in the severe accident sequence evaluation.

GDCS Deluge and BiMAC

The deluge mode of GDCS operation provides flow through the BiMAC to flood the lower drywell when the temperature in the lower drywell increases enough to be indicative of RPV failure and core debris in the lower drywell. The GDCS deluge system is activated by thermocouples embedded in the lower drywell floor.

By flooding the lower drywell after the introduction of core material, the potential for energetic fuel-coolant interaction at RPV failure is minimized. Covering core debris with water provides scrubbing of fission products released from the debris and cools the corium, thus limiting potential core-concrete interaction. The BiMAC provides additional assurance of debris bed cooling by providing an engineered pathway for water flow through the debris bed.

Containment Heat Removal (PCCS and Suppression Pool Cooling)

Containment heat removal can be provided by either the PCCS or the suppression pool-cooling mode of the FAPCS. For sequences with successful containment heat removal, the analysis assumed that the PCCS was available and that suppression pool cooling was not in operation. This assumption bounds the containment pressure response because the PCCS can only limit pressurization, while suppression pool cooling can limit and reduce containment pressure.

The PCCS receives a steam-gas mixture from the upper drywell atmosphere, condenses the steam using the PCCS pools as a heat sink, and returns the condensate to the GDCS pool. The non-condensable gas is drawn to the suppression pool through a submerged vent line by the pressure differential between the drywell and wetwell. The PCCS is designed to remove decay heat added to the containment after a LOCA, thus maintaining the containment within its pressure limits. Operation of the PCCS requires no support systems and, as illustrated in

Section 8.3, there is adequate inventory in the PCCS pools to provide containment heat removal for more than 24 hours after the onset of core damage.

Drywell Spray

Drywell spray provides the capability to condense steam in the containment atmosphere to limit pressurization and cool a corium debris bed to limit core-concrete interaction. Drywell spray is not credited in this analysis.

Vacuum Breakers

Vapor suppression requires that a pressure differential be maintained between the drywell and the suppression pool. Failure of the vacuum breakers, either due to a preexisting condition or failure to reclose, is assumed to result in loss of the vapor suppression capability. That is, sequences in which vacuum breaker failure occurred were modeled with an open path between the drywell and wetwell airspace.

Suppression Chamber Vent

To prevent overpressurization failure of the containment as a result of long-term core-concrete interaction or failure of containment heat removal, the ESBWR contains a manually controlled vent connecting the suppression chamber gas space to the environment. Opening the vent would greatly decrease the magnitude of a potential release in comparison to containment failure by forcing the radionuclide pathway through the suppression pool. As will be shown in Section 8.3, failure of containment heat removal does not cause the containment to pressurize to the point at which venting is likely to be implemented to prevent containment failure in the 24-hour time frame after onset of core damage.

Reactor Building Effects

Fission product releases to the environment through the paths representing "normal" containment leakage, i.e., leakage up to the amount allowed by the Technical Specifications, could be reduced for some sequences if credit were taken for radionuclide removal by the reactor building HVAC system. However, such a source term reduction was not credited in the severe accident sequence modeling. Therefore, the source terms of sequences with only Technical Specification leakage are conservative in that they represent a direct release from the containment to the environment. Sequences in which the drywell failure is at the drywell head seals are also conservative because credit is not taken for refueling pool scrubbing. Sequences with drywell failure at other locations are not significantly affected because the release path bypasses the reactor building or would overwhelm the capacity of the reactor building ventilation system.

8.2.1.3 Top Events

Section 8.2.1.1 identified the entry events for the containment system event tree. The next step in constructing CSET was to define, as top events, the functions needed to assess the containment response to bypass and overpressurization challenges. These functions are "containment isolation", "vapor suppression", "containment heat removal" and "venting".

Defining top events for the recovery of failed systems and for operator actions was considered, but was judged unnecessary, as indicated in the following sections. As a result, the event tree necessary to model the containment response became simple in form. Further,

because of the passive nature of the containment design, containment systems have no dependencies on the accident initiator that must be reflected in the tree structure itself. That is, the structure of a CSET is the same irrespective of the initiating event being considered. The trees differ only in the quantification as dependencies on the entry event are reflected in the different branch probabilities. The CSET structure is provided as Figure 8.2-1 with corresponding event probabilities provided in Table 8.2-1. A discussion of the treatment of system recovery, operator actions and top events follows. Appendix A.8 provides additional discussion of the top event probabilities.

8.2.1.3.1 Repair of Failed Systems

Recovery of failed systems was not credited in the severe accident analysis.

8.2.1.3.2 Key Operator Actions

Because of the passive nature of the ESBWR containment systems, there are no operator actions required to support the containment response to a severe accident in the 24 hour period after onset of core damage. The containment isolation system, vacuum breakers, and PCCS do not require operator action to initiate or function. Analyses provided in Section 8.3 will show that operator action is not required to maintain containment heat removal through the PCCS for the 24 hour period after onset of core damage and that containment venting will not be required during that period. Thus, operator actions are considered in the containment evaluation only in terms of:

1. Action taken to recover system failures. Such actions are considered in the fault tree analysis. An example would be an operator action to close a redundant valve in the vacuum relief path if an individual vacuum breaker were to fail to properly seat.
2. Action taken as a backup to an automatic action, e.g., to open the connecting valve for PCCS pool makeup if the low-water level signal were to fail.
3. Action taken to initiate a backup system, e.g., to actuate the FAPCS if the PCCS were unavailable.
4. Actions requiring a long time period to initiate. For example, the suppression chamber vent is under operator control. As indicated in Section 8.3, there would be a long time period (more than 24 hours) in virtually all scenarios to initiate venting to prevent containment overpressure due to a loss of containment heat removal.

Because these operator actions are redundant to passive system functioning or are required only after a long time period, such actions do not have a significant effect on the probability of containment failure.

8.2.1.3.3 Top Event CIS

Top event CIS, representing the containment isolation system, assesses the probability that the containment has not been isolated and, as a result, there is a pathway from containment into the reactor building or directly into the environment.

Section 4.18 documents containment isolation from the perspective of analyzing pipe breaks outside of containment for the Level 1 analysis. As indicated in Appendix C.8, a screening evaluation was performed to identify those containment penetrations that could potentially

lead to offsite consequences. The screening analysis found that there were no penetrations that required isolation to prevent significant offsite consequences. Thus, the containment isolation function, as applied to the Level 2 analysis, was modeled considering only the isolation signal common to all penetration paths, as discussed in Appendix A.8. This approach addresses the "failure-to-close" probability of valves that may be periodically opened as well as the potential common mode failure of small penetrations which have not yet undergone detailed design.

If CIS is failed, the event tree path has no additional branching because the containment has been bypassed and operation of the vacuum breakers, containment heat removal or venting functions is irrelevant. The bypass failure is assumed to be present at the onset of core damage and is not recovered for the duration of the sequence.

8.2.1.3.4 Top Event VB

Top event VB models vacuum breaker operation. Successful vacuum breaker function is necessary to maintain the pressure differential between the upper drywell and suppression pool and thus enable the steam condensation by the PCCS and suppression pool. If VB were not successful, i.e., a vacuum breaker fails to reclose or exhibits excessive leakage, the containment would pressurize relatively quickly because the vapor suppression function is ineffective. The failure probability is a conditional probability derived from fault tree modeling as discussed in Section 4.18.

8.2.1.3.5 Top Event W

Top event W models containment heat removal. The event is partitioned into "short-term" and "long-term" heat removal functions, "W1" and "W2", respectively. The passive PCCS system and the active suppression pool cooling mode of the FAPCS are considered in these nodes. As indicated in Section 4.19.2, the PCCS is designed with adequate water in the PCCS pools to mitigate a design basis event for 24 hours after event initiation. Accordingly, event W1 addresses the period from event initiation to 24 hours after event initiation. This is conservative as indicated by Figure 8.2-2, which illustrates that the PCCS pool water level does not drop below the top of the PCCS heat exchangers in the 24-hour period after onset of core damage. The failure probability for W1 is a conditional probability derived from fault tree modeling. There is some dependency on the initiating event because the suppression pool cooling system requires power to operate.

After 24 hours, it is assumed that the PCCS pool must be replenished by opening valves to an additional water pool. Upon connecting the additional pool, there is adequate water to maintain containment heat removal for the longer term, defined as 24 to 72 hours after event initiation. Long-term containment heat removal is modeled as event W2. As with W1, the failure probability for event W2 is a conditional probability derived from fault tree modeling. The W2 event frequency is dependent on the initiating event because DC power is required to open the valves to the additional water source and the suppression pool cooling system requires power to operate.

8.2.1.3.6 Top Event VT

Top event VT models operator action to prevent containment failure by use of a suppression chamber vent path. If Event VT occurs, the release path is controlled and directed through the suppression pool where significant filtering can occur to reduce the potential source term.

As discussed earlier, operator guidance for controlled venting has not yet been defined. However, insight into the ESBWR passive containment capability, and the need for venting, can be gained by evaluating a severe accident scenario in which there is no containment heat removal (i.e., event W1 is failed). From the Level 1 analysis discussed in Section 7, the sequence that dominates the core damage frequency is a transient in which the RPV is successfully depressurized. For such a sequence, Figure 8.2-3 illustrates that, for a dominant Class I contributor to the core damage frequency, the containment pressurizes to less than 1.0 MPa. As will be shown in Section 8.3, similar results were obtained for representative Class III and IV sequences. Thus, it is very unlikely that controlled venting in the 24-hour period after the onset of core damage will be required to prevent containment overpressure failure for the sequences dominating the core damage frequency.

8.2.1.4 Release Categories

Completion of a path through the event tree presented in Figure 8.2-1 provides the necessary information to establish categories for potential radionuclide release to the environment. A release category descriptor for each path is shown in Figure 8.2-1 in the column headed "Rel Cat". The release categories differ in the timing of containment breach and the magnitude of the radionuclide source term. By several orders of magnitude, the most likely path through the CSET results in an intact containment with the source term being associated with containment leakage up to the limit allowed by Technical Specifications. This release category is termed "TSL". The release categories associated with the CSET presented in Figure 8.2-1 are discussed in more detail in the following sections. Drawing on the quantification presented in Appendix A.8, the probability of each CSET release category is summarized in Table 8.2-2.

Containment Bypass (BYP)

The release category "Bypass" represents those sequences in which containment isolation has not occurred due to failure of the containment isolation system. Thus, the BYP failure mode provides for a direct path from the containment to the environment and results in an earlier environmental release than an overpressure event. However, due to the reliability of the containment isolation system, the probability of such a release occurring is approximately four orders of magnitude less than the TSL release category. Because the calculated probability of the BYP release category is so small, containment bypass is not considered a credible containment failure mode for the ESBWR. However, the BYP release category will be considered in Section 9 as a potential source term.

Filtered Release (FR)

The release category "Filtered Release" represents those sequences in which the suppression chamber vent is used to control the containment pressure and potential release point. In such a situation, the containment boundary remains under operator control. As a result, the

magnitude of the release is much less than if the containment were to fail because the release path is through the suppression pool, which provides significant radionuclide filtering.

As indicated earlier, in the 24-hour period after onset of core damage, the ESBWR containment would likely not require venting even in the absence of containment heat removal for the sequences that dominate the core damage frequency. Although venting is not likely to be required in the 24 hour period after onset of core damage, the option is maintained in the containment system event tree. Treating the possibility of FR in this way accounts for uncertainties in the loss of heat removal analysis and provides a conservative estimate of the likelihood of a controlled release. Further, inclusion of venting on the CSET allows for modeling a period longer than 24 hours after the onset of core damage. The probability of the FR release category was calculated as about two orders of magnitude less than the TSL release category.

Overpressurization (OP)

The release category "Overpressurization" represents those sequences in which there has been inadequate post-accident heat removal resulting in the containment pressure exceeding the ultimate containment strength. Two categories of overpressure failure are considered. The category "OPW" applies to severe accident sequences in which the vapor suppression function is successful and only the containment heat removal function has failed. Both early (OPW1) and late (OPW2) failures of containment heat removal are considered. The category "OPVB" applies to sequences in which the vapor suppression function fails; in that situation, the containment heat removal function is also failed. As indicated in Table 8.2-2, the total probability of the overpressure failure mode (OPW1, OPW2 and OPVB) is about three orders of magnitude less likely than the TSL failure mode and is associated predominantly with failure of long term heat removal. Each subcategory is discussed below.

OPVB: The release category "OPVB" applies to sequences in which vacuum breaker failure has occurred. Failure of the vacuum breakers to close, or to be open in a pre-existing condition, results in failure of the containment vapor suppression function. If the vacuum breakers fail to function effectively, the overpressurization occurs fairly early in the severe accident sequence because the vapor suppression function is not effective. Because of the high reliability of the vacuum breakers necessary for the vapor suppression function, the calculated probability of the OPVB release category is more than four orders of magnitude less than the TSL release category. Thus, vapor suppression failure it is not considered a credible containment failure mode for the ESBWR. However, the OPVB release category will be used in Section 9 as part of a conservative evaluation of potential source terms.

OPW1: The release category "OPW1" applies to sequences in which containment heat removal fails within 24 hours after event initiation. In such sequences, vapor suppression has been successful, but the passive PCCS system is unavailable as well as the active FPACS, either of which provides the capability to remove energy from the containment. The 24-hour transition point from W1 to W2 was selected to correspond with the design requirement regarding the amount of water available to the PCCS cubicles without connection to a supplemental pool source. Because of the reliability of the fuel pool cooling mode of the FAPCS and the passive PCCS, the

calculated probability of the OPW1 release category is more than four orders of magnitude less than the TSL release category. Thus, loss of containment heat removal is not considered a credible containment failure mode for the ESBWR. However, the OPW1 release category will be used in Section 9 as part of a conservative evaluation of potential source terms.

OPW2: The release category "OPW2" applies to sequences in which containment heat removal fails between 24 and 72 hours. In such sequences, the passive PCCS system becomes unavailable after PCCS pool dryout due to failure to connect to supplemental water pools; FAPCS availability was also evaluated at this time. Because of the minimum system requirements to provide additional water to the PCCS pools, long term heat removal (>24 hours) is very reliable. The probability of the OPW2 release category is about three orders of magnitude less than the TSL release category. As with other release categories, OPW2 will be represented in the source term evaluation.

Containment failure due to overpressurization is conservatively modeled as a direct path from the drywell to the environment. Thus, potential uncertainty in the location of the failure point is accommodated by the assumption of a direct path to the environment if the containment is overpressurized.

Technical Specification Leakage (TSL)

The release category "Technical Specification Leakage" represents those sequences in which there is neither a release due to containment failure nor a controlled filtered venting. The TSL release category provides a source term that exceeds that associated with normal operation because of the severe accident conditions within the containment. It is assumed that the leakage area corresponds to the Technical Specification allowable containment leakage rate of 0.5% of containment air volume per day at rated pressure.

The leakage path was conservatively assumed to occur between the drywell atmosphere and environment. Thus, no credit is taken for source term reduction if the leakage could be affected by potential refueling pool scrubbing or the reactor building HVAC system.

8.2.1.5 Release Category Frequency and Containment Effectiveness

The frequency of a given release category for each initiator is found by quantifying the CSET path ending with that release category. To provide the total probability of a release category for all initiators, the CSET is evaluated for each entry event and the probabilities are summed. As seen in Table 8.2-2, the most likely release category is that associated with leakage from an intact containment, TSL. Controlled, filtered venting, FR, is the next most likely release category with a release frequency two orders of magnitude lower than TSL. Release categories associated with containment failure, i.e., OP and BYP, are several orders of magnitude less likely than the TSL release category.

The release categories associated with containment failure are so much lower than the TSL category, and their calculated probabilities are so low on an absolute basis, that containment failure due to overpressurization or bypass in the 24-hour period after the onset of core damage is not considered credible. Thus, it is clear that the ESBWR provides a reliable barrier to radionuclide release. This conclusion is reflected in the quantification of

containment effectiveness. The containment effectiveness can be conservatively quantified as the probability of release category TSL (i.e., an intact containment) divided by the probability of all release categories. This method is conservative in that the FR category is included in the denominator although it does not involve loss of containment boundary control. Using the values from Appendix A.8, Table A.8-3, and applying "ε" for probabilities less than 1E-12,

$$\text{Containment effectiveness} \equiv \frac{\text{Probability of TSL release category}}{\text{Probability of all release categories}}$$

$$= \frac{2.84\text{E-}8}{(2.89\text{E-}10+2.9\text{E-}11+\varepsilon+2.52\text{E-}10+\varepsilon+2.84\text{E-}8+2.33\text{E-}10+1.4\text{E-}11+\varepsilon+\varepsilon+1\text{E}12+4\text{E-}12)}$$

$$= 0.97$$

Table 8.2-1

Summary of CSET Initiating and Branch Failure Probabilities

CSET	Entry Event*	Entry Event Frequency	Top Event CIS	Top Event VB	Top Event W1	Top Event W2	Top Event VT
Class IL (RPV failure at low pressure and loss of preferred power)	IL_CS	1.62E-8	3.50E-5	5.48E-6	3.66E-5	4.12E-7	5.69E-2
Class IN (RPV failure at low pressure without loss of preferred power)	IN_CS	1.20E-8	3.50E-5	6.14E-6	7.97E-6	1.45E-5	5.69E-2
Class IIIL (RPV failure at high pressure and loss of preferred power)	IIIL_CS	3.16E-10	3.50E-5	3.00E-4	1.82E-4	7.60E-1	5.69E-2
Class IIIN (RPV failure at high pressure without loss of preferred power)	IIIN_CS	8.90E-12	3.50E-5	2.92E-4	1.77E-4	6.87E-1	5.69E-2
Class IVL (ATWS with RPV failure at low pressure and loss of preferred power)	IVL_CS	4E-12	3.50E-5	5.32E-6	6.18E-6	8.98E-8	5.69E-2
Class IVN (ATWS with RPV failure at low pressure without loss of preferred power)	IVN_CS	1.75E-10	3.50E-5	5.33E-6	5.76E-6	4.72E-8	5.69E-2

*Nomenclature used in event tree quantification provided in Appendix A.8

Table 8.2-2

CSET Release Category Frequencies

Release category	Frequency (per year)*
TSL	2.84E-8
FR	2.33E-10
BYP	1E-12
OPVB	<1E-12
OPW1	<1E-12
OPW2	1.4E-11

*The frequency is the summed contribution to the release category from all accident classes, as shown in Table A.8-3.

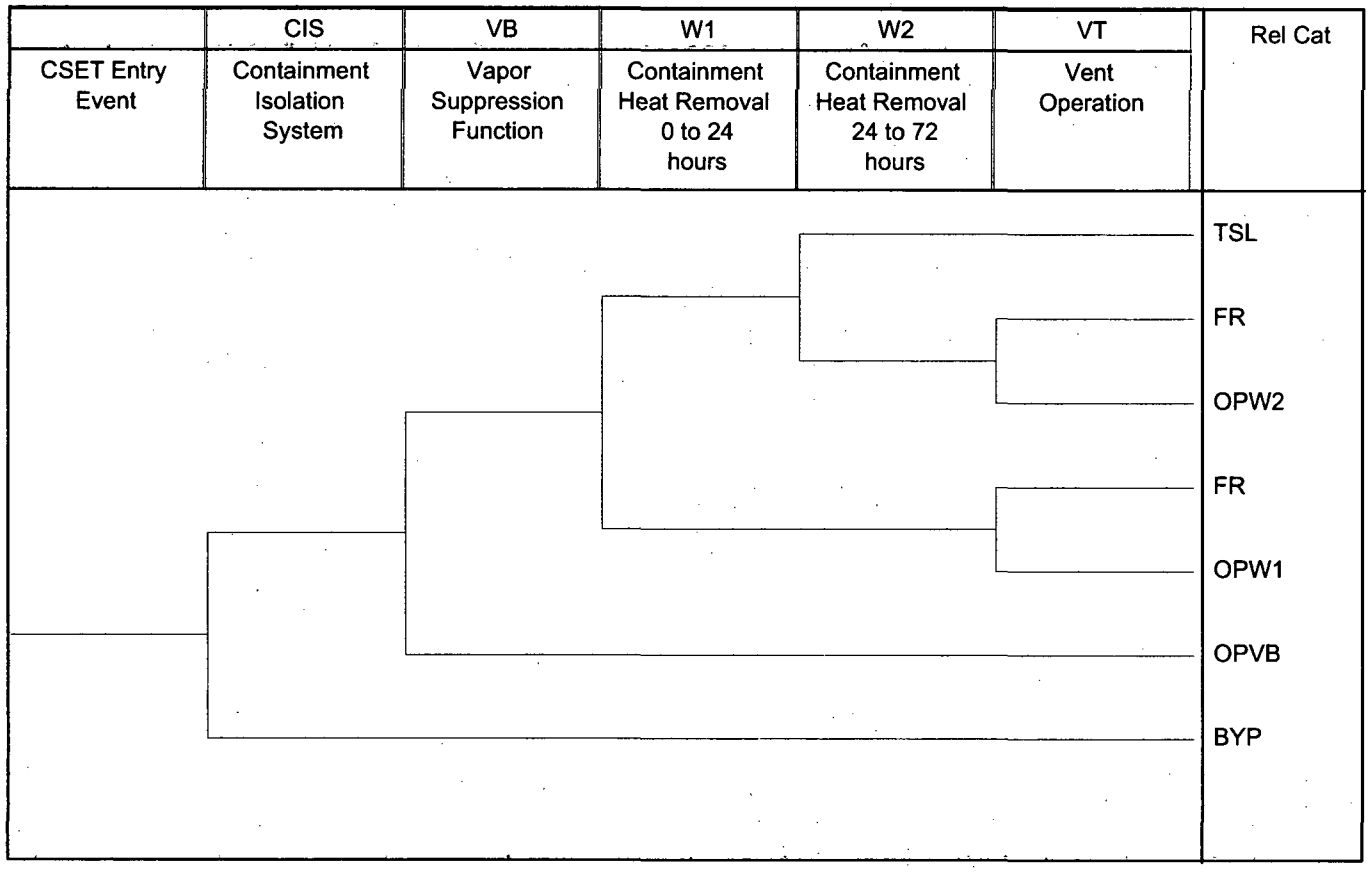

Figure 8.2-1. Containment System Event Tree

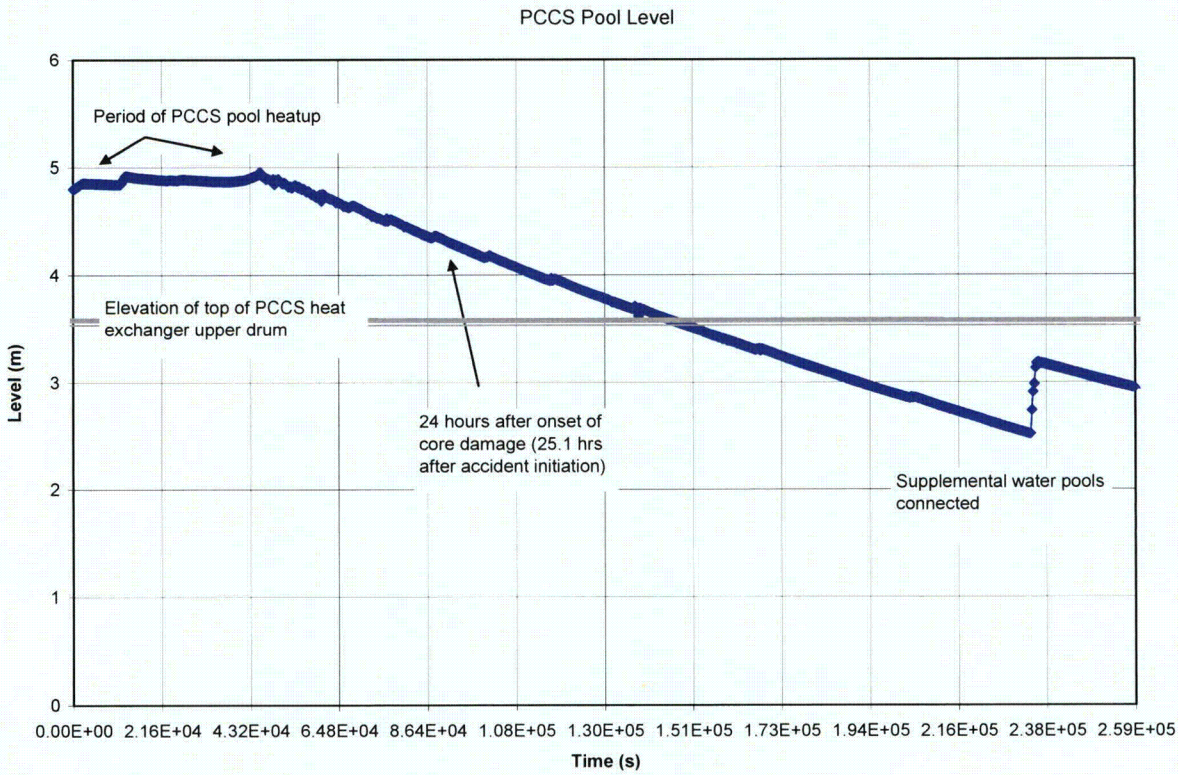

Figure 8.2-2. PCCS heat removal capability for 24 hour period

Example shown is for a dominant Class I sequence, a transient followed by loss of core injection. The PCCS heat exchangers remain covered for more than 24 hours after onset of core damage.

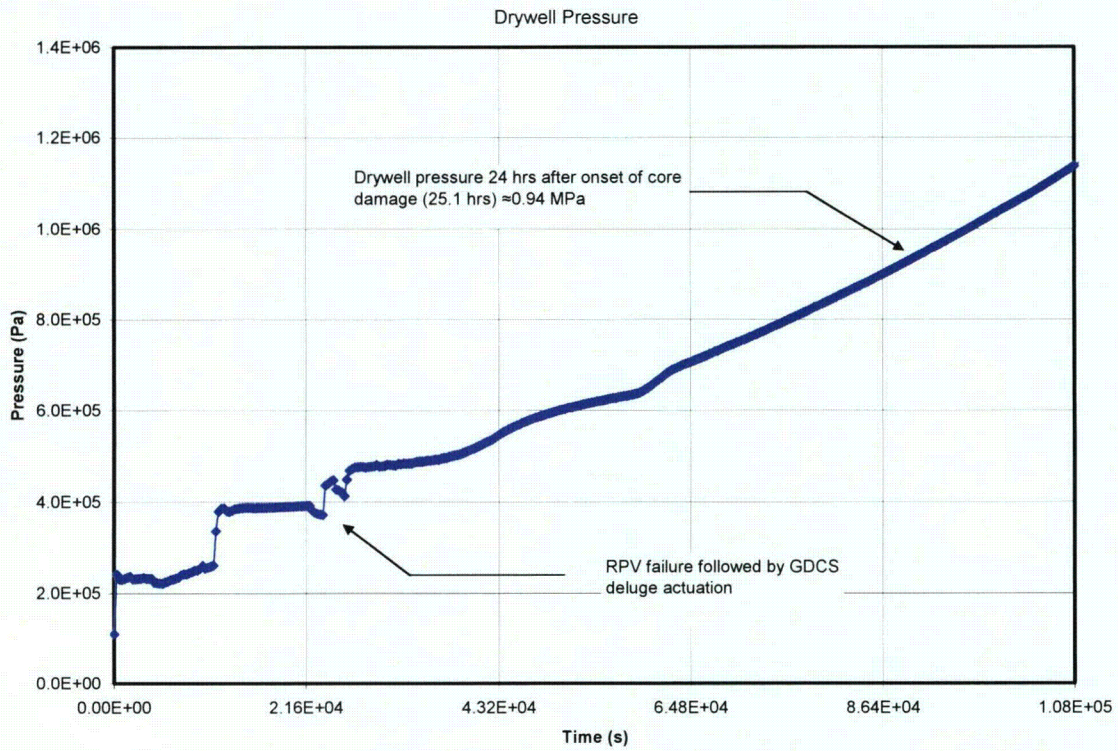

Figure 8.2-3. Containment Pressure with No Containment Heat Removal

Example shown is for a dominant Class I sequence, a transient followed by loss of core injection. With vapor suppression function successful, containment does not pressurize to failure within 24 hours after onset of core damage.

8.3 CONTAINMENT PERFORMANCE AGAINST OVERPRESSURE

To determine the key characteristics of the containment response to a severe accident, an ESBWR simulation model was developed. The model is used to gain insights into the timing of severe accident progression, the containment pressure-temperature response and ultimately the potential source term if the containment were to fail. As demonstrated in the prior section, the reliability of containment systems designed to mitigate a severe accident is such that the calculated probabilities of containment bypass and overpressure failure are so small that they may be considered negligible. Thus, only the TSL and FR release categories are discussed in this section. Hypothetical scenarios in which the containment is bypassed or fails due to overpressurization are considered in the evaluation of potential source terms, as presented in Section 9.

Analysis of the ultimate strength of the containment indicates that the drywell head is the most likely failure location if the containment were to overpressurize. The analysis also illustrates that the containment pressure capability is a function of temperature. This pressure capability profile was used in the simulation modeling.

Section 8.3.1 summarizes the code used for accident simulation. Section 8.3.2 provides the simulation results for a spectrum of potential severe accidents representing each accident class. Appendix B.8 provides the ultimate containment strength analysis.

8.3.1 Simulation Code

The ESBWR was modeled using a computer code capable of modeling the integrated plant response to a severe accident. The code used for this purpose is the Modular Accident Analysis Program code (MAAP), Version 4.0.6, Reference 8.3-1. The code was developed as part of the Industry Degraded Core Rulemaking (IDCOR) program to investigate the physical phenomena that might occur in the event of a severe light water reactor accident leading to core damage, possible RPV failure, and ultimately possible failure of containment integrity and release of fission products to the environment. MAAP development was sponsored by the Atomic Industrial Forum. MAAP includes models for the important phenomena that might occur in a severe light water reactor accident.

MAAP has a long history of use in severe accident analysis, including severe accident analysis of the ABWR as described in Reference 8.3-2, which was based on an earlier version of MAAP. MAAP requires that phenomenological information and plant specific design characteristics be provided in the form of a parameter file. Parameter file inputs related to accident phenomenology were based on the values provided in MAAP sample files, which are maintained for the MAAP Users Group; these values were provided by the code developer. Parametric values related to the ESBWR design were based on review of design documentation information, as it was available in February 2005. In some cases, design information was updated between February and August 2005 when significant design decisions were made.

8.3.2 Sequences Representative of Each Accident Class

As discussed in earlier sections, severe accidents were grouped in five categories in the Level 1 analysis. The Level 1 analysis results were reviewed to identify sequences which were

dominant contributors to the core damage frequency. A single dominant sequence was then selected to represent each of the accident classes for detailed modeling. In this way, the containment response to the complete spectrum of accidents contributing to the core damage frequency could be evaluated.

Table 8.3-1 identifies the sequences that were used to represent each accident class. The "core damage sequence descriptor" used in the table derives from the results of the Level 1 analysis. Table 7.2-3 identified the sequences which were significant contributors to the core damage frequency. The representative sequences shown in Table 8.3-1 are based on the Level 1 results presented in Table 7.2-3. For example, Table 7.2-3 indicates that about 99% of the Class I frequency is associated with loss of preferred power (T-LOPP) or loss of feedwater (T-FDW) sequences. From the perspective of modeling the containment response to a severe accident, both of these sequences can be represented as a transient with loss of injection "T-nIN". A similar approach was used in selecting the representative sequence for the other accident classes. Table 8.3-1 provides a summary description for each representative sequence.

Table 8.3-2 couples the representative core damage sequence with one of the release categories illustrated on the containment system event tree, Figure 8.2-1. The resulting scenario is assigned a "containment response sequence descriptor" to summarize the core damage and containment release information. Recalling that Table 8.2-2 provided the total contribution of all accident classes to each release category frequency, Table 8.3-2 provides additional information by presenting the release category frequency in terms of the contribution from each accident class. As indicated in the table, there is a negligible probability of a core damage sequence resulting in overpressure or bypass failure. However, such hypothetical scenarios are retained for evaluation in Section 9 to assure that a conservative source term is developed.

8.3.2.1 Class I: Sequences with RPV Failure at Low Pressure

Accident Class I involves sequences in which the RPV fails at low pressure; this accident class represents approximately 98% of the core damage frequency. As indicated in Tables 7.2-3 and 7.2-5, the class is dominated by transient sequences in which there is no core injection. Thus, the sequence "T_nIN" described below was used to evaluate the containment response to Class I events.

8.3.2.1.1 Sequence T_nIN_TSL

The initiating event for the T_nIN sequence is a transient initiated by a loss-of-preferred power. No short or long-term coolant injection to the RPV by the feedwater, CRD or GDCS is available. The ADS functions to reduce the RPV pressure. As stated earlier, heat removal by the isolation condensers is not credited. Containment heat removal in the short-term is accomplished by successful PCCS functioning; PCCS pool makeup is successful, thus allowing long-term containment heat removal. The GDCS deluge system and BiMAC are available for debris bed cooling. With successful containment isolation, vapor suppression and containment heat removal the containment remains intact. Technical Specification leakage is the only mode of fission product release.

The key events of the sequence are summarized in Table 8.3-3. Figures 8.3-1a through e show the system behavior throughout the accident sequence.

In this event, the primary system rapidly depressurizes due to opening of the first ADS-actuated valves at about 47 seconds. The pressure in the containment increases as the drywell is filled with steam and heats up. About thirty minutes into the event, core uncovery occurs which results in fuel rod heatup and melting. Fission products and non-condensable gases are swept into the containment through the DPVs as the core melts. This leads to further heating and pressurization of the drywell air space.

The reactor pressure vessel lower head penetrations fail about 6.4 hours into the event. Corium is deposited on the lower drywell floor, which results in local temperatures that are high enough to cause the GDCS deluge line to open. As a result, the GDCS pool water drains into the lower drywell and covers the debris bed. Because the debris is quenched by the successful GDCS deluge and BiMAC function, significant core-concrete interaction does not occur. Therefore, no significant fission product aerosols or non-condensable gases are generated in the ex-vessel phase of the accident sequence.

Continued heating by debris of the water in the lower drywell leads to the temperature in the overlying water pool reaching saturation. Steam generation in the lower drywell then leads to further increases in the containment pressure until the PCCS heat removal capacity becomes consistent and comparable to the decay heat generated by the core debris. The containment pressure reaches about 0.65 MPa 24 hours after onset of core damage, well below the point at which containment venting would be implemented. Radionuclide release to the environment occurs only through potential containment leakage as the containment remains intact and venting is not required.

8.3.2.1.2 Sequence T_nIN_nCHR_FR

Sequence T_nIN_nCHR_FR is the same as the representative Class I sequence T_nIN, except that the containment response differs because containment heat removal has failed. As a result, containment pressurization increases and controlled venting may be implemented to limit the pressure rise and control the radionuclide release point. Specific guidance for the use of the suppression pool vent has not been developed. Indeed, as discussed earlier, venting in the ESBWR does not appear necessary to limit the containment pressure to less than its ultimate strength in the 24-hour period after core damage. The venting scenario is evaluated here to provide insights into vent timing and provide a basis for the FR release category used in the source term evaluation.

The key events of the sequence are summarized in Table 8.3-3. Figures 8.3-2a through d show the system behavior throughout the accident sequence. The sequence proceeds as discussed in the previous section except that venting is assumed to occur when the containment pressure reaches 90% of the ultimate containment strength. As indicated, in Figure 8.3-2b, the drywell pressure has reached less than 70% of the ultimate containment strength within 24 hours after onset of core damage; thus venting would not likely be implemented in this time frame. The 90% assumption is met at 32.3 hours, which is about 2.7 hours before containment overpressurization would occur if controlled venting were not implemented.

The sequence demonstrates that venting is not required to prevent containment failure in the 24-hour period after onset of core damage due to a Class I event, even if containment heat removal were unavailable. In such a scenario, there is a long time period after core damage to prepare for venting and take other mitigating actions.

8.3.2.2 Class II: Sequences with Containment Failure Preceding Core Damage

Accident Class II involves sequences in which containment failure, due to a loss of heat removal capability, precedes RPV failure. After containment failure, RPV makeup capability is assumed to be lost due to the gradual boiloff of water in the passive systems; potential damage to piping connections renders active makeup systems unavailable. As a result, core damage and RPV failure occur after containment failure. The sequence MLi_nCHR was selected to represent the containment response to Class II events because the sequence provides containment pressurization due to the break and failure of the containment heat removal function.

As indicated in Section 3.2.4, Class II sequences do not contribute to the core damage frequency because of the long time for sequence development and the potential for operator recovery action. The following discussion illustrates this conclusion.

8.3.2.2.1 Sequence MLi_nCHR

The initiating event for the sequence MLi_nCHR is a medium LOCA, assumed to occur in the GDCS injection line. Failure of containment heat removal is followed by containment pressurization to its ultimate capacity. Core cooling occurs by gravity feed through the GDCS injection and equalizing lines. Eventually, the water used for RPV makeup is boiled off.

The key events of the sequence are summarized in Table 8.3-3. Figures 8.3-3a through c show the system behavior throughout the accident sequence. The figures illustrate that the containment pressurizes until the ultimate strength is reached at about 31 hours. The ADS depressurizes the RPV allowing GDCS tanks to drain into the RPV, then into the lower drywell through the break. The shroud water level initially rises in response to the GDCS tank injection, then decays as the GDCS inventory is depleted. The shroud level decreases below the elevation of the break at about six hours. Further, shroud level decrease occurs until flow through the equalizing line begins at about 8.3 hours. Flow from the suppression pool maintains RPV level above the top of active fuel for about 71 hours. Shortly thereafter, core heat up begins.

The results of the sequence simulation indicate that the core damage following containment failure due to loss of containment heat removal does not occur within a 24 period after accident initiation. In fact, core temperatures do not reach the point of fuel damage until more than 72 hours after accident initiation. Given the long time for mitigating action to supplement RPV makeup, Class II events are not considered contributors to the core damage frequency and inclusion of such events in the offsite consequence analysis is unnecessary.

Because core damage is not indicated for such a long period from the start of the severe accident sequence, no release category is identified for the representative Class II sequence in Table 8.3-2.

8.3.2.3 Class III: Sequences with RPV Failure at High Pressure

Accident Class III involves sequences in which the RPV fails at high pressure; this accident class approximately 1.4% of the core damage frequency. As indicated in Tables 7.2-3 and 7.2-5, the class is dominated by transient sequences in which there is no core injection. Thus, sequence "T_nDP_nIN" described below was used to evaluate the containment response to Class III events.

8.3.2.3.1 Sequence T_nDP_nIN_TSL

The initiating event for the sequence T_nDP_nIN is a loss-of-offsite power. The sequence differs from T_nIN in that depressurization fails, although the SRVs remain functional in the relief mode. The ICS was not credited. The CRD and Feedwater systems are unavailable. Because depressurization is unsuccessful, the RPV fails at high pressure, i.e., at the pressure controlled by the relief valve setpoint. GDCS deluge and BiMAC function to cool the debris bed in the lower drywell.

The key events of the sequence are summarized in Table 8.3-3. Figures 8.3-4a and b summarize the system behavior throughout the accident sequence.

The RPV fails about 4.9 hours. Actuation of the GDCS deluge line and successful BiMAC function prevent significant core-concrete interaction from occurring in the lower drywell. Material dispersed to the upper drywell does not result in significant CCI because the large dispersal area allows the material to be cooled. Continued heating of the water by debris in the lower drywell leads to continued steam generation, which increases containment pressure. The PCCS removes heat from the containment, thus preventing overpressurization. The containment pressure reaches about 0.7 MPa 24 hours after onset of core damage, well below the point at which containment venting would be implemented. Radionuclide release to the environment occurs only through potential containment leakage as the containment remains intact and venting is not required.

8.3.2.3.2 Sequence T_nDP_nIN_nCHR_FR

Sequence T_nDP_nIN_nCHR is the same as sequence T_nDP_nIN except that containment heat removal has failed. As a result, containment pressurization increases and controlled venting is implemented to limit the pressure rise and control the radionuclide release point. As indicated earlier, specific guidance for the use of the suppression pool vent has not been developed, thus, venting is assumed to occur when the containment pressure reaches 90% of the ultimate containment strength.

The key events of the sequence are summarized in Table 8.3-3. Figures 8.3-5a and b show the system behavior throughout the accident sequence. As indicated, in Figure 8.3-5b, the drywell pressure has reached less than 70% of the ultimate containment strength within 24 hours after onset of core damage; thus venting would not likely be implemented in this time frame. The 90% assumption is met at 42.5 hours after accident initiation, which is about 2.9 hours before containment overpressurization would occur.

The sequence demonstrates that venting is not required to prevent containment failure in the 24-hour period after onset of core damage due to a Class III event, even if containment heat

removal were unavailable. In such a scenario, there is a long time period after core damage to prepare for venting and take other mitigating actions.

8.3.2.4 Class IV: Sequences with Failure to Insert Negative Reactivity

Accident Class IV includes sequences that are initiated by an ATWS and followed by failure to initiate negative reactivity. Such sequences represent less than 1% of the core damage frequency. From the Level 1 analysis summarized in Table 7.2-3, the largest Class IV contributor to the core damage frequency is a general transient followed by failure to scram. Thus, the sequence termed "T-AT_nIN", which defines the ATWS initiator with no core injection, was selected to evaluate the containment response to Class IV events.

8.3.2.4.1 Sequence T-AT_nIN_TSL

Sequence T-AT_nIN is a general transient followed by ATWS. The standby liquid control system is ineffective or unavailable. The RPV is not initially depressurized because ADS inhibit is successful. To control the ATWS power level, feedwater runback is successful with operator control assumed at the top of active fuel. The PCCS is available, but no active containment heat removal (FAPCS) is assumed.

The key events of the sequence are summarized in Table 8.3-3. Figures 8.3-6a through c show the system behavior throughout the accident sequence.

In this sequence, feedwater runback is successful. Control of core water level just above the top of active fuel results in a core power level of about 30% full power three minutes after the transient begins. At that time, it is assumed that feedwater is terminated and safety system injection to the RPV does not occur. (System pressure prevents gravity drain from the GDCS and the CRD system is unavailable for forced flow.) Because the ADS inhibit is successful, the RPV is maintained at high pressure, controlled by the SRV setpoint, until the core water level decreases below the point of effective cooling. At that point, manual depressurization is initiated, but injection into the RPV continues to be unsuccessful. RPV failure occurs at about 4.0 hours at low pressure.

Actuation of the GDCS deluge line and successful BiMAC function prevent significant CCI from occurring in the lower drywell. Material dispersed to the upper drywell does not result in significant CCI because the large dispersal area allows the material to be cooled. Continued heating by debris of the water in the lower drywell leads to continued steam generation, which increases containment pressure. The PCCS removes heat from the containment, thus preventing overpressurization. The containment pressure reaches about 0.6 MPa 24 hours after onset of core damage, well below the point at which containment venting would be implemented. Radionuclide release to the environment occurs only through potential containment leakage as the containment remains intact and venting is not required.

8.3.2.4.2 Sequence T-AT_nIN_nCHR_FR

Sequence T-AT_nIN_nCHR_FR is the same as sequence T-AT_nIN except that containment heat removal has failed. As a result, containment pressurization increases and controlled venting is implemented to limit the pressure rise and control the radionuclide release point. As indicated earlier, specific guidance for the use of the suppression pool vent has not been

developed, thus, venting is assumed to occur when the containment pressure reaches 90% of the ultimate containment strength.

The key events of the sequence are summarized in Table 8.3-3. Figure 8.3-7a shows the containment response for the accident sequence. As indicated in the figure, the containment pressure 24 hours after the onset of core damage is about 1.0 MPa, within the pressure retaining capability of the containment. The 90% assumption for action to initiate controlled venting is met at about 29 hours after accident initiation.

The sequence demonstrates that venting is not required to prevent containment failure in the 24-hour period after onset of core damage due to a Class IV event, even if containment heat removal were unavailable. In such a scenario, there is a long time period after core damage to prepare for venting and take other mitigating actions.

8.3.2.5 Class V: Sequences with Interfacing LOCA

Because Class V sequences are associated with a direct path from the RPV to the environment the containment response is not relevant to preventing a radionuclide release. The risk of such low probability events is accounted for by defining a release category, "BOC" for break-outside-of-containment, and assigning a frequency in the source term analysis, as discussed in Section 9.0.

Table 8.3-1

Representative Core Damage Sequences

Accident Class	Core Damage Sequence Descriptor	Sequence Summary
I	T_nIN	Transient initiator followed by no short or long-term coolant injection. ADS functions. ICS not credited. PCCS available, but no active containment heat removal (FAPCS). GDCS/BiMAC function successful.
II	MLi_nCHR	Medium liquid line break: GDCS injection line. System is depressurized and injection systems function. Containment heat removal not available.
III	T_nDP_nIN	Transient initiator followed by no short or long-term coolant injection. The RPV is not depressurized; pressure controlled at relief valve setpoint. ICS not credited. PCCS available, but no active containment heat removal (FAPCS). GDCS/BiMAC function successful.
IV	T-AT_nIN	Transient followed by failure to insert negative reactivity. ICS not credited. RPV is not initially depressurized (ADS inhibit successful). SLC is ineffective or unavailable. FW runback is successful. No short or long-term coolant injection. PCCS available, but no active containment heat removal (FAPCS). GDCS/BiMAC function successful.
V	None	No representative sequence assigned for containment evaluation as Class V events involve direct communication between the RPV and environment

Table 8.3-2

Representative Containment Response Sequence

Containment Response Sequence Descriptor	Release Category	Frequency* (per reactor-year)	Containment Response Summary
T_nIN _TSL	TSL	2.81E-08	Release path from drywell through area associated with Technical Specification leakage. All containment systems function effectively.
_nCHR _FR	FR	1E-12	Release path through wetwell vent. Containment heat removal function failed.
_nCHR_W1	OPW1	ε	Release path from drywell through area large enough to depressurize containment. Containment heat removal fails early (<24 hrs); no controlled venting.
_nCHR_W2	OPW2	ε	Release path from drywell through area large enough to depressurize containment. Containment heat removal fails late (>24 hrs); no controlled venting.
_nVB	OPVB	ε	Release path from drywell through area large enough to depressurize containment. Vapor suppression, containment heat removal and controlled venting functions failed.
_BYP	BYP	1E-12	Release path from drywell through open line connecting drywell atmosphere to environment
MLi_nCHR	None	0.0	Release path from drywell through area large enough to depressurize containment. Containment heat removal not available.
T_nDP_nIN_TSL	TSL	7.9E-11	Release path from drywell through area associated with Technical Specification leakage. All containment systems function effectively.
nCHR_FR	FR	2.32E-10	Release path through wetwell vent. Containment heat removal function failed.
_nCHR_W1	OPW1	ε	Release path from drywell through area large enough to depressurize containment. Containment heat removal fails early (<24 hrs); no controlled venting.
_nCHR_W2	OPW2	1.4E-11	Release path from drywell through area large enough to depressurize containment. Containment heat removal fails late (>24 hrs); no controlled venting.
_nVB	OPVB	ε	Release path from drywell through area large enough to depressurize containment. Vapor suppression, containment heat removal and controlled venting functions failed.
_BYP	BYP	ε	Release path from drywell through open line connecting drywell atmosphere to environment

Table 8.3-2

Representative Containment Response Sequence

Containment Response Sequence Descriptor	Release Category	Frequency* (per reactor-year)	Containment Response Summary
T-AT_nIN_TSL	TSL	1.79E-10	Release path from drywell through area associated with Technical Specification leakage. All containment systems function effectively.
nCHR_FR	FR	ε	Release path through wetwell vent. Containment heat removal function failed.
_nCHR_W1	OPW1	ε	Release path from drywell through area large enough to depressurize containment. Containment heat removal fails early (<24 hrs); no controlled venting.
_nCHR_W2	OPW2	ε	Release path from drywell through area large enough to depressurize containment. Containment heat removal fails late (>24 hrs); no controlled venting.
_nVB	OPVB	ε	Release path from drywell through area large enough to depressurize containment. Vapor suppression, containment heat removal and controlled venting functions failed.
_BYP	BYP	ε	Release path from drywell through open line connecting drywell atmosphere to environment

Notes:

"Frequency" indicates contribution from all sequences in accident class, not just the representative sequence. Refer to Table A.8-3 for additional detail regarding release category frequency.

"ε" refers to a calculated frequency of <1.0E-12.

Table 8.3-3

Summary of Results of Severe Accident Sequence Analysis

Sequence Descriptor	RPV Depressurization Initiated (seconds)	Core Uncovered (hours)	Onset of Core Damage (hours)*	RPV Failure (hours)	Deluge Actuated (hours)	Concrete Ablation 24 hrs. after onset of core damage (meters)	Drywell Pressure 24 hrs. after onset of core damage (MPa)	Containment Vent (hours after onset of core damage)
T_nIN _TSL	47	0.47	1.1	6.4	6.5	0.1	0.65	NA
T_nIN_nCHR_FR	47	0.44	1.2	6.6	6.6	0.1	0.9	>24
MLi_nCHR	88	71	>72	>72	NA	NA	NA	NA
T_nDP_nIN _TSL	NA	0.87	1.5	4.9	4.9	<0.1	0.72	NA
T_nDP_nIN_nCHR _FR	NA	0.86	1.5	4.6	4.6	<0.1	0.86	>24
T-AT_nIN_TSL	1015	0.1	0.67	4.0	4.1	0.1	0.61	NA
T-AT_nIN_nCHR_FR	1002	0.1	0.68	4.0	4.0	<0.1	1.0	>24

Key:
MLi: Medium Liquid break (injection line)
T: Transient
T-AT: Transient without negative reactivity insertion
nCHR: No containment heat removal
nDP: No depressurization
nIN: No injection
FR: Filtered release (controlled vent)
TSL: Technical Specification Leakage
NA: Not Applicable
*Time of maximum core temperature > 2499°K

Figs 8.3-1a through e: Sequence T_nIN_TSL

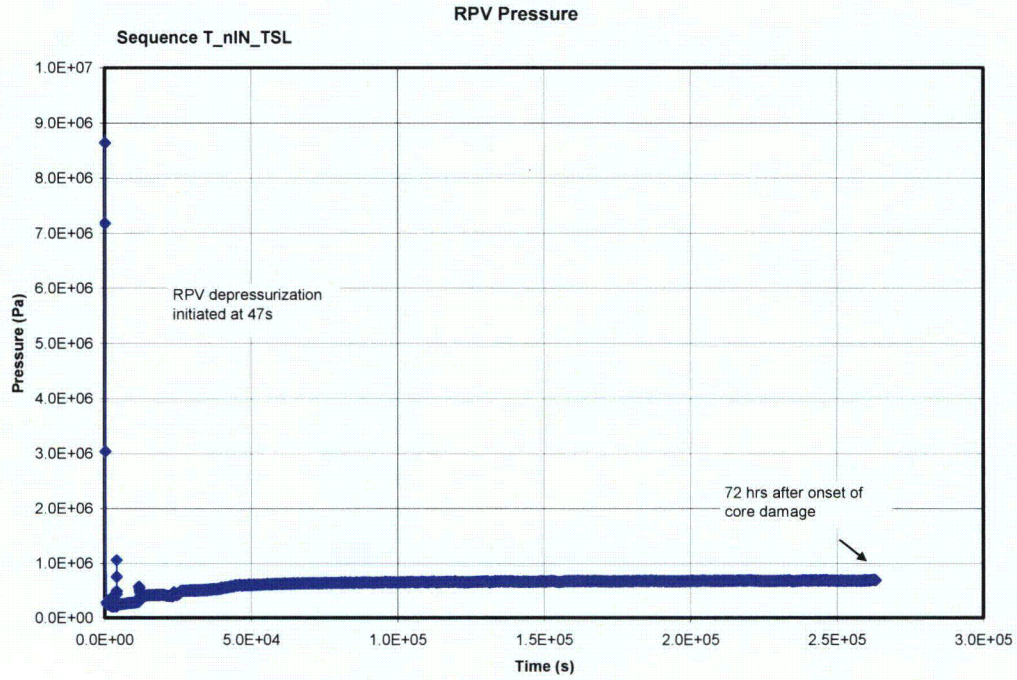

Figure 8.3-1a. T_nIN_TSL: RPV Pressure vs. Time

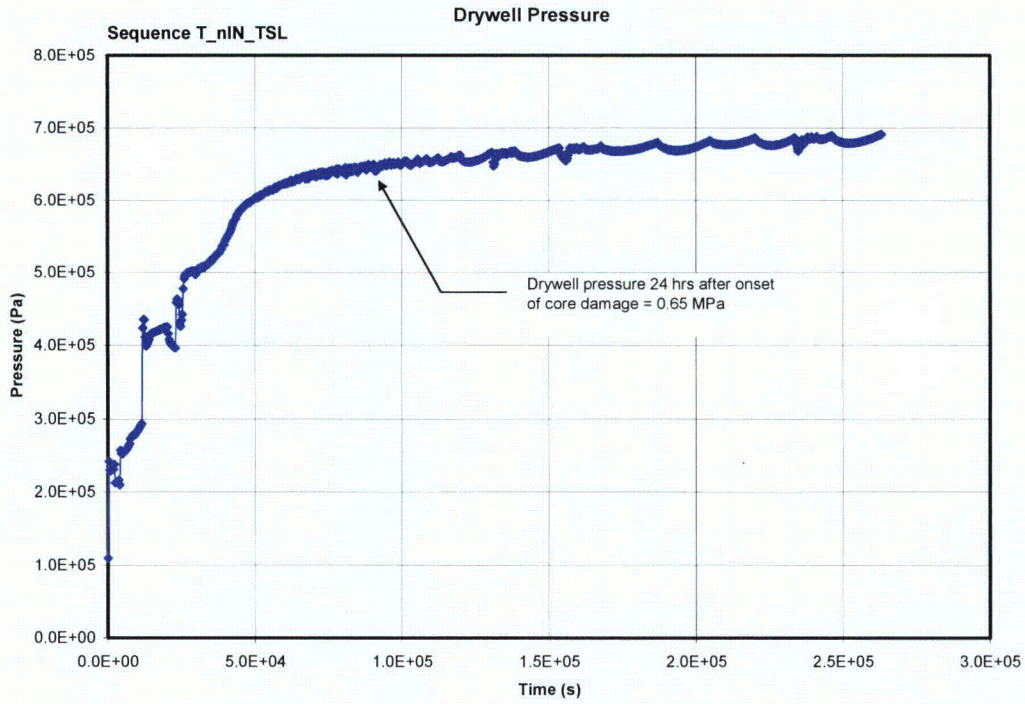

Figure 8.3-1b. T_nIN_TSL: Containment Pressure vs. Time

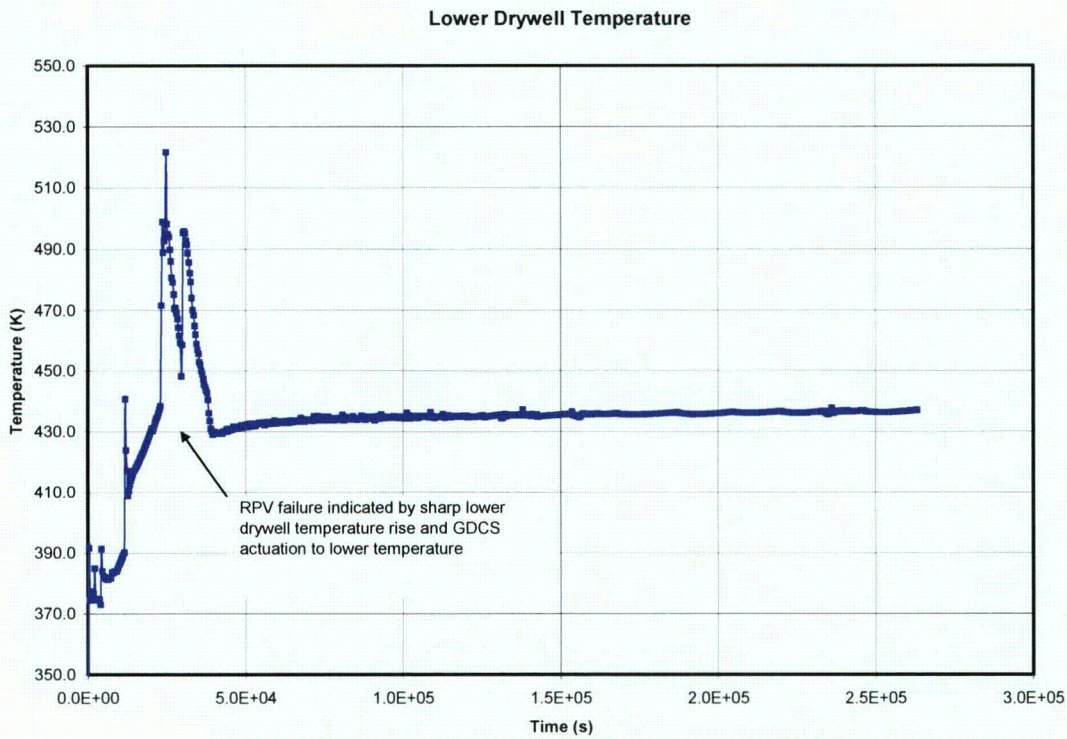

Figure 8.3-1c. T_nIN_TSL: Lower Drywell Temperature vs. Time

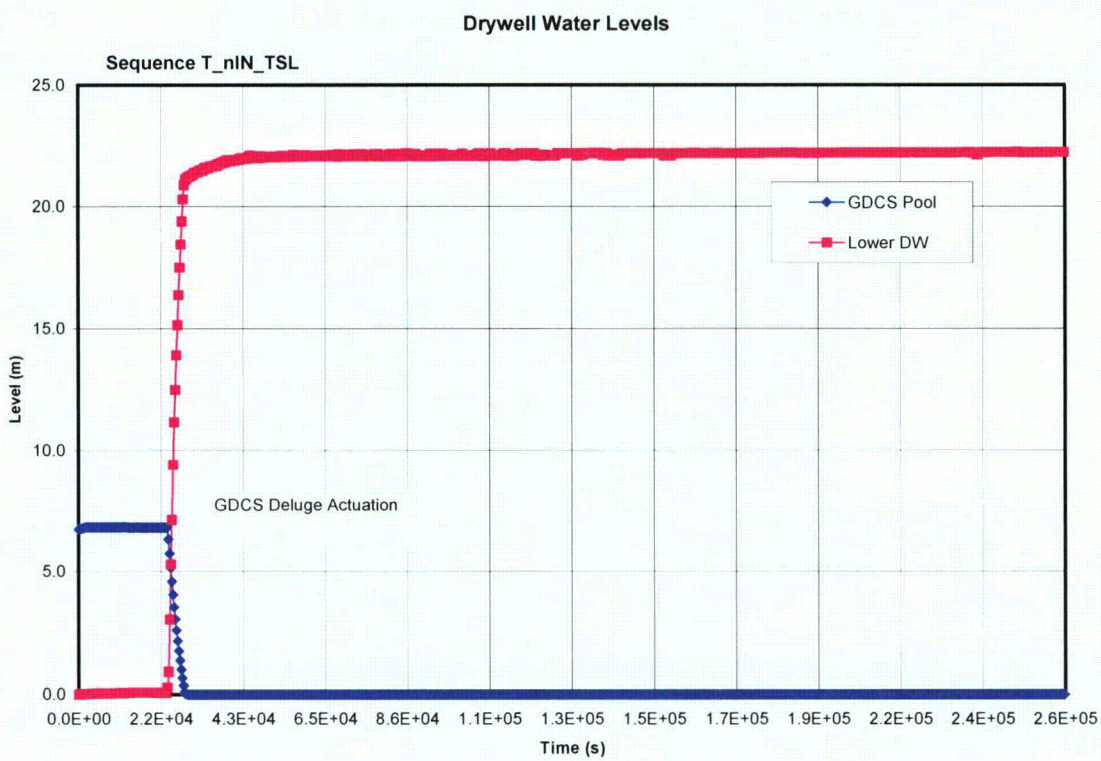

Figure 8.3-1d. T_nIN_TSL: Drywell Water Levels vs. Time

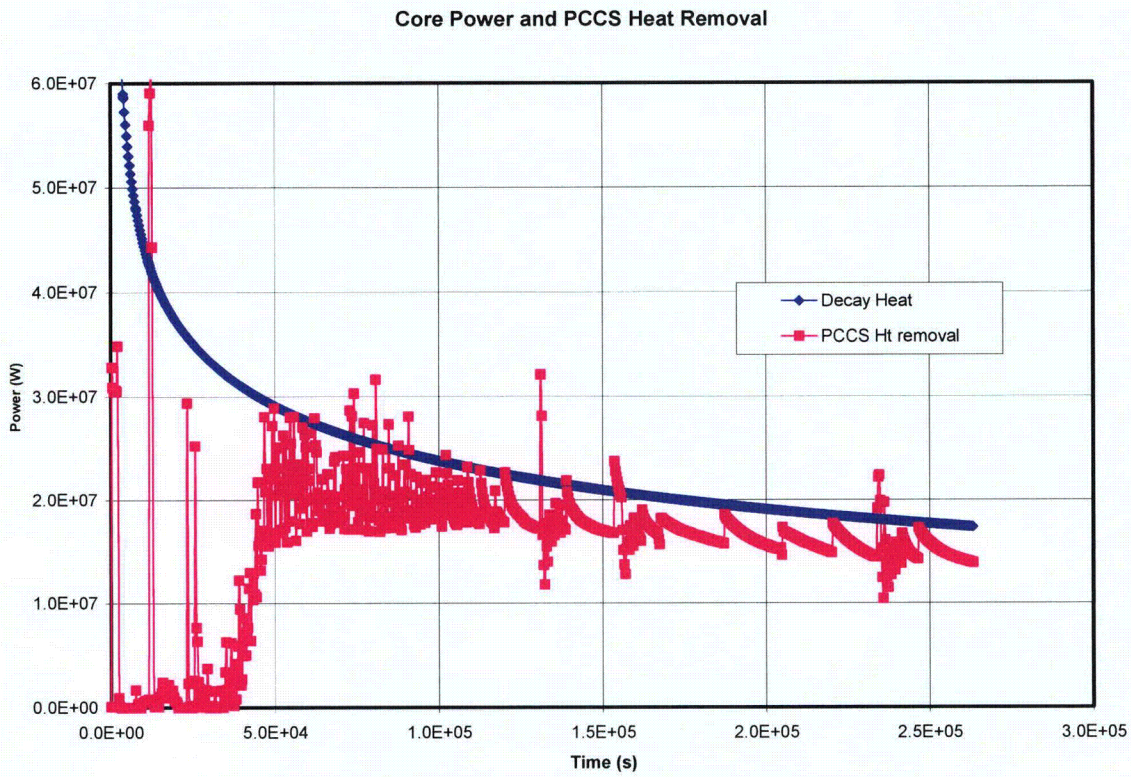

Figure 8.3-1e. T_nIN_TSL: Core Power and PCCS Heat Removal vs. Time

Figs 8.3-2a through d: T_nIN_nCHR_FR

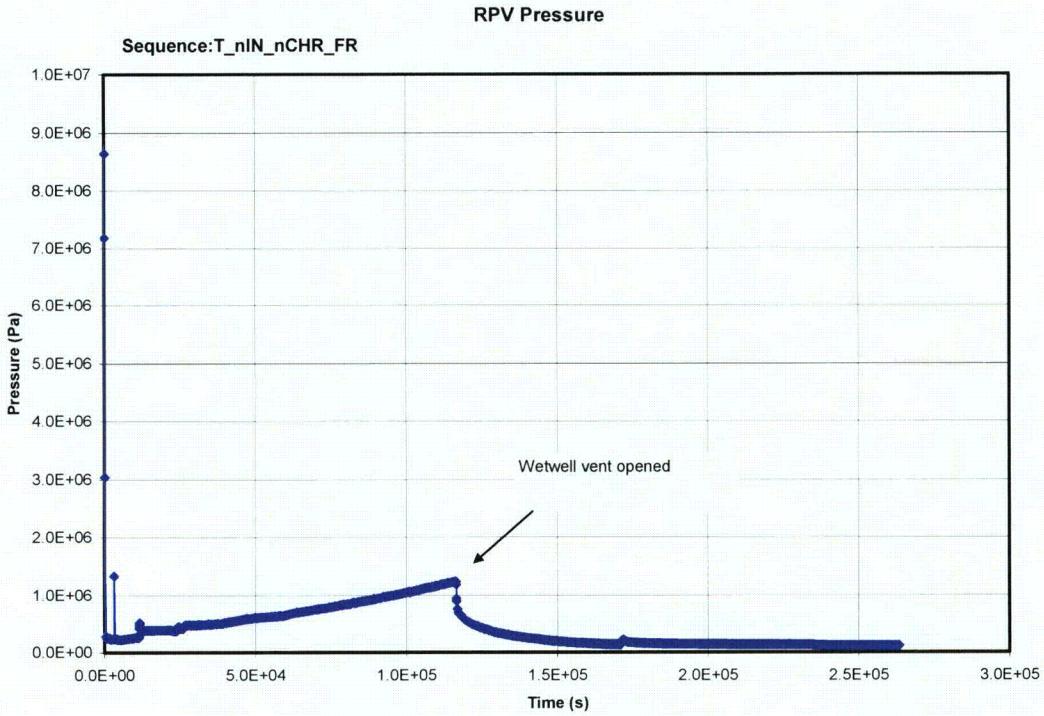

Figure 8.3-2a. T_nIN_nCHR_FR: RPV Pressure vs. Time

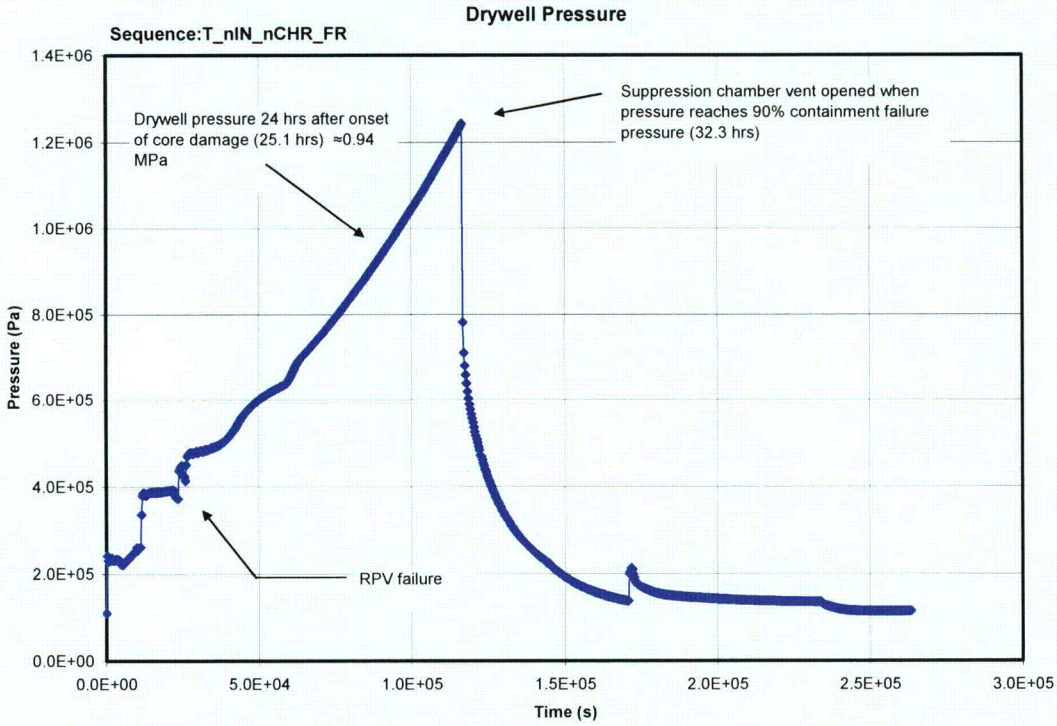

Figure 8.3-2b. T_nIN_nCHR_FR: Containment Pressure vs. Time

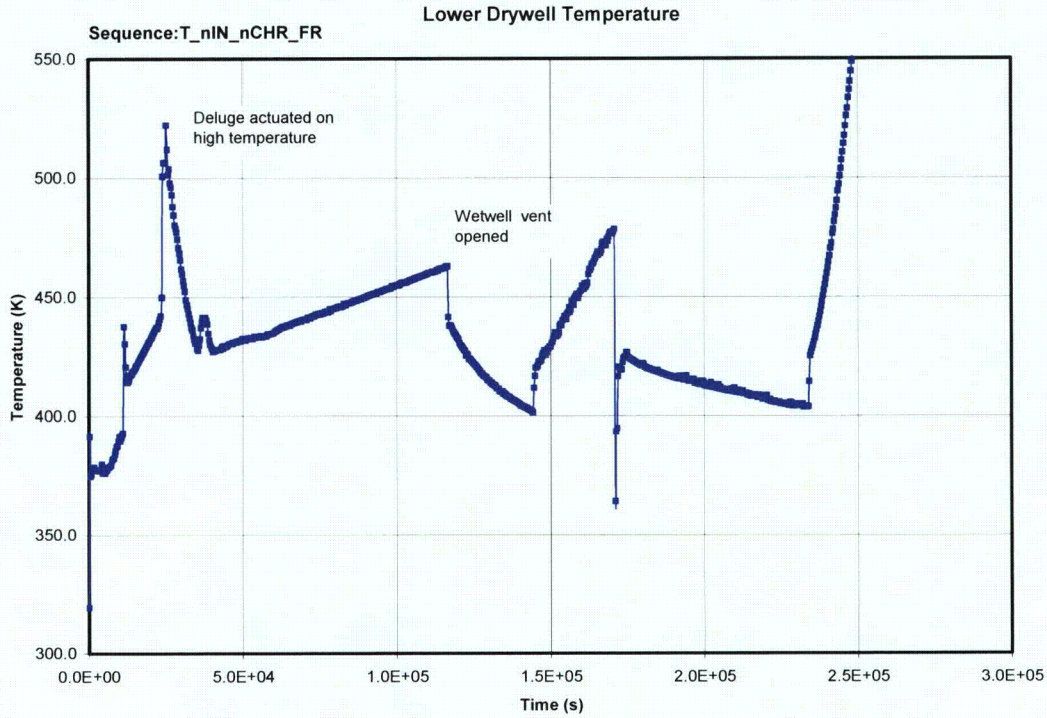

Figure 8.3-2c. T_nIN_nCHR_FR: Lower Drywell Temperature vs. Time

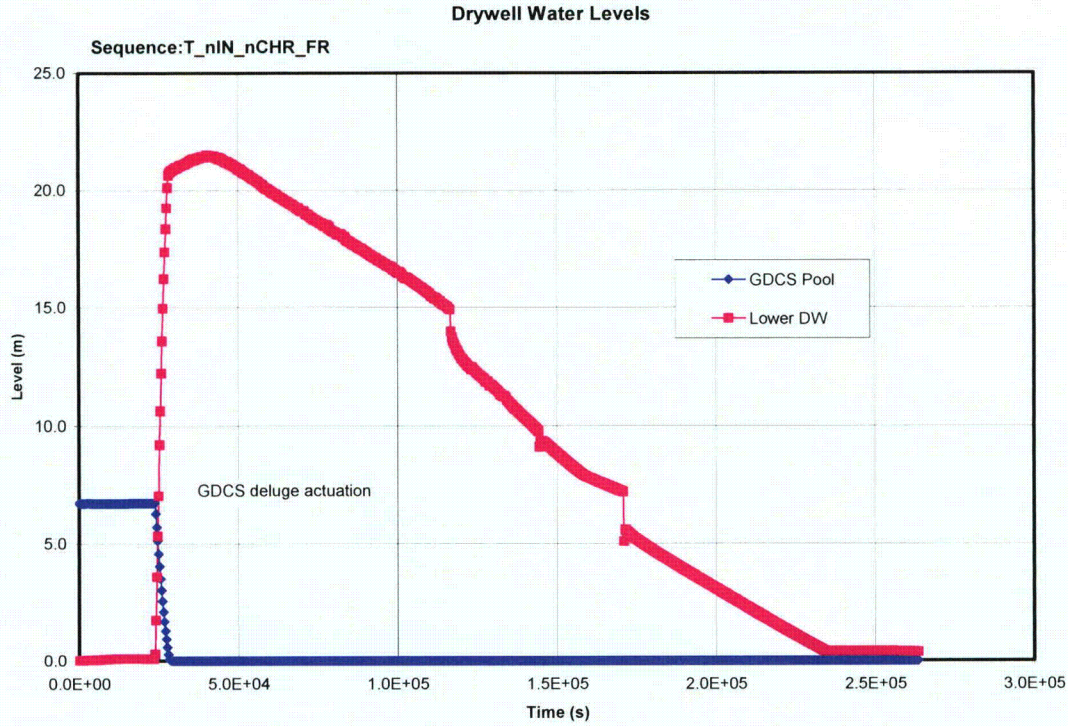

Figure 8.3-2d. T_nIN_nCHR_FR: Drywell Water Levels vs. Time

Figs 8.3-3a through c: MLi_nCHR

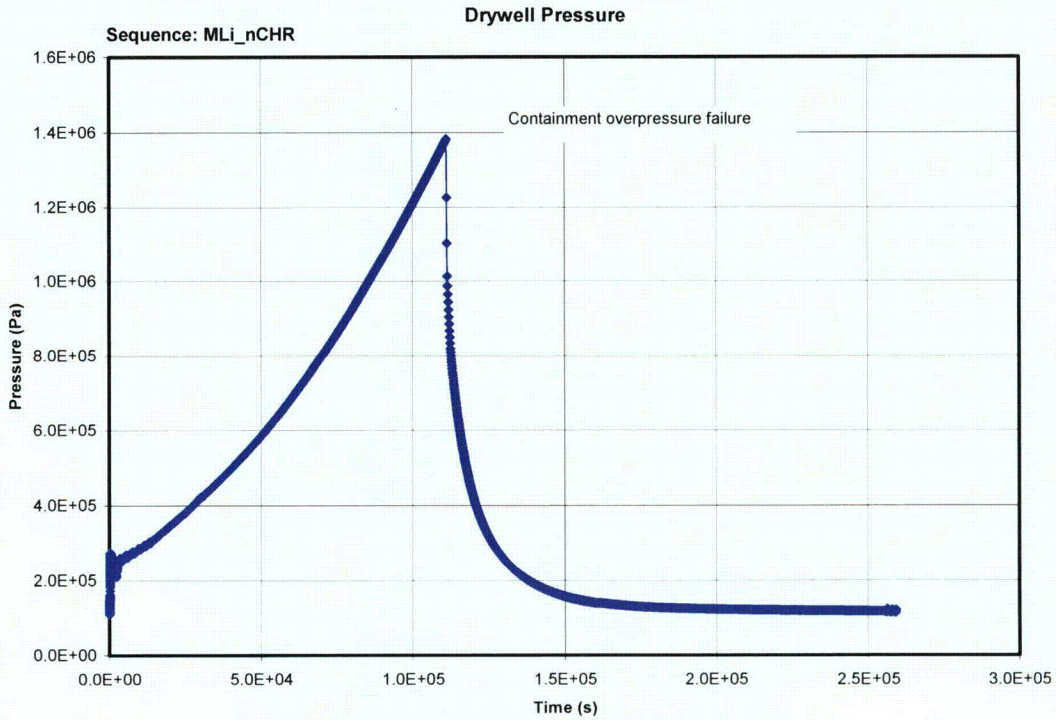

Figure 8.3-3a. MLi_nCHR: Containment Pressure vs. Time

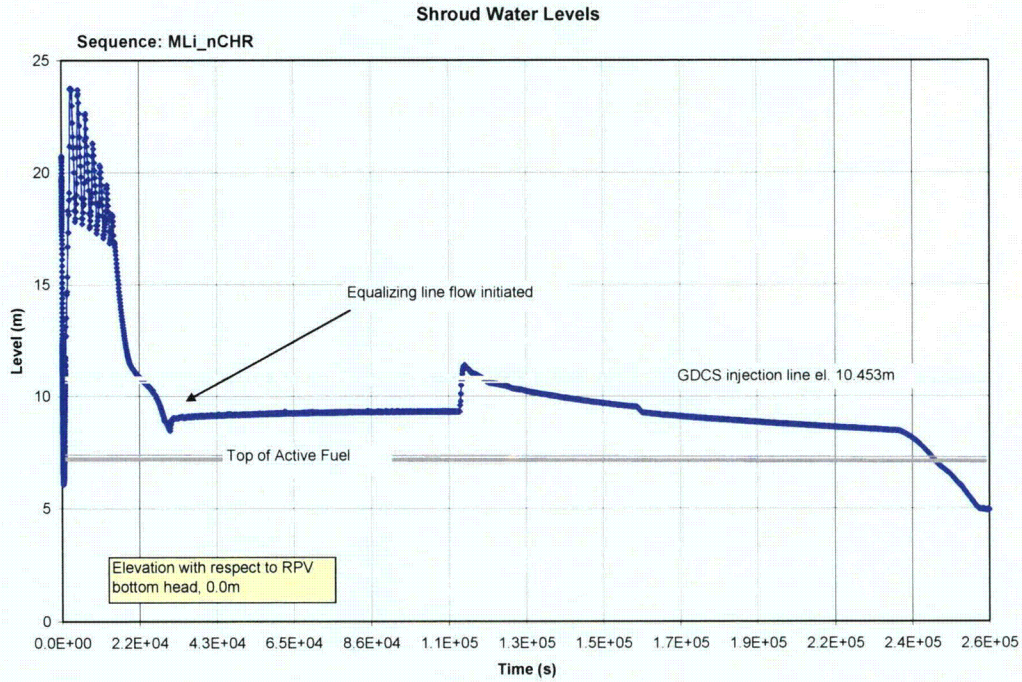

Figure 8.3-3b. MLi_nCHR: Shroud Water Level vs. Time

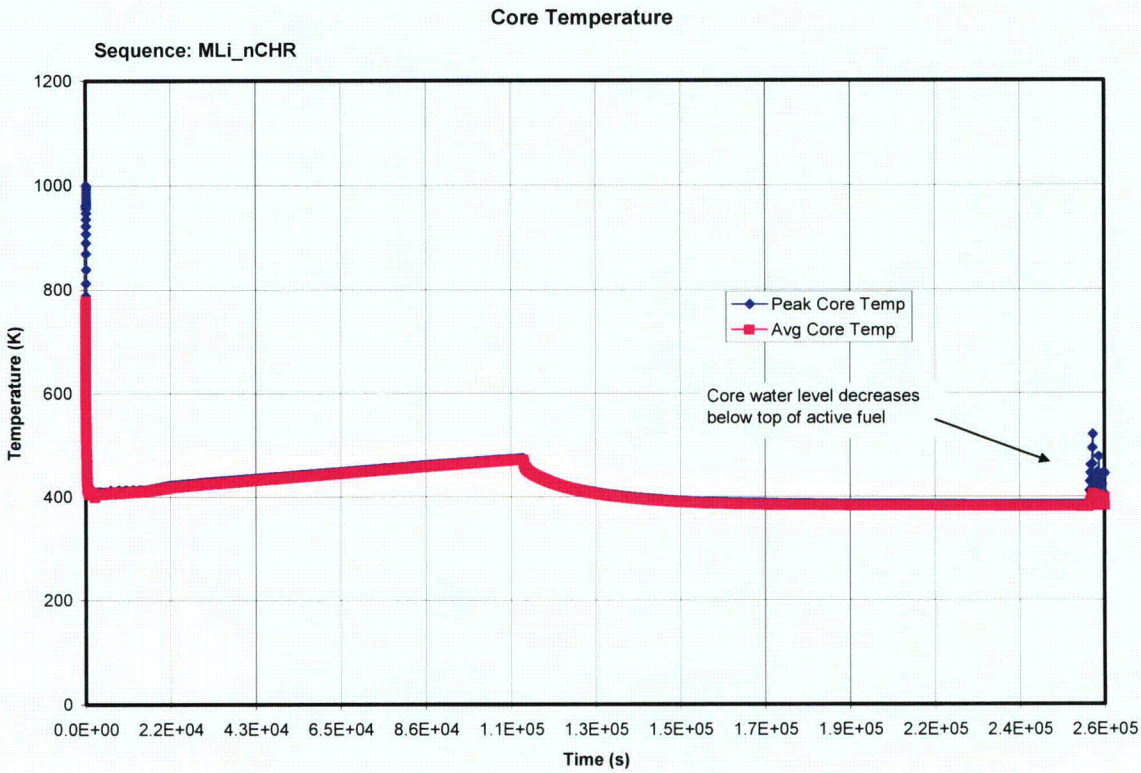

Figure 8.3-3c. MLi_nCHR: Core Heatup vs. Time

Figs 8.3-4a through b: T_nDP_nIN_TSL

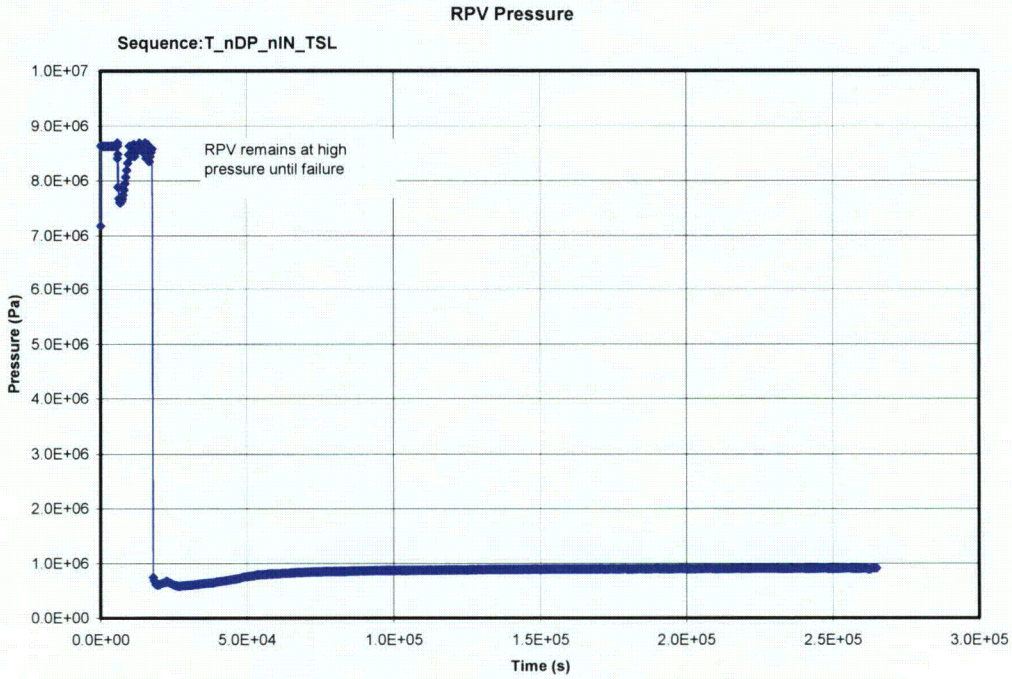

Figure 8.3-4a. T_nDP_nIN_TSL: RPV Pressure vs. Time

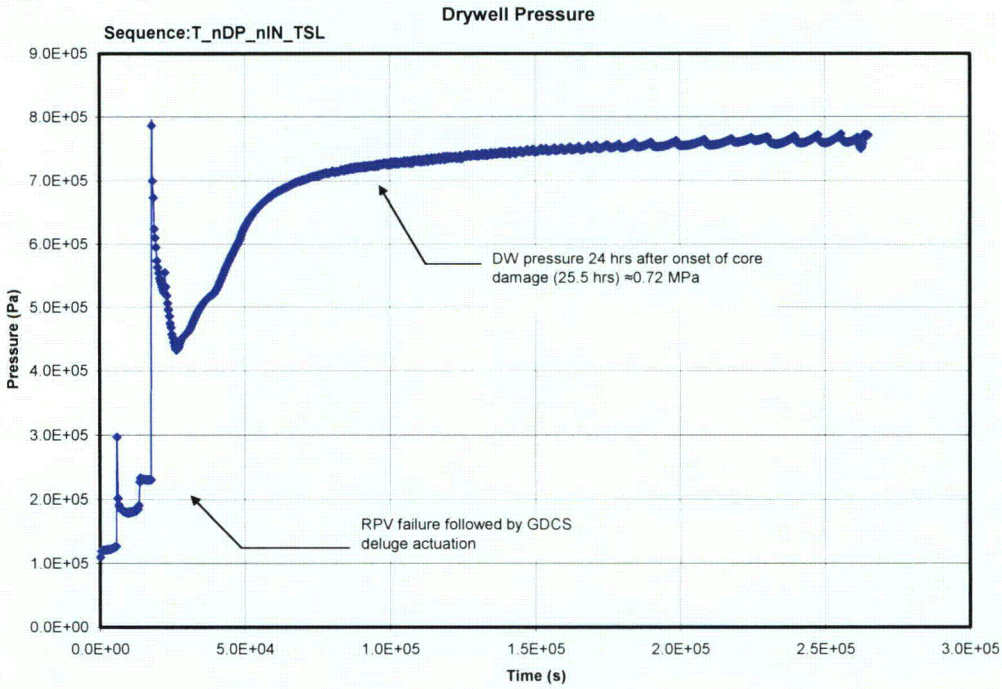

Figure 8.3-4b. T_nDP_nIN_TSL: Containment Pressure vs. Time

Figs 8.3-5a through b: T_nDP_nIN_nCHR_FR

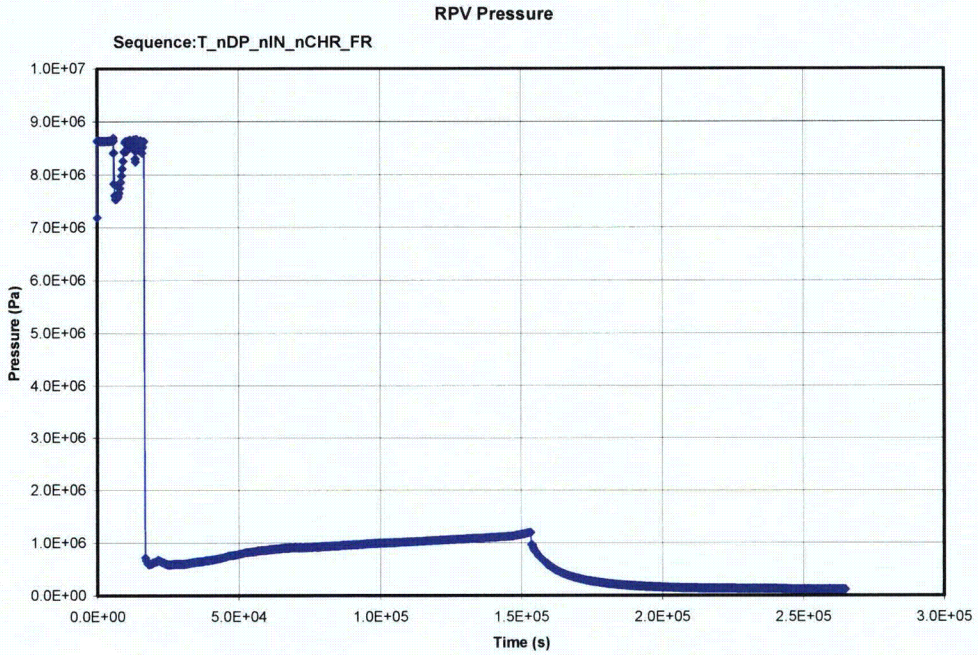

Figure 8.3-5a. T_nDP_nIN_nCHR_FR: RPV Pressure vs. Time

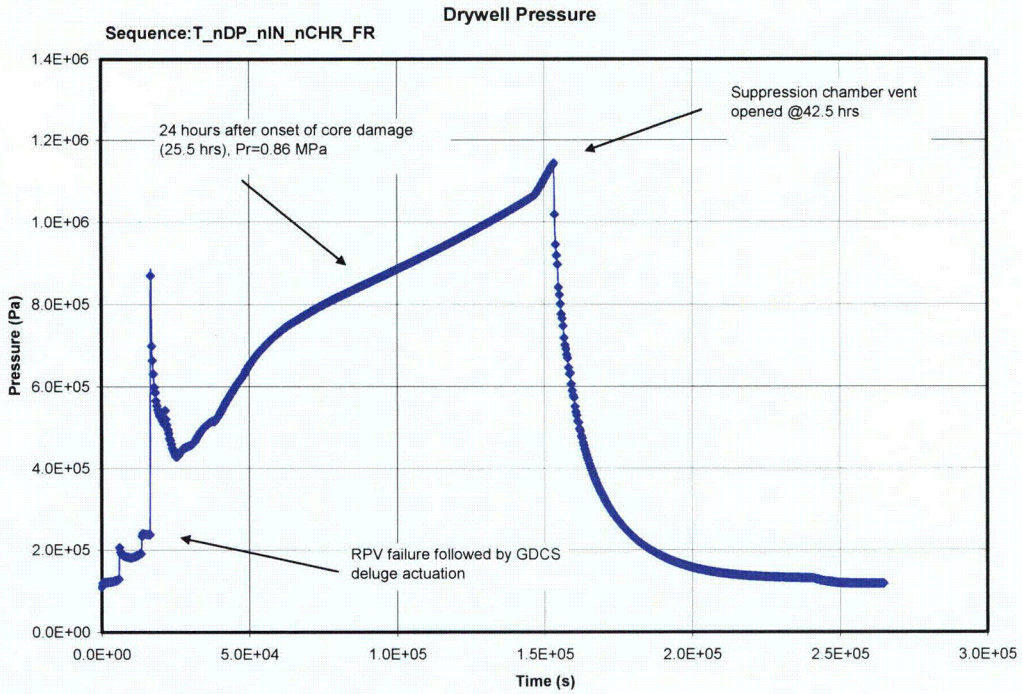

Figure 8.3-5b. T_nDP_nIN_nCHR_FR: Containment Pressure vs. Time

Figs 8.3-6a through c: Sequence T-AT_nIN_TSL

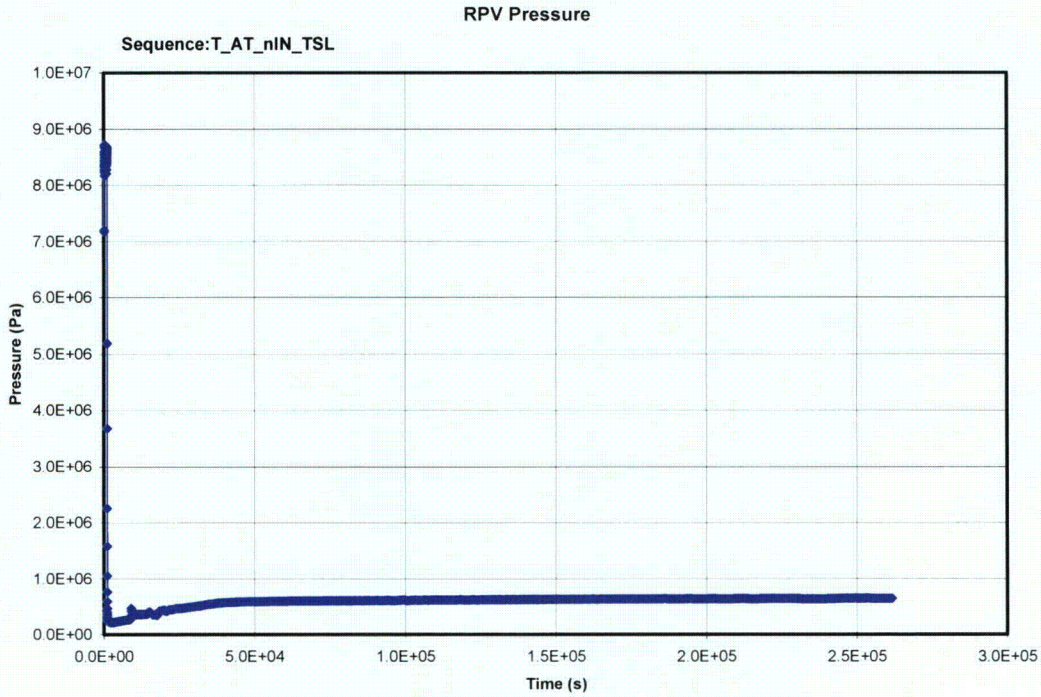

Figure 8.3-6a. T-AT_nIN_TSL: RPV Pressure vs. Time

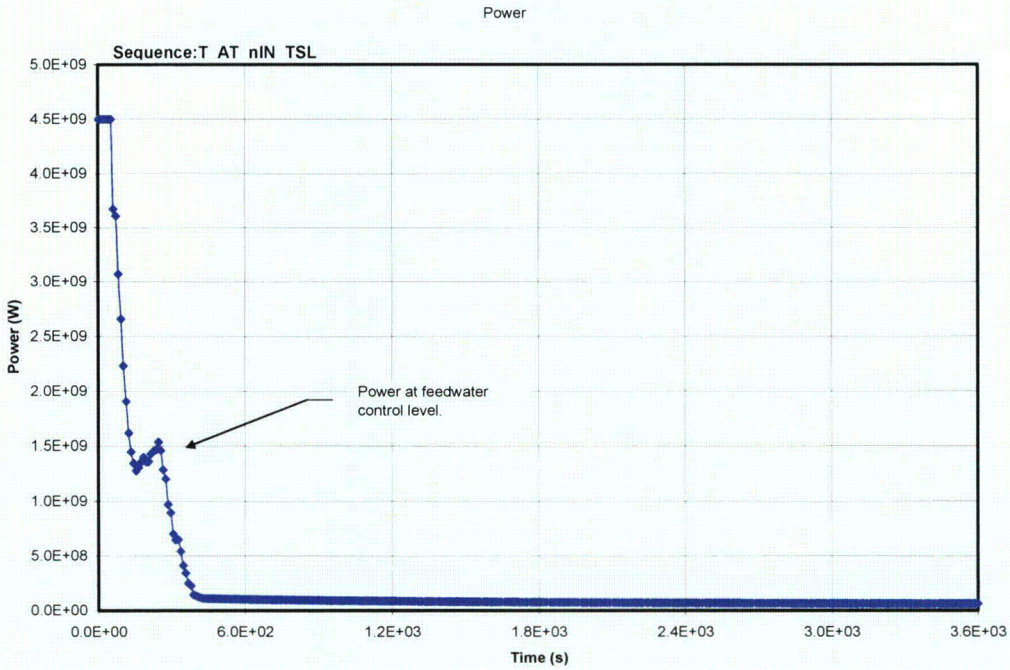

Figure 8.3-6b. T-AT_nIN_TSL: Core Power vs. Time

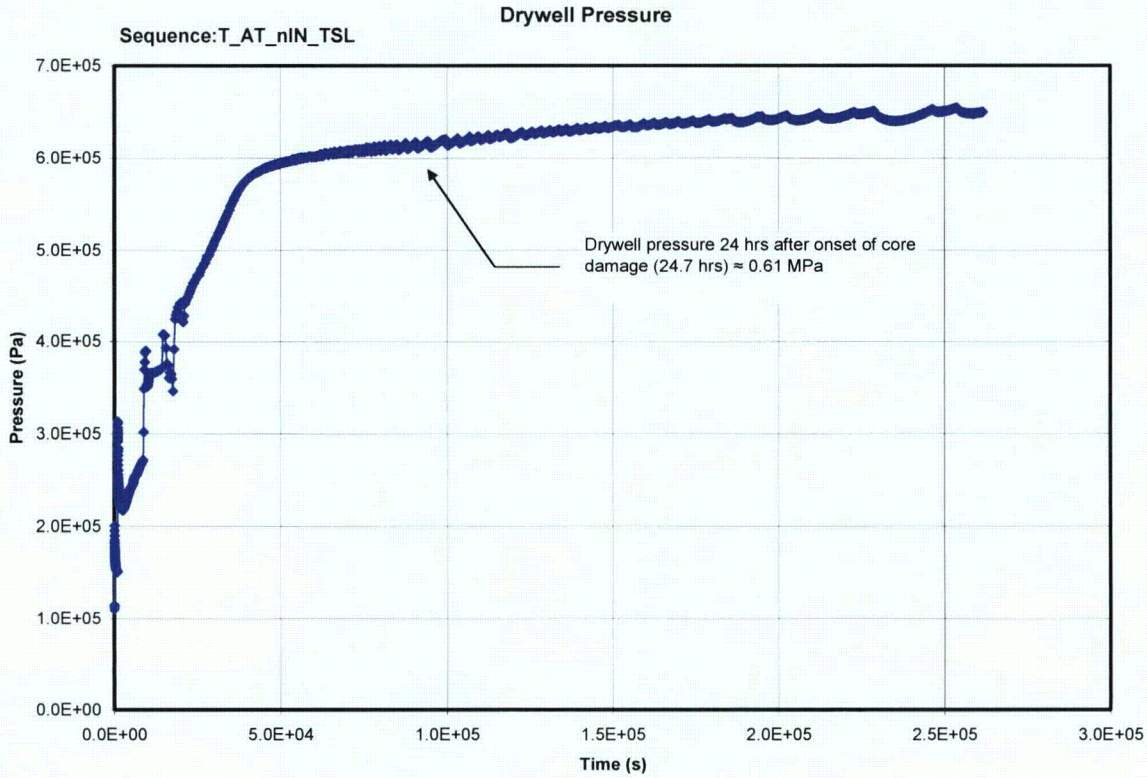

Figure 8.3-6c. T-AT_nIN_TSL: Containment Pressure vs. Time

Fig 8.3-7a: Sequence T-AT_nIN_nCHR_FR

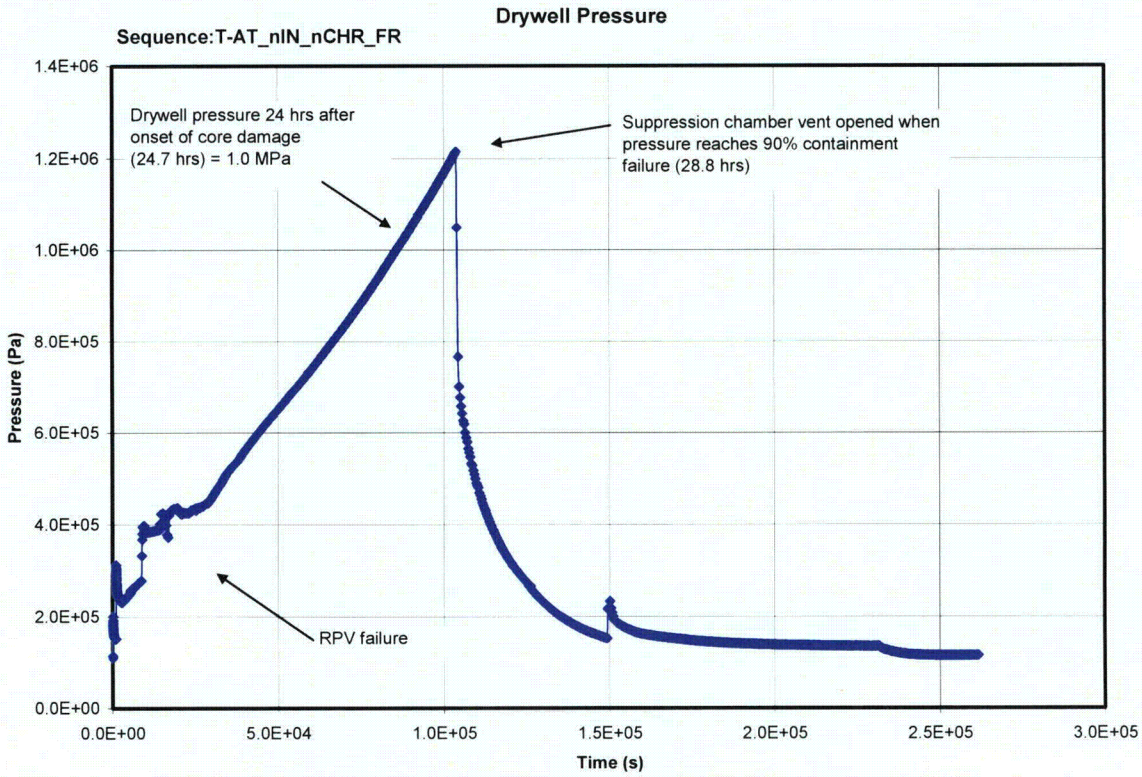

Figure 8.3-7a. T-AT_nIN_nCHR_FR: Containment Pressure vs. Time

8.4 SUMMARY

In this section, the potential for containment failure due to combustible gas generation, containment bypass and overpressurization was evaluated. Because of the ESBWR design and reliability of containment systems, the most likely containment response to a severe accident is associated with successful containment isolation, vapor suppression and containment heat removal. As a result, the containment provides a highly reliable barrier to the release of fission products after a severe accident, with the dominant release category being that defined by Technical Specification leakage (TSL). This conclusion is based on the following insights:

- The combustible gas generation analysis indicated that a combustible gas mixture within containment would not occur within 24 hours after the occurrence of a severe accident. Thus, containment failure by this mechanism is not considered further.
- Containment bypass (BYP) which results in a direct path between the containment atmosphere and environment was evaluated. A containment penetration screening evaluation indicated that there were no penetrations that required isolation to prevent significant offsite consequences. Thus, the probability of the bypass failure mode is dominated by a common isolation signal failure probability, resulting in a calculated frequency of containment bypass about four orders of magnitude lower than the TSL release category.
- Containment overpressurization was evaluated in terms of early and late loss of containment heat removal as well as the loss of the vapor suppression function. Overpressure failure was found to be about three orders of magnitude less likely than the TSL release category after a severe accident, specifically
  - The frequency of loss of containment heat removal in the first 24 hours after accident initiation, release category OPW1, was evaluated to be more than four orders of magnitude lower than the TSL release category.
  - The frequency of loss of containment heat removal in the period between 24 and 72 hours after accident initiation, release category OPW2, was evaluated to be about three orders of magnitude lower than the TSL release category.
  - The frequency of vacuum breaker failure, which would result in the shortest time to containment overpressurization because of the loss of the vapor suppression function, release category OPVB, was evaluated to be more than four orders of magnitude lower than the TSL release category.
- The need for controlled filtered venting, release category FR, in the 24 hour period after onset of core damage was evaluated. The evaluation considered loss of containment heat removal for the spectrum of applicable accident classes. In each representative sequence, operator controlled venting could be implemented to control the containment pressure boundary and potential leak path. However, venting was found not to be necessary to prevent containment failure within 24 hours after onset of core damage for scenarios in which containment heat removal is lost.

Consistent with advanced light water reactor goals established by the NRC, reliability and phenomenological analyses have established that the ESBWR containment maintains its integrity

for a 24-hour period after the onset of core damage in a severe accident. An additional insight regarding the ESBWR containment capability can be gained by calculating the "containment effectiveness". The containment effectiveness was calculated as 0.97, which exceeds guidelines provided in Reference 8.0-1 regarding the "conditional containment failure probability".

The release categories and frequencies discussed above will be retained for use in a conservative evaluation of potential source terms, as discussed in Section 9.

8.5 REFERENCES

8.0-1 SECY-93-087, "Policy, Technical and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs", April 2, 1993.

8.1-1 NUREG-0800, "Standard Review Plan", Section 6.2.5, "Combustible Gas Control in Containment".

8.1-2 Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident".

8.3-1 "MAAP4 Modular Accident Analysis Program for LWR Power Plants," Transmittal Document for MAAP4 Code Revision MAAP 4.0.6, Rev. 0, Report Number FAI/05-47, prepared for Electric Power Research Institute, 05/05/05.

8.3-2 "ABWR Design Control Document, Tier 2" Section 19.2.

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A.8 QUANTIFICATION OF CONTAINMENT EVENT TREES

The purpose of this appendix is to present the quantification of the containment event trees. The results are used to determine the conditional containment failure probability and to calculate the frequencies of the various release categories used in the Level 3 PRA.

The Containment Phenomenological Event Tree (CPET) structure is described in Section 21.1 and the Containment Systems Event Tree (CSET) structure is described in Section 8.2. This structure was appended to the Level 1 full power, internal events cutsets to determine the frequencies of the end states shown on the CPETs and CSETs. In this manner, the total CDF is mapped into appropriate Level 2 end states.

A.8.1 BINNING OF LEVEL 1 RESULTS

In order to determine the values to use on the CPET and CSET branches, the Level 1 cutsets are sorted into subclasses based on accident class and availability of offsite power. These were used to determine the conditional failure probabilities for the systems on the CSETs. The Class I and Class IV subclasses were further divided into bins that specify the water level in the containment at the time of vessel breach. These bins are used to determine the fraction of sequences that are susceptible to steam explosions in the CPET.

Table A.8-1 shows the subclass and bin assignment of the sequences above the Level 1 truncation value.

- Class I

  In these cases, core damage occurs when the RPV is at low pressure. All of these sequences remain at low pressure in the RPV through the time of vessel breach.

  The key information needed for the CPET is the water level in the lower drywell at the time of vessel breach. If the water is above 1.5 m, failure of the pedestal due to steam explosion cannot be excluded, and therefore is conservatively assumed to occur. If the water level is between 0.7 m and 1.5 m, there is the possibility of a steam explosion but failure of the pedestal is physically unreasonable. Water level below 0.7 m does not allow a steam explosion impulse of a magnitude that will challenge the containment structure. The criteria for determining the water level are presented in Section 7.2.5.

  The key information needed for quantification of the CSET is the availability of offsite power. This is needed because the logic flag settings are different in some of the CSET nodes depending on whether the initiating event is a loss of preferred power.

  The following subclasses are defined for quantification:

  - Subclass IN Vessel failure occurs at low pressure (<1 MPa)
    Initiating event does not involve Loss of Preferred Power
  - Subclass IL Vessel failure occurs at low pressure (<1 MPa)
    Initiating event involves Loss of Preferred Power

  The water level is not presented as a separate subclass, but is treated as a split fraction on the CPET.

- Class II

  There are no sequences that are binned to this accident class.

- Class III

  In these cases, core damage occurs when the RPV is at high pressure. Any of these sequences that are initiated by an inadvertent open relief valve (IORV) are grouped with the Class I sequences. The rest of the sequences are assumed to remain with high pressure in the RPV through the time of vessel breach.

  No additional information is needed for the CPET quantification.

  The key information needed for quantification of the CSET is the availability of offsite power. This is needed because the logic flag settings are different in some of the CSET nodes depending on whether the initiating event is a loss of preferred power.

  The following subclasses are defined for quantification:

  - Subclass IIINVessel failure occurs at high pressure (>1 MPa)
    Initiating event does not involve Loss of Preferred Power
  - Subclass IIIL Vessel failure occurs at high pressure (>1 MPa)
    Initiating event involves Loss of Preferred Power

- Class IV

  In these cases, core damage sequences are initiated by a failure to reduce reactivity in the core. By the time that the core uncovers, however, the power is essentially shut down due to lack of moderator. The principle difference between these sequences and the Class I or III is the amount of energy transferred to the containment prior to vessel breach. The excess energy is not enough to change the key physics involved in containment failure, so the class can be treated just like the previously defined classes. In the ESBWR Level 1, all Class IV sequences above the truncation limit have depressurization available throughout the sequences, so the core damage is assumed to occur when the RPV is at low pressure. All of these sequences remain at low pressure in the RPV through the time of vessel breach. Therefore, the Class IV sequences use the same quantification model as the Class I.

  Class IV is retained separately because the timing of key events is somewhat faster than the Class I events.

- Class V

  These are cases where core damage occurs with the RPV open to the environment. No containment event trees are needed. All of these sequences are assigned to the release category of BOC.

A.8.2 ASSIGNMENT OF NODE PROBABILITIES FOR CPETS AND CSETS

Each of the CPET and CSET pairs for the subclasses are solved by assigning an initiator value based on the sum of the Level 1 sequences that make up the subclass, followed by nodal probabilities for the various branches. The probabilities assigned to the branches are based on criteria and models that are described later in this section. The event trees are then quantified by

multiplying the node probabilities (or the complement on the success branches) for each sequence.

The following CPET/CSET nodes are independent of the Level 1 sequences:

- BI_FN Debris is Successfully Cooled
- BI_SP GDCS Deluge Supply to BiMAC Successful
- CIS Containment Isolation System
- DCH Containment Intact / Insignificant DCH
- EVE_DAM Pedestal Intact
- RCB_I Reactor Coolant Boundary Intact
- VT Vent Operation

These nodes are assigned the same value in all sub-classes. The nodes themselves are described in either Section 8 or Section 21. The probabilities used for the CPET / CSET nodes are summarized in Table A.8-2.

The event trees in different subclasses may have different probabilities assigned to the other nodes because of dependences with the Level 1 sequences. These nodes are:

- LD_LVL Water Level Prior to RPV Failure
- VB Vapor Suppression Function
- W1 Containment Heat Removal (Short Term: <24 Hours)
- W2 Containment Heat Removal (Long Term: <24 Hours)

Conditional probabilities for the node LD_LVL were calculated by identifying the sequences that contribute to the particular water level bin. The node probability is assigned according to the fraction of the total subclass frequency that results in the given water level condition.

Conditional probabilities for the failure branches of CSET nodes VB, W1, and W2 were calculated by developing fault trees for these nodes, converting the subclass cutsets into fault trees, linking these fault trees using simple event trees, and quantifying these event trees using the cutset methodology. Conditional probabilities were then calculated based on the sequence quantification results of the simple event trees.

The system fault trees were generated by extracting the appropriate gates from the Master CAFTA file of the Level 1 Internal Events PRA. This way, all support systems are accounted for, consistently with the Level 1 model. The top gates of the systems modeled are:

VB	EQU GT10-0001-_1	
W1	AND GT15TOP	GG21-0001-_6
W2	AND GT15-0033-_1	GG21-0001-_6

Where:

GT10-0001-_1: Isolation of Vacuum Breaker Leaks Fails

GT15TOP: 3/6 PCCS Fail

GG21-0001-_6: Both FAPCS Trains Fail SPC Op. Mode Actuation After ADS

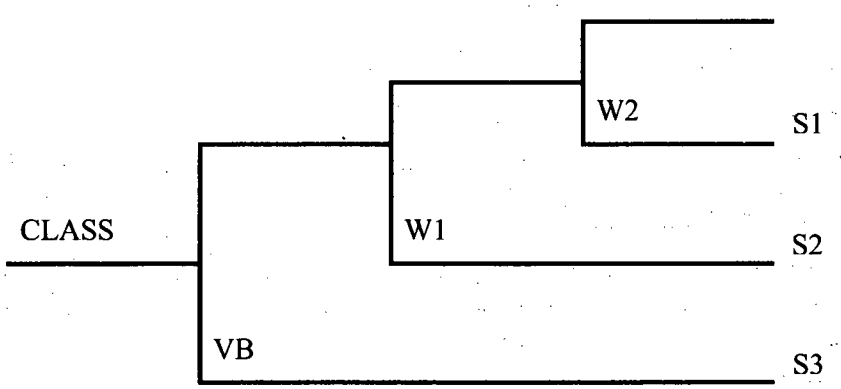
GT15-0033-_1: Loss of Pool Water (72 hours)

These fault trees are shown in Section 4.

The Level 1 accident classes were divided into subclasses (as described in A.8-1) to match the system behavior modeled by the system fault trees. Each accident class was divided in two subclasses, one resulting from the Loss of Preferred Power initiating event, and the other one resulting from any other initiating event. Table A.8-1 shows the mapping of the Level 1 Internal Events accident sequences to the accident subclasses.

Accident sequences that result in containment failure in the in the CPETs are containment bypass sequences. Therefore, dependency of the CSET nodes on these sequences does not need to be considered, and they were not included in the CDF subclasses for Level 2 CSETs. Table A.8-1 identifies which sequences are in this category.

The typical structure of the simplified event trees used for determining conditional probabilities for the system nodes is:



The conditional probabilities for failure branches were calculated as follows:

$P(VB) = P(S3) / P(CLASS)$

$P(W1) = P(S2) / \{P(CLASS) * [1 - P(VB)]\}$

$P(W2) = P(S1) / \{P(CLASS) * [1 - P(VB)] * [1 - P(W1)]\}$

where:

P(VB), P(W1), and P(W2) are the conditional probabilities of branches VB, W1, and W2

P(S1), P(S2), AND P(S3) are the sequence probabilities for quantified using the cutset method

P(CLASS) is the probability of the accident subclass obtained by binning the Level 1 accident sequences into subclasses

The probabilities used for the CPET / CSET nodes are summarized in Table A.8-2. The following subsections provide the basis for these probabilities.

A.8.2.1 Debris is Successfully Cooled (BI_FN)

This node is only asked following successful operation of the deluge system. Section 21 identifies the failure of this function as physically unreasonable given successful operation of deluge. This would imply a node probability of less than 10^{-3} for BI_FN, but because the design optimization of the BiMAC has not been completed, the ESBWR PRA assigns a conservative value of 10^{-2} to this node. This value is considered conservative based on the analysis in Section 21.5 and the possibility that the core would be sufficiently spread on the drywell floor to be cooled solely by the overlying pool of water from the deluge system.

A.8.2.2 GDCS Deluge Supply to BiMAC Successful (BI_SP)

Section 21.5 provides the design requirement that the failure rate of the GDCS deluge system (at high confidence) is not to exceed 10^{-3} per demand. It is assumed that the system will be sufficiently independent from any core damage prevention systems to maintain this level of reliability. Therefore the value of 1.0×10^{-3} is assigned to this node for all subclasses.

A.8.2.3 Containment Isolation System (CIS)

Section 8.1 provides a screening of potential containment penetrations that may need to be isolated in a severe accident. No penetrations were identified that would meet this requirement. There are, however, several small (1" diameter or less) pipe penetrations that have not been specified in sufficient detail in the design to completely exclude from the calculation. It is also possible that screened penetrations could be open for a small fraction of the operating time. To account for these, the CIS node is included in the CSET to represent the common mode isolation failures of these lines. A value of 3.5×10^{-5} was selected to represent isolation failure.

A.8.2.4 Containment Intact / Insignificant DCH (DCH_DAM)

Section 21.3 provides the justification for the failure of this function being physically unreasonable. Therefore the conservative value of 10^{-3} is assigned for all subclasses.

A.8.2.5 Pedestal Intact (EVE_DAM)

Section 21.4 provides the justification for the failure of this function being physically unreasonable in cases where the LDW water level is less than 1.5 m but greater than 0.7 m prior to vessel breach. This function is only asked on sequences with this water level, therefore the conservative value of 10^{-3} is assigned for all subclasses.

A.8.2.6 Water Level Prior to RPV Failure (LD_LVL)

The split fractions for this node are assigned using the same method described in Section 7.2.5. In the CPET quantification, the method is refined to consider the split fractions at the subclass level. Table A.8-1 identifies which Class I and IV sequences have high or low water level in the LDW at the time of RPV breach.

Because there were no cutsets that fell into the medium water level, some of the frequency from the low water case was conservatively moved into the medium branch. This would account for

uncertainties associated with truncation level (It is possible that a lower truncation level would allow discovery of a greater fraction of medium LDW water level sequences). It was assumed that 0.1% of the Class I and Class IV sequences would be in the medium LDW water level bin. The split fractions are for LD_LVL shown in Table A.8-2.

A.8.2.7 Reactor Coolant Boundary Intact (RCB_I)

This branch was not used in the CPET quantification. It was identified in Section 21.2 as a "splinter", which means that it is uncertain which path would be followed in any given sequence and a meaningful probability cannot be assigned to the branch. These are treated by solving both paths independently and taking the maximum of the results. In the ESBWR, the path leading to an intact Reactor Coolant Pressure Boundary is more conservative and therefore included in the results.

A.8.2.8 Vapor Suppression Function (VB)

This node was calculated using the method described at the beginning of this section. The values for the various sub-classes are contained in Table A.8-2.

A.8.2.9 Vent Operation (VT)

Vent operation is modeled using the operator action for venting containment: T11-SYS-FF-OPEN. It is assumed that the vent can be operated (manually) independently of any Level 1 mitigation systems.

A.8.2.10 Containment Heat Removal (W1, Short Term: <24 Hours)

This node was calculated using the method described at the beginning of this section. The values for the various sub-classes are contained in Table A.8-2.

A.8.2.11 Containment Heat Removal (W2, Long Term: <24 Hours)

This node was calculated using the method described at the beginning of this section. The values for the various sub-classes are contained in Table A.8-2.

A.8.3 QUANTIFICATION OF CPETS AND CSETS

The node probabilities were assigned to the CSET and CPET branches. If a node was assigned a 0.0 probability, the sequence was truncated for that subclass and not developed further. Figures A.8-1 through A.8-6 show these trees with the assigned node probabilities and the calculated end state values.

For each similar end state, the values from each of the sub-classes were summed to determine the probability of that end state. Table A.8-3 provides these results.

Table A.8-1

Level 1 Sequence Bin Assignments

Sequence	Initiating Event	CDF	Level 1 Class	L2 Subclass	LDW Water Level Bin
T-LOPP044	T-LOPP	1.63E-08	CDI	I L	Low
AT-T-LOPP011	AT-T-LOPP	5.66E-12	CDI	I L	Low
T-FDW044	T-FDW	1.20E-08	CDI	I N	Low
T-IORV029	T-IORV	7.13E-11	CDIII	I N	Low
T-IORV014	T-IORV	2.13E-11	CDI	I N	Low
T-IORV028	T-IORV	1.15E-11	CDI	I N	Low
T-IORV015	T-IORV	1.07E-11	CDIII	I N	Low
AT-T-FDW011	AT-T-FDW	4.94E-12	CDI	I N	Low
AT-T-SW003	AT-T-SW	5.70E-13	CDI	I N	Low
LL-S-014	LL-S	2.16E-13	CDI	I N	Low
ML-L-014	ML-L	2.23E-10	CDI	I N	High
LL-S-FDWB013	LL-S-FDWB	2.36E-11	CDI	I N	High
ML-L-RWCU013	ML-L-RWCU	1.27E-12	CDI	I N	High
LL-S-FDWA013	LL-S-FDWA	1.03E-12	CDI	I N	High
SL-L-RWCU014	SL-L-RWCU	8.07E-13	CDI	I N	High
SL-L-015	SL-L	4.39E-13	CDI	I N	High
SL-L-RWCU027	SL-L-RWCU	2.64E-13	CDI	I N	High
SL-L-029	SL-L	1.06E-13	CDI	I N	High
T-LOPP049	T-LOPP	3.19E-10	CDIII	I I I L	
T-LOPP030	T-LOPP	8.72E-13	CDIII	I I I L	
T-GEN031	T-GEN	4.64E-12	CDIII	I I I N	
T-PCSB030	T-PCSB	2.07E-12	CDIII	I I I N	

Table A.8-1

Level 1 Sequence Bin Assignments

Sequence	Initiating Event	CDF	Level 1 Class	L2 Subclass	LDW Water Level Bin
T-PCS030	T-PCS	1.30E-12	CDIII	I I I N	
SL-S-029	SL-S	5.31E-13	CDIII	I I I N	
T-FDW049	T-FDW	2.26E-13	CDIII	I I I N	
ML-L-015	ML-L	1.21E-13	CDIII	I I I N	
SL-L-RWCU028	SL-L-RWCU	1.11E-13	CDIII	I I I N	
AT-T-LOPP012	AT-T-LOPP	4.07E-12	CDIV	I V L	Low
AT-T-LOPP013	AT-T-LOPP	1.37E-13	CDIV	I V L	Low
AT-T-GEN012	AT-T-GEN	1.19E-10	CDIV	I V N	Low
AT-T-PCS012	AT-T-PCS	3.31E-11	CDIV	I V N	Low
AT-T-FDW012	AT-T-FDW	8.47E-12	CDIV	I V N	Low
AT-T-GEN013	AT-T-GEN	5.49E-12	CDIV	I V N	Low
AT-T-IORV006	AT-T-IORV	4.07E-12	CDIV	I V N	Low
LL-S-016	LL-S	3.33E-12	CDIV	I V N	Low
AT-T-PCS015	AT-T-PCS	1.41E-12	CDIV	I V N	Low
AT-T-PCS013	AT-T-PCS	1.11E-12	CDIV	I V N	Low
AT-T-FDW013	AT-T-FDW	2.75E-13	CDIV	I V N	Low
AT-T-IORV007	AT-T-IORV	1.37E-13	CDIV	I V N	Low
SL-L-RWCU029	SL-L-RWCU	1.71E-12	CDIV	I V N	High
ML-L-017	ML-L	2.51E-13	CDIV	I V N	High
BOC-FDWB046	BOC-FDWB	2.04E-12	CDV	V	
BOC-FDWB041	BOC-FDWB	9.79E-13	CDV	V	
BOC-FDWB045	BOC-FDWB	5.29E-13	CDV	V	
BOC-FDWB042	BOC-FDWB	4.90E-13	CDV	V	

Table A.8-1

Level 1 Sequence Bin Assignments

Sequence	Initiating Event	CDF	Level 1 Class	L2 Subclass	LDW Water Level Bin
BOC-RWCU045	BOC-RWCU	2.33E-13	CDV	V	

Table A.8-2

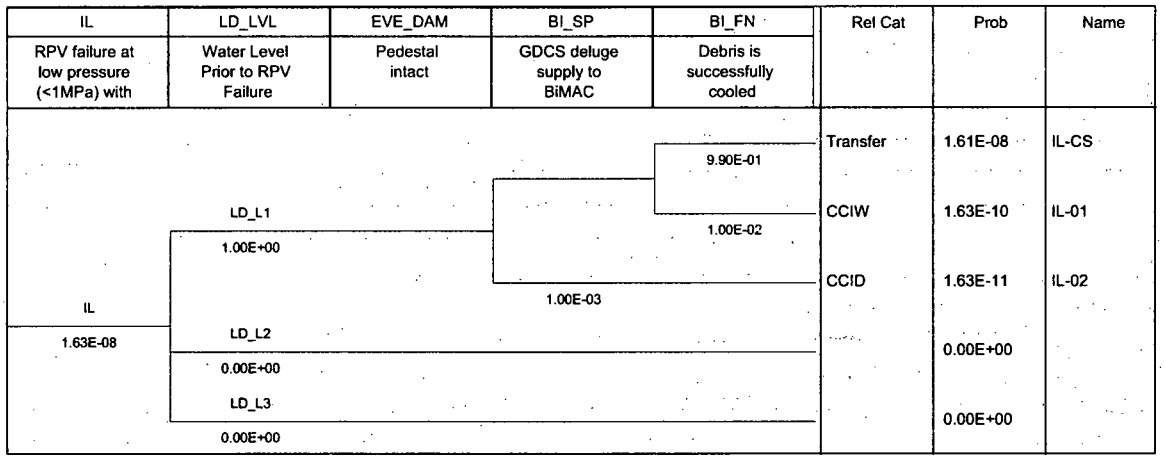
CPET and CSET Node Values

	IL	IN	IIIL	IIIN	IVL	IVN
LD_L1	1.0	9.77E-01			1.0	9.87E-01
LD_L2		2.3E-03				2.3E-03
LD_L3		2.02E-02				1.10E-02
EVE_DAM		1.0E-03				1.0E-03
DCH_DAM			1.0E-03	1.0E-03		
BI_SP	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
BI_FN	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02
CIS	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05
VB	5.48E-06	6.14E-06	3.00E-04	2.92E-04	5.32E-06	5.33E-06
W1	3.66E-05	7.97E-06	1.82E-04	1.77E-04	6.18E-06	5.76E-06
W2	4.12E-07	1.45E-05	7.60E-01	6.87E-01	8.98E-08	4.72E-08
VT	5.69E-02	5.69E-02	5.69E-02	5.69E-02	5.69E-02	5.69E-02

Table A.8-3

Level 2 End State Frequencies

	IL	IN	IIIL	IIIN	IVL	IVN	V	Totals
CCIW	1.63E-10	1.21E-10	3E-12	ε	ε	2E-12		2.89E-10
CCID	1.6E-11	1.2E-11	ε	ε	ε	ε		2.9E-11
EVE		ε				ε		<1E-12
EVE(CCIW*)		2.50E-10				2E-12		2.52E-10
DCH			ε	ε				<1E-12
TSL	1.62E-08	1.20E-08	7.6E-11	3E-12	4E-12	1.75E-10		2.84E-08
FR	1E-12	ε	2.26E-10	6E-12	ε	ε		2.33E-10
OPW2	ε	ε	1.4E-11	ε	ε	ε		1.4E-11
OPW1	ε	ε	ε	ε	ε	ε		<1E-12
OPVB	ε	ε	ε	ε	ε	ε		<1E-12
BYP	1E-12	ε	ε	ε	ε	ε		1E-12
BOC							4E-12	4E-12



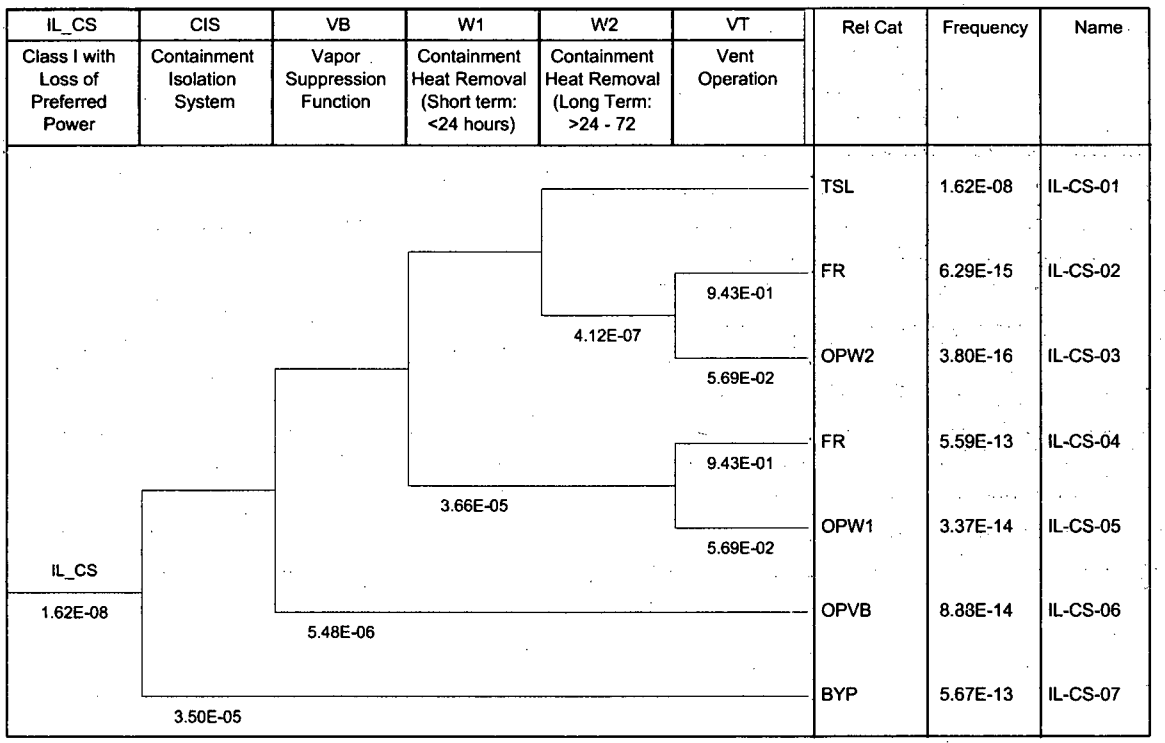
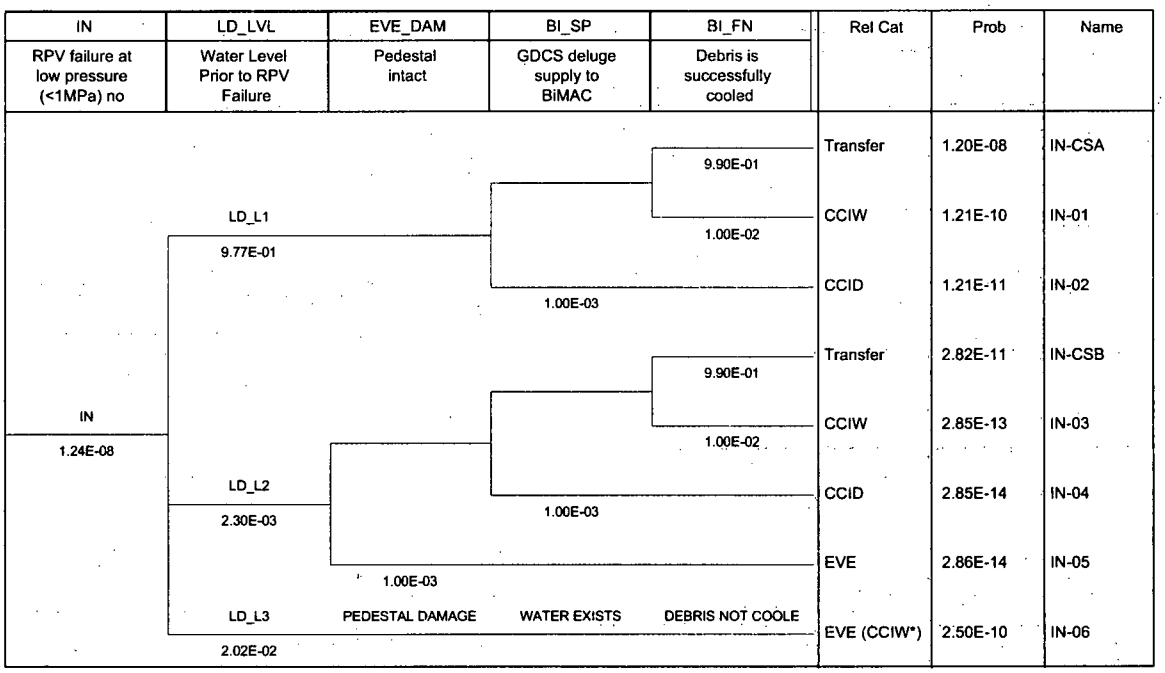


Figure A.8-1. Class I with Loss of Preferred Power CPET / CSET



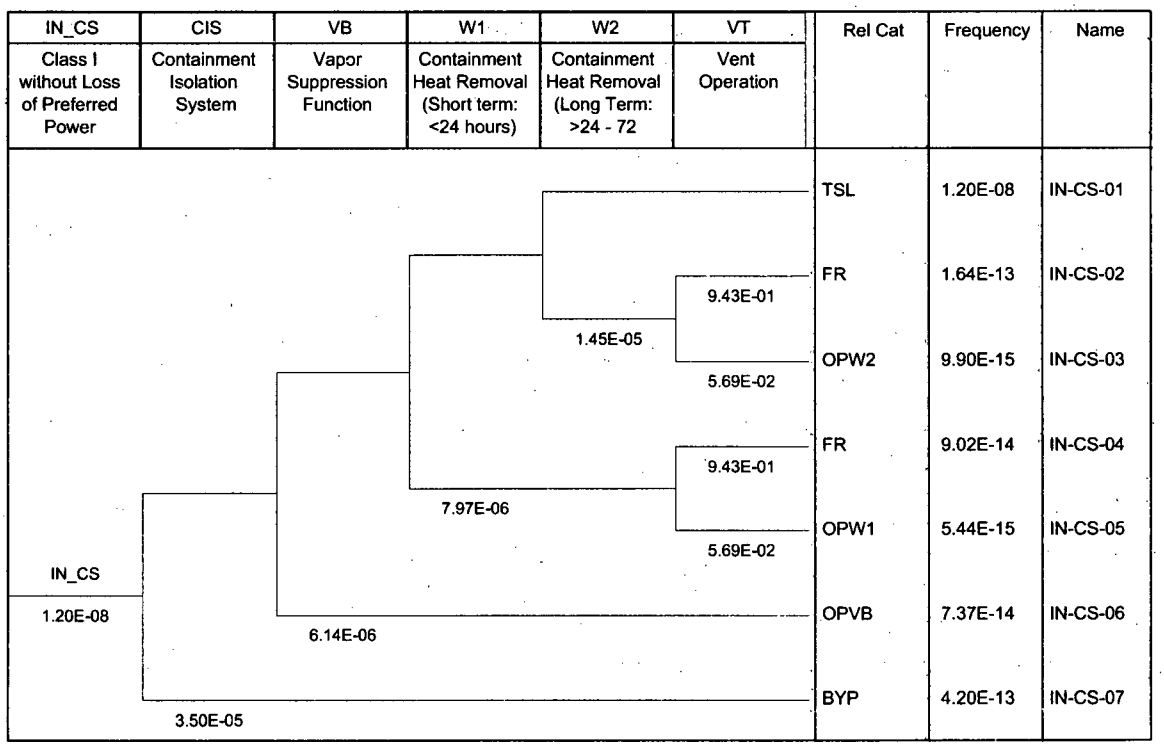
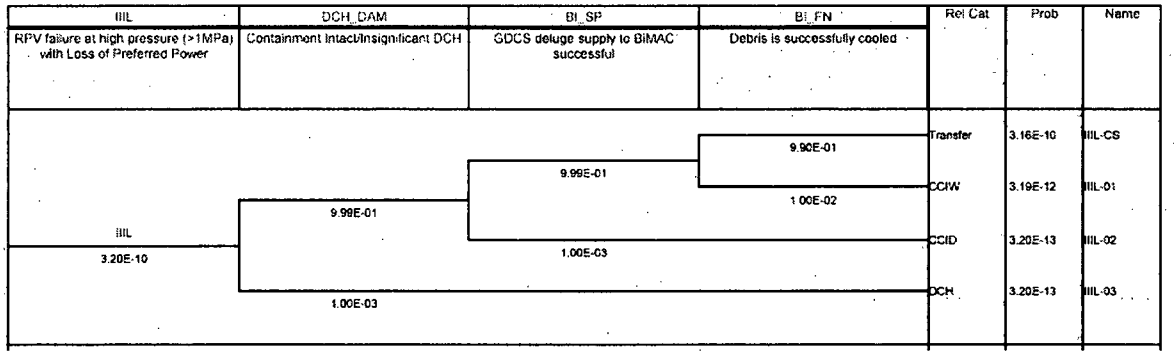


Figure A.8-2. Class I without Loss of Preferred Power CPET / CSET



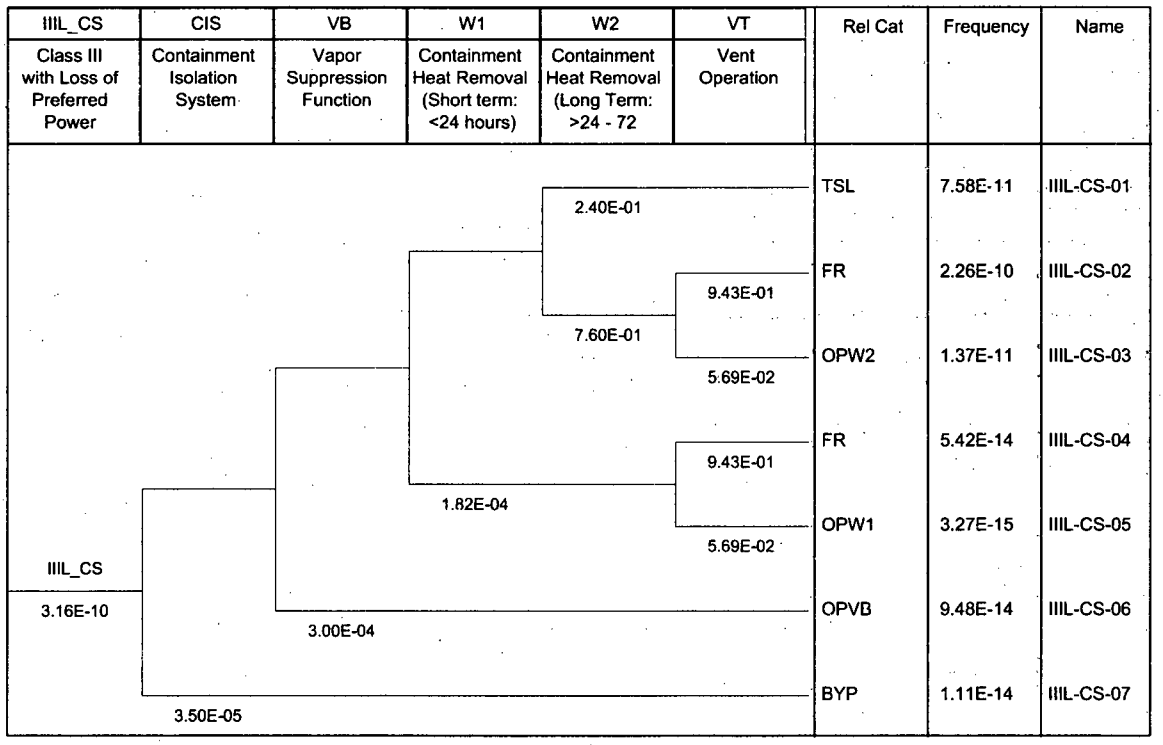
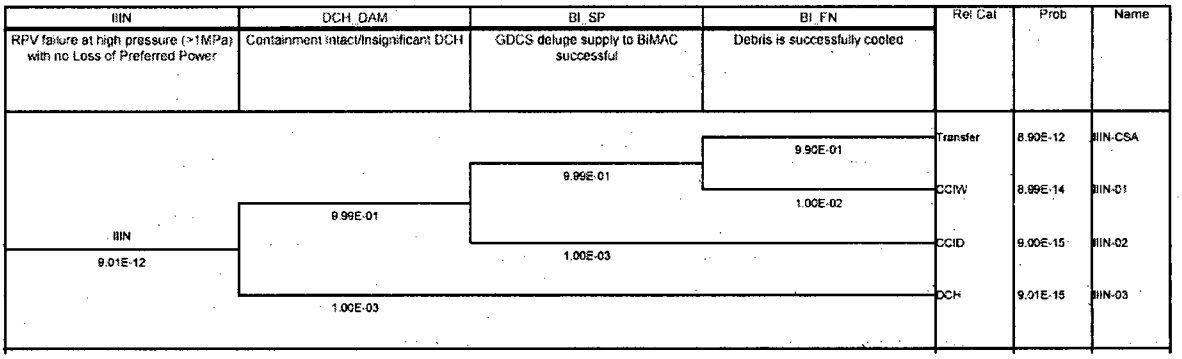


Figure A.8-3. Class III with Loss of Preferred Power CPET / CSET



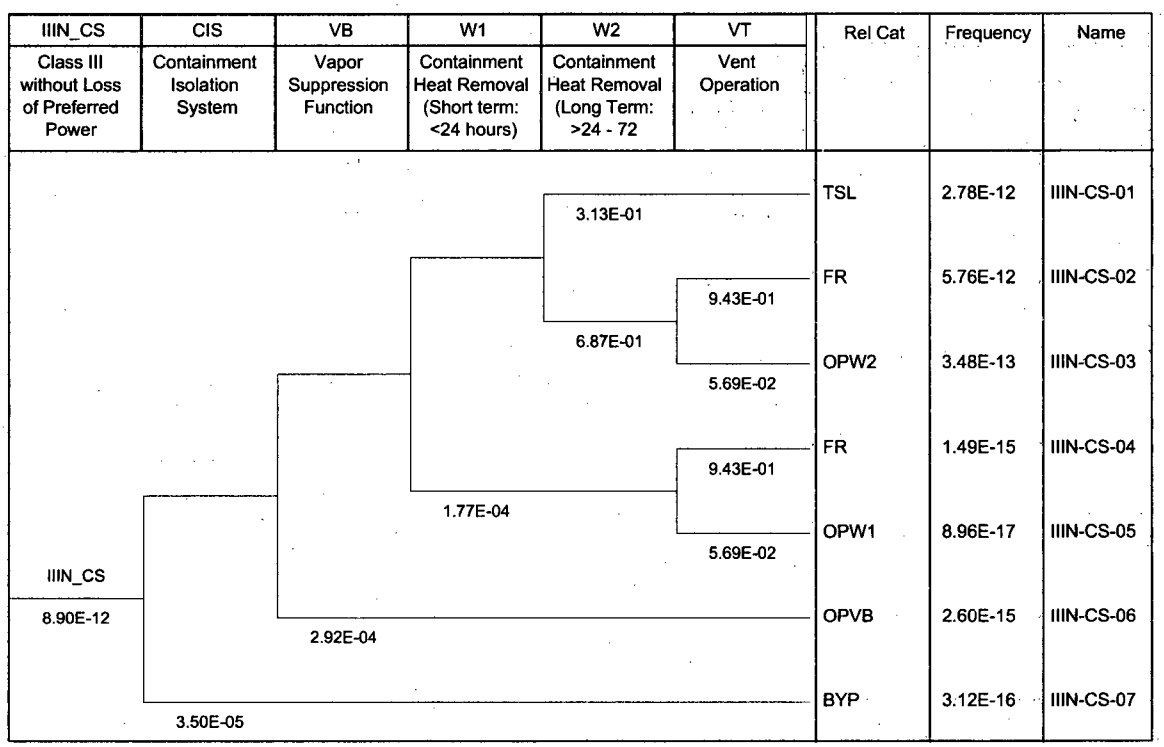
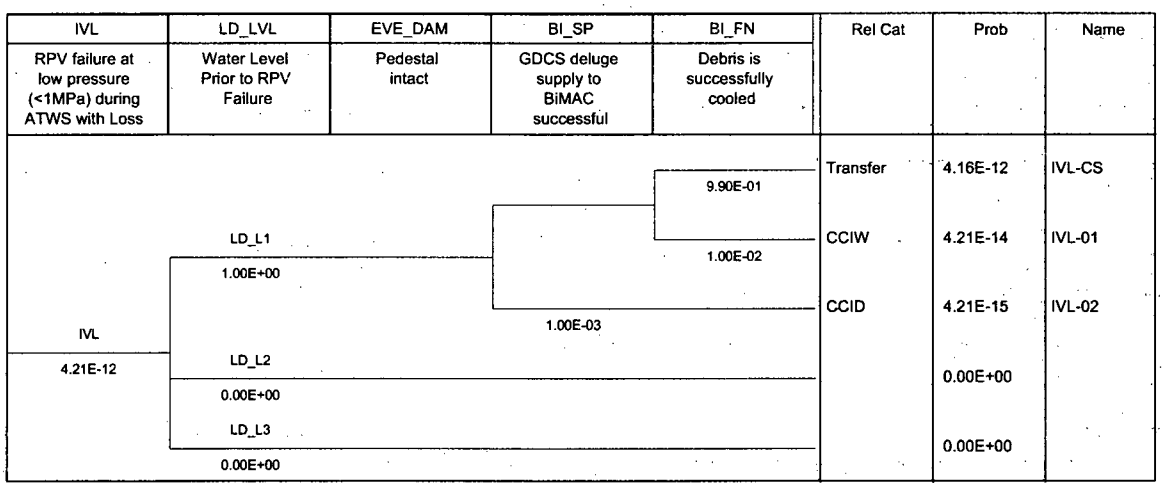


Figure A.8-4. Class III without Loss of Preferred Power CPET / CSET



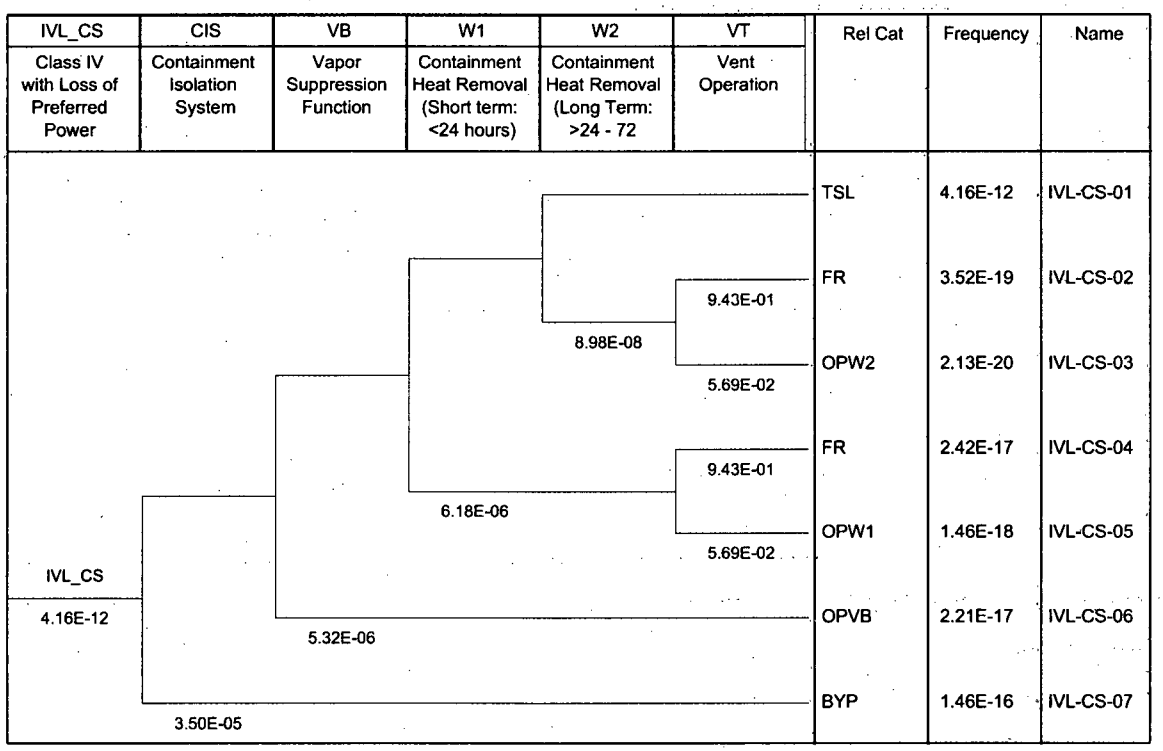
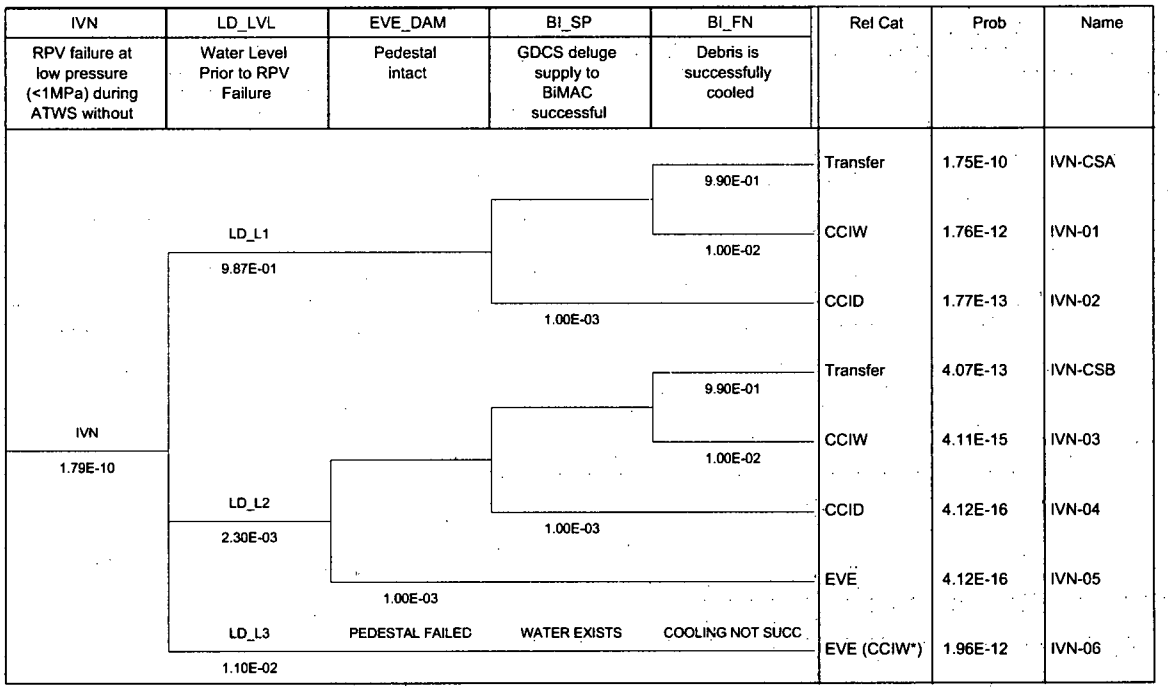


Figure A.8-5. Class IV with Loss of Preferred Power CPET / CSET



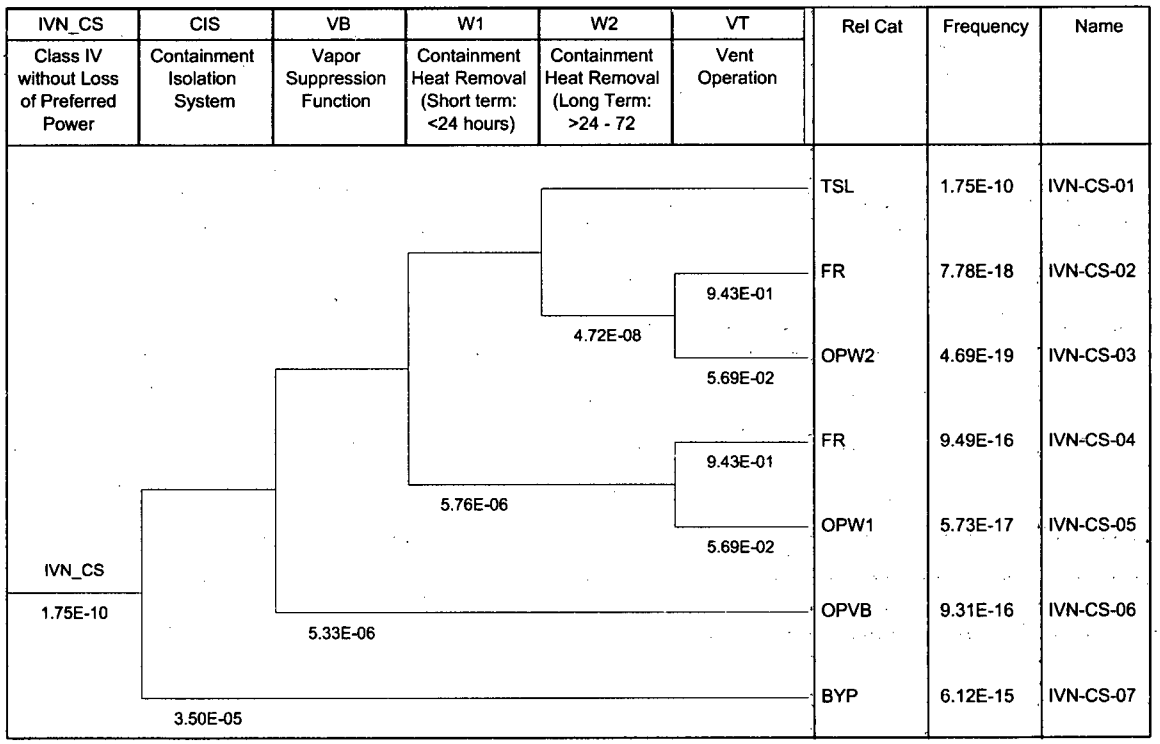


Figure A.8-6. Class IV without Loss of Preferred Power CPET / CSET

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B.8 CONTAINMENT ULTIMATE STRENGTH

This section describes the analysis and evaluation used to estimate the containment internal pressure capability and associated failure mode and location. The ultimate pressure capability of the containment structure is limited by the drywell head whose failure mode is plastic yielding of the torispherical dome. The pressure capability is 1.204 MPa gauge at 533K (500°F). It is a typical temperature for most severe accident sequences. The containment is conservatively assumed to depressurize rapidly when the pressure capability is reached. No significant leakage through penetrations is anticipated before the capability pressure is reached.

The primary function of the containment structure is to serve as the principal barrier to control potential fission product releases. The design basis event for this function is a postulated loss-of-coolant accident (LOCA). Based on this functional requirement, the containment pressure vessel is designed to withstand the maximum pressure and temperature conditions which would occur during a postulated LOCA. The ESBWR containment system employs pressure suppression, which allows a design pressure of 0.310 MPa and a design temperature of 444°K (340°F) for the primary containment pressure vessel. In addition, the suppression pool retains fission products that could be released in the event of an accident. In this section the capability of the containment structural system of the ESBWR standard plant to resist potentially higher internal pressures and temperatures associated with severe accidents is evaluated.

Primary containment, also referred to as "RCCV" for reinforced concrete containment vessel, is a cylindrical structure of steel-lined reinforced concrete. The containment is integrated with the reactor building (RB) walls from the basemat up to the elevation of the containment top slab. The top slab, together with pool girders and building walls, form the IC/PCCS pools and the services pools for storage of Dryer/Separator, fuel handling, new fuel storage and other uses. The elevation view of the reactor building/containment structural system along 0°–180° direction is shown in Figure B.8-1. The containment is divided by the diaphragm floor and the vent wall into a drywell chamber and a suppression chamber or wetwell chamber. The drywell chamber above the diaphragm floor is called the upper drywell (U/D). The drywell chamber enclosed by the RPV support pedestal (a part of RCCV) beneath the RPV is called the lower drywell (L/D). The major penetrations in the containment wall include:

(1) Drywell head

(2) The upper drywell equipment and personnel hatches at azimuth 307° and 52°

(3) The lower drywell personnel and equipment hatches at azimuth 0° and 180°

(4) The wetwell hatch at azimuth 115°

(5) The main steam and feedwater pipe penetrations at the level of the steam tunnel

Additional detail of the containment design is provided in Section 4.0.

The pressure boundary of the containment structure consists of the reinforced concrete containment vessel (RCCV) and the steel drywell head. The structural integrity of the RCCV is investigated for its global strength under internal pressure beyond the design basis using the ANSYS computer program, which is based on the nonlinear finite element method of analysis for 3D reinforced concrete structures. During various severe accident conditions, the ESBWR

containment could also be challenged by high temperatures with a typical temperature of 533°K (500°F) for most accident sequences). At typical accident temperature of 533°K (500°F), the controlling pressure capability is 1.204 MPa associated with the plastic yielding of the drywell head.

In order to evaluate liner response to over-pressurization, liner plates are included in the ANSYS analysis. The analysis results show that the liner strains are much smaller than the ASME code allowable for factory load category when the internal pressure is as high as 1.468 MPa. A separate evaluation further demonstrates that at the governing containment failure pressure of 1.204 MPa at 533°K (500°F), the liner and anchor system will maintain its structural integrity and no liner tearing will occur.

The leakage potential through penetrations is expected to be insignificant.

In conclusion, the ultimate pressure capability is limited by the drywell head. The postulated failure mechanism is the plastic yield of the drywell head. The pressure capability is 1.204 MPa gauge at 533°K (500°F). The pressure capability evaluation described above is based on the deterministic approach. The uncertainties associated with the failure pressure are assessed in Section B.8-3.

B.8.1 RCCV NON-LINEAR ANALYSIS

This subsection describes the non-linear analysis performed for the reinforced concrete containment vessel (RCCV) of the ESBWR Standard Plant. Computer code ANSYS was used for evaluation of the RCCV.

B.8.1.1 Finite Element (FE) Model Description

The containment and the containment internal structures (excluding GDCS pools structures) are axi-symmetric while the RCCV top slab together with the reinforced concrete girders even though not axi-symmetric, are idealized and included in the axi-symmetrical model. Solid elements are used to represent the girders at the top of the RCCV, approximating the stiffness of the actual structure from a detailed model of the walls and slabs in the upper pools.

To represent the restraining effects of the floors outside the containment, horizontal restraining slabs are used with equivalent material properties. The model includes concrete elements, the reinforcing steel, the steel liner plate of the drywell, the drywell head, the wetwell with the vent wall and diaphragm floor structures.

The model consists of 3780 nodal points and 2160 elements. There are 1497 elements representing concrete, whereas 249 elements are isotropic, representing steel plates. The soil below the foundation mat was modeled as 72 spring constants, 342 concentrated mass elements. See Figure B.8-1 for the model.

The ANSYS computer program permits the specification of bi-linear, brittle or ductile material properties. The concrete and soil elements are specified to have properties with no or low tensile capability. The steel plate elements and the rebar elements are specified to have ductile material properties with the same strength in tension and compression. The capability of the ANSYS program to accommodate ductile material behaviors permits both concrete cracking and yielding of steel and rebar. This allows the program to consider redistribution of forces throughout the structure due to the non-linear behavior such as concrete cracking.

B.8.1.2 Analysis

The finite element model was analyzed for internal pressure loading incrementally increased up to 1.486 MPa. The four pressure levels whose results are evaluated and summarized in Table B.8-1 are:

(1) Design pressure, labeled "PD"

(2) Structural Integrity Test 1 (SIT-1) pressure, labeled "IT", with 0.358 MPa pressure in the drywell and wetwell

(3) Severe accident pressures, labeled "SA-1" and "SA-2"

Since ANSYS performs non-linear analysis, it is necessary to apply simultaneously all loads of a loading combination. In addition to internal pressures, only the dead weights are included. The program utilizes a stepwise linear iteration technique. The first cycle results are for elastic analysis. Based upon results of the first cycle, stiffness of all elements is adjusted by the program prior to the next iteration cycle.

B.8.1.3 Results

Table B.8-1 summarizes analytical results for various loading conditions. The results are shown in terms of maximum rebar stresses, concrete stresses, liner strains and structural deformations.

Based on the ANSYS analysis, it can be concluded that the axi-symmetric components of the RCCV, as designed based on ASME Section III Division 2 code requirements, can withstand an internal pressure of 1.486 MPa, i.e., 4.8 times the design pressure, with stresses and strains in the rebar, liner plate and concrete within code allowable limits. The strength is governed by the wetwell wall and the S/P slab junction. The strength of the non-axi-symmetric top slab region is evaluated by extrapolation of the elastic analysis results using a 3D finite element model.

B.8.2 PREDICTION OF CONTAINMENT ULTIMATE STRENGTH

B.8.2.1 Structural Capability

B.8.2.1.1 Concrete Shell

The structural integrity of the RCCV axi-symmetric components has been demonstrated for an internal pressure of 1.486 MPa at ambient temperature from the ANSYS analysis. Based on extrapolation of analysis results, estimate of the ultimate pressure capability is made and discussed in this subsection. The ultimate pressure capability is assumed reached when rebar at both faces of a cross section reaching yield stress or when concrete fails by shear. The estimated pressure capabilities of the various components of the RCCV are shown in Table B.8-2. It should be noted that the extrapolation of results gives only approximate values beyond the analyzed values.

During various severe accident conditions, the ESBWR containment could be challenged by high temperatures with a typical temperature about 533°K (500°F). The effect of elevated temperature on containment pressure capability has been investigated by Argonne National Laboratory (ANL) (Reference B.8-1). The ANL study concluded that for temperatures up to 644°K (700°F), the failure mode and location did not change from the case of internal pressure alone, and the failure pressure was reduced slightly (11% maximum) from that predicted for the

internal pressure alone case. On the basis of the ANL study it is expected that with thermal effects included, the RCCV pressure capability will not be reduced below the drywell head capability for the range of temperatures considered. It is estimated that RCCV pressure capability at 500°F is 90% of the capacity at ambient temperature.

B.8.2.1.2 Drywell Head

This subsection presents an evaluation of the structural capability of the drywell head under internal pressure and temperature loading. The leakage potential of the head closure is discussed in Subsection B.8.2.2.

The drywell head which covers the 10.4 m diameter opening in the upper drywell top slab is a steel torispherical dome assembly. Under internal pressure loading, the most critical location of this type of configuration is the knuckle (or torus) region of the torispherical dome which may fail by plastic yield or buckling.

For torispherical pressure vessel heads, an approximate formula for the limit pressure at which significant plastic deformation occurs was developed by Shield and Drucker (Reference B.8-2) based on the upper and lower bound theorems of limit analysis, and it is

$$P_c = S_Y \left\{ \left(0.33 + 5.5 \cdot \frac{\mathrm{r}}{\mathrm{D}} \right) \frac{t}{L} + 28(1 - 2.2r/D) \left(\frac{t}{L} \right)^2 - 0.0006 \right\} \qquad \text{(B.8-1)}$$

where:

P_c = limit pressure

S_y = yield strength of the material

t = uniform thickness of the head

r = radius of the knuckle shell

D = diameter of the cylindrical shell

L = radius of the spherical cap

Substituting the relevant dimensions into Equation B.8-1 gives

$$P = 0.005156 * Sy \qquad \text{(B.8-2)}$$

The material yield strength depends on temperature. The actual strength of as-built material is generally higher than the specified minimum value used in design. To have a more realistic estimate of the structural strength, the minimum yield strength of material SA-516, Gr. 70 as specified in Appendix I of ASME Section III is increased by 10%. The limit pressure is 1.204 MPa at 533°K (500°F). It is noted that due to the presence of water in the reactor cavity, the outer surface of the drywell head will be at a much lower temperature than the inner surface, which is exposed to the drywell temperature. Consideration of the entire drywell head at 500°F is therefore a conservative assumption.

Buckling is another potential failure mode of the torispherical head under internal pressure since the knuckle is subjected to compressive stress in the hoop direction. Galletly has (Reference B.8-

3) proposed a design equation for preventing buckling in fabricated torispherical shells under internal pressure.

$$P_d = \frac{80\, S_y \left(\frac{r}{D}\right)^{0.825}}{\left(\frac{D}{t}\right)^{1.5} \left(\frac{L}{D}\right)^{1.15}} \qquad \text{(B.8-3)}$$

This equation is based on his previous studies (References B.8-4 and B.8-5) and is formulated for design use with knock-down (capacity reduction) factors included. As compared to all known test results (43 in total), the ratios of the actual buckling pressure to the allowable buckling pressure predicted by this equation were found to range from 1.51 to 4.01. Hence, a minimum factor of safety of 1.5 is ensured by this equation.

The test data presented in Reference B.8-3 (excluding the test performed by Blenkin since no buckling was observed at the maximum test pressure) are summarized graphically in Figure B.8-2, showing the relationship between the test and predicted pressures. The predicted pressures, as can be seen, are at least 1.5 times lower than the test results. In order to gain more insight about the data variability, statistical analyses are performed and the results are given in Figure B.8-3. The PDF (probability density function) of the data shown by solid lines is the histogram of 42 data points expressed in terms of the ratio of test to predicted pressure. It is observed that the data can be reasonably approximated by the lognormal distribution. The medium value of the test to predicted pressure ratios in the data set is 2.27 and the logarithmic standard deviation is 0.293. The resulting lognormal density and cumulative functions are shown in Figure B.8-3. The cumulative probability is 8% for the ratio up to 1.5. It means that the probability of the ratio of actual to predicted pressure being less than 1.5 is 8%. In other words, there is 92% confidence that the margin of safety against buckling is at least 1.5 when Equation B.8-3 is used. The 1.5 factor of safety corresponding to 92nd percentile is deemed sufficient for the assurance of no buckling failure against severe accident loadings of very low probabilities of occurrence.

As mentioned earlier, Equation B.8-3 has a factor of safety of 1.5 as compared to the lower bound of all known test results. From a statistical study of these test results, the medium buckling pressure is estimated to be 2.27 times the value predicted by Equation B.8-3. Multiplying by the median 2.27 value of Equation B.8-3 results in a best estimate buckling failure pressure for the drywell head of 2.667 MPa.

A comparison with the plastic yield limit pressure P_c calculated above indicates that plastic yield will occur before buckling and is the governing failure mode of the drywell head. The capability pressure is 1.204 MPa at 533°K (500°F).

B.8.2.1.3 PCCS Heat Exchangers Ultimate Pressure Capacity

The PCCS heat exchangers are part of containment boundary. Evaluation is performed to determine their ultimate pressure capacity. Analytical calculations are carried out to obtain the

maximum pressure that each heat exchanger component can resist at severe accident temperature, 533°K (500°F).

All of the sections that resist the containment pressure are evaluated in accordance with Service Level D limits of ASME, Section III, Division 1, Subsection NC, Class 2 Components.

The evaluation results reveal that the Level D pressure capacity of the most critical component in the PCCS heat exchangers is 1.77 MPa, which is 1.5 times higher than the pressure capability of the containment structure. The ultimate pressure capability would be even higher; hence the PCCS heat exchangers are not the weak link of the containment pressure boundary.

B.8.2.2 Leakage Potential

The previous subsection has addressed the structural capability of the containment structures under severe accident conditions. However, the containment function can be compromised if excessive leakage occurs before the capability pressure is reached. Leakage above the design allowable could result from failure of the liner plate and penetrations at high pressures and temperatures. The leakage potential of the liner plate and penetrations is evaluated in the following subsections.

B.8.2.2.1 Liner Plate

As discussed earlier, the containment liner plates are included in the ANSYS model. The maximum liner strains are found to be well within the code allowable when the internal pressure is as high as 1.468 MPa.

At the capacity pressure of 1.204 MPa, the maximum liner strain is 0.117% as shown in Table B.8-1 and it is considered as "free-field" strain away from discontinuities such as penetrations. To account for the effects of discontinuities, a strain concentration factor of 33, based on the Sandia containment test results (Reference B.8-6), is conservatively applied to the free-field strain, resulting in 3.96% strain. This strain level is still far lower than the ultimate fracture strain of 21% for the liner plate material. Therefore, it can be inferred that the liner plate will not tear at severe accident pressure of 1.204 MPa.

The most significant effect of thermal loading on the liner performance is a potential buckling failure which may occur if the internal pressure-induced tensile stress is not large enough to overcome the thermal-induced compressive stress. The thermal buckling tests conducted by Construction Technology Laboratories for Electric Power Research Institute (EPRI), Reference B.8-10, showed no buckling for a peak thermal transient exceeding 600°F under a pressure of 65 psi. The representative severe accident temperature for the ESBWR containment is 500°F. Since the increase in internal pressure could be much faster than the heat conduction through the containment wall, it is expected that liner buckling is unlikely to occur under combined pressure and thermal loading associated with severe accidents. As for the thermal effects on linear tearing, an ANATECH study for EPRI (Reference B.8-11) indicated that, for representative reinforced and prestressed concrete containment under WASH-1400 severe accident loading, liner tensile yielding occurred at a higher pressure and the end results near failure were essentially the same as compared to the pressure alone case. On this basis, the liner rupture pressure in excess of 1.204 MPa estimated above for pressure alone is judged to be achievable in combination with temperature. In summary, no liner failure which may lead to leakage can occur before the containment capability pressure of 1.204 MPa at 500°F is reached.

B.8.2.2.2 Penetrations

An ANL study (Reference B.8-8) assigned high priority to the study of large operable penetrations such as the drywell head closure, equipment hatches, and personnel airlocks since they are expected to have high potential for leakage under severe accident conditions. Leakage from fixed penetrations (both electrical and mechanical) appears to be less likely based on the results of experiments conducted to date by Sandia National Laboratories (SNL) and its contractors (Reference B.8-8). In fact, according to the same reference, no leakage was detected from any of the three current electrical penetration assemblies (EPAs) during the severe accident testing (steam environments).

The leakage potential of operable penetrations depends on both the relative position of the sealing surfaces and the performance of the seal material. The position of the sealing surfaces depends on the initial conditions (metal-to-metal contact is maintained under design conditions for most penetrations) and on the deformations induced by accident pressure and temperature. The seal performance depends mainly on temperature as well as the effect of thermal and radiation aging. The recent SNL tests of seals for mechanical penetrations, Reference B.8-8, indicated that

(1) In a steam environment at a constant pressure of 1.069 MPa, the mean degradation temperature was 544°K (520°F) for silicon rubber and 606°K (630°F) for ethylene propylene rubber (EPR), and

(2) In a nitrogen environment at a constant pressure of 1.069 MPa, the mean degradation temperature was 528°K (490°F) for neoprene, and

(3) The degradation temperature was not significantly affected by thermal and radiation aging.

Neoprene is not used for operable penetrations in the ESBWR containment and the seal degradation temperature is conservatively assumed to be 533°K (500°F). The SNL study also showed that even a degraded seal can prevent leakage if the separation of the sealing surfaces is small [less than 0.127 mm (0.005 in.)].

Sandia (Reference B.8-8) has proposed the following equations for "available gasket springback", Sp, for evaluating the leakage potential as a function of the compression set retention and the degradation temperature:

$$S_p = (1-C_B)\, S_q h_i \text{ for } (T<T_d) \qquad \text{(B.8-4)}$$

$$S_p = 0.127 \text{ mm } (0.005 \text{ inch}) \text{ for } (T>T_d) \qquad \text{(B.8-5)}$$

where:

C_B = the compression set retention (a dimensionless measure of the permanent set in the gasket caused by aging),

S_q = the squeeze as illustrated in Figure B.8-4 (a dimensionless measure of the gasket deformation under normal operation conditions),

h_i = the initial seal height, and

T_d = the degradation temperature of the gasket material.

Equation B.8-4 is based on the assumption that significant leakage can be prevented as long as positive compression of the gasket is maintained. Equation B.8-5 is empirical based on test results that even a degraded gasket can effectively prevent leakage if the separation of the sealing surfaces is equal to or less than 0.127 mm (0.005 in).

For the pressure-unseating drywell head closure and equipment hatches, the pressure required to separate the sealing surfaces is a function of the bolt preload, axial stiffness of the bolts and the compression flanges, and the differential thermal expansion between the bolts and the compression flanges. The separation pressure for operable penetrations typically ranges from 1.1 to 1.5 times design pressure (Reference B.8-8). In this study, the separation pressure is assumed to be the average value of 1.3 times design pressure. At and below this pressure, a metal-to-metal contact is maintained and no leakage other than design allowable leak rate is anticipated, even if the seal degradation temperature of about 533°K (500°F) has reached. Additional pressure in excess of the separation pressure is carried entirely by the bolts. The separation displacement between the sealing surface after the separation pressure is reached is:

$$s = \frac{\pi r^2 (p - p_s)}{K_b} \tag{B.8-6}$$

where:

r = the inside radius of the equipment hatch sleeve or drywell head,

p_s = the separation pressure, and

K_b = the total bolt axial stiffness.

The above expression neglects the flexibility due to axial deflection of the compression flanges caused by the Poisson effect which contributes little to the total flexibility of the bolts. This approach for predicting leakage is based on the consideration of structural deformations in terms of separation of connecting flanges of pressure unseating equipment hatches and drywell head. The adequacy of this approach has been recently confirmed by the Sandia hatch leakage tests (Reference B.8-9) in that the predicted leakage onset pressures were in favorable agreement with the test results. The drywell head anchorage to the top slab has a pressure capability higher than the drywell head shell and the leakage path of the drywell head assembly before the failure pressure is reached is through the flanges.

The drywell head is a 10.4-m diameter closure with double seal. One hundred twenty 68-mm diameter bolts hold the head in place. There are 2 drywell equipment hatches and 1 wetwell hatch in the containment wall. All of them have twenty 36-mm minimum diameter bolts with double seal; the diameters are 2.4 m for drywell equipment hatches and 2.0 m for the wetwell hatch. According to Equation B.8-6, the separation displacement at 1.204 MPa capability pressure is calculated to be about 0.146 mm (0.0058 in) for the drywell head and 0.204 mm (0.008 in) for the most flexible hatch. Although they are larger than the springback displacement of 0.127 mm if gaskets are conservatively assumed degraded at 533°K (500°F), the resulting maximum gap of 0.077 mm is deemed small. Hence, no significant leakage is expected before the capability pressure is reached.

For equipment hatches, another potential leakage mechanism is ovalization of the sleeve which causes the sleeve to slide relative to the tensioning ring (or the cover flange). An initiation of

leakage due to sleeve ovalization, however, requires significant deformations of the containment shell around the equipment hatch. The average circumferential membrane strain in the shell that is needed to result in the initiation of leakage from ovalization for equipment hatches identified in the ANL survey (Reference B.8-8) was found to range from 2.5% to 7.3% by SNL (Reference B.8-8). For the equipment hatches under consideration, the ovalization leakage onset strain which is the ratio of the sleeve wall thickness at the sealing surface to the sleeve radius ranges, as a maximum, from about 5.8% to 7.0%. At a pressure of 1.468 MPa, the maximum radial deflection of the wetwell wall was calculated to be 13.02 mm (0.512 in.) from the ANSYS analysis (Table B.8-1). The corresponding hoop membrane strain is 0.072%. It is less than 1.2% and no leakage from sleeve ovalization of the equipment hatches will occur before the capability pressure is reached.

B.8.2.3 Summary

The ultimate pressure capability of the containment structure is limited by the drywell head whose failure mode is plastic yield of the torispherical dome. The pressure capability is 1.204 MPa at 533°K (500°F). No liner leakage will occur before the capability pressure is reached. Leakage through penetrations is expected to be insignificant.

B.8.3 UNCERTAINTY IN THE FAILURE PRESSURE

The uncertainties in the prediction of the failure pressure generally result from uncertainties in the two general areas listed below:

Material Strength (yield strength, tensile strength, modulus of elasticity, etc.)

Modeling (differences between the model and reality, use of simplified models or empirical correlations, uncertainty in dead-loads, etc.)

In a number of the areas listed above very little data may be available to guide the structural analyst in characterizing the uncertainty. Consequently, it is generally necessary to rely to a large extent on engineering judgment and past results to quantify these uncertainties.

As noted above a significant contributor to the uncertainty in the prediction of ultimate capacity derives from uncertainties in the material properties. For most structural materials the lognormal distribution has been shown to be a good model for the variability in material strength. Largely for this reason the lognormal distribution is generally selected to characterize the uncertainty in the prediction of the ultimate pressure capacity for structural components.

The most common form of the lognormal probability density function is:

$$p_f(p) = \frac{1}{p\sqrt{2\pi\beta_c}} \exp\left[-\frac{1}{2}\left[\frac{1}{\beta_c}\ln\left(\frac{P}{P_{med}}\right)\right]^2\right] \qquad \text{(B.8-7)}$$

where:

$p_f(p)$ = the lognormal probability density function for failure pressure,

β_c = logarithmic standard deviation on the pressure capacity p,

p_{med} = the median pressure capacity.

β_c is a combination of the logarithmic standard deviation of material strength uncertainty β_s, and the logarithmic standard deviation of modeling uncertainty β_m. β_c is determined from the standard relationship for combining independent uncertainties.

$$\beta_c = \sqrt{\beta_s^2 + \beta_m^2} \tag{B.8-8}$$

The cumulative distribution function (CDF) is obtained by integrating the PDF

$$P_f(P) = (P \le p) = \int_0^P p_f(p)\,dp \tag{B.8-9}$$

$P_f(p)$ = the probability that the failure pressure is less than pressure p.

The failure pressure of 1.204 MPa [at a drywell temperature of 533 K (500°F)] can be considered to be a lower bound value since a higher failure pressure of 1.632 MPa would be predicted for the drywell head when plastic failure mode is analyzed with Equation 4 of Reference B.8-5 shown below is used.

$$P_{c2} = \frac{20(r/D)^{1.78} S_y}{(D/t)^{1.08}(L/D)^{0.87}}\left[1 + 0.1\left(\frac{r}{D}\right)^{-1.37}\right](1 + 0.001S_y^{1.1}) \tag{B.8-10}$$

The median failure pressure is therefore assumed to be 1.632 MPa. The uncertainties associated with this analysis were estimated using engineering judgment and the results from prior analysis. Typical values for the uncertainties associated with material properties of steel structures range from a β_s of approximately 0.06 to 0.10 and the uncertainties associated with the modeling of simple steel structures range from a (β_m) of approximately 0.10 to 0.16 (References B.8-12 and B.8-13). Using nominal values for β_s of 0.08 and for β_m of 0.14 results in an estimated value for the standard deviation (β_c) of 0.16. The use of 0.14 for β_m is also consistent with Reference B.8-14 in that the variability associated with the modeling error by the use of approximate methods including that for torispherical heads is 0.12. The adequacy of using 0.08 for β_s associated with material property uncertainties at high temperatures is addressed as follows. The ESBWR drywell head material is ASME SA-516, Gr. 70. This material was tested, according to Reference B.8-16, for temperatures up to 477 K (400°F) using the specimens taken from the Sandia's 1/8 scale steel containment model. No actual test data are given but the inferred stress-strain curves (Figures 3.4 and 3.5 of Reference B.8-15) for Gr. 60 of the same material considered in the nonlinear analysis show the same characteristics of nonlinear stress-strain relationships for temperatures up to 477 K (400°F). The same trend is expected to exist for temperatures up to 811 K (1000°F) since it is the upper temperature limit of which the specified minimum material strength is given in the ASME code. Having established this, the variability associated with material strength is expected to be the same regardless of temperatures. The statistical data of 52 tests of A516, Gr. 70 (same as SA-516, Gr. 70) given in Reference B.8-16 show that the average yield strength is 335 MPa and the standard deviation is 24.3 MPa. The coefficient of variation is thus 0.073, which is close to 0.08 used for β_s.

Using the above parameter values results in the containment capacity fragility curve in Figure B.8-5 and Table B.8-3.

The pressure at two standard deviations below the mean is 1.111 MPa. This pressure is 3.58 times the design pressure.

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B.8-14 Reliability Analysis of Steel-Containment Strength, NUREG/CR-2442, June 1982.

B.8-15 Analysis of Shell-Rupture Failure Due to Hypothetical Elevated- Temperature Pressurization of the Sequoyah Unit 1 Steel Containment Building, NUREG/CR-5405, February 1990.

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Table B.8-1

Summary of Stresses and Strains

Loading Case		Maximum rebar Stress/Allow. Stress		Liner Strain		Concrete Compress. Stress/ Allowable stress	Component Rebar Stresses / Allowable Stresses (MPa)										Max. Radial Defl. Wetwell. mm
							MAT		SP/S		Wetwell wall		Upper drywell wall		Top Slab		
Title	P.D. MPa	Merid. MPa	Hoop MPa	Tensile mm/mm	Compress. mm/mm	(MPa)	Mer.	Hoop.	Mer.	Hoop.	Mer.	Hoop.	Mer.	Hoop.	Mer.	Hoop.	
PD	0.310	60.7	11.8	2.40E-04	-1.03E-04	-4.7	23.4	8.0	21.0	10.2	10.0	7.7	20.8	5.7	19.3	7.4	0.68
		248.4	248.4			-20.7	248.4	248.4	248.4	248.4	248.4	248.4	248.4	248.4	248.4	248.4	
IT	0.357	63.9	20.2	2.42E-04	-1.113E-04	-4.8	24.1	5.2	21.4	10.2	9.9	8.7	27.8	6.6	20.6	8.6	0.79
		248.4	248.4			-20.7	248.4	248.4	248.4	248.4	248.4	248.4	248.4	248.4	248.4	248.4	
SA-1	1.210	217.1	262.0	1.17E-03	-5.10E-04	-19.7	217.1	80.4	172.1	70.4	145.6	111.9	188.8	88.7	198.4	41.0	10.19
		414.0	414.0			-34.5	414.0	414.0	414.0	414.0	414.0	414.0	414.0	414.0	414.0	414.0	
SA-2	1.468	284.9	318.7	1.65E-03	-8.59E-04	-31.0	284.9	119.5	221.9	93.3	185.3	142.9	245.4	117.5	267.5	53.7	13.02
		414.0	414.0			-34.5	414.0	414.0	414.0	414.0	414.0	414.0	414.0	414.0	414.0	414.0	

Table B.8-2

Summary of Pressure Capabilities of Various Components of the RCCV and the Drywell Head

Structural Component	Failure Mode[4]	Ultimate Pressure Capability in MPa (gauge)		
		Ambient Temp.[2]	500°F[3]	1000°F[5]
Wetwell	Rebar yielding at DF-Wetwell joint	4.33	3.9	1.94
Upper Drywell	Rebar yielding at DF-Upper Drywell joint	4.8	4.32	1.89
Lower Drywell (Pedestal)	Shear failure at Basemat joint	2.85	2.57	1.16
Suppression Pool Slab	Shear failure at Wetwell joint	1.468	NA[6]	NA[6]
Basemat	Shear failure at Pedestal joint	3.63	3.26	---
Drywell Head	Plastic failure at Knuckle	1.486	1.204[1]	1.13

Notes:

1. Yielding strength based on 10% increase of code-specified values.
2. Extrapolated from Table B.8-1 results for concrete components.
3. Conservatively taken as 90% of the pressure value at ambient temperature.
4. Failure criteria
   - Rebar: 0.01 total strain
   - Concrete: 34.5 MP f'_c compression, 1.95 MPa f_{cT} tension
   - Liner: 0.02 total strain
   - Drywell head: plastic failure
5. Estimated from past study of a similar design.
6. Water stays in suppression pool.

Table B.8-3

Probability of Failure Versus Pressure

(Median Pressure = 1.632 MPa gauge, β_c= .16)

Pressure (MPa) gauge	$\frac{Ln(p/p_{med})}{\beta_c}$	Pf(p)
0..845	-4.114	1.94E-05
0.847	-4.099	2.07E-05
0.849	-4.084	2.21E-05
0.979	-3.184	7.01E-04
1.11	-2.409	7.99E-03
1.197	-1.937	0.026
1.226	-1.788	0.037
1.371	-1.089	0.138
1.458	-0.705	0.241
1.545	-0.342	0.366
1.632	0.0	0.5
1.719	0.325	0.627
1.806	0.633	0.737
1.893	0.927	0.823
1.980	1.208	0.886
2.067	1.477	0.930
2.154	1.735	0.959
2.285	2.103	0.982
2.415	2.449	0.993
2.458	2.56	0.995
2.5	2.666	0.996

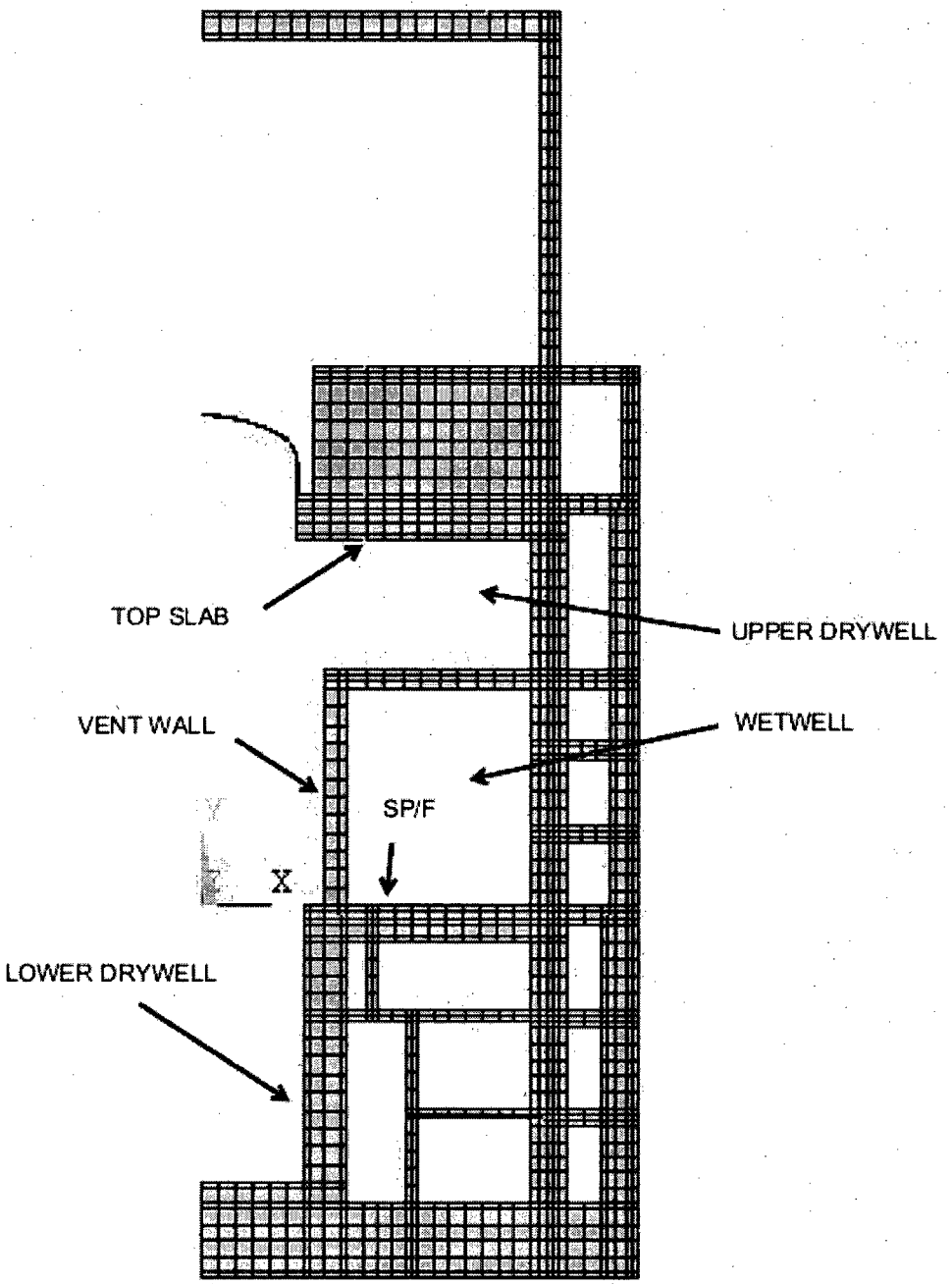


Figure B.8-1. ANSYS model

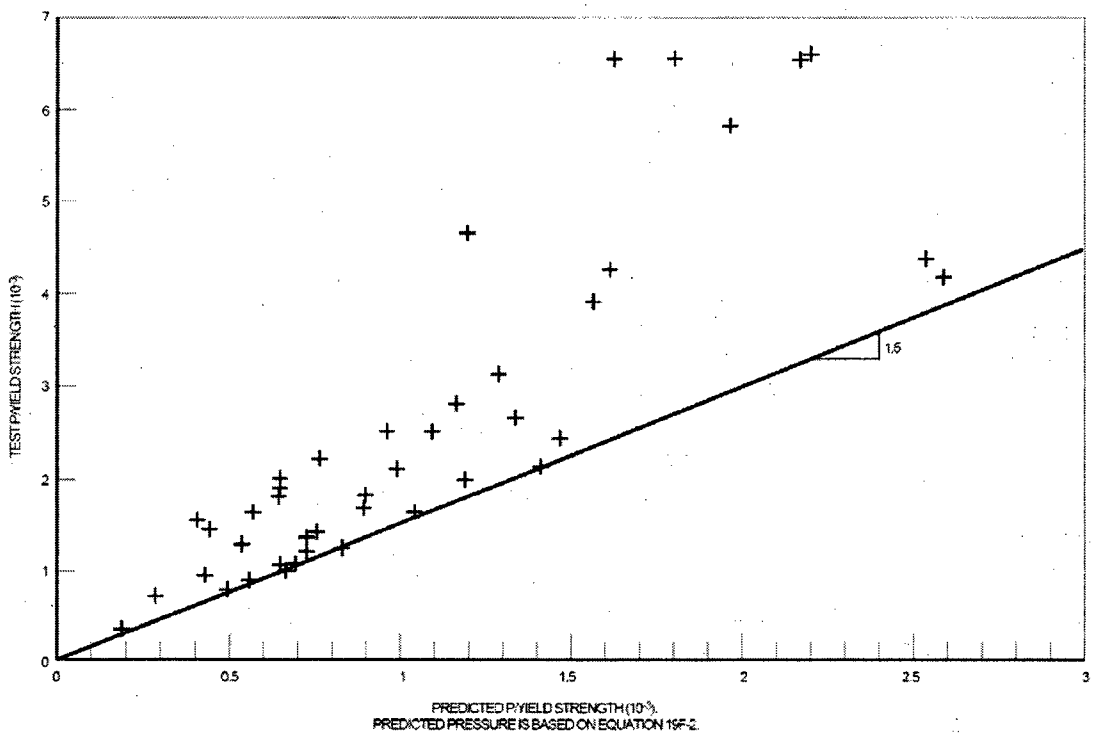


Figure B.8-2. Torispherical Head Buckling Test Data

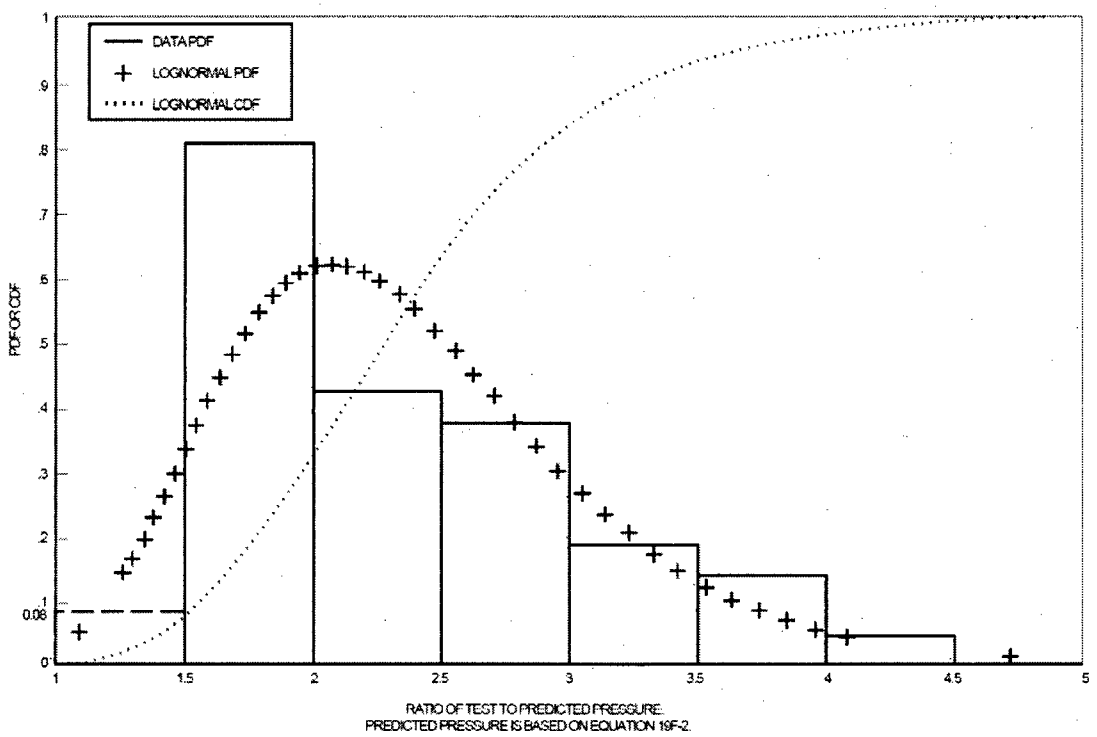
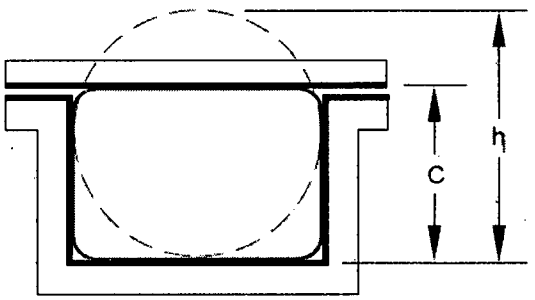


Figure B.8-3. Torispherical Head Buckling Test Data Statistical Distribution



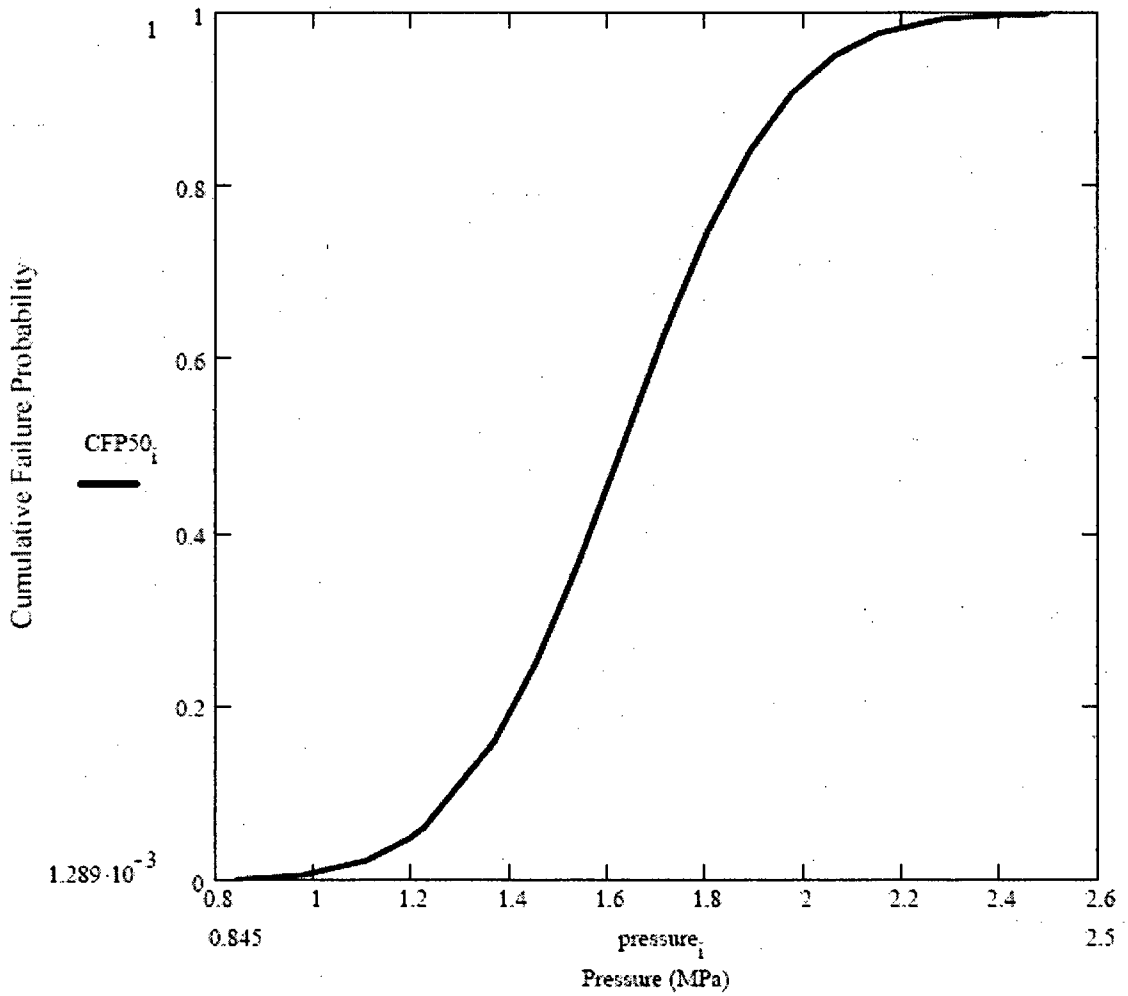
$Sq = (h - C)/h$

WHERE

h = INITIAL SEAL HEIGHT

C = COMPRESSED SEAL HEIGHT IN NORMAL OPERATIONS

Figure B.8-4. Definition of Squeeze for Seals



Cumulative F. P. Pmed=1.632MPa,COV=.16

Figure B.8-5. Cumulative Containment Failure Probability

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C.8 CONTAINMENT PENETRATION SCREENING ANALYSIS

The purpose of this appendix is to present the screening analysis of the containment penetrations identified in DCD Section 6.2.

Section 4.18 documents containment isolation with the perspective of analyzing pipe breaks outside of containment for the Level 1 analysis. In this appendix, a screening evaluation is performed to identify those containment penetrations that could potentially lead to offsite consequences. The screening analysis found that there were no penetrations that required isolation to prevent significant offsite consequences. Thus, the containment isolation function, as applied to the Level 2 analysis, was modeled considering only the isolation signal common to all penetration paths, as discussed in Appendix A.8. The probability of CIS failure is a point estimate that is independent of the Level 1 sequence.

To further clarify the robust containment isolation provided in ESBWR, a screening analysis of the containment penetrations identified in DCD Section 6.2 is performed as follows:

Each of the containment penetrations included in Section 6.2 of the DCD (identified here as Table C.8-1) has been reviewed to select those that potentially could induce:

- a loss of reactor coolant outside the containment,
- a release of radioactive materials outside the containment, in the event of an accident concurrent with a failure of the isolation function.

Next the review identifies those containment penetrations that could potentially lead to off-site consequences. Containment penetrations were eliminated from further analysis if they met one of the following Level 2 screening criteria:

A. Penetrations with normally closed isolation valves.

B. Penetrations connected to a closed system inside the containment.

C. Penetrations having isolation valves plus a closed system outside the containment and with normal operating pressure greater than the expected accident pressure.

D. Penetrations for which isolation failure during an accident event without core damage would not result in an increase of radioactive release compared with normal operation.

Instrument and monitoring lines were not included in this analysis. These RCCV mechanical penetrations are very small (~20 mm, or ¾ in diameter) lines whose failures have negligible contribution to offsite releases.

The containment penetrations screened out and the applicable screening criteria are indicated in Table C.8-1.

Table C.8-1

Containment Penetrations

Penetration ID	Description	Valves				Level 2 Screening Criterion[1]	Level 1 Model
	MAIN STEAM LINE A	F001A	F002A	F016A			Analyzed as BOC-MS
	MAIN STEAM LINE B	F001B	F002B	F016B			Analyzed as BOC-MS
	MAIN STEAM LINE C	F001C	F002C	F016C			Analyzed as BOC-MS
	MAIN STEAM LINE D	F001D	F002D	F016D			Analyzed as BOC-MS
MSL # 3	MAIN STEAM LINE DRAINS	F010	F011			A	
MFWL # 1	FEEDWATER SYSTEM (LINE A)	F102A	F103A				Analyzed as BOC-FDWA
MFWL # 2	FEEDWATER SYSTEM (LINE B)	F102B	F103B				Analyzed as BOC-FDWB
IC # 1A	ISOLATION CONDENSER SYSTEM (LOOP A) STEAM SUPPLY	F001A	F002A			C	Analyzed as BOC-IC
IC # 2A	ISOLATION CONDENSER SYSTEM (LOOP A) CONDENSATE RETURN	F003A	F004A			C	Analyzed as BOC-IC

Table C.8-1

Containment Penetrations

Penetration ID	Description	Valves				Level 2 Screening Criterion[1]	Level 1 Model
IC # 3A	ISOLATION CONDENSER SYSTEM (LOOP A) UPPER HEADER VENT	F007A	F008A			C	
IC # 4A	ISOLATION CONDENSER SYSTEM (LOOP A) LOWER HEADER VENT	F009A	F010A	F011A	F012A	C	
IC # 5A	ISOLATION CONDENSER SYSTEM (LOOP A) PURGE LINE	F014A				C	
IC # 1B	ISOLATION CONDENSER SYSTEM (LOOP B) STEAM SUPPLY	F001B	F002B			C	Analyzed as BOC-IC
IC # 2B	ISOLATION CONDENSER SYSTEM (LOOP B) CONDENSATE RETURN	F003B	F004B			C	Analyzed as BOC-IC
IC # 3B	ISOLATION CONDENSER SYSTEM (LOOP B) UPPER HEADER VENT	F007B	F008B			C	
IC # 4B	ISOLATION CONDENSER SYSTEM (LOOP B) LOWER HEADER VENT	F009B	F010B	F011B	F012B	C	
IC # 5B	ISOLATION CONDENSER SYSTEM (LOOP B) PURGE LINE	F014B				C	

Table C.8-1

Containment Penetrations

Penetration ID	Description	Valves				Level 2 Screening Criterion[1]	Level 1 Model
IC # 1C	ISOLATION CONDENSER SYSTEM (LOOP C) STEAM SUPPLY	F001C	F002C			C	Analyzed as BOC-IC
IC # 2C	ISOLATION CONDENSER SYSTEM (LOOP C) CONDENSATE RETURN	F003C	F004C			C	Analyzed as BOC-IC
IC # 3C	ISOLATION CONDENSER SYSTEM (LOOP C) UPPER HEADER VENT	F007C	F008C			C	
IC # 4C	ISOLATION CONDENSER SYSTEM (LOOP C) LOWER HEADER VENT	F009C	F010C	F011C	F012C	C	
IC # 5C	ISOLATION CONDENSER SYSTEM (LOOP C) PURGE LINE	F014C				C	
IC # 1D	ISOLATION CONDENSER SYSTEM (LOOP D) STEAM SUPPLY	F001D	F002D			C	Analyzed as BOC-IC
IC # 2D	ISOLATION CONDENSER SYSTEM (LOOP D) CONDENSATE RETURN	F003D	F004D			C	Analyzed as BOC-IC

Table C.8-1

Containment Penetrations

Penetration ID	Description	Valves				Level 2 Screening Criterion[1]	Level 1 Model
IC # 3D	ISOLATION CONDENSER SYSTEM (LOOP D) UPPER HEADER VENT	F007D	F008D			C	
IC # 4D	ISOLATION CONDENSER SYSTEM (LOOP D) LOWER HEADER VENT	F009D	F010D	F011D	F012D	C	
IC # 5D	ISOLATION CONDENSER SYSTEM (LOOP D) PURGE LINE	F014D				C	
RWCU # 1	REACTOR WATER CLEANUP/SDC SYSTEM	F002A	F003A			C	Analyzed as BOC-RWCU
RWCU # 2	REACTOR WATER CLEANUP/SDC SYSTEM	F002B	F003B			C	Analyzed as BOC-RWCU
RWCU # 3	REACTOR WATER CLEANUP/SDC SYSTEM	F007A	F008A			C	Analyzed as BOC-RWCU
RWCU # 4	REACTOR WATER CLEANUP/SDC SYSTEM	F007B	F008B			C	Analyzed as BOC-RWCU
RWCU# 5	REACTOR WATER CLEANUP/SDC SYSTEM	F038A	F039A			A	
RWCU # 6	REACTOR WATER CLEANUP/SDC SYSTEM	F038B	F039B			A	
SLC # 1	STANDBY LIQUID CONTROL SYSTEM	F004A	F005A			C	

Table C.8-1

Containment Penetrations

Penetration ID	Description	Valves				Level 2 Screening Criterion[1]	Level 1 Model
SLC # 2	STANDBY LIQUID CONTROL SYSTEM	F004B	F005B			C	
FAPC # 1	FUEL AND AUXILIARY POOLS COOLING SYSTEM	F309	F310			C	
FAPC # 2	FUEL AND AUXILIARY POOLS COOLING SYSTEM	F306	F307			C	
FAPC # 3	FUEL AND AUXILIARY POOLS COOLING SYSTEM	F323	F324			C	
FAPC # 4	FUEL AND AUXILIARY POOLS COOLING SYSTEM	F303	F304			C	
FAPC # 5	FUEL AND AUXILIARY POOLS COOLING SYSTEM	F321				C	
CAC # 1	CONTAINMENT INERTING SYSTEM	F009	F023	F025	F028	C	
CAC # 2	CONTAINMENT INERTING SYSTEM	F007	F008	F023	F024	C	
CAC # 3	CONTAINMENT INERTING SYSTEM	F010	F011	F014	F015	A	
CAC # 4	CONTAINMENT INERTING SYSTEM	F011	F012			A	
CWS # 1 (A+B)[2]	CHILLED COOLING WATER SYSTEM	F001 (A+B)	F002 (A+B)			B	

Table C.8-1

Containment Penetrations

Penetration ID	Description	Valves				Level 2 Screening Criterion(1)	Level 1 Model
CWS # 2 (A+B)[2]	CHILLED COOLING WATER SYSTEM	F003 (A+B)	F004 (A+B)			B	
HPNSS # 1[2]	HIGH PRESSURE NITROGEN SUPPLY SYSTEM	F010A	F011A			C	
HPNSS # 3[2]	HIGH PRESSURE NITROGEN SUPPLY SYSTEM	F003	F004			C	

Notes:

(1) Level 2 Screening Criteria

A. Penetrations with normally closed isolation valves.

B. Penetrations connected to a closed system inside the containment.

C. Penetrations having isolation valves plus a closed system outside the containment and with normal operating pressure greater than the expected accident pressure.

D. Penetrations for which isolation failure during an accident event without core damage would not result in an increase of radioactive release compared with normal operation.

(2) Assumed configuration. Detailed design specified as a COL Applicant responsibility in the DCD

9 SOURCE TERMS

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9 SOURCE TERMS

As discussed in Sections 8 and 21, the containment response to a severe accident is depicted by the end states of containment event trees. These end states become the "release categories" that are used to characterize potential source terms. The source terms will be used in the offsite consequence analysis presented in Section 10.

Table 9-1 summarizes the ESBWR release categories and associated frequencies. As indicated in the table, the release category "TSL", which depicts an intact containment with only leakage providing a source term, is the most likely release category. Other release categories have much lower calculated frequencies. For conservatism, a truncation frequency was used to represent some of these release categories. Specifically, if the calculated probability of the category was less than 10^{-12}, the truncation value of 10^{-12} was carried forward for the consequence evaluation.

The source term evaluation was performed with the MAAP computer code, which produces the distribution of radionuclides released to the environment as a function of time. Each release category is represented by a severe accident sequence that was selected and modeled to represent the group of potential severe accidents that could be associated with that release category. The selection is based on several factors, including the frequency of the various sequences that lead to the end state and the spectrum of response for the various sequences. The selected sequence provides a conservative basis for the source term quantification. The following sections describe the representative sequences and the bases for choosing them. As indicated in the following sections, conservative assumptions were typically made to account for analytical and phenomenological uncertainties. Table 9-1 includes the representative MAAP sequences as well as the time of initial release, and cumulative release fractions of noble gas and CsI at 24 and 72 hours after onset of core damage. Tables 9-2 and 9-3 provide the radionuclide release spectrum for 24 and 72 hours after onset of core damage, respectively.

9.1 BREAK OUTSIDE OF CONTAINMENT (BOC)

The release category "Break Outside-of-Containment" represents sequences in which the RPV communicates directly with the environment due to an unisolated piping break that connects the RPV directly to an area outside of containment. From the Level 1 PRA, two outside-containment break locations contributed to the core damage frequency: breaks in a feedwater line and breaks in a RWCU/SDC line. The RWCU/SDC break event tree includes both a mid-level connection to the RPV and a lower head drain line connection. Although the largest contribution to outside-containment break is associated with the feedwater line, selecting the RWCU/SDC pipe break is conservative because its lower elevation in the RPV results in a more rapid loss of coolant inventory. The mid-level location was selected to represent the BOC release category rather than the drain line because the smaller drain line break produced a lower release fraction.

Therefore, the representative sequence for this category is "BOCsd_nIN". This is an unisolated break outside of containment in the shutdown cooling piping followed by no injection into the RPV. In this scenario, the release begins at the onset of fuel damage and proceeds directly to the environment.

9.2 CONTAINMENT BYPASS (BYP)

The release category "Bypass" represents those sequences in which containment isolation has not occurred due to failure of the CIS function. Thus, there is a direct path from the containment atmosphere to the environment when the severe accident is initiated.

To determine the source term, a large diameter pipe opening was assumed from the time of accident initiation. Sequences in which the RPV is depressurized generally result in an earlier time to core uncovery than those involving failure to depressurize. As a result, the source term is generated earlier and the containment radionuclide concentration is developed earlier because of the path through the DPVs into containment. The low pressure sequences dominate the risk and such a sequence was selected to evaluate the BYP release category. Because of the reliability of the deluge system (i.e., the probability of BYP with failed deluge is below the truncation level), the representative sequence is modeled with deluge success and is termed "T_nIN_BYP".

9.3 CORE-CONCRETE INTERACTION DRY (CCID)

The release category "Core-Concrete Interaction-Dry" applies to sequences in which the containment fails due to core concrete interaction and the lower drywell debris bed is uncovered i.e., the deluge function is unsuccessful.

In these sequences, the core-concrete interaction is not limited by water cooling the debris bed, nor is the radionuclide release limited by the potential scrubbing action of an overlying water pool. Sequences in which the RPV is not depressurized may result in earlier RPV failure, thus initiating earlier CCI. However, sensitivity runs indicate that the potential difference in release fraction between high and low pressure sequences is small in comparison to their relative probabilities. Thus, a low pressure sequence was selected to represent the CCID source term category. The sequence is termed "T_nIN_nD_CCID" to indicate a transient with successful depressurization, but failure of the injection and deluge functions.

9.4 CORE-CONCRETE INTERACTION-WET (CCIW)

The release category "Core-Concrete Interaction-Wet" applies to sequences in which the containment fails due to core concrete interaction even though the lower drywell debris bed is covered with water. In such sequences, the deluge system has functioned to cover the debris bed with water, but the BiMAC is not successful in assuring debris bed cooling. The extent of water penetration into the debris bed, independent of the BiMAC, and thus, the potential for debris bed cooling, is subject to assumption. In the worst-case hypothetical condition, the debris bed is impermeable by the overlying water pool and the extent of CCI could approach that of a dry debris bed. To address this uncertainty associated with the debris bed coolability, the debris bed was modeled as being impermeable, thus maximizing the core-concrete interaction that could occur with an overlying water pool. Unlike the CCID release category, the overlying water pool is present, which provides the potential for scrubbing of the radionuclides evolved from the debris bed.

The representative sequence is termed "T_nIN_CCIW" and differs from the representative CCID sequence only in that the deluge system functions.

9.5 DIRECT CONTAINMENT HEATING (DCH)

The release category "Direct Containment Heating" applies to sequences in which the RPV fails at high pressure and a significant DCH event occurs. From Section 21.3, catastrophic containment failure due to DCH is physically unreasonable but local damage to the liner in the lower drywell cannot be excluded. A conservative approach was used to develop the source term associated with potential DCH damage, specifically assuming that

- Localized DCH effects in the lower drywell could damage wiring, instrumentation or other components such that the deluge system would not function and
- Damage to the lower drywell liner would not result in a direct release path to the environment due to the liner arrangement and backing with structural concrete but would provide a failure area much larger than that associated with normal leakage.

The dominant Class III sequence, a transient with no depressurization and no injection provided the basis for the DCH release category. To address the two points above, the sequence was modeled with deluge failure and a containment failure area that was a factor of 10 larger than that associated with Technical Specification leakage. The representative sequence is termed "T_nDP_nIN_nD_DCH".

9.6 EX-VESSEL STEAM EXPLOSION (EVE)

The release category "Ex-vessel Steam Explosion" applies to sequences in which the RPV fails at low pressure and a significant steam explosion occurs. As indicated in Section 21.4, containment leak tightness and failure of the BiMAC function is physically unreasonable for all but 1% of the sequences contributing to the core damage frequency. A conservative approach was used to develop the source term associated with an EVE, specifically:

- Liner damage was assumed to be significant enough to result in containment depressurization, which occurs at the time of RPV failure,
- No credit was taken for mitigation of the release; i.e., liner damage was assumed to result in direct communication with the environment, and
- Due to uncertainties about potential equipment damage and the distribution of water through containment after the EVE, no credit is taken for a lower drywell water pool that would minimize the source term.

The dominant Class I sequence, a transient with no injection and successful RPV depressurization, provided the basis for this category. To address the preceding points, the sequence was modeled with deluge failure and containment failure occurring at the time of RPV failure. The representative sequence is termed "T_nIN_nD_EVE".

9.6.1 EVE (CCIW*)

The release category applies to the end state depicted in containment event trees shown in Appendix A.8 in which containment failure due to an EVE occurs, but the associated source term would be mitigated by an overlying water pool, i.e. the path in which the initial lower drywell water level exceeded 1.5 meters. For conservatism, no credit is taken for the overlying water pool in the source term evaluation. Thus, the same source term applicable to end state EVE is used to represent this end state and its release category frequency is added to the EVE frequency.

9.7 FILTERED RELEASE (FR)

The ESBWR design includes the potential to manually vent the containment from the suppression chamber air space. This action may be implemented to limit the containment pressure increase if containment heat removal fails or core-concrete interaction generates enough non-condensables to overpressurize the containment. Venting the suppression chamber forces the radionuclides through the suppression pool, which reduces the magnitude of the source term.

To represent the FR category, a sequence with failure to insert negative reactivity was conservatively selected because such a sequence would pressurize containment more quickly than the much more probable non-ATWS sequences. The sequence assumes RPV failure at low pressure, consistent with sequences which dominate the core damage frequency. Operator guidance regarding venting has not been developed, but it is assumed that venting would be delayed until containment integrity is threatened. The analysis assumes that venting does not occur until the containment pressure reaches 90% of the containment ultimate strength. No credit was given in the analysis for closing the vent after reducing the containment pressure. The representative sequence is termed "T-AT_nIN _nCHR_FR".

9.8 OVERPRESSURE-VACUUM BREAKER (OPVB)

The release category "OPVB" applies to sequences in which vacuum breaker failure has occurred. Failure of vacuum breakers to close, or to be open in a pre-existing condition, results in failure of the containment pressure suppression function, which in turn also fails containment heat removal. Thus, such sequences would be expected to result in an earlier release than overpressure sequences with failure of containment heat removal alone.

Review of the containment event trees in Appendix A.8 indicates that vacuum breaker failure is more likely for sequences in which the RPV fails at high pressure. Thus, a Class III sequence was selected as representative of this category. The event trees also illustrate that the OPVB category is logically reached only if deluge/BiMAC function successfully. Thus, the sequence termed "T_nDP_nIN_VB" is used to represent the OPVB release category.

9.9 OVERPRESSURE- EARLY CONTAINMENT HEAT REMOVAL LOSS (OPW1)

The release category "OPW1" applies to sequences in which containment heat removal fails within 24 hours after event initiation. A sequence with RPV failure at high pressure was selected to represent this release category because RPV failure generally occurs earlier than if the vessel were depressurized and the loss of containment heat removal failure probability is higher than for low pressure sequences. Thus, the representative sequence becomes "T_nDP_nIN_nCHR_W1". Containment heat removal is conservatively assumed to be unavailable for the duration of the sequence.

9.10 OVERPRESSURE- LATE CONTAINMENT HEAT REMOVAL LOSS (OPW2)

The release category "OPW2" applies to sequences in which containment heat removal fails after the period covered by OPW1 and up to 72 hours after onset of core damage. In such sequences, the passive PCCS system becomes unavailable after 24 hours due to failure to connect to a supplemental water pool; FAPCS availability is also evaluated at this time. The representative sequence is the same as that used for OPW1 except that containment heat removal is terminated

at 24 hours after event initiation, consistent with the PCCS design basis. The representative sequence is termed "T_nDP_nIN_nCHR_W2".

9.11 TECHNICAL SPECIFICATION LEAKAGE (TSL)

The category "Technical Specification Leakage" applies to sequences in which the containment is intact and the only release is due to the maximum leak rate allowed by Technical Specifications. Sequence T_AT_DP was selected as representative of this category because the core damage time is relatively early for ATWS sequences. For additional conservatism, the area of containment leakage corresponding to the maximum allowable Technical Specification leak rate was doubled to produce the representative source term used for this release category. The representative source term is termed "T-AT_nIN_TSL2x".

9.12 SUMMARY

Potential release categories were defined in Sections 8 and 21. The source terms associated with each release category were developed using MAAP simulations of a representative sequence. Conservative assumptions were used in the selection and simulation of the representative sequence. Table 9-1 summarizes the release category, representative sequence and the cumulative release fractions for noble gases and CsI. Table 9-2 provides source terms for the period 24 hours after onset of core damage. Table 9-3 provides source terms for the period 72 hours after onset of core damage. The source terms and associated release category frequencies are used in the offsite consequence analysis described in Section 10.

Table 9-1

Release Categories

Release Category	Representative Sequence	Frequency (per reactor-year)	Time to Initial Release (hr)	Noble Gas Release Fraction @24 hrs after onset of core damage	CsI Release Fraction @24 hrs after onset of core damage	Noble Gas Release Fraction @72 hrs after onset of core damage	CsI Release Fraction @72 hrs after onset of core damage
BOC	BOCsd_nIN	4E-12	0.6	1.0E+00	8.5E-01	1.0E+00	8.5E-01
BYP	T_nIN_BYP	1E-12	0.5	9.7E-01	4.0E-01	9.8E-01	4.3E-01
CCID	T_nIN_nD_CCID	2.9E-11	14.8	9.1E-01	6.9E-02	9.2E-01	5.3E-01
CCIW	T_nIN_CCIW	2.9E-10	19.3	9.1E-01	8.0E-04	9.2E-01	1.1E-02
DCH	T_nDP_nIN_nD_DCH	<1E-12	4.5	9.0E-01	4.5E-01	9.0E-01	8.0E-01
EVE	T_nIN_nD_EVE	2.5E-10	6.3	8.3E-01	2.5E-02	8.4E-01	2.5E-01
FR	T-AT_nIN _nCHR_FR	2.3E-10	28.5	0.0E+00	0.0E+00	1.0E+00	9.8E-06
OPVB	T_nDP_nIN_VB	<1E-12	18.1	9.1E-01	3.6E-04	9.9E-01	2.8E-01
OPW1	T_nDP_nIN_nCHR_W1	<1E-12	25.4	1.9E-01	1.7E-04	9.9E-01	6.0E-01
OPW2	T_nDP_nIN_nCHR_W2	1.4E-11	40.8	0.0E+00	0.0E+00	9.9E-01	3.8E-02
TSL	T-AT_nIN_TSL2x	2.8E-8	0.3	2.0E-03	1.5E-04	2.0E-03	1.5E-04

Table 9-2

Radionuclide Source Terms (Release Fraction 24 hours after onset of core damage)

Release Category	Xe/Kr	CsI	TeO_2	SrO	MoO_2	CsOH	BaO	La_2O_3	CeO_2	Sb	Te_2	UO_2
BOC	1.0E+00	8.5E-01	7.5E-01	1.5E-02	7.2E-02	3.8E-01	1.5E-02	6.1E-04	3.4E-03	1.5E-01	6.1E-03	2.9E-05
BYP	9.7E-01	4.0E-01	1.9E-01	1.6E-02	1.2E-01	3.5E-01	2.9E-02	5.3E-04	3.3E-03	2.4E-01	4.3E-03	2.4E-05
CCID	9.1E-01	6.9E-02	6.8E-02	2.2E-06	4.7E-06	2.8E-02	1.3E-05	1.3E-07	1.0E-06	1.5E-01	1.4E-02	2.3E-07
CCIW	9.1E-01	8.0E-04	5.9E-05	1.4E-06	4.5E-06	7.6E-04	1.1E-06	1.3E-07	7.6E-07	2.6E-03	3.1E-05	7.9E-09
DCH	9.0E-01	4.5E-01	1.2E-01	3.2E-04	2.7E-04	6.2E-02	3.1E-04	3.1E-04	3.2E-04	8.1E-02	1.1E-04	9.6E-08
EVE	8.3E-01	2.5E-02	6.4E-02	1.3E-02	1.1E-04	7.1E-02	5.7E-03	8.2E-04	6.2E-03	2.1E-01	6.8E-03	5.0E-05
FR	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
OPVB	9.1E-01	3.6E-04	8.2E-04	1.4E-04	1.2E-04	4.9E-03	1.4E-04	1.4E-04	1.4E-04	1.7E-03	2.4E-05	0.0E+00
OPW1	1.9E-01	1.7E-04	2.4E-04	6.0E-07	2.0E-07	5.7E-04	5.8E-07	6.0E-07	6.0E-07	1.3E-02	2.6E-06	0.0E+00
OPW2	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
TSL	2.0E-03	1.5E-04	9.5E-05	2.1E-06	3.9E-05	5.3E-05	7.7E-06	7.3E-08	2.0E-07	9.9E-05	4.6E-08	1.0E-10

Table 9-3

Radionuclide Source Terms (Release Fraction 72 hours after onset of core damage)

Release Category	Xe/Kr	CsI	TeO_2	SrO	MoO_2	CsOH	BaO	La_2O_3	CeO_2	Sb	Te_2	UO_2
BOC	1.0E+00	8.5E-01	7.5E-01	1.5E-02	7.2E-02	3.8E-01	1.5E-02	6.1E-04	3.4E-03	1.5E-01	6.1E-03	2.9E-05
BYP	9.8E-01	4.3E-01	2.3E-01	1.6E-02	1.2E-01	3.7E-01	2.9E-02	5.3E-04	3.3E-03	5.0E-01	1.2E-02	2.4E-05
CCID	9.2E-01	5.3E-01	2.3E-01	2.3E-06	5.1E-06	3.2E-01	2.2E-05	1.4E-07	1.1E-06	3.5E-01	1.5E-02	3.0E-07
CCIW	9.2E-01	1.1E-02	2.7E-03	1.4E-06	4.5E-06	2.5E-02	1.1E-06	1.3E-07	7.6E-07	6.8E-03	6.5E-05	7.9E-09
DCH	9.0E-01	8.0E-01	2.2E-01	3.2E-04	2.7E-04	1.5E-01	3.2E-04	3.2E-04	3.2E-04	2.7E-01	1.1E-04	1.6E-07
EVE	8.4E-01	2.5E-01	1.4E-01	1.3E-02	1.1E-04	3.4E-01	5.7E-03	8.2E-04	6.2E-03	5.4E-01	9.8E-03	5.0E-05
FR	1.0E+00	9.8E-06	8.1E-07	1.1E-08	1.9E-07	4.6E-05	3.2E-08	4.1E-10	1.5E-09	2.5E-03	2.9E-05	1.0E-11
OPVB	9.9E-01	2.8E-01	3.9E-02	1.7E-03	1.2E-04	3.4E-02	8.7E-04	1.5E-04	3.1E-04	7.1E-02	3.1E-05	5.2E-07
OPW1	9.9E-01	6.0E-01	2.1E-01	1.6E-03	4.3E-07	1.4E-01	7.5E-04	5.8E-06	1.8E-04	1.6E-01	3.2E-05	5.9E-07
OPW2	9.9E-01	3.8E-02	5.7E-02	1.2E-03	2.0E-07	4.3E-02	5.7E-04	3.9E-06	1.4E-04	1.0E-01	1.5E-05	3.4E-07
TSL	2.0E-03	1.5E-04	9.5E-05	2.1E-06	3.9E-05	5.5E-05	7.7E-06	7.3E-08	2.0E-07	1.2E-04	4.8E-08	1.0E-10

10 CONSEQENCE ANALYSIS

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10 CONSEQENCE ANALYSIS

10.1 INTRODUCTION

This section describes the offsite consequence evaluation. Key inputs and assumptions are described. The calculated results are compared to consequence related goals to determine if the goals are satisfied.

The MACCS2 Version 1.12 computer code (Reference 10-1) is used to determine the consequences of potential reactor accidents. The MACCS2 code evaluates offsite dose and consequences such as early fatality risk and latent cancer fatality risk for each source term (i.e., radionuclide release category) over a range of possible weather conditions and evacuation assumptions. The MACCS2 code model is described in Reference 10-1. The rationale for site related input selection is presented in Subsection 10.2. Other more generic input parameters for the MACCS2 analysis are based on "Sample Problem A" of Reference 10-1. ESBWR specific reference data from the plant performance analysis in Section 8.0 and Section 9.0 are used as MACCS2 inputs as presented in Subsection 10.3. The calculated consequence results are compared to the goals in Subsection 10.4.

10.2 SITE ASSUMPTIONS

The evaluation of the offsite consequences of a reactor accident is closely tied to the site parameters (e.g., weather, population, land use). For probabilistic offsite consequence evaluations, site related assumptions are required.

The subsections below describe the rationale for the site meteorology, population, and evacuation. The following tables describe these inputs:

Table	Inputs
10-1	Population Density
10-2	Shielding and Exposure Parameters

10.2.1 Meteorology

In the original WASH-1400 analysis (Reference 10-3), a number of actual site meteorological data were used. However, the original WASH-1400 meteorology data files are not compatible with the MACCS2 code. For this study, the ALWR URD (Reference 10-6) meteorological reference data set is used, which is indicative of meteorological data significantly worse than the average U.S. site. Therefore, the results in this study are not indicative of an average U.S. site as was the original purpose of Reference 10-3, but represents a generally bounding evaluation for most U.S. sites.

10.2.2 Population

For the ESBWR consequence evaluation, the SANDIA Siting Study population density data (Table 3-2 of Reference 10-4) is used to develop a uniform population density corresponding to each spatial interval. The population distribution is developed for distances to 0.5, 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 miles from the site. The three offsite consequence goals defined for the ESBWR are concerned with consequences within 10 miles of the site; therefore, a bounding 0-10 mile population density is used. The maximum 0-10 mile population distribution value from the "all" sites column of Table 3-2 of Reference 10-4 is used for the ESBWR consequence evaluation and is provided in Table 10-1. As can be seen from Table 10-1, the 0-5 mile population density is larger than the 5-10 mile population density and is used in this bounding analysis as a constant uniform density for the entire 0-50 mile region. This approach provides a more bounding 0-10 mile population density than that provided in the ALWR URD (Reference 10-6).

10.2.3 Evacuation

Many evacuation related characteristics (local roads, population demographics, emergency services) are quite site specific. No guidance is provided by the NRC for generic evacuation evaluations. The evacuation parameters used in this study are conservative assumptions in that no evacuation or relocation in terms of physical movement are assumed and no sheltering is assumed. The public is assumed to continue normal activity during the reactor accident in this bounding analysis. Shielding and

exposure values used for normal activity are the standard MACCS2 assumptions and are provided in Table 10-2.

Table 10-2 provides the following information for people engaged in normal activity:

- Cloudshine Shielding Factor – Fraction of cloudshine dose received from direct external exposure to the plume
- Inhalation Protection Factor – Fraction of inhalation dose received from cloud inhalation
- Breathing Rate – Breathing rate for people in normal activity
- Skin Protection Factor – Fraction of skin dose received from material deposited on skin
- Groundshine Shielding Factor – Fraction of groundshine dose received from material deposited on the ground

10.3 MACCS2 RADIONUCLIDE RELEASE INPUT DATA

10.3.1 MACCS2 Radionuclide Release Input Data

ESBWR specific radionuclide release data is used in this analysis to model the dispersion of a plume of material released to the environment during a reactor accident.

The following tables describe these inputs:

Table	Inputs
10-3	Building Data for Meteorological Modeling of Wake Effects
10-4	Core Inventory Parameters
10-5A	Reactor Accident Release Parameters 24 Hours After the Onset of Core Damage
10-5B	Reactor Accident Release Parameters 72 Hours After the Onset of Core Damage
10-6	Nuclide Release Categories

10.3.2 ESBWR Release Parameters

ESBWR specific parameters are used for wake effect data, core inventory, and reactor thermal power. The width and height of the building wake are used by MACCS2 to model the initial plume dimensions. These parameters for the ESBWR are provided in Table 10-3.

The core inventory and reactor thermal power used in this analysis are ESBWR specific and are provided in Table 10-4. These parameters are used to determine the inventory of each nuclide in the core at accident initiation.

10.3.3 Input to MACCS2 from MAAP

The severe accident sequence analysis (i.e., MAAP) results provide input parameters to the MACCS2 code and are described here and are shown in Table 10-5A and Table 10-5B. Table 10-5A provides the release parameters 24 hours after the onset of core damage, and Table 10-5B provides the release parameters 72 hours after the onset of core damage. The severe accident sequence analysis performed using the MAAP code is further described in Section 8.0. The representative MAAP cases used as MACCS2 inputs are summarized in Section 9.0. Important input release characteristics include the nuclide release time, duration, and fraction. The MAAP cases are used to develop source terms for each release category for the consequence analysis. Tables 10-5A and 10-5B describe the eleven (11) source terms and corresponding radionuclide release categories used for the MACCS2 analysis.

For each source term which represents a release category from Section 8.0, the following data are used (Table 10-5A and Table 10-5B):

- Source Term – Source term developed from the severe accident analysis that characterizes the release category. The source terms are summarized in Section 9.0.
- Release Category – Release category represented by the source term
- MAAP Case – Severe accident sequence analysis results which are used to develop each source term. Section 8.0 provides a summary of the MAAP cases.
- Release Frequency – The frequency per year associated with the radionuclide release category.
- Time of Plume Release – Time (hr) from reactor shutdown (time of accident initiation) until the time of the modeled plume release to the atmosphere. This parameter is based on the severe accident analysis discussed in Section 8.0 results and is approximately the time when the CsI release from containment begins.
- Duration of Release - Duration of release (hr) of radionuclides from the plant is used to determine the dispersion of the release cloud. Each MAAP case for the ESBWR was performed for 72 hours after the onset of core damage. MACCS2 limits the duration of an individual plume to a maximum of 10 hours. Source terms in which the release flattens out after a short time (i.e., less than 10 hours) are characterized by a release duration corresponding to the time the release starts to the time the release flattens out. Each release fraction is reviewed in determining the release duration, with special attention given to the nuclides with the greatest offsite consequence impacts (i.e., iodine and cesium).

- NG – Release fraction of Noble gases from containment to the environment.
- CsI – Release fraction of Iodine from containment to the environment

For this bounding assessment no warning time is assumed. This is the time between official notification of public and release of radioactivity from the plant.

For each source term, the release is modeled to occur at ground level. The thermal content of the plume is assumed to be the same as ambient (i.e., buoyant plume rise is not modeled). These assumptions are conservative for early fatalities based on Reference 10-4.

MAAP provides results for twelve (12) nuclide release fractions from containment to the atmosphere. These nuclide release fractions are related to the MACCS2 release groups as shown in Table 10-6.

The fission product releases for each source term as a fraction of total core inventory are provided in Section 9. MAAP cases that represent each source term are summarized in Section 8.

10.4 COMPARISON OF RESULTS TO GOALS

10.4.1 Goals

Three major offsite consequence-related goals are established in the GE ESBWR Licensing Review Bases based on the NRC Safety Goal Policy Statement. These goals are:

(1) Individual Risk Goal

The risk to an average individual in the "vicinity" of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one tenth of one percent (0.1%) of the sum of "prompt fatality risks" resulting from other accidents to which members of the U.S. Population are generally exposed. As noted in the Safety Goal Policy statement, "vicinity" is defined as the area within 1.61 km (1 mile) of the plant site boundary. "Prompt Fatality Risks" are defined as those risks to which the average individual residing in the vicinity of the plant is exposed to as a result of normal daily activities. Such risks are the sum of risks that result in fatalities from such activities as driving, household chores, occupational activities, etc. For this evaluation, the sum of prompt fatality risks is taken as the U.S. accidental death risk value of 39.1 deaths per 100,000 people per year based upon Reference 10-7.

(2) Societal Risk Goal

The risk to the population in the area "near" a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one tenth of one percent (0.1%) of the sum of the "cancer fatality risks" resulting from all other causes. As noted in the Safety Goal Policy Statement, "near" is defined as within 16.1 km (10 miles) of the plant. The "cancer fatality risk" is taken as 169 deaths per 100,000 people per year based upon 1983 statistics in Reference 10-8.

(3) Radiation Dose Goal

The probability of exceeding a whole body dose of 0.25 sv at a distance of 805 m (one half mile) from the reactor shall be less than one in a million per reactor year.

The calculated ESBWR consequence results are compared to these goals in the following subsection.

10.4.2 Results

The mean results from the offsite consequence analysis for each source term are shown in Table 10-7A and Table 10-7B. Table 10-7A provides the results 24 hours after the onset of core damage, and Table 10-7B provides the results 72 hours after the onset of core damage. These results are multiplied by the annual release frequency for each source term and then summed to obtain the risk weighted mean consequence results. These results are compared to the consequence goals identified in Section 10.4.1 and

summarized in Table 10-8. A plot of whole body dose at a distance of 805 m (one half mile) against cumulative probability is shown in Figure 10-1. As can be seen, the whole body dose at 805m (0.5 miles) over the entire dose spectrum from 0.1 Sv to >100 Sv is well below the goal of 1E-6/yr exceedance frequency.

Based upon these results, the ESBWR meets the established consequence related goals with substantial margin.

10.5 REFERENCES

10-1 Chanin, D. and Young, M., Code Manual for MACCS2: User's Guide, NUREG/CR-6613, Vol. 1 (SAND97-0594), May1998.

10-2 Spring, J.L. et al, Evaluation of Severe Accident Risks: Quantification of Major Input Parameters, MACCS Input NUREG/CR-4551, December 1990.

10-3 Reactor Safety Study, Appendix 6: Calculation of Reactor Accident Consequences, WASH-1400 (NUREG 75/014), October 1975.

10-4 Aldrich, D.C., et al, Technical Guidance for Siting Criteria Development NUREG/CR-2239, December 1982.

10-5 Criteria for preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654.

10-6 Murley, T.E., Advanced Boiling Water Reactor Licensing Review Bases, Project No. 671, August 7, 1987.

10-7 Accident Facts, 1988, National Safety Council.

10-8 1986 Cancer Facts and Figures, American Cancer Society, 90 Park Ave, New York, NY 10016.

Table 10-1

Population Distribution

Radial Interval	Maximum Population	
	All Sites (people per sq. mi.)	All Sites (people per sq. km.)
0-5 mi (0-8.1 km)	790	305
5-10 mi (8.1-16.1 km)	700	270
10-20 mi (16.1-32.2 km)	730	282
20-30 mi (32.2-48.3 km)	2000	772
30-50 mi (48.3-80.5 km)	2500	965

Data taken from Reference 10-4, Table 3-2.

The 0-5 mile population density (790 people per square mile) is used in the ESBWR bounding analysis as a uniform density for all radial intervals in the 0-50 mile region.

Table 10-2

Shielding and Exposure Data

MACCS2 Parameter	Normal Activity Value
Cloudshine Shielding Factor	0.75
Inhalation Protection Factor	0.41
Breathing Rate (m^3/sec)	2.66E-04
Skin Protection Factor	0.41
Groundshine Shielding Factor	0.33

See Subsection 10.2.3 for additional description of parameters in this table.

All values are based on Reference 10-1

Table 10-3

Site and Reactor Data for Meteorological Modeling

Parameter	Measurement (m)	Measurement (ft)
Reactor Building Length	49.0 m	160 ft.
Reactor Building Width	49.0 m	160 ft.
Reactor Building Height	47.7 m	156 ft.
Fuel Building Length	49.0 m	160 ft.
Fuel Building Height	17.8 m	58 ft.

Table 10-4

ESBWR Core Inventory

ESBWR Core Power is 4500 MWt			
Nuclide	**Bq/MWt**	**Nuclide**	**Bq/MWt**
Co-58	5.10E+12	Te-131m	1.42E+14
Co-60	4.92E+12	Te-132	1.41E+15
Kr-85	1.23E+13	I-131	9.90E+14
Kr-85m	2.73E+14	I-132	1.44E+15
Kr-87	5.27E+14	I-133	2.04E+15
Kr-88	7.42E+14	I-134	2.25E+15
Rb-86	2.35E+12	I-135	1.91E+15
Sr-89	9.93E+14	Xe-133	2.03E+15
Sr-90	9.76E+13	Xe-135	6.72E+14
Sr-91	1.25E+15	Cs-134	1.98E+14
Sr-92	1.34E+15	Cs-136	6.89E+13
Y-90	1.01E+14	Cs-137	1.28E+14
Y-91	1.27E+15	Ba-139	1.84E+15
Y-92	1.34E+15	Ba-140	1.77E+15
Y-93	1.55E+15	La-140	1.82E+15
Zr-95	1.70E+15	La-141	1.68E+15
Zr-97	1.69E+15	La-142	1.62E+15
Nb-95	1.71E+15	Ce-141	1.68E+15
Mo-99	1.89E+15	Ce-143	1.56E+15
Tc-99m	1.68E+15	Ce-144	1.36E+15
Ru-103	1.50E+15	Pr-143	1.53E+15
Ru-105	1.00E+15	Nd-147	6.69E+14
Ru-106	5.21E+14	Np-239	1.93E+16
Rh-105	9.10E+14	Pu-238	3.34E+12
Sb-127	1.03E+14	Pu-239	4.02E+11
Sb-129	3.15E+14	Pu-240	5.21E+11
Te-127	1.05E+14	Pu-241	1.51E+14
Te-127m	1.37E+13	Am-241	1.70E+11
Te-129	3.10E+14	Cm-242	4.01E+13
Te-129m	4.60E+13	Cm-244	1.94E+12

Table 10-5A

Event Release Parameter

24 Hours After the Onset of Core Damage[(1),(2)]

Source Term	Release Category	MAAP CASE	Release Frequency (per year)	Time of Plume Release	Duration of Release[(3)]	NG[(4)] Release Fraction	CsI[(4)] Release Fraction
1	BOC	BOCsd_nIN	4E-12	0.6 hr	2.5 hr	1.0E+0	8.5E-1
2	BYP	T_nIN_BYP	1E-12	0.5 hr	2.2 hr	9.7E-1	4.0E-1
3	CCID	T_nIN_nD_CCID	2.9E-11	14.8 hr	10 hr	9.1E-1	6.9E-2
4	CCIW	T_nIN_CCIW	2.9E-10	19.3 hr	5.8 hr	9.1E-1	8.0E-4
5	DCH	T_nDP_nIN_nD_DCH	<1E-12	4.5 hr	10 hr	9.0E-1	4.5E-1
6	EVE	T_nIN_nD_EVE	2.5E-10	6.3 hr	10 hr	8.3E-1	2.5E-2
7	FR	T-AT_nIN_nCHR_FR	2.3E-10	NA	NA	0.0E+0	0.0E+0
8	OPVB	T_nDP_nIN_VB	<1E-12	18.1 hr	7.1 hr	9.1E-1	3.6E-4
9	OPW1	T_nDP_nIN_nCHR_W1	<1E-12	25.4 hr	0.1 hr	1.9E-1	1.7E-4
10	OPW2	T_nDP_nIN_nCHR_W2	1.4E-11	NA	NA	0.0E+0	0.0E+0
11	TSL	T-AT_nIN_TSL2x	2.8E-8	0.3 hr	10 hr	2.0E-3	1.5E-4

Note:

(1) See Subsection 10.3.3 for definition of parameters in this table.

(2) For this bounding analysis, release height is ground level and release sensible heat is same as ambient.

(3) The release parameters are based on the 24 hours after the onset of core damage value. Each MAAP case for the ESBWR was performed for 72 hours after the onset of core damage. MACCS2 limits the duration of an individual plume to a maximum of 10 hours. Source terms in which the release flattens out after a short time (i.e., less than 10 hours) are characterized by a release duration corresponding to the time the release starts to the time the release flattens out. In general, the nuclides with the greatest offsite consequences (i.e., Iodine and Cesium) are conservatively used.

(4) Noble Gases (NG) and Cesium Iodine (CsI) release fractions are the cumulative release fractions at 24 hours after the onset of core damage.

Table 10-5B
Event Release Parameter
72 Hours After the Onset of Core Damage[(1),(2)]

Source Term	Release Category	MAAP CASE	Release Frequency (per year)	Time of Plume Release	Duration of Release[(3)]	NG[(4)] Release Fraction	CsI[(4)] Release Fraction
1	BOC	BOCsd_nIN	4E-12	0.6 hr	2.5 hr	1.0E+0	8.5E-1
2	BYP	T_nIN_BYP	1E-12	0.5 hr	2.2 hr	9.8E-1	4.3E-1
3	CCID	T_nIN_nD_CCID	2.9E-11	14.8 hr	10 hr	9.2E-1	5.3E-1
4	CCIW	T_nIN_CCIW	2.9E-10	19.3 hr	10 hr	9.2E-1	1.1E-2
5	DCH	T_nDP_nIN_nD_DCH	<1E-12	4.5 hr	10 hr	9.0E-1	8.0E-1
6	EVE	T_nIN_nD_EVE	2.5E-10	6.3 hr	10 hr	8.4E-1	2.5E-1
7	FR	T-AT_nIN_nCHR_FR	2.3E-10	28.5 hr	10 hr	1.0E+0	9.8E-6
8	OPVB	T_nDP_nIN_VB	<1E-12	18.1 hr	10 hr	9.9E-1	2.8E-1
9	OPW1	T_nDP_nIN_nCHR_W1	<1E-12	25.4 hr	10 hr	9.9E-1	6.0E-1
10	OPW2	T_nDP_nIN_nCHR_W2	1.4E-11	40.8 hr	10 hr	9.9E-1	3.8E-2
11	TSL	T-AT_nIN_TSL2x	2.8E-8	0.3 hr	10 hr	2.0E-3	1.5E-4

Note:

(1) See Subsection 10.3.3 for definition of parameters in this table.

(2) For this bounding analysis, release height is ground level and release sensible heat is same as ambient.

(3) Each MAAP case for the ESBWR was performed for 72 hours after the onset of core damage. MACCS2 limits the duration of an individual plume to a maximum of 10 hours. Source terms in which the release flattens out after a short time (i.e., less than 10 hours) are characterized by a release duration corresponding to the time the release starts to the time the release flattens out. In general, the nuclides with the greatest offsite consequences (i.e., Iodine and Cesium) are conservatively used.

(4) Noble Gases (NG) and Cesium Iodine (CsI) release fractions are the cumulative release fractions

at 72 hours after the onset of core damage.

Table 10-6

MACCS2 Release Groups vs. ESBWR Release Groups

MACCS2 Release Groups	MAAP Release Groups	MAAP Output Parameter
1-Xe/Kr	noble gases	FREL (1)
2-I	CsI	FREL (2)
3-Cs	CsOH	FREL (6)
4-Te	TeO2[1] (Sb[1] & Te2[2] fractions are included)	FREL (3), FREL (10) and FREL (11)
5-Sr	SrO	FREL (4)
6-Ru	MoO2 (Mo is in Ru MACCS category)	FREL (5)
7-La	La2O3	FREL (8)
8-Ce	CeO2 (included UO2[2] in this category)	FREL (9) and FREL (12)
9-Ba	BaO	FREL (7)

(1) The larger release fraction of TeO2 and Sb is used as input into MACCS2.

(2) Te2 and UO2 release fractions are negligible.

Table 10-7A

MACCS2 ESBWR Consequence Results by Source Term

24 Hours After the Onset of Core Damage

Source Term	Release Category	Release Frequency (per yr)	Individual Risk (0-1 mile) (1)	Weighted Individual Risk (per year) (2)	Weighted Individual Risk Contribution (% (3)	Societal Risk (0-10 miles) (4)	Weighted Societal Risk (per year) (5)	Weighted Societal Risk Contribution (% (6)	Prob.of Dose ≥2 Sv (0-0.5 mile) (7)	Weighted Prob of Exceedance (per year) (8)	Weighted Dose Contribution (% (9)
1	BOC	4.0E-12	8.84E-02	3.54E-13	1.36	1.09E-02	4.36E-14	0.91	1.00E+00	4.00E-12	0.18
2	BYP	1.0E-12	7.62E-02	7.62E-14	0.29	1.50E-02	1.50E-14	0.31	1.00E+00	1.00E-12	0.05
3	CCID	2.9E-11	8.32E-02	2.41E-12	9.31	5.19E-03	1.51E-13	3.14	1.00E+00	2.90E-11	1.34
4	CCIW	2.9E-10	9.33E-04	2.71E-13	1.04	3.42E-04	9.92E-14	2.07	8.30E-01	2.41E-10	11.13
5	DCH	1.0E-12	9.38E-02	9.38E-14	0.36	8.40E-03	8.40E-15	0.18	1.00E+00	1.00E-12	0.05
6	EVE	2.5E-10	9.08E-02	2.27E-11	87.56	1.08E-02	2.70E-12	56.26	1.00E+00	2.50E-10	11.56
7	FR	2.3E-10	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00
8	OPVB	1.0E-12	2.27E-03	2.27E-15	0.01	9.30E-04	9.30E-16	0.02	9.77E-01	9.77E-13	0.05
9	OPW1	1.0E-12	1.44E-02	1.44E-14	0.06	5.85E-04	5.85E-16	0.01	7.76E-01	7.76E-13	0.04
10	OPW2	1.4E-11	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00
11	TSL	2.8E-08	0.00E+00	0.00E+00	0.00	6.36E-05	1.78E-12	37.11	5.84E-02	1.64E-09	75.61
Total	--	2.9E-08	--	2.59E-11	100.00	--	4.80E-12	100.00	--	2.16E-09	100.00

Notes to Table 10-7A

1. The individual risk is calculated as the total number of early fatalities within one mile divided by the total one mile population
2. The weighted individual risk is the individual risk per year and is calculated as the product of the release category release frequency and the release category individual risk
3. The weighted individual risk contribution is the percentage of a release category's weighted individual risk to the total weighted individual risk
4. The societal risk is calculated as the total number of latent fatalities within ten miles divided by the total ten mile population
5. The weighted societal risk is the societal risk per year and is calculated as the product of the release category release frequency and the release category societal risk
6. The weighted societal risk contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk
7. The probability of dose greater than 0.2 Sv is obtained from the MACCS2 output file and is provided in the form of CCDF tables
8. The weighted probability of exceedance is the probability of exceeding a dose greater than 0.2 Sv per year and is calculated as the product of the release category release frequency and the release category MACCS2 probability of dose greater than 0.2 Sv
9. The weighted probability of exceedance contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk

Table 10-7B

MACCS2 ESBWR Consequence Results by Source Term

72 Hours After the Onset of Core Damage

Source Term	Release Category	Release Frequency (per yr)	Individual Risk (0-1 mile) (1)	Weighted Individual Risk (per year) (2)	Weighted Individual Risk Contribution (% (3)	Societal Risk (0-10 miles) (4)	Weighted Societal Risk (per year) (5)	Weighted Societal Risk Contribution (% (6)	Prob.of Dose ≥2 Sv (0-0.5 mile) (7)	Weighted Prob of Exceedance (per year) (8)	Weighted Dose Contribution (% (9)
1	BOC	4.0E-12	8.84E-02	3.54E-13	0.96	1.09E-02	4.36E-14	0.73	1.00E+00	4.00E-12	0.13
2	BYP	1.0E-12	8.08E-02	8.08E-14	0.22	1.30E-02	1.30E-14	0.22	1.00E+00	1.00E-12	0.03
3	CCID	2.9E-11	1.00E-01	2.90E-12	7.85	1.05E-02	3.05E-13	5.08	1.00E+00	2.90E-11	0.93
4	CCIW	2.9E-10	2.17E-02	6.29E-12	17.04	1.40E-03	4.06E-13	6.78	1.00E+00	2.90E-10	9.33
5	DCH	1.0E-12	1.02E-01	1.02E-13	0.28	1.12E-02	1.12E-14	0.19	1.00E+00	1.00E-12	0.03
6	EVE	2.5E-10	1.04E-01	2.60E-11	70.41	1.31E-02	3.28E-12	54.65	1.00E+00	2.50E-10	8.04
7	FR	2.3E-10	1.43E-04	3.29E-14	0.09	1.58E-04	3.63E-14	0.61	6.83E-02	1.57E-11	0.51
8	OPVB	1.0E-12	8.00E-02	8.00E-14	0.22	5.82E-03	5.82E-15	0.10	1.00E+00	1.00E-12	0.03
9	OPW1	1.0E-12	9.49E-02	9.49E-14	0.26	8.93E-03	8.93E-15	0.15	1.00E+00	1.00E-12	0.03
10	OPW2	1.4E-11	7.05E-02	9.87E-13	2.67	3.86E-03	5.40E-14	0.90	1.00E+00	1.40E-11	0.45
11	TSL	2.8E-08	0.00E+00	0.00E+00	0.00	6.55E-05	1.83E-12	30.61	8.94E-02	2.50E-09	80.49
Total	--	2.9E-08	--	3.69E-11	100.00	--	5.99E-12	100.00	--	3.11E-09	100.00

Notes to Table 10-7B

1. The individual risk is calculated as the total number of early fatalities within one mile divided by the total one mile population
2. The weighted individual risk is the individual risk per year and is calculated as the product of the release category release frequency and the release category individual risk
3. The weighted individual risk contribution is the percentage of a release category's weighted individual risk to the total weighted individual risk
4. The societal risk is calculated as the total number of latent fatalities within ten miles divided by the total ten mile population
5. The weighted societal risk is the societal risk per year and is calculated as the product of the release category release frequency and the release category societal risk
6. The weighted societal risk contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk
7. The probability of dose greater than 0.2 Sv is obtained from the MACCS2 output file and is provided in the form of CCDF tables
8. The weighted probability of exceedance is the probability of exceeding a dose greater than 0.2 Sv per year and is calculated as the product of the release category release frequency and the release category MACCS2 probability of dose greater than 0.2 Sv
9. The weighted probability of exceedance contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk

Table 10-8

Consequence Goals and Results

Goal	Numerical Goal	ESBWR 24 Hours After the Onset of Core Damage	Safety Goal Achieved 24 Hours After the Onset of Core Damage	ESBWR 72 Hours After the Onset of Core Damage	Safety Goal Achieved 72 Hours After the Onset of Core Damage
Individual Risk (0 – 1 Mile)	$<3.9 \times 10^{-7}$ (0.1%)	2.6E-11	YES	3.7E-11	YES
Societal Risk (0 – 10 Mile)	$<1.7 \times 10^{-6}$ (0.1%)	4.8E-12	YES	6.0E-12	YES
Radiation Dose Probability at 0.25 Sv (0 – 0.5 Mile)	$<10^{-6}$	<2.2E-9	YES	<3.1E-9	YES

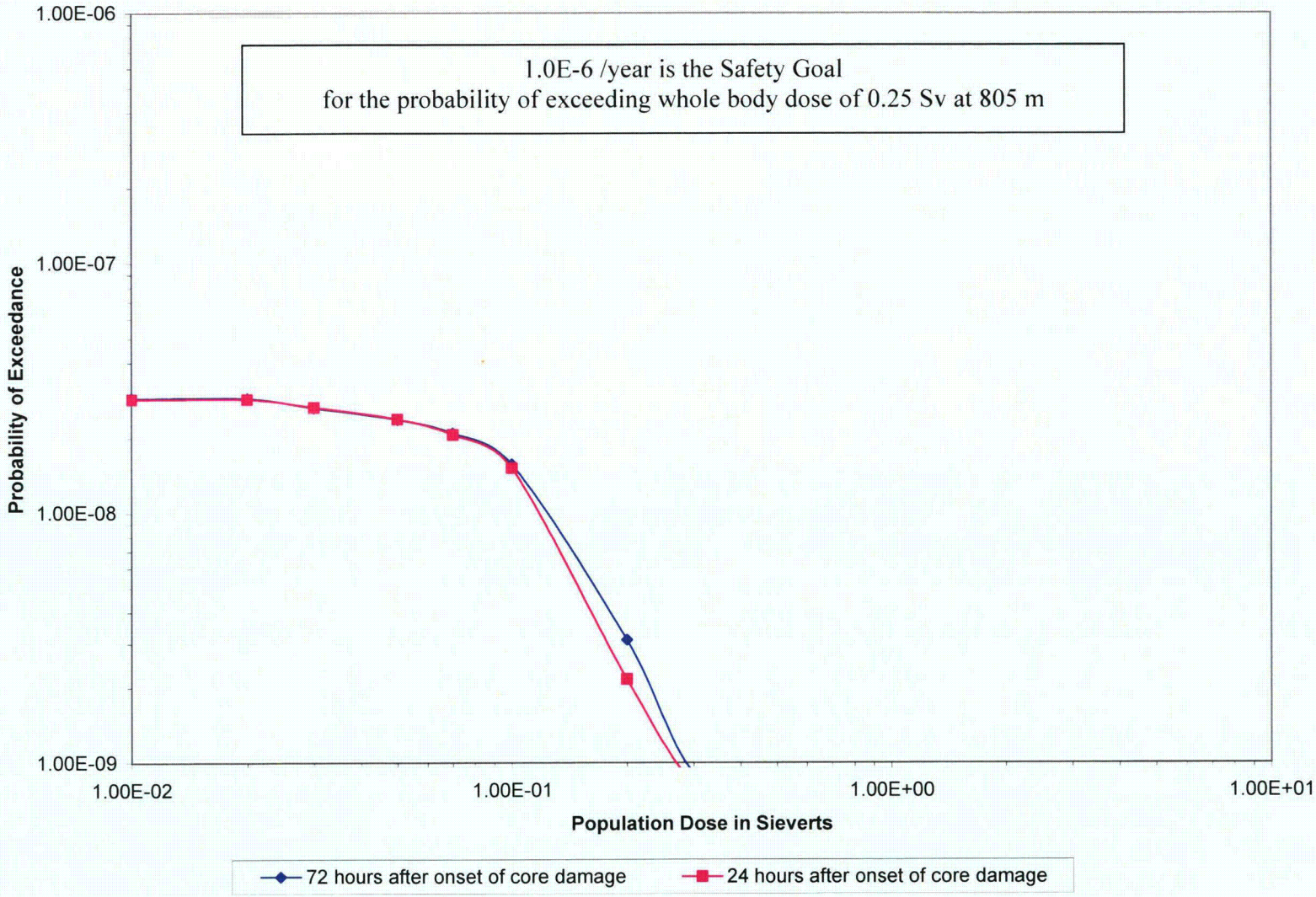

Figure 10-1. Whole Body Dose at 805 m (0.5 Mile) as Probability of Exceedance

*The goal of a maximum probability of 1E-6 is well above the entire dose range at 0.5 mile.

11 UNCERTAINTY AND SENSITIVITY ANALYSIS

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11 UNCERTAINTY AND SENSITIVITY ANALYSIS

11.1 INTRODUCTION

The purpose of this section is to summarize and document the activities carried out in the quantification with respect to the uncertainty and sensitivity analysis of the quantification results as part of the ESBWR PRA[1].

The first part of this section presents the aleatory uncertainty analysis that was performed on the internal events, full power PRA. A description of the analysis method, the data used, and the results are provided in Section 11.2.

The next part describes various sensitivity analyses that were performed to address decisions and assumptions that are embedded in the PRA model. Sensitivity analyses are provided for the chosen mission time of the PRA and the truncation level used in the PRA. Because squib valve reliability is very important in the ESBWR, a sensitivity analysis on the reliability of squib valves is presented. In addition, a sensitivity concerning the contribution of human actions is presented.

Finally, this section presents a summary of the focused PRA that was used to determine which non-safety systems should be part of the RTNSS programs. Chapter 20 provides a full discussion of RTNSS for ESBWR.

[1] In revision 0, this section contained a discussion of importance factors. Starting with revision 1, the importance factors are discussed in Chapter 18.

11.2 UNCERTAINTY ANALYSIS

The uncertainty calculations are performed using the Level 1 internal events, full power core damage cutsets that are described in Chapter 7. The purpose of this calculation is to show that the point estimate CDF calculated elsewhere in this document is an appropriate representation of plant risk given the uncertainties in the input data values.

The uncertainty calculation was performed using the Latin Hypercube sampling method. This method ensures that the upper and lower tails of the distributions are adequately covered in the sampling. The data uncertainty distribution parameters are presented in Chapter 5, Data Analysis. The distributions for all of the data are assumed to be lognormal.

The initial run of the uncertainty calculation provided a mean value that was much higher than the point estimate. This was investigated to determine the cause of this apparent anomaly. In many low level cutsets (below $2x10^{-12}$), there were terms that contained combination of basic events whose values were assigned inappropriately. These cutsets were associated with the spurious opening of multiple (3) BiMAC squib valves. The database contained an erroneously high valve for each valve because a 2-year test interval was assumed. This uncertainty analysis used corrected cutsets that take this into account.

The ESBWR CDF that was evaluated here retained cutsets that had only one spurious BiMAC squib valve open, but did not apply any recovery factor for isolation or credit for shutting down the reactor to prevent other events, i.e. LOCA. The cutsets that contained multiple spurious squib valves were eliminated from the results. This resulted in a point estimate CDF of $2.62x10^{-8}$ for the cutsets evaluated with the uncertainty code.

The parameters associated with the resulting CDF distribution are obtained using the uncertainty module from CAFTA. The Latin Hypercube sampling method was chosen for the quantification of the uncertainty parameters. The values below were obtained using 30,000 simulations.

Mean	2.64E-08
5%	3.34E-09
50%	1.50E-08
95%	8.28E-08

The graphics associated to the uncertainty calculation are shown in Figures 11-1 and 11-2 for the density function and cumulative distribution function, respectively.

This shows that the CDF distribution is still well away from any risk goal thresholds and that numerical uncertainty is not a significant risk driver for ESBWR.

11.3 SENSITIVITY ANALYSES

In order to address the importance of various assumptions in the PRA, a set of sensitivity analyses were performed. This section contains the results of those analyses.

The first assumption addressed is the mission time of the PRA. Like the PRA analyses for the operating plants, the ESBWR uses a 24-hour mission time to evaluate risk. This mission time is consistent with the linked fault tree methodology, which is a time-independent approximation of a fundamentally time-dependent analysis. This section provides a sensitivity analysis that extends the mission time of the PRA beyond 24 hours to 72 hours. It covers both the Level 1 and Level 2 PRA.

The next sensitivity is associated with the credit given for operation of non-safety systems to mitigate risk. It was used to validate the systems that are to be controlled in the Regulatory Treatment of Non-Safety Systems (RTNSS) program. This sensitivity also covers both the Level 1 and Level 2 PRA in a quantitative way.

The third sensitivity covers the selection of the truncation level for the PRA. Typical practice is for the truncation level to be set 5 orders of magnitude below the point estimate of the CDF. This sensitivity assesses if any of the objectives of the PRA would change due to a lower truncation value.

The fourth sensitivity addresses credit for human actions in the ESBWR PRA. It re-quantifies the Level 1 PRA without credit for any post initiator operator actions. Once again, the sensitivity assesses if any of the objectives of the PRA would change if no credit were given for post initiator operator actions.

The final set of sensitivity analyses address the data values used for important passive components. Passive components have not typically been treated in PRA analyses, so therefore the available data for those components is sparse. The only passive components that have a significant contribution in ESBWR are the squib valves in the ECCS system. This sensitivity looks at the PRA goals while varying the estimated failure rate of these valves.

11.3.1 Mission Time of the PRA

The ESBWR Level 1 Internal Events PRA does not include Class II accident sequences in the calculation of CDF. Class II accidents are those where the containment fails while the core is successfully cooled, and the core damage occurs later as a result of the effect that containment failure has on core cooling systems. Section 3.2.4 shows that, for the ESBWR, any core damage that occurs during a Class II sequence occurs later than 72 hours from the initiating event. The mission time of the ESBWR PRA is 24 hours.

The purpose of this sensitivity analysis is to determine the contribution to CDF of Class II accident sequences using an extended mission time of 72 hours.

For this purpose, the Class II accident sequences shown in the even trees of Appendix A.3 are further analyzed in this section. This analysis is performed using additional event trees, which are called Class II Core Cooling Vulnerability (CCV) event trees. Only Class II sequences resulting in a frequency above the truncation limit of 1.0×10^{-13} were further analyzed using the CCV event trees.

11.3.1.1 Class II CCV Event Tree Description

The CCV event trees are presented in Appendix A.11. These event trees take as initiating events the Class II end states of the Level 1 internal events event trees. At this point in each sequence, the containment has failed, but core cooling is still available. The mission time for core cooling is assumed to be 72 hours from the initiating event. Accident sequences resulting from the CCV event trees are grouped into three categories:

- CD-II: Accident sequences that have available cooling only from the GDCS and the suppression pool (i.e. passive systems) at the end of the CCV event trees. These Class II sequences lead to core damage following the end of the 72-hour mission.
- OK: Accident sequences that have additional cooling available from active systems. For these sequences, core damage can be avoided for much longer than the 72-hour mission.
- CD-V: Accident sequences that do not have any cooling available (from passive or active systems). These sequences appear in LOCA scenarios, after loss of the steam suppression function (Node DS). In these scenarios, core damage occurs before the end of the 72-hour mission but after containment failure. These sequences can be considered containment-bypass sequences because they have similar consequences to the Class V sequences described in the base PRA study.

The CCV event trees for transients include mainly the Fuel and Auxiliary Pool Cooling System (FAPCS) and the Fire Protection System (FPS) as additional active cooling systems to be used after successful water injection from GDCS and the suppression pool.

The Loss-of-Preferred-Power CCV event trees also take credit for recovery of offsite power within 24 hours. Most cutsets resulting from the LOPP Class II sequences already contain a short-term power recovery event. Therefore, the probability of failure to recover power within 24 hours, included in the CCV event trees, is conditional of the failure to recover power short term, already included in the model. The value of this probability was calculated based on data from NUREG/CR-INEEL/EXT-04-02326, "Evaluation of Loss of Offsite Power Events at Nuclear Power Plants: 1986 -- 2003 (Draft)", October 2004. Table 4-1 of the NUREG, shows a probability of offsite power recovery failure in 0.5 hours of 0.664, while the probability of offsite power recovery failure in 24 hours is 0.065. Therefore, the conditional probability of offsite recovery failure in 24 hours, given failure to recover in 0.5 hours, is 0.065/0.664 = 0.0979.

The only LOCA sequences resulting in a Class II CDF above the truncation limit of 1.0×10^{-13} are on the failure branch of the DS event-tree node, i.e., following failure of the Steam Suppression System. The CCV event trees shown in figures A.11-5 through A.11-9 represent the continuation of these sequences. Using the same success criteria for active systems as on the success path of the DS node, systems like Control Rod Drive (CRD), Feedwater (FDW), FAPCS and FPS were modeled before Node VG4. The only difference between these CCV sequences, and those modeled on the success branch of Node DS in Chapter 3 consists in the fact that containment will fail before core damage due to failure of the vacuum breakers, i.e., the steam suppression function.

MAAP analyses performed for the steam LOCA scenarios with immediate failure of the Steam Suppression System show that the water level in the vessel can be maintained above the top of active fuel for more than 72 hours with two out of the three GDCS pools, and one equalizing line from the suppression pool available. CCV event-tree node VG4 models this success criterion. For the liquid LOCA scenarios, the core uncovers between 60 and 72 hours for scenarios in which the vacuum breaker fails concurrent with the LOCA and the VG4 node is successful. The failure mode assumed here is the passive function of the vacuum breaker; it is more reasonable to consider an active failure following the first cycling of the vacuum breaker, which occurs much later in the scenario, if at all. In either case, the long time to core uncovery makes it appropriate to treat these the same as the steam LOCA scenarios.

Following success of the passive core cooling systems (success branch of VG4), active systems like Shutdown Cooling (SDC) or FAPCS in suppression pool cooling mode can be used to ensure core cooling far beyond the stated 72-hour mission.

11.3.1.2 Results of the 72-Hour-Mission-Time Sensitivity

Table 11-1 presents the results of the 72-hours-mission-time sensitivity analysis. The table includes all Class II sequences that result in a frequency above the truncation of 1.0×10^{-13} before being taken through the CCV event trees. Table 11-1 presents the results of the Class II sequence quantification both before, and after the CCV event trees.

All CD-V accident sequences have frequencies below a truncation limit, therefore, are considered negligible and results are not reported.

After the CCV event trees, the CDF resulting from accident Class II sequences was reduced to 4.26×10^{-11}, or 0.15% of total CDF. Given the 72-hour length of the mission time, this contribution to CDF could be reduced even further, through detailed recovery analysis at the cutset level. However, this was not considered necessary due to the already insignificant contribution of the Accident Class II sequences to total CDF.

The results of this sensitivity analysis justify not including Class II accident sequences in the calculation of the Level 1 Internal Events CDF, due to their insignificant contribution.

11.3.2 Importance of Non-Safety Systems

The objective of this PRA sensitivity is to evaluate the plant's capab ility to respond to an accident using only safety-related systems, and systems assigned to the Regulatory Treatment of Non-Safety Systems (RTNSS) program. The only systems assigned to the RTNSS program is the portion of the Fire Protection system used to refill the IC and PCCS pools and the BiMAC.

11.3.2.1 Core Damage Frequency Goal

Appendix B.11 presents the event trees used for quantifying the Level 1, internal events model, assuming only safety-related and RTNSS systems are available. These event trees were obtained from the internal-events event trees by eliminating all nodes modeling non-safety systems, except for Node WT modeling the long-term PCC pools inventory. The nodes were eliminated by deleting the success branch; therefore, elimination of these nodes removed any credit for the systems they used to model.

The following non-safety system headings were eliminated from this quantification:

- Power Conversion System
- CRD
- Feedwater and Condensate
- LPCI Mode of FAPCS
- SPC Mode of FAPCS
- SDC Mode of RWCU
- Fire Water Injection
- Containment Vent

A 24-hour mission time was used for this calculation. The CDF resulting from this quantification is 6.68×10^{-6} per year. The quantification for this sensitivity was run at 10^{-11}.

The top 50 cutsets from this sensitivity, representing 99.8% of CDF are presented in Table 11-5. The dominant initiating events are:

- Loss of Feedwater 42%
- Inadvertent Open Relief Valve 31%
- Loss of Preferred Power 21%
- Medium Liquid LOCA 3%
- Small Liquid LOCA 2%

The remaining initiating events each contribute less than 1% of the total.

The dominant failure modes are the common cause failure of GDCS and equalizing line injection valves and the common cause failure of DPVs. These make up 83% and 11%, respectively, of CDF. This is expected because in the top sequences, the ICS is not available due to depressurization of the plant, and the GDCS system is the only safety related injection mode.

11.3.2.2 Large Release Frequency Goal

The method of quantifying the containment event trees described in Chapter 8 was applied to the focused PRA. It is summarized below for the focused PRA calculation.

The systems used in the CSET have a slight dependence on some of the systems used in the Level 1 PRA.

There is a potential for power dependence for the vacuum breakers (node VB) and for the long term containment cooling (node W2). Therefore, the Level 1 results are separated into loss of preferred power (LOPP) sequences vs non-LOPP sequences. This was done by splitting the cutset files based on the initiating event.

The containment response is different based on the accident class. Therefore, the Level 1 results are separated by class. In all, 6 separate cases (subclasses) are generated.

1. Class I LOPP (IL)
2. Class I no-LOPP (IN)

3. Class III LOPP (IIIL)
4. Class III no-LOPP (IIIN)
5. Class IV (IV)
6. Class V (V)

Class IV did not contain any LOPP initiated cutsets. The cutsets for Class IV do not contain any failures that would preclude plant depressurization. Therefore, just as in the Chapter 8 base case, it is assumed that the Class IV sequences behave similar to Class I sequences. Also Class V goes directly to a release, so no CET processing is needed. There are no Class II sequences in the 24-hour PRA.

In Chapter 8, the LDW water level bins were determined on a sequence basis. In this chapter, they were determined on a cutset basis. The cutset binning based on the initiating event provides an acceptable method because the initiating event is the primary determining factor for this parameter. All cutsets with the following initiating events were assigned to a high water bin:

- Feedwater Line Breaks
- Medium Liquid LOCAs
- Small Liquid LOCAs

All other cutsets were assigned to a low water bin. Some of the small LOCAs could reasonably be considered to result in a medium water level, however it is conservative to assign them to the high water level bin.

The frequencies of the bins generated for this analysis are:

IN-HWL	3.44×10^{-7}
IN-LWL	4.93×10^{-6}
IL-LWL	1.39×10^{-6}
IIIN-HWL	4.79×10^{-9}
IIIN-LWL	1.00×10^{-8}
IIIL-LWL	6.3×10^{-11}
IV	1.11×10^{-10}
V	1.16×10^{-10}

Each of the CPET and CSET pairs for the subclasses are solved by assigning an initiator value based on the sum of the Level 1 sequences that make up the subclass, followed by nodal probabilities for the various branches. The probabilities assigned to the branches are based on criteria and models that are described later in this section. The event trees are then quantified by multiplying the node probabilities (or the complement on the success branches) for each sequence.

The following CPET/CSET nodes are independent of the Level 1 sequences:

- BI_FN Debris is Successfully Cooled

- BI_SP GDCS Deluge Supply to BiMAC Successful
- CIS Containment Isolation System
- DCH Containment Intact / Insignificant DCH
- EVE_DAM Pedestal Intact
- VT Vent Operation

These nodes are assigned the same value in all subclasses. The nodes themselves are described in either Chapter 8 or Chapter 21. The probabilities used for the CPET / CSET nodes are summarized in Table 11-3.

The event trees in different subclasses may have different probabilities assigned to the other nodes because of dependences with the Level 1 sequences. These nodes are:

- LD_LVL Water Level Prior to RPV Failure
- VB Vapor Suppression Function
- W1 Containment Heat Removal (Short Term: ~~2~~4 Hours)
- W2 Containment Heat Removal (Long Term: ~~2~~4 Hours)

Conditional probabilities for the node LD_LVL were calculated by identifying the sequences that contribute to the particular water level bin. The node probability is assigned according to the fraction of the total subclass frequency that results in the given water level condition. Conditional probabilities for the failure branches of CSET nodes VB, W1, and W2 were calculated by developing fault trees for these nodes, converting the subclass cutsets into fault trees, linking these fault trees using simple event trees, and quantifying these event trees using the cutset methodology. Conditional probabilities were then calculated based on the sequence quantification results of the simple event trees.

The system fault trees were generated by extracting the appropriate gates from the master model files of the Level 1 Internal Events Focused PRA. This way, all support systems are accounted for, consistently with the Level 1 model. The top gates of the systems modeled are:

VB = GT10-0001-_1

W1 = GT15TOP

W2 = GT15-0033-_1

Where:

GT10-0001-_1: Isolation of Vacuum Breaker Leaks Fails

GT15TOP: 3/6 PCCS Fail

GT15-0033-_1: Loss of Pool Water (72 hours)

These fault trees are shown in Chapter 4.

Accident sequences that result in containment failure in the in the CPETs are containment bypass sequences. Therefore, dependency of the CSET nodes on these sequences does not need to be considered, and they were not included in the CDF subclasses for Level 2 CSETs. All of the

LDW high water level cutsets are in this category. Table 11-3 contains the calculated conditional probabilities.

In the base PRA, an insignificant fraction of the Class III scenarios had high water in the lower drywell. In the focused PRA, however, some cutsets resulting in high water level in the lower drywell have a significant contribution. These cutsets were conservatively treated as containment failure scenarios. They are depicted in the CPET for Class III without LOPP using the LD_LVL node. This is shown in Figure 11-3.

The end states for each of the CETs were evaluated and are shown on Table 11-4. The total LRF for the focused PRA is 4.2×10^{-7}, which represents 6.3% of the focused PRA CDF of 6.68×10^{-6} per year.

Most of this, 5% of CDF, is associated with steam explosions caused by high water level in the LDW at the time of vessel failure. This compares to the base PRA value of 1% of CDF. The main reason for this is that in LOCAs, the ICS does not perform any useful function. Therefore, the active systems are the primary backup for GDCS. In transients, the active systems plus ICS are available in addition to GDCS. The relatively small increase in contribution, however, does not warrant designating any of the active systems RTNSS.

The other 1% of CDF that results in LRF is associated with the uncertainty of the BiMAC functionality. This is the same as in the base PRA.

Practically no containment systems contribute to LRF, therefore, no additional systems need to be considered for RTNSS based on the Focused Level 2 analysis.

11.3.3 Truncation Value

The ESBWR Internal Events PRA is quantified with a truncation value of 1.0×10^{-13}. This value is five orders of magnitude below CDF, and is sufficient to capture most of the risk. The 24-hour model was requantified using a truncation level of 1.0×10^{-14} to validate the selected truncation value. The result is presented in Table 11-2.

This quantification brings in an additional 79,000 cutsets, yet only increases the mean CDF by 8%. The dominating initiating events in the additional cutsets are Loss of Preferred Power (83%) and Loss of Feedwater (14%). The rest each contribute less than 2% each. These dominant initiators reflect the ESBWR overall risk profile. Therefore no new insight is brought in by this.

The basic event importance ranking was also reviewed for the lower truncation value. There are no new events that contribute a significant fraction to CDF than in the base case. There are a few common cause events that have a moderately high RAW value (between 10 and 100) that are added during this sensitivity. These are all in combination with other common cause failures in the cutsets and have a very low FV importance. Because of this, these should be reviewed by the expert panel in the D-RAP phase 2.

The additional sequences that were introduced by this sensitivity do not affect the calculation of LRF.

11.3.4 Human Reliability

The ESBWR Internal Events PRA model includes minimal credit for operator actions. This sensitivity is provided to demonstrate the contribution of the modeled human action to CDF.

The sensitivity is performed by setting all post-initiator human actions to TRUE, or always failed. The Level 1, internal events model is re-quantified to obtain the result. The result is presented in Table 11-2. The top 200 cutsets, representing 63% of CDF, are presented in Table 11-6.

The dominating initiating events in the additional cutsets are Loss of Preferred Power (57%) and Loss of Feedwater (38%). The rest each contribute less than 1.5% each. These dominant initiators reflect the ESBWR overall risk profile. Therefore no new insight is brought in by this.

The basic event importance ranking was also reviewed for the case without operator actions. There are four additional components that are identified as having a significant contribution (FV $\geq$ 0.005) in this sensitivity. These are in the service air system and in the electrical system, and should be reviewed by the expert panel in phase 2 of the D-RAP. There are a few common cause events that have a moderately high RAW value (between 10 and 100) that are added during this sensitivity. These are all in combination with other common cause failures in the cutsets and have a very low FV importance. Because of this, these should be reviewed by the expert panel in the D-RAP phase 2.

It is not useful to perform LRF based sensitivities for operator actions. First, because the total CDF estimated in this sensitivity is less than 10^{-6} per year, it is not possible to raise the LRF value above the goal. Second, there are no important operator actions credited in the LRF evaluation[2]. For example, removing containment vent from the LRF calculation would not affect the results because both the success of vent and the failure of containment due to overpressure are treated as large releases.

11.3.5 Squib Valve Reliability

The ESBWR PRA includes data for squib valve failures based on generic data. An increased failure rate was used for the squib valves located in harsh environments. The ESBWR passive systems relay heavily on squib valves; therefore, this sensitivity was performed to provide assurance that this component selection is appropriate.

Two sensitivity cases were analyzed, one with squib-valve failure rates increased by a factor of 5, and another one with the failure rates increased by a factor of 10. Common cause failure probabilities of squib valves were also increased by the same factors. The results are presented in Table 11-2.

The results of this sensitivity are expected. More than 80% of the CDF in ESBWR involves cutsets with squib valve failures. This would indicate that the CDF would vary linearly with the probability of squib valve failure. This sensitivity bears that out.

The base value used in the model for squib valve failure is fairly high in the first place. There is no reason to believe that these valves would fail at a higher rate than a currently available MOV.

[2] Isolation of the backup vacuum breaker was conservatively modeled as a purely manual action. In fact, the design of the vacuum breaker described in DCD Chapter 6 indicates that this isolation is an automatic feature. This automatic isolation makes the manual backup action much less important.

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Table 11-1

Results of the 72-Hour Mission Time Sensitivity Analysis

Initiating Event	Quantification Results without CCV Treatment				Quantification Results after CCV Treatment			
	Acc. Sequence	CDF [/yr]	% of Class	% of Total	Acc. Sequence	CDF [/yr]	% of Class	% of Total
T-GEN	T-GEN022	4.22E-13	0.02%	0.00%	T-CCV02	3.13E-11	73.46%	0.11%
	T-GEN025	1.97E-13	0.01%	0.00%				
T-FDW	T-FDW039	3.27E-11	1.30%	0.10%				
	T-FDW042	8.72E-13	0.03%	0.00%				
T-IORV	T-IORV023	4.86E-12	0.19%	0.02%				
	T-IORV010	3.01E-13	0.01%	0.00%	T-IORV010	3.01E-13	0.71%	0.00%
T-SW	T-SW005	4.58E-12	0.18%	0.01%	T-SW005	4.58E-12	10.75%	0.02%
	T-SW007	1.20E-12	0.05%	0.00%	T-SW007	1.20E-12	2.81%	0.00%
	T-SW014	6.38E-12	0.25%	0.02%	T-SWCCV02	4.04E-13	0.95%	0.00%
	T-SW016	2.68E-12	0.11%	0.01%				
T-LOPP	T-LOPP008	2.20E-13	0.01%	0.00%	T-LOPPACCV02	ε		
	T-LOPP011	1.03E-13	0.00%	0.00%				
	T-LOPP021	3.92E-12	0.16%	0.01%	T-LOPPBCCV03	4.82E-12	11.33%	0.02%
	T-LOPP024	1.83E-12	0.07%	0.01%				
	T-LOPP036	1.51E-11	0.60%	0.05%				
	T-LOPP039	1.13E-09	45.00%	3.56%				
	T-LOPP042	1.94E-10	7.74%	0.61%				
LL-S	LL-S-015	9.99E-10	39.79%	3.15%	LL-S-CCV05	ε		
LL-S-FDWA	LL-S-FDWA014	1.11E-11	0.44%	0.04%	LL-S-FDWACCV04	ε		
LL-S-FDWB	LL-S-FDWB014	1.11E-11	0.44%	0.04%	LL-S-FDWBCCV04	ε		
ML-L	ML-L-016	7.53E-11	3.00%	0.24%	ML-L-CCV05	ε		
ML-L-RWCU	ML-L-RWCU015	1.47E-11	0.58%	0.05%	ML-L-RWCUCCV04	ε		
Class II Totals:		**2.51E-09**	100.00%	**7.91%**		**4.26E-11**	100.00%	**0.15%**
Total CDF, without Class II:		**2.92E-08**				**2.92E-08**		
Total CDF, including Class II:		**3.17E-08**				**2.93E-08**		

Note: "ε" indicates that the accident sequence quantification did not produce any cutsets above the truncation limit of 1.0E-13

Table 11-2

Sensitivity Analysis Results Compilation

Case	CDF [/yr]
Base	2.92×10^{-8}
Non-Safety Systems Unavailable – 24-Hour Mission Time	6.68×10^{-6}
Truncation 1.0×10^{-14}	3.15×10^{-8}
No Operator Credit	1.49×10^{-7}
Squib Valve Failure Rate x 5	1.40×10^{-7}
Squib Valve Failure Rate x 10	2.81×10^{-7}

Table 11-3

Focused Level 2 Node Probabilities

	IL	IN	IIIL	IIIN	IVN
LD_L1	1.0	9.35E-01	1.0	6.77E-01	1.0
LD_L2		0.00E+00		0.00E+00	
LD_L3		6.52E-02		3.23E-01	
EVE_DAM		1.00E-03		1.00E-03	
DCH_DAM			1.00E-03	1.00E-03	
BI_SP	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
BI_FN	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
CIS	3.50E-05	3.50E-05	3.50E-05	3.50E-05	3.50E-05
VB	5.36E-06	5.38E-06	3.00E-04	1.30E-05	5.36E-06
W1	1.82E-04	1.82E-04	1.82E-04	1.82E-04	1.82E-04
W2	8.64E-07	1.10E-06	5.38E-03	4.22E-05	8.24E-07
VT	1.0	1.0	1.0	1.0	1.0

Table 11-4

Focused Level 2 End State Frequencies

	IL	IN	IIIL	IIIN	IVN	V	Totals
CCIW	1.39E-08	4.93E-08	6E-13	1.00E-10	1.1E-12		6.33E-08
CCID	1.39E-09	4.93E-09	ε	1.00E-11	1E-13		6.33E-09
EVE	0	0			0		0
EVE(CCIW)*	0	3.44E-07		4.79E-09	0		3.49E-07
DCH			ε	1.00E-11			1.01E-11
TSL	1.38E-06	4.88E-06	6.22E-11	9.92E-09	1.10E-10		6.26E-06
FR	0	0	0	0	0		0
OPW2	1.2E-12	5.4E-12	3E-13	4E-13	ε		7.30E-12
OPW1	2.51E-10	8.86E-10	ε	1.8E-12	ε		1.14E-09
OPVB	7.4E-12	2.63E-11	ε	1E-13	ε		3.38E-11
BYP	4.82E-11	1.71E-10	ε	3E-13	ε		2.19E-10
BOC						1.16E-10	1.16E-10

Table 11-5

Top 50 Cutsets for RTNSS Sensitivity Analysis

Probability	%	Class	Initiator	Basic Events	
1.39E-06	20.80%	CDI	%T-FDW	E50-SQV-CF-GDCS7OPEN	
1.39E-06	41.50%	CDI	%T-FDW	E50-SQV-CF-OPENALL	
6.90E-07	51.80%	CDIII	%T-IORV	B21-SQV-CF-DPVOPEN	
6.90E-07	62.20%	CDI	%T-IORV	E50-SQV-CF-GDCS7OPEN	
6.90E-07	72.50%	CDI	%T-IORV	E50-SQV-CF-OPENALL	
6.90E-07	82.80%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	
6.90E-07	93.10%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	
6.41E-08	94.10%	CDI	%SL-L-RWCU	E50-STR-CF-SPPLUG	
4.28E-08	94.70%	CDI	%SL-L	E50-STR-CF-SPPLUG	
3.33E-08	95.20%	CDI	%ML-L	E50-SQV-CO-F009A	E50-SYS-FF-MLLOCA
3.33E-08	95.70%	CDI	%ML-L	E50-SQV-CO-F009D	E50-SYS-FF-MLLOCA
3.33E-08	96.20%	CDI	%ML-L	E50-SQV-CO-F009E	E50-SYS-FF-MLLOCA
3.33E-08	96.70%	CDI	%ML-L	E50-SQV-CO-F009H	E50-SYS-FF-MLLOCA
3.33E-08	97.20%	CDI	%ML-L	E50-SQV-CO-F009I	E50-SYS-FF-MLLOCA
3.33E-08	97.70%	CDI	%ML-L	E50-SQV-CO-F009L	E50-SYS-FF-MLLOCA
1.11E-08	97.90%	CDI	%T-FDW	B21-LT_-CF-N001ABCD	
9.66E-09	98.00%	CDIII	%T-IORV	C51-ACT-CF-APRMSTUCK	
9.41E-09	98.20%	CDI	%ML-L	E50-STR-CF-SPPLUG	
9.06E-09	98.30%	CDIII	%SL-S	B21-SQV-CF-DPVOPEN	
9.06E-09	98.40%	CDI	%SL-S	E50-SQV-CF-GDCS7OPEN	
9.06E-09	98.60%	CDI	%SL-S	E50-SQV-CF-OPENALL	
6.66E-09	98.70%	CDI	%T-FDW	E50-OR_-CF-PLUGALL	
6.48E-09	98.80%	CDI	%T-FDW	E50-OR_-CF-7PLUG	
5.52E-09	98.90%	CDI	%T-IORV	B21-LT_-CF-N001ABCD	
5.52E-09	98.90%	CDI	%T-LOPP	B21-LT_-CF-N001ABCD	
5.13E-09	99.00%	CDI	%SL-L-RWCU	E50-SQV-CF-EQALLOPEN	
4.99E-09	99.10%	CDI	%LL-S	E50-SQV-CF-GDCS7OPEN	
4.99E-09	99.20%	CDI	%LL-S	E50-SQV-CF-OPENALL	
3.42E-09	99.20%	CDI	%SL-L	E50-SQV-CF-EQALLOPEN	
3.31E-09	99.30%	CDI	%T-IORV	E50-OR_-CF-PLUGALL	
3.31E-09	99.30%	CDI	%T-LOPP	E50-OR_-CF-PLUGALL	
3.22E-09	99.40%	CDI	%T-IORV	E50-OR_-CF-7PLUG	
3.22E-09	99.40%	CDI	%T-LOPP	E50-OR_-CF-7PLUG	
2.56E-09	99.50%	CDIII	%SL-L-RWCU	B21-SQV-CF-DPVOPEN	
2.56E-09	99.50%	CDI	%SL-L-RWCU	E50-SQV-CF-4OPEN	
2.56E-09	99.50%	CDI	%SL-L-RWCU	E50-SQV-CF-GDCS7OPEN	
2.05E-09	99.60%	CDI	%SL-L-RWCU	C74-DTM-CF-ALL	
1.83E-09	99.60%	CDI	%ML-L-RWCU	E50-STR-CF-SPPLUG	
1.71E-09	99.60%	CDIII	%SL-L	B21-SQV-CF-DPVOPEN	
1.71E-09	99.60%	CDI	%SL-L	E50-SQV-CF-4OPEN	

Table 11-5

Top 50 Cutsets for RTNSS Sensitivity Analysis

Probability	%	Class	Initiator	Basic Events	
1.71E-09	99.70%	CDI	%SL-L	E50-SQV-CF-GDCS7OPEN	
1.37E-09	99.70%	CDI	%SL-L	C74-DTM-CF-ALL	
7.60E-10	99.70%	CDI	%T-GEN	B21-SYS-FF-1/9OPEN	C71-SYS-FF-SCRAM
7.53E-10	99.70%	CDI	%ML-L	E50-SQV-CF-EQALLOPEN	
5.34E-10	99.70%	CDI	%SL-L-RWCU	C74-VLU-CF-ALL	
5.20E-10	99.70%	CDI	%T-FDW	E50-SQV-CF-4OPEN	E50-STR-CF-SPPLUG
4.60E-10	99.70%	CDI	%T-IORV	C71-SYS-FF-SCRAM	
3.76E-10	99.70%	CDIII	%ML-L	B21-SQV-CF-DPVOPEN	
3.76E-10	99.70%	CDI	%ML-L	E50-SQV-CF-4OPEN	
3.76E-10	99.80%	CDI	%ML-L	E50-SQV-CF-GDCS7OPEN	

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
3.20E-09	2.20%	CDI	%T-FDW	C12-XHE-MH-F013A	C12-XHE-MH-F013B	E50-SQV-CF-GDCS7OPEN	
3.20E-09	4.30%	CDI	%T-FDW	C12-XHE-MH-F013A	C12-XHE-MH-F013B	E50-SQV-CF-OPENALL	
3.20E-09	6.50%	CDI	%T-FDW	C12-XHE-MH-F013A	C12-XHE-MH-F015B	E50-SQV-CF-GDCS7OPEN	
3.20E-09	8.60%	CDI	%T-FDW	C12-XHE-MH-F013A	C12-XHE-MH-F015B	E50-SQV-CF-OPENALL	
3.20E-09	10.80%	CDI	%T-FDW	C12-XHE-MH-F013B	C12-XHE-MH-F015A	E50-SQV-CF-GDCS7OPEN	
3.20E-09	12.90%	CDI	%T-FDW	C12-XHE-MH-F013B	C12-XHE-MH-F015A	E50-SQV-CF-OPENALL	
3.20E-09	15.10%	CDI	%T-FDW	C12-XHE-MH-F015A	C12-XHE-MH-F015B	E50-SQV-CF-GDCS7OPEN	
3.20E-09	17.20%	CDI	%T-FDW	C12-XHE-MH-F015A	C12-XHE-MH-F015B	E50-SQV-CF-OPENALL	
2.22E-09	18.70%	CDI	%T-FDW	B21-UV_-CC-F102B	E50-SQV-CF-GDCS7OPEN		
2.22E-09	20.20%	CDI	%T-FDW	B21-UV_-CC-F102B	E50-SQV-CF-OPENALL		
2.22E-09	21.70%	CDI	%T-FDW	B21-UV_-CC-F103B	E50-SQV-CF-GDCS7OPEN		
2.22E-09	23.20%	CDI	%T-FDW	B21-UV_-CC-F103B	E50-SQV-CF-OPENALL		
2.22E-09	24.70%	CDI	%T-FDW	C12-UV_-CC-F022	E50-SQV-CF-GDCS7OPEN		
2.22E-09	26.20%	CDI	%T-FDW	C12-UV_-CC-F022	E50-SQV-CF-OPENALL		
1.59E-09	27.20%	CDI	%T-LOPP	C12-XHE-MH-F013A	C12-XHE-MH-F013B	E50-SQV-CF-GDCS7OPEN	
1.59E-09	28.30%	CDI	%T-LOPP	C12-XHE-MH-F013A	C12-XHE-MH-F013B	E50-SQV-CF-OPENALL	
1.59E-09	29.40%	CDI	%T-LOPP	C12-XHE-MH-F013A	C12-XHE-MH-F015B	E50-SQV-CF-GDCS7OPEN	
1.59E-09	30.40%	CDI	%T-LOPP	C12-XHE-MH-F013A	C12-XHE-MH-F015B	E50-SQV-CF-OPENALL	
1.59E-09	31.50%	CDI	%T-LOPP	C12-XHE-MH-F013B	C12-XHE-MH-F015A	E50-SQV-CF-GDCS7OPEN	
1.59E-09	32.60%	CDI	%T-LOPP	C12-XHE-MH-F013B	C12-XHE-MH-F015A	E50-SQV-CF-OPENALL	
1.59E-09	33.60%	CDI	%T-LOPP	C12-XHE-MH-F015A	C12-XHE-MH-F015B	E50-SQV-CF-GDCS7OPEN	
1.59E-09	34.70%	CDI	%T-LOPP	C12-XHE-MH-F015A	C12-XHE-MH-F015B	E50-SQV-CF-OPENALL	
1.10E-09	35.50%	CDI	%T-LOPP	B21-UV_-CC-F102B	E50-SQV-CF-GDCS7OPEN		
1.10E-09	36.20%	CDI	%T-LOPP	B21-UV_-CC-F102B	E50-SQV-CF-OPENALL		
1.10E-09	36.90%	CDI	%T-LOPP	B21-UV_-CC-F103B	E50-SQV-CF-GDCS7OPEN		
1.10E-09	37.70%	CDI	%T-LOPP	B21-UV_-CC-F103B	E50-SQV-CF-OPENALL		
1.10E-09	38.40%	CDI	%T-LOPP	C12-UV_-CC-F022	E50-SQV-CF-GDCS7OPEN		

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
1.10E-09	39.20%	CDI	%T-LOPP	C12-UV_-CC-F022	E50-SQV-CF-OPENALL		
4.23E-10	39.50%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTA1	
4.23E-10	39.70%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTA2	
4.23E-10	40.00%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTB1	
4.23E-10	40.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTB2	
4.23E-10	40.60%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTA1	
4.23E-10	40.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTA2	
4.23E-10	41.20%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTB1	
4.23E-10	41.40%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-TM-R16BTB2	
3.61E-10	41.70%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-CS-ALLDG	
3.61E-10	41.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-CS-ALLDG	
3.38E-10	42.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R22-RE_-FD-10A11	
3.38E-10	42.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R22-RE_-FD-10A21	
3.38E-10	42.60%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R22-RE_-FD-10A11	
3.38E-10	42.80%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R22-RE_-FD-10A21	
3.31E-10	43.10%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R21-DG_-FS-DGB
3.31E-10	43.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R21-DG_-FS-DGA
3.31E-10	43.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R21-DG_-FS-DGB
3.31E-10	43.70%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R21-DG_-FS-DGA
2.84E-10	43.90%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-FS-DGA
2.84E-10	44.10%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-FS-DGB
2.84E-10	44.30%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-FS-DGA
2.84E-10	44.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-FS-DGB
2.84E-10	44.70%	CDI	%T-LOPP	C12-XHE-MH-F003B	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
2.84E-10	44.90%	CDI	%T-LOPP	C12-XHE-MH-F003B	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
2.84E-10	45.10%	CDI	%T-LOPP	C12-XHE-MH-F018A	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB
2.84E-10	45.30%	CDI	%T-LOPP	C12-XHE-MH-F018A	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB
2.84E-10	45.50%	CDI	%T-LOPP	C12-XHE-MH-F018B	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
2.84E-10	45.60%	CDI	%T-LOPP	C12-XHE-MH-F018B	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
2.84E-10	45.80%	CDI	%T-LOPP	C12-XHE-MH-F021A	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB
2.84E-10	46.00%	CDI	%T-LOPP	C12-XHE-MH-F021A	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB
2.84E-10	46.20%	CDI	%T-LOPP	C12-XHE-MH-F021B	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
2.84E-10	46.40%	CDI	%T-LOPP	C12-XHE-MH-F021B	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
2.66E-10	46.60%	CDI	%T-FDW	C12-MOV-CC-F014A	C12-XHE-MH-F013B	E50-SQV-CF-GDCS7OPEN	
2.66E-10	46.80%	CDI	%T-FDW	C12-MOV-CC-F014A	C12-XHE-MH-F013B	E50-SQV-CF-OPENALL	
2.66E-10	46.90%	CDI	%T-FDW	C12-MOV-CC-F014A	C12-XHE-MH-F015B	E50-SQV-CF-GDCS7OPEN	
2.66E-10	47.10%	CDI	%T-FDW	C12-MOV-CC-F014A	C12-XHE-MH-F015B	E50-SQV-CF-OPENALL	
2.66E-10	47.30%	CDI	%T-FDW	C12-MOV-CC-F014B	C12-XHE-MH-F013A	E50-SQV-CF-GDCS7OPEN	
2.66E-10	47.50%	CDI	%T-FDW	C12-MOV-CC-F014B	C12-XHE-MH-F013A	E50-SQV-CF-OPENALL	
2.66E-10	47.70%	CDI	%T-FDW	C12-MOV-CC-F014B	C12-XHE-MH-F015A	E50-SQV-CF-GDCS7OPEN	
2.66E-10	47.80%	CDI	%T-FDW	C12-MOV-CC-F014B	C12-XHE-MH-F015A	E50-SQV-CF-OPENALL	
2.54E-10	48.00%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-EMS-FC-DIVADID	R11-SYS-FF-NOREC	
2.54E-10	48.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-EMS-FC-DIVBDID	R11-SYS-FF-NOREC	
2.54E-10	48.40%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-EMS-FC-DIVADID	R11-SYS-FF-NOREC	
2.54E-10	48.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-EMS-FC-DIVBDID	R11-SYS-FF-NOREC	
2.44E-10	48.70%	CDI	%T-LOPP	C12-XHE-MH-F003B	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	48.90%	CDI	%T-LOPP	C12-XHE-MH-F003B	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	49.00%	CDI	%T-LOPP	C12-XHE-MH-F018A	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	49.20%	CDI	%T-LOPP	C12-XHE-MH-F018A	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	49.30%	CDI	%T-LOPP	C12-XHE-MH-F018B	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	49.50%	CDI	%T-LOPP	C12-XHE-MH-F018B	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	49.70%	CDI	%T-LOPP	C12-XHE-MH-F021A	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	49.80%	CDI	%T-LOPP	C12-XHE-MH-F021A	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	50.00%	CDI	%T-LOPP	C12-XHE-MH-F021B	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.44E-10	50.20%	CDI	%T-LOPP	C12-XHE-MH-F021B	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC
2.11E-10	50.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTA1	

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
2.11E-10	50.50%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTA2	
2.11E-10	50.60%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTB1	
2.11E-10	50.70%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTB2	
2.11E-10	50.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTA1	
2.11E-10	51.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTA2	
2.11E-10	51.20%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTB1	
2.11E-10	51.30%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R16-BT_-LP-R16BTB2	
2.03E-10	51.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R13-INV-FC-R13A1	
2.03E-10	51.60%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R13-INV-FC-R13A2	
2.03E-10	51.70%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R13-INV-FC-R13B1	
2.03E-10	51.90%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R13-INV-FC-R13B2	
2.03E-10	52.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R13-INV-FC-R13A1	
2.03E-10	52.10%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R13-INV-FC-R13A2	
2.03E-10	52.30%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R13-INV-FC-R13B1	
2.03E-10	52.40%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R13-INV-FC-R13B2	
2.00E-10	52.50%	CDI	%T-FDW	C12-XHE-MH-F003B	C12-XHE-MH-F018A	E50-SQV-CF-GDCS7OPEN	
2.00E-10	52.70%	CDI	%T-FDW	C12-XHE-MH-F003B	C12-XHE-MH-F018A	E50-SQV-CF-OPENALL	
2.00E-10	52.80%	CDI	%T-FDW	C12-XHE-MH-F003B	C12-XHE-MH-F021A	E50-SQV-CF-GDCS7OPEN	
2.00E-10	52.90%	CDI	%T-FDW	C12-XHE-MH-F003B	C12-XHE-MH-F021A	E50-SQV-CF-OPENALL	
2.00E-10	53.10%	CDI	%T-FDW	C12-XHE-MH-F018A	C12-XHE-MH-F018B	E50-SQV-CF-GDCS7OPEN	
2.00E-10	53.20%	CDI	%T-FDW	C12-XHE-MH-F018A	C12-XHE-MH-F018B	E50-SQV-CF-OPENALL	
2.00E-10	53.30%	CDI	%T-FDW	C12-XHE-MH-F018A	C12-XHE-MH-F021B	E50-SQV-CF-GDCS7OPEN	
2.00E-10	53.50%	CDI	%T-FDW	C12-XHE-MH-F018A	C12-XHE-MH-F021B	E50-SQV-CF-OPENALL	
2.00E-10	53.60%	CDI	%T-FDW	C12-XHE-MH-F018B	C12-XHE-MH-F021A	E50-SQV-CF-GDCS7OPEN	
2.00E-10	53.70%	CDI	%T-FDW	C12-XHE-MH-F018B	C12-XHE-MH-F021A	E50-SQV-CF-OPENALL	
2.00E-10	53.90%	CDI	%T-FDW	C12-XHE-MH-F021A	C12-XHE-MH-F021B	E50-SQV-CF-GDCS7OPEN	
2.00E-10	54.00%	CDI	%T-FDW	C12-XHE-MH-F021A	C12-XHE-MH-F021B	E50-SQV-CF-OPENALL	
1.88E-10	54.10%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-MCB-CC-XFRMAA2	R11-SYS-FF-NOREC	R21-DG_-FR-DGB

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
1.88E-10	54.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-MCB-CC-XFRMBB2	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
1.88E-10	54.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD1
1.88E-10	54.50%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD2
1.88E-10	54.60%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD3
1.88E-10	54.80%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD4
1.88E-10	54.90%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD5
1.88E-10	55.00%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD1
1.88E-10	55.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD2
1.88E-10	55.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD3
1.88E-10	55.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD4
1.88E-10	55.50%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD5
1.88E-10	55.70%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-MCB-CC-XFRMAA2	R11-SYS-FF-NOREC	R21-DG_-FR-DGB
1.88E-10	55.80%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-MCB-CC-XFRMBB2	R11-SYS-FF-NOREC	R21-DG_-FR-DGA
1.88E-10	55.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD1
1.88E-10	56.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD2
1.88E-10	56.20%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD3
1.88E-10	56.30%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD4
1.88E-10	56.40%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R22-MCB-CC-2LOAD5
1.88E-10	56.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD1
1.88E-10	56.70%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD2
1.88E-10	56.80%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD3
1.88E-10	56.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD4
1.88E-10	57.10%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R22-MCB-CC-1LOAD5
1.62E-10	57.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-MCB-CC-XFRMAA2	R11-SYS-FF-NOREC
1.62E-10	57.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-MCB-CC-XFRMBB2	R11-SYS-FF-NOREC
1.62E-10	57.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD1
1.62E-10	57.50%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD2
1.62E-10	57.60%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD3

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
1.62E-10	57.70%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD4
1.62E-10	57.80%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD5
1.62E-10	57.90%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD1
1.62E-10	58.00%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD2
1.62E-10	58.10%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD3
1.62E-10	58.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD4
1.62E-10	58.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD5
1.62E-10	58.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-MCB-CC-XFRMAA2	R11-SYS-FF-NOREC
1.62E-10	58.60%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-MCB-CC-XFRMBB2	R11-SYS-FF-NOREC
1.62E-10	58.70%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD1
1.62E-10	58.80%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD2
1.62E-10	58.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD3
1.62E-10	59.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD4
1.62E-10	59.10%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-1LOAD5
1.62E-10	59.20%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD1
1.62E-10	59.30%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD2
1.62E-10	59.40%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD3
1.62E-10	59.60%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD4
1.62E-10	59.70%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R22-MCB-CC-2LOAD5
1.42E-10	59.80%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R21-DG_-TM-DGB
1.42E-10	59.90%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R21-DG_-TM-DGA
1.42E-10	59.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGA	R21-DG_-TM-DGB
1.42E-10	60.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	R11-SYS-FF-NOREC	R21-DG_-FR-DGB	R21-DG_-TM-DGA
1.32E-10	60.10%	CDI	%T-LOPP	C12-MOV-CC-F014A	C12-XHE-MH-F013B	E50-SQV-CF-GDCS7OPEN	
1.32E-10	60.20%	CDI	%T-LOPP	C12-MOV-CC-F014A	C12-XHE-MH-F013B	E50-SQV-CF-OPENALL	
1.32E-10	60.30%	CDI	%T-LOPP	C12-MOV-CC-F014A	C12-XHE-MH-F015B	E50-SQV-CF-GDCS7OPEN	
1.32E-10	60.40%	CDI	%T-LOPP	C12-MOV-CC-F014A	C12-XHE-MH-F015B	E50-SQV-CF-OPENALL	
1.32E-10	60.50%	CDI	%T-LOPP	C12-MOV-CC-F014B	C12-XHE-MH-F013A	E50-SQV-CF-GDCS7OPEN	

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
1.32E-10	60.60%	CDI	%T-LOPP	C12-MOV-CC-F014B	C12-XHE-MH-F013A	E50-SQV-CF-OPENALL	
1.32E-10	60.70%	CDI	%T-LOPP	C12-MOV-CC-F014B	C12-XHE-MH-F015A	E50-SQV-CF-GDCS7OPEN	
1.32E-10	60.80%	CDI	%T-LOPP	C12-MOV-CC-F014B	C12-XHE-MH-F015A	E50-SQV-CF-OPENALL	
1.27E-10	60.80%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-10A11	R11-SYS-FF-NOREC	
1.27E-10	60.90%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-10A21	R11-SYS-FF-NOREC	
1.27E-10	61.00%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-ESF1ADID	R11-SYS-FF-NOREC	
1.27E-10	61.10%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-ESF1BDID	R11-SYS-FF-NOREC	
1.27E-10	61.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-ESF2ADID	R11-SYS-FF-NOREC	
1.27E-10	61.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-ESF2BDID	R11-SYS-FF-NOREC	
1.27E-10	61.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-R101	R11-SYS-FF-NOREC	
1.27E-10	61.40%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	H23-RMU-FC-R102	R11-SYS-FF-NOREC	
1.27E-10	61.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-10A11	R11-SYS-FF-NOREC	
1.27E-10	61.60%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-10A21	R11-SYS-FF-NOREC	
1.27E-10	61.70%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-ESF1ADID	R11-SYS-FF-NOREC	
1.27E-10	61.80%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-ESF1BDID	R11-SYS-FF-NOREC	
1.27E-10	61.90%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-ESF2ADID	R11-SYS-FF-NOREC	
1.27E-10	62.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-ESF2BDID	R11-SYS-FF-NOREC	
1.27E-10	62.00%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-R101	R11-SYS-FF-NOREC	
1.27E-10	62.10%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	H23-RMU-FC-R102	R11-SYS-FF-NOREC	
1.22E-10	62.20%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-TM-DGA
1.22E-10	62.30%	CDI	%T-LOPP	E50-SQV-CF-GDCS7OPEN	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-TM-DGB
1.22E-10	62.40%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-TM-DGA
1.22E-10	62.50%	CDI	%T-LOPP	E50-SQV-CF-OPENALL	P30-XHE-MH-F015	R11-SYS-FF-NOREC	R21-DG_-TM-DGB
9.94E-11	62.50%	CDI	%T-LOPP	C12-XHE-MH-F003B	C12-XHE-MH-F018A	E50-SQV-CF-GDCS7OPEN	
9.94E-11	62.60%	CDI	%T-LOPP	C12-XHE-MH-F003B	C12-XHE-MH-F018A	E50-SQV-CF-OPENALL	
9.94E-11	62.70%	CDI	%T-LOPP	C12-XHE-MH-F003B	C12-XHE-MH-F021A	E50-SQV-CF-GDCS7OPEN	
9.94E-11	62.70%	CDI	%T-LOPP	C12-XHE-MH-F003B	C12-XHE-MH-F021A	E50-SQV-CF-OPENALL	
9.94E-11	62.80%	CDI	%T-LOPP	C12-XHE-MH-F018A	C12-XHE-MH-F018B	E50-SQV-CF-GDCS7OPEN	

Table 11-6

Top 200 Cutsets for Human Reliability Sensitivity

Probability	%	Class	Initiator	Basic Events			
9.94E-11	62.90%	CDI	%T-LOPP	C12-XHE-MH-F018A	C12-XHE-MH-F018B	E50-SQV-CF-OPENALL	
9.94E-11	62.90%	CDI	%T-LOPP	C12-XHE-MH-F018A	C12-XHE-MH-F021B	E50-SQV-CF-GDCS7OPEN	
9.94E-11	63.00%	CDI	%T-LOPP	C12-XHE-MH-F018A	C12-XHE-MH-F021B	E50-SQV-CF-OPENALL	
9.94E-11	63.10%	CDI	%T-LOPP	C12-XHE-MH-F018B	C12-XHE-MH-F021A	E50-SQV-CF-GDCS7OPEN	
9.94E-11	63.10%	CDI	%T-LOPP	C12-XHE-MH-F018B	C12-XHE-MH-F021A	E50-SQV-CF-OPENALL	

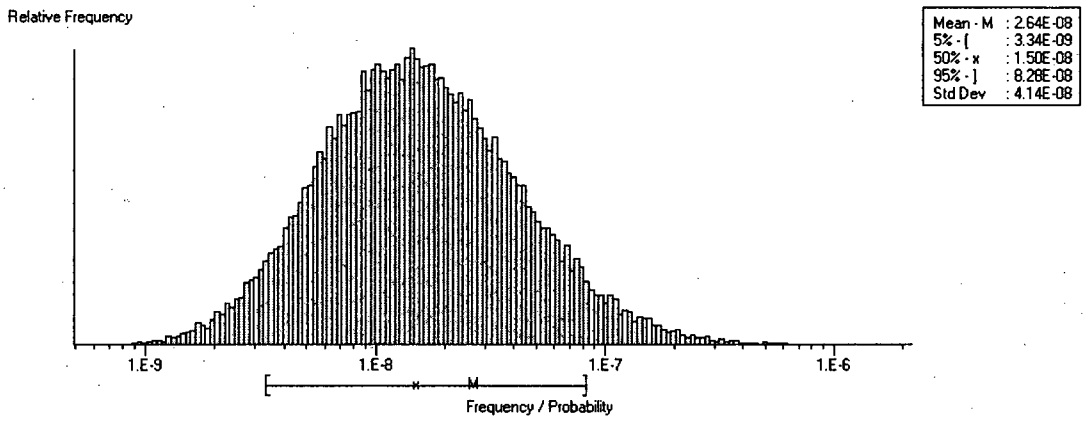

Figure 11-1. Uncertainty Distribution Level 1, Internal Events

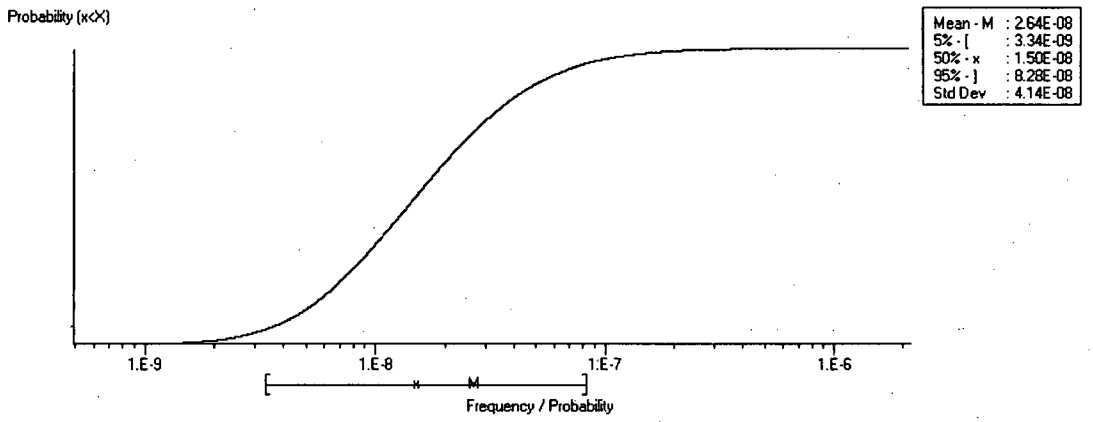

Figure 11-2. Cumulative Distribution Function Level 1, Internal Events

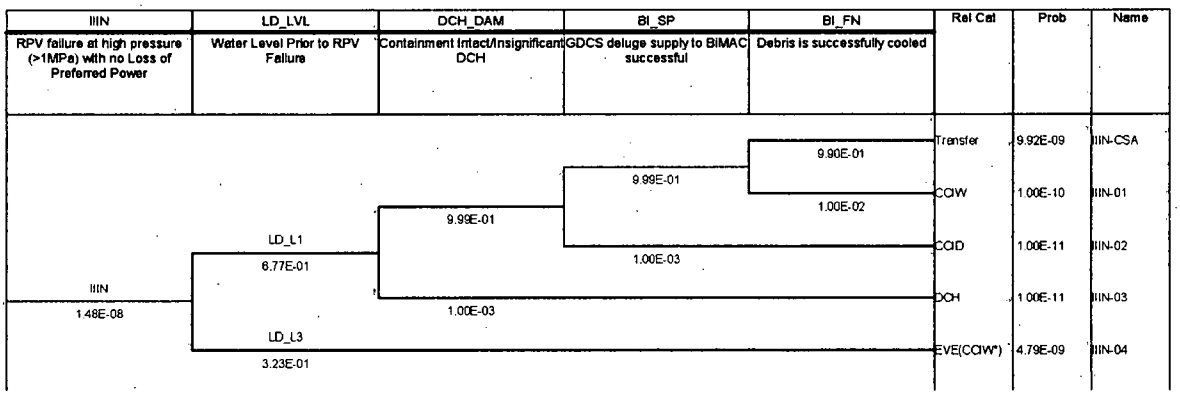

Figure 11-3. Class III without LOPP CPET for RTNSS Sensitivity

Appendix A.11
Class II Core Cooling Vulnerability (CCV) Event Trees

Figure A.11-1. Class II CCV for Transients, Except Loss of Service Water and Power
Figure A.11-2. Class II CCV for Loss of Service Water
Figure A.11-3. Class II CCV for Loss of Preferred Power (A)
Figure A.11-4. Class II CCV for Loss of Preferred Power (B)
Figure A.11-5. Class II CCV for Large LOCA
Figure A.11-6. Class II CCV for Large LOCA in Feedwater Line A
Figure A.11-7. Class II CCV for Large LOCA in Feedwater Line B
Figure A.11-8. Class II CCV for Medium Liquid LOCA
Figure A.11-9. Class II CCV for Medium Liquid LOCA in RWCU

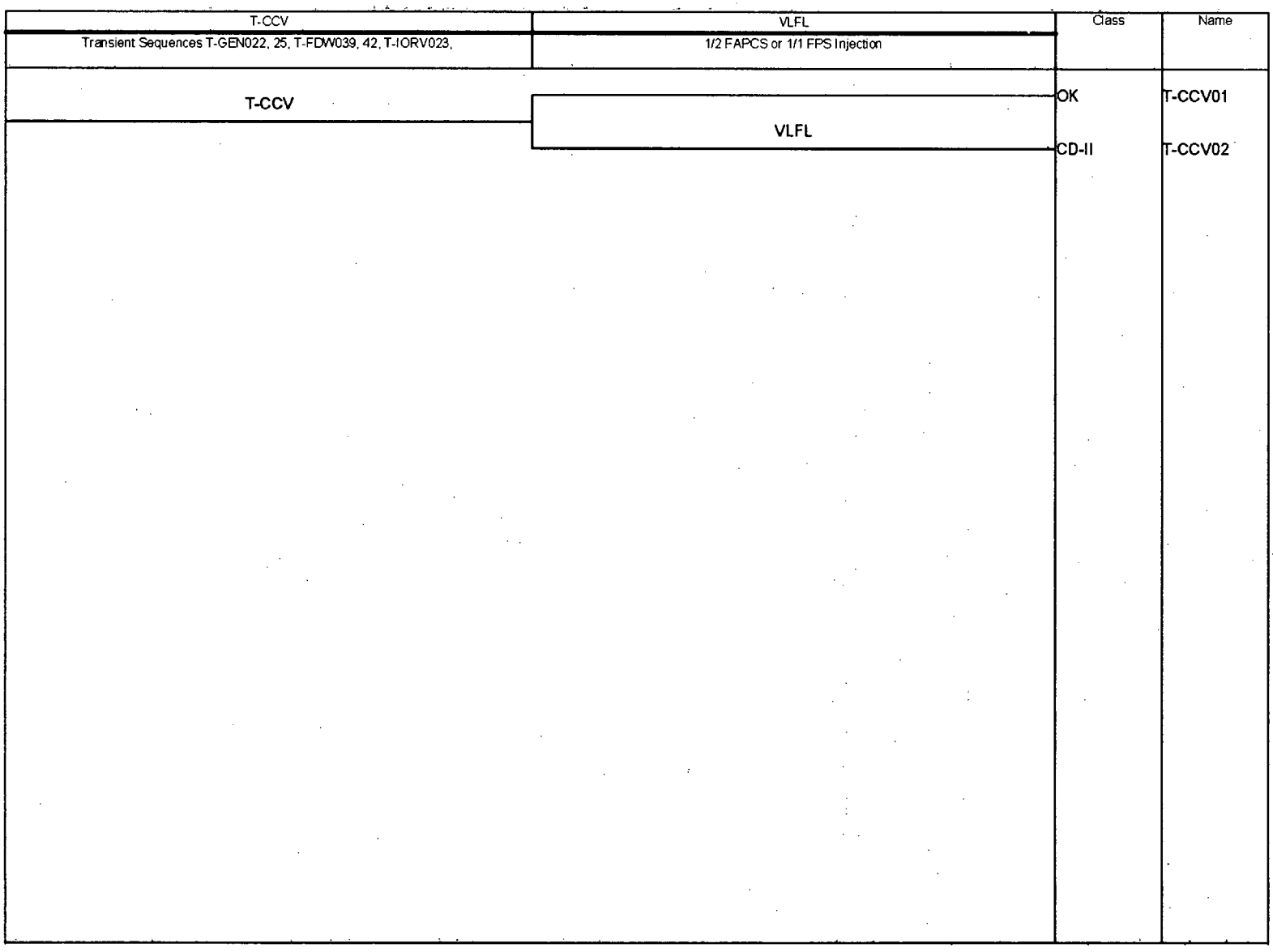

Figure A.11-1. Class II CCV for Transients, Except Loss of Service Water and Power

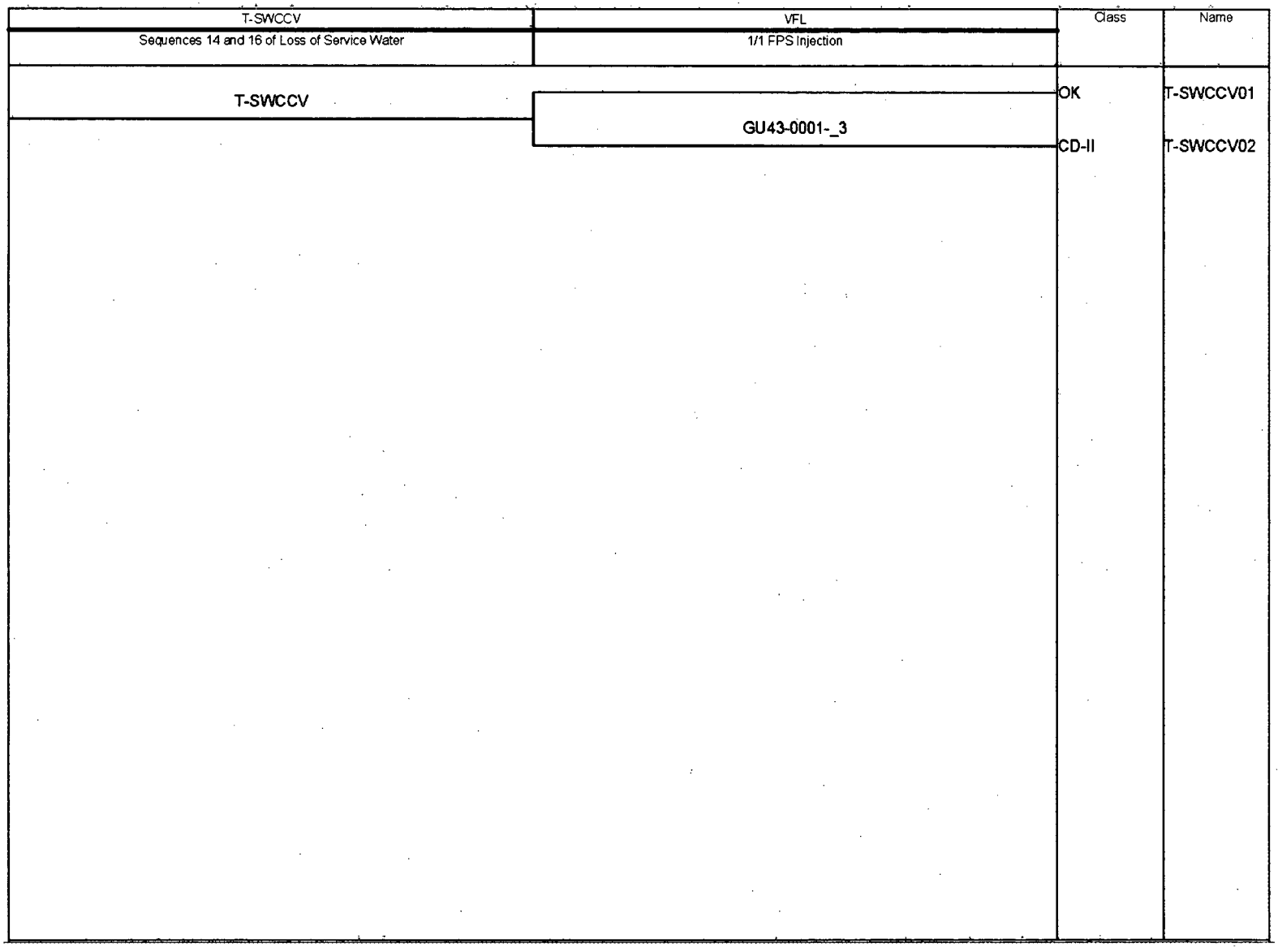

Figure A.11-2. Class II CCV for Loss of Service Water

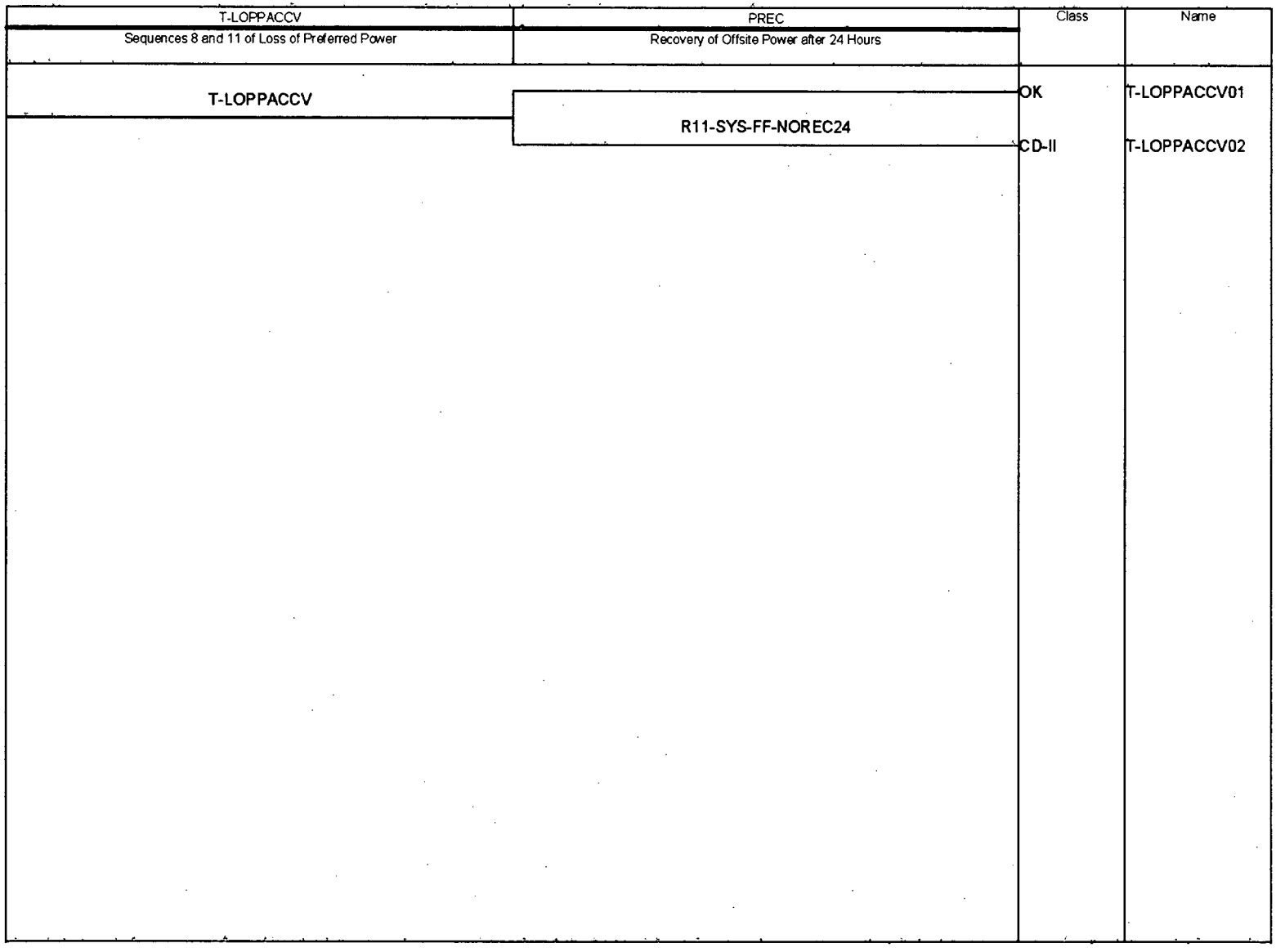

Figure A.11-3. Class II CCV for Loss of Preferred Power (A)

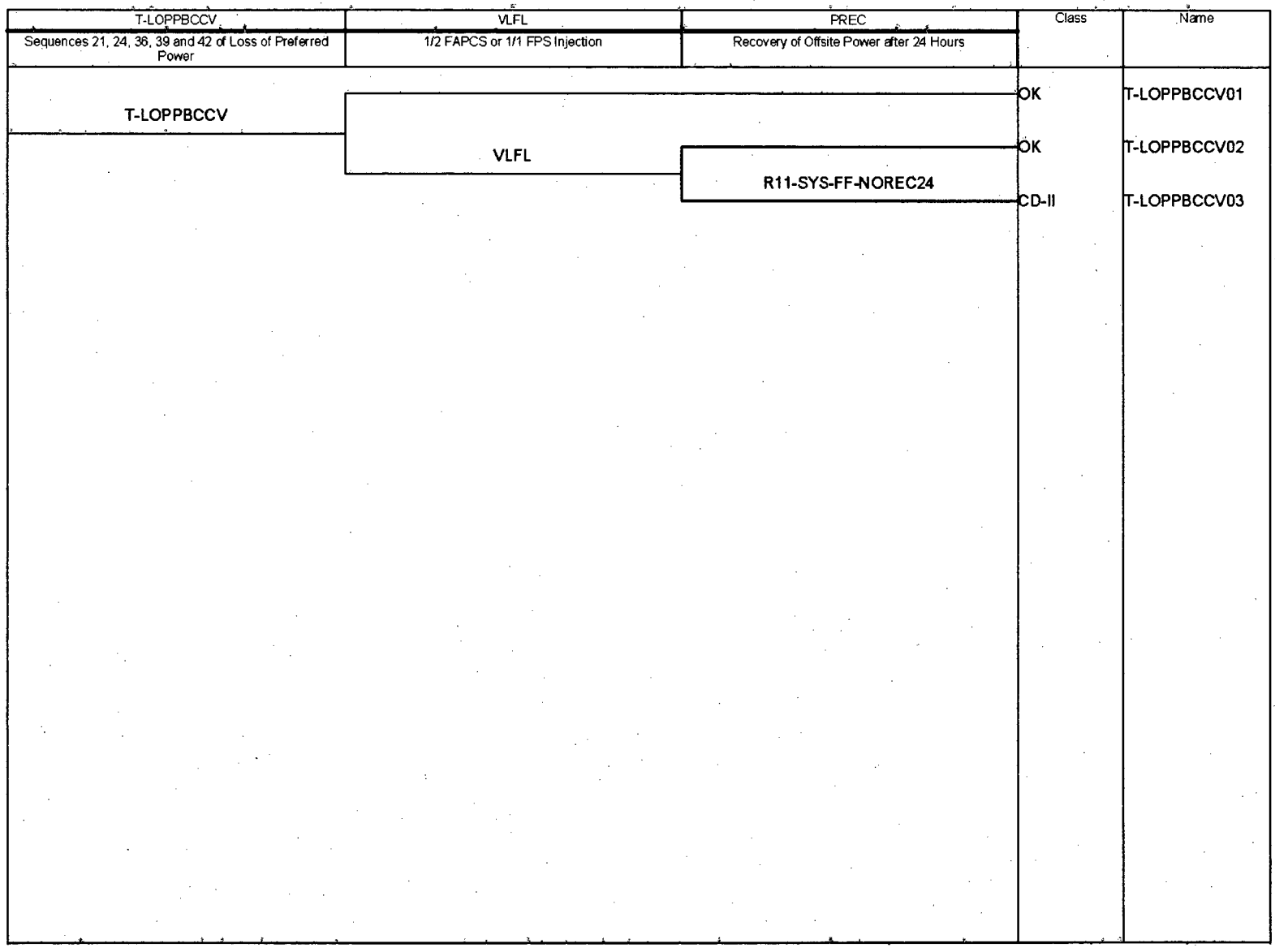

Figure A.11-4. Class II CCV for Loss of Preferred Power (B)

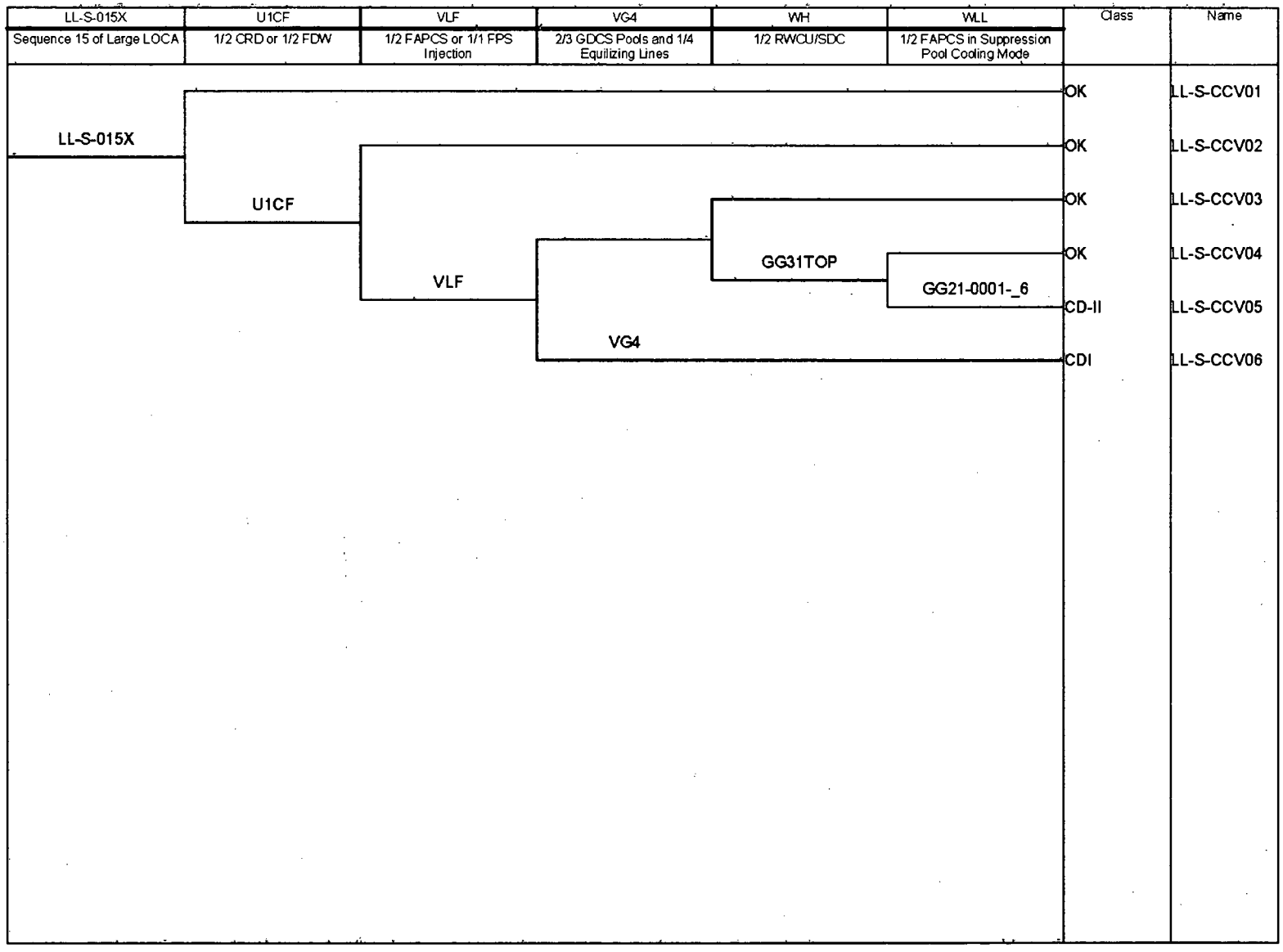

Figure A.11-5. Class II CCV for Large LOCA

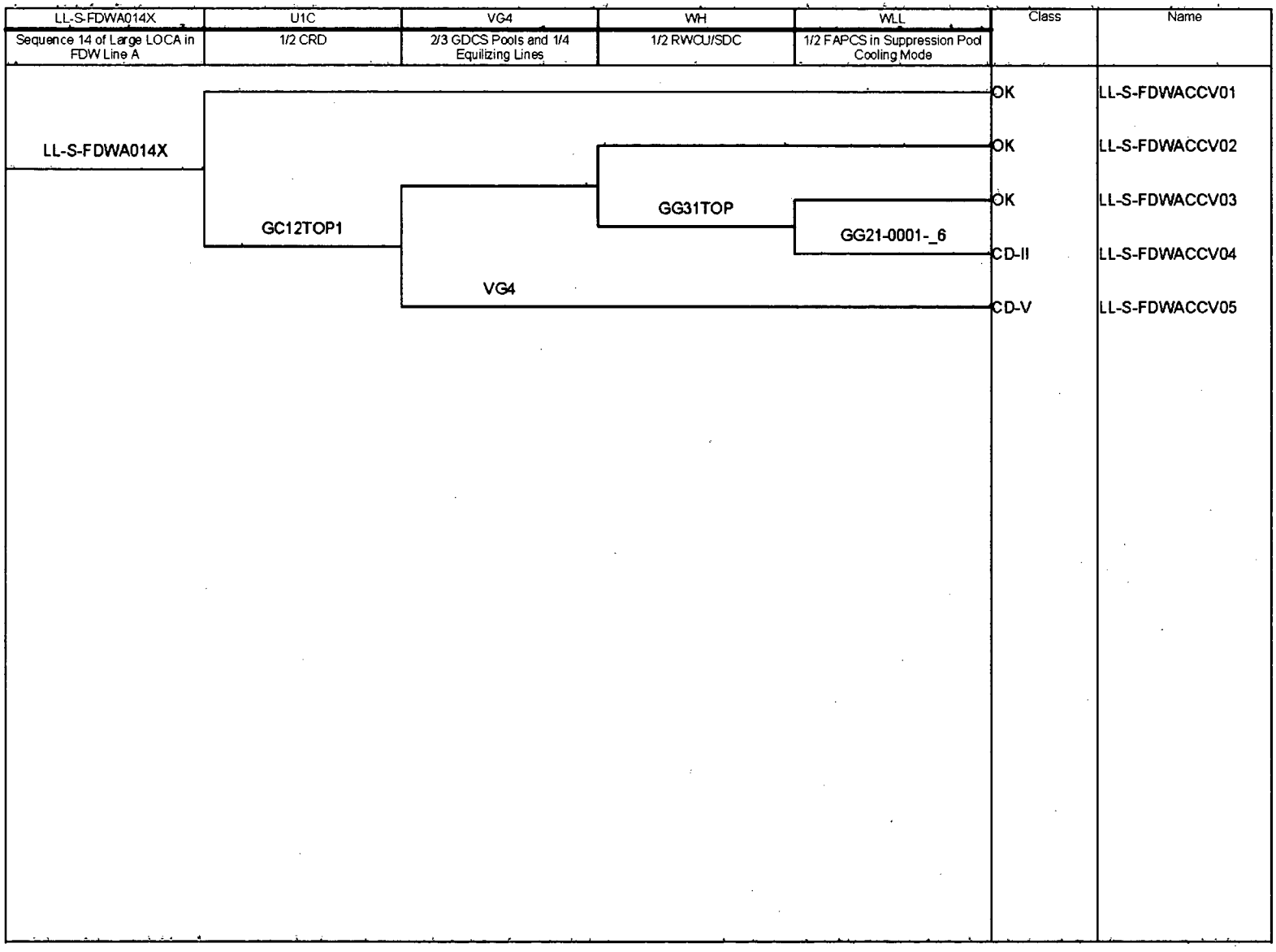

Figure A.11-6. Class II CCV for Large LOCA in Feedwater Line A

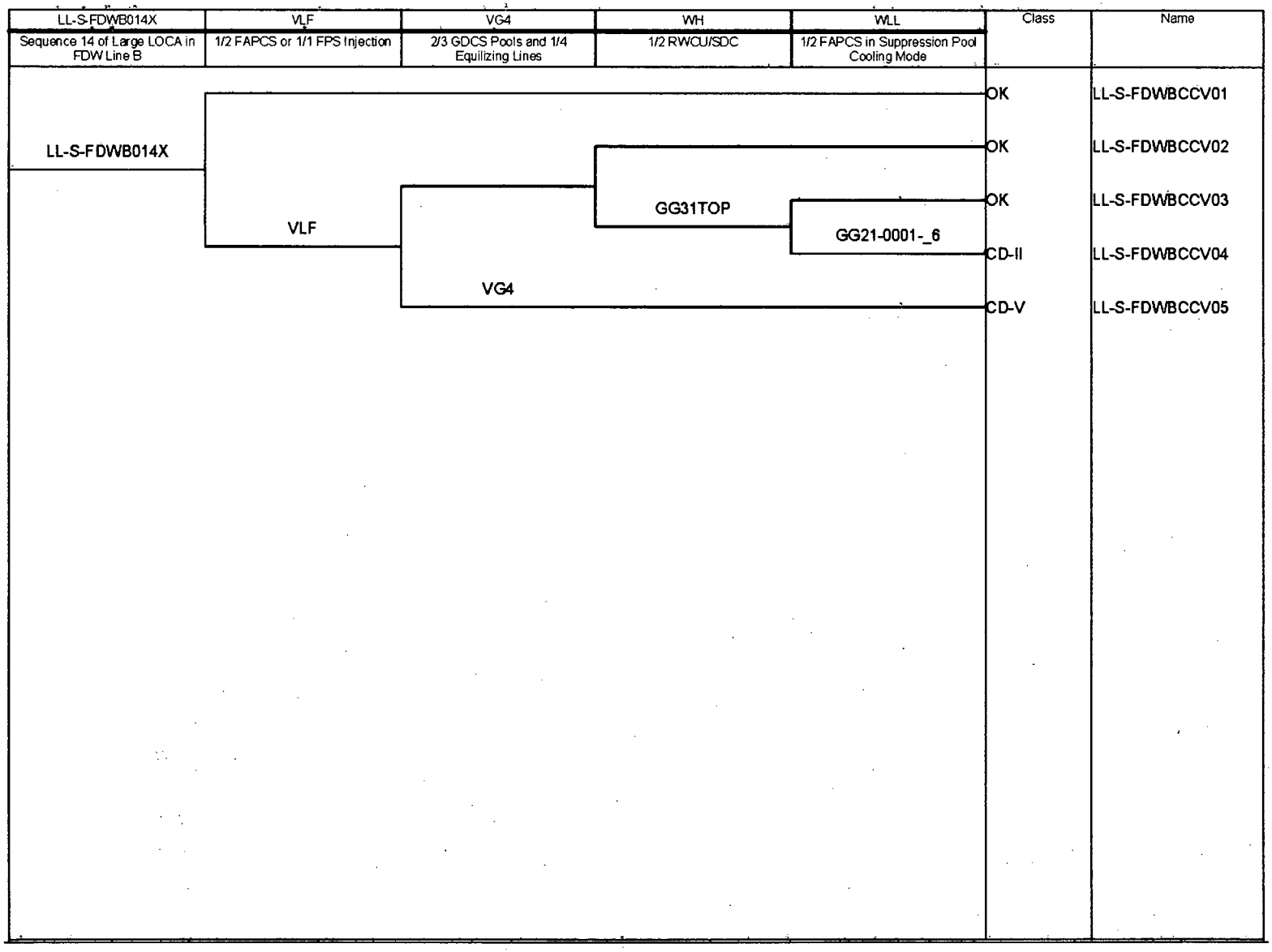

Figure A.11-7. Class II CCV for Large LOCA in Feedwater Line B

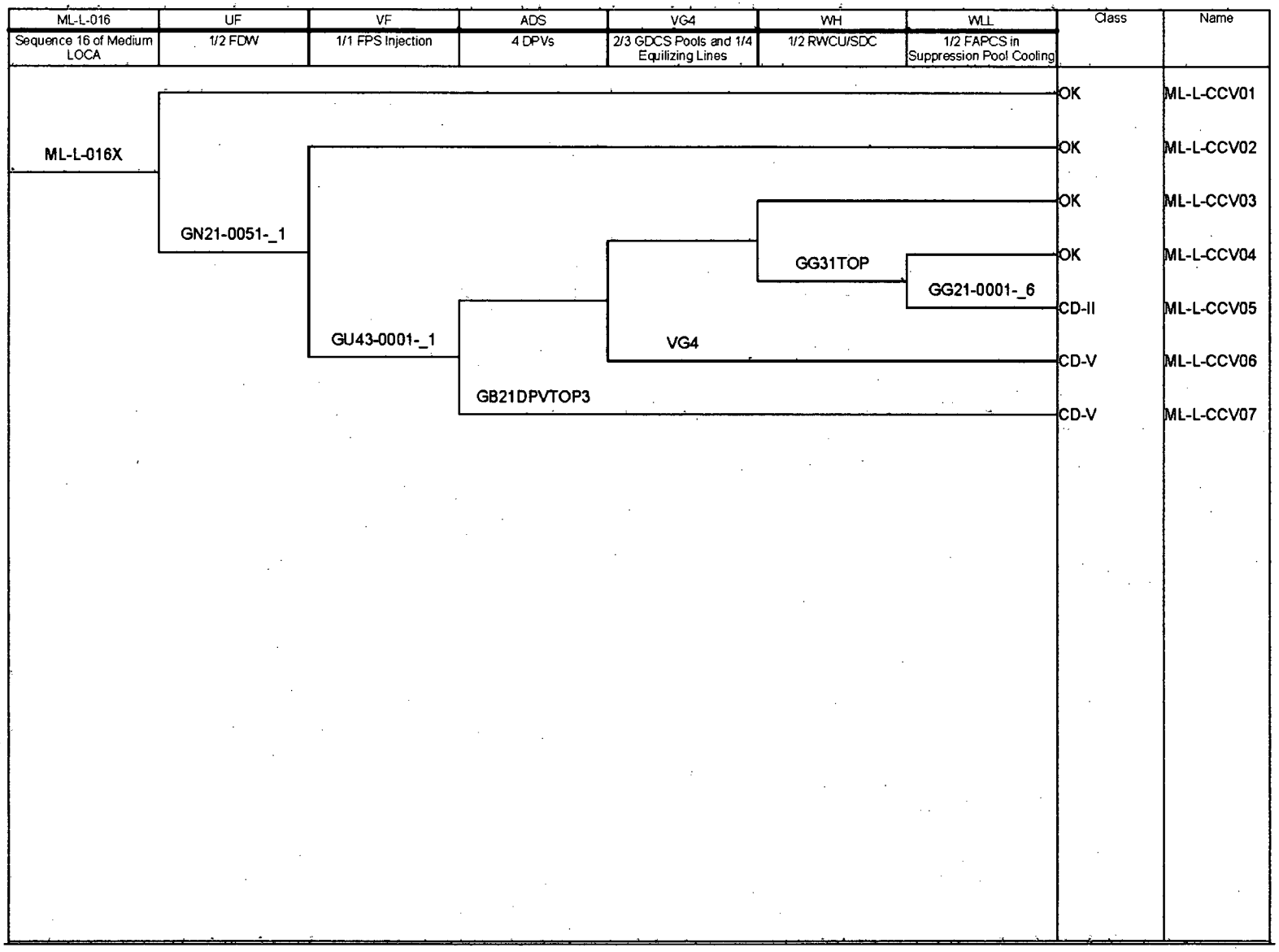

Figure A.11-8. Class II CCV for Medium Liquid LOCA

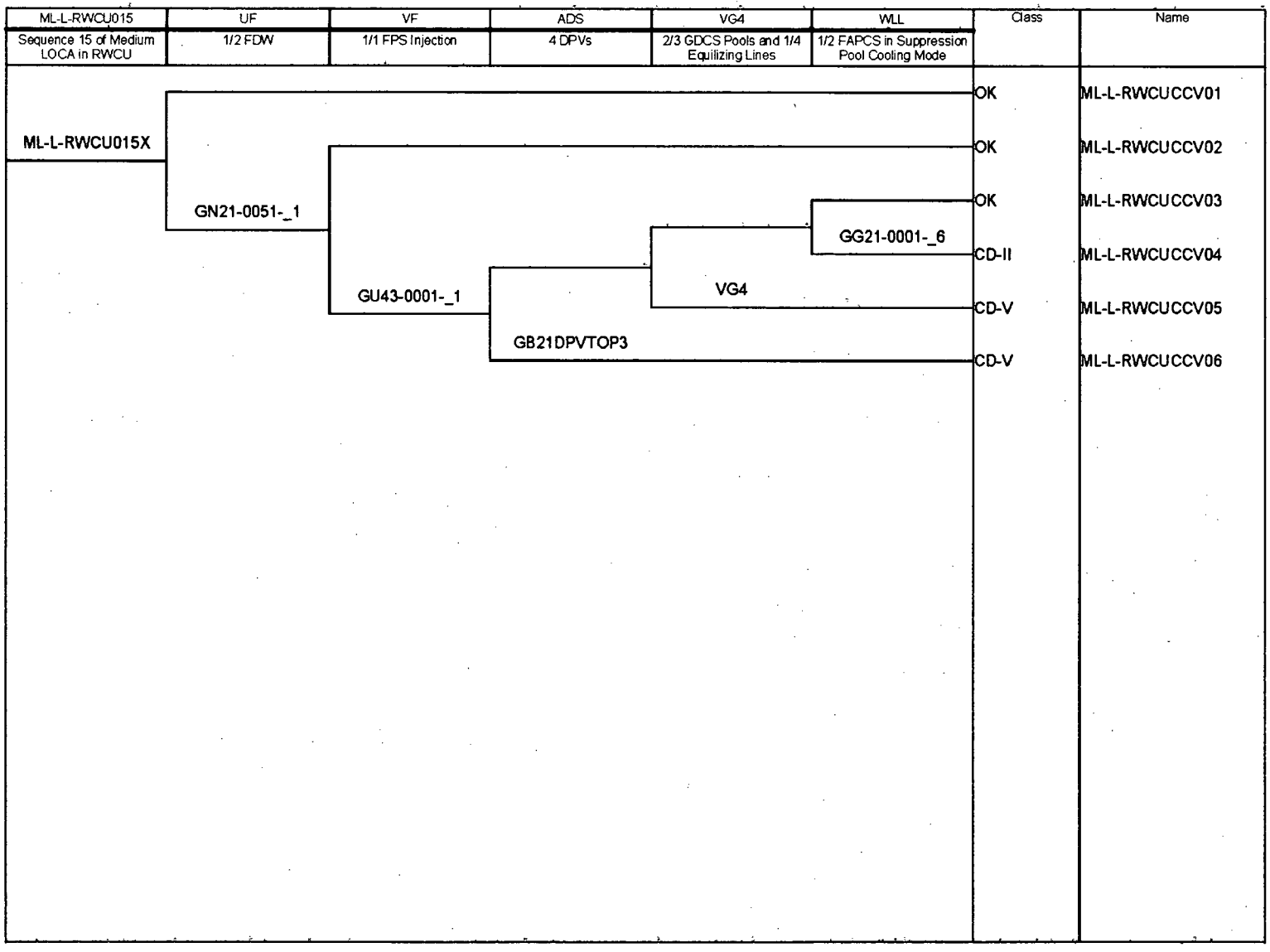

Figure A.11-9. Class II CCV for Medium Liquid LOCA in RWCU

Appendix B.11

Event Trees Used for Assessing the Impact of Non-Safety Systems

Figure B.11-1. General Transient

Figure B.11-2. Transient with PCS Unavailable

Figure B.11-2a. Transient with PCS Unavailable after BOC in IC or MS

Figure B.11-3. Loss of Feedwater Transient

Figure B.11-4. Loss of Service Water System

Figure B.11-5. Loss of Preferred Power Transient

Figure B.11-6. Inadvertent Opening of a Relief Valve

Figure B.11-7. ATWS from General Transient

Figure B.11-7a. ATWS from Loss of Preferred Power

Figure B.11-8. ATWS from Transient Loss of PCS

Figure B.11-8a. ATWS from Loss of PCS after BOC in IC or MS

Figure B.11-9. ATWS from Transient with Loss of Feedwater System

Figure B.11-10. ATWS from Transient with Loss of Service Water System

Figure B.11-11. ATWS from Inadvertent Opening of a Relief Valve

Figure B.11-11a. ATWS from Small LOCA above Reactor Core

Figure B.11-12. Large Steam Breaks (above L3) other than Feedwater Lines

Figure B.11-13. Large Steam Breaks (above L3) in FDW (A) Line

Figure B.11-14. Large Steam Breaks (above L3) in FDW (B) Line

Figure B.11-15. Small Steam Breaks (above L3)

Figure B.11-16. Medium Liquid Breaks (below L3) other than RWCU/SDC Lines

Figure B.11-17. Medium Liquid Breaks (below L3) in RWCU/SDC Lines

Figure B.11-18. Small Liquid LOCA (below L3) other than RWCU/SDC Lines

Figure B.11-19. Small Liquid LOCA (below L3) in RWCU/SDC Lines

Figure B.11-20. Reactor Vessel Rupture

Figure B.11-20a. Reactor Vessel Rupture after Loss of Preferred Power

Figure B.11-21. Steam Break Outside Containment in Main Steam Lines

Figure B.11-22. Steam Break Outside Containment in FDW A Line

Figure B.11-23. Steam Break Outside Containment in FDW B Line

Figure B.11-24. Large Steam Break Outside Containment in IC Lines

Figure B.11-25. Large Liquid Break Outside Containment in RWCU/SDC Lines

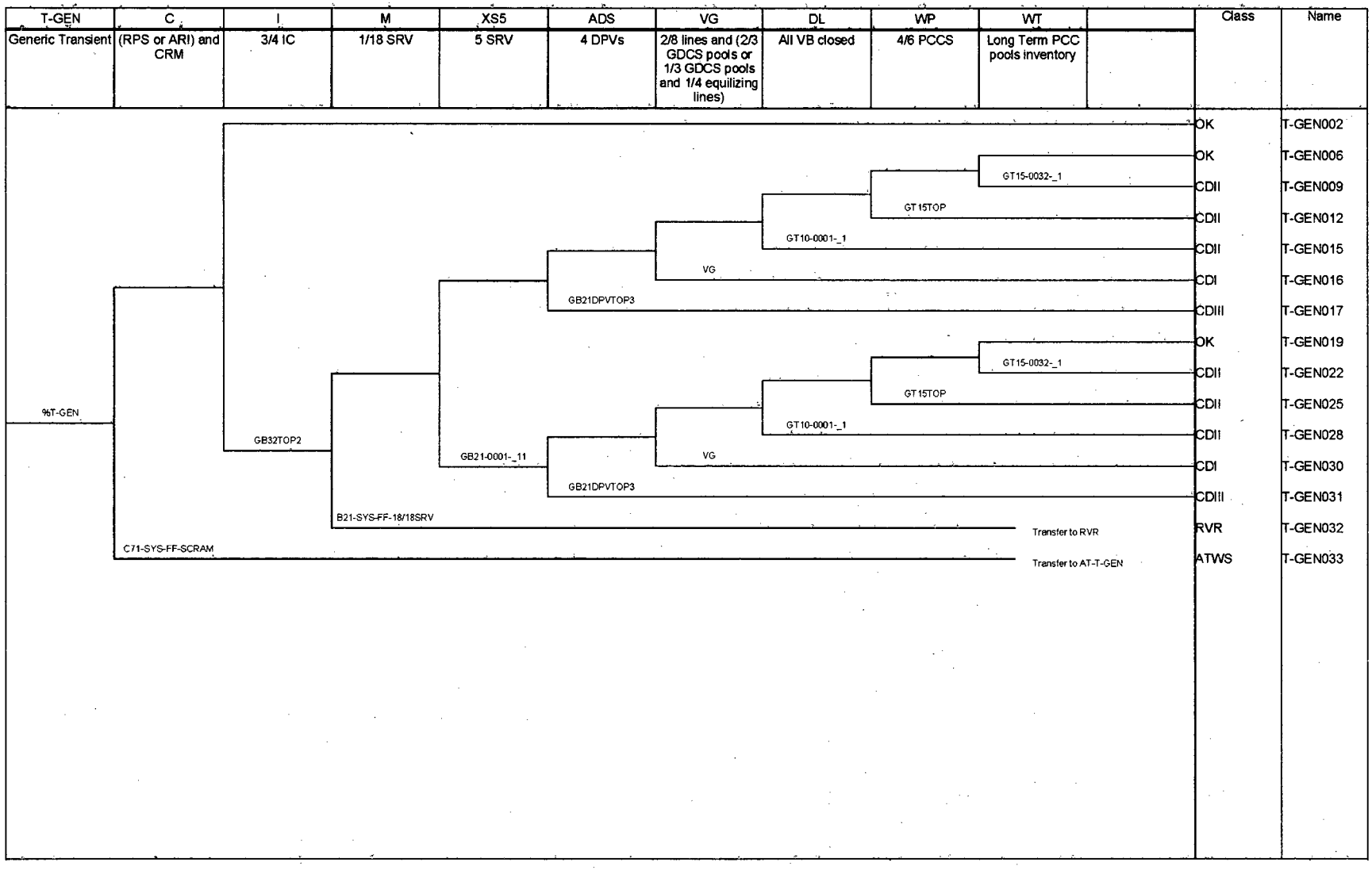

Figure B.11-1. General Transient

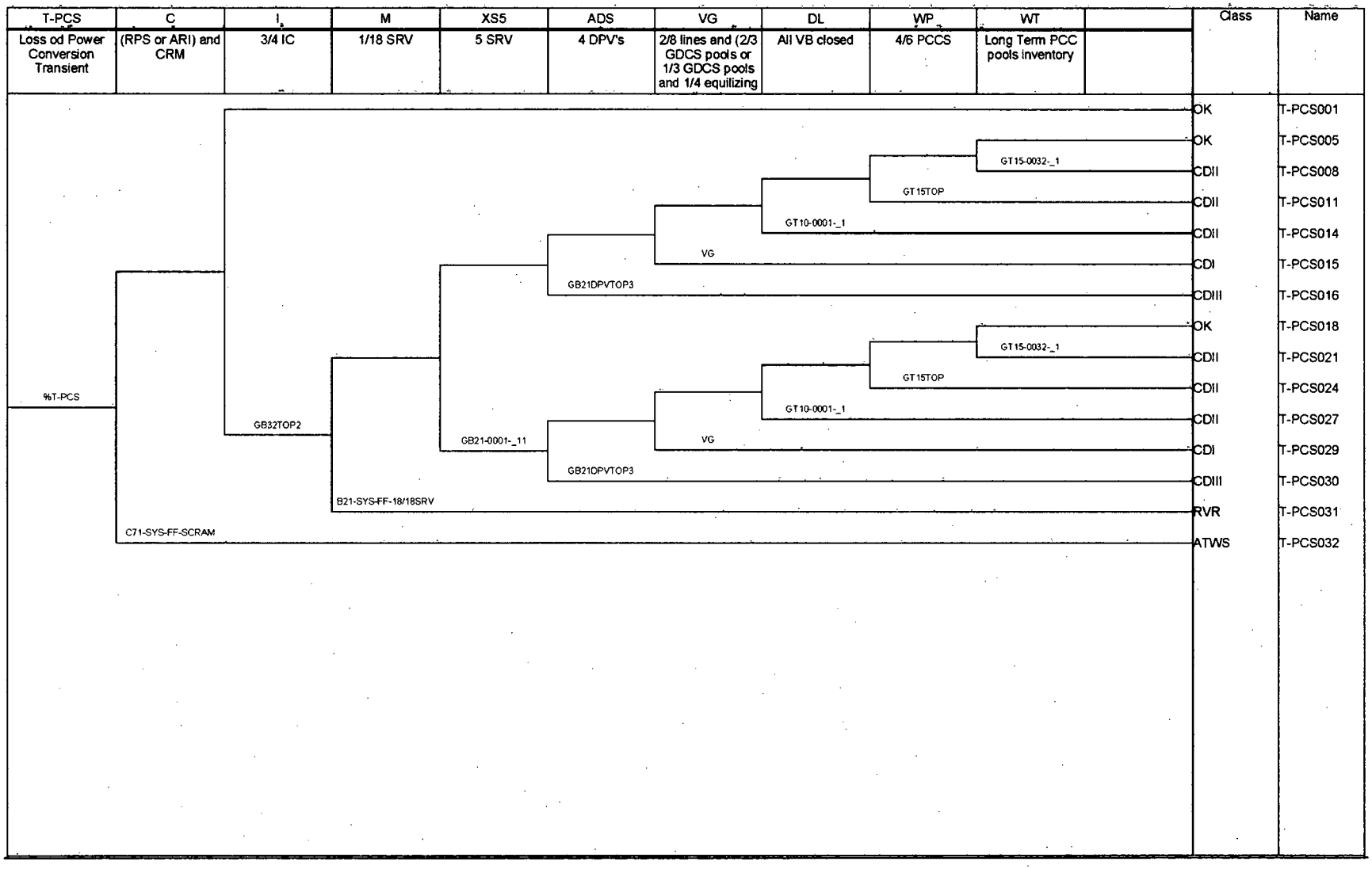

Figure B.11-2. Transient with PCS Unavailable

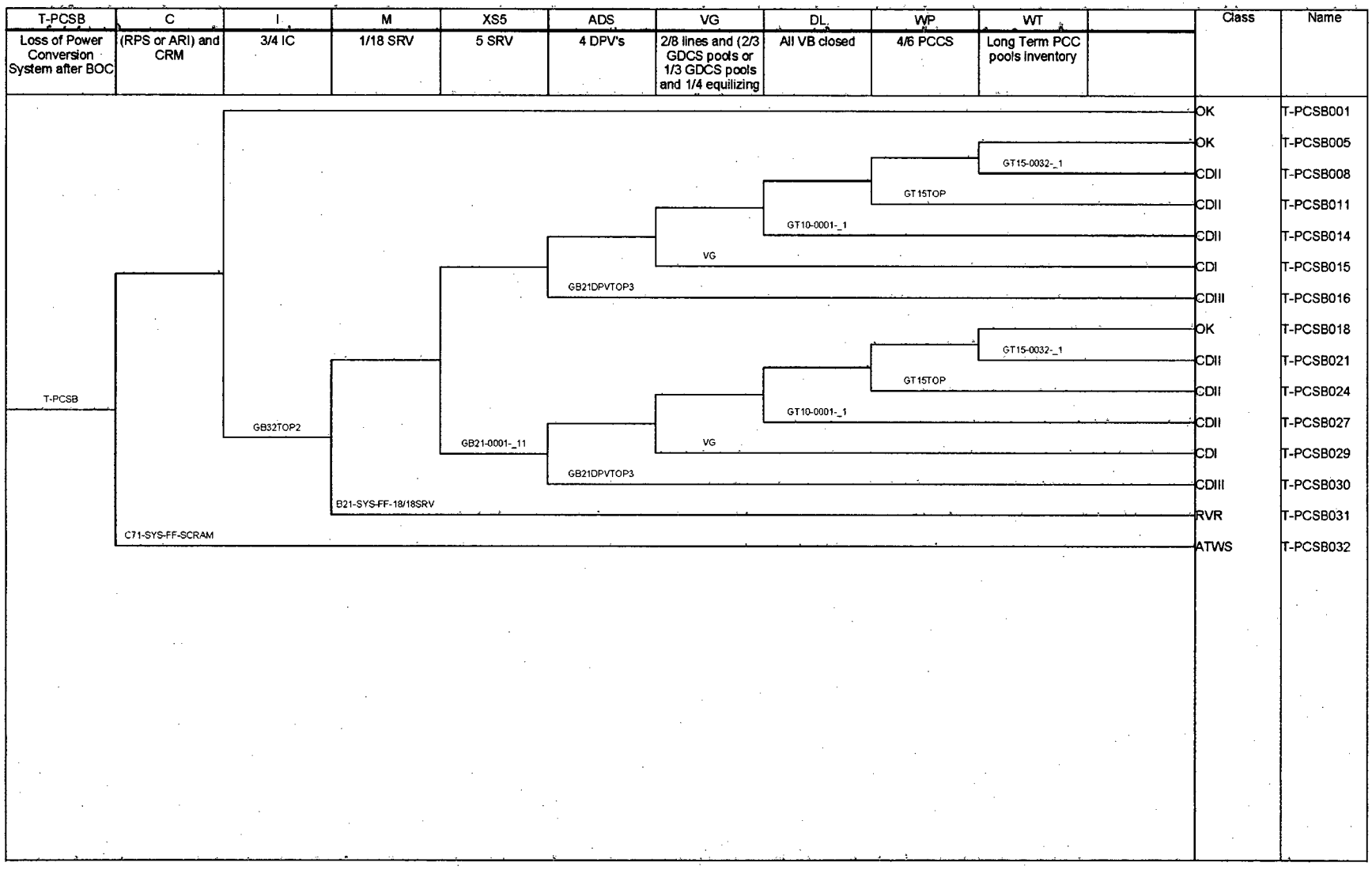

Figure B.11-2a. Transient with PCS Unavailable after BOC in IC or MS

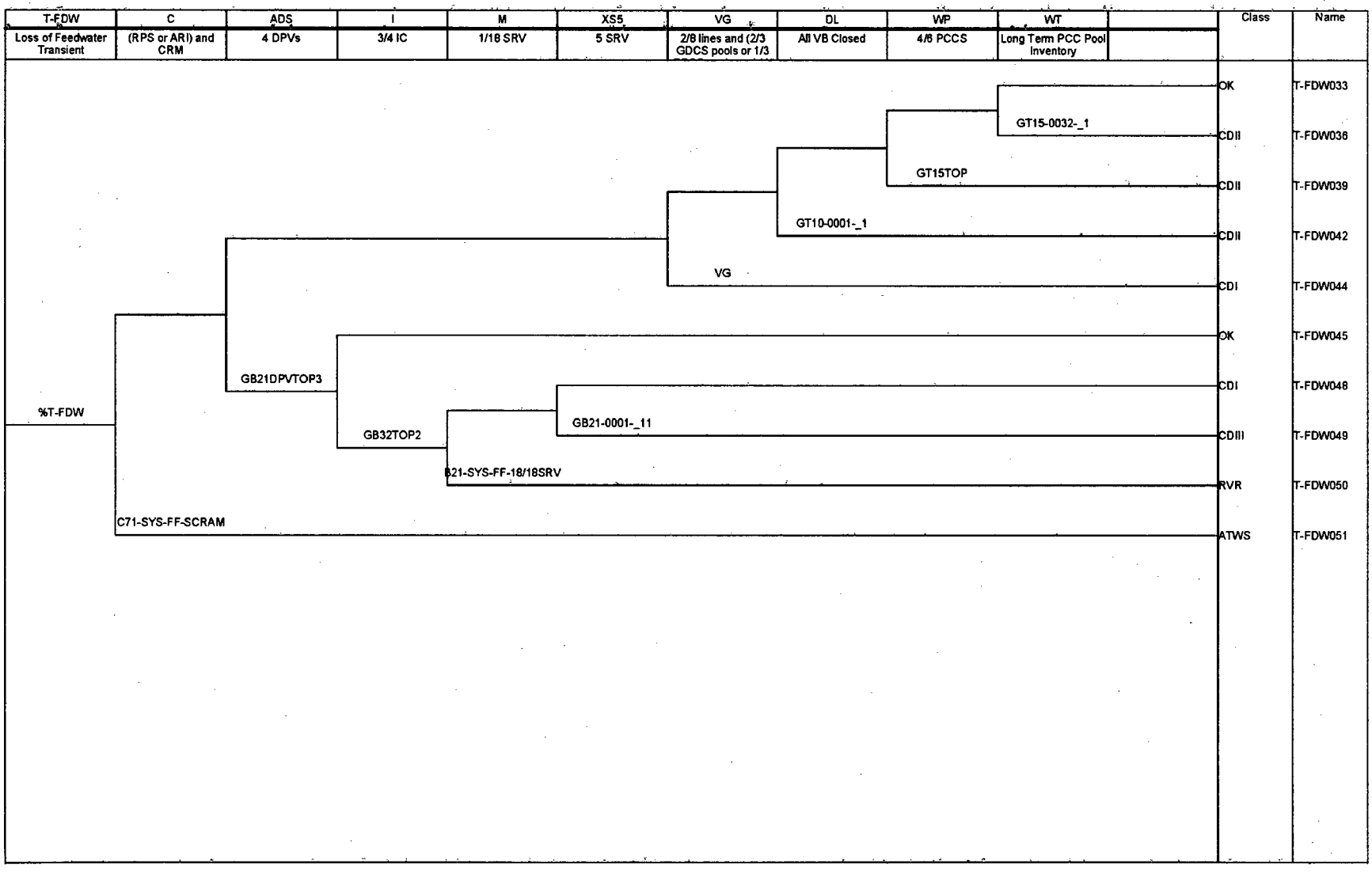

Figure B.11-3. Loss of Feedwater Transient

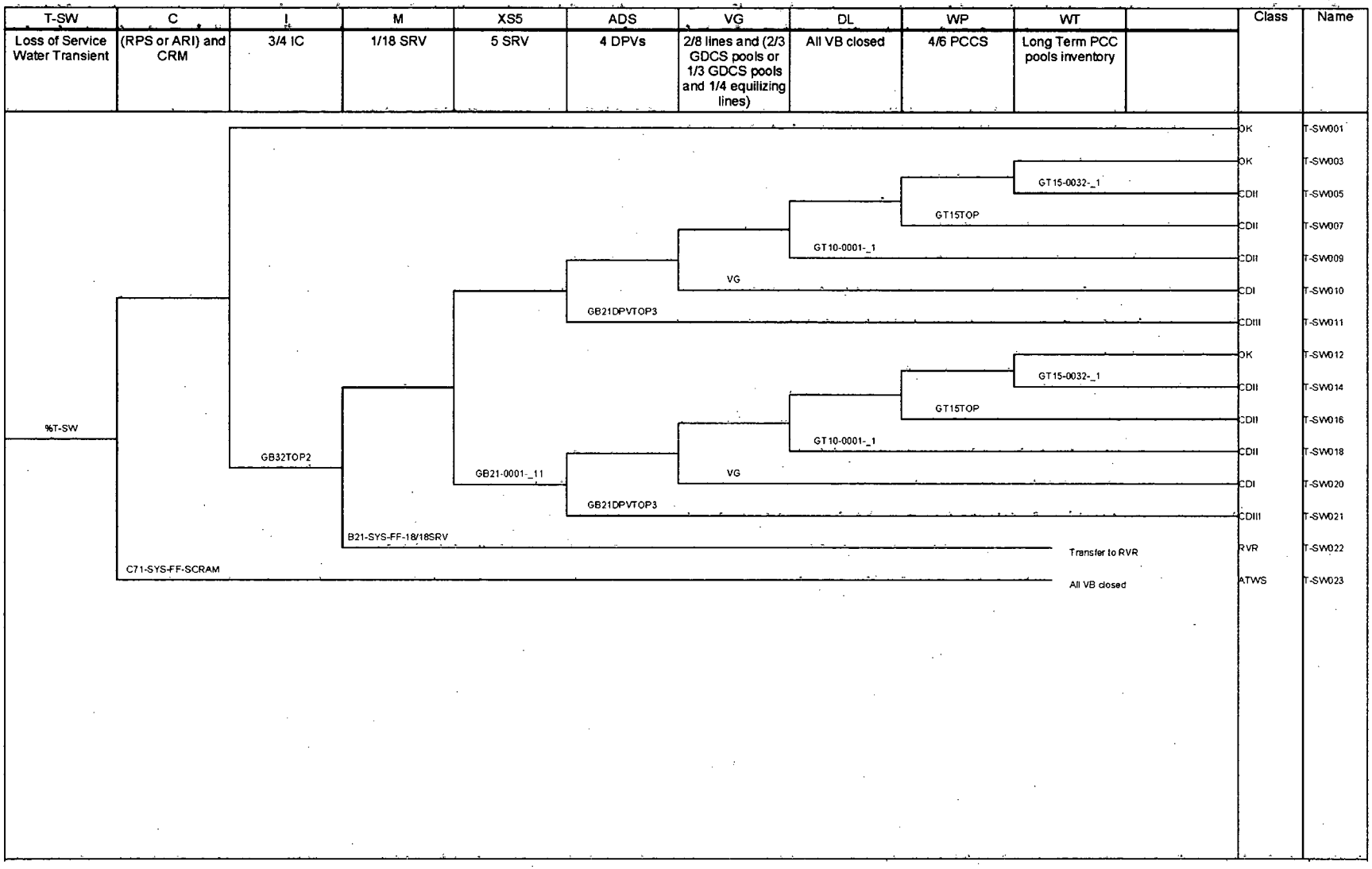

Figure B.11-4. Loss of Service Water System

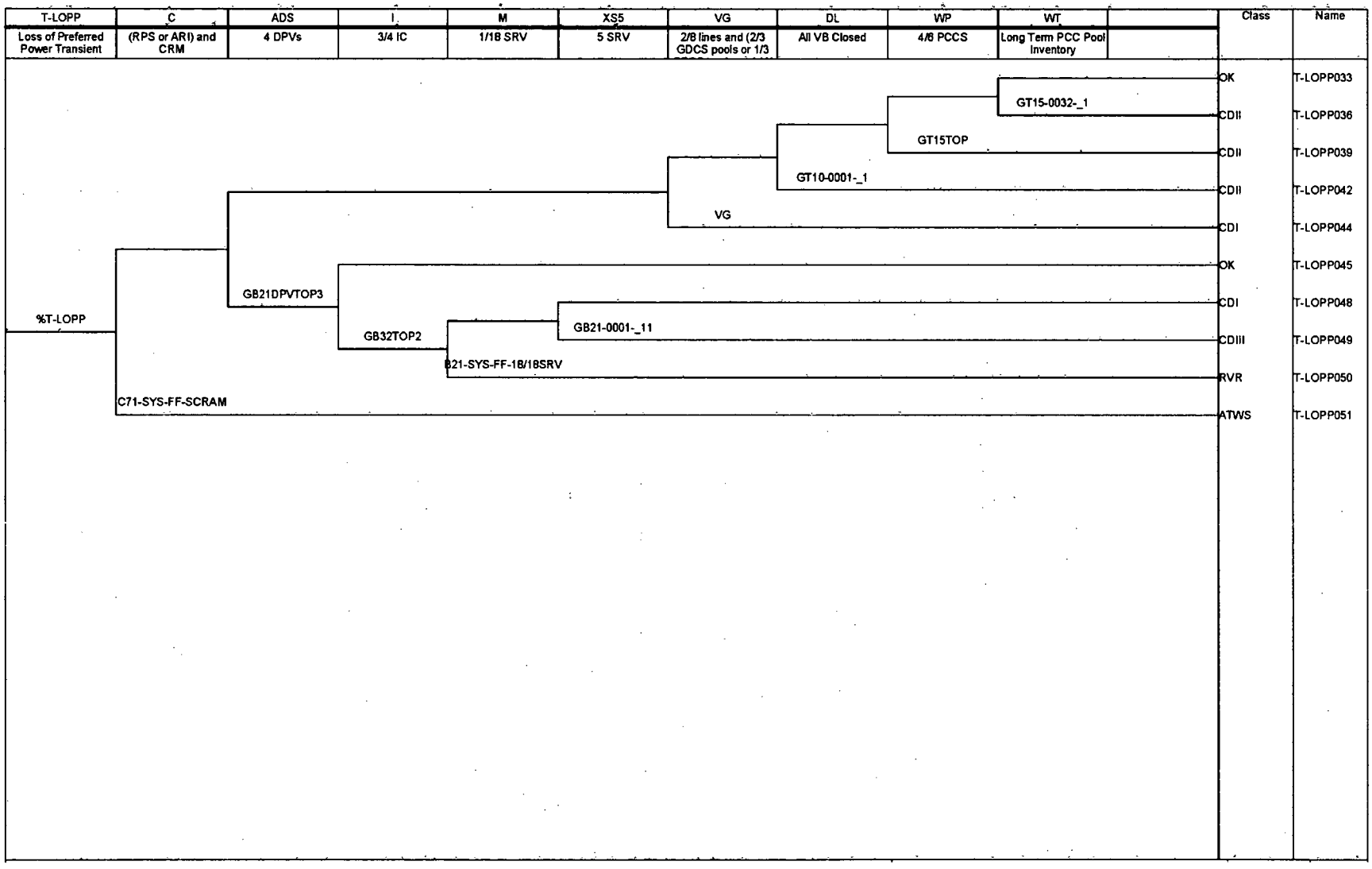

Figure B.11-5. Loss of Preferred Power Transient

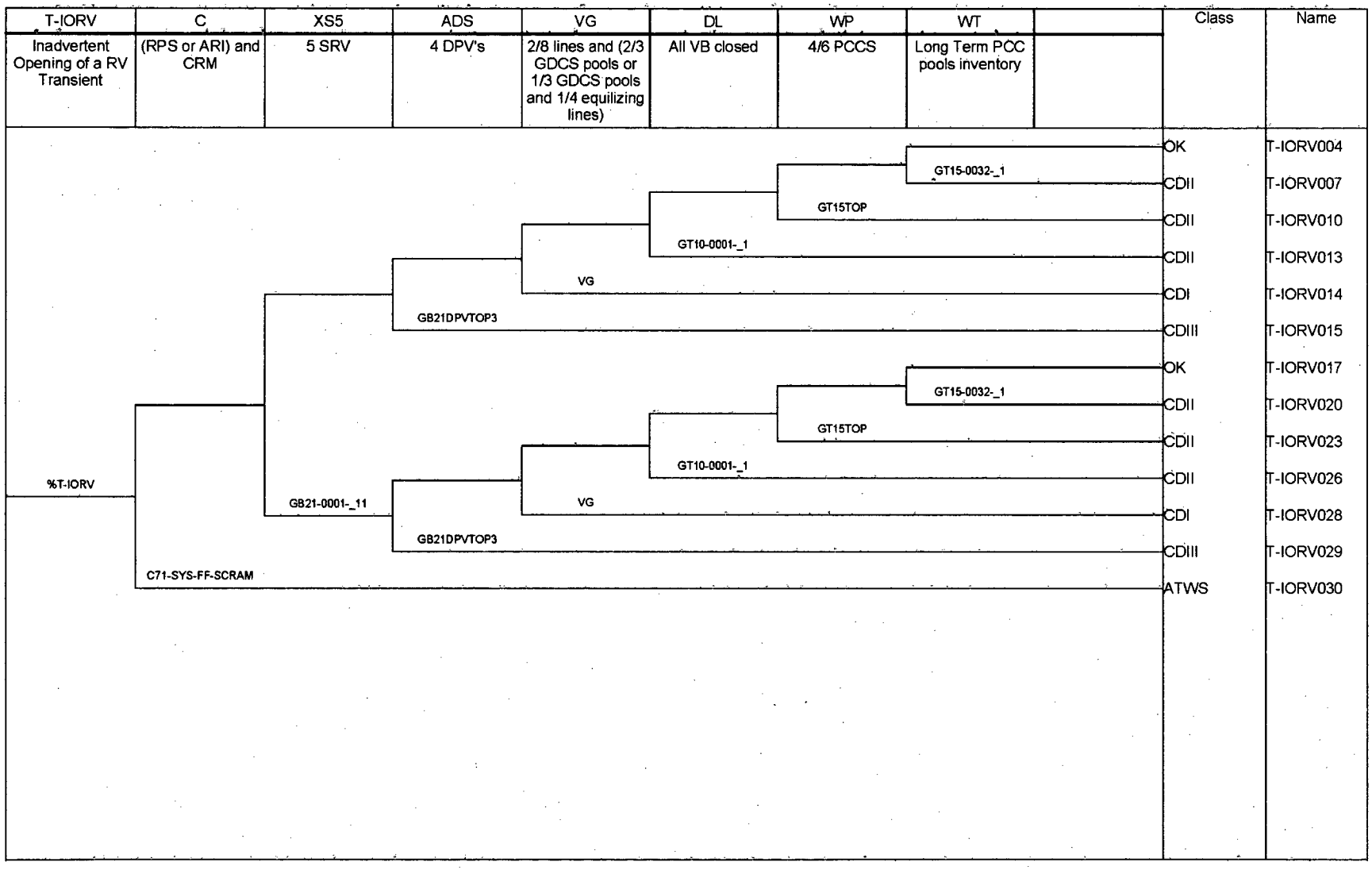

Figure B.11-6. Inadvertent Opening of a Relief Valve

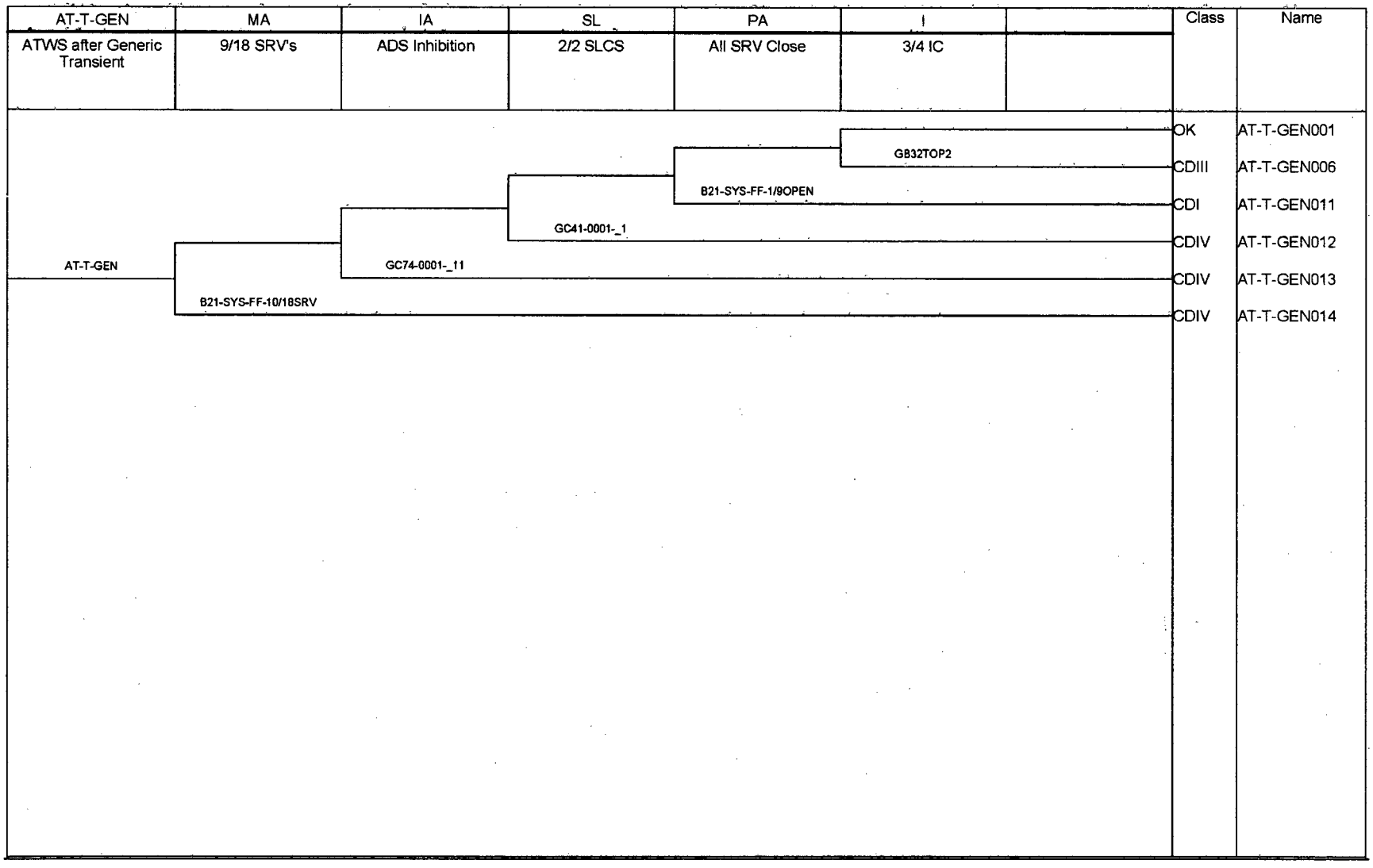

Figure B.11-7. ATWS from General Transient

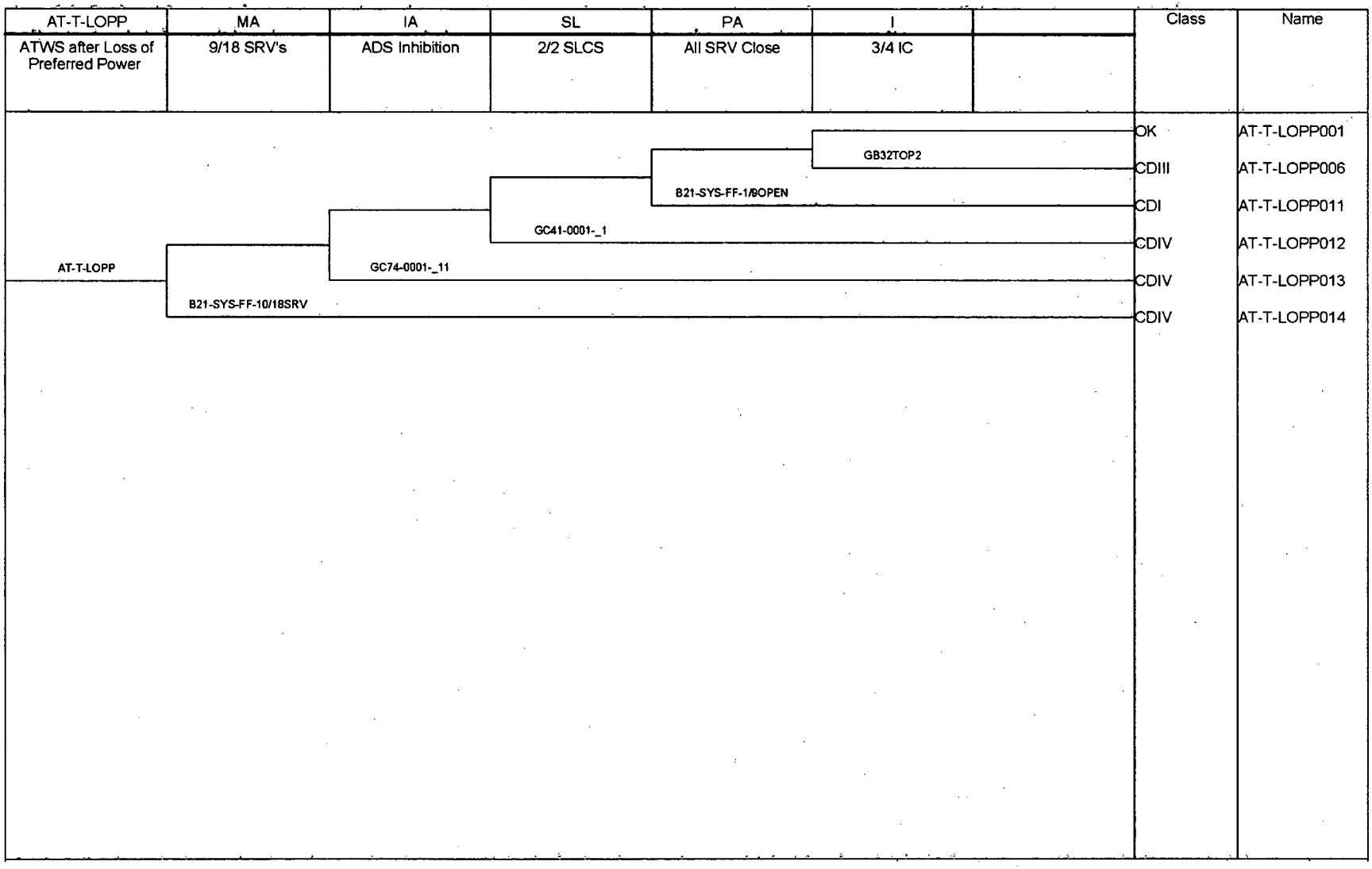

Figure B.11-7a. ATWS from Loss of Preferred Power

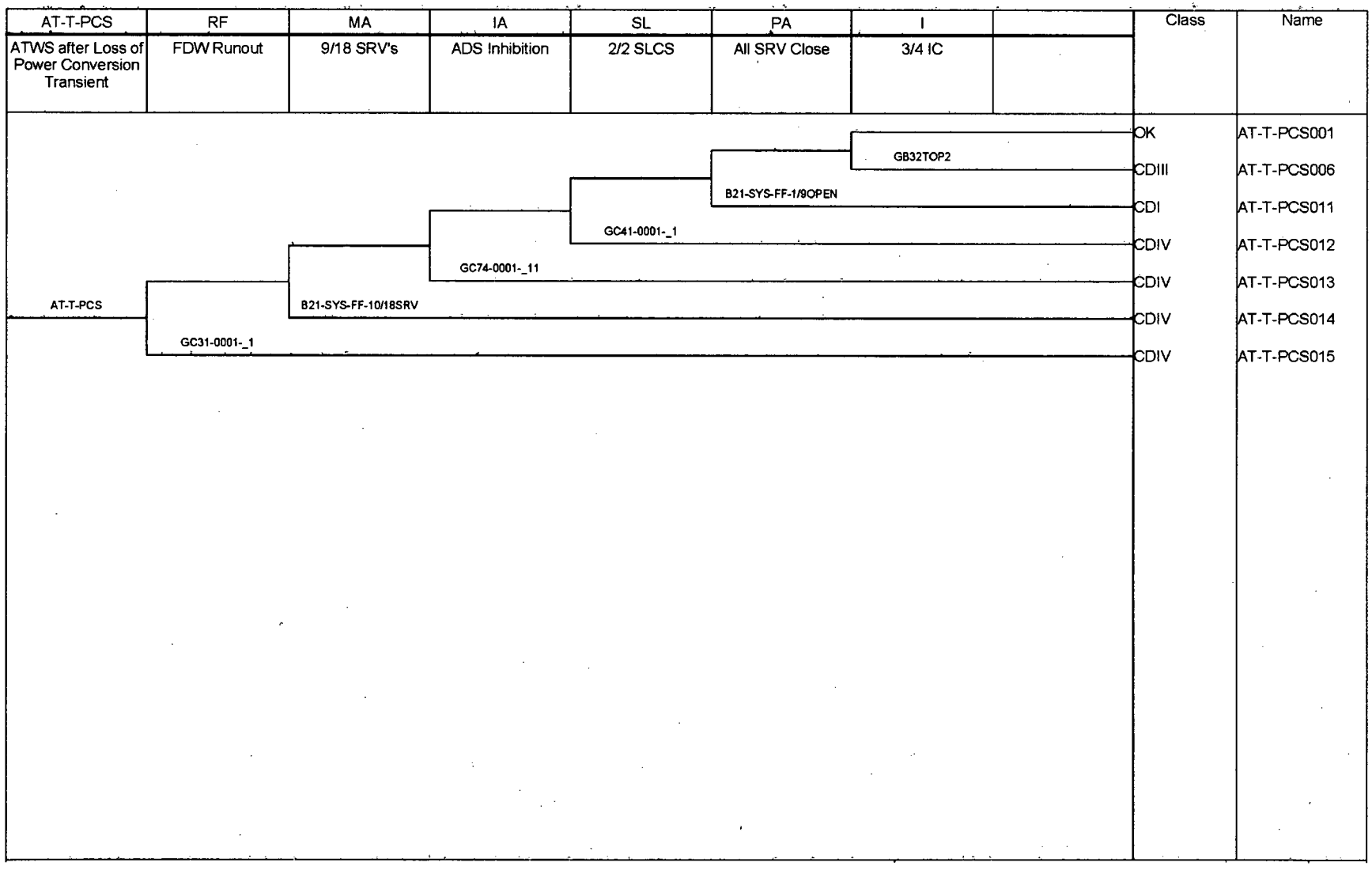

Figure B.11-8. ATWS from Transient Loss of PCS

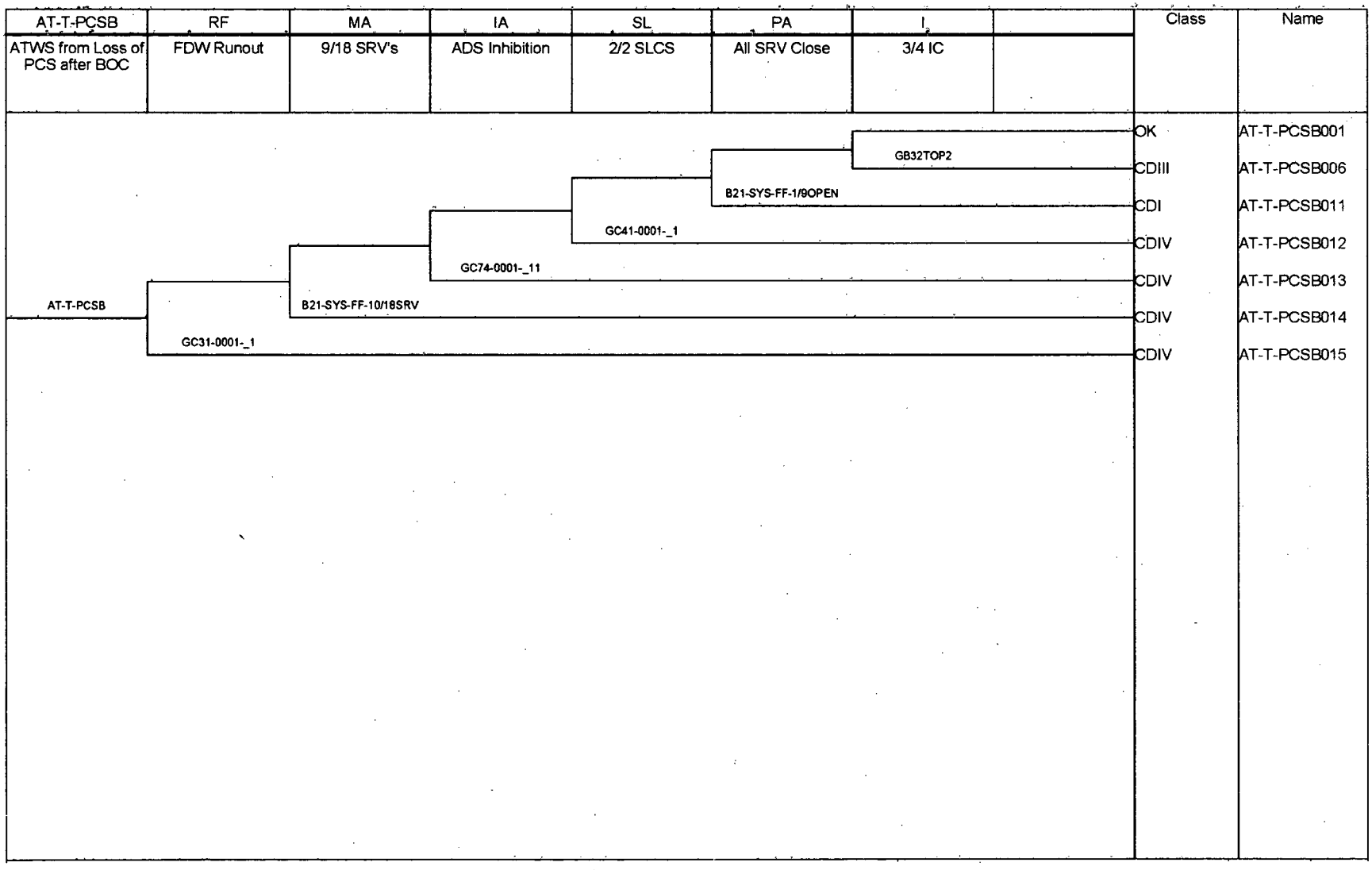

Figure B.11-8a. ATWS from Loss of PCS after BOC in IC or MS

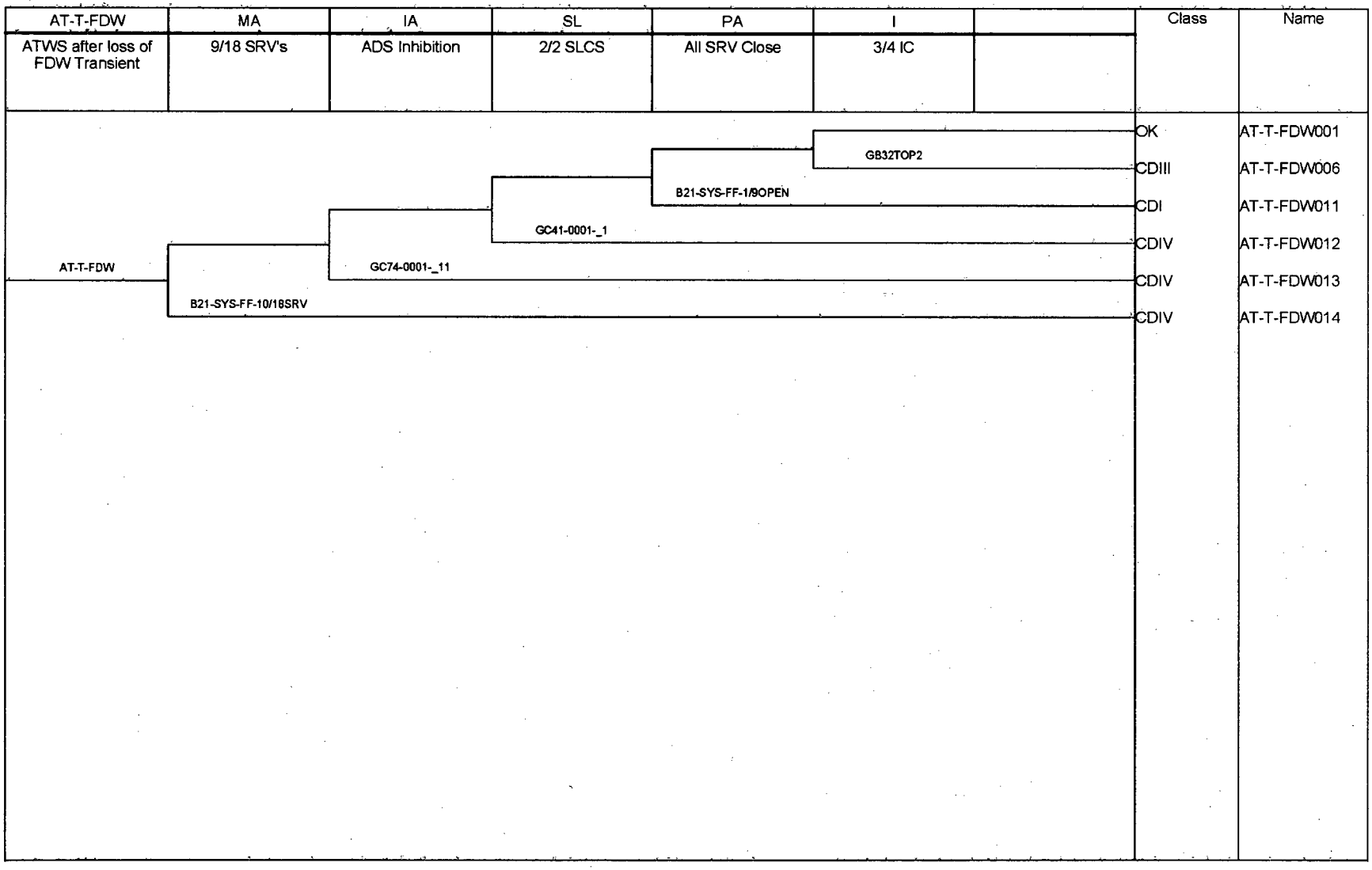

Figure B.11-9. ATWS from Transient with Loss of Feedwater System

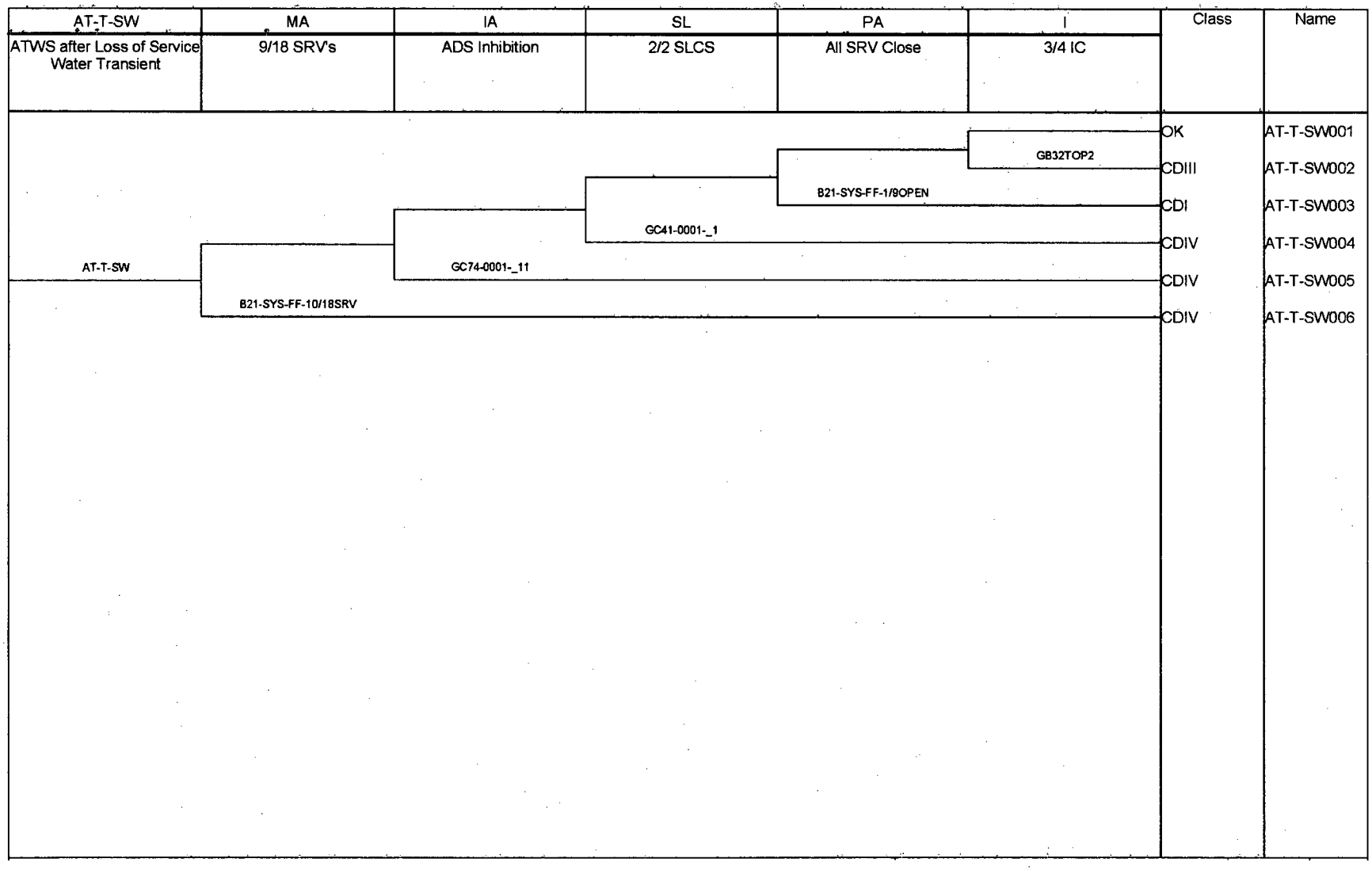

Figure B.11-10. ATWS from Transient with Loss of Service Water System

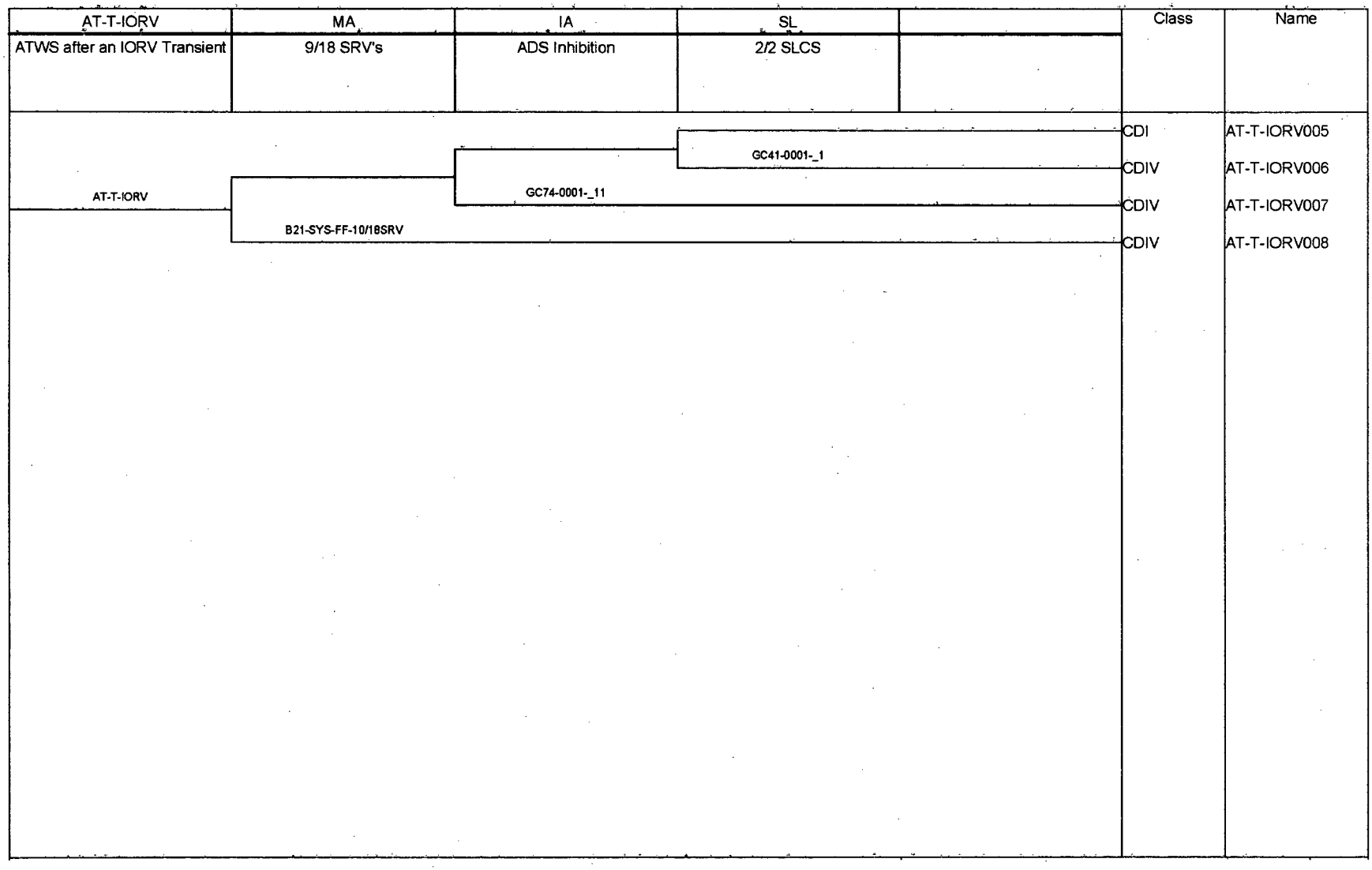

Figure B.11-11. ATWS from Inadvertent Opening of a Relief Valve

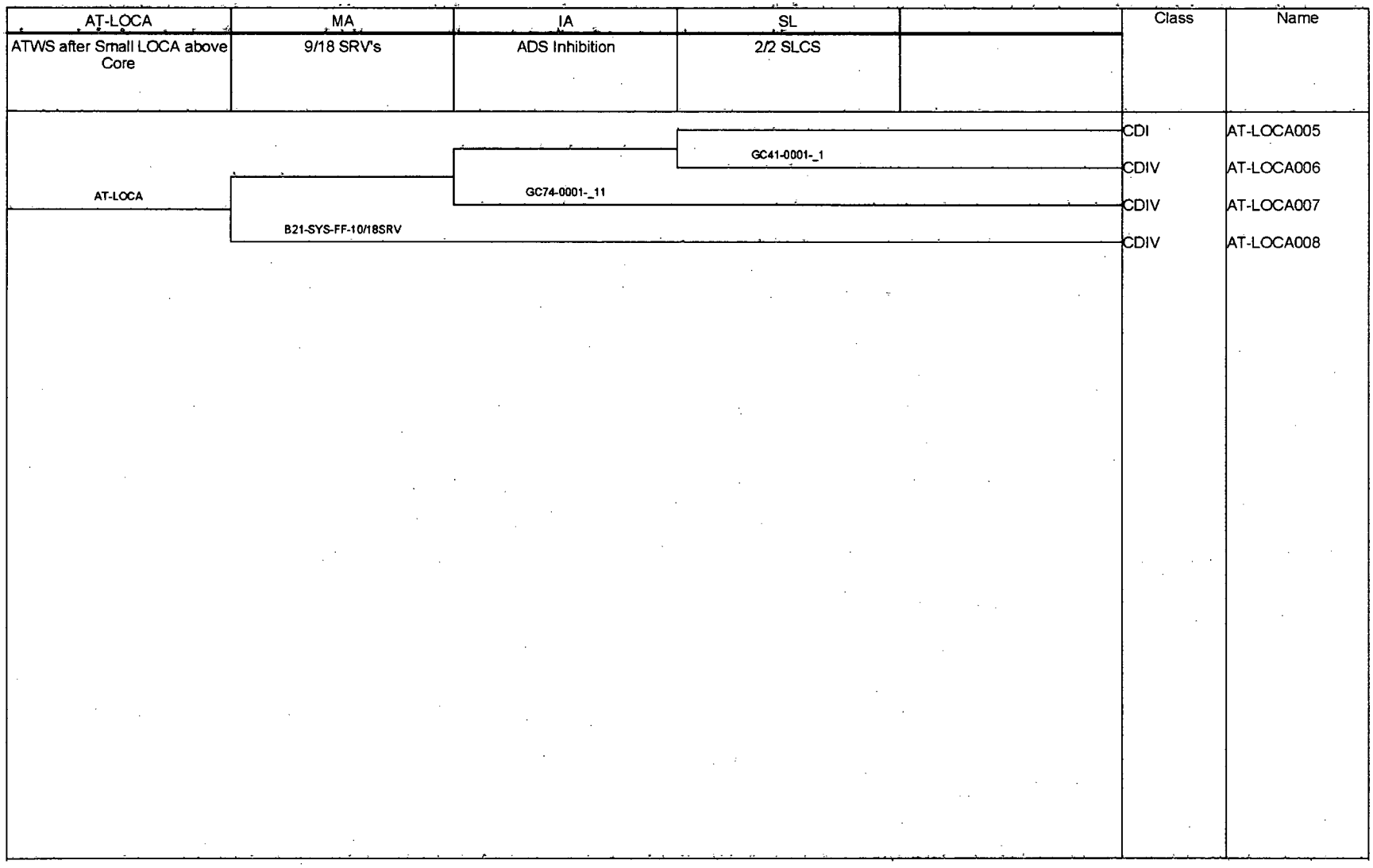

Figure B.11-11a. ATWS from Small LOCA above Reactor Core

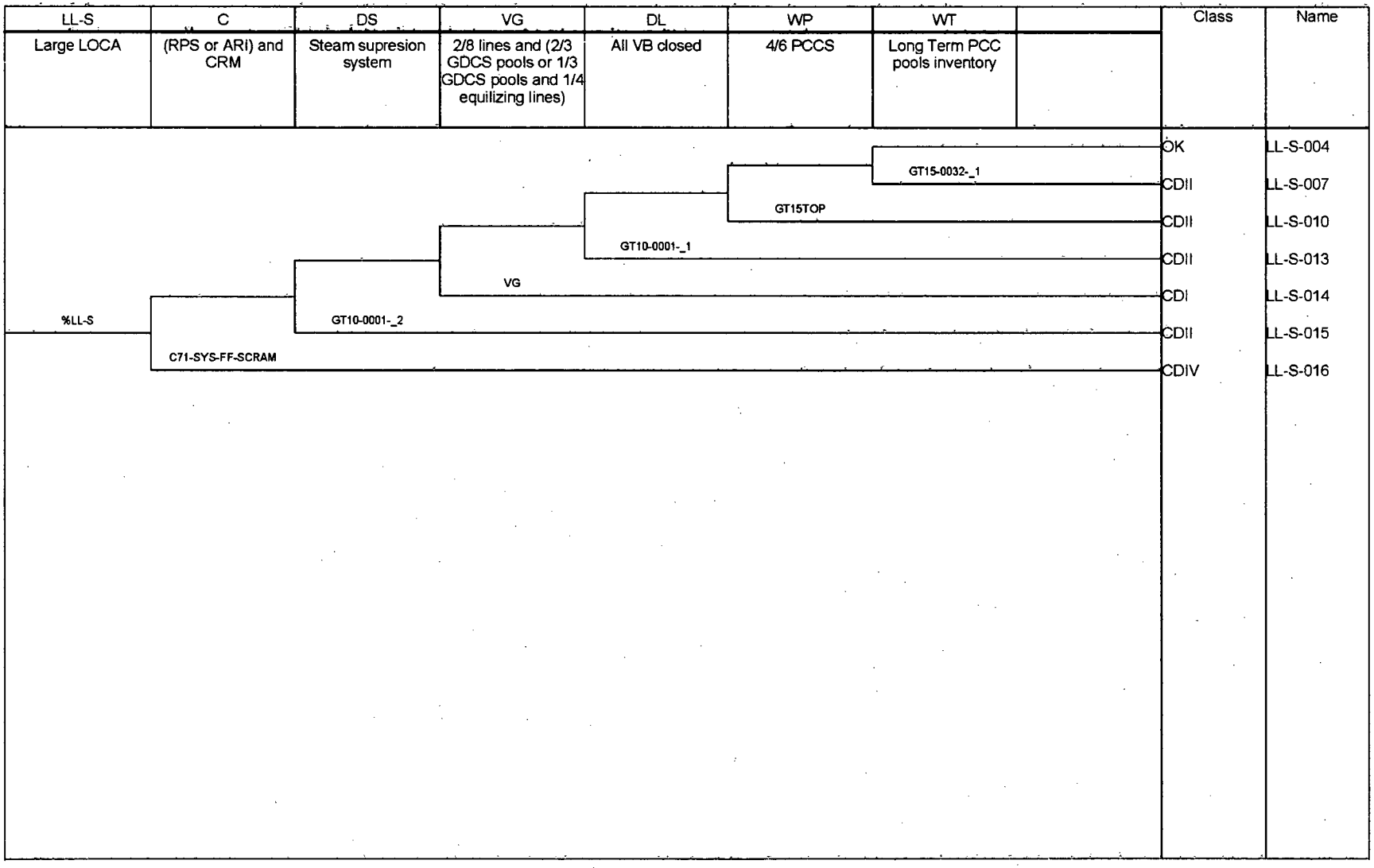

Figure B.11-12. Large Steam Breaks (above L3) other than Feedwater Lines

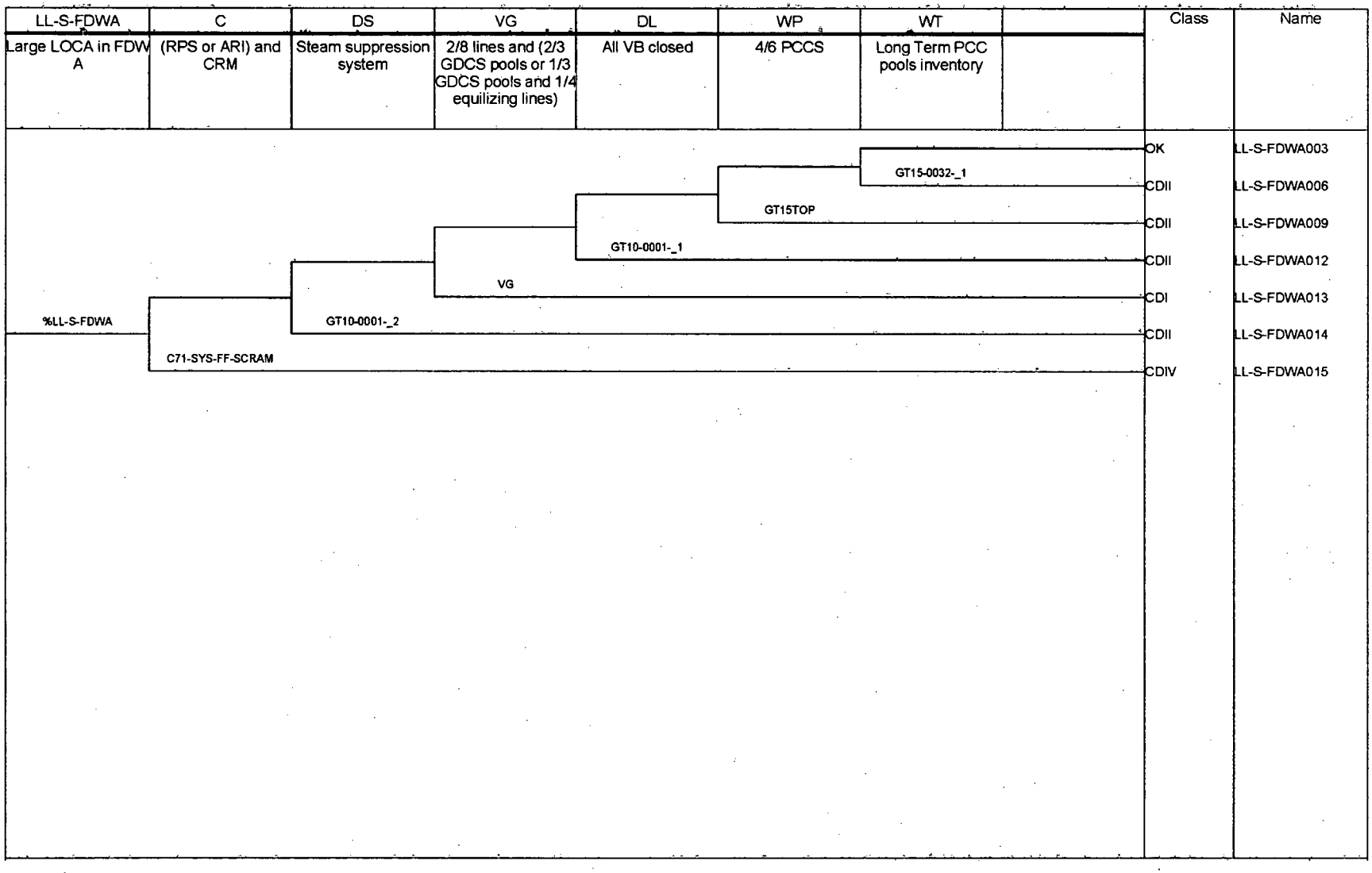

Figure B.11-13. Large Steam Breaks (above L3) in FDW (A) Line

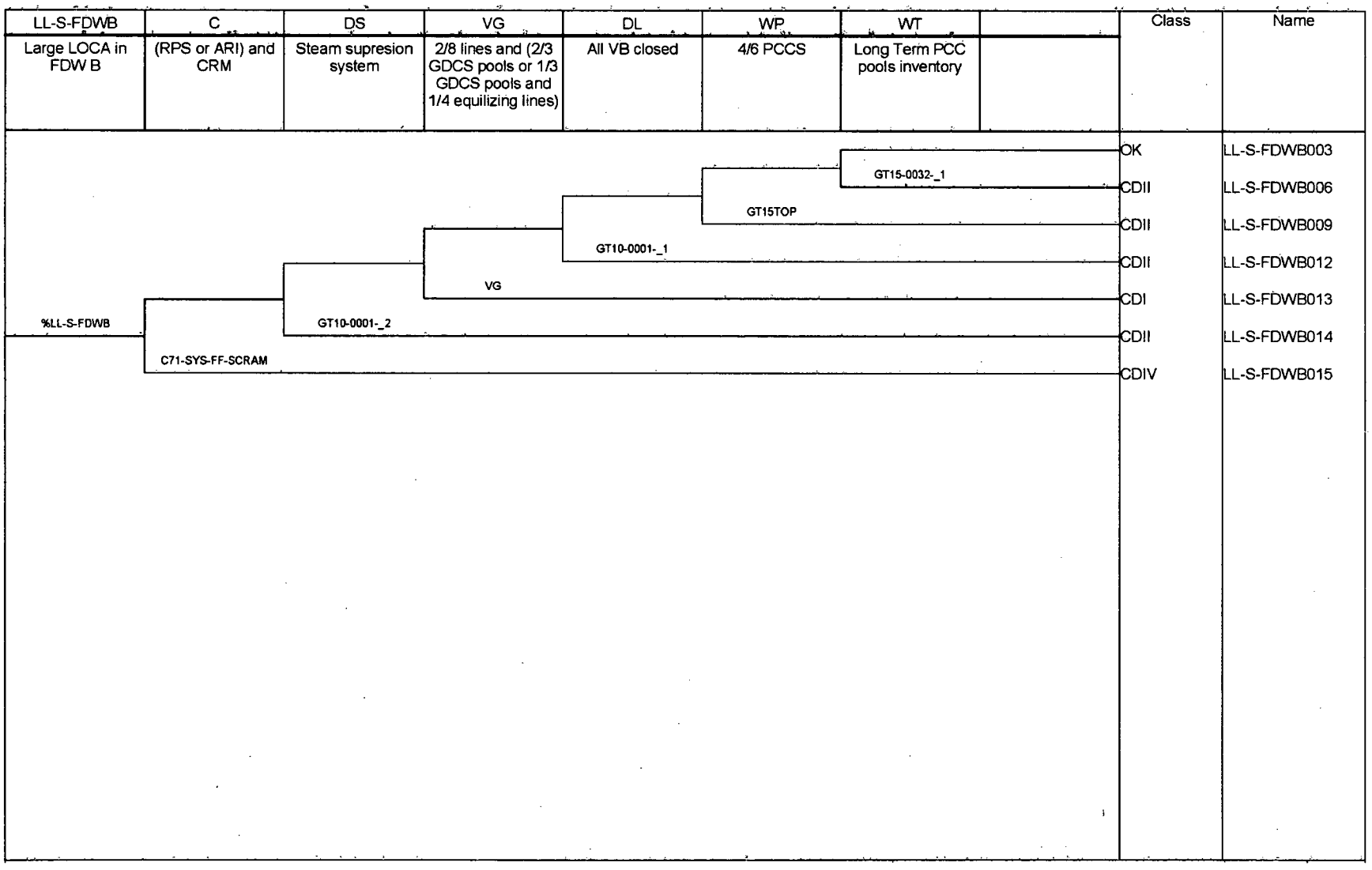

Figure B.11-14. Large Steam Breaks (above L3) in FDW (B) Line

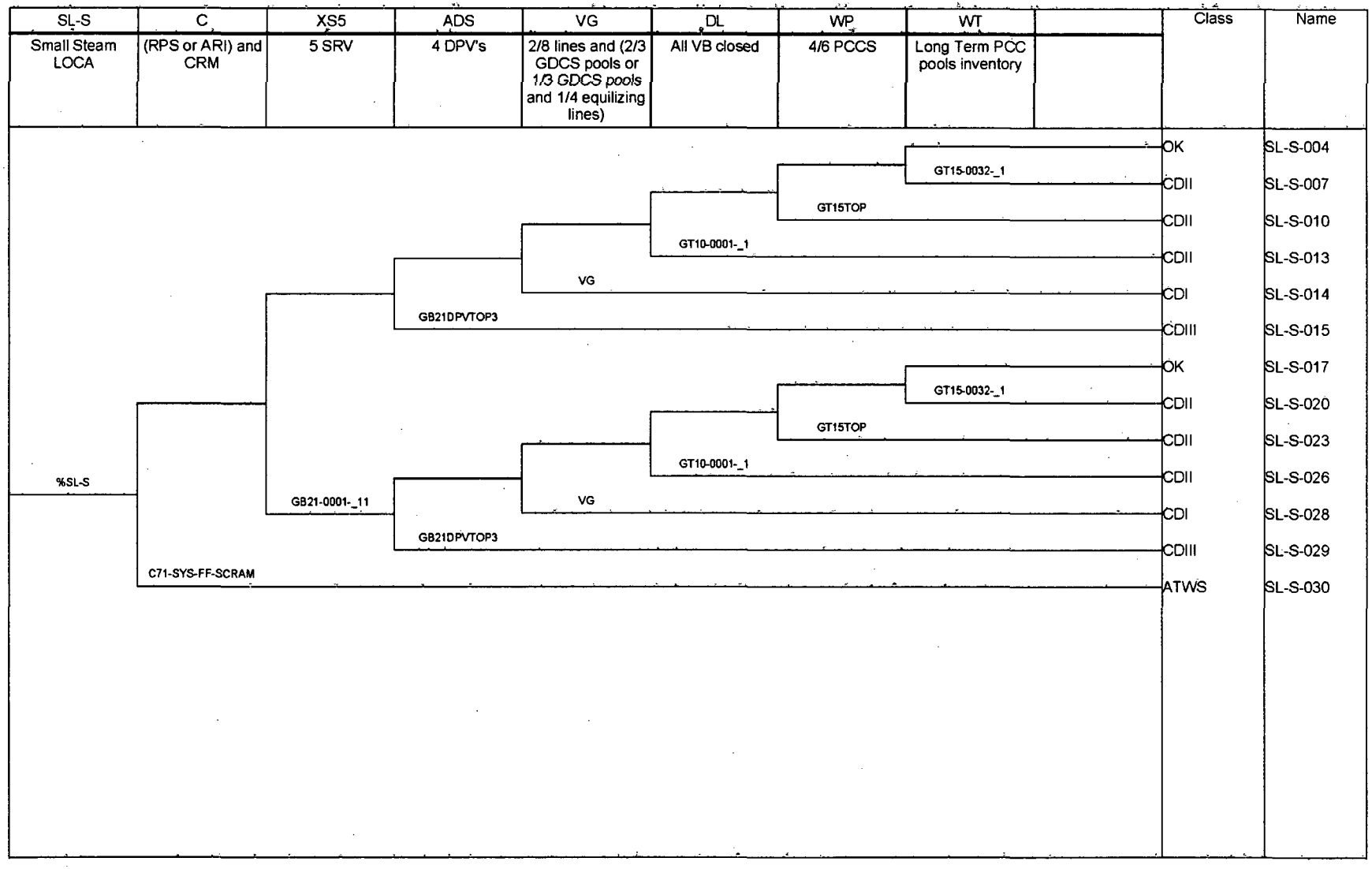

Figure B.11-15. Small Steam Breaks (above L3)

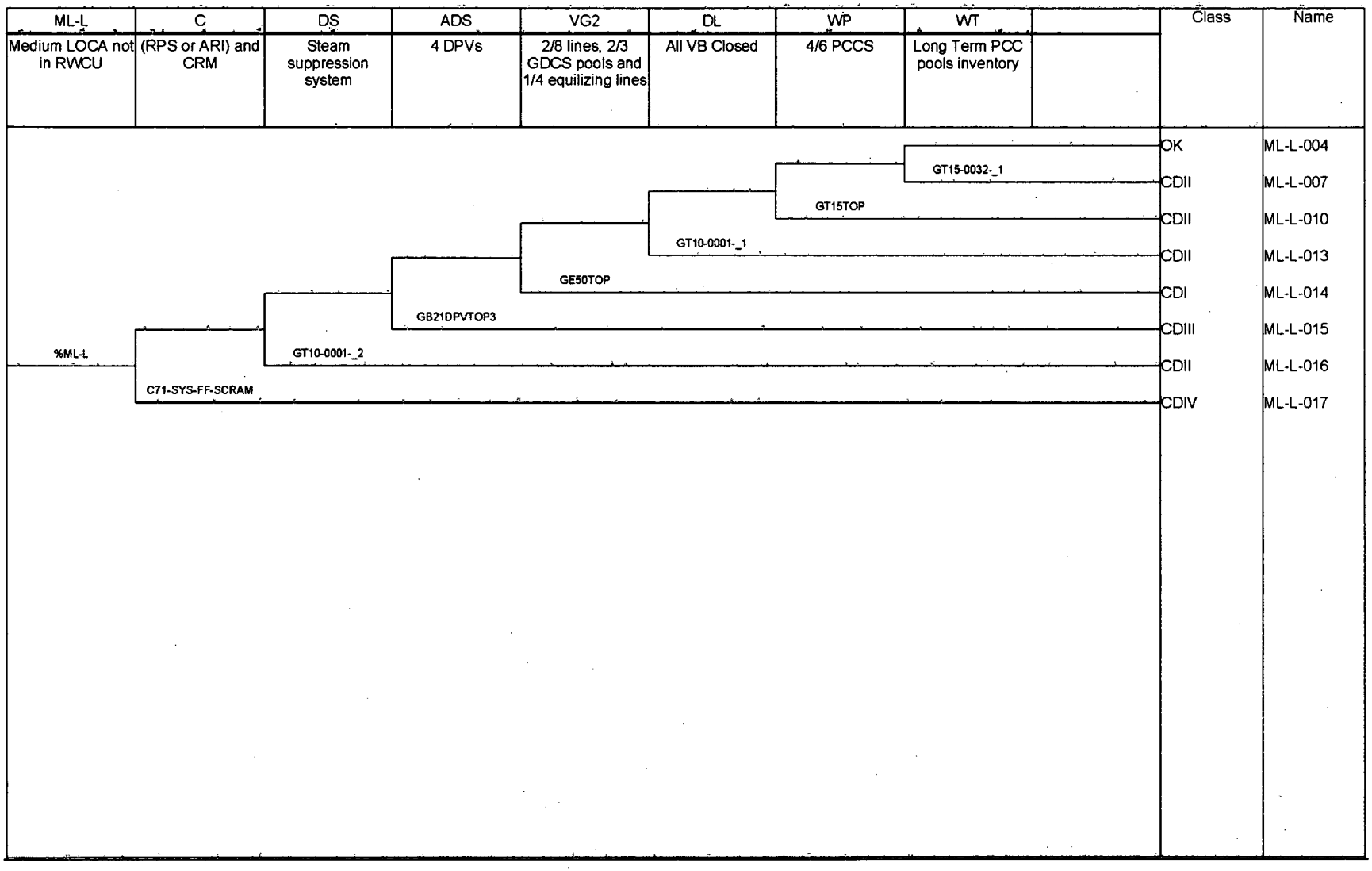

Figure B.11-16. Medium Liquid Breaks (below L3) other than RWCU/SDC Lines

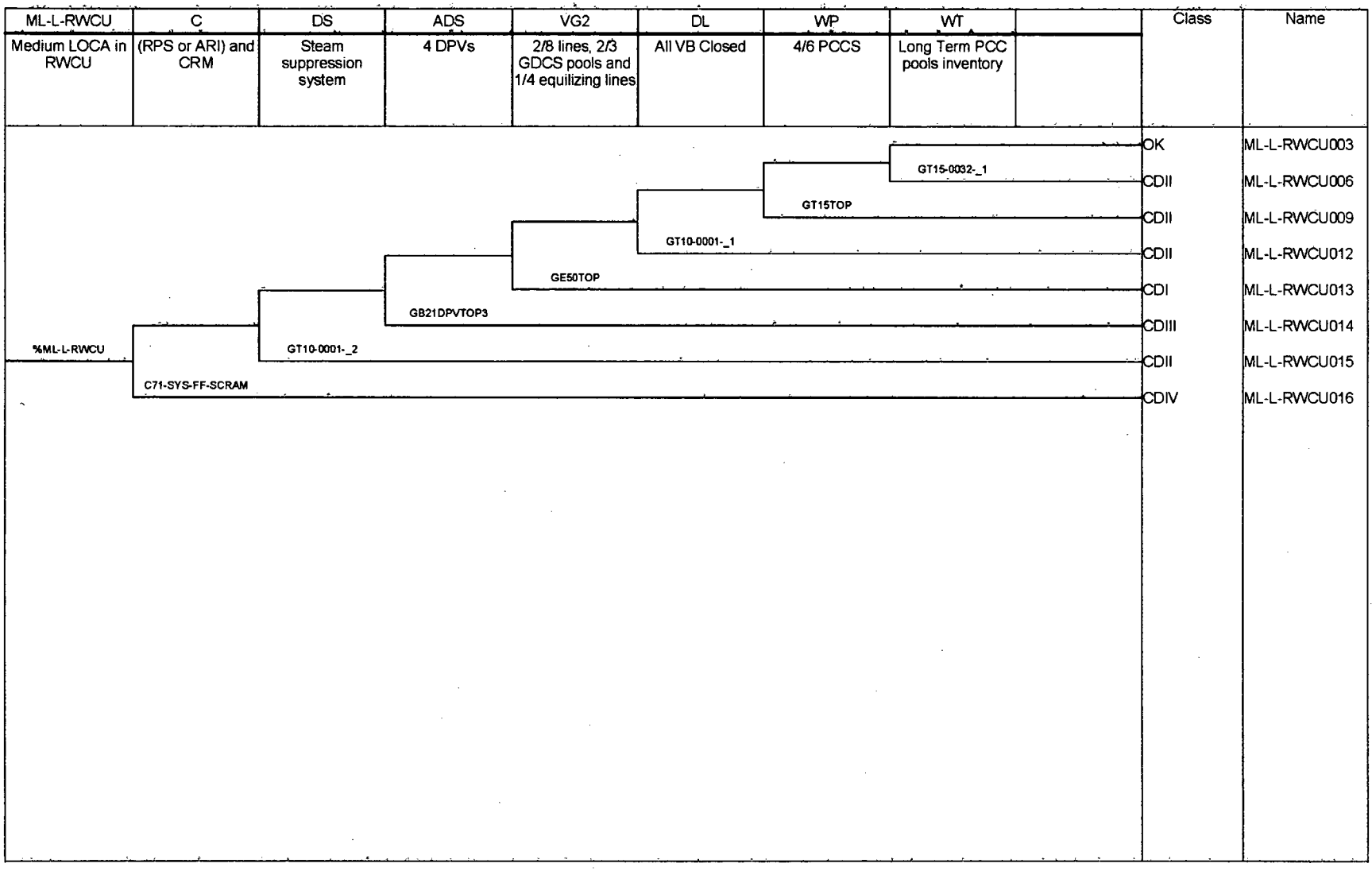

Figure B.11-17. Medium Liquid Breaks (below L3) in RWCU/SDC Lines

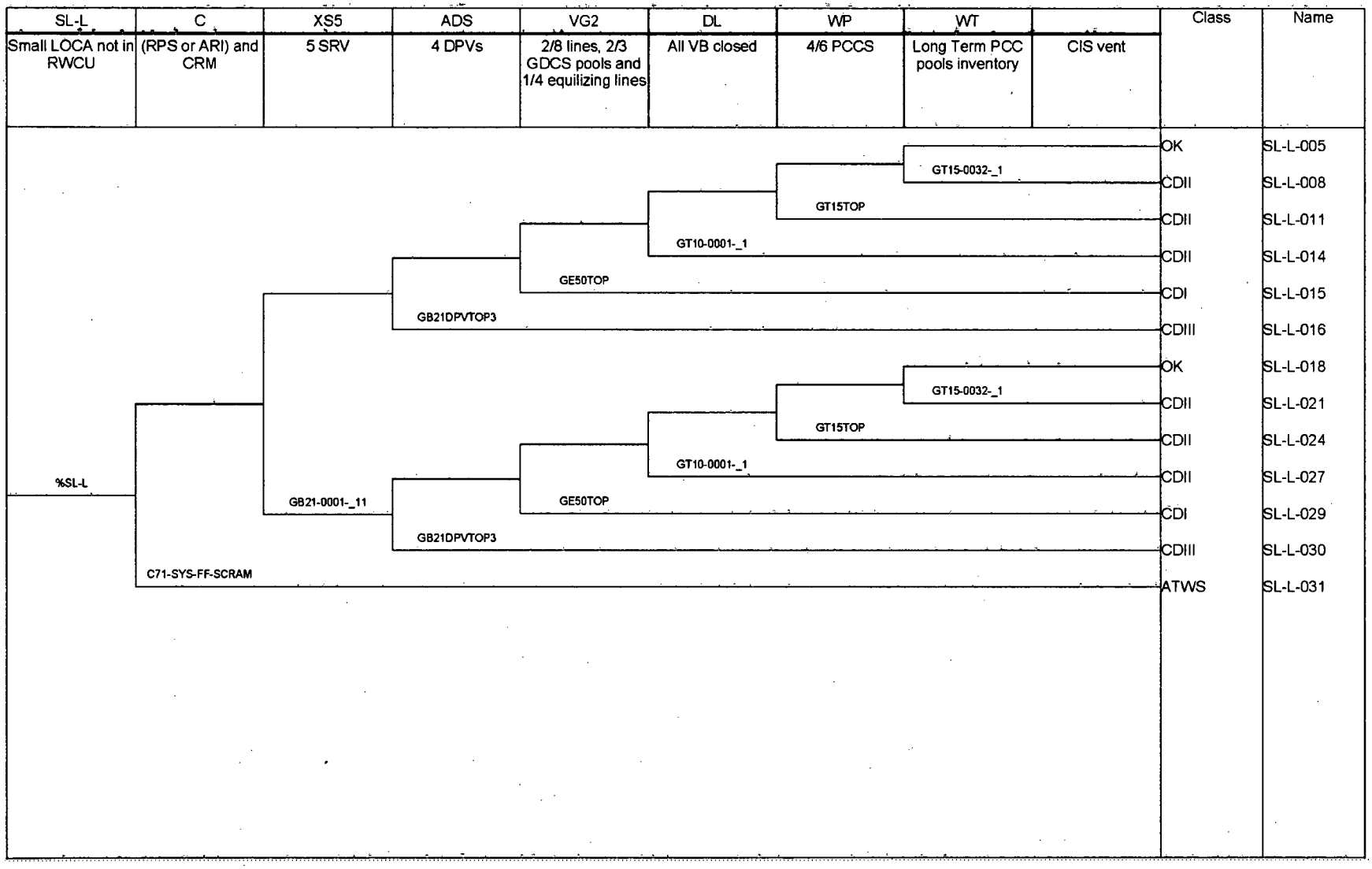

Figure B.11-18. Small Liquid LOCA (below L3) other than RWCU/SDC Lines

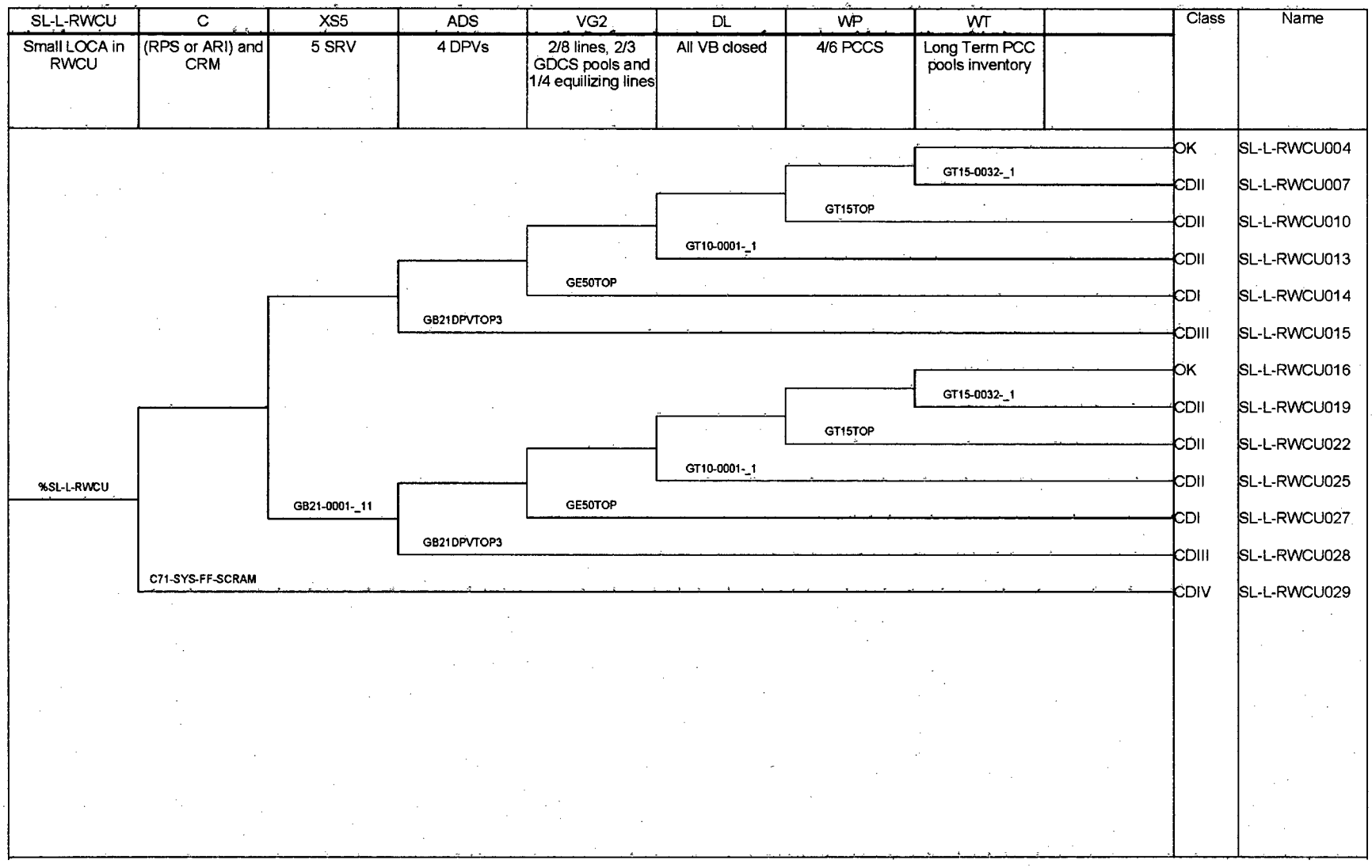

Figure B.11-19. Small Liquid LOCA (below L3) in RWCU/SDC Lines

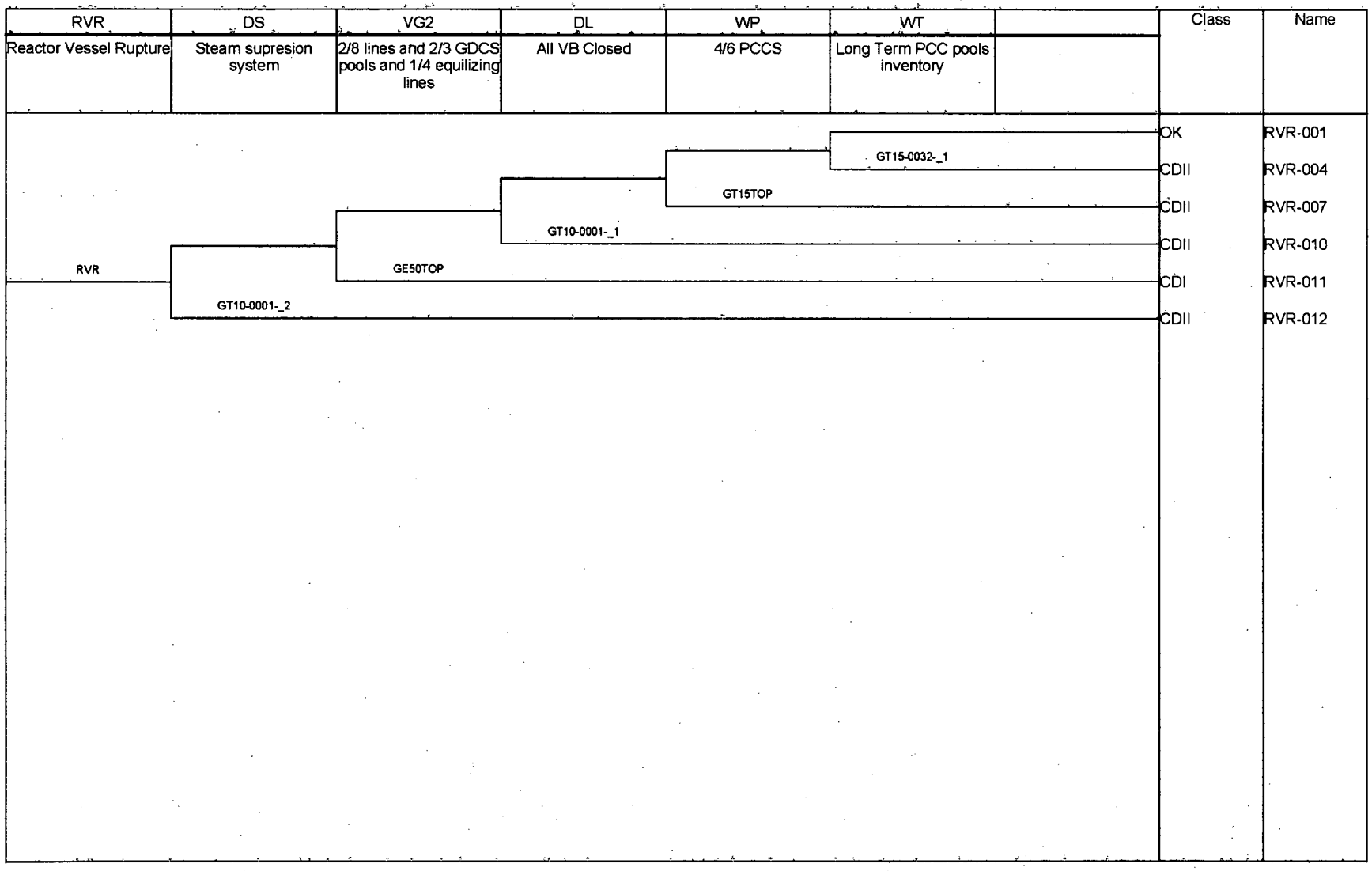

Figure B.11-20. Reactor Vessel Rupture

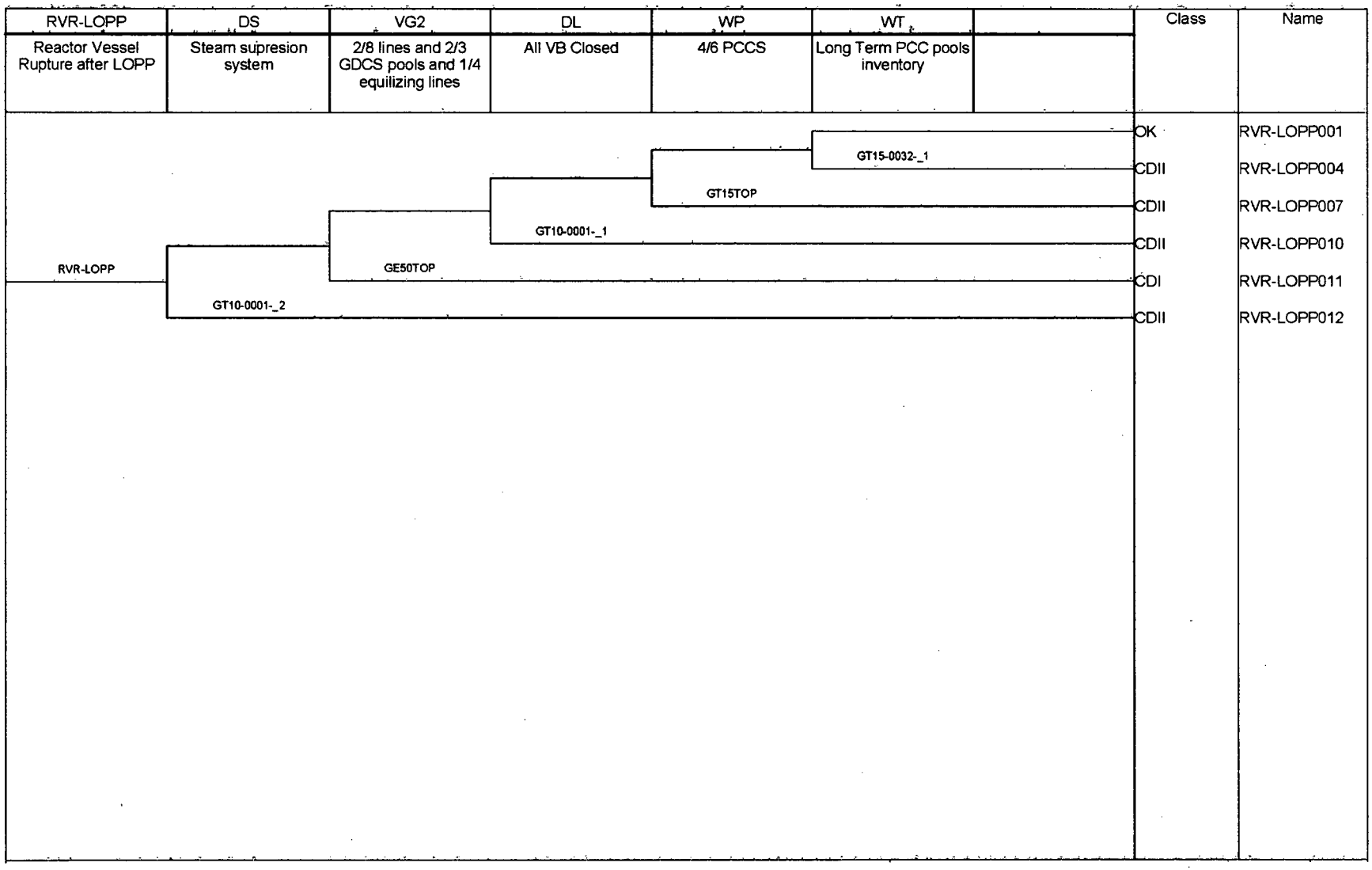

Figure B.11-20a. Reactor Vessel Rupture after Loss of Preferred Power

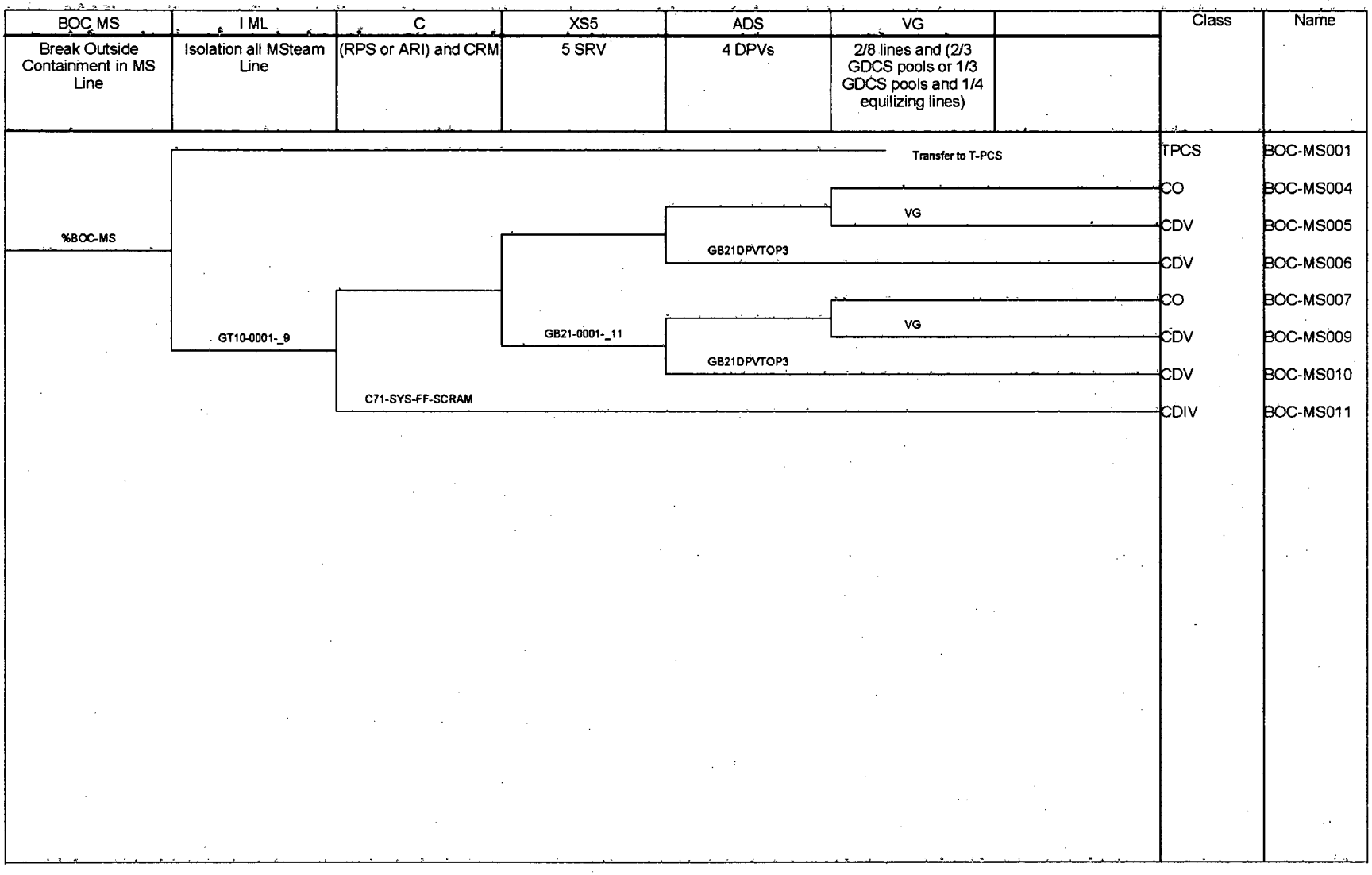

Figure B.11-21. Steam Break Outside Containment in Main Steam Lines

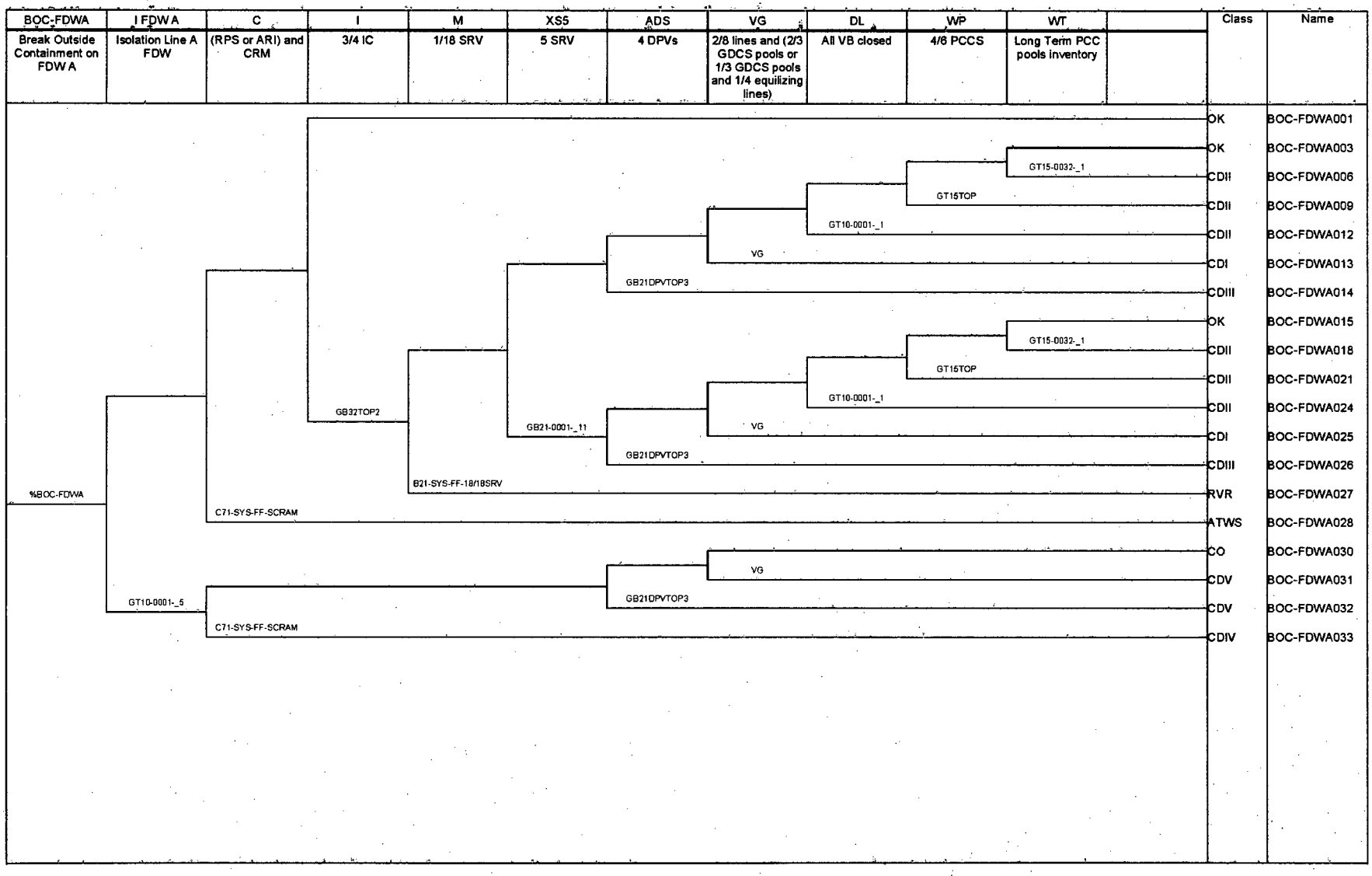

Figure B.11-22. Steam Break Outside Containment in FDW A Line

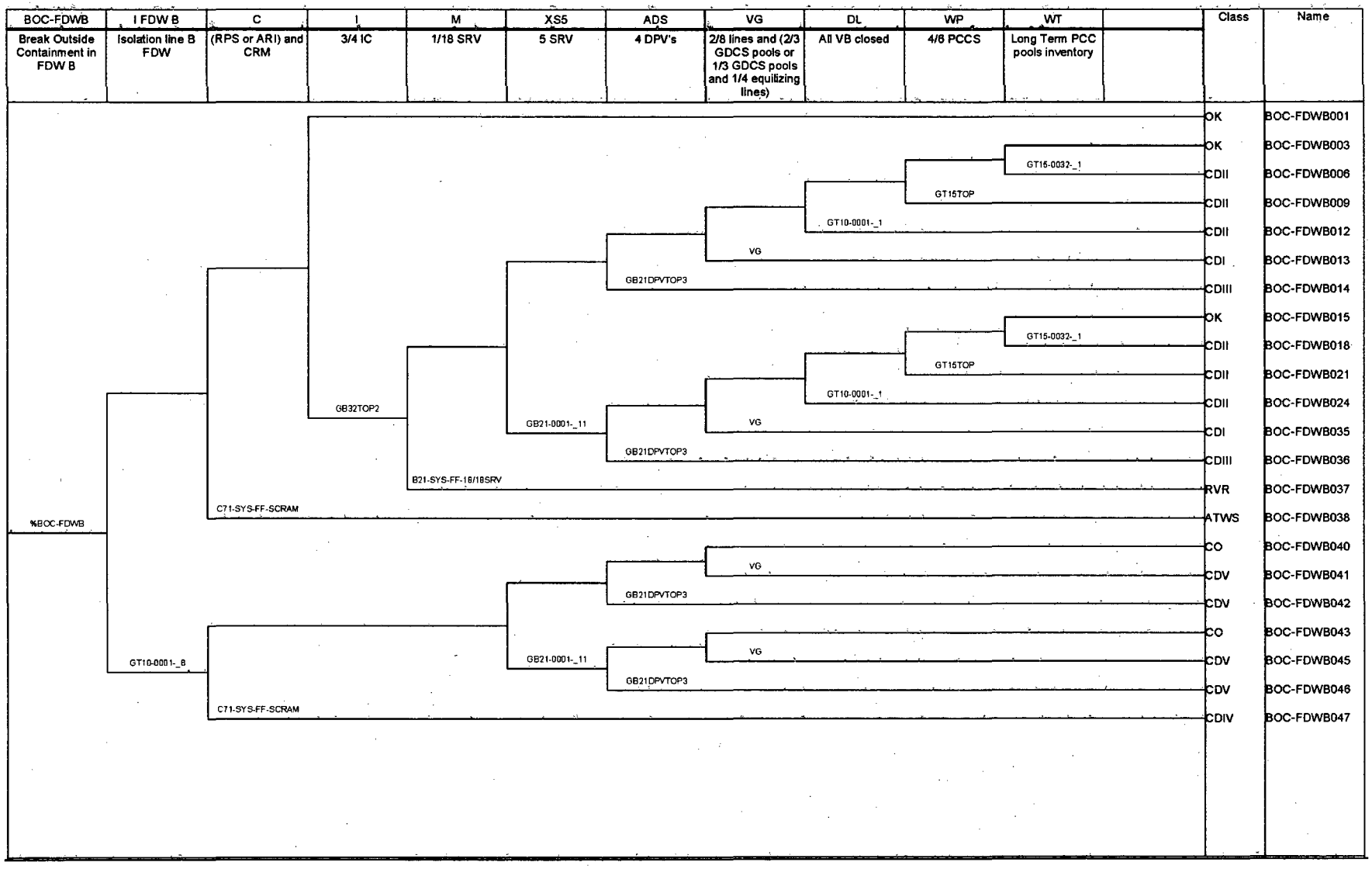

Figure B.11-23. Steam Break Outside Containment in FDW B Line

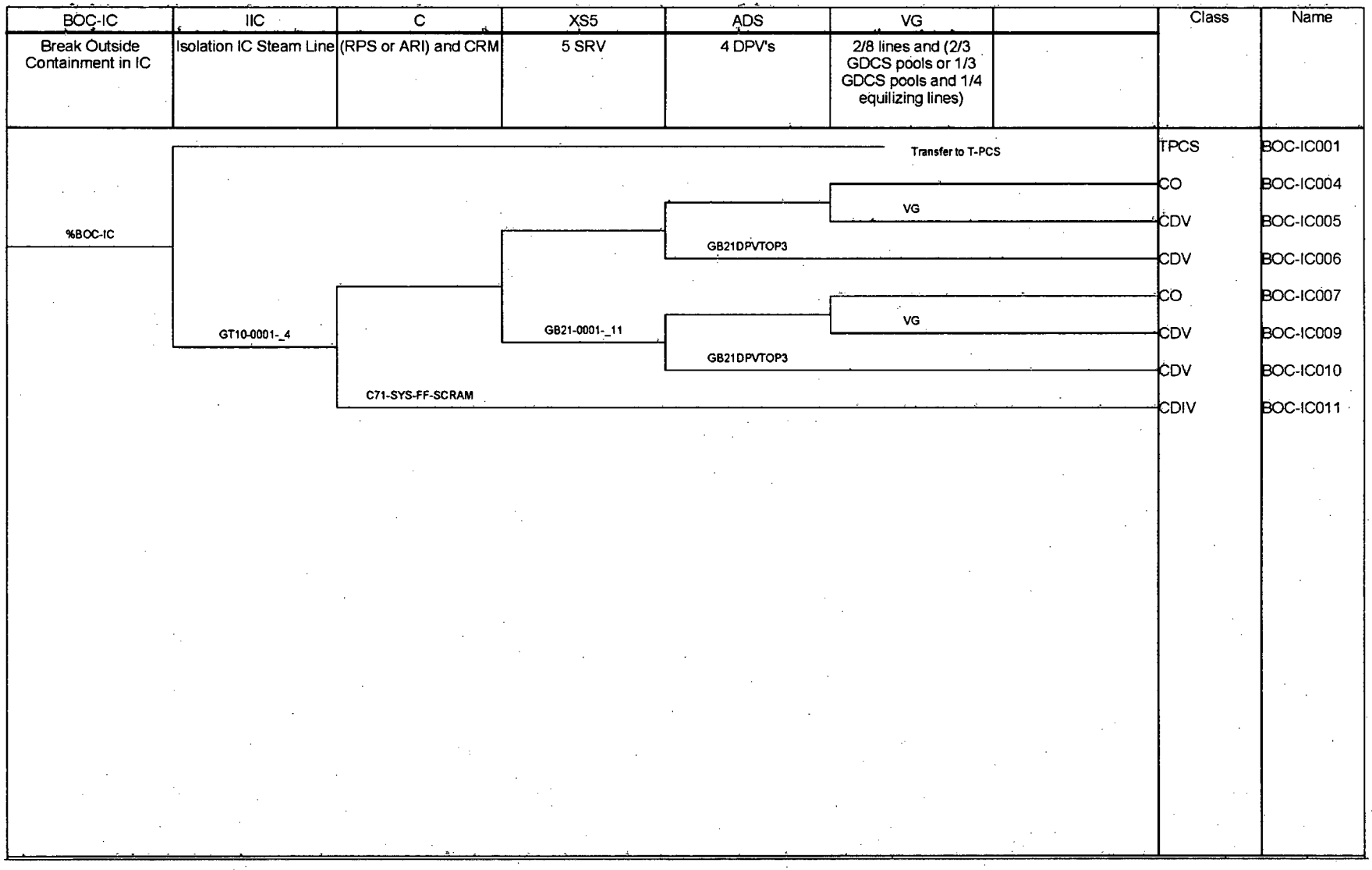

Figure B.11-24. Large Steam Break Outside Containment in IC Lines

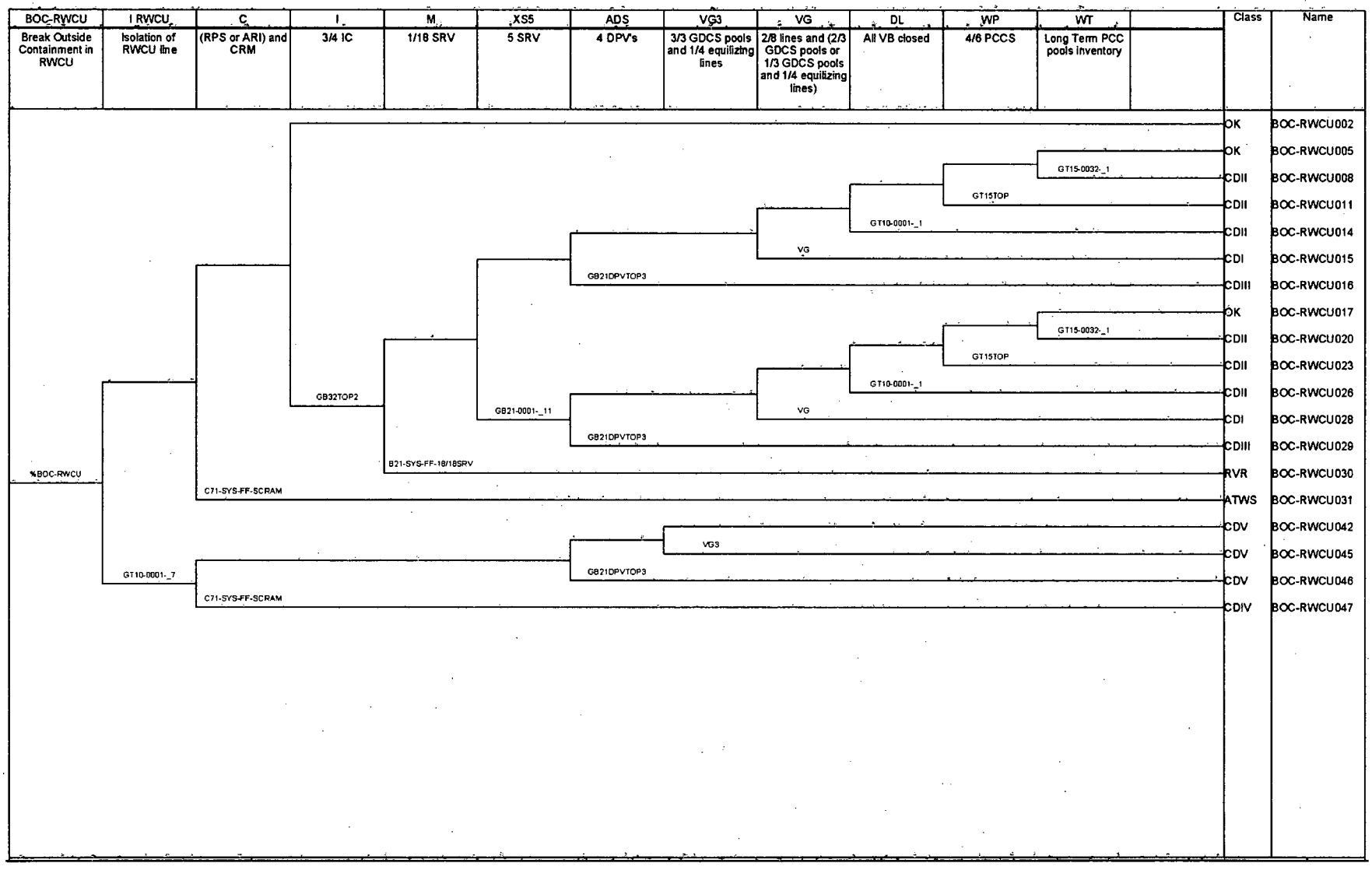

Figure B.11-25. Large Liquid Break Outside Containment in RWCU/SDC Lines

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12 PROBABILISTIC FIRE ANALYSIS

This section documents the internal fire analysis of the ESBWR PRA.

12.1 INTRODUCTION

The probabilistic fire analysis is performed taking into account that the specifics of cable routings, ignition sources, or target locations in each zone of the plant are not known. Because of this limitation, a simplified conservative and bounding approach is used in this analysis.

The aim of the analysis is to show that core damage frequency due to fire is a non-significant contributor to ESBWR core damage risk.

The scope of the analysis includes both at-power and shutdown fire-induced accident scenarios.

12.2 METHODOLOGY

The ESBWR internal fires probabilistic risk assessment is performed per the Fire Vulnerability Evaluation (FIVE) Methodology (Reference 12-1) developed by the Electric Power Research Institute (EPRI). The FIVE methodology provides procedures for identifying fire compartments for evaluation purposes, defining fire ignition frequencies, and performing quantitative analyses of fire risk.

The FIVE methodology involves the following three major steps:

(1) Identification of plant areas

(2) Calculation of fire ignition frequencies

(3) Calculation of fire-induced core damage frequencies

Fire ignition frequencies for power operation at each area are estimated, using the FIVE methodology and data. Fire frequencies for shutdown conditions are estimated using the information included in Reference 12-2.

Fires are conservatively assumed to propagate unchecked in each fire area (no suppression is credited) and damage all functions in the fire area.

The internal events PRA accident sequence structures and system fault trees and success criteria are used in the calculation of the fire CDF.

The fire risk analysis is performed using conservative assumptions due, in part, to the status of the development of the design. The key conservative assumptions are summarized below:

(1) Fire areas are grouped to simplify the analysis. The fire frequency contributions from all the fire areas in the group are added together. The analysis assumes the worst effects of fire on all the equipment and systems located in each group of fire areas. Consequently, the analysis assumes that any fire in any fire area in the group will cause the worst damage.

(2) In the case of the reactor building, the fire frequencies from certain pumps located in the building (RWCU and CRD) and the fire frequencies from panels, battery chargers and batteries are added together despite the fact that these items are located in well-separated locations inside the building. Fires initiated in these separated locations are highly unlikely to affect divisional equipment.

(3) The analysis assumes that a fire ignition in any fire area continues to grow unchecked into a fully-developed fire. The analysis does not take credit for any fire suppression (i.e., self-extinguishment, installed suppression systems, nor manual fire fighting activities).

(4) The analysis assumes that all fires disable all potentially affected equipment in the area. The analysis does not take credit for the distance between fire sources and targets.

(5) The analysis assumes that all fire-induced equipment damage occurs at t=0.

(6) Every fire in the reactor building is conservatively assumed to result in an IORV initiating event. This is conservative because only a few cables in the reactor building could result in spurious opening of SRVs. In addition, a specific fire-induced circuit failure would be required to cause the IORV.

For these reasons, it is inappropriate to add these fire CDF results to the internal events core damage frequencies.

12.3 IDENTIFICATION OF PLANT FIRE AREAS

This section discusses the division of the plant into fire areas for the purpose of the probabilistic internal fires analysis. This division considers separation design criteria and the systems considered significant to the risk profile. The separation design criteria and the resulting fire areas are discussed below.

12.3.1 Separation Criteria

The "Electrical Equipment Separation" design specification provides the basic criteria concerning separation, both physical and electrical, of redundant safety equipment. These specifications are as follows:

- NRC Regulatory Guide 1.75 and IEEE Standard 384 require physical separation and electrical isolation. In addition, the more stringent NRC Policy Statement SECY-89-013 (Paragraph 2.3.c) requires capability for safe shutdown assuming all equipment in any one fire area has been rendered inoperable by fire. In all areas except the Control Room and the primary containment, redundant electrical divisions should be placed in different fire areas separated by fire barriers rated in accordance with the Fire Prevention and Protection Specification.
- Exceptions are anticipated, but must be individually justified. The Control Room is exempted on condition that independent alternate shutdown capability is provided that is physically and electrically independent of the Control Room (i.e., the Remote Shutdown System). The primary containment design should ensure, to as great an extent as possible, that one shutdown division is free of fire damage.

Fire protection is achieved through an adequate balance of:

- Preventing fires from starting
- Detecting fires quickly, suppressing those fires by controlling and extinguishing them quickly, and limiting their damage; and
- Designing plant safety and safety-related systems so that a fire that starts and burns for considerable time does not prevent essential plant safety functions.

The plant is divided into separate fire areas, and the redundant cables and equipment are separated with fire barriers to limit any damage caused by a fire and to provide a means to ensure that there is sufficient capacity to perform safety functions in case of fire,

The ESBWR plant design has three-hour fire rated barriers separating:

(1) Safety-related systems from any potential fires in nonsafety-related areas that could affect their ability to perform their safety function;

(2) Redundant divisions or trains of safety-related systems so that both are not subject to damage from a single credible fire that could consume everything within the given fire area; fires within inerted containment during plant operation are not considered credible;

(3) Components within a single safety division that could present a fire hazard to other safety-related components;

(4) Each remote shutdown panel from the other remote shutdown panel.

The application of these separation criteria ensures an adequate independence of each safety system division, such that a single fire can only affect one safety system division. These criteria are used in this analysis to support definitions of the major fire areas.

ESBWR non-safety systems with the potential (significance) to adversely affect safety are designed with similar separation considerations.

12.3.2 Plant Fire Areas

The ESBWR is divided into the following six major areas for the purpose of this analysis:

(1) DCIS Class 1E Cabinet Areas: This major area contains the control and information cabinets of the four safety divisions in the control building. Each of the four safety divisions is located in a separate fire area. These areas contain the equipment needed for the actuation of safety systems. It is assumed that a fire at any location in a divisional fire area results in the immediate loss of function of that division.

(2) Divisional Areas within the Reactor Building: This major area contains cabinets and electrical equipment associated with each of the 1E class safety divisions. This electrical equipment includes the batteries and the DC distribution panels for all safety equipment. The electrical equipment is distributed on elevations -6400, -1000, 4650 and 9060 within the Reactor Building. Each division is located in a separate fire area, which in some cases include areas on more than one elevation. Each divisional fire area is bounded on all sides by three-hour rated fire barriers. Likewise, it is also assumed that the routing of associated cables respects the separation criteria. It is assumed that a fire at any location in a divisional fire area results in the immediate loss of function of that division.

The Reactor Building also contains other systems that are credited in the PRA models, such as the Reactor Water Cleanup (RWCU) and the Control Rod Drive (CRD) systems. The pumps and heat exchangers of each RWCU train are located in different fire areas. It is assumed that separation criteria are applied using fire barriers such that a single fire affects only a single RWCU train.

The CRD system has been designed per RTNSS using plant investment protection requirements and separation criteria have been applied to the cable routing of this system. Nevertheless, both pumps are located in the same fire area. The CRD pump area location is separated from the rest of the reactor building such that no safety related cables are routed through the CRD pump area. The only fire with the potential to disable both CRD pumps is a fire in the CRD pump area itself. Because such a fire scenario does not impact any safety related components, the contribution to fire CDF from a fire in this area is non-significant. The analysis conservatively addresses fires that disable the CRD pumps by assuming for analysis purposes that the CRD pumps are located in the divisional areas of the reactor building rather than modeling the CRD pump room as a separate area.

(3) Non-Divisional Areas of the Electrical Building; Service Water Building; DCIS Non-Class 1E Panel Areas of the Control Building; and RCCW Pump and Heat Exchanger Areas and Instrument Air Compressor Areas:

The Electrical Building contains the AC and DC distribution systems, with the exception of the class 1E systems that, as mentioned above, are located in the Reactor Building. The diesel generator rooms are attached to the Electrical Building. The electrical systems are divided into two divisions. The cable spreading rooms, batteries, and other electrical equipment of each division are located in separate fire areas. Separation with fire barriers is assumed between both divisions.

It is assumed that the service water pumps in the Service Water Building are located in separate fire areas, consistent with the separation for pumps and heat exchangers of the RCCW system.

The DCIS non-class 1E panels are located at elevation 4650 of the Control Building. They are divided into two separate fire areas corresponding to divisions A and B.

The RCCW system pumps and heat exchangers and the instrument air compressors are located in the Turbine Building, independent from the other Turbine Building areas. Therefore, these areas are analyzed separately from the rest of the Turbine Building and included here with this group of areas. It is assumed that the routing of cables associated with this equipment maintains the same separation criteria.

(4) Turbine Building: The Turbine Building is analyzed as a single fire area, with the exception of the RCCW and instrument air compressor fire areas discussed previously. It is assumed that a fire in the Turbine Building causes loss of the condensate and feedwater systems, and the service air compressors.

(5) Fuel Building: Given that the only relevant system located in the Fuel Building is FAPCS, the entire Fuel Building is analyzed as a single fire area. It is assumed that any fire in the Fuel Building results in a complete failure of the FACPS system.

(6) Control Room: The Control Room contains safety-related equipment for all four divisions in a single fire area and as such is analyzed separately.

Primary containment is not a significant fire area because it is inerted during plant operation. There are certain shutdown conditions in which the drywell head is removed and thus the primary containment is not inerted; however, the small quantity of combustible materials and spatial separation prevent damage to the redundant divisional circuits in this area.

Fire in non safety-related buildings, other than those listed above, is not explicitly analyzed as the buildings are separated from the equipment required for safe shutdown.

12.4 CALCULATION OF THE FIRE IGNITION FREQUENCY

Section 12.4.1 documents the fire ignition frequency calculations for at-power operation.

Section 12.4.2 documents the fire ignition frequency calculations for shutdown conditions.

12.4.1 Calculation of the Full Power Fire Ignition Frequency

This section documents the calculations of the fire ignition frequency during power operation for each of the major fire areas of this analysis. The fire ignition frequency calculation is performed consistent with the guidance and data of Reference 12-1, and includes the following steps:

(1) Select appropriate plant locations

(2) Determine location weighting factors

(3) Determine ignition source weighting factors

(4) Sum individual ignition source contributors to determine fire area ignition frequency

The Reference 12-1 fire ignition frequency data is provided as a function of general plant area and ignition source types. The Reference 12-1 general plant areas are listed in Table 12-1, along with the guidance in determining the location weighting factors (which are used to apportion the general fire frequencies of Reference 12-1). In this analysis, the reactor building is considered to include the control, reactor, fuel and electrical buildings. It does not include the containment.

The Reference 12-1 fire ignition source frequencies, and associated ignition source weighting factor information, are summarized in Table 12-2.

The calculation of weighting factors for certain plant-wide fire ignition sources requires an estimate of the total number of plant fire areas. The total number of plant fire areas is as follows:

Building	Fire Areas
Reactor Building	34
Fuel Building	6
Control Building	11
Turbine Building	20
Electrical Building	33
Service Water Building	6
Total:	110

In addition, the calculation of weighting factors for certain other ignition sources requires an estimate of the total number of the ignition source type across the plant (or in multiple specific areas). These total estimates are discussed below. The estimates are performed based on review of ESBWR general layout drawings.

- Electrical cabinets: This ignition source type is applicable to electrical cabinets in the control, reactor, fuel and electrical buildings of the ESBWR plant design. An estimate of the number of electrical cabinets located in each of these buildings has been performed and is discussed below.

  The control building contains 72 electrical panels. This total is based on an estimate of 12 cabinets for each DCIS area in the control building, which makes a total of 48 cabinets in divisional DCIS areas of the control building, plus an estimate of 24 cabinets in the non-divisional DCIS areas of the control building.

  The reactor building contains 140 electrical panels. This total is based on an estimate of 35 panels per division. This estimate includes the DC and AC motor control centers, and the power distribution centers.

  The fuel building is estimated to contain 20 electrical panels.

  In addition, it is estimated that there are 24 electrical cabinets in the electrical building that do not correspond to the electrical panels of a switchgear room (i.e., switchgear electrical panels are treated separately, see below).

  A total of 256 electrical panels in these areas are obtained from the above data.

- Pumps: Twelve pumps are located in the reactor building: four sump pumps, two CRD pumps, four RWCU/SDC pumps and two associated backwash transfer pumps. Six pumps are located in the fuel building: two sump pumps, two FAPCS pumps and two associated backwash transfer pumps. The six RCCW pumps are located in the turbine building, though in separate fire areas. A total of 24 pumps are estimated in these areas.

- Switchgear room: Four medium voltage switchgear areas are located in the electrical building.

- Battery room: Six battery areas are located in the reactor building, as well as seven more in the electrical building. The reactor building contains the divisional batteries, four 24-hour batteries (one per division) and two 72-hour batteries (one each for Division I and II). The electrical building has seven battery rooms (A, A1, A2, B, B1, B2, C)).

- Fire protection panels: A total of 50 fire protection panels are estimated across the plant.

- Transformers: Twenty low voltage indoor transformers are estimated for the plant.

- Battery chargers: It is assumed that the number of plant wide battery chargers is the same as the number of battery rooms (i.e., six in the reactor building and seven in the electrical building).

- Air compressors: Two instrument air compressors and two service air compressors are located in the plant, four compressors in total.

12.4.1.1 Control Building, DCIS Class 1E Electrical Rooms

There are four DCIS 1E class electrical cabinet areas located on the first floor of the control building. Each of these areas contains equipment associated with a class 1E safety system division. Each area is a separate fire area. The fire ignition frequency is calculated for the Division I area and is assumed to be applicable to each of the four areas due to similarity in number and distribution of equipment.

Based on the information summarized in Table 12-2, the reactor building is selected as the most representative Reference 12-1 general location corresponding to the DCIS area cabinets.

The location weighting factor for the reactor building is 1.0, calculated as the number of units per site (1) divided by the number of reactor building per site (1).

The following ignition sources are estimated for the division I area:

- Electrical Cabinets: Twelve electrical cabinets are estimated for each DCIS area.
- Fire Protection Panels: Two fire protection panels out of a plant-wide total of 50 panels.
- Transients: Only "extension cord" and "heaters" are considered for these areas; it is assumed to be a non-smoking area, with no candles or hot pipes, and no risk due to overheating (due to low power and the use of optical fiber).

The ignition source weighting factor for "cable fires caused by welding" and "transient fires caused by welding and cutting" in the Division I area of the control building is 1/110=0.009.

Refer to Table 12-3 for a summary of the fire ignition frequency calculation. The ignition frequency calculation in Table 12-3 applies to each one of the four DCIS 1E areas in the control building.

12.4.1.2 Reactor Building Divisional Zones

There are four areas in the reactor building containing class 1E safety system divisional equipment. Each area is a separate fire area. Each divisional area encompasses a number of individual separated fire areas. The fire ignition frequency is calculated for the Division I area and is assumed to be applicable to each of the four areas due to similarity in number and distribution of equipment in each of the areas. Use of Division I is slightly conservative given that Divisions I and II have one more battery each than do Divisions III and IV. This ignition frequency is used to model fire-induced accidents initiated in each of the four areas (refer to Section 12.5).

Based on the information summarized in Table 12-2 and due to the existence of safety batteries in the reactor building, the reactor building and the battery room are selected as the most representative Reference 12-1 general locations.

The location weighting factor for the battery room is used to apportion the battery ignition sources in an area. The location weighting factor for a single battery room is 1/13, calculated as the number of units per site (1) divided by the number of battery rooms per site (13). As the division I area contains two battery rooms, the battery room location factor is increased by a factor of two to 2/13.

The location weighting factor for the reactor building is 1.0, calculated as the number of units per site (1) divided by the number of reactor buildings per site (1).

The following ignition sources are estimated for this area:

- Electrical Panels: Thirty-five electrical panels per division.
- Pumps: Three pumps are estimated for each division.
- Fire Protection Panels: Four fire protection panels out of a plant-wide total of 50 panels.
- Transformers: Two transformers are estimated for each area, out of a plant-wide total of 20 transformers.
- Battery chargers: The number of battery chargers in this area is the same as the number of battery rooms in the area, i.e., two.
- Transients: Only "extension cord", "heaters", "overheating" and "hot pipe" are considered for these areas: it is assumed to be a non-smoking area with no candles.

As the Division I area encompasses eight individual fire areas, the ignition source weighting factor for "junction box in qualified cables", "cable fires caused by welding" and "transient fires caused by welding and cutting" in the reactor building Division I area is 8/110=0.073.

Refer to Table 12-4 for a summary of the fire ignition frequency calculation. The ignition frequency calculation in Table 12-4 applies to each one of the four divisional areas in the reactor building.

12.4.1.3 Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building

These locations include those fire areas with non-1E system equipment and cables. As indicated in Section 12.3, the ESBWR separation design maintains the non-1E divisions separately from each other using similar features as that for the 1E divisions. As such, fires in one non-1E divisional area will not impact the other non-1E divisions. The fire ignition frequency is calculated for Division A and is assumed to be applicable to both non-1E divisions due to similarity in number and distribution of equipment (Division B has one extra battery room, the swing battery room, but the impact on the ignition frequency calculation is non-significant). Each non-1E divisional area encompasses a number of individual separated fire areas.

Based on the information summarized in Table 12-2, the reactor building, diesel generator room, switchgear room, battery room and intake structure are selected as the most representative Reference 12-1 general locations.

The location weighting factor for the reactor building is 1.0, calculated as the number of units per site (1) divided by the number of reactor building per site (1).

The location weighting factor for "A" the diesel generator room is 1/2, calculated as the number of diesel generators in the rooms (1) divided by the number of DG rooms per site (2).

The location weighting factor for a switchgear room is 0.25, calculated as the number of units per site (1) divided by the number of switchgear rooms per site (4). As the Division A areas contain two switchgear rooms, the location weighting factor is increased by a factor of two to 0.50.

The location weighting factor for a battery room is 1/13, calculated as the number of units per site (1) divided by the number of battery rooms per site (13). As the Division A areas contain three battery rooms, the location weighting factor is increased by a factor of three to 3/13.

The location weighting factor for the intake structure is 1.0 (number of units per site=1 / number of intake structures =1).

The following ignition sources are estimated for the division A areas:

- Electrical Panels: Twelve panels for each DCIS non-1E area, and twelve panels in the Division A areas of the electrical building (i.e., a total of 24 panels).
- Pumps: Three pumps are estimated for a division.
- Fire Protection Panels: Twenty fire protection panels in the Division A areas, out of a plant-wide total of 50 panels.
- Transformers: Ten transformers are estimated in the Division A areas, out of a plant-wide total of 20.
- Battery chargers: The number of battery chargers in Division A is the same as the number of battery rooms in these areas, i.e., three.
- Air compressors: One instrument air compressor in a division.
- Transients: Only "Extension cord", "heaters", "overheating" and "hot pipe" are considered for these areas; they are assumed to be non-smoking areas with no candles.

As the Division A area encompasses twenty-four individual fire areas, the ignition source weighting factor for "junction box in qualified cables", "cable fires caused by welding" and "transient fires caused by welding and cutting" in the Division A area is 24/110=0.218.

Refer to Table 12-5 for a summary of the fire ignition frequency calculation. The ignition frequency calculation in Table 12-5 applies to each one of the non-1E Division A and B areas.

12.4.1.4 Turbine Building

This location includes the fire areas of the turbine building excluding the fire areas containing the RCCW pumps and instrument air compressors.

Based on the information summarized in Table 12-2, the turbine building is selected as the most representative Reference 12-1 general location.

The location weighting factor for the turbine building is 1.0, calculated as the number of units per site (1) divided by the number of turbine buildings per site (1).

The following ignition sources are estimated for this area:

- Fire Protection Panels: Five fire protection panels out of a plant-wide total of 50 panels.
- Transformers: Two transformers are estimated in each area, out of a plant-wide total of twenty.
- Air compressors: Two service air compressors.
- Transients: Only "Extension cord", "heaters", "overheating" and "hot pipe" are considered for these areas; they are assumed to be non-smoking areas with no candles.

This location has 20 fire areas; as such, the applicable ignition source weighting factor for the "junction box in qualified cables", "cable fires caused by welding" and "transient fires caused by welding and cutting" is 20/110 =0.182.

Refer to Table 12-6 for a summary of the fire ignition frequency calculation for this area.

12.4.1.5 Fuel Building

This location includes the fire areas in the fuel building.

Based on the information summarized in Table 12-2, the reactor building is selected as the most representative Reference 12-1 general location.

The location weighting factor for the reactor building is 1.0, calculated as the number of units per site (1) divided by the number of reactor buildings per site (1).

The following ignition sources are estimated for this area:

- Electrical Panels: Twenty panels are estimated in this area.
- Pumps: Six pumps are estimated in this area.
- Fire Protection Panels: Two fire protection panels out of a plant-wide total of 50 panels.
- Transients: Only "extension cord", "heaters", "overheating" and "hot pipe" are considered for these areas; it is assumed that they are non-smoking areas with no candles.

This location contains six fire areas; as such, the applicable ignition source weighting factor for "junction box in qualified cables", "cable fires caused by welding" and "transient fires caused by welding and cutting" is 6/110=0.055.

Refer to Table 12-7 for a summary of the fire ignition frequency calculation for this area.

12.4.1.6 Control Room

Based on the information summarized in Table 12-2, the control room is selected as the most representative Reference 12-1 general location.

The location weighting factor for the control room is 1.0, calculated as the number of units per site (1) divided by the number of control room per site (1).

The following ignition sources are estimated for this area:

- Fire Protection Panels: One fire protection panel out of a plant-wide total of 50 panels.
- Transients: Only "Extension cord" and "heaters" are considered for this area; it is assumed to be a non-smoking area with no candles.

This location contains one fire area; as such, the applicable ignition source weighting factor for "junction box in qualified cables" is 1/110=0.009.

Refer to Table 12-8 for a summary of the fire ignition frequency calculation for this area.

12.4.2 Calculation of the Shutdown Fire Ignition Frequency

This section documents the fire ignition frequency calculations for shutdown conditions. The fire ignition frequencies are calculated for all six groups of plant locations selected for analysis.

The estimation of fire ignition frequencies in shutdown conditions is performed using the information provided in the document RES/OERAB/S02-01 "Fire Events – Update of U.S. Operating Experience", 1986 – 1999", (Ref. 12-2). This document expands and updates the information of AEOD/S97-03 "Special Study, Fire Events – Feedback of U.S. Operating Experience", June 1997, (Ref. 12-3). Reference 12-2 summarizes information on fire events that occurred during power operation and during shutdown conditions, and provides estimation of fire frequencies both in power and shutdown operation for different types of buildings and locations.

Table ES-2 "Shutdown Fire Frequencies by Plant Location", Ref. 12-2, summarizes estimated fire frequencies for different plant locations on the basis of the reports gathered from different sources of information described in the report. The Reference 12-2 shutdown fire ignition frequencies are summarized here in Table 12-9. The frequencies shown in Table 12-9 are per year of shutdown operation.

The definition of buildings in Reference 12-2, as shown in Table 12-9, does not correspond identically to the definition of buildings of the ESBWR plant. Therefore, it is necessary to establish a correspondence in order to assign the Reference 12-2 shutdown fire ignition frequencies to the ESBWR buildings. The criteria followed to perform this assignment are described below.

12.4.2.1 Control Building DCIS Class 1E Electrical Room

There are four DCIS 1E class electrical cabinet areas located on the first floor of the control building. Each area group contains equipment associated with a class 1E safety system division. Each area is a separate fire area; therefore the fire frequency is determined for each area, assuming that the number and distribution of equipment is similar for each one of them.

The auxiliary building of Table 12-9 is selected as the most representative location for the DCIS area cabinets. However, as discussed in Section 12.4.2.3, the Table 12-9 auxiliary building location is also judged representative of the ESBWR electrical building non-divisional areas; service water building; control building non-1E DCIS rooms; and the RCCW and IAS zones in the turbine building.

Accordingly, half of the Table 12-9 auxiliary building fire ignition frequency is assigned to the ESBWR DCIS class 1E areas, the remainder is assigned to the areas discussed in Section 12.4.2.3.

12.4.2.2 Reactor Building Zones

There are four area groupings defined in the fire analysis for the reactor building. Each area group contains equipment associated with a division of class 1E safety systems. The fire frequency is determined for each location, assuming that the number and distribution of equipment in each area is similar.

The reactor building and the battery room of Table 12-9 are selected as the representative locations for the ESBWR reactor building zones. The battery room is assigned due to the existence of safety batteries in the reactor building. However, as discussed in Section 12.4.2.3, the Table 12-9 battery room location is also assigned to the ESBWR electrical building. Accordingly, half of the Table 12-9 battery room fire ignition frequency is assigned to the ESBWR reactor building zones, the remainder is assigned to the ESBWR electrical building (refer to Section 12.4.2.3).

Therefore, the shutdown fire frequency for the ESBWR reactor building is calculated by adding the Table 12-9 reactor building shutdown fire frequency and half the frequency of the battery room.

12.4.2.3 Non-Divisional Areas of Electrical Building; Service Water Building; Control Building Non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building

This group of locations includes those fire areas with non-1E system equipment and cables.

This group of locations includes the cable distribution areas in the electrical building, the bus and the 13.8 kV and 6.9 kV circuit breaker areas, the diesel generator areas and the areas corresponding to the essential service pump house.

The following Table 12-9 locations are determined applicable to these ESBWR areas: cable spreading room, switchgear room, auxiliary building, battery room, EDG building, SWS pumphouse, and switchyard.

Half of the shutdown fire ignition frequency for the Table 12-9 battery room location is already assigned to ESBWR reactor building zones (as discussed in Section 12.4.2.2). The remaining half of the battery room shutdown fire ignition frequency is assigned to these ESBWR areas.

Similarly, half of the shutdown fire ignition frequency for the Table 12-9 auxiliary building location is already assigned to ESBWR DCIS class 1E areas (as discussed in Section 12.4.2.1). The remaining half of the battery room shutdown fire ignition frequency is assigned to these ESBWR areas.

Therefore, the shutdown fire ignition frequency for these ESBWR areas is calculated by adding the Table 12-9 frequencies for the cable spreading room, switchgear room, EDG building, SWS pumphouse, switchyard, and half of the frequencies for the Table 12-9 auxiliary building and battery room locations.

12.4.2.4 Turbine Building

This group of locations includes the fire areas of the turbine building, with the exception of fire areas containing the RCCW pumps and instrument air compressors.

The turbine building of Table 12-9 is selected as the representative location.

12.4.2.5 Fuel Building

This group of locations includes the fire areas in the fuel building.

The reactor building of Table 12-9 is selected as the representative location. However, the Table 12-9 reactor building fire frequency has already been assigned to the ESBWR reactor building areas (refer to Section 12.4.2.2). As such, the shutdown fire frequency for the ESBWR fuel building is estimated as ten percent of the Table 12-9 reactor building location frequency.

12.4.2.6 Control Room

The control room of Table 12-9 is selected as the representative location for the ESBWR Control Room.

12.4.2.7 Fire Frequencies per Operating Mode

Using the Reference 12-2 data summarized in Table 12-9, and the correspondence of ESBWR buildings to Reference 12-2 buildings as summarized above, the shutdown fire ignition frequencies as a function of ESBWR fire PRA area are determined. The resulting frequencies are summarized in Table 12-10.

In order to obtain ignition frequencies in units of calendar year, the values in Table 12-10 are multiplied by the fraction per calendar year that the ESBWR will be in shutdown. Only one refueling outage every two years is foreseen in the ESBWR design and the expected refueling outage duration is 546 hours. The portion of the calendar year in which the ESBWR power plant is shutdown is estimated as:

$$\frac{546}{2 \times 8760} = 0.0312$$

As the various shutdown operational modes have an influence on timings and other accident progression issues for postulated shutdown accidents, the calendar year based shutdown fire frequencies are further calculated on an operational mode basis. The fractions per calendar year per shutdown operating mode are summarized in Table 12-11. Refer to Section 16.2.1 for descriptions of the operating modes.

The resulting fire ignition frequencies per shutdown operating mode used in this risk analysis are summarized in Table 12-12.

12.5 CALCULATION OF CORE DAMAGE FREQUENCIES

The calculation of the fire induced core damage frequency for each fire scenario requires the determination of the type of initiating event resulting from the fire damage as well as the fire-induced damage to mitigating systems credited in the PRA. Mitigating systems in the PRA include both safety and non-safety equipment.

The fire ignition frequencies for each fire area are discussed in the previous section. A fire in each of the analyzed fire areas of this analysis is assumed to damage all equipment in the area. The sections below describe the type of initiating event that best represents each fire scenario, and the associated core damage accident sequence frequency quantification.

The internal events PRA accident sequence structures and system fault trees and success criteria are used in the calculation of the fire CDF. The CDF quantifications are performed at a quantification truncation limit of 1E-13/yr.

Both at-power and shutdown fire-induced accident sequences are discussed.

12.5.1 Calculation of At Power Core Damage Frequencies

The following paragraphs describe the initiating events and the equipment damage assumed for each of the fire scenarios defined during power operation. Table 12-13 summarizes the damage caused by the fire in each selected location.

12.5.1.1 Control Building, DCIS Class 1E Electrical Rooms

A General Transient initiating event is assumed in these areas. A fire-induced inadvertent opening of an SRV (IORV) is not possible in these rooms because of the specific ESBWR design.

Failure of the corresponding safety system division is assumed for a fire in each of the DCIS 1E areas.

According to the FIVE methodology, the existence of fire detection and extinction systems and firewall barriers and adequate monitoring and supervision means that it can be assumed that fire propagation to the neighboring zones separated by those barriers is a relatively negligible contribution. Nevertheless, the potential propagation of a fire started in one of the divisions of the building and propagating to another divided area is considered in this analysis.

A value of 7.4E-03 is taken as the fire propagation probability from one divisional fire area to another. This probability represents failure of a fire door and is obtained from Reference 12-4. This analysis assumes that the fire ignition does not self-extinguish, but grows to a fully developed fire, and no credit for fire suppression is taken in the analysis.

The multi-divisional area fire scenarios assume that the fire fails two complete divisions. Two such scenarios are analyzed, one failing divisions I and III, and one failing divisions II and IV.

The CDF results for the single divisional area fire scenarios, and for the multi-divisional area fire scenarios, are summarized in Table 12-15. The CDF frequencies for all the fire

scenarios in these areas constitute a negligible risk (all cutsets are below the quantification truncation limit).

12.5.1.2 Reactor Building Divisional Zones

It is conservatively assumed that a fire in these areas causes an inadvertent opening of an SRV (IORV). This spurious operation disables the ICS while preserving the full requirement for depressurizing the plant. If multiple valves are opened due to the fire, depressurization to allow passive GDCS to operate becomes increasingly more reliable.

Failure of the corresponding safety system division is assumed for a fire in each of the reactor building divisional areas. Failure of the RWCU and CRD systems, that are located in this building, is also assumed as follows:

- Train A of RWCU and CRD is assumed failed for fires in the Division I or IV areas.
- Train B of RWCU and CRD is assumed failed for fires in the Division II or III areas.

According to the FIVE methodology, the existence of fire detection and extinction systems and firewall barriers and adequate monitoring and supervision means that it can be assumed that fire propagation to the neighboring zones separated by those barriers is a relatively negligible contribution. Nevertheless, the potential propagation of a fire started in one of the divisions of the building and propagating to another divided area is considered in this analysis.

As discussed previously, a probability of 7.4E-03 is used as the probability of fire propagation from one area to another. The analysis assumes that the fire ignition does not self-extinguish, but grows to a fully-developed fire, and no credit for fire suppression is taken in the analysis.

The multi-divisional area fire scenarios assume that the fire fails two complete divisions. Four such scenarios are analyzed: 1) I and II failed; 2) I and IV failed; 3) II and III failed; and 4) III and IV failed.

The CDF results for the single divisional area fire scenarios, and for the multi-divisional area fire scenarios, are summarized in Table 12-15.

12.5.1.3 Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building

A General Transient initiating event is assumed for a fire in these areas.

According to the FIVE methodology, the existence of fire detection and extinction systems and firewall barriers and adequate monitoring and supervision means that it can be assumed that fire propagation to the neighboring zones separated by those barriers is a relatively negligible contribution. Nevertheless, the potential propagation of a fire started in one fire area and propagating to another divided area is considered in this analysis.

As discussed previously, a probability of 7.4E-03 is used as the probability of fire propagation from one area to another. The analysis assumes that the fire ignition does

not self-extinguish, but grows to a fully-developed fire, and no credit for fire suppression is taken in the analysis.

The multi-divisional area fire scenario assumes that the fire fails both non-1E Divisions A and B.

The CDF results for the single divisional fire scenarios, and for the multi-divisional area fire scenario, are summarized in Table 12-15.

12.5.1.4 Turbine Building

Turbine building fires are assumed to fail the feedwater and condensate systems; as such, the loss of feedwater initiator is assumed for a turbine building fire. In addition, the analysis assumes complete failure of the service air system.

The CDF for the turbine building fire scenario is provided in Table 12-15.

12.5.1.5 Fuel Building

A General Transient initiating event is assumed for fires in the fuel building. The fire is assumed to fail the FAPCS system.

The CDF for the fuel building fire scenario is provided in Table 12-15. Fire scenarios in the fuel building constitute a negligible risk (all cutsets are below the quantification truncation limit).

12.5.1.6 Control Room

The analysis of fires in the control room assumes that the fire forces control room evacuation; as such, no credit is given to manual actuations that must be performed from within the control room. However, it is assumed that automatic signals are not affected because they are generated in panels located outside the control room.

Recovery of the actuation of certain systems is credited due to the existence of remote shutdown panels located outside the control room. However, operator actions are not required to be performed at the remote shutdown panels; the plant proceeds to a safe shutdown without the need for operator intervention. If automatic actuations fail, the operators may manually perform the necessary actuations from the remote shutdown panels.

The recovery credit given to actuation from the remote shutdown panels can vary depending upon the time available:

- A failure probability of 1E-01 is assumed for short-term sequences.
- A failure probability of 1E-02 is assumed for long-term sequences.

In both cases it is assumed that the operators are sufficiently trained to carry out the required tasks from the remote shutdown panels.

A General Transient initiating event is assumed for the control room fire analysis. A fire-induced inadvertent opening of an SRV (IORV) in this room is not possible because of the ESBWR optical fiber design.

12.5.2 Calculation of Shutdown Core Damage Frequencies

The next paragraphs describe the initiating events and the equipment damage assumed for each of the fire scenarios defined during shutdown conditions.

Fire scenarios during Mode 6-Flooded are not explicitly quantified in the accident sequence analysis. Fires cause loss of DHR scenarios, but during Mode 6-Flooded the time to reach RCS boiling is very long. As such, the risk contribution from Mode 6-Flooded fire scenarios is not significant.

Table 12-14 summarizes the damage caused by the fire in each selected location.

12.5.2.1 Control Building, DCIS Class 1E Electrical Rooms

No initiating event that could be caused by a fire in the Control Building, DCIS class 1E Electrical Rooms during shutdown conditions has been identified.

12.5.2.2 Reactor Building Divisional Zones

Mode 5

It is conservatively assumed for operational Mode 5 that a fire in these areas could cause an inadvertent opening of an SRV (IORV).

Failure of the corresponding safety system division is assumed for a fire in each of the Reactor Building divisional areas. Failure of the RWCU and CRD systems, that are located in this building, is also assumed as follows:

- Train A of the RWCU and the CRD is assumed to fail due to fires in Division I or IV areas.
- Train B of the RWCU and the CRD is assumed to fail due to fires in Division II or III areas.

Like the at-power fire analysis, four multi-divisional area shutdown fire scenarios are analyzed for the reactor building divisional zones: 1) I and II failed; 2) I and IV failed; 3) II and III failed; and 4) III and IV failed.

The CDF results for these shutdown fire scenarios are summarized in Table 12-16.

Mode 6-Unflooded

The RWCU pumps are located in the reactor building and therefore it is possible that the entire system could fail due to a fire in this building.

As indicated in previous sections, the two RWCU system trains are assumed to be separated by fire barriers and therefore one fire could not affect both trains simultaneously. The only possible fire event that could lead to a loss of RWCU initiating event is a fire propagating between Divisions I and II, or between Divisions III and IV (RWCU Train A is assumed to fail due to fires in Division I or IV areas, and RWCU Train B is assumed to fail due to fires in Division II or III areas). The total loss of the RWCU and CRD systems, as well as the loss of the corresponding divisions, is assumed in such cases. The frequency of occurrence of the initiating event is the product of fire frequency determined for the group of areas, multiplied by the failure probability of the

fire barriers that separate these areas. The same 7.4E-03 fire propagation probability used in the at-power fire sequences is also used in the shutdown fire sequences. It is acknowledged that during shutdown conditions fire doors may be open for shutdown activities. However, the same probability is judged appropriate because when a fire barrier is not intact a fire watch is posted that will offset the increased fire propagation risk from the open barrier.

Four such scenarios are analyzed: 1) fire in I propagates to II; 2) fire in II propagates to I; 3) fire in III propagates to IV; and 4) fire in IV propagates to III.

The CDF results for these shutdown fire scenarios are summarized in Table 12-16.

12.5.2.3 Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building

Mode 5

The fire areas included in these groups are divided into train A and train B areas separated by fire barriers. A fire that affects only one train (A or B) will not result in a shutdown initiating event. A fire-induced shutdown initiator will only result if the fire propagates and disables both divisions A and B. The frequency of such a fire is the product of the fire ignition frequency and the failure probability of the fire barriers separating these areas (the value of 7.4E-03 is used). Two such scenarios are analyzed: 1) fire in A propagates to B; and 2) fire in B propagates to A.

The CDF results for these shutdown fire scenarios are summarized in Table 12-16.

Mode 6-Unflooded

As discussed above for Mode 5, failure of both divisions A and B is required to result in an initiator during shutdown. The same two fire propagation scenarios analyzed for Mode 5 are also analyzed for the Mode 6-Unflooded case.

The CDF results for these shutdown fire scenarios are summarized in Table 12-16.

12.5.2.4 Turbine Building

No initiating event that could be caused by a fire in the turbine building during shutdown conditions has been identified.

12.5.2.5 Fuel Building

No initiating event that could be caused by a fire in the fuel building during shutdown conditions has been identified.

12.5.2.6 Control Room

The analysis of fires in the control room assumes that the fire forces control room evacuation; as such, no credit is given to manual actuations that must be performed from within the control room. However, it is assumed that automatic signals are not affected because they are generated in panels located outside the control room.

Recovery of the actuation of certain systems is credited due to the existence of remote shutdown panels located outside the control room. However, operator actions are not required to be performed at the remote shutdown panels; the plant proceeds to a safe shutdown without the need for operator intervention. If automatic actuations fail, the operators may manually perform the necessary actuations from the remote shutdown panels.

The recovery credit given to actuation from the remote shutdown panels can vary depending upon the time available. A failure probability of 1E-01 is assumed for short-term sequences.

It is assumed that the operators are sufficiently trained to carry out the required tasks from the remote control panels.

Mode 5

A fire-induced inadvertent opening of an SRV (IORV) is not possible because of the ESBWR optical fiber design.

It is assumed that a fire in the control room forces its evacuation. It is conservatively assumed that the evacuation causes a loss of control of residual heat removal with the RWCU/SDC system, and is assumed to be equivalent to a loss of RWCU/SDC system event.

Mode 6-Unflooded

The same control room fire scenario modeled for Mode 5 is also modeled for Mode 6-Unflooded.

The CDF results for these shutdown fire scenarios are summarized in Table 12-16.

12.6 RESULTS

This analysis is a bounding approach that begins by dividing the plant into major fire areas and then assigning a fire ignition frequency to each fire area. The fire is assumed to grow unchecked and disable all equipment in the area.

The core damage frequency results of the ESBWR probabilistic internal fires analysis are summarized in the following tables:

- CDF Contribution of At-Power Fire Scenarios (Table 12-15)
- CDF Contribution of Shutdown Fire Scenarios (Table 12-16)

Each table lists the fire area, scenario description, fire scenario initiation frequency, and the resulting core damage frequency. As can be seen from these tables, this conservative analysis shows that all the analyzed scenarios have a CDF lower than the internal events CDF.

The top 200 cutsets for the at-power internal fires CDF are provided in Table 12-17, and those for shutdown internal fires CDF are provided in Table 13-18.

The risk importance measures for the at-power internal fires CDF are provided in Table 12-19, and those for shutdown internal fires CDF are provided in Table 12-20.

This is a screening analysis that incorporates a number of conservative assumptions (refer to Section 12.2). For these reasons, it is inappropriate to add these fire CDF results to the internal events core damage frequencies.

12.7 INSIGHTS

The ESBWR probabilistic internal fire analysis highlights the following key insights regarding the fire mitigation capability of the ESBWR:

(1) The ESBWR, due to its basic layout and safety design features, is inherently capable of mitigating potential internal fires. Safety system redundancy and physical separation by fire barriers ensure that in all cases a single fire limits damage to a single safety system division or DID system redundancy. Fire propagation to neighboring areas presents a relatively minor risk contribution.

(2) Fires in the control room are assumed to affect the execution of human actions from there. One feature relevant to the design is that a fire in the control room does not affect the automatic actuations of the safety systems. Additionally, the existence of remote shutdown panels allows the opportunity to perform manual actuations for failed automatic actuations that may occur.

(3) A redundant separated valve to valve F302 of the FACPS system should be added to the design to reduce the importance of this valve during postulated fire scenarios.

12.8 CONCLUSIONS

The main conclusion that can be drawn from the ESBWR probabilistic internal fires analysis is that the risk from internal fires is acceptably low. The estimated core damage frequency for each of the analyzed scenarios even when using a conservative analysis is lower than the internal events CDF.

The ESBWR is inherently safe with respect to internal fire events. All potential fires have been analyzed and it has been shown that the plant can be safely shut down at low risk to plant personnel and the general public.

12.9 REFERENCES

12-1 "Fire Vulnerability Evaluation Methodology, FIVE, Plant Screening Guide", Electric Power Research Institute, September 26, 1991.

12-2 RES/OERAB/S02-01, January 2002, Fire Events – Update of U.S. Operating Experience, 1986 – 1999.

12-3 AEOD/S97-03, "Special Study, Fire Events – Feedback of U.S. Operating Experience", June 1997.

12-4 Report EPRI 1011989 NUREG/CR-6850, September 2005, Fire PRA Methodology for Nuclear Power Facilities, Vol. 2: Detailed Methodology.

12-5 ESBWR Design Control Document, 26A6642 Rev. 01.

Table 12-1

Fire Ignition Frequencies Weighting Factors for Plant-Specific Locations

(Weighting Factors used for Adjusting General Location Fire Frequencies for Application to Plant-Specific Locations - From Table 1.1 of Reference 12-1)

PLANT LOCATION	WEIGHTING FACTORS[1] (WF_L)
Auxiliary Building (PWR)	The number of units per site / divided by the number of auxiliary buildings
Reactor Building (BWR)	The number of units per site / divided by the number of reactor buildings = 1/1
Diesel Generator Room	The number of diesels per site / divided by the number of diesel generator rooms per site = 1/2
Switchgear Room	The number of units per site / divided by the number of switchgear rooms per site = 1/4 (2)
Battery Room	The number of units per site / divided by the number of battery rooms per site. = 2/13 (3)
Control Room	The number of units per site / divided by the number of control rooms per site = 1/1
Cable Spreading Room	The number of units per site / divided by the number of cable spreading rooms per site
Intake Structure	The number of units per site / divided by the number of intake structures = 1/1
Turbine Building	The number of units of units per site / divided by the number of turbine buildings = 1/1
Radwaste Area	The number of units per site / divided by the number of radwaste areas
Transformer Yard	The number of units per site / divided by the number of switchyards. = 1/1
Plant-Wide Components (4)	The number of units per site.

Notes:

(1) The analyst must identify the number of like locations when determining the number of buildings, e.g., a 480 volt load center is "like" a switchgear room.

(2) Division A Location Weighting Factor = 1/2.

(3) The location weighting factor for each class 1E area is calculated as 1 unit divided by 13 battery rooms, then multiplied by two because there are 2 battery rooms in each class 1E area. Division A Location Weighting Factor = 3/13. Division B Location Weighting Factor = 4/13.

(4) Components such as, cables, transformers, elevator motors, hydrogen recombiner/analyzer.

Table 12-2

At Power Plant Location Fire Ignition Sources and Frequencies

(Full Power Fire Ignition Sources and Frequencies by Applicable Plant Location From Table 1.2 of Reference 12-1).

PLANT LOCATION	FIRE IGNITION FUEL SOURCE	IGNITION SOURCE WEIGHTING FACTOR METHOD	FIRE FREQUENCIES[1,2]
Auxiliary Building (PWR)	Switchgear Electrical cabinets Pumps motors	B B B	1.6×10^{-2} 2.0×10^{-2} 1.9×10^{-2}
Reactor Building (BWR) [2]	Electrical cabinets Pumps	B B	4.9×10^{-2} 2.5×10^{-2}
Diesel Generator Room	Diesel generators Electrical cabinets	A A	2.5×10^{-2} 2.3×10^{-3}
Switchgear Room	Electrical cabinets	A	1.6×10^{-2}
Battery Room	Batteries	A	3.1×10^{-3}
Control Room	Electrical cabinets	A	9.3×10^{-3}
Cable Spreading Room	Electrical cabinets	A	3.9×10^{-3}
Intake Structure	Electrical cabinets Fire pumps Others	A A A	2.3×10^{-3} 3.9×10^{-3} 3.1×10^{-3}
Turbine Building	T/G Excitor T/G Oil T/G Hydrogen Electrical cabinets Other pumps Main feedwater pumps Boiler	B B B B B A B	3.9×10^{-3} 1.4×10^{-2} 5.4×10^{-3} 1.3×10^{-2} 7.0×10^{-3} 4.3×10^{-3} 1.6×10^{-3}
Radwaste Area	Miscellaneous components	A	8.5×10^{-3}
Transformer Yard	Yard transformers propagating to Turbine Building Yard transformers (LOSP) Yard transformers (Others)	A A F	3.9×10^{-3} 1.6×10^{-3} 1.5×10^{-2}

Table 12-2

At Power Plant Location Fire Ignition Sources and Frequencies

(Full Power Fire Ignition Sources and Frequencies by Applicable Plant Location From Table 1.2 of Reference 12-1).

PLANT LOCATION	FIRE IGNITION FUEL SOURCE	IGNITION SOURCE WEIGHTING FACTOR METHOD	FIRE FREQUENCIES[1,2]
Plant-Wide Components (cables, transformers, elevator motors, hydrogen recombiner/analyzer).	Fire protection panels	F	2.3×10^{-3}
	RPS MG sets	F	5.4×10^{-3}
	Non-qualified cable run	E	6.2×10^{-3}
	Junction box/Splice in non-qualified cable	E	1.6×10^{-3}
	Junction box in	E	1.6×10^{-3}
	qualified cable	F	7.8×10^{-3}
	Transformers indoor	F	3.9×10^{-3}
	Battery chargers	G	8.4×10^{-2}
	Off-gas H_2 Recombiner	G	3.1×10^{-3}
	(BWR)	C	3.1×10^{-3}
	Hydrogen Tanks	G	3.1×10^{-2}
	Other Hydrogen Fires	F	4.7×10^{-3}
	Gas Turbines (5)	F	9.3×10^{-3}
	Air Compressors		
	Ventilation subsystem	F	6.2×10^{-3}
	(fan motors,	F	8.5×10^{-3}
	compressor motors)	D	1.4×10^{-3}
	Elevator motors	C	5.6×10^{-3}
	Driers	C	2.8×10^{-2}
	Transients (3,4)		
	Cable fires caused by welding (4)		
	Ordinary combustible fires caused by welding and cutting (4).		

Notes for Table 12-2:

(1) Frequencies are per reactor year unless otherwise noted.

(2) Fire frequencies are per fraction of ignition sources per year.

(3) Fire frequency represents one event. The thirteen transient events that occurred during power operation are considered by the weighting factor.

(4) Fire frequency represents years at power operation.

(5) Fire frequency represents an estimated 130 gas-turbine-operating years.

Notes for Ignition Source Weighting Factor Method:

Values can be estimated using methods other than direct counting, including engineering judgment. Attempt to estimate values within about 25%.

A. No ignition source weighting factor is necessary.

B. Obtain the ignition source weighting factor by dividing the number of ignition sources in the fire area by the number in the selected location.

C. Obtain the ignition source weighting factor by calculating the inverse of the number of Appendix R fire areas in the location for which this fire ignition source could be present. Exclude any areas contained in other locations in this table.

D. Obtain the ignition source weighting factor by summing to D factors for ignition sources that are allowed in the zone and dividing by the number of zones in the location in this table. For example, if cigarette smoking is prohibited do not include the cigarette smoking factor in this calculation. The factors are:

- Cigarette smoking 3
- Extension cord 3
- Heater 2
- Candle 2
- Overheating 2
- Hot pipe 1

Overheating addresses errors while heating potential combustibles, e.g. battery terminal grease.

E. Obtain the ignition source weighting factor by dividing the weight (or BTUs) of cable insulation in area by the total weight (or BTUs) of cable insulation in Appendix R fire areas not including fire areas in either the radwaste area or the containment. Cable insulation weight (or BTUs) is provided in Appendix R combustible loadings. (Junction boxes and splices are assumed to be distributed in proportion to the amount of cable).

F. Obtain the ignition source weighting factor by dividing the number of ignition sources in the fire area by the total number in all the locations in this table.

G. Obtain the ignition source weighting factor by dividing the number of ignition sources in the fire area by the total number in all plant locations that were not specified in this table.

Table 12-3

At Power Fire Ignition Frequency: Control Building DCIS Zones

Fire Area Description	**Control Building, DCIS Class 1E Division I**					
Reference 12-1 Plant Location	Reactor Building					
Location Weighting Factor (WF_L)	1					
Ignition Source Frequency (F_{if})						
Fire Area Ignition Sources	**(WF_L)**	**(A)**	**(B)**	**WF_{Is}=A/B**	**F_f (1)**	**F_{if} (2)**
Electrical Cabinets	1	12	256 (3)	0.047	4.90E-02	2.30E-03
Plant Wide Ignition Sources	**(WF_L)**	**(A)**	**(C)**	**WF_{Is}=A/C**	**F_f (1)**	**F_{if} (2)**
Fire Protection Panels	1	2	50	0.040	2.30E-03	9.20E-05
Transients	1	5	110	0.046	1.40E-03	6.36E-05
Cable Fires caused by welding	1	1	110	0.009	5.60E-03	5.09E-05
Transient Fires caused by welding and cutting	1	1	110	0.009	2.80E-02	2.55E-04
Fire Area Ignition Frequency (per year)						2.76E-03

Notes:

1. F_f is the Fire Frequency obtained from Table 12-2.
2. $F_{if} = Ff \bullet WF_{Is}$ or $F_{if} = Ff \bullet WF_L$ as applicable.
3. 256: Corresponds to total number of electrical cabinets in RB; CB; FB and EB.

Table 12-4

At Power Fire Ignition Frequency: Reactor Building Divisional Zones

Fire Area Description	**Reactor Building Divisional Zones (Division I)**					
Reference 12-1 Plant Location	Reactor Building (RB); Battery Room (BR)					
Location Weighting Factor (WF_L)	RB = 1; BR = 2/13					
Ignition Source Frequency (F_{if})						
Fire Area Ignition Sources	**(WF_L)**	**(A)**	**(B)**	**WF_{ls}=A/B**	**F_f (1)**	**F_{if} (2)**
Electrical Cabinets (RB)	1	35	256 (3)	0.137	4.90E-02	6.70E-03
Pumps (RB)	1	3	24 (4)	0.125	2.50E-02	3.13E-03
Batteries (BR)	0.15	n/a	n/a	n/a	3.10E-03	4.77E-04
Plant Wide Ignition Sources	**(WF_L)**	**(A)**	**(C)**	**WF_{ls}=A/C**	**F_f (1)**	**F_{if} (2)**
Fire Protection Panels	1	4	50	0.080	2.30E-03	1.84E-04
Junction box in qualified cables	1	8	110	0.073	1.60E-03	1.17E-04
Transformers	1	2	20	0.100	7.80E-03	7.80E-04
Battery Chargers	1	2	13	0.154	3.90E-03	6.00E-04
Transients	1	8	110	0.073	1.40E-03	1.02E-04
Cable Fires caused by welding	1	8	110	0.073	5.60E-03	4.09E-04
Transient Fires caused by welding and cutting	1	8	110	0.073	2.80E-02	2.04E-03
Fire Area Ignition Frequency (per year)						1.45E-02

Notes:

1. F_f is the Fire Frequency obtained from Table 12-2.
2. $F_{if} = Ff \cdot WF_{ls}$ or $F_{if} = Ff \cdot WF_L$ as applicable.
3. 256: Corresponds to total number of electrical cabinets in RB; CB; FB and EB.
4. 24: Corresponds to total number of pumps in RB, FB and the RCCW in the TB.

Table 12-5

At Power Fire Ignition Frequency: Non Divisional Areas

Fire Area Description	**Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building**					
Reference 12-1 Plant Location	Reactor Building (RB); Diesel Generator Room (DG); Switchgear Room (SR); Battery Room (BR); Intake Structure (IS); Transformer Yard (TY)					
Location Weighting Factor (WF_L)	RB = 1; DG = 1/2; SR = 0.50; BR = 3/13; IS = 1; TY =1					
Ignition Source Frequency (F_{if})						
Fire Area Ignition Sources	**(WF_L)**	**(A)**	**(B)**	**WF_{ls}=A/B**	**F_f (1)**	**F_{if} (2)**
Electrical Cabinets (RB)	1	24 (4)	256 (3)	0.094	4.90E-02	4.59E-03
Pumps (RB)	1	3	24	0.125	2.50E-02	3.13E-03
Diesel Generator (DG)	0.5	n/a	n/a	n/a	2.50E-02	1.25E-02
Electrical Cabinets (DG)	0.5	n/a	n/a	n/a	2.30E-03	1.15E-03
Electrical Cabinets (SR)	0.5	n/a	n/a	n/a	1.60E-02	8.00E-03
Batteries (BR)	0.23	n/a	n/a	n/a	3.10E-03	7.15E-04
Electrical Cabinets (IS)	1	n/a	n/a	n/a	2.30E-03	2.30E-03
Fire Pumps (IS)	1	n/a	n/a	n/a	3.90E-03	3.90E-03
Other Pumps (IS)	1	n/a	n/a	n/a	3.10E-03	3.10E-03
Yard Transformers (TY)	1	n/a	n/a	n/a	1.60E-03	1.60E-03
Plant Wide Ignition Sources	**(WF_L)**	**(A)**	**(C)**	**WF_{ls}=A/C**	**F_f (1)**	**F_{if} (2)**
Fire Protection Panels	1	20	50	0.400	2.30E-03	9.20E-04
Junction box in qualified cables	1	24	110	0.218	1.60E-03	3.49E-04
Transformers	1	10	20	0.500	7.80E-03	3.90E-03
Battery Chargers	1	3	13	0.231	3.90E-03	9.0E-03
Air Compressors	1	1	4	0.250	4.70E-03	1.18E-03
Transients	1	8	110	0.073	1.40E-03	1.02E-04
Cable Fires caused by welding	1	24	110	0.218	5.60E-03	1.22E-03
Transient Fires caused by welding and cutting	1	24	110	0.218	2.80E-02	6.10E-03
Fire Area Ignition Frequency (per year)						5.57E-02

Notes:

1. F_f is the Fire Frequency obtained from Table 12-2.
2. $F_{if} = Ff \cdot WF_{ls}$ or $F_{if} = Ff \cdot WF_L$ as applicable.
3. 256: corresponds to total number of electrical cabinets in RB; CB; FB and EB.
4. 24: corresponds to total number of pumps in RB, FB and the RCCW in the TB.

Table 12-6

At Power Fire Ignition Frequency: Turbine Building

Fire Area Description	**Turbine Building**					
Reference 12-1 Plant Location	Turbine Building (TB); Transformer Yard (TY)					
Location Weighting Factor (WF_L)	TB = 1; TY = 1					
Ignition Source Frequency (F_{if})						
Fire Area Ignition Sources	**(WF_L)**	**(A)**	**(B)**	**WF_{ls}=A/B**	**F_f (1)**	**F_{if} (2)**
T/G Excitor (TB)	1	n/a	n/a	n/a	3.90E-03	3.90E-03
T/G Oil (TB)	1	n/a	n/a	n/a	1.40E-02	1.40E-02
T/G Hydrogen (TB)	1	n/a	n/a	n/a	5.40E-03	5.40E-03
Electrical Cabinets (TB)	1	n/a	n/a	n/a	1.30E-02	1.30E-02
Other Pumps (TB)	1	n/a	n/a	n/a	7.00E-03	7.00E-03
Main Feedwater Pumps (TB)	1	n/a	n/a	n/a	4.30E-03	4.30E-03
Yard Transformers (TY)	1	n/a	n/a	n/a	3.90E-03	3.90E-03
Plant Wide Ignition Sources	**(WF_L)**	**(A)**	**(C)**	**WF_{ls}=A/C**	**F_f (1)**	**F_{if} (2)**
Fire Protection Panels	1	5	50	0.100	2.30E-03	2.30E-04
Junction box in qualified cables	1	20	110	0.182	1.60E-03	2.91E-04
Transformers	1	2	20	0.100	7.80E-03	7.80E-04
Air Compressors	1	2	4	0.500	4.70E-03	2.35E-03
Transients	1	8	110	0.073	1.40E-03	1.02E-04
Cable Fires caused by welding	1	20	110	0.182	5.60E-03	1.02E-03
Transient Fires caused by welding and cutting	1	20	110	0.182	2.80E-02	5.10E-03
Fire Area Ignition Frequency (per year)						6.14E-02

Notes:

1. F_f is the Fire Frequency obtained from Table12-2.
2. $F_{if} = Ff \bullet WF_{ls}$ or $F_{if} = Ff \bullet WF_L$ as applicable.

Table 12-7

At Power Fire Ignition Frequency: Fuel Building

Fire Area Description	**Fuel Building**					
Reference 12-1 Plant Location	Reactor Building					
Location Weighting Factor (WF_L)	1					
Ignition Source Frequency (F_{if})						
Fire Area Ignition Sources	**(WF_L)**	**(A)**	**(B)**	**WF_{ls}=A/B**	**F_f (1)**	**F_{if} (2)**
Electrical Cabinets	1	20	256 (3)	0.078	4.90E-02	3.83E-03
Pumps	1	6	24 (4)	0.250	2.50E-02	6.25E-03
Plant Wide Ignition Sources	**(WF_L)**	**(A)**	**(C)**	**WF_{ls}=A/C**	**F_f (1)**	**F_{if} (2)**
Fire Protection Panels	1	2	50	0.040	2.30E-03	9.20E-05
Junction box in qualified cables	1	6	110	0.055	1.60E-03	8.80E-05
Transients	1	8	110	0.073	1.40E-03	1.02E-04
Cable Fires caused by welding	1	6	110	0.055	5.60E-03	3.08E-04
Transient Fires caused by welding and cutting	1	6	110	0.055	2.80E-02	1.54E-03
Fire Area Ignition Frequency (per year)						1.22E-02

Notes:

1. F_f is the Fire Frequency obtained from Table 12-2.
2. $F_{if} = Ff \cdot WF_{ls}$ or $F_{if} = Ff \cdot WF_L$ as applicable.
3. 256: Corresponds to total number of electrical cabinets in RB; CB; FB and EB.
4. 24: Corresponds to total number of pumps in RB, FB and the RCCW in the TB.

Table 12-8

At Power Fire Ignition Frequency: Control Room

Fire Area Description	**Control Room**					
Reference 12-1 Plant Location	Control Room					
Location Weighting Factor (WF_L)	1					
Ignition Source Frequency (F_{if})						
Fire Area Ignition Sources	**(WF_L)**	**(A)**	**(B)**	**WF_{ls}=A/B**	**F_f (1)**	**F_{if} (2)**
Electrical Cabinets	1	n/a	n/a	n/a	9.30E-03	9.30E-03
Plant Wide Ignition Sources	**(WF_L)**	**(A)**	**(C)**	**WF_{ls}=A/C**	**F_f (1)**	**F_{if} (2)**
Fire Protection Panels	1	1	50	0.020	2.30E-03	4.60E-05
Junction box in qualified cables	1	1	110	0.009	1.60E-03	1.44E-05
Transients	1	5	110	0.046	1.40E-03	6.44E-05
Cable Fires caused by welding	1	0	110	0.0	5.60E-03	0.00E+00
Transient Fires caused by welding and cutting	1	0	110	0.0	2.80E-02	0.00E+00
Fire Area Ignition Frequency (per year)						9.42E-03

Notes:

1. F_f is the Fire Frequency obtained from Table 12-2.
2. $F_{if} = Ff \cdot WF_{ls}$ or $F_{if} = Ff \cdot WF_L$ as applicable.

Table 12-9

Shutdown Fire Ignition Frequencies Per Plant Location

Plant Location	Shutdown Fire Frequencies		
	5%	Mean	95%
Containment	8.93E-04	2.30E-01	8.70E-01
Reactor building	1.30E-03	3.30E-01	1.30E+00
Auxiliary building	1.10E-03	2.80E-01	1.10E+00
Turbine building	1.40E-03	3.60E-01	1.40E+00
Control room	8.90E-05	2.80E-02	8.70E-02
Cable spreading room	1.30E-05	3.20E-03	1.20E-02
Switchgear room	2.00E-04	5.20E-02	2.00E-01
EDG building	2.40E-04	6.20E-02	2.40E-01
SWS pumphouse	5.10E-05	1.30E-02	5.00E-02
Switchyard	2.00E-04	5.20E-02	2.00E-01
Battery room	1.30E-05	3.20E-03	1.20E-02

Note:
This table is reproduced here from Table ES-2 "Shutdown Fire Frequencies by Plant Location", Reference 12-2.

Table 12-10

Shutdown Fire Ignition Frequencies Per Year Outage

ESBWR Fire PRA Area	Frequency per Year Outage
Control building DCIS class 1E	1.40E-01
Reactor building	3.32E-01
Non-divisional areas	3.24E-01
Turbine building	3.60E-01
Fuel building	3.30E-02
Control room	2.80E-02

Table 12-11

Operating Mode Durations

Description	Duration (Hrs)	Fraction per outage	Fraction per year
Mode 4	8	0.0073	4.57E-04
Mode 5	238	0.2179	1.36E-02
Mode 6-Unflooded	59	0.0540	3.37E-03
Mode 6-Flooded	241	0.2207	1.38E-02
Total	546		

Table 12-12

Shutdown Fire Ignition Frequencies Per Operating Mode

ESBWR Fire PRA Area	Mode 4	Mode 5	Mode 6-Unflooded	Mode 6-Flooded(4)
Control building(1)	6.39E-05	1.90E-03	4.71E-04	1.93E-03
Reactor building(2)	1.51E-04	4.50E-03	1.12E-03	4.56E-03
Non-divisional areas(3)	1.48E-04	4.40E-03	1.09E-03	4.45E-03
Turbine building(1)	1.64E-04	4.89E-03	1.21E-03	4.95E-03
Fuel building(1)	1.51E-05	4.48E-04	1.11E-04	4.54E-04
Control room	1.28E-05	3.80E-04	9.43E-05	3.85E-04

Notes:

(1) As discussed in Section 12.5.2, fires in these areas are not quantified in the accident sequence analysis because fires in these areas do not create shutdown initiators.

(2) These frequencies are divided by four in the accident sequence analysis, and applied to each of the four reactor building divisional fires.

(3) These frequencies are divided by two in the accident sequence analysis, and applied to each of the two non-divisional area fires.

(4) Fire scenarios during Mode 6-Flooded are not explicitly quantified in the accident sequence analysis. Fires cause loss of DHR scenarios, but during Mode 6-Flooded the time to reach RCS boiling is very long. As such, the risk contribution from Mode 6-Flooded fire scenarios is not significant.

Table 12-13

At Power Fire Damage Scenarios

Fire Area	PRA Initiating Event[1]	Damage States
Control Building DCIS Class 1E Electrical Rooms	General Transient	One class 1E division
		Two class 1E divisions
Reactor Building Divisional Zones	Inadvertent Opening of an SRV (IORV)	One class 1E division, plus one train of RWCU and one of CRD
		Two class 1E divisions, plus one train of RWCU and one of CRD
		Two class 1E divisions, plus both trains of RWCU and CRD
Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building	General Transient	Non-class 1E Division A or B
		Both non-class 1E Divisions A and B
Turbine Building	Loss of Feedwater	Feedwater, Condensate, Service Air RCCW failed
Fuel Building	General Transient	Fuel and Auxiliary Pools Cooling System (FAPCS)
Control Room	General Transient	Control Room evacuation

Notes:

(1) Identifies the accident sequence structure used in the CDF quantification. Refer to Section 3 for event tree figures.

Table 12-14

Shutdown Fire Damage Scenarios

Fire Area	Mode	PRA Initiating Event	Damage
Control Building DCIS Class 1E Electrical Rooms	5	No initiating event	n/a
	6	No initiating event	n/a
Reactor Building Divisional Zones	5	Inadvertent Opening of an SRV (IORV)	One class 1E division, plus one train each of RWCU and CRD
			Two class 1E divisions, plus one train of RWCU and one of CRD
			Two class 1E divisions, plus both trains of RWCU and CRD
	6	Loss of RWCU	Two class 1E divisions, plus both trains of RWCU and CRD
Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building	5	Loss of RWCU	Non-class 1E divisions A and B
	6	Loss of RWCU	Non-class 1E divisions A and B
Control Room Complex	5	Loss of RWCU	Control Room evacuation
	6	Loss of RWCU	Control Room evacuation
Turbine Building	5	No initiating event	n/a
	6	No initiating event	n/a
Fuel Building	5	No initiating event	n/a
	6	No initiating event	n/a

Table 12-15

Full Power Core Damage Frequency Due to Internal Fires

Fire Area	Scenario[1]	Fire Scenario Frequency (per year)	Core Damage Frequency (per year)
Control Building DCIS Class 1E Electrical Rooms[2]	Division I Fire (FIRE-CONTROL-BUILD-TGEN-DIVI)	2.76E-03	Negligible
	Division II Fire (FIRE-CONTROL-BUILD-TGEN-DIVII)	2.76E-03	1E-13
	Division III Fire (FIRE-CONTROL-BUILD-TGEN-DIVIII)	2.76E-03	Negligible
	Division IV Fire (FIRE-CONTROL-BUILD-TGEN-DIVIV)	2.76E-03	Negligible
Reactor Building Divisional Zones[2]	Division I Fire (FIRE-REACT-BUIL-DIVI)	1.45E-02	7.42E-10
	Division II Fire (FIRE-REACT-BUIL-DIVII)	1.45E-02	7.76E-10
	Division III Fire (FIRE-REACT-BUIL-DIVIII)	1.45E-02	3.61E-10
	Division IV Fire (FIRE-REACT-BUIL-DIVIV)	1.45E-02	3.88E-10
Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building[2]	Division A Fire (FIRE-NON-DIVISIONAL-REDA)	5.57E-02	5.83E-11
	Division B Fire (FIRE-NON-DIVISIONAL-REDB)	5.57E-02	5.83E-11
Turbine Building	Turbine Building Fire (FIRE-TURBINE-BUILD)	6.14E-02	9.69E-09
Fuel Building	Fuel Building Fire (FIRE-FUEL-BUILD)	1.22E-02	Negligible
Control Room	Control Room Fire (FIRE-CONTROL-ROOM-TGEN)	9.42E-03	7.97E-12

Notes:

(1) Parameters shown in parentheses are the fire scenario initiator IDs used in the accident sequence analysis (refer to Tables 12-17 and 12-19).

(2) The CDF results for these scenarios include both single division fire scenarios and multi-divisional fire scenarios (as described in Section 12.5.1 and Table 12-13).

Table 12-16

Shutdown Core Damage Frequencies Due to Internal Fires

Fire Area	Mode[1]	Scenario[2]	Fire Scenario Frequency (per year)	Core Damage Frequency (per year)
Reactor Building Divisional Zones[3]	5	Division I Fire (FIRE-REACT-BUILD-DIVI-M5)	1.12E-03	7.23E-09
		Division II Fire (FIRE-REACT-BUILD-DIVII-M5)	1.12E-03	7.72E-09
		Division III Fire (FIRE-REACT-BUILD-DIVIII-M5)	1.12E-03	3.63E-09
		Division IV Fire (FIRE-REACT-BUILD-DIVIV-M5)	1.12E-03	4.02E-09
	6 Unflooded	Division I Fire (FIRE-REACT-BUILD-DIVI-M6)	2.80E-04	4.53E-11
		Division II Fire (FIRE-REACT-BUILD-DIVII-M6)	2.80E-04	4.53E-11
		Division III Fire (FIRE-REACT-BUILD-DIVIII-M6)	2.80E-04	6.02E-11
		Division IV Fire (FIRE-REACT-BUILD-DIVIV-M6)	2.80E-04	6.02E-11
Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building	5	Division A Fire Propagates to Division B (FIRE-NON-DIVISIONAL-REDA-M5)	2.20E-03	8E-13
		Division B Fire Propagates to Division A (FIRE-NON-DIVISIONAL-REDB-M5)	2.20E-03	8E-13
	6 Unflooded	Division A Fire Propagates to Division B (FIRE-NON-DIVISIONAL-REDA-M6)	5.45E-04	1.92E-10
		Division B Fire Propagates to Division A (FIRE-NON-DIVISIONAL-REDB-M6)	5.54E-04	1.95E-10
Control Room	5	Control Room Fire (FIRE-CONTROL-ROOM-M5)	3.80E-04	2E-13
	6 Unflooded	Control Room Fire (FIRE-CONTROL-ROOM-M6)	9.43E-05	4.56E-11

Notes:

(1) Fire scenarios during Mode 6-Flooded are not explicitly quantified in the accident sequence analysis. Fires cause loss of DHR scenarios, but during Mode 6-Flooded the time to reach RCS boiling is very long. As such, the risk contribution from Mode 6-Flooded fire scenarios is not significant.

(2) Parameters shown in parentheses are the fire scenario initiator IDs used in the accident sequence analysis (refer to Tables 12-18 and 12-20).

(3) The CDF results for these scenarios include both single division fire scenarios and multi-divisional fire scenarios (as described in Section 12.5.2 and Table 12-14).

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
1	3.42E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
2	3.42E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
3	3.42E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
4	3.42E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
5	3.42E-10	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
6	3.42E-10	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
7	3.42E-10	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
8	3.42E-10	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
9	2.37E-10	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
10	2.37E-10	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
11	2.37E-10	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
12	2.37E-10	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
13	2.37E-10	1.60E-03	C12-UV -CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
14	2.37E-10	1.60E-03	C12-UV -CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
15	1.02E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
16	1.02E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
17	1.02E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
18	1.02E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
19	1.02E-10	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
20	1.02E-10	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
21	1.02E-10	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
22	1.02E-10	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
23	8.54E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
24	8.54E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
25	8.54E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
26	8.54E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
27	8.54E-11	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
28	8.54E-11	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
29	8.54E-11	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
30	8.54E-11	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
31	8.54E-11	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
32	8.54E-11	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
33	7.07E-11	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
34	7.07E-11	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
35	7.07E-11	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
36	7.07E-11	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
37	7.07E-11	1.60E-03	C12-UV -CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
38	7.07E-11	1.60E-03	C12-UV -CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
39	3.26E-11	5.57E-02	FIRE-NON-DIVISIONAL-REDA	FIRE IN ELECTRICAL BUILDING ZONE A
		5.85E-02	B21-SYS-FF-1/9OPEN	1 OUT OF 9 SRV FAIL TO CLOSE AFTER OPENING
		1.00E-08	C71-SYS-FF-SCRAM	SCRAM FAILURE
40	3.26E-11	5.57E-02	FIRE-NON-DIVISIONAL-REDB	FIRE IN ELECTRICAL BUILDING ZONE B
		5.85E-02	B21-SYS-FF-1/9OPEN	1 OUT OF 9 SRV FAIL TO CLOSE AFTER OPENING
		1.00E-08	C71-SYS-FF-SCRAM	SCRAM FAILURE
41	2.87E-11	3.12E-05	C62-VLU-CF-DIDALL	CCF OF VOTER LOGIC UNITS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
42	2.87E-11	3.12E-05	C62-VLU-CF-DIDALL	CCF OF VOTER LOGIC UNITS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
43	2.85E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
44	2.85E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
45	2.85E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
46	2.85E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
47	2.85E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
48	2.85E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
49	2.85E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
50	2.85E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
51	2.85E-11	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
52	2.85E-11	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
53	2.85E-11	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
54	2.85E-11	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
55	2.55E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
56	2.55E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
57	2.55E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
58	2.55E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
59	2.55E-11	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
60	2.55E-11	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
61	2.55E-11	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
62	2.55E-11	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
63	2.55E-11	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
64	2.55E-11	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
65	2.22E-11	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
66	2.22E-11	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
67	2.22E-11	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
68	2.22E-11	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
69	2.14E-11	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
70	2.14E-11	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
71	2.14E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
72	2.14E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
73	2.14E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
74	2.14E-11	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
75	2.14E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
76	2.14E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
77	2.14E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
78	2.14E-11	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
79	2.14E-11	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
80	2.14E-11	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
81	2.14E-11	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
82	2.14E-11	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
83	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
84	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
85	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
86	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
87	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
88	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
89	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
90	2.08E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
91	1.71E-11	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
92	1.71E-11	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
93	1.71E-11	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
94	1.71E-11	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
95	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
96	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
97	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
98	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
99	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
100	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
101	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
102	1.37E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
103	1.04E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
104	1.04E-11	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
105	1.04E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
106	1.04E-11	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
107	9.39E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		7.20E-05	R10-CBU-FC-PRE500KV	500KV TRANSMISSION LINE FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
108	9.39E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		7.20E-05	R10-CBU-FC-PRE500KV	500KV TRANSMISSION LINE FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
109	9.39E-12	1.45E-02	FIRE-REACT-BUIL-DIVIII	FIRE IN REACTOR BUILDING DIVISION III ZONE
		7.20E-05	R10-CBU-FC-PRE500KV	500KV TRANSMISSION LINE FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
110	9.39E-12	1.45E-02	FIRE-REACT-BUIL-DIVIV	FIRE IN REACTOR BUILDING DIVISION IV ZONE
		7.20E-05	R10-CBU-FC-PRE500KV	500KV TRANSMISSION LINE FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
111	8.49E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
112	8.49E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
113	8.49E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
114	8.49E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
115	8.49E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
116	8.49E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
117	8.49E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
118	8.49E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
119	8.49E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
120	8.49E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
121	8.49E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
122	8.49E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
123	7.42E-12	5.57E-02	FIRE-NON-DIVISIONAL-REDA	FIRE IN ELECTRICAL BUILDING ZONE A
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.00E-03	U43-SYS-FF-YARD	HARDWARE FAILURES IN YARD AREA
124	7.42E-12	5.57E-02	FIRE-NON-DIVISIONAL-REDB	FIRE IN ELECTRICAL BUILDING ZONE B
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.00E-03	U43-SYS-FF-YARD	HARDWARE FAILURES IN YARD AREA
125	7.12E-12	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
126	7.12E-12	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
127	7.12E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
128	7.12E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
129	7.12E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
130	7.12E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
131	7.12E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
132	7.12E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
133	7.12E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
134	7.12E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
135	7.12E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
136	7.12E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
137	6.83E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
138	6.83E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
139	6.83E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
140	6.83E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.31E-03	N21-ACV-OC-F018	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
141	6.63E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
142	6.63E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
143	6.63E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
144	6.63E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
145	6.57E-12	5.57E-02	FIRE-NON-DIVISIONAL-REDA	FIRE IN ELECTRICAL BUILDING ZONE A
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		1.77E-03	U43-XHE-FO-YARD	OPERATOR FAILS TO MAKE UP FROM YARD AREA
146	6.57E-12	5.57E-02	FIRE-NON-DIVISIONAL-REDB	FIRE IN ELECTRICAL BUILDING ZONE B
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		1.77E-03	U43-XHE-FO-YARD	OPERATOR FAILS TO MAKE UP FROM YARD AREA
147	6.37E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
148	6.37E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
149	6.37E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
150	6.37E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
151	6.37E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
152	6.37E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
153	6.37E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
154	6.37E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
155	6.37E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
156	6.37E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
157	6.37E-12	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
158	6.37E-12	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
159	6.37E-12	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
160	6.37E-12	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
161	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
162	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
163	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
164	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
165	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
166	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
167	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
168	6.21E-12	1.45E-02	FIRE-REACT-BUIL-DIVII	FIRE IN REACTOR BUILDING DIVISION II ZONE
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
169	6.10E-12	9.42E-03	FIRE-CONTROL-ROOM-TGEN	FIRE IN CONTROL ROOM
		7.20E-05	R10-CBU-FC-PRE500KV	500KV TRANSMISSION LINE FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
170	5.97E-12	5.57E-02	FIRE-NON-DIVISIONAL-REDA	FIRE IN ELECTRICAL BUILDING ZONE A

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		1.61E-03	XXX-XHE-FO-ICPCCS	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
171	5.97E-12	5.57E-02	FIRE-NON-DIVISIONAL-REDB	FIRE IN ELECTRICAL BUILDING ZONE B
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		1.61E-03	XXX-XHE-FO-ICPCCS	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
172	5.56E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
173	5.56E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
174	5.56E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
175	5.56E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
176	5.56E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
177	5.56E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
178	5.56E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
179	5.56E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
180	5.56E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
181	5.56E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
182	5.34E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
183	5.34E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
184	5.34E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
185	5.34E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
186	5.09E-12	2.40E-03	C12-MP -FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
187	5.09E-12	2.40E-03	C12-MP -FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
188	5.09E-12	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
189	5.09E-12	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		6.14E-02	FIRE-TURBINE-BUILD	FIRE IN TURBINE BUILDING
190	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
191	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
192	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report
Fire Full Power
Core Damage Frequency = 1.21E-08/year
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
193	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
194	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
195	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
196	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
197	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE

Table 12-17

Internal Fire Full-Power Cutset Report

Cutsets with Descriptions Report Fire Full Power Core Damage Frequency = 1.21E-08/year Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
198	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
199	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
200	5.00E-12	1.45E-02	FIRE-REACT-BUIL-DIVI	FIRE IN REACTOR BUILDING DIV I ZONE
		3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.00E-03	P22-ACV-FT-BYPASS	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
		7.43E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
1	2.16E-10	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
2	2.16E-10	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
3	2.16E-10	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
4	2.16E-10	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
5	2.16E-10	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
6	2.16E-10	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
7	2.16E-10	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
8	2.16E-10	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
9	2.16E-10	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
10	2.16E-10	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
11	2.16E-10	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
12	2.16E-10	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
13	2.16E-10	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
14	2.16E-10	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
15	2.16E-10	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
16	2.16E-10	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
17	1.08E-10	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
18	1.08E-10	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
19	1.08E-10	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
20	1.08E-10	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
21	1.08E-10	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
22	1.08E-10	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
23	1.08E-10	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
24	1.08E-10	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
25	6.44E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
26	6.44E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
27	6.44E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
28	6.44E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
29	6.44E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
30	6.44E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
31	6.44E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
32	6.44E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
33	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
34	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
35	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
36	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
37	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
38	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
39	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
40	6.44E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
41	6.15E-11	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		5.54E-04	FIRE-NON-DIVISIONAL-REDB-M6	
42	6.15E-11	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		5.54E-04	FIRE-NON-DIVISIONAL-REDB-M6	
43	6.05E-11	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		5.45E-04	FIRE-NON-DIVISIONAL-REDA-M6	
44	6.05E-11	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		5.45E-04	FIRE-NON-DIVISIONAL-REDA-M6	
45	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
46	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
47	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
48	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
49	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
50	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
51	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
52	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
53	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
54	5.19E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
55	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
56	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
57	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
58	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
59	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
60	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
61	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
62	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
63	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
64	5.19E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
65	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
66	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
67	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
68	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
69	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
70	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
71	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
72	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
73	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
74	5.19E-11	3.00E-03	B21-SQV-CC-F004C	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
75	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

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Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
76	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
77	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
78	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
79	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
80	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
81	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
82	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
83	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
84	5.19E-11	3.00E-03	B21-SQV-CC-F004D	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
85	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
86	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE

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Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
87	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
88	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
89	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

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No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
90	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
91	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
92	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
93	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE

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		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
94	5.19E-11	3.00E-03	B21-SQV-CC-F004E	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
95	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
96	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

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No.	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
97	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
98	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
99	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
100	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
101	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
102	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
103	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
104	5.19E-11	3.00E-03	B21-SQV-CC-F004F	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
105	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
106	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
107	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
108	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
109	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
110	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

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Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
111	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
112	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
113	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
114	5.19E-11	3.00E-03	B21-SQV-CC-F004G	EXPLOSIVE VALVE DPV G FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
115	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
116	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
117	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
118	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
119	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
120	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
121	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
122	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
123	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
124	5.19E-11	3.00E-03	B21-SQV-CC-F004H	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
125	3.69E-11	7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		5.54E-04	FIRE-NON-DIVISIONAL-REDB-M6	
126	3.63E-11	7.40E-03	EB-DAMPER	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		5.45E-04	FIRE-NON-DIVISIONAL-REDA-M6	
127	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
128	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
129	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
130	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
131	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
132	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
133	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D

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Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
134	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
135	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
136	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
137	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
138	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
139	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
140	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
141	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
142	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
143	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
144	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
145	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
146	3.50E-11	1.50E-05	B21-SQV-CF-DPVOPEN	CCF OF DPV'S TO OPEN

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
147	3.22E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
148	3.22E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
149	3.22E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
150	3.22E-11	6.00E-04	C74-DTM-FC-DIV3	DTM OF SSLC DIV. 3 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
151	3.22E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
152	3.22E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
153	3.22E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
154	3.22E-11	6.00E-04	C74-DTM-FC-DIV4	DTM OF SSLC DIV. 4 FAILS TO TRIP
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
155	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
156	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
157	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
158	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS

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Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
159	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
160	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
161	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
162	3.22E-11	4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
163	3.22E-11	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
164	3.22E-11	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
165	3.22E-11	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
166	3.22E-11	6.00E-04	H23-EMS-FC-DIV3	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
167	3.22E-11	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
168	3.22E-11	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
169	3.22E-11	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
170	3.22E-11	6.00E-04	H23-EMS-FC-DIV4	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
171	2.80E-11	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.20E-05	C74-DTM-CF-ALL	CCF 3/4 DTM OF SSLC DIV1/2/3/4

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
172	2.80E-11	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.20E-05	C74-DTM-CF-ALL	CCF 3/4 DTM OF SSLC DIV1/2/3/4
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
173	2.80E-11	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.20E-05	C74-DTM-CF-ALL	CCF 3/4 DTM OF SSLC DIV1/2/3/4
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
174	2.80E-11	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.20E-05	C74-DTM-CF-ALL	CCF 3/4 DTM OF SSLC DIV1/2/3/4
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
175	2.80E-11	1.20E-05	C74-DTM-CF-ALL	CCF 3/4 DTM OF SSLC DIV1/2/3/4
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		1.61E-01	XXX-XHE-FO-DEPRESS	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
176	1.61E-11	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
177	1.61E-11	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
178	1.61E-11	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
179	1.61E-11	3.00E-04	H23-RMU-FC-DIV3	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
180	1.61E-11	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
181	1.61E-11	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
182	1.61E-11	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
183	1.61E-11	3.00E-04	H23-RMU-FC-DIV4	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
184	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
185	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
186	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
187	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
188	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
189	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
190	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
191	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
192	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIII-M5	
193	1.55E-11	3.00E-03	B21-SQV-CC-F004A	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVII-M5	
194	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report Fire Shutdown Core Damage Frequency = 2.32E-08/year Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
195	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
196	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
197	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	

Table 12-18

Internal Fire Shutdown Cutset Report

Cutsets with Descriptions Report
Fire Shutdown
Core Damage Frequency = 2.32E-08/year
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
198	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	
199	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-CONDPUMPD	OPERATOR FAILS TO START CONDENSATE PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVIV-M5	
200	1.55E-11	3.00E-03	B21-SQV-CC-F004B	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	N21-XHE-FO-FWPUMPD	OPERATOR FAILS TO START FEEDWATER PUMP D
		7.40E-03	RB-DAMPER	FIRE BARRIER IN REACTOR BUILDING FAILS
		1.12E-03	FIRE-REACT-BUILD-DIVI-M5	

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
B21-LT_-CF-N001ABCD	1.20E-07	2.44E-03	2.03E+04	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
B21-LT_-NO-N001C	2.40E-05	3.34E-04	14.93	WIDE RANGE LEVEL TRANSMITTER 1C (LEVEL 1&2) FAILS
B21-LT_-NO-N001D	2.40E-05	3.34E-04	14.93	WIDE RANGE LEVEL TRANSMITTER 1D (LEVEL 1&2) FAILS
B21-OR_-PG-01A	1.44E-05	1.62E-04	12.23	ORIFICE INSTR. LINE 1A FAILS TO REMAIN OPEN (PLUG)
B21-OR_-PG-01B	1.44E-05	1.62E-04	12.23	ORIFICE INSTR. LINE 1B FAILS TO REMAIN OPEN (PLUG)
B21-OR_-PG-01C	1.44E-05	1.62E-04	12.23	ORIFICE INSTR. LINE 1C FAILS TO REMAIN OPEN (PLUG)
B21-OR_-PG-01D	1.44E-05	1.62E-04	12.23	ORIFICE INSTR. LINE 1D FAILS TO REMAIN OPEN (PLUG)
B21-SQV-CC-F004A	3.00E-03	1.02E-02	4.4	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
B21-SQV-CC-F004B	3.00E-03	1.07E-02	4.55	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
B21-SQV-CC-F004C	3.00E-03	1.02E-02	4.4	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
B21-SQV-CC-F004D	3.00E-03	1.07E-02	4.55	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
B21-SQV-CC-F004E	3.00E-03	1.02E-02	4.4	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
B21-SQV-CC-F004F	3.00E-03	1.07E-02	4.55	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
B21-SQV-CC-F004G	3.00E-03	1.02E-02	4.4	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
B21-SQV-CC-F004H	3.00E-03	1.07E-02	4.55	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
B21-SQV-CF-DPVOPEN	1.50E-05	1.31E-02	873.91	CCF OF DPV'S TO OPEN
B21-SYS-FF-1/9OPEN	5.85E-02	5.77E-03	1.09	1 OUT OF 9 SRV FAIL TO CLOSE AFTER OPENING
B21-UV_-CC-F102A	1.60E-03	5.03E-03	4.14	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F102B	1.60E-03	6.48E-02	41.48	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103A	1.60E-03	5.03E-03	4.14	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F103B	1.60E-03	6.48E-02	41.48	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
B21-XHE-FO-6OPEN	1.61E-03	2.63E-04	1.16	OPERATOR FAILS TO OPEN 6/10 SRVS
B32-ACV-CC-F006B	2.00E-03	5.11E-05	1.03	AIR OPERATED VALVE F006B FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CC-F006C	2.00E-03	5.11E-05	1.03	AIR OPERATED VALVE F006A FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CC-F006D	2.00E-03	5.11E-05	1.03	AIR OPERATED VALVE F006D FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CF-2ICABCD	1.55E-05	3.65E-05	3.36	CCF TO OPEN 2/4 ACV VALVES TRAINS A,B,C,D
B32-SYS-TM-ICA	4.16E-02	1.53E-04	1	IC "A" UNAVAILABLE [# 7]
C12-MCB-OO-C001B	1.00E-03	2.59E-03	3.59	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
C12-MOV-CC-F014A	4.00E-03	1.39E-02	4.47	MOTOR OPER. VALVE F014A FAILS TO OPEN
C12-MOV-CC-F014B	4.00E-03	1.39E-02	4.46	MOTOR OPER. VALVE F014B FAILS TO OPEN
C12-MOV-CC-F020A	4.00E-03	1.38E-02	4.43	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	1.11E-02	3.76	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-CF-OPEN	1.78E-04	2.97E-04	2.67	CCF MOV TO OPEN
C12-MOV-FC-F020A	3.13E-03	1.07E-02	4.4	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	8.56E-03	3.73	FLOW CONTROL B FAILS WIDE OPEN
C12-MP_-FS-C001BOIL	2.40E-03	6.54E-03	3.72	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
C12-MPC-FR-C001A	5.76E-05	5.10E-05	1.88	MOTOR-DRIVEN PUMP C001A FAILS TO RUN, GIVEN START
C12-MPC-FR-C001B	5.76E-05	3.40E-05	1.59	MOTOR-DRIVEN PUMP C001B FAILS TO RUN, GIVEN START
C12-MPC-FS-C001B	2.40E-03	6.54E-03	3.72	MOTOR-DRIVEN PUMP C001B FAILS TO START
C12-OR_-PG-D007A	6.48E-04	1.00E-03	2.54	ORIFICE D007A FAILS TO REMAIN OPEN (PLUG)
C12-OR_-PG-D007B	6.48E-04	6.28E-04	1.97	ORIFICE D007B FAILS TO REMAIN OPEN (PLUG)
C12-SYS-TM-TRAINB	3.00E-03	8.21E-03	3.73	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	6.48E-02	41.48	CHECK VALVE F022 FAILS TO OPEN

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
C12-XHE-FO-LEVEL2	3.22E-02	4.35E-05	1	MANUAL ACTUATION FAILURE
C12-XHE-MH-F003B	1.20E-02	3.79E-02	4.12	MISPOSITION OF VALVE F003B
C12-XHE-MH-F013A	4.80E-02	2.08E-01	5.13	MISPOSITION OF VALVE F013A
C12-XHE-MH-F013B	4.80E-02	2.07E-01	5.11	MISPOSITION OF VALVE F013B
C12-XHE-MH-F015A	4.80E-02	2.08E-01	5.13	MISPOSITION OF VALVE F015A
C12-XHE-MH-F015B	4.80E-02	2.07E-01	5.11	MISPOSITION OF VALVE F015B
C12-XHE-MH-F018A	1.20E-02	4.62E-02	4.8	MISPOSITION OF VALVE F018A
C12-XHE-MH-F018B	1.20E-02	3.79E-02	4.12	MISPOSITION OF VALVE F018B
C12-XHE-MH-F021A	1.20E-02	4.62E-02	4.8	MISPOSITION OF VALVE F021A
C12-XHE-MH-F021B	1.20E-02	3.79E-02	4.12	MISPOSITION OF VALVE F021B
C41-SYS-FF-MAKEUP	1.00E-01	1.78E-05	1	INVENTORY MAKE-UP BORATION FAILURE
C41-UV_-CC-F004A	1.60E-03	5.30E-05	1.03	CHECK VALVE F004A FAILS TO OPEN
C41-UV_-CC-F004B	1.60E-03	5.30E-05	1.03	CHECK VALVE F004B FAILS TO OPEN
C41-UV_-CC-F005A	1.60E-03	5.30E-05	1.03	CHECK VALVE F005A FAILS TO OPEN
C41-UV_-CC-F005B	1.60E-03	5.30E-05	1.03	CHECK VALVE F005B FAILS TO OPEN
C41-XHE-FO-INISLCS	1.77E-01	2.48E-04	1	OPERATOR FAILS TO MANUALLY INITIATE SLCS (SHORT TIME)
C41-XHE-FO-OPENF002A	2.69E-01	2.74E-05	1	OPERATOR FAILS TO OPEN VALVE F002A (AFTER INADV.CLOS.)
C41-XHE-FO-OPENF002B	2.69E-01	2.74E-05	1	OPERATOR FAILS TO OPEN VALVE F002B (AFTER INADV.CLOS.)
C41-XHE-MH-F002A	4.03E-03	5.89E-05	1.01	MISPOSITION OF VALVE F002A
C41-XHE-MH-F002B	4.03E-03	5.89E-05	1.01	MISPOSITION OF VALVE F002B
C51-ACT-CF-1PRM	2.98E-04	4.26E-05	1.14	CCF APRM NEUTRON CHANNELS
C51-ACT-CF-APRMSTUCK	2.10E-07	5.37E-04	2.56E+03	CCF APRM DETECTORS STUCK AT POWER LEVEL

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
C62-DTM-CF-DIDALL	5.50E-05	1.28E-04	3.32	COMMON CAUSE FAILURE 3/4 DTM DID LOGIC
C62-DTM-CF-N1EALL	5.50E-05	9.06E-03	165.69	CCF OF DIGITAL TRIP MODULES NO 1E
C62-VLU-CF-DIDALL	3.12E-05	4.80E-03	154.82	CCF OF VOTER LOGIC UNITS
C62-VLU-CF-N1EALL	3.12E-05	3.06E-04	10.79	CCF OF VOTER LOGIC UNITS
C71-SYS-FF-SCRAM	1.00E-08	6.35E-03	6.33E+05	SCRAM FAILURE
C72-VLU-CF-DPSALL	3.12E-06	1.79E-05	6.74	CCF OF VOTER LOGIC UNITS
C74-DTM-CF-ALL	1.20E-05	2.62E-03	219.16	CCF 3/4 DTM OF SSLC DIV1/2/3/4
C74-DTM-FC-DIV1	6.00E-04	1.48E-03	3.47	DTM OF SSLC DIV. 1 FAILS TO TRIP
C74-DTM-FC-DIV2	6.00E-04	1.55E-03	3.58	DTM OF SSLC DIV. 2 FAILS TO TRIP
C74-DTM-FC-DIV3	6.00E-04	1.29E-02	22.46	DTM OF SSLC DIV. 3 FAILS TO TRIP
C74-DTM-FC-DIV4	6.00E-04	1.29E-02	22.41	DTM OF SSLC DIV. 4 FAILS TO TRIP
C74-VLU-CF-ALL	3.12E-06	8.39E-04	269.79	CCF OF VOTER LOGIC UNITS
E50-OR_-CF-7PLUG	7.00E-08	1.35E-03	1.93E+04	CCF OF 7 ORIFICES TO PLUG
E50-OR_-CF-PLUGALL	7.20E-08	1.45E-03	2.01E+04	CCF OF ALL ORIFICES TO PLUG
E50-SQV-CC-F002A	3.00E-03	1.14E-02	4.78	SQUIB VALVE F002A FAILS TO OPERATE
E50-SQV-CC-F002D	3.00E-03	1.14E-02	4.78	SQUIB VALVE F002D FAILS TO OPERATE
E50-SQV-CC-F002E	3.00E-03	1.14E-02	4.78	SQUIB VALVE F002E FAILS TO OPERATE
E50-SQV-CC-F002H	3.00E-03	1.14E-02	4.78	SQUIB VALVE F002H FAILS TO OPERATE
E50-SQV-CF-4OPEN	1.50E-05	4.24E-05	3.83	CCF OF 4 OR MORE SQUIB VALVES TO OPEN
E50-SQV-CF-GDCS7OPEN	1.50E-05	3.45E-01	2.30E+04	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
E50-SQV-CF-OPENALL	1.50E-05	3.45E-01	2.30E+04	CCF OF ALL SQUIB VALVES TO OPEN
E50-SQV-CO-F009A	3.50E-03	2.56E-02	8.29	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
E50-SQV-CO-F009B	3.50E-03	1.88E-02	6.37	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
E50-SQV-CO-F009C	3.50E-03	1.88E-02	6.37	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
E50-SQV-CO-F009D	3.50E-03	2.56E-02	8.29	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
E50-SQV-CO-F009E	3.50E-03	2.56E-02	8.29	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
E50-SQV-CO-F009F	3.50E-03	1.88E-02	6.37	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
E50-SQV-CO-F009G	3.50E-03	1.88E-02	6.37	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
E50-SQV-CO-F009H	3.50E-03	2.56E-02	8.29	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
E50-SQV-CO-F009I	3.50E-03	2.56E-02	8.29	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
E50-SQV-CO-F009J	3.50E-03	1.88E-02	6.37	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
E50-SQV-CO-F009K	3.50E-03	1.88E-02	6.37	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
E50-SQV-CO-F009L	3.50E-03	2.56E-02	8.29	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
E50-STR-CF-SPPLUG	3.75E-04	1.60E-03	5.26	CCF FILTER/STRAINER IN PSP TO PLUG
E50-UV_-OC-F003A	1.75E-03	6.64E-03	4.79	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003D	1.75E-03	6.64E-03	4.79	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003E	1.75E-03	6.64E-03	4.79	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003H	1.75E-03	6.64E-03	4.79	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
EB-DAMPER	7.40E-03	4.08E-03	1.55	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
FIRE-CONTROL-BUILD-TGEN-DIVII	2.76E-03	1.10E-05	1	FIRE IN CONTROL BUILDING DIV I ZONE
FIRE-CONTROL-ROOM-TGEN	9.42E-03	6.60E-04	1.07	FIRE IN CONTROL ROOM
FIRE-NON-DIVISIONAL-REDA	5.57E-02	4.83E-03	1.08	FIRE IN ELECTRICAL BUILDING ZONE A
FIRE-NON-DIVISIONAL-REDB	5.57E-02	4.83E-03	1.08	FIRE IN ELECTRICAL BUILDING ZONE B
FIRE-REACT-BUIL-DIVI	1.45E-02	6.14E-02	5.17	FIRE IN REACTOR BUILDING DIV I ZONE

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
FIRE-REACT-BUIL-DIVII	1.45E-02	6.42E-02	5.37	FIRE IN REACTOR BUILDING DIVISION II ZONE
FIRE-REACT-BUIL-DIVIII	1.45E-02	2.99E-02	3.03	FIRE IN REACTOR BUILDING DIVISION III ZONE
FIRE-REACT-BUIL-DIVIV	1.45E-02	3.21E-02	3.18	FIRE IN REACTOR BUILDING DIVISION IV ZONE
FIRE-TURBINE-BUILD	6.14E-02	8.02E-01	13.26	FIRE IN TURBINE BUILDING
G21-ACV-CC-F321	2.00E-03	6.75E-05	1.03	AOV F321 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-ACV-CC-F322	2.00E-03	6.75E-05	1.03	AOV F322 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-ACV-CC-F332	2.00E-03	6.30E-03	4.14	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-UV_-CC-F333	1.60E-03	5.03E-03	4.14	CHECK VALVE F333 FAILS TO OPEN
G21-UV_-TM-F332/333	8.00E-04	2.43E-03	4.03	MAINTENANCE FOR CV F332 OR CV F333
G21-XHE-FO-LPCIADS	1.61E-02	1.66E-03	1.1	OPERATOR FAILS TO ALIGN AND ACTUATE FAPCS IN LPCI MODE
G21-XHE-MH-F334	4.80E-02	2.10E-01	5.17	MISPOSITION OF VALVE F334
H23-EMS-CF-ALL	1.80E-06	4.16E-04	232.06	CCF OF ESSENTIAL MULTIPLEXING SYSTEM DIV 1/2/3/4
H23-EMS-CF-DIDALL	1.80E-06	2.74E-04	153.49	CCF OF ALL DIVISION OF THE EMS
H23-EMS-FC-DIV1	6.00E-04	1.48E-03	3.47	ESSENTIAL MULTIPLEXING SYSTEM DIV 1 FAILS TO FUNCTION
H23-EMS-FC-DIV2	6.00E-04	1.55E-03	3.58	ESSENTIAL MULTIPLEXING SYSTEM DIV 2 FAILS TO FUNCTION
H23-EMS-FC-DIV3	6.00E-04	1.38E-02	24.05	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
H23-EMS-FC-DIV4	6.00E-04	1.29E-02	22.45	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
H23-RMU-CF-ALL	9.00E-07	1.85E-04	206.21	CCF OF REMOTE MULTIPLEXING UNITS TO OPERATE
H23-RMU-CF-DIDALL	9.00E-07	1.37E-04	153.49	CCF OF REMOTE MULTIPLEXING UNITS (DID)
H23-RMU-FC-DIV1	3.00E-04	5.74E-04	2.91	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DIV2	3.00E-04	5.95E-04	2.98	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DIV3	3.00E-04	6.01E-03	21.01	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
H23-RMU-FC-DIV4	3.00E-04	6.00E-03	20.98	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF13	3.00E-04	3.71E-04	2.23	1ST DIV III ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF23	3.00E-04	3.71E-04	2.23	2ND DIVIII ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
N21-ACV-CC-F023	1.58E-02	6.86E-03	1.43	AIR OPERATED VALVE N21-F023 FAILS TO OPEN
N21-ACV-CC-F026	1.58E-02	6.77E-03	1.42	AIR OPERATED VALVE N21-F026 FAILS TO OPEN
N21-ACV-CF-MKUPA/B	1.08E-04	2.18E-03	21.16	CCF TO OPERATE AOVS TRAINS A & B
N21-ACV-OC-F016	1.31E-03	8.96E-04	1.68	AIR OPERATED VALVE N21-F016 FAILS TO REMAIN OPEN
N21-ACV-OC-F018	1.31E-03	5.51E-02	42.9	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
N21-ACV-TM-F026	8.00E-04	8.74E-05	1.11	VALVE N21-F026 UNAVAILABLE DUE TO TEST OR MAINTENANCE
N21-LT_-CF-FWTKNO	4.38E-05	9.54E-04	22.77	CCF FEEDWATER STORAGE TANK LEVEL TRANSMITTERS
N21-LT_-CF-HWNO	4.38E-05	7.57E-04	18.29	CCF HOTWELL LEVEL TRANSMITTERS
N21-LT_-NO-FWTKA	8.71E-03	3.89E-03	1.44	LEVEL TRANSMITTER TRAIN A FAILS
N21-LT_-NO-FWTKB	8.71E-03	3.89E-03	1.44	LEVEL TRANSMITTER TRAIN B FAILS
N21-LT_-NO-FWTKC	8.71E-03	3.89E-03	1.44	LEVEL TRANSMITTER TRAIN C FAILS
N21-LT_-NO-HWA	8.71E-03	3.06E-03	1.35	LEVEL TRANSMITTER TRAIN A FAILS
N21-LT_-NO-HWB	8.71E-03	3.06E-03	1.35	LEVEL TRANSMITTER TRAIN B FAILS
N21-LT_-NO-HWC	8.71E-03	3.06E-03	1.35	LEVEL TRANSMITTER TRAIN C FAILS
N21-MOV-CC-F061	3.13E-02	8.96E-04	1.03	MOTOR OPERATED VALVE N21-F061 FAILS TO OPEN
P22-ACV-FT-BYPASS	2.00E-03	8.67E-02	44.25	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
P22-HX_-PG-B001A	5.28E-05	9.78E-05	2.85	HEAT EXCHANGER A FAILS
P22-XHE-FO-HXB	2.69E-01	9.78E-05	1	OPERATOR FAILS TO ALIGN HX B
P30-UV_-CC-CV01T	2.00E-04	4.22E-04	3.11	CHECK VALVE CV01T FAILS TO OPEN

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
P30-XHE-MH-F015	4.80E-02	1.76E-01	4.48	MISPOSITION OF VALVE F01T
P41-FAN-CS-2ALL	7.20E-06	7.45E-04	104.39	CCF TO START 2 FAN UNITS
P41-MP -CR-3ALL	1.17E-05	1.53E-03	131.98	CCF TO RUN 3 PUMPS TRAINS A AND B
P41-MP -CS-3ALL	6.26E-06	5.19E-04	83.83	CCF TO START PUMPS TRAINS A AND B
P41-STR-CF-3ALL	1.07E-05	1.40E-03	131.98	CCF 3 STRAINERS PLUGGED
P51-ACV-CC-F008A	2.00E-03	6.55E-04	1.33	AIR OPERATED VALVE F008A FAILS TO OP. TO DEENERG. POSIT.
P51-ACV-CC-F010C	2.00E-03	6.55E-04	1.33	AOV F010C FAILS TO OPERATE TO NOT DEENERG. POSITION
P51-ACV-CF-OPEN	1.35E-05	9.31E-05	7.89	CCF OF AOV TO OPEN
P51-CMP-CR-RUN	1.49E-04	4.08E-03	28.35	CCF OF P51 COMPRESSORS TO RUN
P51-CMP-FR-C001A	2.40E-03	9.88E-04	1.41	MOTOR-DRIVEN AIR COMPRESS. C001A FAILS TO CONT.OPER.
P51-CMP-FS-C001B	2.00E-02	9.88E-04	1.05	MOTOR-DRIVEN AIR COMPRESS. C001B FAILS TO START
P51-XHE-FO-STDBYCOMP	1.77E-02	7.56E-04	1.04	OPERATOR FAILS TO ACTUATE STAND-BY COMPRESSOR
P52-XHE-FO-IAS/SAS	1.61E-02	5.55E-04	1.03	OPER. FAILS TO REC. NEED FOR MANUAL INTERV. ON IAS/SAS
R10-BAC-LP-500KVMAIN	4.80E-06	2.41E-04	51.23	500 KV MAIN DISTRIBUTION BUS FAILS DURING OPERATION
R10-CBU-FC-PRE500KV	7.20E-05	3.62E-03	51.23	500KV TRANSMISSION LINE FAILS
R10-SYS-FF-500KV	1.20E-06	6.03E-05	51.24	500KV SWITCHYARD FAILS DURING OPERATION
R10-XFH-TM-XFRMA	1.00E-04	8.31E-06	1.08	TRANSFORMER XFRM-A IN MAINTENANCE
R10-XFH-TM-XFRMB	1.00E-04	8.31E-06	1.08	TRANSFORMER XFRM-B IN MAINTENANCE
R11-BAC-LP-R11B2	4.80E-06	1.93E-04	41.26	BUS R11-B2 FAILS DURING OPERATION
R11-BAC-TM-R11B2	4.80E-06	1.93E-04	41.26	6.9 KV AC BUS R11-B2 IN MANTENANCE
R11-MCB-CO-B2B3	1.20E-05	8.28E-05	7.89	CIRCUIT BREAKER FROM R11-B2 OPENS SPURIOUSLY
R13-BAC-LP-R1311	4.80E-06	4.57E-05	10.51	BUS R13-31 FAILS DURING OPERATION

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
R13-BAC-LP-R13111	4.80E-06	4.57E-05	10.51	BUS R13-11-1 FAILS DURING OPERATION
R13-BAC-LP-R1321	4.80E-06	4.57E-05	10.51	BUS R13-21 FAILS DURING OPERATION
R13-BAC-LP-R13211	4.80E-06	4.57E-05	10.51	BUS R13-21-1 FAILS DURING OPERATION
R13-BAC-LP-R1331	4.80E-06	4.57E-05	10.51	BUS R13-31 FAILS DURING OPERATION
R13-BAC-LP-R13311	4.80E-06	4.57E-05	10.51	BUS R13-31-1 FAILS DURING OPERATION
R13-BAC-LP-R1341	4.80E-06	4.57E-05	10.51	BUS R13-41 FAILS DURING OPERATION
R13-BAC-LP-R13411	4.80E-06	4.57E-05	10.51	BUS R13-41-1 FAILS DURING OPERATION
R13-LCB-CO-FR13111	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13211	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13311	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13411	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13C13	1.44E-05	9.93E-05	7.89	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13111	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13211	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13311	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13411	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13C13	1.44E-05	9.93E-05	7.89	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-TOR1311	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER TO R13-11 OPENS SPURIOUSLY
R13-LCB-CO-TOR1321	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER TO R13-21 OPENS SPURIOUSLY
R13-LCB-CO-TOR1331	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER TO R13-31 OPENS SPURIOUSLY
R13-LCB-CO-TOR1341	1.44E-05	1.62E-04	12.23	CIRCUIT BREAKER TO R13-41 OPENS SPURIOUSLY
R13-LCB-CO-TOR13C	1.44E-05	9.93E-05	7.89	CIRCUIT BREAKER TO R13-C OPENS SPURIOUSLY

Table 12-19

Internal Fire Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Full Power
Core Damage Frequency = 1.21E-08/year

Event Name	Probability	F-V	RAW	Description
R13-XFL-LP-R13111	1.92E-05	2.37E-04	13.35	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13211	1.92E-05	2.37E-04	13.35	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13311	1.92E-05	2.37E-04	13.35	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13411	1.92E-05	2.37E-04	13.35	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13C13	1.92E-05	1.32E-04	7.89	TRANSFORMER FAILS DURING OPERATION
R16-BT_-CF-ALLBATT	9.00E-06	7.39E-03	822.31	BATTERY CCF #2
R16-BT_-LP-R16BT21	5.00E-04	1.99E-04	1.4	BATTERY DE3BY001 FAILS TO PROVIDE OUTPUT
R16-BT_-TM-R16BT21	1.00E-03	4.22E-04	1.42	BATTERY R16-BT21 IN TEST
RB-DAMPER	7.43E-03	1.58E-01	22.11	FIRE BARRIER IN REACTOR BUILDING FAILS
U43-SYS-FF-LPCI	2.40E-02	1.52E-02	1.62	U43 HARDWARE FAILURES
U43-SYS-FF-YARD	2.00E-03	1.25E-03	1.62	HARDWARE FAILURES IN YARD AREA
U43-XHE-FO-LPCI	1.61E-03	2.63E-04	1.16	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE
U43-XHE-FO-LPCIADS	1.61E-02	6.68E-04	1.04	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
U43-XHE-FO-YARD	1.77E-03	1.09E-03	1.61	OPERATOR FAILS TO MAKE UP FROM YARD AREA
XXX-XHE-FO-DEPRESS	1.61E-01	1.31E-01	1.68	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
XXX-XHE-FO-ICPCCS	1.61E-03	9.89E-04	1.61	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
XXX-XHE-FO-LPMAKEUP	1.61E-01	6.01E-01	4.13	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
B21-LT_-CF-N001A/B/C/D	1.20E-07	6.03E-05	503.69	CCF OF DIVERSIFIED LEVEL 1 & 2 TRANSM. 10A/B/C/D
B21-LT_-CF-N001ABCD	1.20E-07	4.20E-05	350.99	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
B21-LT_-NO-DPSWRC	2.40E-05	1.11E-05	1.46	DPS WIDE RANGE LEVEL TRANSMITTER C (LEVEL 1&2) FAILS
B21-LT_-NO-DPSWRD	2.40E-05	1.11E-05	1.46	DPS WIDE RANGE LEVEL TRANSMITTER D (LEVEL 1&2) FAILS
B21-LT_-NO-N001A	2.40E-05	2.79E-04	12.61	WIDE RANGE LEVEL TRANSMITTER 1A (LEVEL 1&2) FAILS
B21-LT_-NO-N001B	2.40E-05	2.96E-04	13.35	WIDE RANGE LEVEL TRANSMITTER 1B (LEVEL 1&2) FAILS
B21-LT_-NO-N001C	2.40E-05	2.31E-03	97.42	WIDE RANGE LEVEL TRANSMITTER 1C (LEVEL 1&2) FAILS
B21-LT_-NO-N001D	2.40E-05	2.31E-03	97.05	WIDE RANGE LEVEL TRANSMITTER 1D (LEVEL 1&2) FAILS
B21-OR_-PG-01A	1.44E-05	1.23E-03	86.19	ORIFICE INSTR. LINE 1A FAILS TO REMAIN OPEN (PLUG)
B21-OR_-PG-01B	1.44E-05	1.23E-03	86.19	ORIFICE INSTR. LINE 1B FAILS TO REMAIN OPEN (PLUG)
B21-OR_-PG-01C	1.44E-05	1.36E-03	95.43	ORIFICE INSTR. LINE 1C FAILS TO REMAIN OPEN (PLUG)
B21-OR_-PG-01D	1.44E-05	1.36E-03	95.43	ORIFICE INSTR. LINE 1D FAILS TO REMAIN OPEN (PLUG)
B21-SQV-CC-F004A	3.00E-03	4.89E-02	17.26	EXPLOSIVE VALVE DPV A FAILS TO OPERATE
B21-SQV-CC-F004B	3.00E-03	5.20E-02	18.29	EXPLOSIVE VALVE DPV B FAILS TO OPERATE
B21-SQV-CC-F004C	3.00E-03	4.96E-02	17.49	EXPLOSIVE VALVE DPV C FAILS TO OPERATE
B21-SQV-CC-F004D	3.00E-03	5.13E-02	18.06	EXPLOSIVE VALVE DPV D FAILS TO OPERATE
B21-SQV-CC-F004E	3.00E-03	4.89E-02	17.26	EXPLOSIVE VALVE DPV E FAILS TO OPERATE
B21-SQV-CC-F004F	3.00E-03	5.20E-02	18.29	EXPLOSIVE VALVE DPV F FAILS TO OPERATE
B21-SQV-CC-F004G	3.00E-03	4.96E-02	17.49	EXPLOSIVE VALVE DPV G FAILS TO OPERATE
B21-SQV-CC-F004H	3.00E-03	5.13E-02	18.06	EXPLOSIVE VALVE DPV H FAILS TO OPERATE
B21-SQV-CF-DPVOPEN	1.50E-05	6.39E-02	4.26E+03	CCF OF DPV'S TO OPEN
B21-SQV-CF-F004AB	3.60E-05	8.29E-04	24.03	CCF OF DPV A AND B TO OPEN

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
B21-SQV-CF-F004ABC	9.00E-06	1.34E-04	15.88	CCF OF DPV A,B & C TO OPEN
B21-SQV-CF-F004ABD	9.00E-06	1.34E-04	15.88	CCF OF DPV A,B & D TO OPEN
B21-SQV-CF-F004ABE	9.00E-06	1.34E-04	15.88	CCF OF DPV A,B & E TO OPEN
B21-SQV-CF-F004ABF	9.00E-06	1.34E-04	15.88	CCF OF DPV A,B & F TO OPEN
B21-SQV-CF-F004ABG	9.00E-06	1.34E-04	15.88	CCF OF DPV A,B & G TO OPEN
B21-SQV-CF-F004ABH	9.00E-06	1.34E-04	15.88	CCF OF DPV A,B & H TO OPEN
B21-SQV-CF-F004AC	3.60E-05	4.01E-04	12.14	CCF OF DPV A AND C TO OPEN
B21-SQV-CF-F004ACD	9.00E-06	1.34E-04	15.88	CCF OF DPV A,C & D TO OPEN
B21-SQV-CF-F004ACE	9.00E-06	6.70E-05	8.44	CCF OF DPV A,C & E TO OPEN
B21-SQV-CF-F004ACF	9.00E-06	1.34E-04	15.88	CCF OF DPV A,C & F TO OPEN
B21-SQV-CF-F004ACG	9.00E-06	6.70E-05	8.44	CCF OF DPV A,C & G TO OPEN
B21-SQV-CF-F004ACH	9.00E-06	1.34E-04	15.88	CCF OF DPV A,C & H TO OPEN
B21-SQV-CF-F004AD	3.60E-05	8.29E-04	24.03	CCF OF DPV A AND D TO OPEN
B21-SQV-CF-F004ADE	9.00E-06	1.34E-04	15.88	CCF OF DPV A,D & E TO OPEN
B21-SQV-CF-F004ADF	9.00E-06	1.34E-04	15.88	CCF OF DPV A,D & F TO OPEN
B21-SQV-CF-F004ADG	9.00E-06	1.34E-04	15.88	CCF OF DPV A,D & G TO OPEN
B21-SQV-CF-F004ADH	9.00E-06	1.34E-04	15.88	CCF OF DPV A,D & H TO OPEN
B21-SQV-CF-F004AE	3.60E-05	4.01E-04	12.14	CCF OF DPV A AND E TO OPEN
B21-SQV-CF-F004AEF	9.00E-06	1.34E-04	15.88	CCF OF DPV A,E & F TO OPEN
B21-SQV-CF-F004AEG	9.00E-06	6.70E-05	8.44	CCF OF DPV A,E & G TO OPEN
B21-SQV-CF-F004AEH	9.00E-06	1.34E-04	15.88	CCF OF DPV A,E & H TO OPEN
B21-SQV-CF-F004AF	3.60E-05	8.29E-04	24.03	CCF OF DPV A AND F TO OPEN
B21-SQV-CF-F004AFG	9.00E-06	1.34E-04	15.88	CCF OF DPV A,F & G TO OPEN

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
B21-SQV-CF-F004AFH	9.00E-06	1.34E-04	15.88	CCF OF DPV A,F & H TO OPEN
B21-SQV-CF-F004AG	3.60E-05	4.01E-04	12.14	CCF OF DPV A AND G TO OPEN
B21-SQV-CF-F004AGH	9.00E-06	1.34E-04	15.88	CCF OF DPV A,G & H TO OPEN
B21-SQV-CF-F004AH	3.60E-05	8.29E-04	24.03	CCF OF DPV A AND H TO OPEN
B21-SQV-CF-F004BC	3.60E-05	8.29E-04	24.03	CCF OF DPV B AND C TO OPEN
B21-SQV-CF-F004BCD	9.00E-06	1.34E-04	15.88	CCF OF DPV B,C & D TO OPEN
B21-SQV-CF-F004BCE	9.00E-06	1.34E-04	15.88	CCF OF DPV B,C & E TO OPEN
B21-SQV-CF-F004BCF	9.00E-06	1.34E-04	15.88	CCF OF DPV B,C & F TO OPEN
B21-SQV-CF-F004BCG	9.00E-06	1.34E-04	15.88	CCF OF DPV B,C & G TO OPEN
B21-SQV-CF-F004BCH	9.00E-06	1.34E-04	15.88	CCF OF DPV B,C & H TO OPEN
B21-SQV-CF-F004BD	3.60E-05	4.28E-04	12.89	CCF OF DPV B AND D TO OPEN
B21-SQV-CF-F004BDE	9.00E-06	1.34E-04	15.88	CCF OF DPV B,D & E TO OPEN
B21-SQV-CF-F004BDF	9.00E-06	6.70E-05	8.44	CCF OF DPV B,D & F TO OPEN
B21-SQV-CF-F004BDG	9.00E-06	1.34E-04	15.88	CCF OF DPV B,D & G TO OPEN
B21-SQV-CF-F004BDH	9.00E-06	6.70E-05	8.44	CCF OF DPV B,D & H TO OPEN
B21-SQV-CF-F004BE	3.60E-05	8.29E-04	24.03	CCF OF DPV B AND E TO OPEN
B21-SQV-CF-F004BEF	9.00E-06	1.34E-04	15.88	CCF OF DPV B,E & F TO OPEN
B21-SQV-CF-F004BEG	9.00E-06	1.34E-04	15.88	CCF OF DPV B,E & G TO OPEN
B21-SQV-CF-F004BEH	9.00E-06	1.34E-04	15.88	CCF OF DPV B,E & H TO OPEN
B21-SQV-CF-F004BF	3.60E-05	4.28E-04	12.89	CCF OF DPV B AND F TO OPEN
B21-SQV-CF-F004BFG	9.00E-06	1.34E-04	15.88	CCF OF DPV B,F & G TO OPEN
B21-SQV-CF-F004BFH	9.00E-06	6.70E-05	8.44	CCF OF DPV B,F & H TO OPEN
B21-SQV-CF-F004BG	3.60E-05	8.29E-04	24.03	CCF OF DPV B AND G TO OPEN

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
B21-SQV-CF-F004BGH	9.00E-06	1.34E-04	15.88	CCF OF DPV B,G & H TO OPEN
B21-SQV-CF-F004BH	3.60E-05	4.28E-04	12.89	CCF OF DPV B AND H TO OPEN
B21-SQV-CF-F004CD	3.60E-05	8.29E-04	24.03	CCF OF DPV C AND D TO OPEN
B21-SQV-CF-F004CDE	9.00E-06	1.34E-04	15.88	CCF OF DPV C,D & E TO OPEN
B21-SQV-CF-F004CDF	9.00E-06	1.34E-04	15.88	CCF OF DPV C,D & F TO OPEN
B21-SQV-CF-F004CDG	9.00E-06	1.34E-04	15.88	CCF OF DPV C,D & G TO OPEN
B21-SQV-CF-F004CDH	9.00E-06	1.34E-04	15.88	CCF OF DPV C,D & H TO OPEN
B21-SQV-CF-F004CE	3.60E-05	4.01E-04	12.14	CCF OF DPV C AND E TO OPEN
B21-SQV-CF-F004CEF	9.00E-06	1.34E-04	15.88	CCF OF DPV C,E & F TO OPEN
B21-SQV-CF-F004CEG	9.00E-06	6.70E-05	8.44	CCF OF DPV C,E & G TO OPEN
B21-SQV-CF-F004CEH	9.00E-06	1.34E-04	15.88	CCF OF DPV C,E & H TO OPEN
B21-SQV-CF-F004CF	3.60E-05	8.29E-04	24.03	CCF OF DPV C AND F TO OPEN
B21-SQV-CF-F004CFG	9.00E-06	1.34E-04	15.88	CCF OF DPV C,F & G TO OPEN
B21-SQV-CF-F004CFH	9.00E-06	1.34E-04	15.88	CCF OF DPV C,F & H TO OPEN
B21-SQV-CF-F004CG	3.60E-05	4.01E-04	12.14	CCF OF DPV C AND G TO OPEN
B21-SQV-CF-F004CGH	9.00E-06	1.34E-04	15.88	CCF OF DPV C,G & H TO OPEN
B21-SQV-CF-F004CH	3.60E-05	8.29E-04	24.03	CCF OF DPV C AND H TO OPEN
B21-SQV-CF-F004DE	3.60E-05	8.29E-04	24.03	CCF OF DPV D AND E TO OPEN
B21-SQV-CF-F004DEF	9.00E-06	1.34E-04	15.88	CCF OF DPV D,E & F TO OPEN
B21-SQV-CF-F004DEG	9.00E-06	1.34E-04	15.88	CCF OF DPV D,E & G TO OPEN
B21-SQV-CF-F004DEH	9.00E-06	1.34E-04	15.88	CCF OF DPV D,E & H TO OPEN
B21-SQV-CF-F004DF	3.60E-05	4.28E-04	12.89	CCF OF DPV D AND F TO OPEN
B21-SQV-CF-F004DFG	9.00E-06	1.34E-04	15.88	CCF OF DPV D,F & G TO OPEN

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
B21-SQV-CF-F004DFH	9.00E-06	6.70E-05	8.44	CCF OF DPV D,F & H TO OPEN
B21-SQV-CF-F004DG	3.60E-05	8.29E-04	24.03	CCF OF DPV D AND G TO OPEN
B21-SQV-CF-F004DGH	9.00E-06	1.34E-04	15.88	CCF OF DPV D,G & H TO OPEN
B21-SQV-CF-F004DH	3.60E-05	4.28E-04	12.89	CCF OF DPV D AND H TO OPEN
B21-SQV-CF-F004EF	3.60E-05	8.29E-04	24.03	CCF OF DPV E AND F TO OPEN
B21-SQV-CF-F004EFG	9.00E-06	1.34E-04	15.88	CCF OF DPV E,F & G TO OPEN
B21-SQV-CF-F004EFH	9.00E-06	1.34E-04	15.88	CCF OF DPV E,F & H TO OPEN
B21-SQV-CF-F004EG	3.60E-05	4.01E-04	12.14	CCF OF DPV E AND G TO OPEN
B21-SQV-CF-F004EGH	9.00E-06	1.34E-04	15.88	CCF OF DPV E,G & H TO OPEN
B21-SQV-CF-F004EH	3.60E-05	8.29E-04	24.03	CCF OF DPV E AND H TO OPEN
B21-SQV-CF-F004FG	3.60E-05	8.29E-04	24.03	CCF OF DPV F AND G TO OPEN
B21-SQV-CF-F004FGH	9.00E-06	1.34E-04	15.88	CCF OF DPV F,G & H TO OPEN
B21-SQV-CF-F004FH	3.60E-05	4.28E-04	12.89	CCF OF DPV F AND H TO OPEN
B21-SQV-CF-F004GH	3.60E-05	8.29E-04	24.03	CCF OF DPV G AND H TO OPEN
B21-SRV-CF-6OPEN	1.90E-04	2.20E-04	2.15	CCF TO OPEN 6 SRVS
B21-UV_-CC-F102A	1.60E-03	5.29E-03	4.3	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F102B	1.60E-03	5.40E-03	4.37	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103A	1.60E-03	5.29E-03	4.3	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F103B	1.60E-03	5.40E-03	4.37	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
B21-XHE-FO-6OPEN	1.61E-03	4.72E-03	3.93	OPERATOR FAILS TO OPEN 6/10 SRVS
C12-MCB-OO-C001B	1.00E-03	1.52E-03	2.52	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
C12-MOV-CC-F014A	4.00E-03	7.10E-03	2.77	MOTOR OPER. VALVE F014A FAILS TO OPEN
C12-MOV-CC-F014B	4.00E-03	6.41E-03	2.6	MOTOR OPER. VALVE F014B FAILS TO OPEN

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
C12-MOV-CC-F020A	4.00E-03	7.06E-03	2.76	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	6.37E-03	2.59	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-CF-OPEN	1.78E-04	3.40E-04	2.91	CCF MOV TO OPEN
C12-MOV-FC-F020A	3.13E-03	5.48E-03	2.75	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	4.98E-03	2.59	FLOW CONTROL B FAILS WIDE OPEN
C12-MP_-FS-C001BOIL	2.40E-03	3.76E-03	2.56	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
C12-MPC-FS-C001B	2.40E-03	3.76E-03	2.56	MOTOR-DRIVEN PUMP C001B FAILS TO START
C12-OR_-PG-D007A	6.48E-04	9.66E-04	2.49	ORIFICE D007A FAILS TO REMAIN OPEN (PLUG)
C12-OR_-PG-D007B	6.48E-04	9.24E-04	2.43	ORIFICE D007B FAILS TO REMAIN OPEN (PLUG)
C12-SYS-TM-TRAINB	3.00E-03	4.70E-03	2.56	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	5.40E-03	4.37	CHECK VALVE F022 FAILS TO OPEN
C12-XHE-FO-LEVEL2	3.22E-02	3.07E-04	1.01	MANUAL ACTUATION FAILURE
C12-XHE-MH-F003B	1.20E-02	2.04E-02	2.68	MISPOSITION OF VALVE F003B
C12-XHE-MH-F013A	4.80E-02	9.88E-02	2.96	MISPOSITION OF VALVE F013A
C12-XHE-MH-F013B	4.80E-02	8.65E-02	2.71	MISPOSITION OF VALVE F013B
C12-XHE-MH-F015A	4.80E-02	9.88E-02	2.96	MISPOSITION OF VALVE F015A
C12-XHE-MH-F015B	4.80E-02	8.65E-02	2.71	MISPOSITION OF VALVE F015B
C12-XHE-MH-F018A	1.20E-02	2.31E-02	2.9	MISPOSITION OF VALVE F018A
C12-XHE-MH-F018B	1.20E-02	2.04E-02	2.68	MISPOSITION OF VALVE F018B
C12-XHE-MH-F021A	1.20E-02	2.31E-02	2.9	MISPOSITION OF VALVE F021A
C12-XHE-MH-F021B	1.20E-02	2.04E-02	2.68	MISPOSITION OF VALVE F021B
C51-ACT-CF-APRMSTUCK	2.10E-07	3.95E-03	1.88E+04	CCF APRM DETECTORS STUCK AT POWER LEVEL

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
C62-DTM-CF-N1EALL	5.50E-05	1.83E-04	4.33	CCF OF DIGITAL TRIP MODULES NO 1E
C62-VLU-CF-DIDALL	3.12E-05	4.44E-04	15.24	CCF OF VOTER LOGIC UNITS
C72-DTM-FC-DPSDIV1	6.00E-04	8.93E-05	1.15	DTM OF DPS DIV. 1 FAILS TO TRIP
C72-DTM-FC-DPSDIV2	6.00E-04	8.93E-05	1.15	DTM OF DPV DIV. 2 FAILS TO TRIP
C72-DTM-FC-DPSDIV3	6.00E-04	8.39E-04	2.4	DTM OF DPS DIV. 3 FAILS TO TRIP
C72-DTM-FC-DPSDIV4	6.00E-04	8.39E-04	2.4	DTM OF DPS DIV. 4 FAILS TO TRIP
C72-VLU-CF-DPSALL	3.12E-06	4.38E-04	141.33	CCF OF VOTER LOGIC UNITS
C74-DTM-CF-ALL	1.20E-05	1.33E-02	1.11E+03	CCF 3/4 DTM OF SSLC DIV1/2/3/4
C74-DTM-FC-DIV1	6.00E-04	1.17E-02	20.48	DTM OF SSLC DIV. 1 FAILS TO TRIP
C74-DTM-FC-DIV2	6.00E-04	1.13E-02	19.81	DTM OF SSLC DIV. 2 FAILS TO TRIP
C74-DTM-FC-DIV3	6.00E-04	6.34E-02	106.6	DTM OF SSLC DIV. 3 FAILS TO TRIP
C74-DTM-FC-DIV4	6.00E-04	6.29E-02	105.72	DTM OF SSLC DIV. 4 FAILS TO TRIP
C74-VLU-CF-ALL	3.12E-06	3.46E-03	1.11E+03	CCF OF VOTER LOGIC UNITS
E50-MP_-TM-POOLB	1.00E-02	1.53E-03	1.15	
E50-OR_-CF-7PLUG	7.00E-08	2.45E-05	351.02	CCF OF 7 ORIFICES TO PLUG
E50-OR_-CF-PLUGALL	7.20E-08	2.52E-05	350.99	CCF OF ALL ORIFICES TO PLUG
E50-SQV-CC-F002A	3.00E-03	3.41E-04	1.11	SQUIB VALVE F002A FAILS TO OPERATE
E50-SQV-CC-F002D	3.00E-03	3.41E-04	1.11	SQUIB VALVE F002D FAILS TO OPERATE
E50-SQV-CC-F002E	3.00E-03	3.41E-04	1.11	SQUIB VALVE F002E FAILS TO OPERATE
E50-SQV-CC-F002H	3.00E-03	3.41E-04	1.11	SQUIB VALVE F002H FAILS TO OPERATE
E50-SQV-CF-GDCS7OPEN	1.50E-05	3.34E-02	2.22E+03	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
E50-SQV-CF-OPENALL	1.50E-05	3.34E-02	2.22E+03	CCF OF ALL SQUIB VALVES TO OPEN
E50-SQV-CO-F009A	3.50E-03	1.06E-03	1.3	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
E50-SQV-CO-F009B	3.50E-03	8.19E-04	1.23	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
E50-SQV-CO-F009C	3.50E-03	8.19E-04	1.23	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
E50-SQV-CO-F009D	3.50E-03	8.06E-04	1.23	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
E50-SQV-CO-F009E	3.50E-03	1.06E-03	1.3	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
E50-SQV-CO-F009F	3.50E-03	8.19E-04	1.23	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
E50-SQV-CO-F009G	3.50E-03	8.19E-04	1.23	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
E50-SQV-CO-F009H	3.50E-03	8.06E-04	1.23	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
E50-SQV-CO-F009I	3.50E-03	1.06E-03	1.3	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
E50-SQV-CO-F009J	3.50E-03	8.19E-04	1.23	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
E50-SQV-CO-F009K	3.50E-03	8.19E-04	1.23	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
E50-SQV-CO-F009L	3.50E-03	8.06E-04	1.23	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
E50-UV_-OC-F003A	1.75E-03	6.42E-05	1.04	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003D	1.75E-03	6.42E-05	1.04	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003E	1.75E-03	6.42E-05	1.04	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003H	1.75E-03	6.42E-05	1.04	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
E50-XHE-FO-GDCS	1.61E-03	4.20E-04	1.26	OPERATOR FAILS TO ACTUATE GDCS
EB-DAMPER	7.40E-03	1.67E-02	3.24	FIRE BARRIER IN ELECTRICAL BUILDING FAILS
FIRE-CONTROL-ROOM-M5	3.80E-04	1.06E-05	1.03	
FIRE-CONTROL-ROOM-M6	9.43E-05	1.96E-03	21.8	
FIRE-NON-DIVISIONAL-REDA-M5	2.20E-03	3.39E-05	1.02	
FIRE-NON-DIVISIONAL-REDA-M6	5.45E-04	8.25E-03	16.12	
FIRE-NON-DIVISIONAL-REDB-M5	2.20E-03	3.39E-05	1.02	
FIRE-NON-DIVISIONAL-REDB-M6	5.54E-04	8.38E-03	16.12	

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
FIRE-REACT-BUILD-DIVIII-M5	1.12E-03	1.56E-01	139.77	
FIRE-REACT-BUILD-DIVIII-M6	2.80E-04	2.59E-03	10.23	
FIRE-REACT-BUILD-DIVII-M5	1.12E-03	3.32E-01	295.87	
FIRE-REACT-BUILD-DIVII-M6	2.80E-04	1.95E-03	7.96	
FIRE-REACT-BUILD-DIVI-M5	1.12E-03	3.11E-01	276.79	
FIRE-REACT-BUILD-DIVI-M6	2.80E-04	1.95E-03	7.96	
FIRE-REACT-BUILD-DIVIV-M5	1.12E-03	1.73E-01	154.82	
FIRE-REACT-BUILD-DIVIV-M6	2.80E-04	2.59E-03	10.23	
G21-ACV-CC-F332	2.00E-03	6.93E-03	4.46	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-UV_-CC-F333	1.60E-03	5.29E-03	4.3	CHECK VALVE F333 FAILS TO OPEN
G21-UV_-OC-F331	2.16E-04	2.49E-04	2.15	CHECK VALVE F331 FAILS TO CLOSE
G21-UV_-TM-F332/333	8.00E-04	2.29E-03	3.86	MAINTENANCE FOR CV F332 OR CV F333
G21-XHE-MH-F334	4.80E-02	2.11E-01	5.18	MISPOSITION OF VALVE F334
H23-EMS-CF-ALL	1.80E-06	1.97E-03	1.10E+03	CCF OF ESSENTIAL MULTIPLEXING SYSTEM DIV 1/2/3/4
H23-EMS-CF-DPSALL	1.80E-06	2.12E-04	118.75	CCF OF ESSENTIAL MULTIPLEXING SYSTEM DIV 1/2/3/4
H23-EMS-FC-DIV1	6.00E-04	1.32E-02	22.94	ESSENTIAL MULTIPLEXING SYSTEM DIV 1 FAILS TO FUNCTION
H23-EMS-FC-DIV2	6.00E-04	1.28E-02	22.26	ESSENTIAL MULTIPLEXING SYSTEM DIV 2 FAILS TO FUNCTION
H23-EMS-FC-DIV3	6.00E-04	7.02E-02	117.99	ESSENTIAL MULTIPLEXING SYSTEM DIV 3 FAILS TO FUNCTION
H23-EMS-FC-DIV4	6.00E-04	6.29E-02	105.72	ESSENTIAL MULTIPLEXING SYSTEM DIV 4 FAILS TO FUNCTION
H23-EMS-FC-DIVCN1E	6.00E-04	4.97E-04	1.83	ESSENTIAL MULTIPLEXING SYSTEM DIV C (N1E) FAILS TO FUNCTION
H23-EMS-FC-DPSDIV1	6.00E-04	8.93E-05	1.15	ESSENTIAL MULTIPLEXING SYSTEM DPS DIV 1 FAILS TO FUNCTION
H23-EMS-FC-DPSDIV2	6.00E-04	8.93E-05	1.15	ESSENTIAL MULTIPLEXING SYSTEM DPS DIV 2 FAILS TO FUNCTION
H23-EMS-FC-DPSDIV3	6.00E-04	8.72E-04	2.45	ESSENTIAL MULTIPLEXING SYSTEM DPS DIV 3 FAILS TO FUNCTION

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
H23-EMS-FC-DPSDIV4	6.00E-04	8.72E-04	2.45	ESSENTIAL MULTIPLEXING SYSTEM DPS DIV 4 FAILS TO FUNCTION
H23-RMU-CF-ALL	9.00E-07	8.96E-04	996.18	CCF OF REMOTE MULTIPLEXING UNITS TO OPERATE
H23-RMU-CF-DPSALL	9.00E-07	8.16E-05	91.7	CCF OF REMOTE MULTIPLEXING UNITS TO OPERATE
H23-RMU-FC-DIV1	3.00E-04	5.42E-03	19.06	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DIV2	3.00E-04	5.27E-03	18.58	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DIV3	3.00E-04	3.14E-02	105.73	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DIV4	3.00E-04	3.12E-02	104.92	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DPSDIV3	3.00E-04	4.11E-04	2.37	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-DPSDIV4	3.00E-04	4.11E-04	2.37	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF13	3.00E-04	3.48E-03	12.59	1ST DIV III ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF14	3.00E-04	2.23E-04	1.74	1ST DIV IV ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF1CN1E	3.00E-04	1.04E-04	1.35	1ST DIV C (N1E) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF23	3.00E-04	3.48E-03	12.59	2ND DIVIII ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF24	3.00E-04	2.23E-04	1.74	2ND DIVIII ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF2CN1E	3.00E-04	1.04E-04	1.35	2ND DIV C (N1E) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
N21-ACV-CC-F023	1.58E-02	8.68E-05	1.01	AIR OPERATED VALVE N21-F023 FAILS TO OPEN
N21-ACV-CC-F026	1.58E-02	8.68E-05	1.01	AIR OPERATED VALVE N21-F026 FAILS TO OPEN
N21-ACV-OC-F018	1.31E-03	1.27E-03	1.97	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
N21-MPF-FS-C001A	4.70E-01	1.15E-04	1	
N21-MPF-FS-C001B	4.70E-01	1.15E-04	1	
N21-MPF-FS-C001C	4.70E-01	1.15E-04	1	
N21-MPF-FS-C001D	2.00E-03	5.76E-05	1.03	MOTOR-DRIVEN FEEDWATER PUMP D FAILS TO RESTART
N21-MPF-TM-C001D	2.00E-03	5.76E-05	1.03	FEEDWATER PUMP BRANCH D IN MAINTENANCE

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
N21-XHE-FO-CONDPUMPD	2.69E-01	5.30E-01	2.44	OPERATOR FAILS TO START CONDENSATE PUMP D
N21-XHE-FO-FWPUMPD	2.69E-01	4.38E-01	2.19	OPERATOR FAILS TO START FEEDWATER PUMP D
P22-ACV-FT-BYPASS	2.00E-03	2.21E-03	2.1	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
P30-UV_-CC-CV01T	2.00E-04	1.79E-04	1.89	CHECK VALVE CV01T FAILS TO OPEN
P30-XHE-MH-F015	4.80E-02	9.24E-02	2.83	MISPOSITION OF VALVE F01T
P51-ACV-CC-F008A	2.00E-03	1.17E-05	1.01	AIR OPERATED VALVE F008A FAILS TO OP. TO DEENERG. POSIT.
P51-ACV-CC-F010C	2.00E-03	1.17E-05	1.01	AOV F010C FAILS TO OPERATE TO NOT DEENERG. POSITION
P51-CMP-CR-RUN	1.49E-04	4.13E-05	1.28	CCF OF P51 COMPRESSORS TO RUN
P54-CPV-CF-CONTROL	1.57E-04	1.81E-04	2.15	CCF OF PRESSURE CONTROL VALVES FAILURES
P54-PS_-CO-PS001	1.19E-04	1.10E-04	1.92	PRESSURE SWITCH PS001 (PT001) OPERATES SPURIOUSLY
R10-CBU-FC-PRE500KV	7.20E-05	1.36E-04	2.89	500KV TRANSMISSION LINE FAILS
R13-BAC-LP-R1311	4.80E-06	4.31E-04	90.71	BUS R13-31 FAILS DURING OPERATION
R13-BAC-LP-R13111	4.80E-06	3.86E-04	81.47	BUS R13-11-1 FAILS DURING OPERATION
R13-BAC-LP-R1321	4.80E-06	4.31E-04	90.71	BUS R13-21 FAILS DURING OPERATION
R13-BAC-LP-R13211	4.80E-06	3.86E-04	81.47	BUS R13-21-1 FAILS DURING OPERATION
R13-BAC-LP-R1331	4.80E-06	4.31E-04	90.71	BUS R13-31 FAILS DURING OPERATION
R13-BAC-LP-R13311	4.80E-06	4.31E-04	90.71	BUS R13-31-1 FAILS DURING OPERATION
R13-BAC-LP-R1341	4.80E-06	4.31E-04	90.71	BUS R13-41 FAILS DURING OPERATION
R13-BAC-LP-R13411	4.80E-06	4.31E-04	90.71	BUS R13-41-1 FAILS DURING OPERATION
R13-INV-FC-R1311	4.80E-04	2.34E-05	1.05	INVERTER TO R13-11 FAILS
R13-INV-FC-R1321	4.80E-04	2.34E-05	1.05	INVERTER TO R13-21 FAILS
R13-INV-FC-R1331	4.80E-04	2.34E-05	1.05	INVERTER TO R13-31 FAILS

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
R13-INV-FC-R1341	4.80E-04	2.34E-05	1.05	INVERTER TO R13-41 FAILS
R13-LCB-CO-FR13111	1.44E-05	1.31E-03	92.22	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13112	1.44E-05	8.70E-05	7.03	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13211	1.44E-05	1.23E-03	86.19	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13311	1.44E-05	1.45E-03	101.46	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13312	1.44E-05	8.70E-05	7.03	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13411	1.44E-05	1.36E-03	95.43	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13111	1.44E-05	1.31E-03	92.22	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13112	1.44E-05	8.70E-05	7.03	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13211	1.44E-05	1.23E-03	86.19	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13311	1.44E-05	1.45E-03	101.46	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13312	1.44E-05	8.70E-05	7.03	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13411	1.44E-05	1.36E-03	95.43	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-TOR1311	1.44E-05	1.45E-03	101.46	CIRCUIT BREAKER TO R13-11 OPENS SPURIOUSLY
R13-LCB-CO-TOR1321	1.44E-05	1.36E-03	95.43	CIRCUIT BREAKER TO R13-21 OPENS SPURIOUSLY
R13-LCB-CO-TOR1331	1.44E-05	1.45E-03	101.46	CIRCUIT BREAKER TO R13-31 OPENS SPURIOUSLY
R13-LCB-CO-TOR1341	1.44E-05	1.36E-03	95.43	CIRCUIT BREAKER TO R13-41 OPENS SPURIOUSLY
R13-SEL-FT-A31R1311	7.88E-04	2.34E-05	1.03	AUTOMATIC SELECTOR FAILS TO TRANSFER
R13-SEL-FT-B31R1321	7.88E-04	2.34E-05	1.03	AUTOMATIC SELECTOR FAILS TO TRANSFER
R13-SEL-FT-C31R1331	7.88E-04	2.34E-05	1.03	AUTOMATIC SELECTOR FAILS TO TRANSFER
R13-SEL-FT-D31R1341	7.88E-04	2.34E-05	1.03	AUTOMATIC SELECTOR FAILS TO TRANSFER
R13-XFL-LP-R13111	1.92E-05	1.76E-03	92.68	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13112	1.92E-05	1.16E-04	7.03	TRANSFORMER FAILS DURING OPERATION

Table 12-20

Internal Fire Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Fire Shutdown
Core Damage Frequency = 2.32E-08/year

Event Name	Probability	F-V	RAW	Description
R13-XFL-LP-R13211	1.92E-05	1.64E-03	86.65	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13311	1.92E-05	1.94E-03	101.92	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13312	1.92E-05	1.16E-04	7.03	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13411	1.92E-05	1.82E-03	95.89	TRANSFORMER FAILS DURING OPERATION
R16-BT_-CF-ALLBATT	9.00E-06	3.35E-03	373.65	BATTERY CCF #2
RB-DAMPER	7.40E-03	8.29E-01	112.15	FIRE BARRIER IN REACTOR BUILDING FAILS
U43-SYS-FF-LPCI	2.40E-02	8.95E-02	4.64	U43 HARDWARE FAILURES
U43-SYS-FF-YARD	2.00E-03	2.52E-05	1.01	HARDWARE FAILURES IN YARD AREA
U43-XHE-FO-LPCI	1.61E-03	4.87E-03	4.02	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE
U43-XHE-FO-LPCIADS	1.61E-02	8.60E-04	1.05	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
U43-XHE-FO-YARD	1.77E-03	2.23E-05	1.01	OPERATOR FAILS TO MAKE UP FROM YARD AREA
XXX-XHE-FO-DEPRESS	1.61E-01	6.34E-01	4.3	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
XXX-XHE-FO-ICPCCS	1.61E-03	2.03E-05	1.01	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
XXX-XHE-FO-LPMAKEUP	1.61E-01	2.34E-02	1.12	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
XXX-XHE-FO-RPVLDE	1.61E-02	9.51E-03	1.58	OP. FAILS TO RECOG. OR CHECK THE RPV DECREASING LEVEL

13 PROBABILISTIC FLOOD ANALYSIS

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13 PROBABILISTIC FLOOD ANALYSIS

This section documents the internal flooding analysis of the ESBWR PRA.

13.1 INTRODUCTION

The objective of the ESBWR internal probabilistic flood analysis is to identify and provide a quantitative assessment of the core damage frequency due to internal flood events. It models potential flood vulnerabilities, in conjunction with random failures modeled as part of the internal events PRA. Through this process, flood vulnerabilities that could jeopardize core integrity are identified.

The floods may be caused by large leaks due to rupture or cracking of pipes, piping components, or water containers such as storage tanks. Other possible flooding causes are the operation of fire protection equipment and human errors during maintenance. The spraying or dripping of water from pipe breaks or fire protection equipment onto equipment is also considered in the analysis assuming the loss of all the components that can be affected by the water and are located in the sprayed zone.

The scope of the analysis includes both at-power and shutdown flood-induced accident scenarios.

13.2 METHODOLOGY

The internal probabilistic flood analysis is performed taking into account that piping layout specifics are not known. Therefore, a simplified probabilistic flooding approach is employed using general design assumptions to identify potential flooding vulnerabilities.

A flooding event may result in an initiating event and may also disable mitigating systems. As such, buildings containing mitigating equipment credited in the PRA accident sequence analysis, or equipment whose loss could cause an initiating event, are of interest to the flooding analysis. Therefore, this analysis considers flood scenarios in the following buildings:

- Reactor Building
- Control Building
- Fuel Building
- Turbine Building
- Electrical Building
- Service Water Building
- Tunnels and Galleries connected with the buildings indicated above.

Floods in the remaining ESBWR buildings are not considered in the study because the flood water cannot propagate to any of the above buildings.

The frequencies of flood scenarios in these buildings are based on generic information.

The analysis considers aspects that affect flood progression in each building. Depending on the building and the origin of the flood, the following aspects are considered:

- Automatic flood detection systems
- Automatic systems to terminate flooding
- Watertight doors to prevent the progression of flooding
- Other design or construction characteristics that contribute to minimize the consequences of flooding

The systems inside each building that could represent a flood source are considered. From these systems, the building flood source that presents the most critical characteristics for flood progression and which has the capacity to damage mitigation equipment is chosen.

The following general assumptions are used in the analysis:

(1) Flooding resulting from component ruptures, maintenance actions and spurious system actuations is considered in this analysis.

(2) For each storage tank rupture, it is assumed that the entire tank inventory is drained.

(3) For this analysis, non-qualified submerging equipment (motors or solenoids for valves, control cabinets and circuitry) is assumed to result in equipment failure. Also, water intrusion from non-qualified equipment being sprayed or splashed results in equipment failure unless it can be otherwise justified.

(4) The expected effect of spraying or flooding electrical equipment such as motor control centers, electrical cabinets, and terminal boxes, is a short to ground, removing power from the loads served by the component This analysis addresses all such failures of electrical equipment as ground shorts.

(5) Water-induced failure of air-operated valves (AOVs) causes the valve to move to the deenergized position.

(6) Motor-operated valves (MOVs) require the application of current to the motor to change the valve position. Without power, the valve will remain in its current position. Flooding and/or spraying of a motor-operated valve will therefore cause the valve to fail as is.

(7) Passive components, such as check valves, pipes, and tanks are not considered to be vulnerable to flooding effects.

(8) Flooding has no effect on test and maintenance unavailability. Additional testing and maintenance may be required after a flood. Prior to and during a flood, the unavailability of equipment from test and maintenance is unaffected by flooding.

(9) Flooding has no effect on common cause failures from a design point of view. The flooding itself may be considered a common cause failure in that it can result in the simultaneous failure of several components. In addition, flooding may have an effect on future common cause failures; however, all equipment affected by a flood is assumed tested, repaired and/or replaced as necessary. Therefore, the effects of flooding on future common cause failures are not evaluated.

(10) Water in a stairwell or propagating into a stairwell preferentially continues to travel down the stairwell as opposed to propagating under a door leading outside the stairwell.

(11) The mission time of the flooding risk analysis is 24 hours.

(12) Concurrent spray and flooding events from different sources are not considered in the flooding analysis.

(13) Components that are environmentally qualified are considered to be invulnerable to the effects of spraying. Some components are qualified for safe operation in submersion environments.

(14) Piping is assumed to develop a double-ended guillotine break. Expansion joints and flex connections are assumed to fail catastrophically.

(15) It is assumed that the interaction of cables with the water can only take place at their unconnected ends and, therefore, their insulation is not lost at any other point of their routing.

(16) Flooding effects on termination and junction boxes are considered; however, flooding effects are not considered to affect power or the instrument cables between terminations or junction boxes.

(17) The internal flooding analysis uses the same systemic success criteria as used in the internal events PRA.

(18) Electrical connections in the termination boxes on the containment wall are adequately protected to prevent water spray-induced failure.

(19) The solenoid valve associated with an air-operated valve is located in the vicinity of the air-operated valve.

(20) Fire doors are not watertight.

(21) No credit is taken for operation of sump pumps to mitigate the consequences of flooding.

(22) Walls are assumed to be capable of withstanding the expected maximum flood loading. Therefore, walls are assumed to remain intact throughout a flooding event.

(23) It is assumed that electrical circuit fault protection has been designed to provide protection for plant electric circuits via protective relaying, circuit breakers, and fuses. Therefore, loss of a component due to flooding will not result in the loss of the bus that supplies power to the affected component.

(24) Safety-related Class 1E electrical equipment will be qualified for environmental conditions in which they are required to function, including water spray. Containment isolation valves located inside containment are not evaluated for spray-induced failure with respect to containment isolation because they will be qualified for the environmental conditions in which they are required to function.

(25) For floor drains, appropriate precautions such as check valves, back flow preventers, and siphon breaks are assumed to prevent back flow and any potential flooding.

(26) In the Control Building it is assumed that the only wet pipe sections of the FPS are located in the stairwells. Said sections are those running between the building walls and the hose stations and their length never exceeds 2 feet for any hose station.

(27) It is assumed that the doors that connect the Control and Reactor Buildings with the Electrical Building galleries are watertight, for flooding of the galleries up to the ground level elevation. It is also assumed that the watertight doors are normally closed. Opening of the doors would generate an alarm in the Control Room, and procedures direct their immediate closure upon receipt of an alarm.

(28) It is assumed that the operation of the components located in Containment would not be affected in the event of a LOCA or if the Drywell was flooded to a level equivalent to the level of the suppression pool.

(29) It is assumed that the opening of the hatches, which communicate the Containment with others buildings, would be carried out in Mode 6-Flooded (Reactor Well flooded). The time interval during which the Drywell atmosphere and the atmosphere of other buildings are communicated through hatches is sufficiently short such that Containment flood scenarios involving an open Containment are non-significant.

(30) The feedwater and condensate systems are assumed unavailable in shutdown and during Modes 5 and 6.

(31) It is assumed that, during shutdown, manual and automatic depressurization (ADS) of the vessel are available while the vessel head is in place.

(32) It is assumed that none of the FPS pipes located in the Electrical or Turbine Buildings has the capacity to affect the operation of the RCCWS.

(33) It is assumed that the actuation of the GDCS due to an RPV Level 1 water level signal is available during the entire shutdown period.

(34) It is assumed that 480V AC power centers A1, A2, B1, B2 and C are located at El. 22000 of the Electrical Building.

(35) It is assumed that the FPS pipes routed inside the Electrical Building are designed such that the water released in the event of an FPS pipe break above elevation 13000 does not affect simultaneously the 13.8 kV buses A1, B1, C1 and D1.

(36) It is assumed that the volume of water available to the FPS from the primary source and the secondary supply is less than 5400 m3.

(37) It is assumed that the cable tunnels between the Reactor and Control Buildings are located at an elevation above -5000.

(38) Any flooding event in a given building is assumed to be the worst case flood possible (i.e., a double ended shear of the largest pipe). This is a conservative assumption because, in general, most floods result in leaks, not double ended breaks.

(39) In the Turbine building rooms located above elevation 4650 where components with the potential to result in complete loss of RCCWS and complete loss of Air systems are located, no pipes other than those related to the operation of these systems are routed.

(40) Dry pipe systems (such as a pre-action FPS system) are not modeled as flood sources due to the low frequency of a failure of the dry pipe coincident with spurious opening of the actuation valve.

The core damage frequency for each flood damage state is obtained via the quantification of the internal event PRA models. The internal event initiator and associated accident sequence structure that best represents the flood progression is used to model the flood. The damage caused by the flood is input into the accident sequence quantification by use of the selected initiator and/or with modifications to the accident sequence nodal fault trees, as appropriate.

This analysis is a bounding approach that begins by assigning a flood initiation frequency to every flood scenario in a building that is equal to the entire flood initiation frequency for that building. Following the accident sequence quantification, the flood scenario with the highest CDF in each building is used to represent the flood CDF for that building. The total flood risk is the sum of the CDFs of the bounding flood scenario for each building.

The flooding scenarios considered in each building are discussed in more detail in Section 13.5 below.

13.3 FLOOD SOURCES

The plant systems through which water flows and which have components located in the above-mentioned buildings (excluding Containment) are the following:

- Control Rod Drive System (CRDS)
- Standby Liquid Control System (SLCS)
- Fuel and Auxiliary Pools Cooling System (FAPCS)
- Reactor Water Cleanup and Shutdown Cooling System (RWCU/SDCS)
- Condensate and Feedwater System (C&FS)
- Make Up Water System (MWS)
- Reactor Component Cooling Water (RCCWS)
- Turbine Component Cooling Water (TCCWS)
- Chiller Water System (CWS)
- Process Sampling System (PSS)
- Condensate Storage and Transfer System (CS&TS)
- Plant Service Water System (PSWS)
- Hot Water System (HWS)
- Potable Water and Sanitary Waste System (PWSWS)
- Fire Protection System (FPS)
- Circulating Water System (CIRC)

Components inside Containment considered in the flooding analysis as potential flood sources are those in which a break would cause a LOCA. LOCA scenarios in Containment are already modeled in the internal events PRA analysis and as such are not analyzed in the internal flooding analysis. Therefore, there are no flood scenarios in Containment that are analyzed further in the internal flooding analysis.

13.4 FLOODING FREQUENCIES

Section 13.4.1 documents the flood initiating event frequency calculations for at-power operation.

Section 13.4.2 documents the flood initiating event frequency calculations for shutdown conditions.

13.4.1 At-Power Flooding Frequencies

The ESBWR PRA at power flooding initiating frequencies are based on generic information contained in NUREG/CR-5750 (Ref. 13-1) and NUREG/CR-2300 (Ref. 13-2). Refer to Table 13-1 for the at-power flooding frequencies used in this analysis.

In the Turbine building flood analysis, it is assumed that the worst flood results from a break in the circulating water system. The frequency of flooding due to circulating water system failures is obtained from "medium-large flood frequency derived in Section 11 of NUREG/CR-2300 (Reference 13-2). The NUREG/CR-2300 "medium-large" flood is defined as one resulting in the release of several thousands of gallons of water. Therefore, it is judged that the use of the NUREG/CR-2300 "medium-large" flood frequency to represent complete breakage of a CWS expansion joint or pipe is conservative.

13.4.2 Shutdown Flooding Frequencies

The flooding frequency per calendar year during shutdown in BWR plants is obtained by dividing the number of floods that have occurred during shutdown by the total number of years of US BWR industry commercial operation.

The number of floods that have occurred during shutdown in BWR plants is obtained from the information contained in the Nuclear Power Experience database (Ref.13-3). Based on this information, flooding events that have occurred during shutdown at US BWR plants up through August 1996 have been identified. These events are summarized in Table 13-2.

The flooding events to be used in the determination of the flooding frequency during shutdown only include those that occurred during commercial operation of the plant. Excluding initiating event experience data covering non-commercial operation phases of plant life is appropriate and a standard PRA practice. As such, some of the flood events summarized in Table 13-2 are excluded from the initiating event frequency analysis because they occurred outside the period of commercial operation of the plants (see Note 1 to Table 13-2).

Consequently, the floods considered for calculating the flooding frequencies during shutdown are the remaining 21.

As can be seen from Table 13-2, twenty-one (21) flood events are maintained for calculation of the shutdown flood initiating event frequencies. The distribution of these flood events, as a function of the building in which they started, is as follows:

- Reactor building 8
- Auxiliary building 6
- Turbine building 4

- Transformer area 1
- Other buildings 2

The number of operational years for US BWR plants up through August 1996 is 668.58 years (Ref.13-4).

According to Appendix C, page C-10; of NUREG/CR-5496 (Ref. 13-5), the calendar, critical and outage years for the 1980-1996 period (USA NPPs) are 1644.345 (calendar years), 1188.836 (critical years) and 455.509 (outage years). Therefore, the generic probability of being in outage in a calendar year is estimated here as:

$$\frac{455.509}{1644.345} = 0.28$$

Therefore, the number of US BWR shutdown years up through 1996 is estimated as:

668.58 years x 0.28 = 187.20 shutdown years

The flooding frequencies per shutdown year for the different buildings are:

Reactor building $\frac{8}{187.20}$ = 4.27E-02 per shutdown year

Auxiliary building $\frac{6}{187.20}$ = 3.21E-02 per shutdown year

Turbine building $\frac{4}{187.20}$ = 2.14E-02 per shutdown year

Transformer area $\frac{1}{187.20}$ = 5.34E-03 per shutdown year

Other buildings $\frac{2}{187.20}$ = 1.07E-02 per shutdown year

Only one refueling outage every two years is expected in the ESBW design and, according to Section 16.2-1, the expected refueling outage duration is 546 hours. Therefore, the portion of the calendar year in which the ESBWR power plant is in a refueling outage is calculated as:

$$\frac{546}{2 \times 8760} = 0.0312$$

The generic flooding frequencies per calendar year for the different buildings in the ESBWR are:

- Reactor building 4.27E-02 x 0.0312 = 1.33E-03 per calendar year
- Auxiliary building 3.21E-02 x 0.0312 = 1.00E-03 per calendar year

- Turbine building 2.14E-02 x 0.0312 = 6.68E-04 per calendar year
- Transformer area 5.34E-03 x 0.0312 = 1.67E-04 per calendar year
- Other buildings 1.07E-02 x 0.0312 = 3.34E-04 per calendar year

From Figure 16.2-1, the period of time for each operation mode during the outage can be obtained:

- MODE 5 238 hours
- MODE 6 (Unflooded) 59 hours
- MODE 6 (Flooded) 241 hours

The generic shutdown flooding frequencies per calendar year and per operational mode for the different buildings in the ESBWR are calculated as follows:

Reactor Building

MODE 5 $1.33E\text{-}03 \times \frac{238}{546} = 5.80E\text{-}04$ per calendar year

MODE 6 (Unflooded) $1.33E\text{-}03 \times \frac{59}{546} = 1.44E\text{-}04$ per calendar year

MODE 6 (Flooded) $1.33E\text{-}03 \times \frac{241}{546} = 5.87E\text{-}04$ per calendar year

Auxiliary Building

MODE 5 $1.00E\text{-}03 \times \frac{238}{546} = 4.36E\text{-}04$ per calendar year

MODE 6 (Unflooded) $1.00E\text{-}03 \times \frac{59}{546} = 1.08E\text{-}04$ per calendar year

MODE 6 (Flooded) $1.00E\text{-}03 \times \frac{241}{546} = 4.41E\text{-}04$ per calendar year

Turbine Building

MODE 5 $6.68E\text{-}04 \times \frac{238}{546} = 2.91E\text{-}04$ per calendar year

MODE 6 (Unflooded) $6.68E\text{-}04 \times \frac{59}{546} = 7.22E\text{-}05$ per calendar year

MODE 6 (Flooded) $6.68E\text{-}04 \times \frac{241}{546} = 2.95E\text{-}04$ per calendar year

Transformer Area

MODE 5 $1.67E\text{-}04 \times \frac{238}{546} = 7.28E\text{-}05$ per calendar year

MODE 6 (Unflooded) $1.67E\text{-}04 \times \frac{59}{546} = 1.80E\text{-}05$ per calendar year

MODE 6 (Flooded) $1.67E\text{-}04 \times \frac{241}{546} = 7.37E\text{-}05$ per calendar year

Other Buildings

MODE 5 $3.34E\text{-}04 \times \frac{238}{546} = 1.46E\text{-}04$ per calendar year

MODE 6 (Unflooded) $3.34E\text{-}04 \times \frac{59}{546} = 3.61E\text{-}05$ per calendar year

MODE 6 (Flooded) $3.34E\text{-}04 \times \frac{241}{546} = 1.47E\text{-}04$ per calendar year

Table 13-3 summarizes the shutdown flood initiating event frequencies used in this analysis.

13.5 ANALYSIS OF FLOODING SCENARIOS

Flooding initiating events are the starting point for flood-induced accident sequence analysis. The magnitude of the flood and the associated plant damage impact from the flood effects determine the appropriate accident sequence analysis. The accident sequence analysis is also determined by the whether the plant is at-power or in an outage.

For postulated flood events occurring at-power, the damage potential of the flood is assessed to determine the appropriate plant initiating event category and associated accident sequence logic to be used to model the accident progression. Refer to Section 2.0 for at-power initiating event categories. The calculated flood initiator frequency and associated equipment impacts are then propagated through the appropriate Level 1 internal events accident sequence logic determined to apply to the flood scenario.

In the case of postulated flood events that occur during shutdown, the accident sequence modeling for the flood considers the flood impacts on the following two critical safety functions during shutdown:

- Decay Heat Removal (DHR)
- Reactor Coolant System Inventory Control

The decay heat removal function during all shutdown modes of operation is provided by the Reactor Water Cleanup/Shutdown Cooling System (RWCU/SDCS) operating in shutdown cooling mode. If the reactor well is flooded (Mode 6-Flooded), the risk associated with loss of decay heat removal is not significant given the very long time it takes to reach coolant boiling. For the other shutdown modes (Modes 5 and 6-Unflooded), one RWCU/SDCS train is sufficient to remove decay heat. Both RWCU/SDCS trains are running during these conditions; as such, failure of one train of RWCU/SDCS does not cause a shutdown.

The reactor coolant system inventory control function is defined as maintenance of the RCS inventory at a level sufficient to sustain decay heat removal. LOCA and RPV draindown events can potentially challenge this critical safety function. They can occur as a result of any of the following:

- Random pipe breaks within the ROCS (including breaks related to maintenance or refueling operations).
- Misalignment of systems connected to the RPV.
- Leakage during FMCRD replacement.

The flooding scenarios analyzed for each building are discussed below.

13.5.1 Reactor Building Flooding Scenarios

All the ESBWR safety systems, the Isolation Condenser, Reactor Depressurization, Gravity Driven Cooling, and Passive Containment Cooling, as well as the DC and Uninterruptible AC distribution system, are contained in the Reactor Building.

The Reactor Building is divided into two major types of areas for this analysis:

- Containment

- Outside Containment

The Containment is isolated from the rest of the Reactor Building during power operation. The lower drywell hatches are only opened, allowing intercommunication between the two areas, during shutdown activities (see Section 16.3.4.4).

Reactor Building areas outside Containment are differentiated as follows for this analysis:

- Controlled access area
- Non-controlled access area

Potential flood sources in the Reactor Building areas outside Containment are due to component failures in the following systems:

- Control Rod Drive System (CRDS)
- Standby Liquid Control System (SLCS)
- Fuel and Auxiliary Pools Cooling System (FAPCS)
- Reactor Water Cleanup and Shutdown Cooling System (RWCU/SDCS)
- Condensate and Feedwater System (C&FS)
- Make Up Water System (MWS)
- Reactor Component Cooling Water (RCCWS)
- Chiller Water System (CWS)
- Condensate Storage and Transfer System (CS&TS)
- Process Sampling System (PSS)
- Fire Protection System (FPS)

The above sources are located in controlled areas on various elevations and in the pipe chases. FPS is also located in the stairwells.

The Reactor Building non-controlled access area is divided into four quadrants, each one containing a safety system division. This group of zones has cabinets and electrical equipment associated with each of the 1E safety divisions. This electrical equipment includes the safety batteries for the DC distribution panels for all the safety equipment. The electrical equipment is distributed in the reactor building on various elevations.

In the case of flooding of the lower floor of the Reactor Building, flood water does not propagate to the lower floor of the Control Building via the cable galleries due to the general arrangement and the design measures provided.

13.5.1.1 Reactor Building At-Power Flooding Scenarios

Containment At-Power Flooding Scenarios

During power operation, the only initiating events that can be produced inside Containment are those due to pipe breaks leading to a LOCA. The components located inside Containment are qualified to perform their functions under the environmental conditions produced by a LOCA

and, therefore, they are not affected by the water released inside Containment. At-power LOCA scenarios inside Containment are not considered further in the flooding analysis as they are already addressed in the internal events analysis.

Reactor Building Outside Containment At-Power Flooding Scenarios

Based on the flood sources and potential impacts, the following flood scenarios are identified for consideration (other flood sources are of limited capacity or impact):

- Loss of power conversion system due to main steam pipe breaks
- Complete loss of feedwater due to feedwater pipe breaks
- Complete Loss of RCCWS due to system pipe breaks
- CRDS system pipe break
- FPS system pipe breaks
- RWCU/SDC line break outside of containment

The main steam and feedwater pipes are located in the steam tunnel. The water released by these breaks propagates toward the Turbine Building without affecting components located inside the Reactor Building. Therefore, these flooding scenarios are addressed in the Turbine Building analysis (refer to Section 13.5.4).

The RCCWS system is a closed system. The volume of available water is relatively small and discharges in the lower floor of the building. RCCWS flood water will not affect equipment other than that affected as a consequence of a loss of the RCCWS system. As such, RCCWS flood scenarios are not considered further in the flooding analysis as they are already encompassed by the loss of RCCWS initiating event in the internal events analysis.

A CRDS pipe break has the potential flood volume of the water stored in the CST. Such a volume is sufficient to completely flood the ground floor of the Reactor and Fuel Buildings, causing a generic transient, loss of vessel water supply functions via CRDS and FAPCS, as well as failure of residual heat removal via the RWCU/SDC system. This flood is maintained in this analysis as Flooding Scenario AP-1. The analysis conservatively does not credit the potential manual isolation of the broken pipe.

Similarly, breaks in the FPS system have the potential for a large available water supply (i.e., the fire protection system water sources). Such a volume is sufficient to completely flood the lower floor of the Reactor and Fuel Buildings, causing a generic transient, loss of vessel water supply functions via FPS and FAPCS, as well as failure of residual heat removal via the RWCU/SDC system. This flood is maintained in this analysis as Flooding Scenario AP-2. The analysis conservatively does not credit the potential manual isolation of the broken pipe.

A line break in the RWCU/SDCS system outside Containment, combined with failure of automatic isolation of the break, will result in flooding the lower floor of the Reactor Building and into the lower floor of the Fuel Building via the door separating the two areas. The flood effects of this postulated flood are failure of the RWCU/SDC and FAPC systems. This flood scenario is maintained in this analysis as Flooding Scenario AP-3.13.5.1 2 Reactor Building Shutdown Flooding Scenarios

Containment Shutdown Flooding Scenarios

As discussed previously, LOCAs inside Containment are already addressed in the internal events analysis. During shutdown conditions, LOCA frequencies are much lower than at-power conditions and as such shutdown LOCAs are non-significant risk contributors and are not analyzed further in this analysis.

During Mode 6 (with the hatches open), water released from a LOCA inside Containment can propagate to the lower floor of the Reactor Building and impact the operation of the RWCU/SDC system. However, given the short time interval during which the hatches are open, and the low LOCA frequencies during shutdown conditions, such scenarios are non-significant risk contributors and not analyzed further in this analysis.

Reactor Building Outside Containment Shutdown Flooding Scenarios

As discussed previously, postulated flood events during shutdown are assessed with respect to their impact on decay heat removal and reactor coolant inventory control.

Loss of Decay Heat Removal

As discussed previously, flood scenarios resulting in failure of decay heat removal are only significant during Modes 5 and 6 (Reactor Well unflooded). Such flood scenarios could occur due to:

- CRDS pipe break
- FPS pipe break
- RCCWS pipe break

A CRDS pipe break has the potential flood volume of the water stored in the CST. Such a volume is sufficient to completely flood the ground floor of the Reactor and Fuel Buildings, causing loss of vessel water supply functions via CRDS and FAPCS, as well as failure of residual heat removal via the RWCU/SDC system. The analysis models two such flood scenarios, one during Mode 5 (Flooding Scenario SD-1) and one during Mode 6 (Flooding Scenario SD-3). The analysis conservatively does not credit the potential manual isolation of the broken pipe.

Similarly, breaks in the FPS system have the potential for a large available water supply (i.e., the fire protection system water sources). Such a volume is sufficient to completely flood the lower floor of the Reactor and Fuel Buildings, causing the loss of vessel water supply functions via FPS and FPACS, as well as failure of residual heat removal via the RWCU/SDC system. The analysis models two such flood scenarios, one during Mode 5 (Flooding Scenario SD-2) and one during Mode 6 (Flooding Scenario SD-4). The analysis conservatively does not credit the potential manual isolation of the broken pipe.

As discussed previously, a break in the RCCWS system has the only impact of failing RCCWS. Such scenarios are already addressed in the internal events shutdown analysis (refer to Section 16).

Reactor Coolant System Inventory Control

As discussed previously, LOCAs inside containment during shutdown are non-significant risk contributors and are not evaluated further. Those flood scenarios that can significantly impact

the coolant inventory function during shutdown are those involving RWCU/SDCS pipe breaks with automatic isolation failure. Such scenarios will result in flooding the lower floor or the Reactor Building and into the lower floor of the Fuel Building via the door separating the two areas. The flood effects of an unisolated RWCU/SDCS system break are failure of the RWCU/SDC and FAPC systems.

The flooding analysis models three RWCU/SDCS flood scenarios during shutdown in the Reactor Building, one during Mode 5 (Flooding Scenarios SD-5), a second during Mode 6-Unflooded (Flooding Scenario SD-6a) and a third during Mode 6-Flooded (Flooding Scenario SD-6b).

The accident progression of these three floods is modeled with the event tree shown in Figure 13-1.

13.5.2 Control Building Flooding Scenarios

The flood scenarios of interest in this building are any that can impact the cabinets or control panels located at elevations –6400, -1400 and 4650.

The flood sources in this building are:

- Chiller Water System (CWS)
- Potable Water and Sanitary Waste System (PWSWS)
- Fire Protection System (FPS)

The Chiller Water System (CWS) components are located at elevation 9060 and in the building pipe chases. A CWS system break would result in water reaching elevations 9060 and -6400 (via the drain system and stairwells). However, CWS is a closed system, and the volume of water available is not sufficient to cause an initiating event.

The Potable Water and Sanitary Waste System (PWSWS) components are located at elevation –1400 (servicing the restrooms) and in the building pipe chases. Even though these sources have a high volume of water at their disposal, the potential flow rate is small (small diameter pipes) and within the capacity of the building drain system. Additionally, the Control Room is located on this elevation. Given that the Control Room is continuously manned, isolation of a PWSWS flood will be rapid and the total volume of water released will be small.

The Fire Protection System (FPS) system pipes located inside the Control Building are in the stairwells and are very short (less than 16 inches), with diameters that do not exceed 2-1/2 inches. As such, the frequency of a Control Building FPS flood event is low and the plant impact would be minor.

Based on the above discussions, Control Building flood scenarios are non-significant risk contributors and are not analyzed further in this risk assessment.

13.5.3 Fuel Building Flooding Scenarios

The flood sources in this building are:

- Reactor Component Cooling Water (RCCWS)
- Fuel and Auxiliary Pools Cooling System (FAPCS)

- Make Up Water System (MWS)
- Chiller Water System (CWS)
- Process Sampling System (PSS)
- Potable Water and Sanitary Waste System (PWSWS)
- Fire Protection System (FPS)

As discussed previously, RCCWS is a closed system with a limited water volume. Floods due to RCCWS system breaks only impact RCCWS and are already addressed in the internal events at-power and shutdown analyses.

Similarly, as discussed previously, the CWS and PWSWS systems are low volume and low flow rate systems and are also not significant flood sources.

The fuel pool and suppression pool are protected against loss of coolant by check valves and vacuum breaker valves designed to eliminate the potential for a siphon effect. Flooding from FAPCS requires the failure of at least one vacuum breaker or check valve in addition to a system pipe break. As such, a FAPCS flood is a low frequency event and is not analyzed further in this analysis.

The MWS and PSS systems are non-significant flood sources and thus are not analyzed further.

The scenarios of interest are those involving large volume flood sources with a significant flow rate. The system with these characteristics in the Fuel Building is the FPS system. A break in the FPS system will propagate to the lower floor of the Fuel Building and propagate to the lower floor of the Reactor Building via the door separating the two areas. The effects of such a flood are loss of FPS, FAPCS and RWCU/SDCS. As such, a break in the FPS system is the modeled flood for the Fuel Building.

13.5.3.1 Fuel Building At-Power Flooding Scenarios

The at-power flooding scenario for the Fuel Building is Flooding Scenario AP-4. It is an FPS system break resulting in a general transient, loss of FPS, FAPCS, and RWCU/SDCS. The analysis conservatively does not credit the potential manual isolation of the broken pipe. 13.5.3.2 Fuel Building Shutdown Flooding Scenarios

The flooding analysis models two FPS flood scenarios during shutdown in the Fuel Building, one during Mode 5 (Flooding Scenario SD-7) and the second during Mode 6-Unflooded (Flooding Scenario SD-8). Each scenario is a FPS flood that fails RWCU/SDCS, FAPCS, and FPS. Each scenario is a scenario that fails decay heat removal, and thus a flood during Mode 6-Flooded is not quantified due to the very long time necessary to result in coolant boiling.

No shutdown flood scenarios involving coolant draindown events are applicable to the Fuel Building.

13.5.4 Turbine Building Flooding Scenarios

The flood sources in this building are:

- Condensate and Feedwater System (C&FS)

- Make Up Water System (MWS)
- Reactor Component Cooling Water (RCCWS)
- Turbine Component Cooling Water (TCCWS)
- Chiller Water System (CWS)
- Process Sampling System (PSS)
- Condensate Storage and Transfer System (CS&TS)
- Plant Service Water System (PSWS)
- Hot Water System (HWS)
- Potable Water and Sanitary Waste System (PWSWS)
- Fire Protection System (FPS).
- Circulating Water System (CIRC)

A flood in the Turbine Building caused by a PSWS break results in the same consequences as the Complete Loss of PSWS initiator already included in the internal events PRA. As such, PSWS floods in the Turbine Building are not analyzed further in the flooding analysis.

Similarly, a flood in the Turbine Building caused by a RCCWS break results in the same consequences as the Loss of RCCWS initiator already included in the internal events PRA. As such, RCCWS floods in the Turbine Building are not analyzed further in the flooding analysis.

A break of the C&FS systems is already addressed in the internal events analysis and is not analyzed further in the flooding analysis.

Of the remaining water sources in the Turbine Building, flooding from the circulating water system (CIRC) is the bounding scenario due to the following reasons:

- Circulating water flow is the highest of all water sources
- Circulating water can provide an unlimited amount of water if the flooding is not stopped
- Flooding propagation into the Reactor Building via the Turbine Building requires a large amount of water.

Each of the four circulating water system pumps is equipped with a motor-operated isolation (shutoff) valve. Additional isolation valves are located at the entrance to and exit from the main condenser. If a large pipe break develops in the CIRC system and initiates flooding in the Turbine Building, termination of the flood requires either tripping all the pumps or closing the shutoff valves. Four redundant safety grade water level sensors, operating in a two-out-of-four logic, located in the condenser pit of the Turbine Building initiate automatic tripping of the CIRC pumps and closure of the shutoff valves.

If one or more pumps fail to trip and the associated shutoff valves fail to close, the water level may rise up to the top of the condenser pit, flood the bottom floor, and reach grade level.

The water released inside the building floods the bottom floor and accumulates there until reaching the elevation where the water exits the building and flows towards the controlled access

tunnel. In no case, however, does the water reach the buildings that contain the equipment included in the mitigation system models drawn up in the internal event analysis. Consequently, the water only affects the components located in the Turbine Building.

13.5.4.1 Turbine Building At-Power Flooding Scenarios

The potential at-power Turbine Building flood-induced initiators of interest are:

- Loss of Power Conversion System (PCS)
- Complete loss of feedwater
- Complete loss of RCCWS
- Complete loss of TCCWS
- Complete loss of Air systems

The components with the potential to result in complete loss of RCCWS or complete loss of air are located above the elevation where flood water would exit the building (i.e., grade elevation). A large volume system would be required to result in flooding up to this initial elevation. The only system with this characteristic is the CIRC system.

The components with the potential to result in loss of the Power Conversion System (PCS), complete loss of feedwater (except feedwater suction and discharge pipes and the feedwater storage tank) or complete loss of TCCWS are located below grade elevation. Rupture of the feedwater storage tank or the feedwater pipes would not affect components related to the RCCWS or Air systems.

Based on the above, the flooding scenarios analyzed in the Turbine building at-power flooding analysis are those depicted in the flood progression event tree provided in Figure 13-2. These flooding scenarios are described below:

- Flooding of the bottom floor of the Turbine Building, but flood does not reach grade elevation (Flooding Scenario AP-5).

  The analysis conservatively assumes that this scenario can be caused by any flood source located inside the building.

  If all CIRC pumps trip, or one or more CIRC pumps fails to trip but the shutoff valves close, the level of flood water does not reach grade elevation.

  The resulting flood-induced initiating event type is a complete loss of feedwater and the equipment affected by the flood is that located below grade elevation. These components are all related to the power conversion system function.

- Flooding of the bottom floor of the Turbine Building and flood level reaches grade elevation (Flooding Scenario AP-6).

  This scenario results when automatic isolation of the CIRC break fails. Automatic break isolation occurs by either tripping all CIRC pumps or closure of the shutoff valves upon receipt of an isolation signal from the four redundant safety grade water level sensors, operating in a two-out-of-four logic, located in the condenser pit of the Turbine Building. Therefore, the isolation fails if one of the following situations occurs:

- Water level sensor signal fails
- One or more pumps fail to trip and shutoff valve closure fails

When automatic break isolation fails, flood water level reaches grade elevation, leading to complete loss of RWCCS and damaging all the components located on or below grade elevation.

Failure rates for the level detectors, shutoff valve closure, and pump trip are provided in Table 13-4. These failure rates are used to estimate the nodal probabilities used in the event tree in Figure 13-2.

13.5.4.2 Turbine Building Shutdown Flooding Scenarios

The only initiating event that can occur in the Turbine Building during shutdown is loss of decay heat removal caused by loss of RCCWS. However, such a flooding scenario is not possible in shutdown since the CIRC pumps are not in operation.

13.5.5 Electrical Building Flooding Scenarios

For the purpose of the flooding analysis, the Electrical Building is differentiated into two general areas:

- Diesel Generator rooms
- Remainder of the building

Flood sources outside the diesel generator rooms are due to component failures in the following systems:

- Make Up Water System (MWS)
- Chiller Water System (CWS)
- Potable Water and Sanitary Waste System (PWSWS)
- Fire Protection System (FPS).

These sources are located on various elevations, in the stairwells and in the pipe chases.

The flood sources belonging to the Chiller Water System (CWS) are located on an upper elevation and in the building pipe chases. As discussed previously, the CWS system is a closed system with limited water volume. CWS floods are not analyzed further in this analysis.

The flood sources belonging to the PWSWS and MWS systems are located on the ground floor of the building. Although these sources have a potentially large volume of water, the flow rates from a system break are small and within the capacity of drain systems. As such, PWSWS and MWS floods are not analyzed further in this analysis.

The flood sources belonging to the FPS system are located in the stairwells and various elevations. These sources include:

- Manual spray systems. These are dry pipe systems with the actuation valve located outside the rooms.
- Sprinkler systems located in the cable rooms. These are wet pipe systems.

- Piping located in the stairwells and in the pipe chases. Breaks in this piping will only affect components located on the ground floor of the building.

The flood sources in the diesel generator rooms are due to failure of components in the following systems:

- Reactor Component Cooling Water (RCCWS)
- Potable Water and Sanitary Waste System (PWSWS)
- Fire Protection System (FPS)

In each case, after reaching the ground floor of the building, the water released from a break in the above systems in the DG rooms exits through the drain system and doors, without affecting components located in other buildings.

13.5.5.1 Electrical Building At-Power Flooding Scenarios

The worst case flood in the Electrical Building outside the diesel generator rooms is an FPS pipe break on an upper elevation, since all the components located on lower elevations could be affected by flooding. The affected equipment would be the 13.8 kV buses and batteries A, A1, A2, B, B1, B2 and C. All these failures result in a damage state defined by the loss of PCS initiator. This scenario is identified as Flooding Scenario AP-7. The analysis conservatively does not credit the potential manual isolation of the broken pipe.

The flooding analysis models two at-power flood scenarios for the DG rooms, one for a flood in DG Room A (Flooding Scenario AP-8) and the other for a flood in DG Room B (Flooding Scenario AP-9). Each scenario is a manual scram with failure of the diesel generator located in the room.

13.5.5.2 Electrical Building Shutdown Flooding Scenarios

As discussed previously, the worst case flood in the Electrical Building outside the diesel generator rooms is an FPS pipe break on an upper elevation. However, the associated equipment damage does not cause an initiating event during shutdown.

The only possible initiating event, during shutdown, in the diesel generator rooms is loss of decay heat removal due to a RCCWS pipe break. The water released by these flood sources only affects the components located in the area where the source is located. The internal events shutdown analysis (refer to Section 16) already covers loss of RCCWS scenarios.

13.5.6 Service Water Building Flooding Scenarios

The primary flood source in the Service Water Building is the Plant Service Water System (PSWS).

Floods in the Service Water Building only result in failure of the PSWS system. The loss of service water scenario is already included in the internal events PRA with the Complete Loss of PSWS initiator. As such, Service Water Building flood scenarios are not analyzed further in the flooding analysis.

13.5.7 Tunnels and Galleries Flooding Scenarios

Flooding of tunnels and galleries up to ground level can only affect buildings with elevations below ground level.

However, given the general arrangement provisions and the flood protection measures of the design, the contribution of tunnel and gallery flooding to CDF is non-significant.

13.6 RESULTS

This analysis is a bounding approach that begins by assigning a flood initiation frequency to every flood scenario in a building that is equal to the entire flood initiation frequency for that building. Following the accident sequence quantification, the flood scenario with the highest CDF in each building is used to represent the flood CDF for that building. The total flood risk is the sum of the CDFs of the bounding flood scenario for each building.

The core damage frequency results of the ESBWR probabilistic flooding analysis are summarized in the following tables:

- CDF Contribution of At-Power Flooding Scenarios (Table 13-5)
- CDF Contribution of Shutdown Flooding Scenarios (Table 13-6)

Each table lists the scenario ID, scenario description, flood initiation frequency, initiating event type used in the accident sequence analysis, the flood-induced equipment damage, and the resulting core damage frequency. As can be seen from these tables, the at-power internal flooding CDF is estimated at 3.68E-09/yr, and the shutdown internal flooding CDF is estimated at 1.64E-09/yr.

The top 200 cutsets for the at-power internal flooding CDF are provided in Table 13-7, and those for shutdown internal flooding CDF are provided in Table 13-8.

The risk importance measures for the at-power internal flooding CDF are provided in Table 13-9, and those for shutdown internal flooding CDF are provided in Table 13-10.

13.7 INSIGHTS GAINED FROM THE ANALYSIS

The ESBWR probabilistic shutdown flooding analysis highlights the following key insights regarding the flooding mitigation capability of the ESBWR:

(1) The ESBWR, due to its basic layout and safety design features, is inherently capable of mitigating potential flooding. Safety system redundancy and physical separation providing protection from flooding by large water sources, along with alternate safe shutdown features in buildings separated from flooding of safety systems provide the ESBWR with significant flooding mitigation capability.

(2) Due to the inherent ESBWR flooding mitigation capability, only a small number of flooding specific design features are key in the mitigation of significant flood sources, for example:

- Using watertight doors in the accesses to tunnels and galleries from the Control and Reactor Buildings.
- Not locating flood sources with a significant volume of water in the Control Building.
- Locating flood sources in the Electrical Building in such a way that a flood does not affect key components.
- Limiting the volume of water that the FPS can distribute in the Reactor Building.
- Reducing as much as possible the time interval during which the Drywell atmosphere and the atmosphere of other buildings are communicated through the hatches.
- Locating an automatic CWS pump trip and valve closure on high water level in the condenser pit.

(3) While timely operator action can limit potential flood damage, all postulated floods can be mitigated (from a risk perspective) without operator action.

13.8 CONCLUSIONS

The main conclusion that can be drawn from the ESBWR probabilistic flooding analysis is that the risk from internal flooding is acceptably low. The estimated core damage frequency (both at-power and shutdown conditions) from all internal flood sources is 5.32E-09 per calendar year.

The ESBWR is inherently safe with respect to internal flood events and no operator actions are required to mitigate postulated floods (although timely operator action can reduce damage to equipment and flood severity). All potential floods have been analyzed and it has been shown that the plant can be safely shut down at low risk to plant personnel and the general public.

13.9 REFERENCES

13.1 NUREG/CR 5750. Rates of Initiating Events at US Nuclear Power Plants: 1987 – 1995. February 1999.

13.2 NUREG/CR-2300, PRA Procedures Guide, January 1983.

13.3 World Nuclear Industry Handbook. 1999.

13.4 NPE. Nuclear Power Experience. Issue 2. September 1999.

13.5 NUREG/CR-5496. Evaluation of Loss of Offsite Power Events at Nuclear Power Plants: 1980 – 1996. November 1998.

13.6 EPRI, ALWR Requirements Document

13.7 GE Reliability Data Manual Used for Probabilistic Risk Analysis

Table 13-1

At-Power Flooding Frequencies

Building	**Flood Initiator Frequency (per year)**	Comment
Reactor Building	3.40E-3	FPS break; NUREG/CR-5750 frequency estimate for major on-site pipe break (Flood-J1).
Control Building	3.40E-3	FPS break; NUREG/CR-5750 frequency estimate for major on-site pipe break (Flood-J1).
Fuel Building	3.40E-3	FPS break; NUREG/CR-5750 frequency estimate for major on-site pipe break (Flood-J1).
Turbine Building	2.80E-2	CWS break; NUREG/CR-2300 frequency estimate for circulating water system "medium-large" flood.
Electrical Building	3.40E-3	FPS break; NUREG/CR-5750 frequency estimate for major on-site pipe break (Flood-J1).

Table 13-2

Flooding Events during Shutdown in BWR Plants

UNIT	DATE	STATE	DESCRIPTION	BUILDING	VOLUME
Hatch 2	Dec-86	Refueling	Leak from Spent Fuel Pool.	Turbine, Reactor and Others	150000 gal
Vermont Yankee	Aug-87	Refueling	PVC pipe breaks in PCI system due to water-hammer / PCI diesel pump starts / Loss of off-site power.	Reactor	2000 gal
Quad-Cities 2	April-92	Cold shutdown	Deluge system actuation during deluge drain procedure.	Transformers	n/a
Browns Ferry 1	May-74	n/a	Valve left open when the flange was removed. (Note 1)	Pipe tunnel	85000 gal
Dresden 2	Nov-77	Refueling shutdown	Water spilled from disassembled LPCI Heat exchanger valve.	Auxiliary	n/a
LaSalle 1	Jan-82	Shutdown	Reactor vessel was overfilled and water spilled into the drywell. (Note 1)	Reactor (drywell)	n/a
Quad-Cities 2	Jun-74	Shutdown	Pipe break in the feedwater system due to vibrations.	Turbine	12500 gal
Pilgrim 1	Jan-76	20% power / shutdown	Pipe break in the feedwater system due to vibrations.	Turbine	5000 gal
Oyster Creek	April-81	Shutdown	Leak of condensate due to valve packing failure.	Turbine	10000 gal
Fermi 2	Dec-86	Cold shutdown	CST contents spilled due to return line expansion joint rupture. (Note 1)	Turbine, Radwaste	275000 gal
Peach Bottom 3	Feb-86	Cold shutdown	CST overflow.	Radwaste, Offsite	38000 gal

Table 13-2

Flooding Events during Shutdown in BWR Plants

UNIT	DATE	STATE	DESCRIPTION	BUILDING	VOLUME
Nine Mile Pt.2	Nov-87	Cold shutdown	CST rupture. (Note 1)	Reactor, Radwaste	200000 gal
Dresden 1	May-94	Defueled	CST contents pumped out through a broken pipe. (Note 1)	n/a	50000 gal
Quad Cities 1	Jun-72	n/a	Expansion joint rupture due to water hammer in the circulation water system. (Note 1)	Turbine	n/a
Monticello	May-76	Shutdown	Expansion joint rupture.	Cooling tower pumphouse	n/a
Hatch 1	Dec- 85	Refueling	Isolation valve open during RHR pump suction line maintenance.	Auxiliary	n/a
Millstone 1	Jan-94	Refueling	During LPCI test, water was sprayed into the drywell.	Reactor(drywell)	12000 gal
Millstone 1	April-94	Refueling	During LPCI test, water was sprayed into the drywell.	Reactor(drywell)	12000 gal
Oyster Creek	Jan-82	Shutdown	Fire protection deluge system actuated due to an overheated bearing in the Clean-up system auxiliary pump motor.	Reactor	n/a
Peach Bottom 3	Jun-84	Refueling	Fire header pipe broke in an elbow.	Turbine	n/a
River Bend 1	Jan-86	3% Startup	Fire protection water curtain was inadvertently actuated. (Note 1)	Auxiliary	n/a
Browns Ferry 1	April-86	Cold shutdown	Reactor cavity overfilled.	Reactor	33000 gal
Shoreham	Oct-89	Cold shutdown	Fire suppression deluge system manually actuated. (Note 1)	Reactor	n/a

Table 13-2

Flooding Events during Shutdown in BWR Plants

UNIT	DATE	STATE	DESCRIPTION	BUILDING	VOLUME
Quad-Cities 1	Nov-89	10% power	HPCI pump room fire suppression deluge system auto actuated during performance of HPCI system turbine overspeed test.	Auxiliary	n/a
Browns Ferry 2	Jun 90	Cold shutdown	During fire protection testing, water was expelled onto analog trip units.	Auxiliary	n/a
Millstone 1	May-71	Process of cooldown	MCC flooded due to a leak in the reactor building closed cooling water heat exchanger service water discharge. (Note 1)	Reactor	n/a
Oyster Creek	Sep-87	Cold shutdown	PCIV leakage during maintenance.	Reactor	n/a
Brunswick 1	Jul-77	Shutdown	Gasket rupture on the service water system.	Reactor	n/a
River Bend 1	April-89	Refueling	SW supply line freeze plug failed.	Auxiliary	15000 gal
Dresden 3	Nov-81	14% power	Fire protection deluge system actuates due to high humidity conditions.	Auxiliary	n/a

Note 1: This flood event is not included in the frequency calculation because it did not occur during commercial operation.

Table 13-3

Shutdown Flooding Frequencies

BWR BUILDING	FLOOD FREQUENCY (per shutdown year)	MODE	FLOOD FREQUENCY (per calendar year)	ESBWR BUILDING
REACTOR	1.33E-03	5	5.80E-04	REACTOR
		6-Unflooded	1.44E-04	
		6-Flooded	5.87E-04	
AUXILIARY	1.00E-03	5	4.36E-04	FUEL
		6-Unflooded	1.08E-04	
		6-Flooded	4.41E-04	
TURBINE	6.68E-04	5	2.91E-04	TURBINE
		6-Unflooded	7.22E-05	
		6-Flooded	2.95E-04	
TRANSFORMERS	1.67E-04	5	7.28E-05	ELECTRICAL
		6-Unflooded	1.80E-05	
		6-Flooded	7.37E-05	
OTHERS	3.34E-04	5	1.46E-04	OTHERS
		6-Unflooded	3.61E-05	
		6-Flooded	1.47E-04	

Table 13-4

Failure Data for ESBWR Probabilistic Flood Analysis[1]

Failure Rate		
Component, Element	**Failure Mode**	**Failure Rate (per demand except as noted)**
Level Sensors	Fail to operate	1.0E-03
	Fail to operate (standby)	3.3E-07/h
Isolation Valve	Fail to close	4.0E-03
Motor Driven Pump	Fail to trip pump (Breaker fails to open)	1.0E-03

Notes to Table 13-4:

[1]Data obtained from the following references:

- EPRI ALWR Utility Requirements Document (Reference 13-6)
- GE Reliability Data Manual (Reference 13-7)

Table 13-5

CDF Contribution of At-Power Flooding Scenarios

BUILDING	FLOOD SCENARIO	DESCRIPTION[1]	FREQUENCY (per year)	INITIATING EVENT TYPE[2]	DAMAGE	CDF (per year)[3]
Reactor	AP-1	CRDS Pipe Break Outside Containment (FLOOD-RB-CRD-POWER)	3.40E-03	T-GEN	CRDS, FAPCS and RWCU/SDCS	9.74E-14
	AP-2	FPS Pipe Break Outside Containment (FLOOD-RB-FP-POWER)	3.40E-03	T-GEN	FPS, FAPCS and RWCU/SDCS	Truncated[4]
	AP-3	RWCU/SDCS Pipe Break Outside Containment (FLOOD-RB-RWCU-POWER)	3.40E-03	BOC RWCU	FAPCS and RWCU/SDCS	1.19E-12
Fuel	AP-4	FPS Pipe Break in Fuel Building (FLOOD-FB-FP-POWER)	3.40E-03	T-GEN	FPS, FAPCS and RWCU/SDCS	Truncated[4]
Turbine	AP-5	CIRC Pipe Break, Flood below grade elevation (FLOOD-TB-ALL-POWER)	2.80E-02	T-FDW	PCS	3.68E-09
	AP-6	CIRC Pipe Break, Flood above grade elevation (FLOOD-TB-CIRC-POWER)	2.85E-06	T-PSW	PCS, RWCCS	Truncated[4]
Electrical	AP-7	FPS Pipe Break Outside DG Rooms (FLOOD-EB-FP-POWER)	3.40E-03	T-PCS	13.8 kV buses and Batteries A, A1, A2, B, B1, B2, C	Truncated[4]

Table 13-5

CDF Contribution of At-Power Flooding Scenarios

BUILDING	FLOOD SCENARIO	DESCRIPTION(1)	FREQUENCY (per year)	INITIATING EVENT TYPE(2)	DAMAGE	CDF (per year)(3)
	AP-8	Flood in DG Room A (FLOOD-EBGDA-FP-POWER)	3.40E-03	T-GEN	DG(A)	Truncated(4)
	AP-9	Flood in DG Room B (FLOOD-EBGDB-FP-POWER)	3.40E-03	T-GEN	DG(B)	Truncated(4)
TOTAL AT-POWER FLOODING CDF						3.68E-09

Notes:

(1) Parameters shown in parentheses are the at-power flood scenario initiator IDs used in the accident sequence analysis (refer to Tables 13-7 and 13-9).

(2) Identifies the accident sequence structure used in the CDF quantification. Refer to Section 3 for event tree figures.

(3) The quantification is performed at a truncation limit of 1E-14/yr.

(4) No accident sequence cutsets remained above the quantification truncation limit.

Table 13-6

CDF Contribution of Shutdown Flooding Scenarios

BUILDING	FLOOD SCENARIO	DESCRIPTION[1]	MODE	FREQUENCY (per year)	INITIATING EVENT TYPE[2]	DAMAGE	CDF (per year)[3]
Reactor (Outside Containment)	SD-1	CRD pipe break (FLOOD-RB-CRD-PB5)	5	5.80E-04	Loss of RWCU/SDCS	CRDS, FAPCS and RWCU/SDCS	1.32E-13
	SD-2	FPS pipe break (FLOOD-RB-U43-PB5)	5	5.80E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	Truncated[4]
	SD-3	CRD pipe break (FLOOD-RB-CRD-PB6)	6-Unflooded	1.44E-04	Loss of RWCU/SDCS	CRDS, FAPCS and RWCU/SDCS	1.49E-09
	SD-4	FPS pipe break (FLOOD-RB-U43-PB6)	6-Unflooded	1.44E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	8.69E-11
	SD-5	RWCU/SDC pipe break (%BOC-RWCUSD5)	5	5.80E-04	BOC RWCU	FAPCS and RWCU/SDCS	7.37E-14
	SD-6[5]	RWCU/SDC pipe break (%BOC-RWCUSD6)	6	5.87E-04	BOC RWCU	FAPCS and RWCU/SDCS	1.12E-13
Fuel	SD-7	FPS pipe break (FLOOD-FB-U43-PB5)	5	4.36E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	Truncated[4]
	SD-8	FPS pipe break (FLOOD-FB-U43-PB6)	6-Unflooded	1.08E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	6.26E-11
TOTAL SHUTDOWN FLOODING CDF							1.64E-09

Notes:

(1) Parameters shown in parentheses are the shutdown flood scenario initiator IDs used in the accident sequence analysis (refer to Tables 13-8 and 13-10).

(2) Identifies the accident sequence structure used in the CDF quantification. Refer to Section 16 for event tree figures.

(3) The quantification is performed at a truncation limit of 1E-14/yr.

(4) No accident sequence cutsets remained above the quantification truncation limit.

(5) Both Scenarios 6a (Mode 6-Unflooded) and 6b (Mode 6-Flooded) are included in this line item summary.

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
1	1.56E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
2	1.56E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
3	1.56E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
4	1.56E-10	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
5	1.56E-10	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
6	1.56E-10	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
7	1.56E-10	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
8	1.56E-10	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
9	1.08E-10	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
10	1.08E-10	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
11	1.08E-10	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
12	1.08E-10	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
13	1.08E-10	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
14	1.08E-10	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
15	4.64E-11	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
16	4.64E-11	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
17	4.64E-11	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
18	4.64E-11	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
19	4.64E-11	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
20	4.64E-11	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
21	4.64E-11	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
22	4.64E-11	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
23	3.22E-11	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
24	3.22E-11	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
25	3.22E-11	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
26	3.22E-11	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
27	3.22E-11	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
28	3.22E-11	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
29	1.31E-11	3.12E-05	C62-VLU-CF-DIDALL	CCF OF VOTER LOGIC UNITS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
30	1.31E-11	3.12E-05	C62-VLU-CF-DIDALL	CCF OF VOTER LOGIC UNITS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
31	1.30E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
32	1.30E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
33	1.30E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
34	1.30E-11	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
35	1.30E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
36	1.30E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
37	1.30E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
38	1.30E-11	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
39	9.74E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
40	9.74E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
41	9.74E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
42	9.74E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
43	9.74E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
44	9.74E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
45	9.74E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
46	9.74E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
47	9.74E-12	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
48	9.74E-12	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
49	9.74E-12	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
50	9.74E-12	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
51	3.87E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
52	3.87E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
53	3.87E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
54	3.87E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
55	3.87E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
56	3.87E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
57	3.87E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
58	3.87E-12	4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
59	3.25E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
60	3.25E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
61	3.25E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
62	3.25E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
63	3.25E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
64	3.25E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
65	3.25E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
66	3.25E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
67	3.25E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
68	3.25E-12	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
69	2.90E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
70	2.90E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
71	2.90E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
72	2.90E-12	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
73	2.90E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
74	2.90E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
75	2.90E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
76	2.90E-12	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
77	2.90E-12	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
78	2.90E-12	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
79	2.90E-12	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
80	2.90E-12	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
81	2.54E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
82	2.54E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
83	2.54E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
84	2.54E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
85	2.54E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
86	2.54E-12	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
87	2.54E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
88	2.54E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
89	2.54E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
90	2.54E-12	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
91	2.43E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
92	2.43E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
93	2.43E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
94	2.43E-12	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
95	1.95E-12	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
96	1.95E-12	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
97	1.95E-12	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
98	1.95E-12	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
99	1.95E-12	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
100	1.95E-12	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
101	1.95E-12	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
102	1.95E-12	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
103	1.94E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
104	1.94E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
105	1.94E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
106	1.94E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
107	1.94E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
108	1.94E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
109	1.94E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
110	1.94E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
111	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
112	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
113	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
114	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
115	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
116	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
117	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
118	1.55E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
119	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
120	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
121	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
122	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
123	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
124	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
125	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
126	1.55E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
127	1.55E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
128	1.55E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
129	1.55E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
130	1.55E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
131	1.55E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
132	1.55E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
133	1.55E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
134	1.55E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
135	1.34E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
136	1.34E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
137	1.34E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
138	1.34E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
139	1.34E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
140	1.34E-12	1.60E-03	C12-UV -CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
141	1.25E-12	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
142	1.25E-12	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
143	1.25E-12	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
144	1.25E-12	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
145	1.11E-12	3.74E-01	%T-PCS	LOSS OF POWER CONVERSION SYSTEM
		2.98E-04	C51-ACT-CF-1PRM	CCF APRM NEUTRON CHANNELS
		1.00E-08	C71-SYS-FF-SCRAM	SCRAM FAILURE
146	1.08E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
147	1.08E-12	4.00E-03	C12-MOV-CC-F014A	MOTOR OPER. VALVE F014A FAILS TO OPEN
		4.00E-03	C12-MOV-CC-F014B	MOTOR OPER. VALVE F014B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
148	1.08E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
149	1.08E-12	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
150	1.07E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
151	1.07E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
152	1.07E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
153	1.07E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
154	1.07E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
155	1.07E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
156	1.07E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
157	1.07E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
158	1.07E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
159	1.07E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
160	1.07E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
161	1.07E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
162	1.07E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
163	1.07E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
164	1.07E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
165	1.07E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
166	1.07E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
167	1.07E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
168	1.06E-12	3.74E-01	%T-PCS	LOSS OF POWER CONVERSION SYSTEM
		1.60E-03	C41-UV_-CC-F004A	CHECK VALVE F004A FAILS TO OPEN
		1.77E-01	C41-XHE-FO-INISLCS	OPERATOR FAILS TO MANUALLY INITIATE SLCS (SHORT TIME)
		1.00E-08	C71-SYS-FF-SCRAM	SCRAM FAILURE
169	1.06E-12	3.74E-01	%T-PCS	LOSS OF POWER CONVERSION SYSTEM
		1.60E-03	C41-UV_-CC-F004B	CHECK VALVE F004B FAILS TO OPEN

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		1.77E-01	C41-XHE-FO-INISLCS	OPERATOR FAILS TO MANUALLY INITIATE SLCS (SHORT TIME)
		1.00E-08	C71-SYS-FF-SCRAM	SCRAM FAILURE
170	9.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
171	9.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
172	9.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
173	9.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
174	9.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
175	9.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
176	9.68E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
177	9.68E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
178	9.68E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
179	9.68E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
180	8.65E-13	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
181	8.65E-13	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
182	8.65E-13	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report
Flooding Full Power
Core Damage Frequency = 3.68E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
183	8.45E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
184	8.45E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
185	8.45E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
186	8.45E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
187	8.11E-13	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
188	8.11E-13	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
189	8.11E-13	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
190	8.11E-13	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
191	8.11E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
192	8.11E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
193	7.74E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
194	7.74E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
195	7.74E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333

Table 13-7

Internal Flooding Full-Power Cutset Report

Cutsets with Descriptions Report Flooding Full Power Core Damage Frequency = 3.68E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
196	7.74E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
197	7.74E-13	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
198	7.74E-13	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
199	7.74E-13	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
200	7.74E-13	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		2.80E-02	FLOOD-TB-ALL-POWER	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
1	3.48E-10	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
2	3.48E-10	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
3	1.04E-10	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
4	1.04E-10	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
5	5.18E-11	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
6	5.18E-11	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
7	3.48E-11	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
8	3.48E-11	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
9	4.98E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
10	4.98E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
11	4.98E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
12	4.98E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
13	4.98E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
14	4.98E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
15	4.98E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
16	4.98E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
17	4.87E-12	2.10E-07	C51-ACT-CF-APRMSTUCK	CCF APRM DETECTORS STUCK AT POWER LEVEL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN CRD
18	4.32E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
19	4.32E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	G21-ACV-CC-F332	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
20	3.73E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
21	3.73E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
22	3.73E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
23	3.73E-12	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
24	3.73E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
25	3.73E-12	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
26	3.73E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
27	3.73E-12	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
28	3.45E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
29	3.45E-12	1.60E-03	B21-UV_-CC-F102A	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
30	3.45E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
31	3.45E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
32	3.45E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
33	3.45E-12	1.60E-03	B21-UV_-CC-F103A	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
34	3.45E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
35	3.45E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
36	3.45E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
37	3.45E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.44E-04	FLOOD-RB-U43-PB5	FLOOD DURING SHUTDOWN IN REACTOR BUILDING DUE TO BREAK IN FPS
38	3.45E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
39	3.45E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.60E-03	G21-UV_-CC-F333	CHECK VALVE F333 FAILS TO OPEN
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
40	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
41	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
42	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
43	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
44	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
45	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
46	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
47	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
48	2.83E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
49	2.78E-12	1.20E-07	B21-LT_-CF-N001ABCD	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
50	2.59E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
51	2.59E-12	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
52	2.59E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
53	2.59E-12	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
54	2.59E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS
55	2.59E-12	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.08E-04	FLOOD-FB-U43-PB5	FLOOD DURING SHUTDOWN IN FUEL BUILDING DUE TO BREAK IN FPS

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
56	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
57	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
58	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
59	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
60	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
61	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
62	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
63	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
64	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
65	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
66	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
67	2.43E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
68	1.73E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
69	1.73E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	G21-UV_-TM-F332/333	MAINTENANCE FOR CV F332 OR CV F333
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
70	1.67E-12	7.20E-08	E50-OR_-CF-PLUGALL	CCF OF ALL ORIFICES TO PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
71	1.62E-12	7.00E-08	E50-OR_-CF-7PLUG	CCF OF 7 ORIFICES TO PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
72	1.45E-12	2.10E-07	C51-ACT-CF-APRMSTUCK	CCF APRM DETECTORS STUCK AT POWER LEVEL
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
73	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003D	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
74	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003H	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
75	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003A	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
76	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003E	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
77	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003D	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
78	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003H	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
79	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003A	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
80	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003E	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
81	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003D	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
82	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003H	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
83	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003A	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
84	1.42E-12	1.00E-02	E50-MP_-TM-POOLB	GDCS POOL B IN MAINTENANCE
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.75E-03	E50-UV_-OC-F003E	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
85	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
86	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
87	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
88	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
89	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
90	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
91	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
92	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
93	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
94	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
95	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
96	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
97	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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No.	Cutset Prob	Event Prob	Event	Description
98	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
99	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
100	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
101	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
102	9.90E-13	3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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Core Damage Frequency = 1.64E-09
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No.	Cutset Prob	Event Prob	Event	Description
103	9.90E-13	3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
104	9.90E-13	3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
105	9.90E-13	3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
106	9.90E-13	3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
107	9.90E-13	3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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No.	Cutset Prob	Event Prob	Event	Description
108	9.90E-13	3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
109	9.90E-13	3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
110	9.90E-13	3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
111	9.90E-13	3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
112	9.90E-13	3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
113	9.90E-13	3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
114	9.90E-13	3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
115	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
116	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
117	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
118	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
119	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
120	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
121	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
122	9.90E-13	3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
123	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
124	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
125	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
126	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
127	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
128	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
129	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
130	9.90E-13	3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
131	9.90E-13	3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
132	9.90E-13	3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
133	9.90E-13	3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
134	9.90E-13	3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
135	9.90E-13	3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
136	9.90E-13	3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
137	9.90E-13	3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
138	9.90E-13	3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
139	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
140	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
141	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
142	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
143	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
144	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
145	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
146	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
147	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
148	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
149	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
150	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
151	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
152	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
153	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
154	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
155	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
156	8.50E-13	3.00E-03	E50-SQV-CC-F002A	SQUIB VALVE F002A FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
157	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
158	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
159	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
160	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
161	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
162	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
163	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
164	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
165	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
166	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
167	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report
Flooding Shutdown
Core Damage Frequency = 1.64E-09
Top 200 Cutsets

No.	Cutset Prob	Event Prob	Event	Description
168	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
169	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
170	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
171	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
172	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
173	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
174	8.50E-13	3.00E-03	E50-SQV-CC-F002D	SQUIB VALVE F002D FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
175	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
176	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
177	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

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Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
178	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
179	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
180	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
181	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
182	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
183	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
184	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009D	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
185	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
186	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
187	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
188	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
189	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
190	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009H	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
191	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
192	8.50E-13	3.00E-03	E50-SQV-CC-F002E	SQUIB VALVE F002E FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009L	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
193	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
194	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009C	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
195	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009F	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
196	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009G	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
197	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009J	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-8

Internal Flooding Shutdown Cutset Report

Cutsets with Descriptions Report Flooding Shutdown Core Damage Frequency = 1.64E-09 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
198	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009A	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009K	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
199	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009E	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD
200	8.50E-13	3.00E-03	E50-SQV-CC-F002H	SQUIB VALVE F002H FAILS TO OPERATE
		3.50E-03	E50-SQV-CO-F009B	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
		3.50E-03	E50-SQV-CO-F009I	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		1.44E-04	FLOOD-RB-CRD-PB5	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD

Table 13-9

Internal Flooding Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Full Power
Core Damage Frequency = 3.68E-09

Event Name	Probability	F-V	RAW	Description
B21-LT_-CF-N001ABCD	1.20E-07	3.16E-03	2.63E+04	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
B21-SYS-FF-1/9OPEN	5.85E-02	2.66E-04	1	1 OUT OF 9 SRV FAIL TO CLOSE AFTER OPENING
B21-UV_-CC-F102A	1.60E-03	5.94E-03	4.71	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F102B	1.60E-03	9.67E-02	61.41	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103A	1.60E-03	5.94E-03	4.71	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F103B	1.60E-03	9.67E-02	61.41	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
B32-MOV-CF-F72HADOPEN	2.00E-04	9.09E-06	1.05	CCF VALVES F72HA AND D TO OPEN
B32-MOV-CF-F72HBCOPEN	2.00E-04	9.09E-06	1.05	CCF VALVES F72HB AND C TO OPEN
C12-MCB-OO-C001B	1.00E-03	1.53E-03	2.53	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
C12-MOV-CC-F014A	4.00E-03	2.33E-02	6.8	MOTOR OPER. VALVE F014A FAILS TO OPEN
C12-MOV-CC-F014B	4.00E-03	2.33E-02	6.8	MOTOR OPER. VALVE F014B FAILS TO OPEN
C12-MOV-CC-F020A	4.00E-03	1.04E-02	3.59	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	6.35E-03	2.58	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-CF-OPEN	1.78E-04	6.92E-04	4.89	CCF MOV TO OPEN
C12-MOV-FC-F020A	3.13E-03	8.12E-03	3.59	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	4.94E-03	2.58	FLOW CONTROL B FAILS WIDE OPEN
C12-MP_-FS-C001BOIL	2.40E-03	3.76E-03	2.56	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
C12-MPC-FR-C001A	5.76E-05	1.20E-04	3.08	MOTOR-DRIVEN PUMP C001A FAILS TO RUN, GIVEN START
C12-MPC-FR-C001B	5.76E-05	8.10E-05	2.4	MOTOR-DRIVEN PUMP C001B FAILS TO RUN, GIVEN START
C12-MPC-FS-C001B	2.40E-03	3.76E-03	2.56	MOTOR-DRIVEN PUMP C001B FAILS TO START
C12-OR_-PG-D007A	6.48E-04	1.60E-03	3.47	ORIFICE D007A FAILS TO REMAIN OPEN (PLUG)
C12-OR_-PG-D007B	6.48E-04	9.59E-04	2.48	ORIFICE D007B FAILS TO REMAIN OPEN (PLUG)
C12-SYS-TM-TRAINB	3.00E-03	4.75E-03	2.58	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	9.67E-02	61.41	CHECK VALVE F022 FAILS TO OPEN

Table 13-9

Internal Flooding Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Full Power
Core Damage Frequency = 3.68E-09

Event Name	Probability	F-V	RAW	Description
C12-XHE-FO-LEVEL2	3.22E-02	9.86E-05	1	MANUAL ACTUATION FAILURE
C12-XHE-MH-F003B	1.20E-02	2.16E-02	2.78	MISPOSITION OF VALVE F003B
C12-XHE-MH-F013A	4.80E-02	2.90E-01	6.76	MISPOSITION OF VALVE F013A
C12-XHE-MH-F013B	4.80E-02	2.90E-01	6.76	MISPOSITION OF VALVE F013B
C12-XHE-MH-F015A	4.80E-02	2.90E-01	6.76	MISPOSITION OF VALVE F015A
C12-XHE-MH-F015B	4.80E-02	2.90E-01	6.76	MISPOSITION OF VALVE F015B
C12-XHE-MH-F018A	1.20E-02	3.52E-02	3.89	MISPOSITION OF VALVE F018A
C12-XHE-MH-F018B	1.20E-02	2.16E-02	2.78	MISPOSITION OF VALVE F018B
C12-XHE-MH-F021A	1.20E-02	3.52E-02	3.89	MISPOSITION OF VALVE F021A
C12-XHE-MH-F021B	1.20E-02	2.16E-02	2.78	MISPOSITION OF VALVE F021B
C31-VLU-FC-RUNBACK	7.80E-05	7.91E-05	2.01	C31 SYSTEM VOTER LOGIC UNIT FAILS
C41-SYS-FF-MAKEUP	1.00E-01	8.68E-04	1.01	INVENTORY MAKE-UP BORATION FAILURE
C41-UV_-CC-F004A	1.60E-03	4.49E-04	1.28	CHECK VALVE F004A FAILS TO OPEN
C41-UV_-CC-F004B	1.60E-03	4.49E-04	1.28	CHECK VALVE F004B FAILS TO OPEN
C41-UV_-CC-F005A	1.60E-03	4.49E-04	1.28	CHECK VALVE F005A FAILS TO OPEN
C41-UV_-CC-F005B	1.60E-03	4.49E-04	1.28	CHECK VALVE F005B FAILS TO OPEN
C41-XHE-FO-INISLCS	1.77E-01	1.54E-03	1.01	OPERATOR FAILS TO MANUALLY INITIATE SLCS (SHORT TIME)
C41-XHE-FO-OPENF002A	2.69E-01	3.04E-04	1	OPERATOR FAILS TO OPEN VALVE F002A (AFTER INADV.CLOS.)
C41-XHE-FO-OPENF002B	2.69E-01	3.04E-04	1	OPERATOR FAILS TO OPEN VALVE F002B (AFTER INADV.CLOS.)
C41-XHE-MH-F002A	4.03E-03	3.04E-04	1.08	MISPOSITION OF VALVE F002A
C41-XHE-MH-F002B	4.03E-03	3.04E-04	1.08	MISPOSITION OF VALVE F002B
C51-ACT-CF-1PRM	2.98E-04	3.02E-04	2.01	CCF APRM NEUTRON CHANNELS
C51-ACT-CF-SRNM	2.98E-04	3.02E-04	2.01	CCF OF SRNM CORE FLUX CHANNELS
C62-DTM-CF-DIDALL	5.50E-05	8.44E-05	2.53	COMMON CAUSE FAILURE 3/4 DTM DID LOGIC
C62-DTM-CF-N1EALL	5.50E-05	3.18E-04	6.77	CCF OF DIGITAL TRIP MODULES NO 1E

Table 13-9

Internal Flooding Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Full Power
Core Damage Frequency = 3.68E-09

Event Name	Probability	F-V	RAW	Description
C62-DTM-FC-N1EA	9.00E-04	2.77E-05	1.03	DIGITAL TRIP MODULE TRAIN A NO 1E FAILS
C62-DTM-FC-N1EB	9.00E-04	2.77E-05	1.03	DIGITAL TRIP MODULE TRAIN B NO 1E FAILS
C62-DTM-FC-N1EC	9.00E-04	2.77E-05	1.03	DIGITAL TRIP MODULE TRAIN C NO 1E FAILS
C62-VLU-CF-DIDALL	3.12E-05	8.71E-03	280.03	CCF OF VOTER LOGIC UNITS
C62-VLU-CF-N1EALL	3.12E-05	7.13E-05	3.28	CCF OF VOTER LOGIC UNITS
C71-SYS-FF-SCRAM	1.00E-08	3.35E-03	3.35E+05	SCRAM FAILURE
C72-DTM-CF-DPSALL	1.20E-05	1.42E-05	2.18	CCF 3/4 DTM OF DPS DIV 1/2/3/4
C74-DTM-CF-ALL	1.20E-05	1.56E-04	13.97	CCF 3/4 DTM OF SSLC DIV1/2/3/4
C74-VLU-CF-ALL	3.12E-06	2.62E-05	9.39	CCF OF VOTER LOGIC UNITS
E50-LT_-CF-N005ABCLOW	2.40E-07	8.79E-06	37.61	CCF 2/3 LEVEL TRANSMITTERS E50-N005A/B/C LOW
E50-OR_-CF-7PLUG	7.00E-08	1.80E-03	2.57E+04	CCF OF 7 ORIFICES TO PLUG
E50-OR_-CF-PLUGALL	7.20E-08	1.85E-03	2.57E+04	CCF OF ALL ORIFICES TO PLUG
E50-SQV-CC-F002A	3.00E-03	1.61E-02	6.36	SQUIB VALVE F002A FAILS TO OPERATE
E50-SQV-CC-F002D	3.00E-03	1.61E-02	6.36	SQUIB VALVE F002D FAILS TO OPERATE
E50-SQV-CC-F002E	3.00E-03	1.61E-02	6.36	SQUIB VALVE F002E FAILS TO OPERATE
E50-SQV-CC-F002H	3.00E-03	1.61E-02	6.36	SQUIB VALVE F002H FAILS TO OPERATE
E50-SQV-CF-4OPEN	1.50E-05	1.25E-04	9.33	CCF OF 4 OR MORE SQUIB VALVES TO OPEN
E50-SQV-CF-GDCS7OPEN	1.50E-05	4.13E-01	2.75E+04	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
E50-SQV-CF-OPENALL	1.50E-05	4.13E-01	2.75E+04	CCF OF ALL SQUIB VALVES TO OPEN
E50-SQV-CO-F009A	3.50E-03	3.69E-02	11.52	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
E50-SQV-CO-F009B	3.50E-03	2.71E-02	8.73	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
E50-SQV-CO-F009C	3.50E-03	2.71E-02	8.73	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
E50-SQV-CO-F009D	3.50E-03	3.69E-02	11.52	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
E50-SQV-CO-F009E	3.50E-03	3.69E-02	11.52	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
E50-SQV-CO-F009F	3.50E-03	2.71E-02	8.73	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]

Table 13-9

Internal Flooding Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Full Power
Core Damage Frequency = 3.68E-09

Event Name	Probability	F-V	RAW	Description
E50-SQV-CO-F009G	3.50E-03	2.71E-02	8.73	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
E50-SQV-CO-F009H	3.50E-03	3.69E-02	11.52	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
E50-SQV-CO-F009I	3.50E-03	3.69E-02	11.52	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
E50-SQV-CO-F009J	3.50E-03	2.71E-02	8.73	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
E50-SQV-CO-F009K	3.50E-03	2.71E-02	8.73	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
E50-SQV-CO-F009L	3.50E-03	3.69E-02	11.52	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
E50-STR-CF-SPPLUG	3.75E-04	4.36E-03	12.59	CCF FILTER/STRAINER IN PSP TO PLUG
E50-UV_-OC-F003A	1.75E-03	9.42E-03	6.37	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003D	1.75E-03	9.42E-03	6.37	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003E	1.75E-03	9.42E-03	6.37	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003H	1.75E-03	9.42E-03	6.37	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
FLOOD-RB-CRD-POWER	3.40E-03	2.65E-05	1.01	FLOOD IN REACTOR BUILDING DUE TO BREAK IN CRD SYSTEM
FLOOD-RB-RWCU-POWER	3.40E-03	3.24E-04	1.09	FLOOD IN REACTOR BUILDING DUE TO BREAK IN RWCU SYSTEM
FLOOD-TB-ALL-POWER	2.80E-02	9.97E-01	35.59	FLOOD IN TURBINE BUILDING DUE TO BREAK IN CIRC SYSTEM
G21-ACV-CC-F321	2.00E-03	2.56E-04	1.13	AOV F321 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-ACV-CC-F322	2.00E-03	2.56E-04	1.13	AOV F322 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-ACV-CC-F332	2.00E-03	7.47E-03	4.73	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-ACV-TM-F321/F322	8.00E-04	8.84E-05	1.11	AOVs F321 OR F322 IN MAINTENANCE OR TEST
G21-STR-CF-SPPLUG	1.01E-03	1.30E-04	1.13	CCF FILTER/STRAINER IN PSP TO PLUG
G21-UV_-CC-F331	1.60E-03	2.04E-04	1.13	CHECK VALVE F331 FAILS TO OPEN
G21-UV_-CC-F333	1.60E-03	5.94E-03	4.71	CHECK VALVE F333 FAILS TO OPEN
G21-UV_-CC-F348	1.60E-03	2.04E-04	1.13	CHECK VALVE F348 FAILS TO OPEN
G21-UV_-TM-F332/333	8.00E-04	2.94E-03	4.67	MAINTENANCE FOR CV F332 OR CV F333
G21-XHE-FO-LPCIADS	1.61E-02	2.30E-03	1.14	OPERATOR FAILS TO ALIGN AND ACTUATE FAPCS IN LPCI MODE
G21-XHE-MH-F334	4.80E-02	2.17E-01	5.29	MISPOSITION OF VALVE F334

Table 13-9

Internal Flooding Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Full Power
Core Damage Frequency = 3.68E-09

Event Name	Probability	F-V	RAW	Description
G31-ACV-OO-F006A	2.00E-03	1.11E-04	1.06	NOV F006A FAILS TO OPERATE TO DEENER. POSITION.
G31-ACV-OO-F3A	2.00E-03	2.47E-04	1.12	AOV F3A FAILS TO CLOSE
G31-BV_-OO-BOC	2.63E-04	3.91E-06	1.01	MANUAL VALVE RWCU BOC ISOLATION FAILS
G31-MOV-OO-F005A	4.00E-03	1.11E-04	1.03	MOTOR OPER. VALVE F005A FAILS TO CLOSE
G31-XHE-FO-MIBOC	5.32E-04	7.88E-06	1.01	OPERATOR FAILS IN MANUAL ISOLATION AFTER BOC IN RWCU
H23-EMS-CF-ALL	1.80E-06	1.51E-05	9.39	CCF OF ESSENTIAL MULTIPLEXING SYSTEM DIV 1/2/3/4
H23-EMS-CF-DIDALL	1.80E-06	4.10E-04	228.67	CCF OF ALL DIVISION OF THE EMS
H23-EMS-FC-DIVADID	6.00E-04	3.52E-05	1.06	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION
H23-RMU-CF-ALL	9.00E-07	4.75E-06	6.25	CCF OF REMOTE MULTIPLEXING UNITS TO OPERATE
H23-RMU-CF-DIDALL	9.00E-07	2.05E-04	228.7	CCF OF REMOTE MULTIPLEXING UNITS (DID)
H23-RMU-FC-ESF1ADID	3.00E-04	1.23E-05	1.04	1ST DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF2ADID	3.00E-04	1.23E-05	1.04	2ND DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
N21-ACV-OC-F016	1.31E-03	9.39E-05	1.07	AIR OPERATED VALVE N21-F016 FAILS TO REMAIN OPEN
N21-ACV-OC-F018	1.31E-03	2.42E-04	1.18	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
N21-LT_-CF-FWTKNO	4.38E-05	1.00E-04	3.28	CCF FEEDWATER STORAGE TANK LEVEL TRANSMITTERS
N21-LT_-NO-FWTKA	8.71E-03	3.74E-04	1.04	LEVEL TRANSMITTER TRAIN A FAILS
N21-LT_-NO-FWTKB	8.71E-03	3.74E-04	1.04	LEVEL TRANSMITTER TRAIN B FAILS
N21-LT_-NO-FWTKC	8.71E-03	3.74E-04	1.04	LEVEL TRANSMITTER TRAIN C FAILS
N21-MOV-CC-F061	3.13E-02	9.39E-05	1	MOTOR OPERATED VALVE N21-F061 FAILS TO OPEN
P22-ACV-FT-BYPASS	2.00E-03	3.68E-04	1.18	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
P30-XHE-MH-F015	4.80E-02	1.59E-03	1.03	MISPOSITION OF VALVE F01T
R10-CBU-FC-PRE500KV	7.20E-05	3.71E-05	1.51	500KV TRANSMISSION LINE FAILS
R11-BAC-TM-R11B2	4.80E-06	8.43E-06	2.76	6.9 KV AC BUS R11-B2 IN MANTENANCE
R12-LCB-CO-A2R12A202A	1.44E-05	1.91E-05	2.32	CIRCUIT BREAKER IN R12-A2-02A OPENS SPURIOUSLY
R12-LCB-CO-B2R12B202B	1.44E-05	1.28E-05	1.88	CIRCUIT BREAKER IN R12-B2-02B OPENS SPURIOUSLY

Table 13-9

Internal Flooding Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Full Power
Core Damage Frequency = 3.68E-09

Event Name	Probability	F-V	RAW	Description
R12-LCB-CO-FA2R12A202A	1.44E-05	1.91E-05	2.32	CIRCUIT BREAKER FROM BUS R11-A2 OPENS SPURIOUSLY
R12-LCB-CO-FB2R12B202B	1.44E-05	1.28E-05	1.88	CIRCUIT BREAKER FROM BUS R11-B2 OPENS SPURIOUSLY
R12-XFL-LP-R12A202A	1.92E-05	2.53E-05	2.32	TRANSFORMER TO R12-A2-02AFAILS TO OPERATE
R12-XFL-LP-R12B202B	1.92E-05	1.69E-05	1.88	TRANSFORMER TO R12-B2-02B FAILS TO OPERATE
R13-LCB-CO-FR13A12	1.44E-05	1.91E-05	2.32	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13B12	1.44E-05	1.28E-05	1.88	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13A12	1.44E-05	1.91E-05	2.32	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13B12	1.44E-05	1.28E-05	1.88	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-TOR13A1	1.44E-05	1.91E-05	2.32	CIRCUIT BREAKER TO R13-A1 OPENS SPURIOUSLY
R13-LCB-CO-TOR13B1	1.44E-05	1.28E-05	1.88	CIRCUIT BREAKER TO R13-B1 OPENS SPURIOUSLY
R13-XFL-LP-R13A12	1.92E-05	2.53E-05	2.32	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13B12	1.92E-05	1.69E-05	1.88	TRANSFORMER FAILS DURING OPERATION
R16-BT_-CF-ALLBATT	9.00E-06	3.71E-05	5.11	BATTERY CCF #2
T10-XHE-FO-CLOSEIVS	1.77E-02	2.12E-04	1.01	OPERATOR FAILS TO MANUALLY CLOSE ISOLATION VALVES
T11-SYS-FF-OPEN	5.69E-02	2.65E-05	1	ALL OVERPRESSURE PROTECTION VALVES FAIL TO OPEN
U43-SYS-FF-LPCI	2.40E-02	2.08E-03	1.08	U43 HARDWARE FAILURES
U43-SYS-FF-YARD	2.00E-03	9.87E-06	1	HARDWARE FAILURES IN YARD AREA
U43-XHE-FO-LPCIADS	1.61E-02	1.38E-03	1.08	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
U43-XHE-FO-YARD	1.77E-03	8.73E-06	1	OPERATOR FAILS TO MAKE UP FROM YARD AREA
XXX-POL-RP-IC/PCC	3.00E-07	8.37E-06	28.89	LOSS OF IC/PCC POOL WATER DUE TO BREAK DURING ACCIDENT
XXX-XHE-FO-DEPRESS	1.61E-01	2.65E-05	1	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION
XXX-XHE-FO-ICPCCS	1.61E-03	2.61E-05	1.02	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS

Table 13-10

Internal Flooding Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Shutdown
Core Damage Frequency = 1.64E-09

Event Name	Probability	F-V	RAW	Description
B21-LT_-CF-N001ABCD	1.20E-07	2.97E-03	2.47E+04	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
B21-SQV-CF-DPVOPEN	1.50E-05	4.04E-05	3.69	CCF OF DPV'S TO OPEN
B21-UV_-CC-F102A	1.60E-03	4.72E-03	3.95	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F102B	1.60E-03	8.26E-03	6.16	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103A	1.60E-03	4.72E-03	3.95	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F103B	1.60E-03	8.26E-03	6.16	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
B32-ACV-CF-2ICABCD	1.55E-05	5.32E-05	4.42	CCF TO OPEN 2/4 ACV VALVES TRAINS A,B,C,D
B32-MOV-CF-2ICABCD	8.08E-06	2.77E-05	4.42	CCF TO OPEN 2/4 MOV VALVES TRAINS A,B,C,D
C12-MCB-OO-C001B	1.00E-03	1.11E-04	1.11	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
C12-MOV-CC-F014A	4.00E-03	1.85E-03	1.46	MOTOR OPER. VALVE F014A FAILS TO OPEN
C12-MOV-CC-F014B	4.00E-03	1.85E-03	1.46	MOTOR OPER. VALVE F014B FAILS TO OPEN
C12-MOV-CC-F020A	4.00E-03	9.41E-04	1.23	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	5.75E-04	1.14	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-CF-OPEN	1.78E-04	8.21E-04	5.62	CCF MOV TO OPEN
C12-MOV-FC-F020A	3.13E-03	7.36E-04	1.23	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	4.50E-04	1.14	FLOW CONTROL B FAILS WIDE OPEN
C12-MP_-FS-C001BOIL	2.40E-03	3.45E-04	1.14	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
C12-MPC-FS-C001B	2.40E-03	3.45E-04	1.14	MOTOR-DRIVEN PUMP C001B FAILS TO START
C12-OR_-PG-D007A	6.48E-04	1.08E-04	1.17	ORIFICE D007A FAILS TO REMAIN OPEN (PLUG)
C12-OR_-PG-D007B	6.48E-04	7.22E-05	1.11	ORIFICE D007B FAILS TO REMAIN OPEN (PLUG)
C12-SYS-TM-TRAINB	3.00E-03	4.32E-04	1.14	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	8.26E-03	6.16	CHECK VALVE F022 FAILS TO OPEN
C12-XHE-MH-F003B	1.20E-02	1.76E-03	1.14	MISPOSITION OF VALVE F003B
C12-XHE-MH-F013A	4.80E-02	2.74E-02	1.54	MISPOSITION OF VALVE F013A

Table 13-10

Internal Flooding Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Shutdown
Core Damage Frequency = 1.64E-09

Event Name	Probability	F-V	RAW	Description
C12-XHE-MH-F013B	4.80E-02	2.74E-02	1.54	MISPOSITION OF VALVE F013B
C12-XHE-MH-F015A	4.80E-02	2.74E-02	1.54	MISPOSITION OF VALVE F015A
C12-XHE-MH-F015B	4.80E-02	2.74E-02	1.54	MISPOSITION OF VALVE F015B
C12-XHE-MH-F018A	1.20E-02	2.91E-03	1.24	MISPOSITION OF VALVE F018A
C12-XHE-MH-F018B	1.20E-02	1.76E-03	1.14	MISPOSITION OF VALVE F018B
C12-XHE-MH-F021A	1.20E-02	2.91E-03	1.24	MISPOSITION OF VALVE F021A
C12-XHE-MH-F021B	1.20E-02	1.76E-03	1.14	MISPOSITION OF VALVE F021B
C51-ACT-CF-APRMSTUCK	2.10E-07	5.20E-03	2.47E+04	CCF APRM DETECTORS STUCK AT POWER LEVEL
C62-DTM-CF-N1EALL	5.50E-05	2.54E-04	5.62	CCF OF DIGITAL TRIP MODULES NO 1E
C62-VLU-CF-DIDALL	3.12E-05	2.27E-04	8.26	CCF OF VOTER LOGIC UNITS
C74-DTM-CF-ALL	1.20E-05	8.79E-05	8.3	CCF 3/4 DTM OF SSLC DIV1/2/3/4
C74-VLU-CF-ALL	3.12E-06	1.44E-05	5.57	CCF OF VOTER LOGIC UNITS
E50-MP_-TM-POOLB	1.00E-02	7.85E-02	8.77	GDCS POOL B IN MAINTENANCE
E50-OR_-CF-7PLUG	7.00E-08	1.73E-03	2.47E+04	CCF OF 7 ORIFICES TO PLUG
E50-OR_-CF-PLUGALL	7.20E-08	1.78E-03	2.47E+04	CCF OF ALL ORIFICES TO PLUG
E50-OR_-PG-D001A	1.44E-05	2.16E-05	2.48	ORIFICE 001A FAILS TO REMAIN OPEN (PLUG) [# 5]
E50-OR_-PG-D001D	1.44E-05	2.16E-05	2.48	ORIFICE 001D FAILS TO REMAIN OPEN (PLUG) [# 5]
E50-OR_-PG-D001E	1.44E-05	2.16E-05	2.48	ORIFICE 001E FAILS TO REMAIN OPEN (PLUG) [# 5]
E50-OR_-PG-D001H	1.44E-05	2.16E-05	2.48	ORIFICE 001H FAILS TO REMAIN OPEN (PLUG) [# 5]
E50-SQV-CC-F002A	3.00E-03	2.29E-02	8.61	SQUIB VALVE F002A FAILS TO OPERATE
E50-SQV-CC-F002D	3.00E-03	2.29E-02	8.61	SQUIB VALVE F002D FAILS TO OPERATE
E50-SQV-CC-F002E	3.00E-03	2.29E-02	8.61	SQUIB VALVE F002E FAILS TO OPERATE
E50-SQV-CC-F002H	3.00E-03	2.29E-02	8.61	SQUIB VALVE F002H FAILS TO OPERATE
E50-SQV-CF-4OPEN	1.50E-05	1.30E-04	9.64	CCF OF 4 OR MORE SQUIB VALVES TO OPEN
E50-SQV-CF-EQALLOPEN	3.00E-05	9.59E-05	4.18	CCF OF ALL 4 SQUIB VALVES TO OPEN

Table 13-10

Internal Flooding Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Shutdown
Core Damage Frequency = 1.64E-09

Event Name	Probability	F-V	RAW	Description
E50-SQV-CF-F002A/2E	3.60E-05	1.66E-04	5.61	CCF OF SQUIB VALVES F002A/ F002E
E50-SQV-CF-F002D/2H	3.60E-05	1.66E-04	5.61	CCF OF SQUIB VALVES F002D/ F002H
E50-SQV-CF-GDCS7OPEN	1.50E-05	3.78E-01	2.52E+04	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
E50-SQV-CF-OPENALL	1.50E-05	3.78E-01	2.52E+04	CCF OF ALL SQUIB VALVES TO OPEN
E50-SQV-CO-F009A	3.50E-03	5.23E-02	15.92	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
E50-SQV-CO-F009B	3.50E-03	2.54E-02	8.23	SQUIB DELUGE VALVE F009B SPUR. OPENING [#7]
E50-SQV-CO-F009C	3.50E-03	2.54E-02	8.23	SQUIB DELUGE VALVE F009C SPUR. OPENING [#7]
E50-SQV-CO-F009D	3.50E-03	5.23E-02	15.92	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
E50-SQV-CO-F009E	3.50E-03	5.23E-02	15.92	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
E50-SQV-CO-F009F	3.50E-03	2.54E-02	8.23	SQUIB DELUGE VALVE F009F SPUR. OPENING [#7]
E50-SQV-CO-F009G	3.50E-03	2.54E-02	8.23	SQUIB DELUGE VALVE F009G SPUR. OPENING [#7]
E50-SQV-CO-F009H	3.50E-03	5.23E-02	15.92	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
E50-SQV-CO-F009I	3.50E-03	5.23E-02	15.92	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
E50-SQV-CO-F009J	3.50E-03	2.54E-02	8.23	SQUIB DELUGE VALVE F009J SPUR. OPENING [#7]
E50-SQV-CO-F009K	3.50E-03	2.54E-02	8.23	SQUIB DELUGE VALVE F009K SPUR. OPENING [#7]
E50-SQV-CO-F009L	3.50E-03	5.23E-02	15.92	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
E50-STR-CF-SPPLUG	3.75E-04	6.38E-03	17.97	CCF FILTER/STRAINER IN PSP TO PLUG
E50-UV_-OC-F003A	1.75E-03	1.30E-02	8.39	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003D	1.75E-03	1.30E-02	8.39	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003E	1.75E-03	1.30E-02	8.39	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003H	1.75E-03	1.30E-02	8.39	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
FLOOD-FB-U43-PB6	1.08E-04	3.82E-02	354.88	FLOOD DURING SHUTDOWN IN THE FUEL BUILDING DUE TO BREAK IN FPS
FLOOD-RB-CRD-PB5	5.80E-04	8.08E-05	1.14	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD DURING MODE 5
FLOOD-RB-CRD-PB6	1.44E-04	9.09E-01	6.31E+03	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN CRD DURING MODE 6

Table 13-10

Internal Flooding Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Shutdown
Core Damage Frequency = 1.64E-09

Event Name	Probability	F-V	RAW	Description
FLOOD-RB-U43-PB6	1.44E-04	5.31E-02	369.79	FLOOD DURING SHUTDOWN IN THE REACTOR BUILDING DUE TO BREAK IN FPS
G21-ACV-CC-F332	2.00E-03	6.79E-03	4.38	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-UV_-CC-F333	1.60E-03	4.72E-03	3.95	CHECK VALVE F333 FAILS TO OPEN
G21-UV_-OC-F331	2.16E-04	5.70E-04	3.64	CHECK VALVE F331 FAILS TO CLOSE
G21-UV_-TM-F332/333	8.00E-04	2.30E-03	3.87	MAINTENANCE FOR CV F332 OR CV F333
G21-XHE-MH-F334	4.80E-02	1.70E-01	4.38	MISPOSITION OF VALVE F334
G31-ACV-OO-F006A	2.00E-03	1.15E-05	1.01	NOV F006A FAILS TO OPERATE TO DEENER. POSITION.
G31-ACV-OO-F3A	2.00E-03	9.73E-05	1.05	AOV F3A FAILS TO CLOSE
G31-MOV-OO-F005A	4.00E-03	1.15E-05	1	MOTOR OPER. VALVE F005A FAILS TO CLOSE
H23-EMS-FC-DIVADID	6.00E-04	1.65E-05	1.03	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION
N21-ACV-OC-F018	1.31E-03	2.91E-04	1.22	AIR OPERATED VALVE N21-F018 FAILS TO REMAIN OPEN
P21-MP_-CS-5ALL	6.50E-06	3.01E-05	5.61	CCF TO START PUMPS DIVISIONS A AND B
P22-ACV-FT-BYPASS	2.00E-03	4.44E-04	1.22	HEAT EXCHANGERS BYPASS VALVE FAILS TO REGULATE
P30-XHE-MH-F015	4.80E-02	7.68E-04	1.02	MISPOSITION OF VALVE F01T
P41-FAN-CS-2ALL	7.20E-06	3.34E-05	5.62	CCF TO START 2 FAN UNITS
P41-MP_-CR-3ALL	1.17E-05	5.43E-05	5.62	CCF TO RUN 3 PUMPS TRAINS A AND B
P41-MP_-CS-3ALL	6.26E-06	2.90E-05	5.62	CCF TO START PUMPS TRAINS A AND B
P41-STR-CF-3ALL	1.07E-05	4.94E-05	5.61	CCF 3 STRAINERS PLUGGED
P51-CMP-CR-RUN	1.49E-04	3.31E-05	1.22	CCF OF P51 COMPRESSORS TO RUN
R10-CBU-FC-PRE500KV	7.20E-05	1.57E-04	3.18	500KV TRANSMISSION LINE FAILS
R16-BT_-CF-ALLBATT	9.00E-06	1.57E-04	18.41	BATTERY CCF #2
T10-XHE-FO-CLOSEIVS	1.77E-02	1.02E-04	1.01	OPERATOR FAILS TO MANUALLY CLOSE ISOLATION VALVES
U43-SYS-FF-LPCI	2.40E-02	8.52E-02	4.46	U43 HARDWARE FAILURES
U43-XHE-FO-LPCIADS	1.61E-02	5.71E-02	4.49	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
XXX-XHE-FO-DEPRESS	1.61E-01	2.02E-05	1	OPERATOR FAILS TO RECOGNIZE NEED OF DEPRESSURIZATION

Table 13-10

Internal Flooding Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Flooding Shutdown
Core Damage Frequency = 1.64E-09

Event Name	Probability	F-V	RAW	Description
XXX-XHE-FO-LPMAKEUP	1.61E-01	5.72E-01	3.98	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
B21-LT_-CF-N001ABCD	1.20E-07	2.97E-03	2.47E+04	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
B21-SQV-CF-DPVOPEN	1.50E-05	4.04E-05	3.69	CCF OF DPV'S TO OPEN
B21-UV_-CC-F102A	1.60E-03	4.72E-03	3.95	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F102B	1.60E-03	8.26E-03	6.16	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103A	1.60E-03	4.72E-03	3.95	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F103B	1.60E-03	8.26E-03	6.16	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
B32-ACV-CF-2ICABCD	1.55E-05	5.32E-05	4.42	CCF TO OPEN 2/4 ACV VALVES TRAINS A,B,C,D
B32-MOV-CF-2ICABCD	8.08E-06	2.77E-05	4.42	CCF TO OPEN 2/4 MOV VALVES TRAINS A,B,C,D
C12-MCB-OO-C001B	1.00E-03	1.11E-04	1.11	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
C12-MOV-CC-F014A	4.00E-03	1.85E-03	1.46	MOTOR OPER. VALVE F014A FAILS TO OPEN
C12-MOV-CC-F014B	4.00E-03	1.85E-03	1.46	MOTOR OPER. VALVE F014B FAILS TO OPEN
C12-MOV-CC-F020A	4.00E-03	9.41E-04	1.23	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	5.75E-04	1.14	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-CF-OPEN	1.78E-04	8.21E-04	5.62	CCF MOV TO OPEN
C12-MOV-FC-F020A	3.13E-03	7.36E-04	1.23	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	4.50E-04	1.14	FLOW CONTROL B FAILS WIDE OPEN
C12-MP_-FS-C001BOIL	2.40E-03	3.45E-04	1.14	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
C12-MPC-FS-C001B	2.40E-03	3.45E-04	1.14	MOTOR-DRIVEN PUMP C001B FAILS TO START
C12-OR_-PG-D007A	6.48E-04	1.08E-04	1.17	ORIFICE D007A FAILS TO REMAIN OPEN (PLUG)
C12-OR_-PG-D007B	6.48E-04	7.22E-05	1.11	ORIFICE D007B FAILS TO REMAIN OPEN (PLUG)
C12-SYS-TM-TRAINB	3.00E-03	4.32E-04	1.14	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	8.26E-03	6.16	CHECK VALVE F022 FAILS TO OPEN
C12-XHE-MH-F003B	1.20E-02	1.76E-03	1.14	MISPOSITION OF VALVE F003B

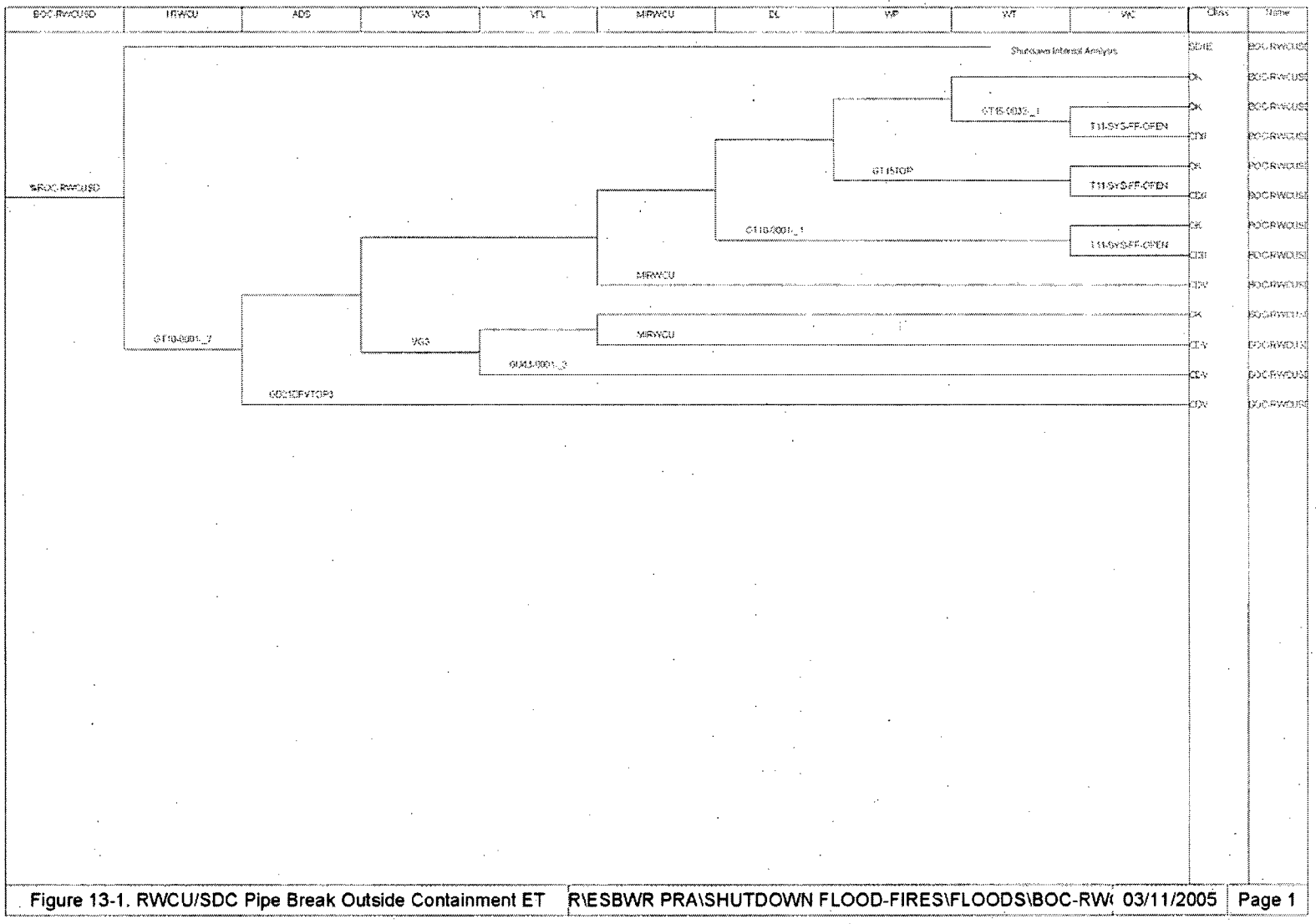

Figure 13-1. RWCU/SDC Pipe Break Outside Containment Event Tree

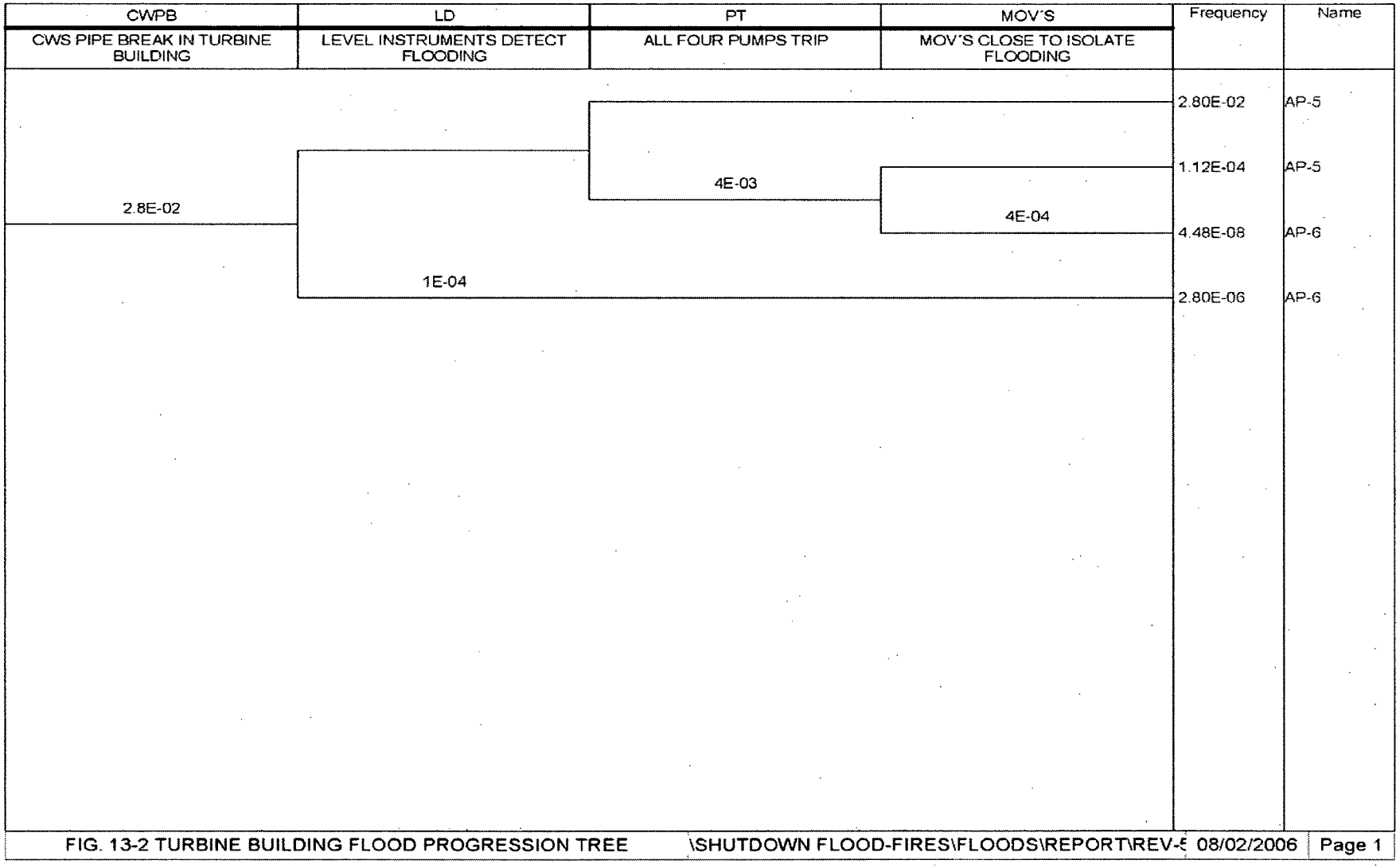

Figure 13-2. Turbine Building Flood Progression Event Tree

14 HIGH WIND RISK

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14 HIGH WIND RISK

This section documents the high winds analysis of the ESBWR PRA.

14.1 INTRODUCTION

The probabilistic high winds analysis is performed to assess the impacts of high wind forces on the safe operation of the ESBWR plant.

Previous EPRI assessment (Reference 14-3) of the exhaustive external events identified in the PRA Procedures Guide (Reference 14-1) determined that events hazards other than tornado and earthquake are not significant contributors to ALWR core damage risk, based on design, proper siting, and low probability of occurrence. That assessment is considered fully applicable to ESBWR design. As such, the ESBWR high wind analysis explicitly quantifies accident sequences initiated by tornado winds. Straight winds are lesser velocity winds that pose minimal challenges to the plant design. Hurricane winds are very site specific and are not specifically analyzed in this analysis.

The analysis shows that the core damage frequency due to high winds is a non-significant contributor to ESBWR core damage risk.

The scope of the analysis includes both at-power and shutdown tornado-induced accident scenarios.

14.2 METHODOLOGY

The tornado risk analysis follows the same approach applied in the ABWR Probabilistic Risk Assessment (PRA) (Reference 14-2). The analysis involves the following three major steps:

(1) Tornado hazard frequency

(2) Tornado-induced plant impacts

(3) Calculation of tornado-induced core damage frequencies

The tornado hazard frequency is based on generic data (Reference 14-4). The tornado-induced plant impacts are based on a qualitative evaluation based on ESBWR plant design criteria (Reference 14-3). The internal events PRA accident sequence structures and system fault trees and success criteria are used in the calculation of the tornado CDF.

Both at-power and shutdown tornado-induced accident scenarios are quantified.

14.3 CALCULATION OF THE TORNADO STRIKE FREQUENCY

This section documents the calculation of the annual exceedance frequency for the tornado hazard. The tornado hazard is a function of tornado strike frequency and intensity. A commonly used definition of tornado intensity is the Fujita, or F-scale, tornado wind speed intensity relationship developed by Dr. Theodore Fujita of the University of Chicago. The Fujita F-scale is a classification based on increasing intensity from F-0 to F-6, with each level corresponding to a range of wind speeds. The intensity levels and associated wind speeds are summarized in Table 14-1.

As part of the support provided to EPRI in the development of the ALWR Requirements Document, ARSAP (Reference 14.3) performed an evaluation of ALWR designs (as defined by the EPRI ALWR Requirements Document) to identify vulnerabilities to tornado events, and developed a model and approach to quantitatively estimate expected ALWR core damage frequency due to tornado strikes. Results of this activity are documented in Reference 14-3. Reference 14-3 is used as the basis for the tornado hazard frequency.

The ARSAP tornado evaluation developed expected tornado strike frequencies from regional historical data summarized in an EPRI report on tornado missile risk assessment (Reference 14-4). Tornadoes were combined to generate total regional frequencies per square mile per year. The ESBWR tornado strike frequency is estimated by multiplying the regional values by an assumed plant area of approximately 0.363 square kilometers (0.14 square miles). The maximum assessed regional value of 2.86E-05 tornado strikes per year is calculated as ESBWR tornado risk initiating event frequency. This tornado hazard frequency is considered conservative because this frequency applies to tornadoes F-1 and higher, where F-1 tornadoes are of lower intensity with little likelihood of causing significant plant damage.

The 2.86E-05/yr tornado strike frequency is apportioned for at-power conditions and shutdown conditions, for use in the at-power and shutdown accident sequence calculations. As discussed in Section 13.4.2, the fraction of time the ESBWR plant is expected to be at-power in a given year is 0.97 (1.0 – 0.0312). Therefore, the at-power tornado initiating event frequency is 0.97 x 2.86E-05/yr = 2.77E-05/yr.

The fraction of time the plant is expected to be in shutdown in a given year is 0.0312. The shutdown tornado initiating event frequencies used in this analysis are:

- Tornado strike frequency (Mode 5): 4.02E-07/yr
- Tornado strike frequency (Mode 6-Unflooded): 9.63E-08/yr.

14.4 TORNADO IMPACT ANALYSIS

Reference 14-3 documents an evaluation of ALWR designs (as defined by the EPRI ALWR Requirements Document) that identifies vulnerabilities to tornado events. Reference 14-3 indicates most vulnerabilities found in past tornado PRAs are not expected to occur in the ESBWR and that the dominant effect of a tornado strike is expected to be a prolonged loss of offsite power. The ESBWR tornado risk analysis assumes the following impacts occur with a probability of 1.0 given a tornado strike:

- Switchyard component failures (i.e., loss of preferred power)
- Condensate storage tank failure
- No offsite power recovery within 24 hours of the tornado strike

14.5 CALCULATION OF CORE DAMAGE FREQUENCY

The internal events PRA accident sequence structures and system fault trees and success criteria are used in the calculation of the tornado CDF. The CDF quantifications are performed at a quantification truncation limit of 1E-14/yr.

Both at-power and shutdown tornado-induced accident sequences are quantified.

14.5.1 At-Power Core Damage Frequencies

To assess the ESBWR at-power tornado induced core damage risk, the loss of offsite power event tree of Section 3 is quantified using the frequency of tornado strikes per year at-power as the initiating event frequency.

In addition, the following assumptions are made to reflect the ARSAP qualitative evaluation of the expected ALWR tornado strike vulnerabilities:

- Condensate storage tank failed
- Power conversion and feedwater systems unavailable due to loss of offsite power
- No offsite power recovery within 24 hours.

The remaining assumptions and conditions for the tornado accident sequence analysis are the same as those documented in Section 3 for the loss of offsite power and station blackout event trees.

14.5.2 Shutdown Core Damage Frequencies

The shutdown mode tornado initiating event frequencies are used in the internal events shutdown event trees, with the same modeling assumptions discussed previously.

Tornado scenarios during Mode 5 and Mode 6-Unflooded are explicitly quantified. Scenarios during Mode 6-Flooded are not explicitly quantified in the accident sequence analysis. Tornadoes during shutdown cause loss of DHR type initiators, but during Mode 6-Flooded the time to reach RCS boiling is very long. As such, the risk contribution from Mode 6-Flooded tornado scenarios is not significant.

14.6 RESULTS

The core damage frequency results of the ESBWR tornado risk analysis are summarized in Table 14-2. The total core damage frequency for both at-power and shutdown conditions is 4.86E-11/yr (4.77E-11/yr at-power and 8.67E-13/yr during shutdown). This frequency is non-significant in comparison to the internal events result and the core damage frequency goal. Because the tornado-induced CDF is non-significant, the current high-level evaluation is sufficient and more detailed analysis is not warranted.

The dominant cutsets for the at-power tornado CDF are provided in Table 14-3, and those for shutdown tornado CDF are provided in Table 14-4.

The risk importance measures for the at-power tornado CDF are provided in Table 14-5, and those for shutdown internal fires CDF are provided in Table 14-6.

14.7 INSIGHTS

The main contributors to the tornado core damage risk (in terms of percent contribution to CDF) are common cause failures of the GDCS squib valves and operator action errors in aligning alternative low pressure injection systems. The importance of low pressure injection systems in the tornado risk profile is due to initiation of ADS that occurs in certain equipment failure scenarios. The initial water level shrinkage in the vessel following a loss of feedwater type event causes level to drop below Level 1.5, which initiates a 15 minute ADS timer. Two CRD pumps are required for injection to bring level above Level 1.5 within 15 minutes to prevent automatic ADS. Failure of one CRD pump or one diesel during the modeled tornado accident will ultimately result in automatic emergency depressurization and reliance on low pressure injection systems to maintain adequate core cooling.

14.8 CONCLUSIONS

The main conclusion that can be drawn from the ESBWR tornado risk analysis is that the risk from tornado strikes on the plant is acceptably low. The estimated core damage frequency (both at-power and shutdown conditions) from tornadoes is 4.86E-11 per calendar year.

The ESBWR is inherently safe with respect to tornado events and the plant can be safely shut down at low risk to plant personnel and the general public.

14.9 REFERENCES

14-1 PRA Procedures Guide – A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants, NUREG/CR-2300, Final Report, U.S. Nuclear Regulatory Commission, January 1983.

14-2 ABWR – Design Control Document Tier 2 Chapter 19.4, 23A6100 Rev. 9

14-3 Summit, R.L., Estimation of Core Damage Frequency for Advanced Light Water Reactors Due to Tornado Events (Task 4.3.2.1), Advanced Reactor Severe Accident Program, U.S. Department of Energy, December 1988.

14-4 Tornado Missile Simulation and Design methodology, Volumes 1 and 2, EPRI NP-2005, Electric Power Research Institute, August 1981.

Table 14-1

Tornado F-Scale Intensities

F-Scale	Wind Speed (mph)
F-0	≤ 72
F-1	73-112
F-2	113-157
F-3	158-206
F-4	207-260
F-5	261-317
F-6	≥ 318

Table 14-2

Tornado-Induced CDF

Plant Mode	Tornado Strike Frequency (per year)	CDF (per year) (1)
At-Power	2.77E-05	4.77E-11
Shutdown Mode 5	4.02E-07	Negligible(2)
Shutdown Mode 6-Unflooded	9.63E-08	8.67E-13

Notes:

(1) The quantification is performed at a truncation limit of 1E-14/yr.

(2) No accident sequence cutsets remained above the quantification truncation limit.

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
1	9.37E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
2	9.37E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
3	9.37E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
4	9.37E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
5	8.03E-13	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
6	8.03E-13	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
7	8.03E-13	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
8	8.03E-13	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
9	8.03E-13	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
10	8.03E-13	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
11	8.03E-13	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
12	8.03E-13	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
13	8.03E-13	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
14	8.03E-13	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
15	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMAA2	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
16	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMBB2	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
17	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
18	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
19	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
20	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
21	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
22	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
23	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
24	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
25	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
26	5.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
27	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMAA2	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
28	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMBB2	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
29	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
30	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
31	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
32	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
33	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-1LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
34	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
35	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
36	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
37	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
38	5.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R22-MCB-CC-2LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
39	4.99E-13	9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.00E-03	U43-SYS-FF-YARD	HARDWARE FAILURES IN YARD AREA
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
40	4.41E-13	9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		1.77E-03	U43-XHE-FO-YARD	OPERATOR FAILS TO MAKE UP FROM YARD AREA
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
41	4.01E-13	9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		1.61E-03	XXX-XHE-FO-ICPCCS	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
42	4.01E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.00E-03	R21-DG_-TM-DGA	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
43	4.01E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.00E-03	R21-DG_-TM-DGB	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
44	4.01E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.00E-03	R21-DG_-TM-DGA	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
45	4.01E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.00E-03	R21-DG_-TM-DGB	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
46	2.79E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
47	2.79E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
48	2.79E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
49	2.79E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
50	2.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
51	2.68E-13	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
52	2.68E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
53	2.68E-13	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
54	2.68E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.00E-03	R21-SYS-FC-FUELDG4	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
55	2.68E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.00E-03	R21-SYS-FC-FUELDG5	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
56	2.68E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.00E-03	R21-SYS-FC-FUELDG4	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
57	2.68E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.00E-03	R21-SYS-FC-FUELDG5	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
58	2.39E-13	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
59	2.39E-13	1.20E-02	C12-XHE-MH-F003B	MISPOSITION OF VALVE F003B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
60	2.39E-13	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
61	2.39E-13	1.20E-02	C12-XHE-MH-F018A	MISPOSITION OF VALVE F018A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
62	2.39E-13	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
63	2.39E-13	1.20E-02	C12-XHE-MH-F018B	MISPOSITION OF VALVE F018B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
64	2.39E-13	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	Cutset Prob	Event Prob	Event	Description
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
65	2.39E-13	1.20E-02	C12-XHE-MH-F021A	MISPOSITION OF VALVE F021A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
66	2.39E-13	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
67	2.39E-13	1.20E-02	C12-XHE-MH-F021B	MISPOSITION OF VALVE F021B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
68	2.09E-13	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
69	2.09E-13	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
70	2.09E-13	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
71	2.09E-13	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
72	2.01E-13	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
73	2.01E-13	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
74	1.61E-13	2.40E-03	C12-MP_-FS-C001AOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001A FAILS TO RESTART
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
75	1.61E-13	2.40E-03	C12-MP_-FS-C001AOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001A FAILS TO RESTART
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
76	1.61E-13	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
77	1.61E-13	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
78	1.61E-13	2.40E-03	C12-MPC-FS-C001A	MOTOR-DRIVEN PUMP C001A FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
79	1.61E-13	2.40E-03	C12-MPC-FS-C001A	MOTOR-DRIVEN PUMP C001A FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
80	1.61E-13	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
81	1.61E-13	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
82	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R11-MCB-CC-XFRMAA2	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
83	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R11-MCB-CC-XFRMBB2	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
84	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
85	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.96E-03	R22-MCB-CC-1LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
86	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
87	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
88	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
89	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
90	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
91	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
92	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.96E-03	R22-MCB-CC-2LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
93	1.59E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
94	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R11-MCB-CC-XFRMAA2	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
95	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R11-MCB-CC-XFRMBB2	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
96	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
97	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
98	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
99	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.96E-03	R22-MCB-CC-1LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
100	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-1LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
101	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
102	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
103	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
104	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
105	1.59E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		7.96E-03	R22-MCB-CC-2LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
106	1.54E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
107	1.54E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
108	1.54E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
109	1.54E-13	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
110	1.54E-13	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
111	1.54E-13	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
112	1.54E-13	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
113	1.54E-13	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
114	1.20E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-03	R21-DG_-TM-DGA	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
115	1.20E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-03	R21-DG_-TM-DGB	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
116	1.20E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-03	R21-DG_-TM-DGA	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
117	1.20E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.00E-03	R21-DG_-TM-DGB	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
118	1.07E-13	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
119	1.07E-13	1.60E-03	B21-UV_-CC-F102B	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
120	1.07E-13	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
121	1.07E-13	1.60E-03	B21-UV_-CC-F103B	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
122	1.07E-13	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
123	1.07E-13	1.60E-03	C12-UV_-CC-F022	CHECK VALVE F022 FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
124	7.98E-14	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
125	7.98E-14	4.00E-03	C12-MOV-CC-F020A	MOTOR OPER. VALVE F020A FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
126	7.98E-14	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
127	7.98E-14	4.00E-03	C12-MOV-CC-F020B	MOTOR OPER. VALVE F020B FAILS TO OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
128	7.98E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.00E-03	R21-SYS-FC-FUELDG4	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
129	7.98E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.00E-03	R21-SYS-FC-FUELDG5	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
130	7.98E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.00E-03	R21-SYS-FC-FUELDG4	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
131	7.98E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		4.00E-03	R21-SYS-FC-FUELDG5	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
132	6.69E-14	1.00E-03	C12-MCB-OO-C001A	CIRCUIT BREAKER FOR C001A & OIL PUMP A FAILS TO CLOSE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
133	6.69E-14	1.00E-03	C12-MCB-OO-C001A	CIRCUIT BREAKER FOR C001A & OIL PUMP A FAILS TO CLOSE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
134	6.69E-14	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
135	6.69E-14	1.00E-03	C12-MCB-OO-C001B	CIRCUIT BREAKER FOR C001B & AUX OIL PMP B FAILS TO CLOSE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
136	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTA	BATTERY R16-BTA IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
137	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTA1	BATTERY R16-BTA1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
138	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
139	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTB	BATTERY R16-BTB IN TEST

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
140	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTB1	BATTERY R16-BTB1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
141	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
142	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R21-MCB-OO-DGAR11A2	CIRCUIT BREAKER FROM DG-A TO R11-A2 FAILS TO CLOSE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
143	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R21-MCB-OO-DGBR11B2	CIRCUIT BREAKER FROM DG-B TO R11-B2 FAILS TO CLOSE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
144	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R21-SYS-FC-AIRDG4	AIR STARTING SYSTEM FAILURE [#13]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
145	6.69E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.00E-03	R21-SYS-FC-AIRDG5	AIR STARTING SYSTEM FAILURE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
146	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTA	BATTERY R16-BTA IN TEST

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
147	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTA1	BATTERY R16-BTA1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
148	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
149	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTB	BATTERY R16-BTB IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
150	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTB1	BATTERY R16-BTB1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
151	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
152	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R21-MCB-OO-DGAR11A2	CIRCUIT BREAKER FROM DG-A TO R11-A2 FAILS TO CLOSE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
153	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R21-MCB-OO-DGBR11B2	CIRCUIT BREAKER FROM DG-B TO R11-B2 FAILS TO CLOSE

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
154	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R21-SYS-FC-AIRDG4	AIR STARTING SYSTEM FAILURE [#13]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
155	6.69E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.00E-03	R21-SYS-FC-AIRDG5	AIR STARTING SYSTEM FAILURE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
156	6.23E-14	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
157	6.23E-14	3.13E-03	C12-MOV-FC-F020A	FLOW CONTROL A FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
158	6.23E-14	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
159	6.23E-14	3.13E-03	C12-MOV-FC-F020B	FLOW CONTROL B FAILS WIDE OPEN
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
160	5.98E-14	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
161	5.98E-14	3.00E-03	C12-SYS-TM-TRAINB	TRAIN B IN MAINTENANCE
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
162	5.70E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.52E-04	R21-DG_-CS-ALLDG	CCF OF DIESEL GENERATORS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
163	5.70E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.52E-04	R21-DG_-CS-ALLDG	CCF OF DIESEL GENERATORS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
164	5.35E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	R22-RE_-FD-10A11	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
165	5.35E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		8.00E-04	R22-RE_-FD-10A21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
166	5.35E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	R22-RE_-FD-10A11	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
167	5.35E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		8.00E-04	R22-RE_-FD-10A21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
168	4.79E-14	2.40E-03	C12-MP_-FS-C001AOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001A FAILS TO RESTART
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
169	4.79E-14	2.40E-03	C12-MP_-FS-C001AOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001A FAILS TO RESTART
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
170	4.79E-14	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
171	4.79E-14	2.40E-03	C12-MP_-FS-C001BOIL	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
172	4.79E-14	2.40E-03	C12-MPC-FS-C001A	MOTOR-DRIVEN PUMP C001A FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
173	4.79E-14	2.40E-03	C12-MPC-FS-C001A	MOTOR-DRIVEN PUMP C001A FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
174	4.79E-14	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
175	4.79E-14	2.40E-03	C12-MPC-FS-C001B	MOTOR-DRIVEN PUMP C001B FAILS TO START
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
176	4.60E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
177	4.60E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
178	4.60E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
179	4.60E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
180	4.60E-14	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
181	4.60E-14	4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
182	4.60E-14	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
183	4.60E-14	4.80E-02	C12-XHE-MH-F015A	MISPOSITION OF VALVE F015A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
184	4.01E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.00E-04	H23-EMS-FC-DIVADID	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
185	4.01E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.00E-04	H23-EMS-FC-DIVBDID	ESSENTIAL MULTIPLEXING SYSTEM DIV B (DID) FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
186	4.01E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.00E-04	H23-EMS-FC-DIVADID	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
187	4.01E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.00E-04	H23-EMS-FC-DIVBDID	ESSENTIAL MULTIPLEXING SYSTEM DIV B (DID) FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
188	3.34E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTA	BATTERY R16-BTA FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
189	3.34E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTA1	BATTERY R16-BTA1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
190	3.34E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTA2	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
191	3.34E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTB	BATTERY R16-BTB FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
192	3.34E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTB1	BATTERY R16-BTB1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
193	3.34E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTB2	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
194	3.34E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTA	BATTERY R16-BTA FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
195	3.34E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTA1	BATTERY R16-BTA1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
196	3.34E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTA2	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
197	3.34E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTB	BATTERY R16-BTB FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
198	3.34E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTB1	BATTERY R16-BTB1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
199	3.34E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		5.00E-04	R16-BT_-LP-R16BTB2	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO
200	3.21E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-04	R13-INV-FC-R13A1	INVERTER TO R13-A1 FAILS

Table 14-3

Internal Tornado Full-Power Cutset Report

Cutsets with Descriptions Report Tornado Full Power Core Damage Frequency = 4.77E-11 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		2.77E-05	TORNADO-FP	LOSS OF OFFSITE POWER DUE TO TORNADO

Table 14-4

Internal Tornado Shutdown Cutset Report

Cutsets with Descriptions Report Tornado Shutdown Core Damage Frequency = 8.67E-13 Top 200 Cutsets				
No.	**Cutset Prob**	**Event Prob**	**Event**	**Description**
1	8.67E-13	9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		9.63E-08	TORNADO-SH6	LOSS OF OFFISTE POWER DURING SHUTDOWN DUE TO TORNADO

Table 14-5

Internal Tornado Full-Power Importance Measure Report

F-V and RAW Importance Measures Report (F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure) Tornado Full Power Core Damage Frequency = 4.77E-11				
Event Name	**Probability**	**F-V**	**RAW**	**Description**
B21-UV_-CC-F102B	1.60E-03	5.12E-03	4.19	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103B	1.60E-03	5.12E-03	4.19	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
C12-MOV-CC-F020A	4.00E-03	1.28E-02	4.19	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	1.28E-02	4.19	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-FC-F020A	3.13E-03	1.00E-02	4.19	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	1.00E-02	4.19	FLOW CONTROL B FAILS WIDE OPEN
C12-MP_-FS-C001AOIL	2.40E-03	7.68E-03	4.19	MOTOR-DRIVEN AUX. OIL PUMP FOR C001A FAILS TO RESTART
C12-MP_-FS-C001BOIL	2.40E-03	7.68E-03	4.19	MOTOR-DRIVEN AUX. OIL PUMP FOR C001B FAILS TO START
C12-MPC-FS-C001A	2.40E-03	7.68E-03	4.19	MOTOR-DRIVEN PUMP C001A FAILS TO START
C12-MPC-FS-C001B	2.40E-03	7.68E-03	4.19	MOTOR-DRIVEN PUMP C001B FAILS TO START
C12-SYS-TM-TRAINB	3.00E-03	9.60E-03	4.19	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	5.12E-03	4.19	CHECK VALVE F022 FAILS TO OPEN
C12-XHE-MH-F003B	1.20E-02	4.98E-02	5.1	MISPOSITION OF VALVE F003B
C12-XHE-MH-F013A	4.80E-02	1.47E-02	1.29	MISPOSITION OF VALVE F013A
C12-XHE-MH-F013B	4.80E-02	1.47E-02	1.29	MISPOSITION OF VALVE F013B
C12-XHE-MH-F015A	4.80E-02	1.47E-02	1.29	MISPOSITION OF VALVE F015A
C12-XHE-MH-F015B	4.80E-02	1.47E-02	1.29	MISPOSITION OF VALVE F015B
C12-XHE-MH-F018A	1.20E-02	4.98E-02	5.1	MISPOSITION OF VALVE F018A
C12-XHE-MH-F018B	1.20E-02	4.98E-02	5.1	MISPOSITION OF VALVE F018B
C12-XHE-MH-F021A	1.20E-02	4.98E-02	5.1	MISPOSITION OF VALVE F021A
C12-XHE-MH-F021B	1.20E-02	4.98E-02	5.1	MISPOSITION OF VALVE F021B

Table 14-5

Internal Tornado Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Tornado Full Power
Core Damage Frequency = 4.77E-11

Event Name	Probability	F-V	RAW	Description
E50-SQV-CF-GDCS7OPEN	1.50E-05	4.84E-01	3.23E+04	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
E50-SQV-CF-OPENALL	1.50E-05	4.84E-01	3.23E+04	CCF OF ALL SQUIB VALVES TO OPEN
G21-XHE-MH-F334	4.80E-02	1.86E-01	4.7	MISPOSITION OF VALVE F334
R11-MCB-CC-XFRMAA2	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
R11-MCB-CC-XFRMBB2	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
R16-BT_-CF-ALLBATT	9.00E-06	3.21E-02	3.56E+03	BATTERY CCF #2
R21-DG_-FS-DGA	1.40E-02	5.81E-02	5.09	DIESEL GENERATOR "A" FAILS TO START
R21-DG_-FS-DGB	1.40E-02	5.81E-02	5.09	D/G "B" FAILS TO START AND LOAD
R21-DG_-TM-DGA	6.00E-03	2.49E-02	5.13	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
R21-DG_-TM-DGB	6.00E-03	2.49E-02	5.13	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE
R21-SYS-FC-FUELDG4	4.00E-03	1.28E-02	4.19	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
R21-SYS-FC-FUELDG5	4.00E-03	1.28E-02	4.19	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
R22-MCB-CC-1LOAD1	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
R22-MCB-CC-1LOAD2	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
R22-MCB-CC-1LOAD3	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
R22-MCB-CC-1LOAD4	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
R22-MCB-CC-1LOAD5	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
R22-MCB-CC-2LOAD1	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
R22-MCB-CC-2LOAD2	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
R22-MCB-CC-2LOAD3	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
R22-MCB-CC-2LOAD4	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
R22-MCB-CC-2LOAD5	7.96E-03	3.30E-02	5.12	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN

Table 14-5

Internal Tornado Full-Power Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Tornado Full Power
Core Damage Frequency = 4.77E-11

Event Name	Probability	F-V	RAW	Description
TORNADO-FP	2.77E-05	1.00E+00	3.61E+04	LOSS OF OFFSITE POWER DUE TO TORNADO
U43-SYS-FF-YARD	2.00E-03	1.19E-02	6.95	HARDWARE FAILURES IN YARD AREA
U43-XHE-FO-YARD	1.77E-03	1.06E-02	6.95	OPERATOR FAILS TO MAKE UP FROM YARD AREA
XXX-XHE-FO-ICPCCS	1.61E-03	9.60E-03	6.95	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
XXX-XHE-FO-LPMAKEUP	1.61E-01	7.82E-01	5.07	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 14-6

Internal Tornado Shutdown Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Tornado Shutdown
Core Damage Frequency = 8.67E-13

Event Name	Probability	F-V	RAW	Description
R16-BT_-CF-ALLBATT	9.00E-06	1.00E+00	1.11E+05	BATTERY CCF #2
TORNADO-SH6	9.63E-08	1.00E+00	1.04E+07	LOSS OF OFFISTE POWER DURING SHUTDOWN DUE TO TORNADO

15 SEISMIC MARGINS ANALYSIS

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15 SEISMIC MARGINS ANALYSIS

This section documents the seismic analysis of the ESBWR PRA.

15.1 INTRODUCTION

The seismic risk analysis is performed to assess the impacts of seismic events on the safe operation of the ESBWR plant.

A seismic margins analysis (SMA) is performed for the ESBWR using a modification of the fragility analysis method of Reference 15-1 to calculate high confidence low probability of failure (HCLPF) accelerations for important accident sequences and accident classes.

The analysis shows that the ESBWR plant and equipment are capable of withstanding an earthquake with a magnitude at least two times the safe shutdown earthquake (SSE) with a high confidence of low probability of failure.

The scope of the analysis includes both at-power and shutdown seismic-induced accident scenarios.

15.2 METHODOLOGY

The seismic risk assessment uses a seismic margins analysis (SMA) method based on that of Reference 15-1 to calculate high confidence low probability of failure (HCLPF) accelerations for important accident sequences and accident classes.

The seismic margins approach used in this analysis evaluates the capability of the plant and equipment to withstand an earthquake of 2 times the safe shutdown earthquake (2*SSE). (Reference 15-1)

The analysis involves the following two major steps:

(1) Seismic fragilities

(2) Accident sequence HCLPF analysis

The seismic fragilities of the ESBWR systems, structures, and components are based on generic industry information and ESBWR specific seismic capacity calculations for certain structures.

The MIN-MAX method is used in the determination of functional and accident sequence fragilities. Per the MIN-MAX method, the overall fragility of a group of inputs combined using OR logic (i.e., seismic event tree nodal fault tree) is determined by the lowest (minimum) HCLPF input. Conversely, per the MIN-MAX method, the overall fragility of a group of inputs combined using AND logic (i.e., seismic event tree sequence) is determined by the highest (maximum) HCLPF input.

Both at-power and shutdown seismic-induced accident scenarios are analyzed.

15.3 SEISMIC FRAGILITIES

15.3.1 Overview

This subsection presents seismic capacities for selected structures and components that have been identified as potentially important to the seismic risk analysis of the ESBWR standard plant. The seismic capabilities in terms of seismic fragilities are first estimated, from which the high confidence low probability of failure (HCLPF) capacities are then derived. The HCLPF capacities serve as input to the system analysis following the seismic margins approach.

The peak ground acceleration of the design earthquakes is 0.3g minimum for the Safe Shutdown Earthquake (SSE). Extensive seismic soil-structure interaction analyses of the reactor building and control building complex were performed for a wide range of generic site conditions under a 0.3g SSE and for North Anna Early Site Permit (ESP) site-specific SSE. The analysis results in terms of site-envelope SSE loads are presented in Appendix 3A of the ESBWR DCD Tier 2 Rev. 1 (Reference 15-2). The standard plant designed to these site-envelope seismic loads may result in significant design margins when it is situated at a specific site, particularly a soft soil site. Thus, the seismic capacities estimated from the site-envelope design requirements may be very conservative for certain sites.

For the seismic category I structures and components for which seismic design information is available, the seismic fragilities are evaluated using the factor of safety approach, which is called the Zion method in NUREG/CR-2300, PRA Procedures Guide (Reference 15-3). This approach identifies various conservatisms and associated uncertainties introduced in the seismic design process and provides a probabilistic estimate of the earthquake level required to fail a structure or component in a postulated failure mode by linear extrapolation of the design information supplemented by judgment.

For certain safety-related components such as pumps, valves, and electrical equipment whose design details are not currently available, the generic seismic fragilities recommended in the EPRI ALWR Utility Requirements Document, Appendix A PRA Key Assumptions and Ground rules (Reference 15-4) or other data sources (References 15-5 and 15-6) are used as appropriate. Those generic fragilities were chosen based on a review of prior PRAs and fragility data. They are considered achievable for the ESBWRs with an evolutionary improvement in the seismic capacities of the components designed to a 0.3g SSE minimum.

15.3.2 Fragility Formulation

Seismic fragility of a structure or component is defined herein to be the cumulative conditional probability of its failure as a function of the mean peak ground acceleration (i.e., the average of the peak of the two horizontal components).

The probability model adopted for fragility description is the lognormal distribution. Using the lognormal distribution assumption, an entire family of fragility curves can be fully described in terms of the median ground acceleration and two random variables as:

$$A = A_m \varepsilon_\gamma \varepsilon_\mu \qquad (15.3\text{-}1)$$

Where:

A_m = median peak ground acceleration corresponding to 50% failure probability.

ε_γ = a lognormally distributed random variable accounting for inherent randomness about the median. It is characterized by unit median and logarithmic standard deviation β_γ.

ε_μ = a lognormally distributed random variable accounting for uncertainty in the median value. It is characterized by unit median and logarithmic standard deviation β_μ.

With known values of A, β_γ, and β_μ, the failure probability P_f at acceleration less than m or equal to a given acceleration a can be computed using the following equation for any non-exceedance probability (NEP) level Q.

$$P_f(A \le a|Q) = \phi\left[\frac{1}{\beta_\gamma} In\left(\frac{a}{A_m}\right) + \frac{\beta_\mu}{\beta_\gamma}\phi^{-1}(Q)\right] \tag{15.3-2}$$

Where φ is the standard Gaussian cumulative distribution function. Figure 15-1 shows a typical family of fragility curves for various NEP levels. The center solid curve represents the median fragility curve at 50% NEP level. The logarithmic standard deviation of the randomness component β_γ determines the curve slope. The logarithmic standard deviation of the uncertainty component β_μ is a measure of the spread from the median curve. The 95th percentile and 5th percentile curves in Figure 15-1 are the upper and lower bounds of the failure probability for a given acceleration, corresponding to 95% and 5% NEP levels, respectively.

When only the point estimate is of interest, which is the case for this analysis, the total variability about the median value is taken to be the square root of the sum of the squares (SRSS) of the randomness and uncertainty components.

$$\beta_c = \sqrt{\beta_\gamma^2 + \beta_\mu^2} \tag{15.3-3}$$

The fragility curve corresponding to the median value A_m with associated composite logarithmic standard deviation can be computed by the following equation:

$$P_f(A \le a) = \phi\left[\frac{1}{\beta_c}\ln\left(\frac{a}{A_m}\right)\right] \tag{15.3-4}$$

This composite fragility curve is also called the mean fragility curve and is shown as the dashed curve in Figure 15-1 for illustration. It represents the best estimate fragility description.

In estimating the median ground acceleration capacity and the associated variability, an intermediate variable defined as safety factor F is utilized. The safety factor is related to the median ground acceleration capacity by the following relationship.

$$A_m = FA_d \tag{15.3-5}$$

Where A_d is the ground acceleration of the reference design earthquake to which the structure or component is designed. A key step in the seismic fragility estimate thus involves the evaluation of the factor of safety associated with the design for each important potential failure mode. The design margins inherent in the component capacity and the dynamic response to the specific acceleration are the two basic considerations. Each of the capacity and response margins involves several variables, and each variable has a median factor of safety and variability

associated with it. The overall factor of safety F is the product of the factor of safety for each variable F_i.

$$F = \prod_i F_i \tag{15.3-6}$$

The overall composite logarithmic standard deviation is SRSS of the composite logarithmic standard deviations in the individual factors of safety.

$$\beta_c = \sqrt{\sum_i \beta_{ci}^2} \tag{15.3-7}$$

Knowing the median peak ground acceleration (A_m) and associated logarithmic standard deviation (β_c); the HCLPF capacity is obtained using the equation below.

$$\text{HCLPF} = A_m \exp(-2.326\beta_c) \tag{15.3-7a}$$

15.3.3 Structural Fragility

The plant structures are divided into two categories according to their function and the degree of integrity required to protect the public during a seismic event. These categories are seismic category I and non-category I. Seismic category I includes those structures whose failure might cause or increase the severity of an accident, which would endanger the public health and safety. The reactor building and control building structures are in this category. The non-category I structures are those structures which are important to reactor operation, but are not essential for preventing an accident which would endanger the public health and safety, and are not essential for the mitigation of the consequences of these accidents. One example is the turbine building structure.

For the purpose of this study, structures are considered to fail functionally when inelastic deformations of the structure under seismic load increase to the extent that the operability of the safety-related components attached to the structure cannot be assured. The ductility limits chosen for structures are estimated as corresponding to the onset of significant structural damage. For many potential modes of failure, this is believed to represent a conservative bound on the level of inelastic structural deformation that might interfere with the function of the system housed within the structure.

The potential of seismic-induced soil failure such as liquefaction, differential settlement, or slope instability is highly site dependent and cannot be assessed for generic site conditions. It is assumed in this analysis that there is no soil failure potential in the range of ground motions considered.

Building-to-building impact due to differential building displacements under strong earthquakes is deemed not credible since a sufficient distance to avoid impact separates adjacent buildings. Differential building displacements of sufficient magnitude could, however, potentially result in damage to interconnecting piping, depending on system configuration and sliding resistance of building foundation. Detailed evaluation of seismic capacities of interconnecting systems against differential building displacement cannot be made due to lack of design details and specific site conditions. It is assumed that the mode of failure due to differential building displacement has a capacity no less than the generic piping fragility of 3g (Table 15-1).

15.3.3.1 Reactor Building Complex Structures

Detailed fragility evaluations were made for the following structures in the reactor building (RB) and fuel building (FB) complex. The RB and FB share the same basement and are fully integrated. The term "reactor building" when mentioned hereafter also includes the structures of the fuel building. As for the containment structure, it is enclosed by and integrated into the RB.

- Building shear walls
- Containment wall (upper drywell and wetwell)
- RPV pedestal (same as lower drywell wall)
- RPV support brackets

Those structures were evaluated according to the approach outlined previously and using various safety factors as presented below.

The factor of safety for a structure against a specific failure mode is the product of the capacity factor F_c and structural response factor F_{rs};

$$F = F_c F_{rs} \tag{15.3-8}$$

The individual factors, the capacity factor and the response factor, are discussed in the following subsections.

15.3.3.1.1 Capacity Factor (F_c)

The capacity factor represents the capability of a structure to withstand seismic excitation in excess of the design earthquake. This factor is composed of two parts:

$$F_c = F_s F_u \tag{15.3-9}$$

Where:

F_s = the ultimate structural strength margin above the design SSE load, and

F_u = the inelastic energy absorption factor accounting for additional capacity of the structure to undergo inelastic deformations beyond yield.

The capacity estimated by this approach is the elastic capacity equivalent to the actual nonlinear behavior under strong motion earthquakes.

<u>Strength Factor (Fs)</u>

The strength factor associated with seismic load can be calculated using the following equation.

$$F_s = \frac{P_u - P_n}{P_s} \tag{15.3-10}$$

Where:

P_u = the actual ultimate strength,

P_n = the normal operating loads, and

P_s = the design SSE load.

The earthquake-resistant structural elements of the reactor building are reinforced concrete shear walls that are integrated with the reinforced concrete cylindrical containment through concrete floor slabs. The specified compressive strength of concrete is 34.5 MPa for the building and 27.5 MPa for the mat. The specified yield strength of reinforcing steel of ASTM A615, Grade 60 is 414 MPa. These are design values; the actual material strengths are higher.

Concrete compressive strength used for design is normally specified as a value at a specific time after mixing (28 or 90 days). This value is verified by laboratory testing of mix samples. The strength must meet specified values, allowing a finite number of failures per number of trials. There are two major factors that affect the actual strength:

a. To meet the design specifications, the contractor attempts to create a mix that has an "average" strength somewhat above the design strength, and

b. As concrete ages, it increases in strength.

Taking those two elements into consideration, the actual compressive strength of aged concrete is commonly 1.3 times the design strength (Reference 15-7). The total logarithmic standard deviation about the median strength is about 0.13.

According to the same reference, the ratio of the median yield strength to the specified strength of reinforcing steel is taken to be 1.2 with logarithmic standard deviation of 0.12.

The median yield strength of steel plates is typically 1.25 times the code specified strength with logarithmic standard deviation of 0.14 (References 15-7 and 15-8).

The reactor building shear wall is chosen as an example for the discussion of the strength factor evaluation. For reinforced concrete shear walls the ultimate shear strength can be computed using the following equation (Reference 15-9).

$$v_u = v_c + v_s$$

$$= 8.3\sqrt{f_c} - 3.4\sqrt{f'_c}\left(\frac{h}{w} - \frac{1}{2}\right) + \frac{N}{4wt} + \rho_{se} f_y \qquad (15.3\text{-}11)$$

Where:

v_c	=	shear strength provided by concrete
v_s	=	shear strength provided by reinforcing steel
f'_c	=	concrete compressive strength
h	=	wall height
w	=	wall length
N	=	bearing load
f_y	=	yield strength of reinforcing steel
t	=	wall thickness
ρ_{se}	=	$A\rho_v + B\rho_h$

ρ_h = horizontal steel reinforcement ratio

ρ_v = vertical steel reinforcement ratio

A & B = constants depending on h/w:

	A	B
h/w< 0.5	1	0
0.5 ≤ h/w< 1.0	2(1-h/w)	(2h/w-1)
1.0 < h/w	0	1

In computing ultimate shear strength with this equation, the median material strengths of the concrete and reinforcing steel defined above are used and the wall bearing load is conservatively neglected.

The strength factor F_s is then calculated using Equation 15.3-10 for each of the levels of the reactor building shear walls. The normal operating loads do not result in lateral force and horizontal loads induced by SRV actuations are found to be negligible compared to the SSE-induced horizontal loads. Therefore, the strength factor is the ratio of the median shear strength to the design SSE shear. The lowest strength factor is found to be 2.00. The associated logarithmic standard deviation is calculated to be 0.09 using the second moment approximation (Reference 15-9) accounting for both concrete and reinforcing steel material strength variabilities. There is also an uncertainty associated with Equation 15.3-11 since it is an approximate model fit to data. The modeling uncertainty is 0.15 expressed in terms of logarithmic standard deviation (Reference 15-9). The total composite logarithmic standard deviation in the median strength factor is 0.17, which is the SRSS value of 0.09 for the material strength uncertainty and 0.15 for the equation uncertainty.

Inelastic Energy Absorption Factor (F_u)

The inelastic energy absorption factor (F_u) accounts for the fact that an earthquake represents a limited energy source and many structures are capable of absorbing substantial amounts of energy beyond yield without loss of function. The parameter commonly used to measure the energy absorption capacity in the inelastic range is the ductility ratio, μ. It is defined as the ratio of the maximum displacement to the displacement at yield. Newmark, Reference 15-10, has shown that in the amplified acceleration range (approximately 2 to 8 Hz) the inelastic energy absorption factor F_u can be estimated by

$$F_u = \varepsilon\sqrt{2\mu - 1} \qquad (15.3\text{-}12)$$

Where ε is an error variable to account for the uncertainty associated with the use of this equation. This error variable is assumed to be lognormally distributed with a median of unity and a logarithmic standard deviation ranging from 0.02 to 0.1 (Reference 15-11). For rigid structures (fundamental frequency above 20 Hz), the following equation given by Reference 15-11 may be used.

$$F_u = \varepsilon\mu^{0.13} \qquad (15.3\text{-}13)$$

Again, ε is an error variable of unit median and logarithmic standard deviation ranging from 0.02 to 0.1. For intermediate frequencies, the F_u factor can be interpolated from Eqs. 15.3-12 and 15.3-13.

According to Reference 15-7, the system ductility ratio for reinforced concrete shear walls failing in shear is 2.5. The integrated building/containment system responds in multiple modes with predominant modes up to 10 Hz. The corresponding inelastic energy absorption factor is thus about 2.0 according to Equation 15.3-12. The associated logarithmic standard deviation is 0.25 (Reference 15-7). Flexural failures tend to be more ductile than shear failures. A ductility ratio of 4.0 is estimated and the corresponding F_u is 2.65 with logarithmic standard deviation of 0.25.

Steel structures are typically more ductile than concrete structures. When local buckling is prevented, the allowable ductility ratio is 5 (Reference 15-12) for which the corresponding F_u is 3. The F_u factor is taken as unity when the failure mode is of a brittle type such as buckling or failure of high strength anchor bolts.

15.3.3.1.2 Structural Response Factor (F_{rs})

The structural response factor (F_{rs}) consists of a number of factors or parameters introduced in the calculation of structural response in the seismic dynamic analysis. Response calculations performed in the design analysis utilized conservative deterministic parameters. The actual response may differ significantly from the calculated response for a given peak ground acceleration level since many of these parameters are random. The structural response factor is evaluated as the product of the following factors that are considered to have the most influence on the structural response.

$$F_{rs} = F_{sa}F_dF_{ssi}F_mF_{mc}F_{ecc} \qquad (15.3\text{-}14)$$

Where:

F_{sa} = spectral shape factor accounting for the margin of the design ground response spectra with respect to the median centered spectra,

F_d = damping factor accounting for the variability in response due to difference in expected damping at failure and damping used in the analysis,

F_{ssi} = soil-structure interaction factor accounting for the variability associated with SSI effects on structural response,

F_m = structural modeling factor accounting for the variability in response due to modeling assumptions,

F_{mc} = modal response combination factor accounting for the variability in response due to the method used in combining modal responses,

F_{ecc} = earthquake component combination factor accounting for the variability in response due to the method used in combining the earthquake components.

Spectral Shape Factor (F_{sa})

The ground response spectrum considered in the seismic design is taken from both Regulatory Guide (RG) 1.60 site-independent ground spectra and the North Anna ESP site-specific ground spectra. In accordance with the soil-structure interaction analysis performed and described in Appendix 3A, generic sites with 0.3g RG 1.60 input typically higher results in higher structural responses than North Anna ESP conditions for building structures including the containment. Therefore, the spectral shape factor discussed below is derived relative to RG 1.60 ground spectra, normalized to the design ground acceleration. To facilitate dynamic analysis using the time history method, artificial acceleration time histories of three directional components were generated so that the resulting spectra envelop the design spectra for the damping ratios of interest.

For the purpose of seismic risk assessment, the median ground spectrum given in NUREG/CR-0098 (Reference 15-13) is considered to be the realistic input ground motion definition. The differences between the design spectra and median spectra are the margins in the ground motion input.

The spectral shape factor (F_{sa}) is defined to be the ratio of the amplification factor of the design spectrum to that of the median spectrum at the same frequency and damping level.

$$F_{sa} = AF_d / AF_m \qquad (15.3\text{-}15)$$

In constructing the median spectrum, the competent soil condition is conservatively assumed since it results in higher maximum ground velocity and displacement amplitudes than the rock condition for the same maximum ground acceleration. The design spectrum and median spectrum are compared at the 5% damping level for the maximum ground acceleration of 1g. The average spectral shape factors in representative frequency ranges are approximately

Frequency Range (Hz)	Average F_{sa}
2 to 10	1.34
10 to 20	1.20
20 to 33	1.07
Above 33	1.00

The logarithmic standard deviation in the spectral shape factor is the variability in the median spectra, which is 0.2 according to Reference 15-4. No variability exists for frequencies above 33 Hz.

Damping Factor (F_d)

The SSE loads were calculated using the SSE damping ratios specified in RG 1.61. The RG 1.61 damping values are considered to be quite conservative, particularly at response levels near failure. More realistic damping values are specified in Reference 15-13.

For reinforced concrete structures the damping ratio considered in the SSE analysis is 7%. The realistic values at or near yield range from 7 to 10% (Reference 15-13). The upper bound value is considered to be the median and the lower bound corresponds to the 84th percentile level.

The RG 1.60 design ground spectra are used to evaluate the margin in response due to difference in actual damping at failure and design damping. The damping factor F_d can be calculated to be

the ratio of the amplification factor at design damping (AF_{dd}) to the amplification factor at median damping (AF_{md}) at the same frequency.

$$F_d = AF_{dd} / AF_{md} \qquad 15.3\text{-}16)$$

The associated logarithmic standard deviation can be calculated to be the natural log of the ratio of the amplification factor at 84th percentile damping (AF_{bd}) to the amplification factor at median damping (AF_{md}) at the same

$$ßc = \ln (AF_{bd} / AF_{md}) \qquad (15.3\text{-}17)$$

For reinforced concrete structures the average damping factors and associated logarithmic standard deviations in representative frequency ranges are approximately

Frequency Range (Hz)	Average F_d	Average $ß_c$
2 to 10	1.19	0.18
10 to 20	1.12	0.11
20 to 33	1.02	0.02
Above 33	1.00	0.0

Soil-Structure Interaction Factor (F_{ssi})

The design seismic loads were established to be the site-envelope loads calculated by the SSI analyses. The site-envelope loads may have margins for a given site. The margin may be substantial if the specific site is a soft soil site. Since the ESBWR standard plant is designed for generic site conditions, no credit is taken for site margins. Thus, the factor is taken as 1.0. The associated logarithmic standard F_{SSI} deviation is estimated to be 0.1.

Modeling Factor (F_m)

The reactor building complex structural model considered in the seismic design analysis is a multi-degree-of-freedom system constructed according to common modeling techniques and the Standard Review Plan (SRP) requirements in terms of number of degrees of freedom and subsystem decoupling. The model is thus considered to be the best estimate and the resulting dynamic characteristics are the median centered. The modeling factor is thus unity. A relatively large logarithmic standard deviation of 0.15 is estimated to account for the complexity of the integrated reactor building and the containment design.

Modal Response Combination Factor (F_{mc})

The analysis method used in the seismic response analysis is the time history method solved by direct integrations. The phasing between individual modal responses is known and the total response is the algebraic sum of all modes of interest. The maximum response is thus precise and the modal response combination factor (F_{mc}) is unity. The associated uncertainties should be less than the uncertainties associated with the response spectrum method, in which the maximum modal responses are combined by the SRSS method. Therefore, a relatively small logarithmic standard deviation of 0.05 is estimated.

Earthquake Component Combination Factor (F_{ecc})

The effects of multi-directional earthquake excitation on structural response depend on the geometry, dynamic response characteristics, and relative magnitudes of the two horizontal and the vertical earthquake components. The design method is SRSS or 100-40-40. Either method is considered to result in a median-centered response. The earthquake component combination factor is 1.0.

The reactor building walls are designed to resist in-plane loads. The walls mainly respond to the horizontal motion parallel to the walls. The vertical loads on the walls due to the vertical excitation are typically less significant in contributing to the total stresses and there is an equal probability of acting upward or downward. The earthquake component combination effect on the wall design is thus not significant and a small logarithmic standard deviation of 0.05 is estimated.

Other major structures inside the reactor building such as the containment and the pedestal are cylindrical structures. The responses to the three orthogonal excitation components are essentially uncoupled. The logarithmic standard deviation is estimated to be 0.05.

15.3.3.1.3 Fragility Results for Reactor Building Complex

The results of the fragility analysis for the identified reactor building failure modes are summarized in Tables 15-2 through 15-5. The overall safety factor is the product of the individual factors. The total logarithmic standard deviation is the SRSS value of the individual logarithmic standard deviations. The seismic fragility, in terms of median ground acceleration, is the product of the overall factor and the SSE design ground acceleration of 0.3 g. The HCLPF calculated in accordance with the seismic margins method of Reference 15-1 for each failure mode is summarized at the bottom of each of the tables.

15.3.3.2 Control Building Structure

The control building fragility is evaluated using the same procedure described above for the reactor building. The controlling mode of failure is flexural of shear walls. Table 15-6 shows the margin in each of the strength and response factors. The resulting fragility is 4.1 g median peak ground acceleration with a logarithmic standard deviation of 0.44.

15.3.4 Component Fragility

The ESBWR generic components of interest for this seismic risk analysis are the following:

- Shroud support
- CRD guide tubes
- CRD housings
- Fuel assemblies
- Cable trays
- Air-operated valves
- Heat exchangers

- Off-site Power (transformers and ceramic insulators)
- Batteries and battery racks
- Electric equipment (chatter failure mode)
- Switchgear/Motor control centers
- Transformers (480V)
- Motor-driven pumps
- Diesel-driven pumps
- Small tanks (e.g., standby liquid control tank)
- Motor-operated valves
- Safety relief, manual, and check valves
- Hydraulic control units
- Heating, ventilation, and air conditioning ducting
- Air handling units/room air conditioners
- Piping

The shroud support, CRD guide tubes, CRD housing, and fuel assembly fragilities are calculated in a like manner as discussed above in Section 15.3.3. These calculations are summarized in Tables 15-7 through 15-10.

Seismic fragilities for the other component items are obtained from generic sources, as discussed in Section 15.3.1.

15.3.5 Fragility Summary

The structural and component seismic fragilities, and corresponding HCLPF values, are summarized in Table 15-1. These are the same as the ones considered in the ABWR SSAR based on past experience and ALWR recommendations.

15.4 ACCIDENT SEQUENCE HCLPF ANALYSIS

An event tree structure is used in the ESBWR seismic margin analyses to illustrate the accident sequences analyzed in the analysis. This event tree structure is shown in Figure 15-2.

The seismic event tree is used to identify those structures and components requiring seismic capacity analysis (refer to Section 15.3), and to identify the HCLPFs of individual seismic-induced accident sequences.

If a system, S, (or sequence) contains two components (A, B) combined with OR logic, the failure of any component will fail the system (S = A + B), and the cumulative fragility distribution of the system is governed by the fragility distribution of the weakest component. This principle is applied to the system fault trees, which generally are comprised of OR gates.

If two elements operate in AND logic, only the failure of both components will fail the system (S = A * B), and the cumulative fragility distribution of the system is governed by the fragility distribution of the most seismically rugged component. This principle is applied to accident sequences, which are composed of AND elements.

The scope of this analysis includes both at-power and shutdown seismic-induced accident scenarios. The seismic accident analysis for the at-power condition is discussed below in Section 15.4.1, and the analysis for the shutdown condition is discussed in Section 15.4.2.

15.4.1 Full Power Analysis

15.4.1.1 Full Power Seismic Event Tree

The seismic event tree is shown in Figure 15-2. The HCLPF fragility information input into each event tree node is obtained from the fragility analysis summarized in Section 15.3. The HCLPF inputs as a function of event tree node are summarized in Table 15-11.

The event tree begins with the spectrum of seismic events, considers whether or not seismic-induced structural failure (node SI) occurs, and whether or not emergency DC power is lost. Loss of either structural integrity or DC power results in core damage. Thus, all remaining accident sequences in Figure 15-2 are for cases of no structural failure and DC power available.

The success or failure of emergency DC power (node DC) is evaluated in Figure 15-2 to account for support system dependencies. Failure of all DC power results in a high-pressure core melt since all control is lost, the isolation condensers fail, and the reactor cannot be depressurized.

In event of successful emergency DC, the next node questions whether or not seismic-induced failure to scram (node SCRAM) occurs. In the event of an ATWS, sufficient safety relief valves must open to prevent RPV failure due to overpressure. Failure of a sufficient number of safety relief valves to open is assumed to lead to a core damage condition due to the severe potential impact on boron injection effectiveness.

If the SRVs function properly, the next node questions the actuation of the Standby Liquid Control (SLCS) system. Seismic-induced failure of SLCS leads to a core damage condition.

For sequences with failure to scram (SCRAM node failure) but successful SLCS initiation, once the reactor is subcritical and all SRVs are closed, heat removal is achieved through the Isolation Condensers. No credit is given to the actuation of the Passive Containment Cooling system

because of the impact on boron injection effectiveness. Failure of the Isolation Condenser after SLCS leads to a core damage condition.

To extend Isolation Condensers performance well beyond 24 hours, communication between the isolation condenser pools and the PCCS pools must be established. As an alternative to this action, water from a fire protection diesel driven pump may be aligned.

The successful condition of the Scram function (SCRAM node success) leads to another group of sequences. In this group, actuation of the SRVs is also required for initial pressure control. Additional RPV depressurization using the DPVs is required to allow low pressure injection. These valves discharge to the drywell and after their actuation, the Gravity Driven Cooling system (GDCS) is required to provide water to keep the core covered and to compensate for the water losses due to steam discharge to the drywell. Failure of either function will lead to core damage.

Heat removal from the drywell will be achieved through the actuation of the Passive Containment Cooling system (PCCS), a fully passive system that condenses the steam and drives the water back to the GDCS pools. In order to ensure that non-condensable gases cannot prevent steam circulation through PCCS heat exchangers it is necessary that the non-condensables be directed to the wetwell. In order to facilitate this process, wetwell pressure must be lower than drywell pressure. All vacuum breakers that separate the drywell from the wetwell must all be closed to prevent equalizing the wetwell and drywell pressure. It is considered that the failure of one vacuum breaker would prevent the successful operation of the PCCS and consequently would lead to core damage.

Whether heat removal is initially provided by either the isolation condensers (ATWS sequences) or the Passive Containment Cooling System (non-ATWS sequences), long term heat removal success requires that the isolation condensers pool be communicated with the PCCS pools. As an alternative to this action, water from a fire protection diesel driven pump may be aligned.

15.4.1.2 System Analysis

The seismic fault trees contain only those components that might be subject to seismic failure. One of the important ground rules of the seismic margin analysis is that all like components in a system always fail together.

The passive safety systems credited in the analysis have just a few active components (valves), all with automatic actuation and none with reliance on human action that might represent a single failure dominating the overall system reliability. Human actions are required only in the long term and as such, given the low likelihood of failure for operator actions with very long allowable time windows, human action errors do not dominate system failure. As such, random failures are assumed to be non-significant contributors to seismic risk (consistent with past industry seismic studies) and are not explicitly included in the analysis.

Structure failures judged to contribute to seismic core damage are shown on Figure 15-3. In this analysis, any one or more of these structural failures are assumed to result in core damage. The structures having the lowest seismic capacity are the reactor building and control building.

Only passive safety systems are credited in the seismic event tree. The passive concept means that these systems do not require AC power supply for their actuation. However, DC power supply is required for a number of functions in those systems. The PCCS system is the only fully

passive system. These systems require that depressurization valves actuate as well as the Gravity Driven System, and both systems have some dependency on DC power. As such, the DC power supply is considered separately in the seismic event tree. The most critical components in the DC system are the batteries and cable trays that distribute cables associated with DC distribution. Motor control centers are also included, representing the panels that distribute DC and vital AC power to different loads. The seismic fault tree for DC power is shown on Figure 15-4.

The reactor protection system, control rod drive system, and alternate rod insertion system are not modeled because the failure of control rods to insert is dominated by the relatively low seismic fragility of the fuel assemblies, control rod guide tubes, and housings. The seismic fault tree for reactivity control is shown on Figure 15-5. The fuel assemblies are the most fragile component.

The seismic fault tree for safety relief valves, Figure 15-6, models the possible failures of the SRVs themselves. The same is true for the depressurization valves and vacuum breakers (Figures 15-9 and 15-11).

The seismic fault tree for the standby liquid control system is shown on Figure 15-7. Failure of the standby liquid control system is dominated by failure of two components: the squib valves and boron supply tanks. The failure of piping, check valves and motor operated valves is also included in the fault tree.

The seismic fault tree for the isolation condensers is shown in Figure 15-8. Heat exchanger failure is the most significant seismic-induced component failure, failures of nitrogen operated and motor operated valves and the piping are also included.

The gravity driven cooling system is a passive system and the seismic fault tree for this system, Figure 15-10, includes the failure of the squib and check valves, as well as the piping.

The passive containment cooling system is a fully passive system with no active components. The seismic fault tree for PCCS is shown in Figure 15-12; it includes failure of heat exchangers and failure of piping.

Communication between the upper pools requires only the opening of valves. The seismic fault tree for this function is shown in Figure 15-13.

The firewater diesel-driven pump is designed to supply water to the upper pools. The seismic fault tree for this function is shown in Figure 15-14.

15.4.2 Shutdown Analysis

The seismic shutdown analysis uses the same seismic margins approach, as well as many of the risk model elements used in the full power seismic analysis.

The HCLPF nodal fault trees used for the shutdown seismic analysis are the same as those used in the full power seismic analysis, with the exception of the structural failure node.

The earthquake-induced initiating event assumed in the accident sequence analysis is Loss of Preferred Power (LOPP). Scenarios with structural failures are modeled as leading directly to core damage.

Three shutdown seismic event trees are developed to differentiate the major plant operation modes during shutdown conditions. The following three shutdown modes are addressed (consistent with the other external events shutdown analyses): Mode 5, Mode 6-Unflooded, and Mode 6-Flooded.

15.4.2.1 Shutdown Seismic Event Tree

The shutdown seismic event trees are provided in Figures 15-16 through 15-18.

Mode 5 (Cold Shutdown)

The Mode 5 shutdown seismic event tree is shown in Figure 15-16. As discussed previously, the event tree assumes a LOPP condition.

The first node of the tree, SIS, models seismic-induced failures of the containment building, reactor building, control building, RPV pedestal or supports, fuel assemblies or shroud support. Failure of this node is modeled as leading directly to core damage.

The second node of the tree, DC, models seismic-induced failure of emergency DC power. As shown in Figure 15-2, this node models failure of the batteries, motor control centers or cable trays.

Success of the Isolation Condenser, represented by the IC node, guarantees short-term and long-term residual heat removal, even in the event of DC power failure. Failure of both IC and DC leads directly to core damage.

If the isolation condenser function fails but DC power is available, RPV pressure will increase and lead to the actuation of the safety valves, modeled by the SRV node. Sequences with success at the SRV node continue to the node representing fire protection system water injection into the RPV (FPW).

If the SRV function fails, RPV depressurization can be completed using the DPVs. Failure of both SRV and DPV leads directly to core damage.

Following successful RPV depressurization at the DPV node, actuation of the Gravity Driven Cooling System (GDCS node) is next questioned to supply water inventory to maintain the core covered and to compensate for water inventory losses due to steam discharge to the drywell.

For sequences in which the SRVs have failed but successful DPVs, the fire protection system (FPW) can be used as an alternative RPV injection method if GDCS fails.

Long term heat removal, both for successful GDCS or FPW scenarios, requires operation of the PCCS. PCCS is a completely passive system that condenses the steam and returns the condensate to the GDCS pools. In order to ensure that non-condensable gases prevent steam circulation through PCCS heat exchangers, it is necessary that the non-condensables be directed to the wetwell. To facilitate this process, wetwell pressure must be lower than drywell pressure . All vacuum breakers (VB node) that separate the drywell from the wetwell must be closed to prevent equalizing the wetwell and drywell pressure.

Finally, the PI node models failure of the valve allowing communication between the upper pools.

Mode 6 (Unflooded)

The Mode 6-Unflooded shutdown seismic event tree is shown in Figure 15-17. As discussed previously, the event tree assumes a LOPP condition.

The two first nodes of the tree, SIS and DC, are the same as in the Mode 5 tree. Failure of either leads directly to core damage.

Long term cooling in this operation mode would be guaranteed by the actuation of the Fire Protection Water System modeled in the FPW node, or as an alternative, the Gravity Driven Cooling System (GDCS node).

Mode 6 (Flooded)

In this mode of operation, the cavity is flooded and the reactor vessel is open. If an earthquake occurred during this mode, no system would have to be actuated to guarantee long term cooling; only structural integrity would have to be maintained.

The Mode 6-Flooded shutdown seismic event tree, shown in Figure 15-18, includes only one node (SIS) that models the maintenance of structural integrity.

15.4.2.2 System Analysis

The HCLPF nodal fault trees used for the shutdown seismic analysis are the same as those used in the full power seismic analysis, with the exception of the structural failure node. The structural failure nodal fault tree (SIS), refer to Figure 15-15, for the shutdown seismic event tree is developed to include the structural failures included in the full power SI nodal fault tree, as well as the structural elements related to reactivity control.

15.5 RESULTS

The results of the SMA HCLPF accident sequence analysis are shown on Figures 15-2, 15-16, 15-17 and 15-18, and in Tables 15-13 and 15-14. As can be seen, no accident sequence has a HCLPF lower than 0.60 g (i.e., 2 x SSE). As such, the ESBWR plant and equipment are shown to be capable of withstanding an earthquake with a magnitude at least two times the safe shutdown earthquake (SSE).

15.6 INSIGHTS

The ESBWR seismic margins HCLPF accident sequence analysis highlights the following key insights regarding the seismic capability of the ESBWR:

(1) The ESBWR is inherently capable of safe shutdown in response to strong magnitude earthquakes.

(2) The most significant HCLPF sequences (both 0.62g HCLPF) are seismic-induced loss of DC power and seismic-induced ATWS due to seismic-induced failure of the fuel channels and seismic-induced failure of the SLC tank.

15.7 CONCLUSIONS

The ESBWR is inherently capable of safe shutdown in response to strong magnitude earthquakes. The analysis shows that the ESBWR plant and equipment are capable of withstanding an earthquake of a magnitude at least two times the safe shutdown earthquake (SSE) with a high confidence of low probability of failure.

15.8 REFERENCES

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Table 15-1

Seismic Capacity Summary

Structure/Component	Failure Mode	Capacity[1] A_m (g)	Fragility Combined[2] Uncertainty	HCLPF (g)
Reactor Building	Shear	1.9	0.45	0.67
Containment	Shear	3.89	0.44	1.40
RPV Pedestal	Shear	2.86	0.44	1.03
RPV support brackets	Support	3.64	0.33	1.69
Control building	Flexural	4.12	0.44	1.48
Shroud support	Buckling	2.0	0.36	0.87
CRD guide tubes	Buckling	1.8	0.36	0.78
CRD housing	Plastic yielding	3.5	0.46	1.20
Fuel Assemblies	Channel deflection	1.4	0.35	0.62
Hydraulic Control Unit	LOF	2.0	0.50	0.63
Cable trays	Support	3.0	0.60	0.74
Air-operated valves	Stem binding/Air line	3.0	0.60	0.74
Heat Exchanger	Anchorage	2.0	0.45	0.70
Off-site power	Ceramic insulators	0.3	0.55	0.08
Batteries and battery racks	Anchorage/LOF	3.3	0.46	1.13
Electric equipment (chatter):				
• function req'd during event	Relay chattering[3]	N/A	N/A	N/A
• function req'd after event	Relay chattering[3]	2.0	0.50	0.63
Switchgear/Motor control centers	Functional/Structural	1.8	0.46	0.62
Transformers	Functional/Structural	1.8	0.46	0.62
Motor-driven pumps	Anchorage/Impeller deflection	1.8	0.46	0.62
Small tanks	Anchorage	1.8	0.46	0.62
Motor-operated valves	Operator distortion	3.0	0.60	0.74
Safety relief & check valves	Internal damage	3.0	0.60	0.74
Manual valves	Internal damage	3.6	0.60	0.89
HVAC ducting	Support	3.0	0.60	0.74
Air handling units/Room A.C.	Blade rubbing	2.0	0.50	0.63
Piping	Support	3.0	0.60	0.74
Diesel-driven pumps	Support	1.8	0.46	0.62

Notes to Table 15-1:

(1) Capacities are in terms of median peak ground acceleration.

(2) Combined uncertainties are composite logarithmic standard deviations of uncertainty and randomness

(3) The potential for relay chatter was treated in the following manner. Only the scram safety function is required during a seismic event. This function is fail-safe, so relay chatter would cause a safe state failure (scram) even if relays were employed. For the ESBWR, the scram actuating devices are solid state power switches with no failure mode similar to relay chatter. The scram function is supplemented by an alternate scram method (energizing the air header dump valves) to provide diversity. This method uses relay actuation, but no credit was taken for this capability in the seismic analysis. Therefore, there is no potential for relay chatter to prevent safety actions during a seismic event.

Switchgear and motor control centers do include relays whose failure could prevent safety actions after the seismic event. It was assumed that the indicated capacity of this equipment (1.8) was more representative than the specific relay chatter value (2.0) since switchgear and motor control centers are normally qualified with the auxiliary relays in place. Also, the type of auxiliary relays used tends to be the most rugged of relay types and would have a capacity above 2.0. The multiplexer output devices for GDCS and RWCU/SDC operation have been assumed to be solid state devices (rather than relays), so the relay chatter failure mode does not apply.

Table 15-2

Seismic Fragility for Reactor Building Shear Walls

Component:		Shear Walls		
Failure Mode:		Flexural		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	2.00	0.17
	F_u	inelastic energy absorption	2.00	0.25
F_{rs}	F_{sa}	spectral shape margin	1.34	0.20
	F_d	damping margin	1.19	0.18
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**6.38**	**0.45**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = F * A_d = 6.38 * 0.3 = 1.90 g

HCLPF = $A_m \exp(-2.326 * \beta_c)$ = 0.67 g

Table 15-3

Seismic Fragility for Containment Wall

Component:		Containment Lower Wall		
Failure Mode:		Shear		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	4.06	0.15
	F_u	inelastic energy absorption	2.00	0.25
F_{rs}	F_{sa}	spectral shape margin	1.34	0.20
	F_d	damping margin	1.19	0.18
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**12.95**	**0.44**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = F * A_d = 12.95 * 0.3 = 3.89 g

HCLPF = A_m * exp (–2.326 * β_c) = 1.40 g

Table 15-4

Seismic Fragility for RPV Pedestal

Component:		RPV Pedestal		
Failure Mode:		Shear		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	3.26	0.14
	F_u	inelastic energy absorption	2.00	0.25
F_{rs}	F_{sa}	spectral shape margin	1.27	0.20
	F_d	damping margin	1.15	0.18
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**9.52**	**0.44**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = F * A_d = 9.52 * 0.3 = 2.86 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 1.03 g

Table 15-5

Seismic Fragility for RPV Support Brackets

Component:		RPV Support Bracket		
Failure Mode:		Support		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	8.85	0.14
	F_u	inelastic energy absorption	1.00	0.00
F_{rs}	F_{sa}	spectral shape margin	1.27	0.20
	F_d	damping margin	1.08	0.12
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**12.14**	**0.33**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = F * A_d = 12.14 * 0.3 = 3.64 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 1.69 g

Table 15-6

Seismic Fragility for Control Building

Component:		Shear Walls		
Failure Mode:		Flexural		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	3.55	0.17
	F_u	inelastic energy absorption	2.65	0.25
F_{rs}	F_{sa}	spectral shape margin	1.27	0.20
	F_d	damping margin	1.15	0.15
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**13.73**	**0.44**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = $F * A_d$ = 13.73 * 0.3 = 4.12 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 1.48 g

Table 15-7

Seismic Fragility for Shroud Support

Component:		Shroud Support		
Failure Mode:		Buckling		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	4.99	0.20
	F_u	inelastic energy absorption	1.00	0.00
F_{rs}	F_{sa}	spectral shape margin	1.27	0.20
	F_d	damping margin	1.08	0.12
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**6.84**	**0.36**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = F * A_d = 6.84 * 0.3 = 2.0 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 0.87 g

Table 15-8

Seismic Fragility for CRD Guide Tubes

Component:		CRD Guide Tubes		
Failure Mode:		Buckling		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	4.16	0.20
	F_u	inelastic energy absorption	1.00	0.00
F_{rs}	F_{sa}	spectral shape margin	1.18	0.20
	F_d	damping margin	1.25	0.10
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**6.14**	**0.36**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = $F * A_d$ = 6.14 * 0.3 = 1.8 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 0.78 g

Table 15-9

Seismic Fragility for CRD Housings

Component:		CRD Housings		
Failure Mode:		Plastic Yielding		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	7.92	0.35
	F_u	inelastic energy absorption	1.00	0.00
F_{rs}	F_{sa}	spectral shape margin	1.18	0.20
	F_d	damping margin	1.25	0.10
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**11.68**	**0.46**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = $F * A_d$ = 11.68 * 0.3 = 3.5 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 1.2 g

Table 15-10

Seismic Fragility for Fuel Assemblies

Component:		Fuel Assemblies		
Failure Mode:		Channel Excessive Deflection		
Factor of Safety			**Median Value**	**β_c**
F_c	F_s	strength margin	2.36	0.00
	F_u	inelastic energy absorption	1.32	0.21
F_{rs}	F_{sa}	spectral shape margin	1.43	0.20
	F_d	damping margin	1.06	0.06
	F_{ssi}	soil-structure interaction	1.00	0.10
	F_m	modeling factor	1.00	0.15
	F_{mc}	modal response combination	1.00	0.05
	F_{ecc}	earthquake component combination	1.00	0.05
Overall Factor of Safety (F) and Composite Logarithmic Standard Deviation (β_c):			**4.72**	**0.35**

A_d = Ground Acceleration of the Reference Design Earthquake = 0.3 g

A_m = Median Peak Ground Acceleration = $F * A_d$ = 4.72 * 0.3 = 1.4 g

HCLPF = $A_m * \exp(-2.326 * \beta_c)$ = 0.62 g

Table 15-11

ESBWR Systems and Components/Structures Fragilities

System/Component as a function of Event Tree Node	A_m(g)	β_c	HCLPF(g)
PLANT ESS STRUCTURES (SI)			
- Reactor Building (FRBLDG)	1.90	0.45	0.67
- Containment (FCONT)	3.89	0.44	1.40
- RPV Pedestal (FPEDST)	2.86	0.44	1.03
- Control Building (FCTRBLDG)	4.12	0.44	1.48
- Reactor Pressure Vessel Support (FRPV)	3.64	0.33	1.69
DC POWER (DC)			
- Batteries (FBTR)	3.3	0.46	1.13
- Cable trays (FCTRAY)	3.0	0.60	0.74
- Motor control centers (FMCC)	1.8	0.46	0.62
REACTIVITY CONTROL SYSTEM (SCRAM)			
- Fuel assembly (FFASSY)	1.4	0.35	0.62
- CRD Guide tubes (FCRDGTB)	1.8	0.36	0.78
- Shroud support (FSHRSPT)	2.0	0.36	0.87
- CRD Housing (FCRDHS)	3.5	0.46	1.20
- Hydraulic control unit (FHYLTUT)	2.0	0.50	0.63
SRV (SRV)			
- SRV (FSRV)	3.0	0.60	0.74

Table 15-11

ESBWR Systems and Components/Structures Fragilities

System/Component as a function of Event Tree Node	A_m(g)	β_c	HCLPF(g)
STANDBY LIQUID CONTROL (SLCS)			
- Accumulator Tank (FACCT)	1.8	0.46	0.62
- Check valve (FCHV)	3.0	0.60	0.74
- Squib valve (FSQUV)	3.0	0.60	0.74
- Piping (FPIP)	3.0	0.60	0.74
- Valve (motor operated) (FMOV)	3.0	0.60	0.74
ISOLATION CONDENSER (IC)			
- Piping (FPIP)	3.0	0.60	0.74
- Heat exchanger (FICHEX)	2.0	0.45	0.70
- Valve (motor operated) (FMOV)	3.0	0.60	0.74
- Valve (nitrogen operated) (FNOV)	3.0	0.60	0.74
DPV (DPV)			
- DPV (FDPV)	3.0	0.60	0.74
GRAVITY-DRIVEN COOLING (GDCS)			
- Check valve (FCHV)	3.0	0.60	0.74
- Squib valve (FSQUV)	3.0	0.60	0.74
- Piping (FPIP)	3.0	0.60	0.74
VACUUM BREAKERS (VB)			
- Vacuum breaker valve (FVB)	3.0	0.60	0.74

Table 15-11

ESBWR Systems and Components/Structures Fragilities

System/Component as a function of Event Tree Node	A_m(g)	β_c	HCLPF(g)
PASSIVE CONTAINMENT COOLING (PCCS)			
- Heat Exchanger (FPCCSHEX)	2.0	0.45	0.70
- Piping (FPIP)	3.0	0.60	0.74
IC/PCC POOL INTERCONNECTION (PI)			
- Valve (motor operated) (FIC/PCCI)	3.0	0.60	0.74
FIRE PROTECTION WATER SYSTEM (FPW)			
- Pump (diesel driven) (FPUMPDD)	1.8	0.46	0.62

Table 15-12 Seismic Event Tree Nodal HCLPF Equations	
Top Event	**Nodal HCLPP Equations(1) (2)**
Structural Integrity (SI)	FSTRUC = FRBLDG + FCONT + FPEDST + FCTRBLDG + FRPV (0.67g + 1.40g + 1.03g + 1.48g + 1.69g = 0.67g)
DC Power (DC)	FDCP = FBTR + FCTRAY + FMCC (1.13g + 0.74g + 0.62g = 0.62g)
Scram (SCRAM)	FRC = FFASSY + FCRDGTB + FSHRSPT + FCRDHS + FHYCTUT (0.62g + 0.78g + 0.87g + 1.2g + 0.63g = 0.62g)
SRVs (SRV)	FSRV = FSRV′S = 0.74g
Standby Liquid Control (SLCS)	FSLCS = FACCT + FCHV + FSQUV + FPIP + FMOV (0.62g + 0.74g + 0.74g + 0.74g + 0.74g = 0.62g)
Isolation Condensers (IC)	FIC = FPIP + FICHEX + FMOV + FNOV (0.74g + 0.7g + 0.74g + 0.74g = 0.7g)
DPVs (DPV)	FDPV = FDPV′S = 0.74g
Gravity Driven Cooling System (GDCS)	FGDCS = FCHV + FSQUV + FPIP (0.74g + 0.74g + 0.74g = 0.74g)
Vacuum Breakers (VB)	FVB = FVB′S = 0.74g
Passive Containment Cooling (PCCS)	FPCCS = FPCCSHEX + FPIP (0.7g + 0.74g = 0.7g)
IC/PCC Pool Interconnection (PI)	FIC/PCCINT = PIC/PCCI = 0.74g
Fire Protection Water (FPW)	FFPW = FPUMPDD = 0.62g
Structural Integrity Shutdown (SIS)	FSTRUCSH = FRBLDG + FCTRBLDG + FRPV + FFASSY + FPEDST + FSHRSPT + FCONT + FCRDHS (0.67g + 1.48g + 1.69g + 0.62g + 1.03g + 0.87g + 1.4g + 1.2g = 0.62g)

Notes to Table 15-12:

(1) Refer to nodal fault trees (Figures 15-3 through 15-14) for descriptions of the individual fragility basic events.

(2) Per the MIN-MAX convention used, the overall fragility of a group of inputs combined using OR logic is determined by the lowest fragility input.

Table 15-13

HCLPF Derivation for the ESBWR Seismic Event Tree Sequences

(MIN-MAX Method)

SET Sequence	Sequence HCLPF[1]
Sequence 3	PI*FPW = 0.74g*0.62g = 0.74g
SEQUENCE 4	PCCS = 0.7g
Sequence 5	VB = 0.74g
Sequence 6	GDCS = 0.74g
Sequence 7	DPV = 0.74g
Sequence 8	SRV = 0.7g
Sequence 11	SCRAM*PI*FPW = 0.62g*0.74g*0.62 = 0.74g
Sequence 12	SCRAM*IC = 0.62g*0.7g = 0.7g
Sequence 13	SCRAM*SLCS = 0.62g*0.62g = 0.62g
Sequence 14	SCRAM*SRV = 0.62g*0.74g = 0.74g
Sequence 15	DC = 0.62g
Sequence 16	SI = 0.67 g

Notes to Table 15-13:

(1) Per the MIN-MAX convention used, the overall fragility of a group of inputs combined using AND logic is determined by the highest fragility input.

Table 15-14

HCLPF Derivation for the ESBWR Shutdown Seismic Event Tree Sequences

(MIN-MAX Method)

MODE 5

SET Sequence	Sequence HCLPF[1]
Sequence 4	IC *FPW*PI = 0.7g*0.62g*0.74g = 0.74g
Sequence 5	IC *FPW*PCCS = 0.7g*0.62g*0.7g = 0.7g
Sequence 6	IC *FPW*VB = 0.7g*0.62g*0.74g = 0.74g
Sequence 7	IC *FPW*GDCS = 0.7g*0.62g*0.74g = 0.74g
Sequence 8	IC *FPW*DPV = 0.7g *0.62g*0.74g = 0.74g
Sequence 10	IC *SRV*PIT = 0.7g *0.74g*0.74g = 0.74g
Sequence 11	IC *SRV* PCCS = 0.7g *0.74g*0.7g = 0.74g
Sequence 12	IC *SRV* VB = 0.7g*0.74g*0.74g = 0.74g
Sequence 14	IC *SRV* GDCS*PIT = 0.7g*0.74g*0.74g*0.7g = 0.74g
Sequence 15	IC* SRV* GDCS* PCCS = 0.7g*0.74g*0.74g*0.74g = 0.74g
Sequence 16	IC *SRV* GDCS* VB = 0.7g *0.74g*0.74g*0.74g = 0.74g
Sequence 17	IC *SRV* GDCS* FPW = 0.7g *0.74g*0.74g*0.62g = 0.74g
Sequence 18	IC *SRV* DPV = 0.7g*0.74g*0.74g = 0.74g
Sequence 20	IC *DC = 0.7g*0.62g = 0.7g
Sequence 21	SIS = 0.62g

MODE 6 UNFLOODED

SET Sequence	Sequence HCLPF[1]
Sequence 3	FPW*GDCS = 0.62g*0.74g = 0.74g
Sequence 4	DC = 0.62g
Sequence 5	SIS = 0.62g

MODE 6 FLOODED

SET Sequence	Sequence HCLPF
Sequence 2	SIS = 0.62g

Notes to Table 15-14:

(1) Per the MIN-MAX convention used, the overall fragility of a group of inputs combined using AND logic is determined by the highest fragility input.

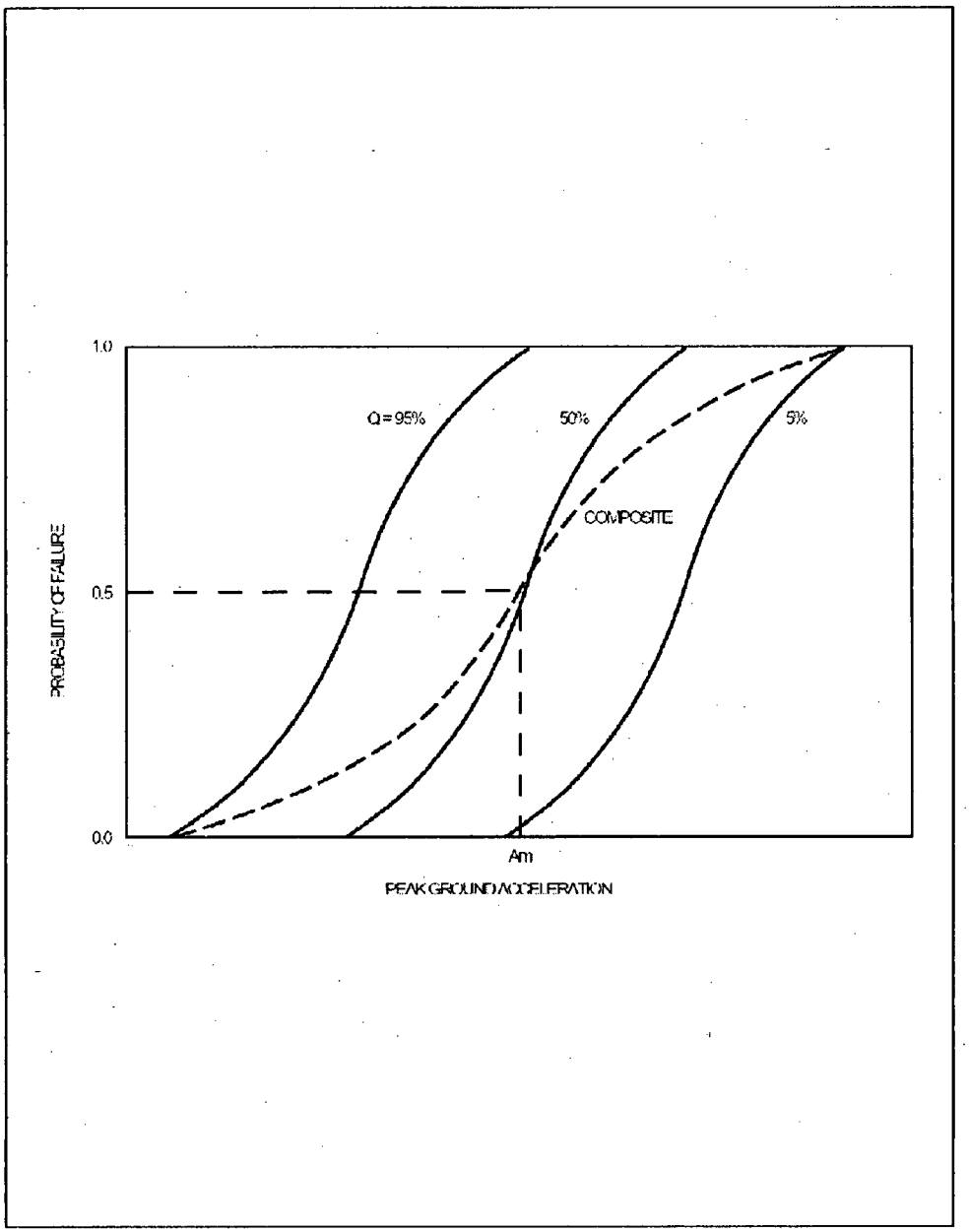

Figure 15-1. Typical Fragility Curves

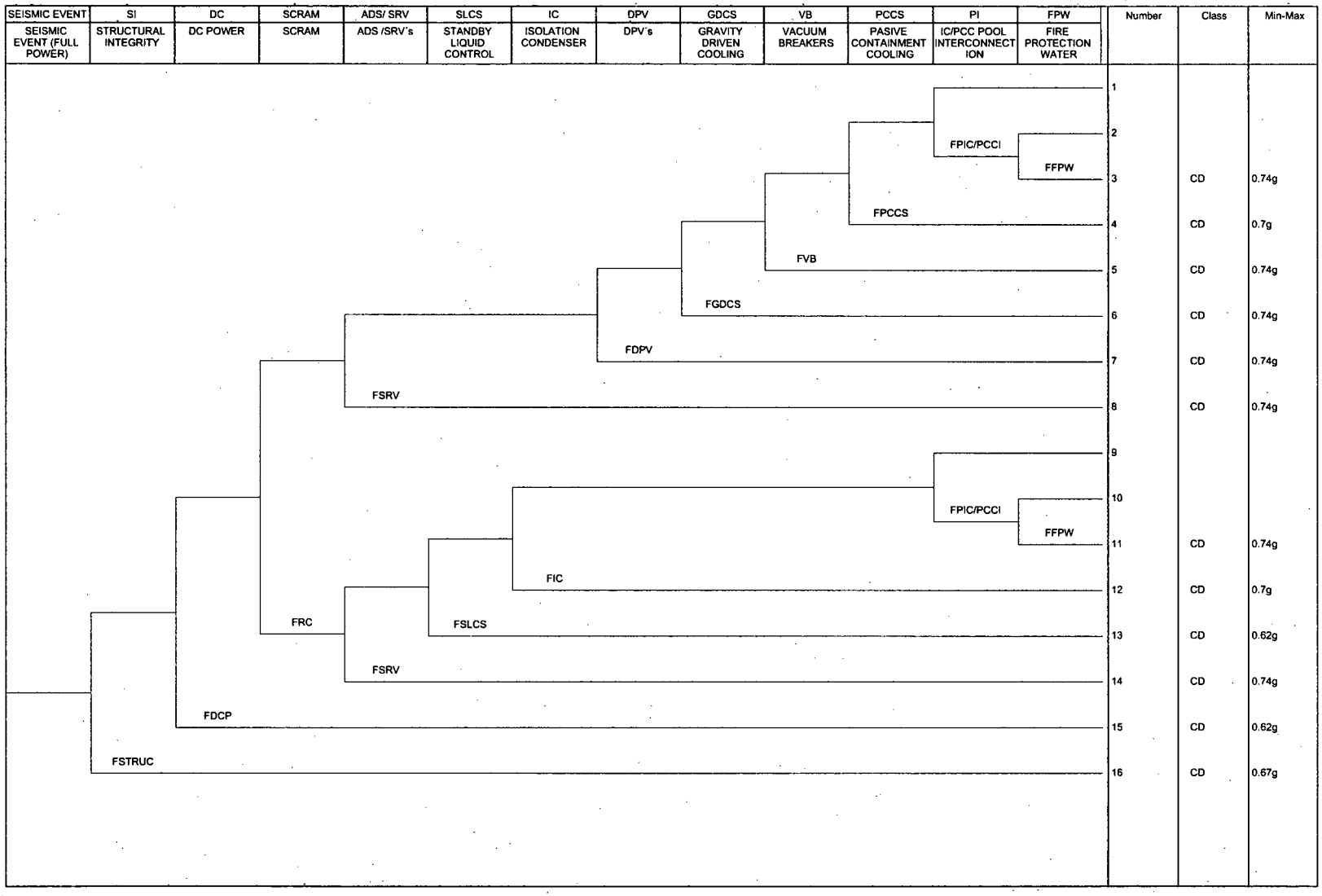

Figure 15-2. Seismic Event Tree (Full Power)

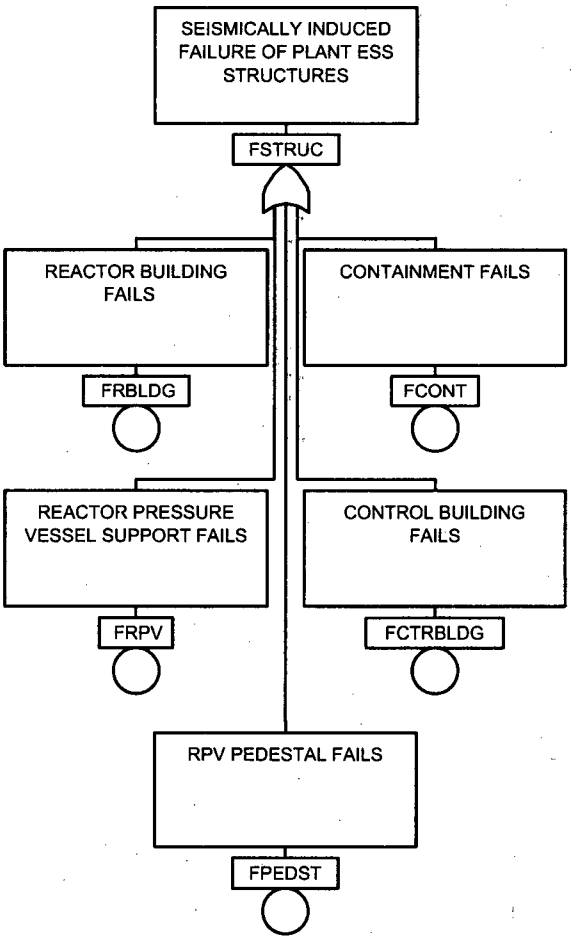

Figure 15-3. Structural Seismic Fault Tree (Full Power)

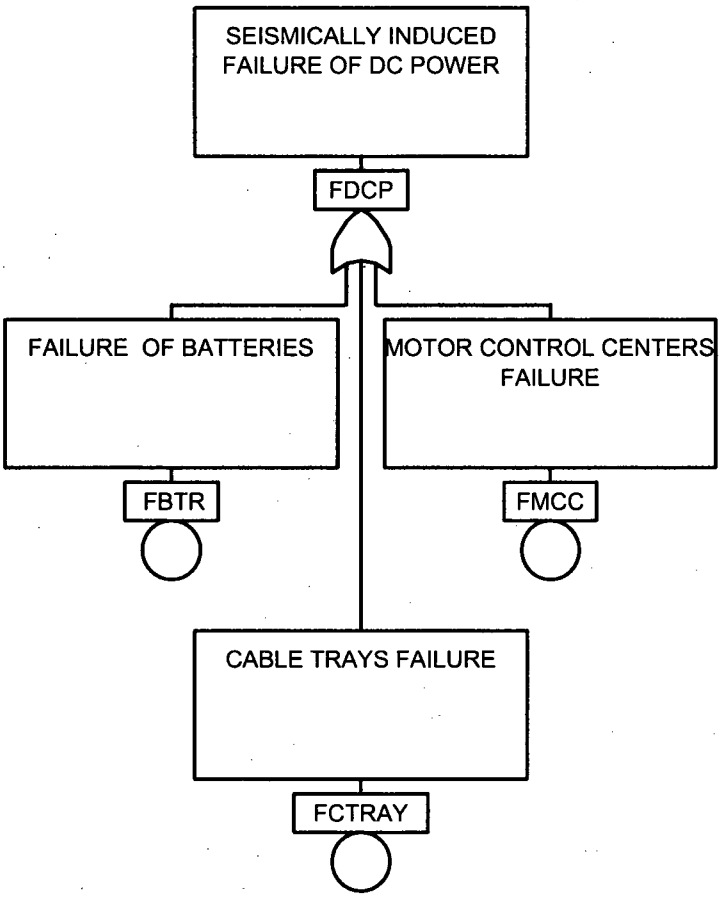

Figure 15-4. DC Power Seismic Fault Tree

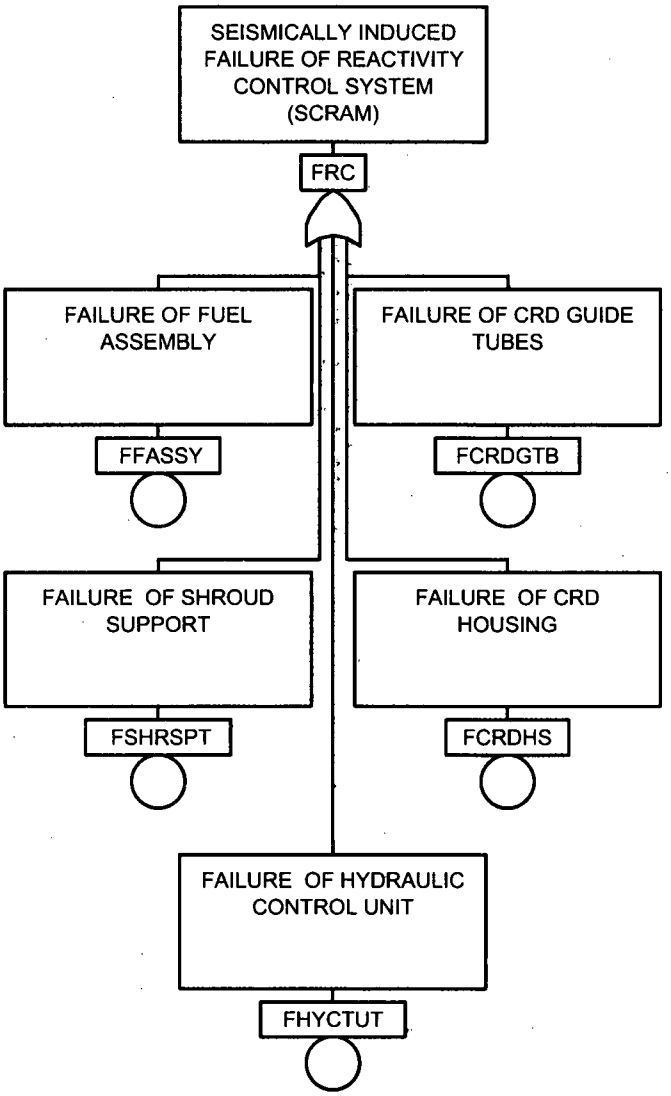

Figure 15-5. SCRAM Seismic Fault Tree

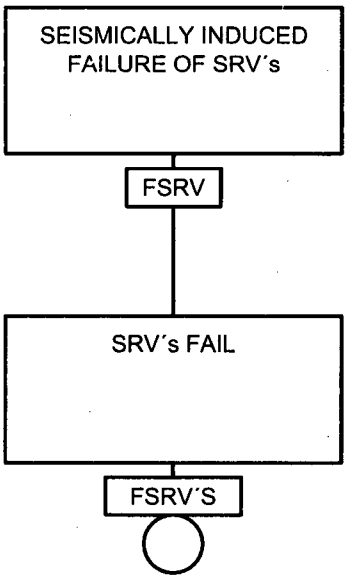

Figure 15-6. SRV Seismic Fault Tree

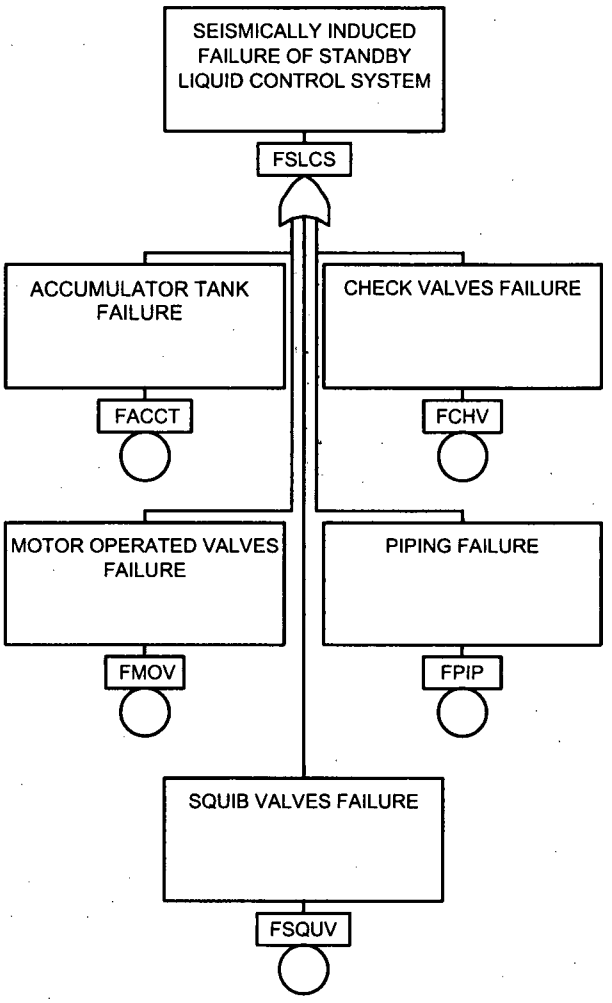

Figure 15-7. SLCS Seismic Fault Tree

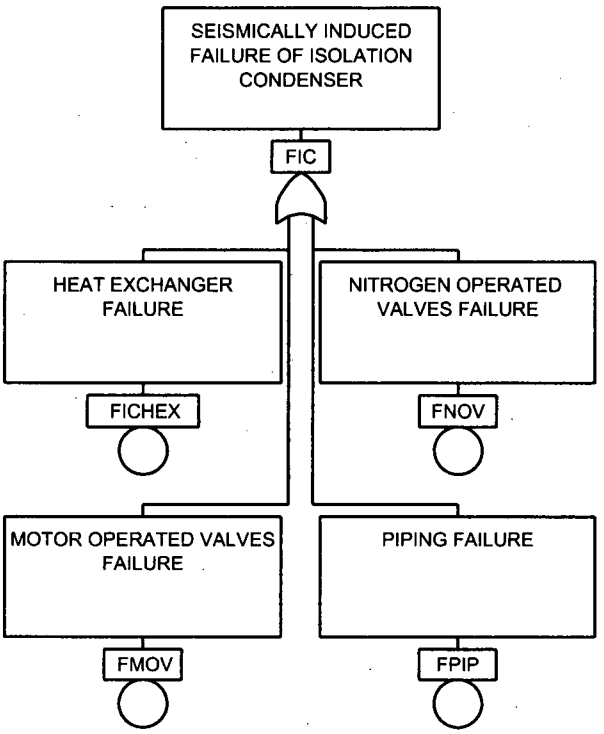

Figure 15-8. IC Seismic Fault Tree

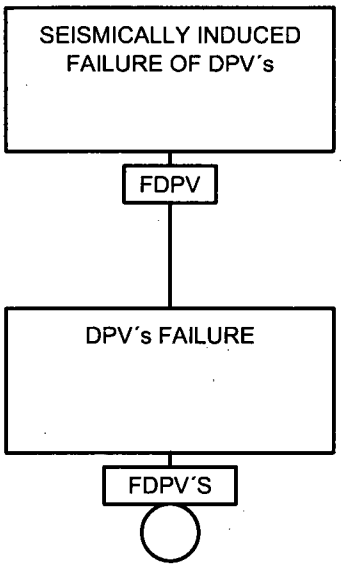

Figure 15-9. DPV Seismic Fault Tree

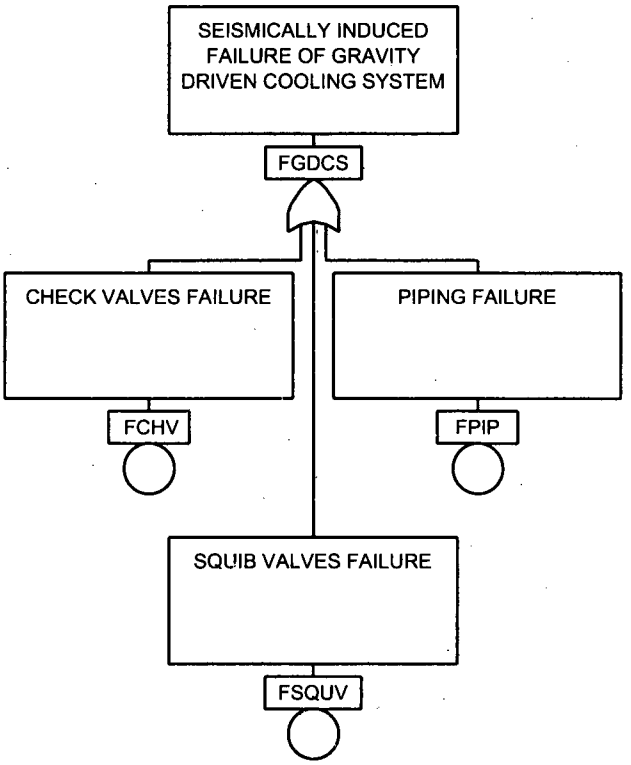

Figure 15-10. GDCS Seismic Fault Tree

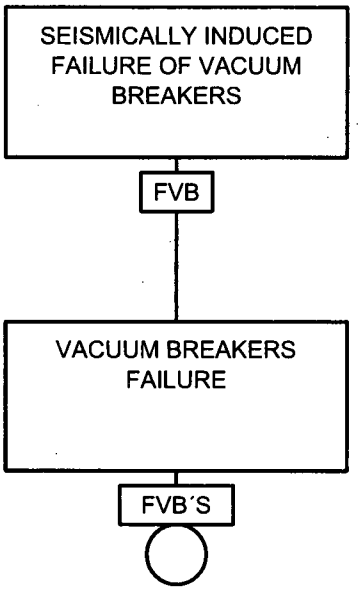

Figure 15-11. VC Seismic Fault Tree

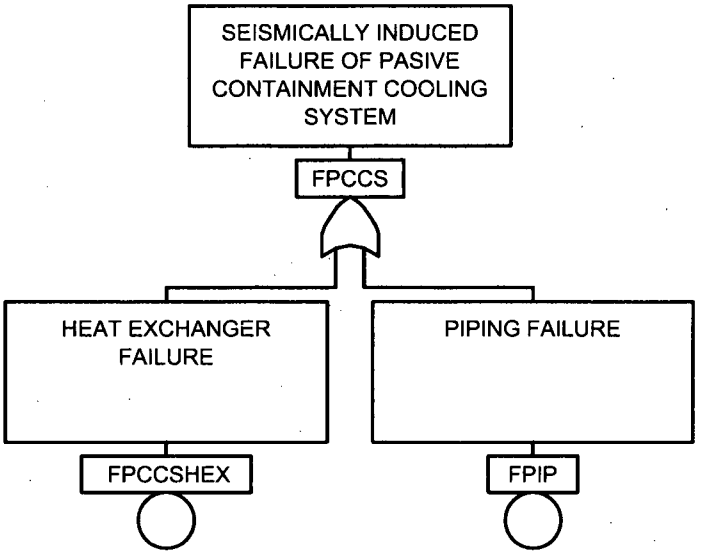

Figure 15-12. PCCS Seismic Fault Tree

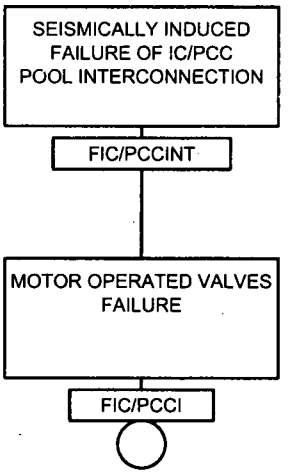

Figure 15-13. PI Seismic Fault Tree

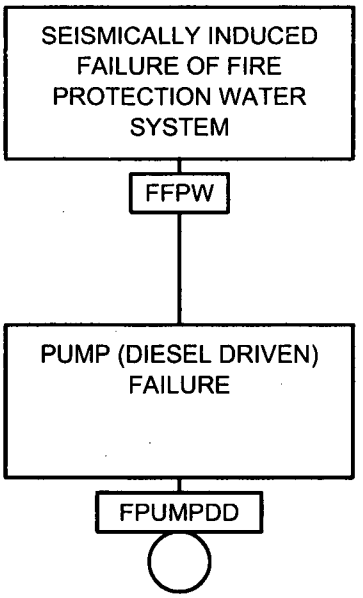

Figure 15-14. FPW Seismic Fault Tree

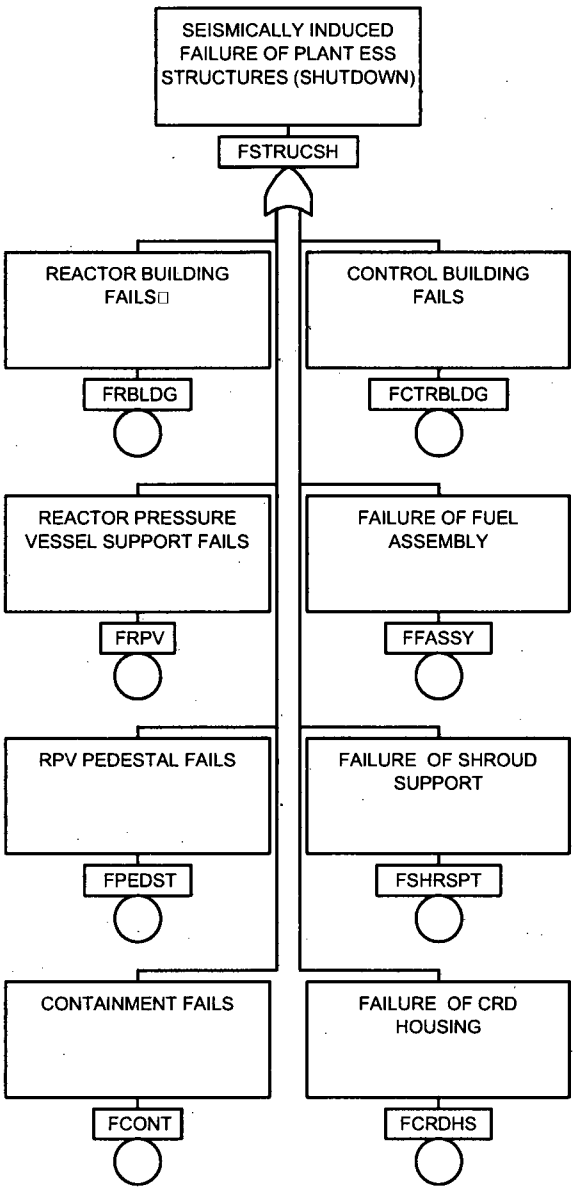

Figure 15-15. Structural Seismic Fault Tree (Shutdown Conditions)

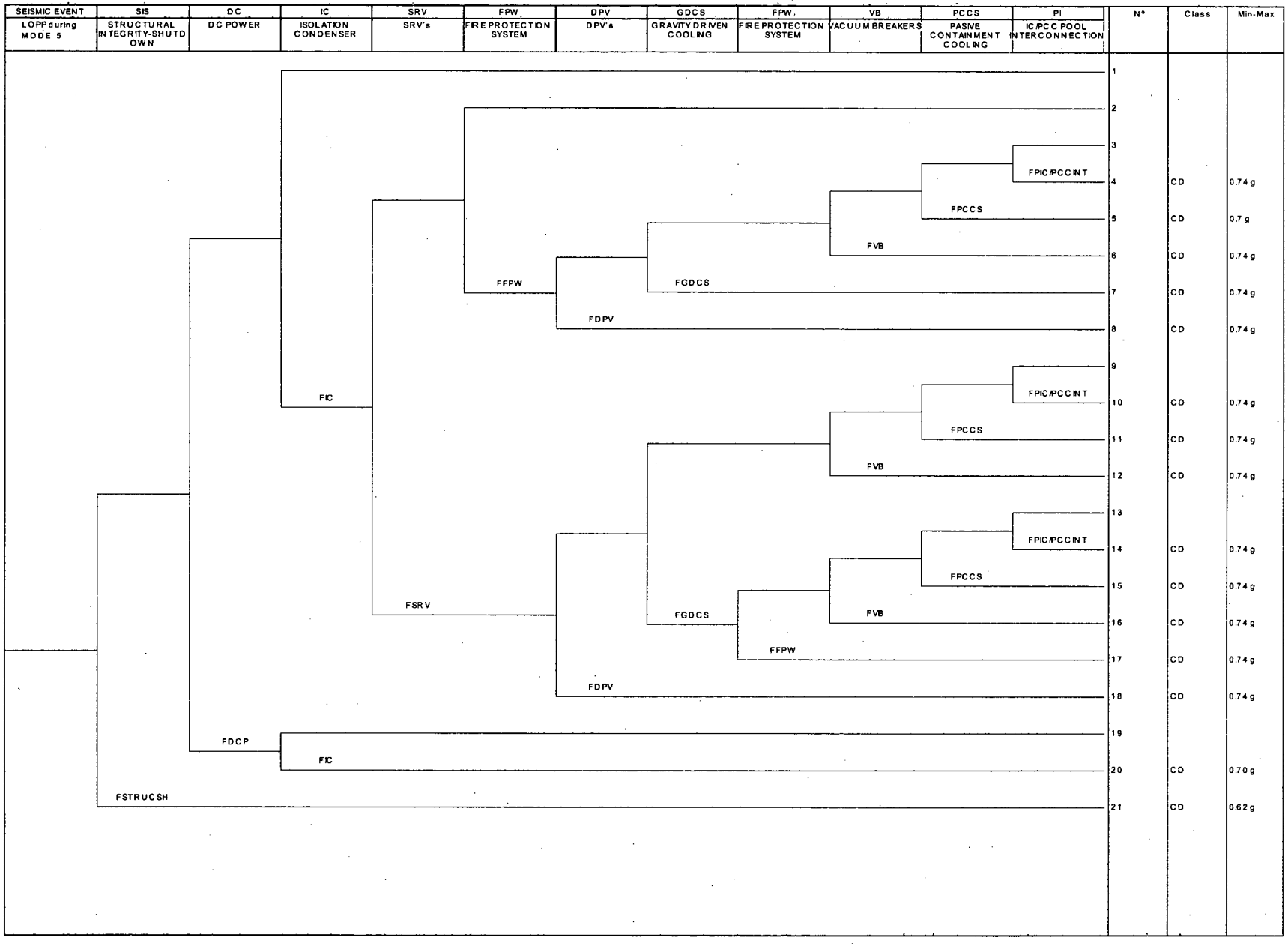

Figure 15-16. Seismic Event Tree – Shutdown Mode 5

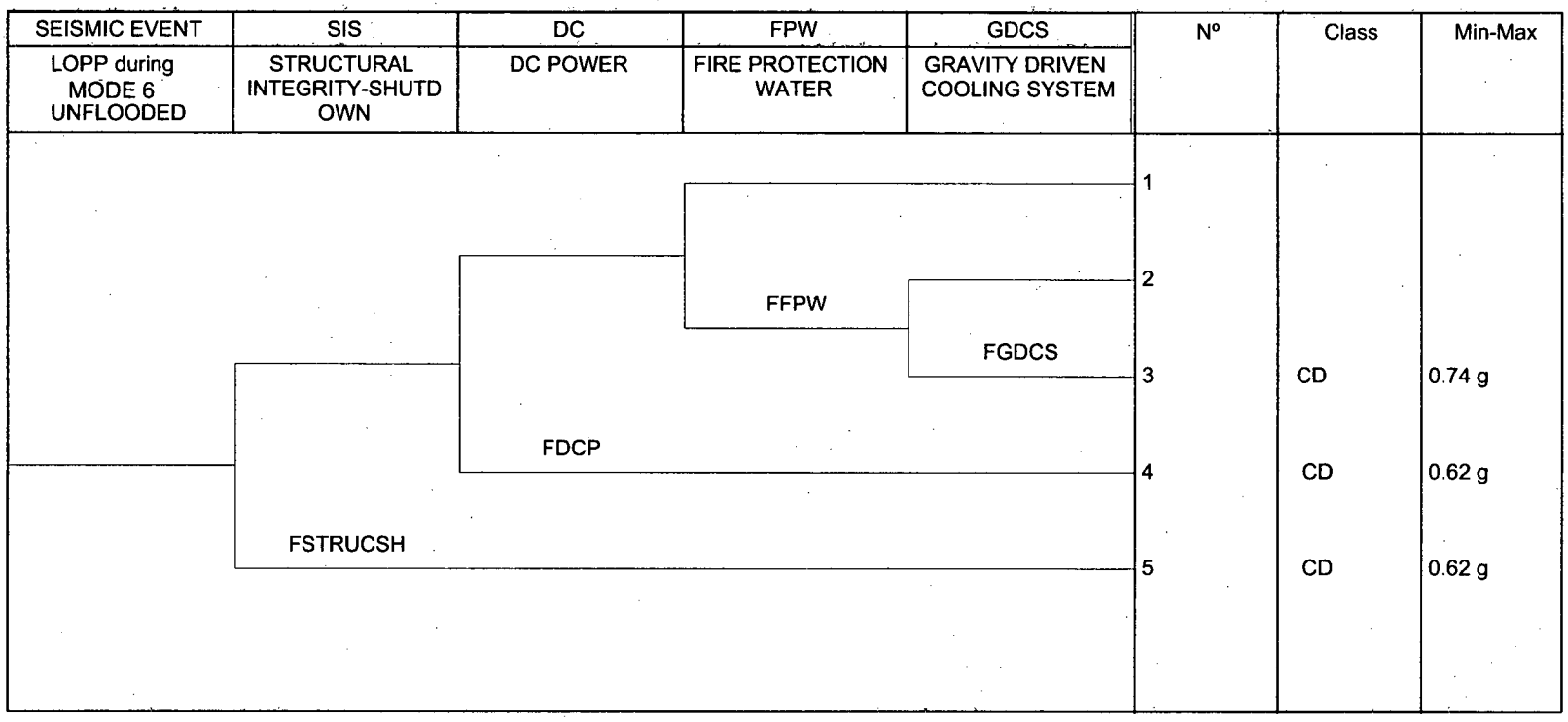

Figure 15-17. Seismic Event Tree – Shutdown Mode 6 Unflooded

SEISMIC EVENT	SIS	Nº	Class	Min-Max
SEISMIC EVENT IN MODE 6 FLOODED	STRUCTURAL INTEGRITY-SHUTDOWN			
		1		
	FSTRUCSH	2	CD	0.62g

Figure 15-18. Seismic Event Tree – Shutdown Mode 6 Flooded

16 SHUTDOWN RISK

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16 SHUTDOWN RISK

16.1 INTRODUCTION

A detailed PRA is performed to determine the core damage frequency during shutdown. Loss of the Reactor Water Cleanup/Shutdown Cooling System, Loss of Reactor Component Cooling Water System, Loss of Plant Service Water System, and Loss of Preferred Power are all investigated. Additionally, the Core Damage Frequency (CDF) due to drain down of the RPV or Loss of Coolant Accidents (LOCAs) during shutdown is evaluated. Fault trees and event trees are used to determine the shutdown CDF for each event analyzed.

The evaluation encompasses plant operation in shutdown modes. This evaluation addresses conditions for which there is fuel in the RPV. It includes all aspects of the NSSS, the containment, and all systems that support operation of the NSSS and containment.

The scope of the Shutdown PRA is that of a Level 1 PRA. The different accident sequences are classified according to whether the core is damaged or not. The latter are further subdivided into two classes: those without release of radionuclides to the environment and those with release of radionuclides to the environment (either because the containment was open at the time of the initiating event or because the containment cooling failed).

The following subsections discuss the shutdown PRA modeling methodology, data sources, modeling assumptions, and the results of the data analyses for inclusion in the shutdown PRA model. Shutdown PRA analyses during external events are covered in individual sections on external events sections such as Sections 12 (Fire), 13 (Flood) and 14 (High Wind).

16.2 PLANT CONFIGURATIONS IN SHUTDOWN

The differences between the shutdown PRA and the power operation PRA are due to the following:

- Plant operating mode
- Time after shutdown
- RPV and containment status
- Water levels and temperatures
- Fuel location
- Availability of required systems

To develop a suitable shutdown model, multiple bounding plant configurations are defined with similar characteristics in relation to the residual heat, the availability of systems, and the RPV water levels.

The outage plant operating mode is used to define the initial plant condition for individual accident sequence quantification.

Once the outage plant configurations have been defined, the duration of each one is estimated to determine its contribution to the overall calculation of annual core damage frequency. The duration is expressed in hours per refueling outage.

16.2.1 Definition of Plant Shutdown Configurations

The shutdown PRA considers the following outage plant configurations as representative of the possible plant configurations during shutdown.

- Mode 4 (hot shutdown) – included in full-power PRA
- Mode 5 (cold shutdown)
- Mode 6-Unflooded (refueling)
- Mode 6-Flooded (refueling)

Figure 16.2-1 displays the duration of the different outage plant configurations considered in the ESBWR Shutdown PRA. The following paragraphs describe each of these configurations, detailing the vessel pressure and temperature conditions, as well as the assumed duration and status of RWCU/SDCS and other decay heat removal systems.

16.2.1.1 Mode 4 – Hot Shutdown

This is the cooldown phase to bring the plant to cold shutdown. The reactor mode switch is in the shutdown position. It begins after control rod insertion is completed. Operation of the reactor mode switch from one position to another bypasses Reactor Protection System trips and channels and automatically alters Neutron Monitoring System trip setpoints in accordance with the reactor conditions implied by the given position of the mode switch (Reference DCD Chapter 7).

Decay and sensible heat are removed through the Main Condenser and/or Isolation Condenser. Approximately one-half hour after control rod insertion, both RWCU/SDCS trains are operating,

with the regenerative heat exchangers bypassed and pumps running at reduced speed to avoid exceeding the RCCWS design cold leg temperature. The control rod drive system is in service to provide makeup water for the reactor coolant contraction.

The duration of this mode is assumed to be 8 hours.

Containment is de-inerted but integrity is maintained during this mode.

The initial RPV pressure and temperature is the same as power operating values. Because the plant configuration during this period is very similar to that existing in full power, the CDF contribution of this mode is modeled as included in the full power PRA.

16.2.1.2 Mode 5 – Cold Shutdown (After Power Operation)

Cooldown of the reactor coolant is continued during this phase. The reactor mode switch is in the shutdown position. Once in cold shutdown, the heat removal requirements are transferred to the RWCU/SDCS. The Main Condenser and circulating water pumps are removed from service and the use of the isolation condensers is terminated.

Both RWCU/SDCS trains run in parallel, with regenerative heat exchangers bypassed and the pump speed gradually increasing up to the maximum flow rate.

The duration of this mode is assumed to be 88 hours.

Containment is opened at some time during this mode. The drywell head removal operations are expected to begin, and eventually be completed, in this configuration. However, because it is expected that containment will be intact during most of the time spent in this mode, the shutdown PRA assumes containment to be intact for Mode 5.

Initial RPV conditions in this mode are a pressure of 0.75 MPa (109 psia) and a temperature of 168 °C (334 °F).

16.2.1.3 Mode 6 – Refueling (Unflooded)

As soon as the reactor coolant temperature reaches 49 °C (120 °F), reactor head removal operations may start. Prerequisites required to remove reactor head, such as reactor well drain or drywell head removal occur during the cooldown phase.

Decay heat removal is provided by the RWCU/SDCS. At the start of this mode, both trains are expected to be running. Later, only one is required to keep the reactor coolant temperature within limits.

The duration of this mode is assumed to be approximately 59 hours, including the period before refueling and the period after refueling.

In this configuration the reactor head is either removed or not fully tensioned, and the reactor well is not flooded.

RPV is at atmospheric pressure and the temperature is maintained at about 49 °C (120 °F). The reactor vessel is assumed to be open to the reactor building.

16.2.1.4 Mode 6 – Refueling (Flooded)

The plant enters this configuration after the reactor well flooding is completed.

Decay heat removal is provided by RWCU/SDCS, with only one train running much of the time in this mode. The FAPCS, operating in the reactor well cooling mode, can be used also to cool the reactor. If required, train B of FAPCS can be operated in Reactor Well Cooling mode. In this mode, water from the reactor well is directed to the train B heat exchanger to ensure adequate cooling of the upper layer of the reactor well water. It is expected that FAPCS Train B operates in this mode 8 hours in every refueling outage.

The duration of Mode 6- Flooded is assumed to be approximately 241 hours (10 days).

In this configuration, the reactor head is removed and the reactor well is flooded.

The RPV is at atmospheric pressure and the reactor coolant temperature is maintained between 54 °C (150 °F) and 51 °C (124 °F). The reactor vessel is assumed to be open to the reactor building.

16.2.1.5 Mode 5 – Cold Shutdown (Before Power Operation)

After completing the refueling, an additional period in cold shutdown may be required for completing other maintenance activities.

The plant configuration is described in 16.2.1.2, except that initial pressure and temperature of the RPV and decay heat are reduced. One RWCU/SDCS train is running.

This analysis assumes that the duration of this mode is approximately 150 hours per refueling outage.

16.2.2 Mission Time

For the quantification of core damage frequency, the mission time is assumed to be 24 hours. However, the availability of inventories of water and power sufficient to ensure core cooling from 24 h to 72 hours is also considered.

16.3 INITIATING EVENTS

The purpose of this subsection is to determine the initiating events that challenge the critical safety functions (e.g., heat removal, inventory control) during shutdown operations. A shutdown initiating event is defined as any event that provokes a disturbance in the stable state of the plant and that requires some kind of action to prevent damage to the core.

Section 16.3.1 discusses the shutdown critical safety functions and the shutdown initiating events that challenge these critical safety functions. Section 16.3.2 presents the analysis of the initiating events considered in the Shutdown PRA. Frequencies for initiating events are estimated in Section 16.3.3 and the recovery actions credited are discussed in Section 16.3.4.

16.3.1 Shutdown Critical Safety Functions

The primary critical safety functions accounted for in the Level 1 internal event shutdown evaluation are the following:

- Decay Heat Removal (DHR)
- Reactor Coolant System Inventory Control

16.3.1.1 Decay Heat Removal

The decay heat removal function during all shutdown modes of operation is provided by the Reactor Water Cleanup/Shutdown Cooling System (RWCU/SDCS) operating in shutdown cooling mode. In Mode 6 with the reactor well flooded, the Fuel and Auxiliary Pools Cooling System (FAPCS) may be used as an alternative.

At the beginning of every shutdown period, both RWCU/SDCS trains will be running, with pumps varying their speed in order to meet the cooldown rate objectives. Once in Mode 6, before completing reactor cavity flooding, only one train is required.

If the reactor well is flooded (Mode 6-Flooded), the risk associated to loss of decay heat removal has been judged to be negligible because of the following:

- In addition to RWCU/SDCS, FAPCS can be aligned to cool the reactor well water, constituting a valid alternative for RWCU/SDCS, thus reducing the probability of losing the decay heat removal function.
- The large amount of water stored above the core assures core cooling during a long period of time. This time would be significantly longer than 24 hours. This long period could be used to establish an adequate path from an external water source to the reactor well. CRD pumps, FAPCS pumps, condensate pumps, or firewater pumps could provide this makeup function. The long period of time available makes it practically certain that sufficient inventory can be supplied.

Therefore, the loss of decay heat removal is not analyzed in detail for the case when the reactor well is flooded (Mode 6-Flooded).

For the other shutdown modes (Modes 5 and 6 with the reactor well unflooded), it is assumed that one RWCU/SDCS train is sufficient to remove decay heat to prevent reactor coolant boiling.

It is assumed that both RWCU/SDCS trains are running, because the time periods in which only one is running occurs when the reactor well is flooded. Consequently, failure of one of the trains is not considered an initiating event.

16.3.1.2 Reactor Coolant System Inventory Control

This critical safety function is defined as maintenance of the RCS inventory at a level sufficient to sustain decay heat removal.

LOCA and RPV draindown events can potentially challenge this critical safety function. They can occur as a result of:

- Random pipe breaks within the RCS (including breaks related to maintenance or refueling operations).
- Misalignment of systems connected to the RPV.
- Leakage during FMCRD replacement.

16.3.1.2.1 Pipe breaks

Two different cases are analyzed, depending on whether the reactor vessel head is installed or not.

16.3.1.2.1.1 Mode 5

As long as the reactor vessel head is in place with its bolts fully tightened, the accident sequence following a Loss of Coolant Accident is considered included in the Full Power PRA.

The frequency of these events is expected to be lower than at full power, due to the reduced vessel pressure and temperature. For example, the Grand Gulf Shutdown Study (Reference 16-1) reports that the large LOCA frequency for shutdown events is a factor of ten lower than the frequency for the full power case. Also, control rods are fully inserted at the beginning of the sequence, and the reduced pressure and temperature of the reactor coolant, and the lower decay heat level allow for longer times available for adequate action.

It is judged that no specific shutdown LOCA event trees are required for shutdown modes where the reactor vessel is closed.

16.3.1.2.1.2 Mode 6

As long as the RPV level is above Level 3 (L3), it is assumed that RWCU/SDCS provides adequate core cooling. Natural circulation of coolant inside the vessel is not challenged because L3 is above the bottom of the steam separators. As such, any break above L3 does not constitute a shutdown initiating event, as RWCU/SDCS will continue to ensure normal core cooling and the core will remain covered.

However, if RPV level drops to L3, RWCU/SDCS pumps receive a runback signal, slowing down to cleanup mode flow rate. In addition, once water level in the vessel falls below the bottom of the steam separators, natural circulation is not assured and the core cooling function of RWCU/SDCS may not be adequate. As such, breaks below L3 are included in the analysis as shutdown initiating events.

Breaks below L3 are divided into the following two categories: breaks outside containment and inside containment.

Breaks Outside Containment

Breaks outside containment can originate only in RWCU/SDCS piping, as this is the only system that removes reactor coolant from the containment in Mode 6; the rest of the RPV vessel piping is isolated.

The RWCU/SDCS containment penetrations have redundant and automatic power-operated containment isolation valves that close on signals from the leak detection and isolation system and the reactor protection system. The inboard valves are nitrogen-operated and the outboard valves are air-operated. Both the inboard and outboard valves are solenoid actuated with spring-to-close provisions. An additional, diverse non-safety isolation of the RWCR/SDCS system provides protection in the event of a break outside containment.

The RWCU/SDCS return lines to the feedwater lines are each provided with redundant check valves in series located in the Main Steam Tunnel. A single-power operated isolation valve in each line is located upstream of the check valves and inside the Reactor Building. The FAPCS and CRDS connections are downstream of the two check valves. A postulated break in the RWCU/SDCS piping system inside the Reactor Building, which would otherwise allow reactor coolant to flow backwards through main feedwater lines and to spill into the Reactor Building, will be isolated by the redundant RWCU/SDCS check valves even if a single failure of one check valve is assumed.

Therefore, the shutdown PRA considers RWCU/SDCS breaks outside containment to be negligible risk contributors and does not analyze them further. This is consistent with the at-power PRA which shows the CDF contribution from RWCU/SDCS breaks outside containment to be negligible.

Breaks Inside Containment

For breaks inside containment, coolant flows through the break to the lower drywell. Decay heat removal is achieved in this case by allowing reactor coolant boiling and then venting the steam to the atmosphere (i.e., the drywell head is removed in Mode 6). To maintain adequate water level in the vessel, a water supply to the vessel is required.

If a break is located below TAF, to reach a safe core cooling condition, it is necessary to flood the drywell and the vessel up to a level above the TAF.

The lower drywell is equipped with a personnel hatch and with an equipment hatch to allow access to the containment for personnel and equipment. These hatches are closed during normal operation, but they may be open during refueling. A manual recovery action to close these two hatches is required for successful drywell flooding (see recovery analysis below).

Two different cases are considered for breaks inside containment below TAF during Mode 6:

- Reactor well flooded (Mode 6-Flooded):

  If the reactor well is flooded, the water inventory stored above the core is assumed to be sufficient to flood the drywell and the vessel well above the TAF if the two lower drywell access hatches are closed at the time of the event or they are manually closed before the water level in the drywell reaches the elevation of the hatches

- Reactor well unflooded (Mode 6-Unflooded):

  If the well is not flooded, the water inventory stored above the core is assumed to be insufficient to cover the core, and additional coolant supply is required

As discussed previously, only pipe breaks below RPV Level 3 (L3) are considered shutdown initiating events. Therefore, breaks in main steam lines, DPVs, and instrument lines above L3 are not considered as shutdown initiating events.

Based on the discussions above, and the line breaks identified in Table 2.3-1, the following line break categories are identified as potential shutdown LOCA initiators:

- GDCS injection line break: this event degrades the passive inventory control system.
- Feedwater line A break: it is assumed that the break occurs in FW line A because this disables effective injection of LPCI and Firewater.
- Line breaks above TAF other than GDCS injection or Feedwater lines.
- Line breaks below the TAF: closure of the lower DW hatches is required to achieve core cooling.

16.3.1.2.2 RPV draindown events due to misalignments

The ESBWR design has significantly reduced the number of potential RPV draindown pathways due to postulated system misalignment during shutdown conditions.

In particular, as compared to Residual Heat Removal System in current BWRs, the RWCU/SDCS in the ESBWR does not have the potential for diverting RPV inventory to the suppression pool through the SP suction, return, or spray lines. RWCU/SDCS does not provide any drywell spray function, so the potential RPV draindown through drywell spray does not exist either.

In addition, the absence of recirculation lines in the ESBWR design further reduces the potential RPV draining paths.

The only operating system that has the potential to drain the RPV during this mode of shutdown is RWCU/SDCS. This system is connected to the RPV during shutdown and it is used to discharge excess reactor coolant to the main condenser or to the radwaste system during startup, shutdown and hot standby conditions.

An analysis of this possible path has been conducted. The conclusion of the analysis is that the ESBWR design eliminates most of the risk for potential drain down from this path. Therefore, the contribution to the core damage frequency in shutdown is judged negligible and this scenario is not analyzed further.

16.3.1.2.3 FMCRD replacement

FMCRD replacement is performed in two steps. First, the CRD spool piece is removed, at which time the spindle adaptor seats on the spindle adaptor back seat to prevent any leakage of water from the RPV. Next, the CRDM is withdrawn until the blade back-seats on the guide tube to provide a metal-to-metal contact. This provides a seal preventing the reactor water from draining. The drive can then be removed and replaced. This arrangement for preventing vessel

draining through back-seating of the control blade is the same as the one used in the current BWRs and in the ABWR.

The potential exists for the operator to remove the blade inadvertently, establishing a direct path for draining the RPV. If a crew of operators is replacing one FMCRD drive while another crew is replacing or rotating the blades from the top, and the blade belonging to the removed drive is acting as a plug, and if inadvertently pulled out, a drain path can be established. It is assumed that, as a normal practice, a blind flange is installed during a temporary removal of the drive or a new drive is installed in a short period of time.

According to these assumptions, two operational errors must occur to allow a drain event to occur:

- Failure to install a blind flange
- Failure to recognize that the blade to be pulled out is withdrawn and already decoupled from the drive.

For these reasons, it is judged that the contribution of this initiating event to the core damage frequency is non-significant.

16.3.2 Identification of Initiating Events

The identification of the shutdown initiating events for inclusion in the ESBWR shutdown risk assessment is based on:

- Review of past shutdown PRAs
- Review of the ESBWR full power PRA initiators
- Consideration of the ESBWR design and configuration during shutdown

The potential initiator scenarios are described in Section 16.3.1. The resulting list of initiating event types during shutdown (and as a function of critical safety function) is presented in Table 16.3-1.

16.3.3 Frequency of Initiating Events

Initiating event frequencies are quantified based on a review of BWR operating experience as well as ESBWR specific evaluations.

16.3.3.1 Loss of Both Operating RWCU/SDCS Trains

The main components of the system are the pumps, heat exchangers, demineralizers, valves and piping.

RWCU/SDCS is connected to non-safety-related standby AC power (diesel generators) allowing it to perform its reactor cooling function when the preferred power source is not available.

In addition to AC power, RWCU/SDCS requires the operation of the Reactor Component Cooling Water System (RCCWS) and the Plant Service Water System (PSWS) in order to remove decay heat.

The unavailability of the RWCU/SDCS system can occur for the following general reasons:

- Failure of both RWCU/SDCS trains
- Isolation of the RWCU/SDCS, caused by RPV low level (Level 3 causes RWCU/SDCS pump runback and Level 2 causes loss of suction pressure), SLCS initiation, LD&IS signals, high temperature in main steam tunnel or high system flow
- Loss of Preferred Power (LOPP)
- Loss of RCCWS or PSWS

The Loss of RWCU/SDCS shutdown initiating event is defined by failure of both trains, either due to RWCU/SDCS component failures or by automatic closure of isolation valves. LOPP and Loss of RCCWS/PSWS are modeled as separate shutdown initiating events.

Automatic closure of RWCU/SDCS isolation valves can be initiated by the following signals:

- High RWCU/SDCS flow
- Low reactor water level (level 2)
- High temperature in main steam tunnel
- Initiation of the Standby Liquid Control System
- Leak Detection and Isolation System signals

ESBWR logic design uses four divisions of power backed up by safety-related batteries. Therefore, loss of power to the logic is highly unlikely. Three divisional logic power supply failures are required to initiate the SDC isolation; as such, this RWCU/SDC failure mode is non-significant compared to loss of support systems or mechanical failures.

The initiating frequency for Loss of RWCU/SDCS is calculated from the dominant failure mode, common cause failure to run of the two RWCU pumps.

16.3.3.2 Loss of Preferred Power

Loss of Preferred Power (LOPP) may happen as a result of severe weather, grid failures or switchyard faults.

The LOPP shutdown initiator frequency is calculated using the loss of offsite power during shutdown data documented in NUREG/CR-5496. (Reference 16-2)

16.3.3.3 Loss of RCCWS/PSWS

This initiating event is the loss of the Reactor Component Cooling water System (RCCWS) or the loss of the Plant Service Water System (PSWS) supporting the RWCU/SDCS operating in shutdown cooling mode. This initiating event poses a DHR challenge and renders the RWCU/SDCS system unavailable.

The frequency of this initiator is based on the Loss of PSWS initiating event frequency calculated for the at-power PRA.

16.3.3.4 LOCA in Mode 6

The following LOCA initiators are quantified in the shutdown PRA:

- Break in one of the GDCS injection lines (Mode 6-Unflooded)
- LOCA in FW-A (Mode 6-Unflooded)
- LOCA other than FW or GDCS (Mode 6-Unflooded)
- LOCA below TAF in RWCW/SDC drain lines (Mode 6-Unflooded; Mode 6-Flooded)
- LOCA below TAF in instrument lines (Mode 6-Unflooded; Mode 6-Flooded)

The shutdown LOCA frequencies are based on the at-power RCS line break frequencies (refer to Table 2.3-1). The at-power RCS line break frequencies are reduced by a factor of 10 for the shutdown PRA to reflect the low pressure and temperature during shutdown conditions. (Reference 16-1)

16.3.4 Recovery Actions

This section documents the calculation of time-dependent, post-initiator recovery probabilities used in the ESBWR Shutdown PRA. The recovery events addressed in this section are those that terminate or mitigate the initiating event before a safety function is challenged. Unlike at full-power conditions, during shutdown modes extended time can be available to terminate the initiating event. This justifies the quantification of recovery possibilities.

Recovery events are analyzed for the following initiating events:

- Loss of both operating RWCU/SDCS trains: Operators recover at least one of the two failed trains.
- Loss of Preferred Power: Offsite AC power recovered.
- Loss of RCCWS/PSWS: Operators recover the failed equipment.
- LOCA Below TAF (Mode 6): Operators close the two lower drywell hatches if they are open.

The analysis of these events is performed using the BWR industry data from References 16-3, 16-4, 16-5 and 16-6. Industry data is included here based on operating experience in Modes 5 and 6.

The operating experience events in each category are analyzed to determine the time elapsed before the initiating event was terminated. Because of the limited data for extended durations, an additional assumed event with a recovery time of 20 hours is added to all distributions.

It is then assumed that the time to recovery is a random variable following a lognormal probability density distribution. The parameters of the distribution are chosen so that a best fit between the real data and the theoretical curve is achieved. The resulting curve provides the probability of shutdown initiating event recovery as a function of time.

16.3.4.1 Recovery of RWCU/SDCS

The most functionally similar system to RWCU/SDCS in current BWRs is the Residual Heat Removal system.

Events involving the loss of a running RHR pump at BWRs are identified from References 16-3, 16-4 and 16-5, and are shown in Table 16.3-4. However, due to the lack of BWR events

specifying the duration, PWR events (see Reference 16-6) are also used in the recovery analysis, excluding those occurring during reduced inventory conditions. Using the methodology described above, the lognormal distribution parameters m and s are determined to be 2.73 and 2.08, respectively. The resulting recovery probability curve as a function of time for the Loss of RWCU/SDCS initiator is provided in Figure 16.3-1.

The allowable time frame for recovery of a Loss of RWCU/SDCS initiator is defined as the time for RPV level to boil-off and drop to RPV Level 3 (at which point a RWCU/SDCS pump runback signal would be initiated – further hampering recovery of RWCU/SDCS cooling).

For Mode 5, the available time is 1.2 hours.

For Mode 6-Unflooded, the available time is 1.3 hours.

These times are based on the ABWR thermal hydraulic calculations (Reference 16-7) and are estimated by the time to reach RCS boiling (assuming the initiating event occurs at the start of the outage phase). These estimates are conservative for the following two reasons: 1) the ESBWR RPV is a larger vessel than the ABWR, thus the larger water volume of the ESBWR would take longer to reach boiling; and 2) the additional time for water level boil-off down to L3 is not credited.

The non-recovery probabilities for these two cases are shown in Table 16.3-5.

16.3.4.2 Power Recovery after LOPP

Recovery from this initiating event implies that the offsite AC power has been restored. Following restoration of offsite power, operator action to align the systems participating in the decay heat removal function is assumed to be required.

NUREG/CR-5496 (Reference 16-2) distinguishes two types of LOPP: plant-centered LOPP and external LOPP (severe weather or grid-related). For each type, a different probability density function is given for the time to recover.

For LOPP cases related to plant-centered events, it is conservatively assumed that recovery time probability density distribution corresponds to the type of "maintained events", as reported in NUREG/CR-5496. Using the plant-centered events data, the lognormal distribution parameters m and s are determined to be 3.39 and 1.44, respectively. The resulting recovery curve is provided in Figure 16.3-2.

For external LOPP cases, the recovery time probability density distribution corresponds to the type of "severe weather", as reported in NUREG/CR-5496. This data results in a lognormal distribution with parameters m and s equal to 5.83 and 1.63, respectively. The recovery curve is provided in Figure 16.3-3.

The allowable time frame for recovery is taken to be the same as that for Loss of RWCU/SDCS.

For Modes 4 and 5, the available time is 1.2 hours.

For Mode 6-Unflooded, the available time is 1.3 hours.

The corresponding shutdown LOPP recovery failure probabilities are determined using a weighted average based on the frequencies of the two LOPP cases (plant-centered and external). The resulting LOPP non-recovery probabilities are shown in Table 16.3-5.

16.3.4.3 Recovery of RCCWS/PSWS

The RCCWS and PSWS are used during shutdown to remove decay heat and other heat loads. The main components in the system are pumps and heat exchangers. It is assumed that the time to recover from a Loss of RCCWS/PSWS shutdown initiator follows the same probability density distribution as the time to recover the RWCU/SDCS.

The allowable time frame for recovery is taken to be the same as that for Loss of RWCU/SDCS.

For Mode 5, the available time is 1.2 hours.

For Mode 6-Unflooded, the available time is 1.3 hours.

The non-recovery probabilities for these two cases are shown in Table 16.3-5.

16.3.4.4 Close Lower Drywell Hatches

An equipment hatch for removal of equipment during maintenance and an air lock for entry of personnel are provided in both the lower and upper drywell. These access openings are sealed under normal plant operation but are opened when the plant is shut down for refueling. Credit is not given for closing the doors after reactor coolant overflows through the hatches. Therefore, the time available for closing both hatches depends on the volume of the lower drywell under the bottom edge of the hatches, on the size of the break, and on the water level in the vessel or reactor well above the break.

This action is required for the shutdown LOCA below TAF initiators during Mode 6. These LOCAs involve breaks in the RWCU/SDC drain lines and instrument lines.

The flow through the break is assumed constant and equal to $S\sqrt{2gh}$, where S is the break area, h is the height of water above the break, and g is the acceleration due to gravity.

Both break locations, in RWCU/SDCS drain lines and instrument lines, are evaluated. The calculation assumes the reactor well is not flooded at the time of the break. Table 16.3-6 summarizes the calculation.

Detection of the event will be immediate if personnel are present in the lower drywell. If this is not the case, it is assumed that an alarm on drywell sump high level is available in the control room.

Once the event has been detected, the plant operator must correctly diagnose the situation, make the decision to close the hatches, gain access to elevation –6400 mm in the reactor building, and manually close the equipment hatch and the personnel air lock. It is assumed that during the outage, personnel will be continuously located in the area of the doors.

Probabilities of 1.0E-1 and 1.0E-2 are assigned for failing to close the DW hatches for breaks in RWCU/SDCS drain lines and instrument line breaks, respectively.

16.4 EVENT TREES

The shutdown PRA event trees are shown in Figures 16.4-1 through 16.4-13.

The event tree construction takes into account the following aspects:

- Chronological order of system actuation
- Grouping of mitigating systems by safety functions

Descriptions of all event tree headings are provided below, though headings appearing in different event trees are described only once.

The success criteria used in the different events are reported under the description of the event heading.

The accident sequence end state nomenclature is the same as in the full power PRA:

- OK: The core is successfully cooled and the containment is intact. There is no core damage in these events.
- CD I: The containment is intact when core damage occurs and the RPV is at low pressure.
- CD II: The containment fails while the core is successfully cooled, leading to subsequent core damage.
- CD III: The containment is intact when core damage occurs and the RPV is at high pressure.
- CD V: The containment is bypassed at the time of core damage.

During Mode 6, when the containment is open, sequences leading to core damage are designated as CD V.

16.4.1 Loss of Decay Heat Removal

Initiators leading to a loss of decay heat removal function are grouped into scenarios occurring during Mode 5 or during Mode 6. Given the three initiating event types leading to loss of DHR scenarios (Loss of RWCU/SDC, Loss of RCCWS/PSWS and Loss of Preferred Power), six shutdown loss of DHR event trees are analyzed.

16.4.1.1 Loss of DHR in Mode 5

Following loss of the decay heat removal function, pressure and temperature in the RPV gradually increase. Due to reduced initial pressure and temperature during shutdown conditions, the operator has the opportunity to recover the lost function before the pressure reaches the SRV setpoint.

If recovery of decay heat removal is not possible, the isolation condenser (I) function will be initiated on RPV high pressure or low RPV water level (Level 2). This function provides short term as well as the long term core cooling.

If ICS fails, RPV pressure increase leads to SRV opening. Steam generated by decay heat is then discharged to the suppression pool, where it is condensed. As the level inside the RPV decreases, high pressure makeup is required to keep the core covered.

Failure of all of the SRVs to open could be postulated to lead to a vessel rupture scenario. Even if mitigation is still possible, core damage is assumed.

Either the feedwater and condensate pumps or the Control Rod Drive system (CRD) can fulfill the high-pressure makeup function. CRD is automatically initiated in the injection mode on RPV water Level 2.

It is possible that the suppression pool water level could exceed the maximum allowed temperature limit, and the depressurization of the Reactor Pressure Vessel (RPV) is required. It is considered that this depressurization is performed using only the SRVs, so the containment heat removal function can still be performed by the FAPCS in the suppression pool cooling mode.

If all high pressure makeup alternatives fail, low pressure makeup is required. The opening of two SRVs enables the injection modes of either FAPCS or the Fire Protection System (FPS).

If low pressure injection systems fail after manual depressurization with 2 SRVs, the ADS will actuate and the short term and long term core cooling functions are performed with 2 of 8 lines from the Gravity Driven Cooling System (GDCS), 2 of 3 GDCS pools and the opening of at least one equalizing line. The equalizing line will permit effective RPV flooding with the suppression pool water, as long as at least 4 DPVs have opened. If for some reason GDCS cannot inject into the depressurized reactor, either FAPCS or FPS injection mode can support the short term and long term core cooling functions.

The containment heat removal function is performed, in both cases, by either the PCCS and if this system fails, FAPCS in the suppression pool cooling mode can be aligned. If both PCCS and FAPCS are not effective, the containment vent can be actuated to reduce the pressure in the containment through at least one path to the atmosphere. In the event of failure of the containment vent function, it is assumed that long term core coolant makeup is failed and, as such, such sequences are modeled as leading to core damage.

16.4.1.1.1 Loss of Both RWCU/SDCS Trains (Mode 5)

The event tree for this initiating event is shown in Figure 16.4-1. The description given above corresponds to this case. The event tree headings are described below.

RW4 - Recovery of RWCU/SDCS (Mode 5)

The operator has the opportunity to recover the RWCU/SDCS before any other system actuates or any other safety function is challenged. See Section 16.3 above for the time available and the recovery failure probability.

I - Isolation Condensers

Regardless of initial RPV pressure, if decay heat is not removed, the Isolation Condenser System is initiated automatically on high reactor pressure, or later on RPV water level Level 2.

The I function is able to prevent RPV Level 1 from being reached if:

- The initial RPV water inventory is above Level 3
- There is little or no leakage from the RPV.

The maximum RCPB leak rate within the Technical Specification during full power operation is assumed to be insufficient to decrease the level to the point where an ADS signal occurs, even if high pressure RPV makeup is not established during the sequence mission time. Therefore, failure of the I function due to leaks is considered a low probability.

The success criterion of this function is the operation of at least 3 of 4 ICs during the sequence mission time, and success of the Long Term Containment Cooling System (WT) described later.

M – At Least 1 SRV Open

If the I function fails, the RPV pressure will increase up to the SRVs setpoint. The success criterion for this function is the automatic operation of at least 1 SRV. Failure of this function is conservatively assumed to lead to core damage.

The possibility of a stuck open relief valve is not modeled. As no credit is given for the I function after the opening of an SRV, it is not necessary to assume that all SRVs are closed.

U1CF – High Pressure Injection Systems

Water level can be maintained above RPV Level 1 by the FDW or by the CRD system. FDW needs to be aligned and initiated by the operator while CRD system automatic initiation occurs at RPV Level 2.

Successful FDW is modeled as at least 1 FDW pump and 1 Condensate pump taking suction from the Condenser, which in turn is supplied from the Condensate Storage Tank (CST). If failure of FDW occurs, RPV Level 2 setpoint is reached and CRD injection initiates. Successful CRD injection into the reactor vessel requires 1 CRD pump taking suction from the CST.

XS2 – At Least 2 SRVs Open

If no high pressure injection system is available, it is necessary to depressurize the RPV to allow FAPCS or FPS injection to the RPV.

Success of this function requires the operator to manually open at least 2 SRVs.

The time available to the operator to manually initiate RPV depressurization is defined by the time when RPV level falls below L2 to the time when the ADS system will automatically initiate (i.e., at RPV Level 1).

VLF – Low Pressure Injection Systems

After successful RPV depressurization, either FAPCS or FPS can fulfill the core cooling function when configured in the RPV injection mode. Both systems are manually actuated.

The time available to the operator to manually initiate either of these two systems is defined by the time when RPV pressure has been sufficiently reduced to the time when the ADS system will automatically initiate (i.e., at RPV Level 1).

Success of this function requires the operator to manually align at least 1 FAPCS or FPS train in RPV injection mode.

ADS - At Least 4 DPVs Open Automatically

If RPV water level falls below Level 1, the ADS system automatically initiates.

The success criterion for this function is that at least 4 DPVs automatically open.

VG – Gravity Driven Cooling System

If all the active low pressure injection systems are unavailable after successful RPV depressurization, the passive GDCS system will automatically inject water into the RPV. Short term core cooling is accomplished by the opening of at least 2 GDCS lines and the discharge of at least 2 GDCS pools. One equalizing line must be opened for long term core cooling.

The success criteria for this function are the discharge of at least 2 lines and 2 GDCS pools and the opening of at least 1 equalizing line.

VLFL - Low Pressure Injection Systems after ADS

This event tree node models initiation of low pressure injection following automatic RPV depressurization by the ADS system. As in the VLF node, either 1 train of FAPCS or FPS operating in the RPV injection mode can fulfill this function. However, the time available to the operator to perform the manually alignment is different in the scenario with automatic ADS. The time available to the operator to perform the alignment is defined by the time when the GDCS fails to initiate to the time when core damage starts.

DL – Vacuum Breaker Closed

When the RPV is depressurized through the DPVs, the vacuum breakers connecting the wetwell and the drywell must remain closed; otherwise the PCCS can not effectively remove heat from the containment.

If a vacuum breaker opens, it is possible to close it or the associated series isolation valve. The time available to close or isolate an open vacuum breaker is defined by the time of RPV depressurization to the time when containment pressure reaches venting pressure.

The success criterion for this heading is that all vacuum breakers remain isolated.

WP – Passive Containment Cooling System

The short term passive containment heat removal function is performed by the PCCS. The PCCS is effective only when the drywell pressure is greater than the wetwell pressure and all the vacuum breakers are closed.

The system is always open to the containment atmosphere and it has no valves that require opening. Failure of this function is the loss of effectiveness of the heat exchangers in removing the decay heat from containment atmosphere (e.g., tube plugging).

The success criterion for this function is the operation of at least 4 heat exchangers.

WT – Long Term Containment Cooling System

This heading models the potential for long term containment heat removal failure.

When PCCS or the ICs are performing the containment heat removal function, long term containment heat removal is achieved via use of all the water in the pools of the upper part of the reactor building.

The success criterion for this function is the full connection of the pools in the reactor building.

WLL – Suppression Pool Cooling after Depressurization

If other containment cooling systems have failed, the decay heat removal function can be accomplished by the FAPCS in the suppression pool cooling mode. This requires manual initiation.

The time available to the operators to initiate suppression pool cooling is defined by the time when PCCS fails to the time when containment pressure reaches the containment venting pressure.

Success of this function requires manual alignment of at least 1 FAPCS train in suppression pool cooling mode.

WC – Containment Overpressure Protection System

If no containment heat removal system is available, the operators can reduce containment pressure by venting from the suppression pool to the stack via the Containment Inerting System.

Success of this function requires manually opening the vent line. The time available to the operator to initiate venting is defined by the time that the CIS setpoint is reach until the time of containment failure.

16.4.1.1.2 Loss of Preferred Power (Mode 5)

The event tree for this initiating event is shown in Figure 16.4-3. The event tree heading descriptions above for loss of DHR in Mode 5 is applicable to this case, except for those systems that are unavailable because they cannot be not powered by the standby diesel generators (i.e., Feedwater and Condensate pumps).

As a result, heading U1CF in the Loss of RWCU/SDC event tree is replaced by U1C, and RW4 is removed. The recovery of power is accounted for in the fault tree models.

Also, a new heading, WH, is introduced to account for the RWCU/SDCS restart on diesel generator power after the LOPP event.

The event tree headings UC and WH are described below.

U1C – Control Rod Drive System

In case of failure of the I function, water level can be maintained above RPV Level 1 by the high pressure CRD system. Automatic initiation of the CRD injection mode occurs at RPV Level 2.

Success of CRD for this function is the effective injection into the reactor vessel of 1 CRD pumps taking suction from the CST.

WH – Reactor Water Cleanup/Shutdown Cooling System

After a LOPP event, the RWCU/SDCS pumps are tripped and the decay heat removal function is temporarily unavailable. This heading represents the restart of the two RWCU/SDCS trains relying on the diesel generator power supplies.

The success criterion is that at least one RWCU/SDCS train successfully restarts after a LOPP event and operates during the sequence mission time.

16.4.1.1.3 Loss of RCCWS/PSWS (Mode 5)

The event tree for this initiating event is shown in Figure 16.4-5. The event tree heading descriptions above apply to this tree as well, except for those systems that are unavailable because they rely on RCCWS/PSWS: Feedwater and Condensate, CRD, and FAPCS.

As a result, headings U1CF, WL and WLL are removed from the event tree; heading VLF is replaced by VF; and heading VLFL is replaced by VFL.

The initiating event recovery heading in this tree is named RC4.

The event tree headings RC4, VF, and VFL are described below.

RC4 - Recovery of RCCWS/PSWS (Mode 5)

The operator has the opportunity to recover the RCCWS/PSWS before any safety function is challenged. See Section 16-3 above for the time available and the recovery failure probability.

VF – Fire Protection System

After successful RPV depressurization, the FPS can accomplish the core cooling function when configured in the RPV injection mode. FPS must be manually actuated.

The time available to initiate FPS injection is defined by the time when RPV pressure has been sufficiently reduced to the time when the ADS system will automatically initiate (i.e., at RPV Level 1).

Success of this function requires the operator to manually align at least 1 train of FPS in RPV injection mode.

VFL – Fire Protection System after ADS

This event tree node models initiation of low pressure injection following automatic RPV depressurization by the ADS system. As in the VF node, 1 train of FPS operating in the RPV injection mode can fulfill this function. However, the time available to the operator to perform the manually alignment is different in the scenario with automatic ADS. The time available to the operator to perform the alignment is defined by the time when the GDCS fails to initiate to the time when core damage starts.

16.4.1.2 Loss of DHR in Mode 6 (Unflooded)

In this case, the RPV is open (i.e., the RPV head has been removed, Mode 6), the containment is also open, and the reactor well is assumed to be drained, so the water level is at the elevation of the vessel flange.

A considerable amount of cool water is above the core, allowing the operator significant time to recover failed equipment or systems before coolant boil-off reduces the water level in the vessel, causing safety system actuations.

However, if the decay heat function cannot be recovered, RPV coolant temperature rises, eventually reaching boiling conditions. Makeup water to the RPV is then needed to prevent core damage. Four systems are allowed for the makeup function. Two of them require manual initiation by the operator: FAPCS in injection mode and FPS in injection mode. The other two automatically initiate: CRD (automatic initiation on L2) and GDCS (automatic initiation on Level 1).

16.4.1.2.1 Loss of Both RWCU/SDCS Trains (Mode 6)

The event tree for this initiating event is shown in Figure 16.4-2. All headings for this event tree have been described previously.

16.4.1.2.2 Loss of Preferred Power (Mode 6)

The event tree for this initiating event is shown in Figure 16.4-4. The descriptions above for loss of DHR in Mode 6 apply to this tree as well, except that some systems are unavailable because they are not powered by the standby diesel generators. All headings for this event tree have been described previously.

16.4.1.2.3 Loss of RCCWS/PSWS (Mode 6)

The event tree for this initiating event is shown in Figure 16.4-6. The descriptions above for loss of DHR apply to this tree as well, except that some systems are unavailable because they rely upon RCCWS/PSWS: CRD and FAPCS. FPS and GDCS remain the only makeup systems available. All headings for this event tree have been described previously.

16.4.2 Loss of Coolant Accidents

16.4.2.1 LOCAs in Mode 6 (Unflooded)

In this mode of operation, all LOCAs are liquid breaks. The evolution of the accident and the systems available for mitigation depend on the break location.

Four break locations are analyzed:

- break in a GDCS injection line
- break in Feedwater line A
- break above TAF other than GDCS or FW
- breaks below TAF.

As soon as the break takes place, the liquid coolant flows into the lower drywell, driven by gravity and hydrostatic pressure. If insufficient coolant makeup is provided to the vessel, water level decreases from the vessel flange down to the break elevation. Only break elevations below L3 analyzed; for breaks above L3, the RWCU/SDCS continues removing the decay heat, and no safety function is directly challenged.

Once the level falls below L3, decay heat removal is lost, as the RWCU/SDCS pumps receive a runback signal, and natural circulation inside the vessel is lost when water level drops below the separators skirts.

It is assumed for breaks above TAF that providing makeup to the vessel and allowing coolant boiling is an effective method for core cooling. CRD, FAPCS, Fire Protection and GDCS are considered for water makeup.

For breaks below TAF, the drywell has to be flooded up to an elevation above TAF to reach a safe core cooling condition. The personnel and equipment access hatches to the lower drywell could be open during shutdown, a recovery action to close these doors is modeled.

16.4.2.1.1 LOCA in GDCS Line (Mode 6, Unflooded)

The event tree for this initiating event is shown in Figure 16.4-7. The event heading descriptions above apply to this tree as well. However, the following two new headings are included in this event tree:

- UC – Control Rod Drive System

  The CRD system can provide makeup water in case of a loss of coolant accident during Mode 6. CRD injection mode automatic initiation occurs at RPV Level 2.

  Success of CRD injection into the RPV in this scenario requires 2 CRD pumps taking suction from the CST.

- VG2 – Gravity Driven Cooling System

  If other injection systems are unavailable, the passive GDCS system will inject water into the RPV by gravity.

  Success of this function requires at least 1 GDCS injection line, 2 GDCS pools, and opening at least 1 equalizing line.

  The fault tree of the GDCS system in this event tree accounts for the GDCS line break.

16.4.2.1.2 LOCA in FDW-A Line (Mode 6, Unflooded)

The event tree for this initiating event is shown in Figure 16.4-8. The event heading descriptions above apply to this tree as well, but no credit is given to the systems using the FDW-A piping to inject water in the vessel (FAPCS and FPS). All event tree headings have been described previously.

16.4.2.1.3 LOCA above TAF other than GDCS or FDW-A (Mode 6, Unflooded)

The event tree for this initiating event is shown in Figure 16.4-9. The event heading descriptions above apply to this tree as well. All event tree headings have been described previously.

16.4.2.1.4 LOCA below TAF in RWCU/SDC Drain Lines (Mode 6, Unflooded)

The event tree for this initiating event is shown in Figure 16.4-10. The event tree descriptions above apply to this tree as well, except the recovery action to close the lower drywell hatches. The remaining event tree headings have been described previously.

RLOC1 – Close the lower drywell hatches

If not closed at the time of the initiating event, the operator must close the lower drywell hatches to prevent flooding of reactor building lower levels. See Section 16.3.4.4 for details on time available for this action and the recovery failure probability.

16.4.2.1.5 LOCA below TAF in Instrument Lines (Mode 6, Unflooded)

The event tree for this initiating event is shown in Figure 16.4-11. The description is the same as the preceding case, except that heading RLOC2 is used instead of RLOC1 to account for the longer time available to the operator to close the drywell hatches.

16.4.2.2 *LOCAs in Mode 6 (Flooded)*

Breaks below TAF are analyzed for LOCAs in Mode 6-Flooded. Two break locations are analyzed:

- LOCA below TAF in RWCU.SDC Drain Lines
- LOCA below TAF in Instrument Lines.

The event trees for these two cases are provided in Figures 16.6-12 and 16.6-13, respectively. Each event tree has a single top event modeling failure to close the lower drywell hatches. The failure probabilities for this node are the same as that described previously. Failure to close the lower drywell hatch is modeled as directly leading to a core damage scenario. The scenario with successful closure of the lower drywell hatches does not result in a core damage end state (and no additional top events are questioned) because sufficient water exists above the break to flood the containment above TAF.

16.5 SYSTEM ANALYSIS

This section describes the fault trees used in the Shutdown PRA evaluation. The unavailability of a system to perform its safety function on demand is evaluated by fault tree analysis.

The necessary fault trees are identified following construction of the event trees. These fault trees represent the nodes included in the event trees.

Maximum use is made of the fault trees developed for the Full Power PRA. Potential differences between the full power and the shutdown fault tree models may result from:

- Differences in maintenance unavailabilities
- Differences in success criteria between full power and shutdown condition
- Differences in initial system configuration between full power and shutdown condition
- Differences in human actions

Differences in maintenance during full power and shutdown are addressed by modifying the maintenance unavailability probabilities in the shutdown fault trees. Table 16.5-1 summarizes the maintenance assumptions made for all frontline and support systems used in the shutdown event trees.

The following paragraphs discuss the cases where modifications were made to the full power fault tree logic to reflect the shutdown conditions.

16.5.1 Reactor Water Cleanup / Shutdown Cooling System

A fault tree is required for heading WH in the LOPP event trees. The function to be modeled is the restart of at least one train after a LOPP event, including the start up sequence of the standby diesel generators. This is the same situation as in full power. However, contrary to the full power case, the system is initially operating in the shutdown cooling mode, not in cleanup mode. This means that failures related to the alignment of the system (i.e., failure to open of several MOVs) are removed from the fault tree.

Maintenance is expected to be performed mostly during full power operation, when only one train is operating. Nevertheless, the same maintenance unavailability as used for the full power PRA is conservatively used in the shutdown evaluation.

16.5.2 Feedwater and Condensate

Feedwater and condensate unavailabilities due to maintenance are expected to be higher during shutdown than at full power, as these systems are not required during shutdown.

The initial configuration in shutdown of these systems is with all equipment in standby. This differs from the full power case where the system is running.

A human action to align and initiate the feedwater and condensate pumps to enable water injection to the vessel is required in the shutdown case.

16.5.3 Control Rod Drive System

It is assumed that during the entire shutdown period a single CRD pump is running (providing purge flow to FMCRD and/or the RWCU/SDC pumps) and the second pump is in standby, which is the same initial configuration as at full power.

Additionally, it is assumed that automatic initiation of CRD injection mode on RPV Level 2 is available during shutdown.

16.5.4 Gravity Driven Cooling System

The same initial configuration is valid for full power and for shutdown. However, it is possible that one GDCS pool and one equalizing line could be out of service for maintenance during Mode 6.

16.5.5 Isolation Condenser System

It has been assumed that Technical Specification requirements on ICS availability are the same during Mode 5 as during full power operation. Therefore, the same maintenance unavailabilities are applicable. The only difference in the fault tree model is that automatic ICS initiation signals upon MSIV closure are not available during Mode 5.

16.5.6 High-Pressure Nitrogen Supply System

During Mode 6, low pressure nitrogen loads inside the containment are fed by instrument air instead of nitrogen. As such, for accident sequences initiated during Mode 6, the top event 'Loss of nitrogen to low pressure users inside PC' is replaced by 'Loss of instrument air system'.

16.6 QUANTIFICATION RESULTS

The shutdown accident sequence analysis models the impacts on the following two critical safety functions during shutdown:

- Decay Heat Removal (DHR)
- Reactor Coolant System Inventory Control

Initiating event types, and associated frequencies, are identified that challenge the above critical safety functions (refer to Section 16.3). Event trees are developed specific to the shutdown configurations (refer to Section 16.4) and the system fault tree analysis is based on at-power fault tree models (refer to Section 16.5). The model development and quantification is performed in the CAFTA code. The quantification is performed at a truncation limit of 1E-14/yr.

The core damage frequency results of the ESBWR shutdown risk analysis are summarized in the following tables:

- Shutdown CDF by Initiating Event and Operating Mode (Table 16.6-1)
- Shutdown CDF by Accident Class (Table 16.6-2)

As can be seen from these tables, the shutdown CDF is estimated at 5.56E-09/yr.

The top 200 cutsets for the shutdown CDF are provided in Table 16.6-3.

The risk importance measures for the shutdown CDF are provided in Table 16.6-4.

All evaluated shutdown core damage events are assumed to result in a large release because of the potential for the containment being open during the outage. CCFP is not affected because the containment is not being used as a mitigating system during shutdown.

Maintenance Unavailability Sensitivity

As discussed in Section 16.5, maintenance unavailability was addressed in this analysis be maintaining the maintenance unavailability basic events in the fault trees for all systems, and by adding additional maintenance unavailability basic event probabilities for selected systems.

Quantification sensitivities were performed to address the impact of an alternative modeling approach for treating shutdown maintenance activities. These sensitivities assume a particular train of equipment (Train B selected) is out of service with a 1.0 probability during the entire outage, and the maintenance terms for all other systems are maintained at their shutdown PRA base values.

Multiple sensitivity cases are quantified and the results are summarized in Table 16.6-5. It shows that ESBWR shutdown risk is insensitive to individual system trains being taken out of service. If multiple systems taken out of service for test and maintenance at the same time during shutdown, it has the potential to influence the CDF results, but it is expected that the durations of these combinations would be short and under control of the license holder's outage risk management program. These types of conditions could be searched and minimized in the shutdown program at the plant. The sensitivity to the change in CDF due to multiple systems taken out of service at the same time for test and maintenance during shutdown is also shown in Table 16.6-5. The CDF values are well away from any risk significance threshold.

16.7 INSIGHTS FROM SHUTDOWN PRA

By far, the greatest contribution to shutdown risk comes from breaks in lines connected to the vessel below TAF that occur in Mode 6. In this mode, the lower drywell equipment hatch or personnel hatch is likely to be open to facilitate work in the lower drywell. Although the frequency of these events is very low, there is only one method for mitigation – manual closure of the hatch(es).

In order to minimize the risk from these scenarios, refueling outages must be conducted in a judicious manner. Whenever the hatches are open, procedures shall require personnel to be available and in close proximity to the hatches, with the purpose of providing fast closure of the containment in the event of a water leak. Other measures can be taken, including temporary installation of equipment to aid in closing the hatch or to minimize the flooding rate in the lower drywell.

The next largest contribution to shutdown risk is due to loss of preferred power (LOPP) initiated scenarios.

The contribution from LOPP initiated scenarios is due in part to the need for electric power for alignment of FPS injection to the RPV. Electric power is required to reposition a valve in the injection piping. However, LOPP scenarios are slowly developing events because of the mass of water that must boil away prior to core uncovery and damage. Thermal-hydraulic calculations show that the core will not begin to uncover before approximately 23 hours following the loss of power, allowing significant time for recovery of offsite power that will enable the operators to provide injection to reflood the core.

16.8 CONCLUSIONS

The main conclusion that can be drawn from the ESBWR shutdown risk analysis is that the ESBWR containment and reactor well systems provide a robust, passive means for preventing shutdown core damage events. The key risk insight is that shutdown process should provide assurance that the equipment and personnel hatches in the lower drywell can be isolated in the event of a leak.

16.9 REFERENCES

16-1. Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Grand Gulf, Unit 1, NUREG/CR-6143, Vol. 2, Part 1 A, June 1994

16-2. Evaluation of Loss of Off-site Power Events at NPPs: 1980-1996, NUREG/CR-5496, November 1996

16-3. Residual Heat Removal Experience Review and Safety Analysis: Boiling Water Reactors, NSAC-88, March 1986

16-4. Residual Heat Removal Experience Review and Safety Analysis: Boiling Water Reactors, NSAC-157, June 1991

16-5. Operational Data Analysis of Shutdown and Low Power Licensee Event Reports, AEOD/S93-05, April 1993

16-6. Residual Heat Removal Experience Review and Safety Analysis: Pressurized Water Reactors, NSAC-52, January 1983

16-7. ABWR Standard Safety Analysis Report, 23A6100, August 1996

Table 16.3-1

Shutdown Initiating Events Challenging Critical Safety Functions

Critical Safety Function	Initiating Event
Decay Heat Removal	Loss of Both RWCU/SDCS trains
	Loss of Preferred Power
	Loss of RCCWS/PSWS
Reactor Coolant System Inventory Control	All LOCAs in Modes 4 and 5
	LOCAs in Mode 6-Unflooded (GDCS, FW-A and other)
	All LOCAs in Mode 6-Flooded
	RWCU Misalignment

Table 16.3-2

ESBWR Shutdown PRA Initiating Event Types

Initiating Event	Applicable Modes	Frequency (per hour)
Loss of Both Operating RWCU/SDCS Trains	5 and 6-Unflooded	6.2E-07(1)
Loss of Preferred Power	5 and 6-Unflooded	2.2E-05(2)
Loss of RCCWS/PSWS	5 and 6-Unflooded	1.1E-07 (3)
LOCA in GDCS Line	6	1.1E-10(4) (5)
LOCA in FW-A Line	6	8.5E-11(4) (6)
LOCA other than GDCS/FW	6	1.5E-09(4) (7)
LOCA Below TAF in RWCU/SDC Drain Lines	6	5.6E-11(4) (8)
LOCA Below TAF in Instrument Lines	6	2.0E-09(4) (9)
RWCU Misalignment	5 and 6	Negligible

Notes:

(1) RWCU pump CCF failure to run on a per hour basis.

(2) NUREG/CR-5496 (Reference 16-2) shutdown loss of offsite power frequency on a per hour basis.

(3) Loss of PSWS initiator frequency (refer to Table 2.3-3) on a per hour basis.

(4) Shutdown LOCA frequencies based on at-power RCS line break frequencies (refer to Table 2.3-1), and reduced by a factor of 10 to reflect the low pressure and temperature during shutdown conditions. Expressed on a per hour basis.

(5) Based on lines 'g' of Table 2.3-1.

(6) Based on lines 'd' of Table 2.3-1.

(7) Based on lines 'e', 'f', 'g1', 'i', and 'j2' of Table 2.3-1.

(8) Based on lines 'h' of Table 2.3-1.

(9) Based on lines 'j1' of Table 2.3-1.

Table 16.3-3

ESBWR Shutdown PRA Initiating Event Frequencies

Initiating Event	Operating Mode(1)	Event Tree	Frequency (per yr)(2)
Loss of Both Operating RWCU/SDCS Trains	5	Figure 16.4-1	7.4E-05
	6-Unflooded	Figure 16.4-2	1.8E-05
Loss of Preferred Power	5	Figure 16.4-3	2.6E-03
	6-Unflooded	Figure 16.4-4	6.5E-04
Loss of RCCWS/PSWS	5	Figure 16.4-5	1.3E-05
	6-Unflooded	Figure 16.4-6	3.3E-06
LOCA in GDCS Line	6-Unflooded	Figure 16.4-7	3.2E-09
LOCA in FW-A	6-Unflooded	Figure 16.4-8	2.5E-09
LOCA other than FW or GDCS	6-Unflooded	Figure 16.4-9	4.5E-08
LOCA Below TAF in RWCU/SDCS Drain Line	6-Unflooded	Figure 16.4-10	1.6E-09
	6-Flooded	Figure 16.4-11	6.7E-09
LOCA Below TAF in Instrument Line	6-Unflooded	Figure 16.4-12	5.8E-08
	6-Flooded	Figure 16.4-13	2.4E-07

Notes:

(1) As discussed in Section 16.2, the time in each Operating Mode is assumed to be as follows: Mode 5, 238 hrs; Mode 6-Unflooded, 59 hrs; and Mode 6-Flooded, 241 hrs.

(2) The shutdown initiating event frequencies per year are calculated using the hourly frequencies of Table 16.3-1 and multiplying by the hours in the corresponding Operating Mode. An additional 0.5 factor is applied given that shutdown is expected to occur every two years.

Table 16.3-4

BWR and PWR Loss of Running RHR Pump Events During Shutdown

SITE	CAUSE	REFERENCE	TIME (hours)
AG	PUMP TRIP AFTER TRANSFER OF RPS POWER SUPPLY	NSAC-157	0.02
DAVIS BESSE 1	PUMP FAILED TO START	NSAC-52	0.07
CALVERT CLIFFS 1	LPSI ACTUATION CAUSES PUMP TRIP	NSAC-52	0.25
CALVERT CLIFFS 2	LPSI ACTUATION CAUSES PUMP TRIP	NSAC-52	0.38
272/89-019	GAS BINDING (N2) DURING ACCUMULATOR DISCHARGE VALVE TESTING	AEOD/S93-05	0.70
CALVERT CLIFFS 2	CAVITATION	NSAC-52	2.00
BRUNSWICK 2	START FAILURE	NSAC-88	--
PEACH BOTTOM 3	PUMP TRIP (OVERCURRENT)	NSAC-88	--
BRUNSWICK 2	HIGH PUMP MOTOR RUNNING TEMP	NSAC-88	--
HATCH 1	HIGH RHR PUMP BEARING TEMP	NSAC-88	--
BRUNSWICK 2	LOSS OF PUMP SHAFT SEAL COOLING SYSTEM	NSAC-88	--
GRAND GULF	COOLING FAN FAILURE	NSAC-88	--
BROWNS FERRY 1	PUMP WINDING FAILURE (OVERCURRENT TRIP)	NSAC-88	--
BI	PUMP TRIP DUE TO WORN IMPELLER EYE WEAR RING	NSAC-157	--
DH	PUMP TRIP DUE TO HYDRAULIC TRANSIENT WHEN ONE PUMP STOPPED	NSAC-157	--
AI	PUMP TRIP DUE TO LOGIC POWER SUPPLY DISTURBANCE	NSAC-157	--
271/91-009	AIR BINDING OF PUMP DUE TO LOW RCS LEVEL	AEOD/S93-05	--

Table 16.3-5

Recovery Actions Failure Probabilities

Recovery Event	Mode	Time Allowable (hrs)	Failure Probability
Recovery of RWCU/SDCS	5	1.2	2.29E-01
	6-Unflooded	1.3	2.18E-01
Recovery of Power after LOPP	5	1.2	3.00E-01
	6-Unflooded	1.3	2.82E-01
Recovery of RCCWS/PSWS	5	1.2	2.29E-01
	6-Unflooded	1.3	2.18E-01
Close the lower drywell hatches (RWCU break)	6	1.5	1.00E-01
Close the lower drywell hatches (instr. line break)	6	6.0	1.00E-02

Table 16.3-6

Time Available to Close Lower DW Hatches

Parameter	Break in RWCU/SDCS drainlines	Break in instrument lines below TAF	Units
Lower drywell radius, R	5600		mm
Height from lower drywell to bottom of hatch	2400		mm
Volume of lower drywell below hatch, $V = \pi R^2 H$	236		m^3
Height of water above break, h	25000		mm
Break diameter, d	50	25	mm
Flow rate through break, $Q = (\pi d^2/4)\sqrt{2gh}$	157	39	m^3/hr
Time available(1), $t = V/Q$	91	362	min

Note:

(1) This is the time available to close the lower DW hatches (if open) before flood level in containment reaches the bottom elevation of the hatch opening.

Table 16.5-1

System Maintenance Unavailabilities During Shutdown

System	Mode 5	Mode 6	Observations
ICS	As at full power	Out of service	Maintenance expected in Mode 6, with vessel depressurized.
RWCU/SDC	As at full power	As at full power	1 or 2 trains operating. Maintenance expected to be carried out during full power on one train while the other train operates in RWCU mode.
ADS/SRV	As at full power	Out of service	Maintenance expected in Mode 6, with vessel depressurized.
Feedwater and condensate	Higher maintenance unavailability	Higher maintenance unavailability	All four branches may be unavailable for maintenance during shutdown.
CRD (injection mode)	As at full power	As at full power	Maintenance can be executed during full power on one train while the other train is in operation or on standby.
FAPCS	As at full power	As at full power	Maintenance can be executed during full power as well as during shutdown on one train while the other is operating or on standby.
FPS	As at full power	As at full power	Maintenance can be executed during full power as well as during shutdown on one train while the other is operating or on standby.
GDCS	As in full power	Higher maintenance unavailability	It is assumed that technical specifications will allow 1 out of 3 GDCS pool and one out of four equalizing lines to be out of service during Mode 6
PCCS	As at full power	Out of service	Maintenance expected in Mode 6, with vessel depressurized and containment open
RCCWS	As at full power	As at full power	Maintenance can be executed during full power as well as during shutdown
PSWS	As at full power	As at full power	Maintenance can be executed during full power as well as during shutdown
Service/Instrument Air	As at full power	As at full power	Maintenance can be executed during full power as well as during shutdown
HPNSS	As at full power	As at full power	Maintenance can be executed during full power as well as during shutdown
13.8 kV Power Distribution	As at full power	As at full power	It is assumed that any bus, power center or MCC can be maintained during power operation.
Diesel Generators	As at full power	As at full power	It is assumed that one DG at a time can be maintained during power operation

Table 16.5-1

System Maintenance Unavailabilities During Shutdown

System	Mode 5	Mode 6	Observations
Uninterruptible AC Power	As at full power	As at full power	It is assumed that any bus, power center or MCC can be maintained during power operation.
250V DC Power	As at full power	As at full power	It is assumed that any division can be maintained during power operation.

Table 16.6-1

Shutdown CDF by Initiating Event and by Mode of Operation

Initiating event	CDF (per year)	Operating Mode	CDF (per year)
Loss of RWCU/SDC	Negligible[1]	Mode 5	4.02E-11
Loss of Preferred Power	4.02E-11		
Loss of RCCWS/PSWS	Negligible[1]		
Loss of RWCU/SDC	2.70E-13	Mode 6-Unflooded	2.50E-09
Loss of Preferred Power	1.75E-09		
Loss of RCCWS/PSWS	5.78E-12		
LOCA in GDCS Line	6.49E-13		
LOCA in FW Line A	5.63E-14		
LOCA other than FW or GDCS	1.83E-13		
LOCA Below TAF in RWCU/SDC Drain Lines	1.65E-10		
LOCA Below TAF in Instrument Lines	5.78E-10		
LOCA Below TAF in RWCU/SDC Drain Lines	6.73E-10	Mode 6-Flooded	3.02E-09
LOCA Below TAF in Instrument Lines	2.35E-09		
		TOTAL SHUTDOWN CDF:	5.56E-09

Note:

(1) No cutsets survived the quantification truncation limit of 1E-14/yr.

Table 16.6-2

Shutdown CDF by Accident Class

Accident Class	Description	CDF (per year)
CD I	Core damage with containment intact with RPV at low pressure	Negligible(1)
CD II	Core is successfully cooled initially but containment fails; core damage occurs subsequent to containment failure	Negligible(1)
CD III	Core damage with containment intact with RPV at high pressure	4.02E-11
CD V	Core damage and containment bypassed at the initiation of the accident(2)	5.52E-09

Notes:

(1) No cutsets survived the quantification truncation limit of 1E-14/yr.

(2) During Mode 6, when the containment is open, sequences leading to core damage are designated as CD V.

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report
Internal Events Shutdown
Core Damage Frequency = 5.56E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
1	2.35E-09	1.00E-02	SH-RLOC2	FAILURE TO CLOSE DRYWELL HATCHES (INSTR. LINES BREAK)
		2.35E-07	SH-LBTAF2F	LOCA BELOW TAF (MODE 6, FLOODED), VALUE FOR INSTRUMENT LINES
2	1.65E-09	2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		9.00E-06	R16-BT -CF-ALLBATT	BATTERY CCF #2
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
3	6.73E-10	1.00E-01	SH-RLOC1	FAILURE TO CLOSE DRYWELL HATCHES (RWCU DRAINLINES BREAK)
		6.73E-09	SH-LBTAF1F	LOCA BELOW TAF (MODE 6, FLOODED), VALUE FOR RWCU/SDC DRAINLINES
4	5.78E-10	1.00E-02	SH-RLOC2	FAILURE TO CLOSE DRYWELL HATCHES (INSTR. LINES BREAK)
		5.78E-08	SH-LBTAF2	LOCA BELOW TAF (MODE 6, UNFLOODED), VALUE FOR INSTRUMENT LINES
5	1.65E-10	1.00E-01	SH-RLOC1	FAILURE TO CLOSE DRYWELL HATCHES (RWCU DRAINLINES BREAK)
		1.65E-09	SH-LBTAF1	LOCA BELOW TAF (MODE 6, UNFLOODED), VALUE FOR RWCU/SDC DRAINLINES
6	1.41E-11	3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT -CF-ALLBATT	BATTERY CCF #2
		2.00E-03	U43-SYS-FF-YARD	HARDWARE FAILURES IN YARD AREA
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
7	1.25E-11	3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT -CF-ALLBATT	BATTERY CCF #2
		1.77E-03	U43-XHE-FO-YARD	OPERATOR FAILS TO MAKE UP FROM YARD AREA
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
8	1.14E-11	3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT -CF-ALLBATT	BATTERY CCF #2
		1.61E-03	XXX-XHE-FO-ICPCCS	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
9	3.13E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	P21-ACV-FT-F022A	AIR OPERATED VALVE F022A FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
10	3.13E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	P21-ACV-FT-F022B	AIR OPERATED VALVE F022B FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report
Internal Events Shutdown
Core Damage Frequency = 5.56E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
11	3.13E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	P21-ACV-FT-F025A	AIR OPERATED VALVE F025A FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
12	3.13E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.00E-03	P21-ACV-FT-F025B	AIR OPERATED VALVE F025B FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
13	3.13E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	P21-ACV-FT-F022A	AIR OPERATED VALVE F022A FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
14	3.13E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	P21-ACV-FT-F022B	AIR OPERATED VALVE F022B FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
15	3.13E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	P21-ACV-FT-F025A	AIR OPERATED VALVE F025A FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
16	3.13E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.00E-03	P21-ACV-FT-F025B	AIR OPERATED VALVE F025B FAILS TO TRANSFER
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
17	1.96E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
18	1.96E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
19	1.71E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
20	1.71E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
21	1.41E-12	9.00E-04	C62-DTM-FC-N1EA	DIGITAL TRIP MODULE TRAIN A NO 1E FAILS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
22	1.41E-12	9.00E-04	C62-DTM-FC-N1EA	DIGITAL TRIP MODULE TRAIN A NO 1E FAILS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
23	1.41E-12	9.00E-04	C62-DTM-FC-N1EB	DIGITAL TRIP MODULE TRAIN B NO 1E FAILS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
24	1.41E-12	9.00E-04	C62-DTM-FC-N1EB	DIGITAL TRIP MODULE TRAIN B NO 1E FAILS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
25	1.38E-12	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report
Internal Events Shutdown
Core Damage Frequency = 5.56E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
26	1.38E-12	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
27	9.35E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F022A	AIR OPERATED VALVE F022A FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
28	9.35E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F022B	AIR OPERATED VALVE F022B FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
29	9.35E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F025A	AIR OPERATED VALVE F025A FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
30	9.35E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F025B	AIR OPERATED VALVE F025B FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
31	9.35E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F022A	AIR OPERATED VALVE F022A FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
32	9.35E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F022B	AIR OPERATED VALVE F022B FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
33	9.35E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F025A	AIR OPERATED VALVE F025A FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
34	9.35E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.00E-03	P21-ACV-FT-F025B	AIR OPERATED VALVE F025B FAILS TO TRANSFER
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
35	5.89E-13	2.00E-03	B32-ACV-CC-F006B	AIR OPERATED VALVE F006B FAILS TO OP. TO DEENERG. POSIT.
		4.16E-02	B32-SYS-TM-ICA	IC "A" UNAVAILABLE [# 7]
		3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
36	5.89E-13	2.00E-03	B32-ACV-CC-F006C	AIR OPERATED VALVE F006A FAILS TO OP. TO DEENERG. POSIT.
		4.16E-02	B32-SYS-TM-ICA	IC "A" UNAVAILABLE [# 7]
		3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
37	5.89E-13	2.00E-03	B32-ACV-CC-F006D	AIR OPERATED VALVE F006D FAILS TO OP. TO DEENERG. POSIT.
		4.16E-02	B32-SYS-TM-ICA	IC "A" UNAVAILABLE [# 7]
		3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
38	5.85E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
39	5.85E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
40	5.10E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
41	5.10E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
42	4.70E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-N038B	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
43	4.70E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-P21N038A	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
44	4.70E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-N038B	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
45	4.70E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-P21N038A	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
46	4.42E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
47	4.42E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
48	4.42E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
49	4.42E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
50	4.21E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA1	BATTERY R16-BTA1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
51	4.21E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
52	4.21E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB1	BATTERY R16-BTB1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
53	4.21E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
54	4.21E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA1	BATTERY R16-BTA1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
55	4.21E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
56	4.21E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB1	BATTERY R16-BTB1 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
57	4.21E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
58	4.21E-13	9.00E-04	C62-DTM-FC-N1EA	DIGITAL TRIP MODULE TRAIN A NO 1E FAILS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
59	4.21E-13	9.00E-04	C62-DTM-FC-N1EA	DIGITAL TRIP MODULE TRAIN A NO 1E FAILS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
60	4.21E-13	9.00E-04	C62-DTM-FC-N1EB	DIGITAL TRIP MODULE TRAIN B NO 1E FAILS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report
Internal Events Shutdown
Core Damage Frequency = 5.56E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
61	4.21E-13	9.00E-04	C62-DTM-FC-N1EB	DIGITAL TRIP MODULE TRAIN B NO 1E FAILS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
62	4.20E-13	7.20E-05	R10-CBU-FC-PRE500KV	500KV TRANSMISSION LINE FAILS
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
63	4.13E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
64	4.13E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
65	3.77E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		8.52E-04	R21-DG_-CS-ALLDG	CCF OF DIESEL GENERATORS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
66	3.77E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		8.52E-04	R21-DG_-CS-ALLDG	CCF OF DIESEL GENERATORS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
67	3.76E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.77E-02	G31-XHE-FO-SDC	OPERATOR FAILS TO ACTUATE SDC MODE
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
68	3.76E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.77E-02	G31-XHE-FO-SDC	OPERATOR FAILS TO ACTUATE SDC MODE
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
69	3.46E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
70	3.46E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
71	3.46E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
72	3.46E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
73	3.37E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A11	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
74	3.37E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
75	3.37E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A11	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
76	3.37E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
77	3.06E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		1.95E-04	P21-MP_-CS-TRAINAB	CCF TO START PUMPS TRAINS A AND B
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
78	3.06E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		1.95E-04	P21-MP_-CS-TRAINAB	CCF TO START PUMPS TRAINS A AND B
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
79	3.04E-13	3.12E-05	C62-VLU-CF-DIDALL	CCF OF VOTER LOGIC UNITS
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
80	3.04E-13	3.12E-05	C62-VLU-CF-DIDALL	CCF OF VOTER LOGIC UNITS
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
81	2.93E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
82	2.93E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
83	2.55E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
84	2.55E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
85	2.53E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.00E-04	H23-EMS-FC-DIVADID	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
86	2.53E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		6.00E-04	H23-EMS-FC-DIVBDID	ESSENTIAL MULTIPLEXING SYSTEM DIV B (DID) FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
87	2.53E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.00E-04	H23-EMS-FC-DIVADID	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
88	2.53E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		6.00E-04	H23-EMS-FC-DIVBDID	ESSENTIAL MULTIPLEXING SYSTEM DIV B (DID) FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
89	2.21E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.00E-04	R16-BT_-LP-R16BTA2	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
90	2.21E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.00E-04	R16-BT_-LP-R16BTB2	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
91	2.21E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.00E-04	R16-BT_-LP-R16BTA2	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
92	2.21E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.00E-04	R16-BT_-LP-R16BTB2	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
93	2.12E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.80E-04	R13-INV-FC-R13A2	INVERTER TO R13-A2 FAILS

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
94	2.12E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.80E-04	R13-INV-FC-R13B2	INVERTER TO R13-B2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
95	2.12E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.80E-04	R13-INV-FC-R13A2	INVERTER TO R13-A2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
96	2.12E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.80E-04	R13-INV-FC-R13B2	INVERTER TO R13-B2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
97	2.11E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTA1	BATTERY R16-BTA1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
98	2.11E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTA2	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
99	2.11E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTB1	BATTERY R16-BTB1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
100	2.11E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTB2	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
101	2.11E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTA1	BATTERY R16-BTA1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
102	2.11E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTA2	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
103	2.11E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTB1	BATTERY R16-BTB1 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
104	2.11E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		5.00E-04	R16-BT_-LP-R16BTB2	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
105	2.06E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
106	2.06E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG -FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		2.40E-02	U43-SYS-FF-LPCI	U43 HARDWARE FAILURES
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
107	2.02E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13A1	INVERTER TO R13-A1 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
108	2.02E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13A2	INVERTER TO R13-A2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
109	2.02E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13B1	INVERTER TO R13-B1 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
110	2.02E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13B2	INVERTER TO R13-B2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
111	2.02E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13A1	INVERTER TO R13-A1 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
112	2.02E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report
Internal Events Shutdown
Core Damage Frequency = 5.56E-09
Top 200 Cutsets

No	Cutset Prob	Event Prob	Event	Description
		4.80E-04	R13-INV-FC-R13A2	INVERTER TO R13-A2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
113	2.02E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13B1	INVERTER TO R13-B1 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
114	2.02E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		4.80E-04	R13-INV-FC-R13B2	INVERTER TO R13-B2 FAILS
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
115	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMAA2	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
116	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMBB2	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
117	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
118	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
119	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
120	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
121	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
122	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
123	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		7.96E-03	R22-MCB-CC-1LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
124	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
125	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
126	1.97E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
127	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMAA2	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
128	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		7.96E-03	R11-MCB-CC-XFRMBB2	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
129	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
130	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
131	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
132	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
133	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-2LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
134	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD1	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
135	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD2	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
136	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD3	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
137	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD4	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
138	1.97E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		7.96E-03	R22-MCB-CC-1LOAD5	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
139	1.96E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG_-CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
140	1.96E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		4.44E-03	R21-DG -CR-ALLDG	CCF OF DIESEL GENERATORS TO RUN
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
141	1.71E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
142	1.71E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.18E-01	SH-RC6	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		3.25E-06	SH-SW6	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
143	1.48E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		6.00E-03	R21-DG -TM-DGB	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
144	1.48E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		6.00E-03	R21-DG -TM-DGA	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
145	1.48E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		6.00E-03	R21-DG -TM-DGB	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
146	1.48E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		6.00E-03	R21-DG -TM-DGA	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
147	1.40E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-N038B	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
148	1.40E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-P21N038A	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
149	1.40E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-N038B	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
150	1.40E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		3.00E-04	H23-RMU-FC-P21N038A	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
151	1.38E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		5.60E-02	R21-DG -FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
152	1.38E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG -FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.61E-02	U43-XHE-FO-LPCIADS	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
153	1.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
154	1.32E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
155	1.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
156	1.32E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
157	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-10A11	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
158	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-10A21	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
159	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-ESF1ADID	1ST DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
160	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-ESF1BDID	1ST DIV B (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
161	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-ESF2ADID	2ND DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
162	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-ESF2BDID	2ND DIV B (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
163	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-R101	DTM/TLU 001 OR MUX INTERFACE FAIL TO TRIP (2Y TEST)
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
164	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		3.00E-04	H23-RMU-FC-R102	DTM/TLU 002 OR MUX INTERFACE FAIL TO TRIP (2Y TEST)
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
165	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		3.00E-04	H23-RMU-FC-10A11	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
166	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-10A21	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
167	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-ESF1ADID	1ST DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
168	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-ESF1BDID	1ST DIV B (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
169	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-ESF2ADID	2ND DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
170	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-ESF2BDID	2ND DIV B (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
171	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-R101	DTM/TLU 001 OR MUX INTERFACE FAIL TO TRIP (2Y TEST)
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
172	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		3.00E-04	H23-RMU-FC-R102	DTM/TLU 002 OR MUX INTERFACE FAIL TO TRIP (2Y TEST)
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
173	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA1	BATTERY R16-BTA1 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
174	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
175	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB1	BATTERY R16-BTB1 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
176	1.26E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
177	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA1	BATTERY R16-BTA1 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
178	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTA2	BATTERY R16-BTA2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
179	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB1	BATTERY R16-BTB1 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
180	1.26E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		1.00E-03	R16-BT_-TM-R16BTB2	BATTERY R16-BTB2 IN TEST
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
181	1.12E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		8.52E-04	R21-DG_-CS-ALLDG	CCF OF DIESEL GENERATORS TO START AND LOAD
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
182	1.12E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		8.52E-04	R21-DG_-CS-ALLDG	CCF OF DIESEL GENERATORS TO START AND LOAD
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
183	1.12E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.77E-02	G31-XHE-FO-SDC	OPERATOR FAILS TO ACTUATE SDC MODE
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
184	1.12E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		1.77E-02	G31-XHE-FO-SDC	OPERATOR FAILS TO ACTUATE SDC MODE
		4.80E-02	P30-XHE-MH-F015	MISPOSITION OF VALVE F01T
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
185	1.10E-13	1.55E-05	B32-ACV-CF-2ICABCD	CCF TO OPEN 2/4 ACV VALVES TRAINS A,B,C,D
		3.00E-01	R11-SYS-FF-NORS5	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
		9.00E-06	R16-BT_-CF-ALLBATT	BATTERY CCF #2
		2.62E-03	SH-LOPP5	LOSS OF PREFERRED POWER (MODE 5)
186	1.03E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
187	1.03E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
188	1.03E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGB	D/G "B" FAILS TO START AND LOAD
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
189	1.03E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		1.40E-02	R21-DG_-FS-DGA	DIESEL GENERATOR "A" FAILS TO START

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
190	1.00E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A11	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
191	1.00E-13	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
192	1.00E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A11	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
193	1.00E-13	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		4.80E-02	G21-XHE-MH-F334	MISPOSITION OF VALVE F334
		2.69E-01	P21-XHE-FO-STDBYPUMP	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
		8.00E-04	R22-RE_-FD-10A21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
194	9.90E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		4.00E-03	R21-SYS-FC-FUELDG5	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
195	9.90E-14	1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		4.00E-03	R21-SYS-FC-FUELDG4	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-3

Internal Events Shutdown PRA Cutset Report

Cutsets with Descriptions Report Internal Events Shutdown Core Damage Frequency = 5.56E-09 Top 200 Cutsets				
No	**Cutset Prob**	**Event Prob**	**Event**	**Description**
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
196	9.90E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGA	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
		4.00E-03	R21-SYS-FC-FUELDG5	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
197	9.90E-14	1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.82E-01	R11-SYS-FF-NORS6	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
		5.60E-02	R21-DG_-FR-DGB	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
		4.00E-03	R21-SYS-FC-FUELDG4	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		6.49E-04	SH-LOPP6	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
198	9.40E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.29E-01	SH-RW5	FAILURE IN RWCU/SDC RECOVERY (MODE 5)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		7.38E-05	SH-RWCU5	LOSS OF BOTH RWCU/SDCS TRAINS (MODE 5)
199	9.40E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F013B	MISPOSITION OF VALVE F013B
		1.50E-05	E50-SQV-CF-OPENALL	CCF OF ALL SQUIB VALVES TO OPEN
		2.29E-01	SH-RW5	FAILURE IN RWCU/SDC RECOVERY (MODE 5)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		7.38E-05	SH-RWCU5	LOSS OF BOTH RWCU/SDCS TRAINS (MODE 5)
200	9.40E-14	4.80E-02	C12-XHE-MH-F013A	MISPOSITION OF VALVE F013A
		4.80E-02	C12-XHE-MH-F015B	MISPOSITION OF VALVE F015B
		1.50E-05	E50-SQV-CF-GDCS7OPEN	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
		2.29E-01	SH-RW5	FAILURE IN RWCU/SDC RECOVERY (MODE 5)
		1.61E-01	XXX-XHE-FO-LPMAKEUP	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)
		7.38E-05	SH-RWCU5	LOSS OF BOTH RWCU/SDCS TRAINS (MODE 5)

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
B21-LT_-CF-N001ABCD	1.20E-07	2.94E-05	245.77	CCF OF DIVERSIFIED LEVEL 1& 2 TRANSM. 1A/B/C/D
B21-UV_-CC-F102A	1.60E-03	9.50E-05	1.06	CHECK VALVE F102A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F102B	1.60E-03	1.06E-04	1.07	CHECK VALVE #1 IN FEEDWATER LINE B FAILS TO REOPEN
B21-UV_-CC-F103A	1.60E-03	9.50E-05	1.06	CHECK VALVE F103A IN FEEDWATER LINE A FAILS TO OPEN
B21-UV_-CC-F103B	1.60E-03	1.06E-04	1.07	CHECK VALVE #2 IN FEEDWATER LINE B FAILS TO REOPEN
B32-ACV-CC-F006A	2.00E-03	1.53E-05	1.01	AIR OPERATED VALVE F006A FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CC-F006B	2.00E-03	1.21E-04	1.06	AIR OPERATED VALVE F006B FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CC-F006C	2.00E-03	1.21E-04	1.06	AIR OPERATED VALVE F006A FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CC-F006D	2.00E-03	1.21E-04	1.06	AIR OPERATED VALVE F006D FAILS TO OP. TO DEENERG. POSIT.
B32-ACV-CF-2ICABCD	1.55E-05	1.97E-05	2.27	CCF TO OPEN 2/4 ACV VALVES TRAINS A,B,C,D
B32-MOV-CF-2ICABCD	8.08E-06	1.03E-05	2.27	CCF TO OPEN 2/4 MOV VALVES TRAINS A,B,C,D
B32-SYS-TM-ICA	4.16E-02	3.17E-04	1.01	IC "A" UNAVAILABLE [# 7]
C12-MOV-CC-F020A	4.00E-03	4.47E-06	1	MOTOR OPER. VALVE F020A FAILS TO OPEN
C12-MOV-CC-F020B	4.00E-03	4.47E-06	1	MOTOR OPER. VALVE F020B FAILS TO OPEN
C12-MOV-FC-F020A	3.13E-03	1.96E-06	1	FLOW CONTROL A FAILS WIDE OPEN
C12-MOV-FC-F020B	3.13E-03	1.96E-06	1	FLOW CONTROL B FAILS WIDE OPEN
C12-SYS-TM-TRAINB	3.00E-03	1.88E-06	1	TRAIN B IN MAINTENANCE
C12-UV_-CC-F022	1.60E-03	5.12E-05	1.03	CHECK VALVE F022 FAILS TO OPEN
C12-XHE-MH-F003B	1.20E-02	4.11E-05	1	MISPOSITION OF VALVE F003B
C12-XHE-MH-F013A	4.80E-02	1.48E-04	1	MISPOSITION OF VALVE F013A
C12-XHE-MH-F013B	4.80E-02	1.48E-04	1	MISPOSITION OF VALVE F013B
C12-XHE-MH-F015A	4.80E-02	1.48E-04	1	MISPOSITION OF VALVE F015A
C12-XHE-MH-F015B	4.80E-02	1.48E-04	1	MISPOSITION OF VALVE F015B
C12-XHE-MH-F018A	1.20E-02	4.11E-05	1	MISPOSITION OF VALVE F018A

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
C12-XHE-MH-F018B	1.20E-02	4.11E-05	1	MISPOSITION OF VALVE F018B
C12-XHE-MH-F021A	1.20E-02	4.11E-05	1	MISPOSITION OF VALVE F021A
C12-XHE-MH-F021B	1.20E-02	4.11E-05	1	MISPOSITION OF VALVE F021B
C51-ACT-CF-APRMSTUCK	2.10E-07	6.09E-05	290.53	CCF APRM DETECTORS STUCK AT POWER LEVEL
C62-DTM-CF-N1EALL	5.50E-05	4.02E-05	1.73	CCF OF DIGITAL TRIP MODULES NO 1E
C62-DTM-FC-N1EA	9.00E-04	7.04E-04	1.78	DIGITAL TRIP MODULE TRAIN A NO 1E FAILS
C62-DTM-FC-N1EB	9.00E-04	7.04E-04	1.78	DIGITAL TRIP MODULE TRAIN B NO 1E FAILS
C62-VLU-CF-DIDALL	3.12E-05	1.09E-04	4.5	CCF OF VOTER LOGIC UNITS
C74-VLU-CF-ALL	3.12E-06	3.99E-06	2.27	CCF OF VOTER LOGIC UNITS
E50-MP_-TM-POOLB	1.00E-02	5.77E-04	1.06	GDCS POOL B IN MAINTENANCE
E50-OR_-CF-7PLUG	7.00E-08	1.05E-05	151.51	CCF OF 7 ORIFICES TO PLUG
E50-OR_-CF-PLUGALL	7.20E-08	1.09E-05	151.77	CCF OF ALL ORIFICES TO PLUG
E50-SQV-CC-F002A	3.00E-03	5.48E-05	1.02	SQUIB VALVE F002A FAILS TO OPERATE
E50-SQV-CC-F002D	3.00E-03	5.48E-05	1.02	SQUIB VALVE F002D FAILS TO OPERATE
E50-SQV-CC-F002E	3.00E-03	5.48E-05	1.02	SQUIB VALVE F002E FAILS TO OPERATE
E50-SQV-CC-F002H	3.00E-03	5.48E-05	1.02	SQUIB VALVE F002H FAILS TO OPERATE
E50-SQV-CF-GDCS7OPEN	1.50E-05	9.44E-03	629.95	CCF OF 7 SQUIB VALVES IN GDCS LINES TO OPEN
E50-SQV-CF-OPENALL	1.50E-05	9.44E-03	629.95	CCF OF ALL SQUIB VALVES TO OPEN
E50-SQV-CO-F009A	3.50E-03	1.57E-04	1.04	SQUIB DELUGE VALVE F009A SPUR. OPENING [#7]
E50-SQV-CO-F009D	3.50E-03	1.57E-04	1.04	SQUIB DELUGE VALVE F009D SPUR. OPENING [#7]
E50-SQV-CO-F009E	3.50E-03	1.57E-04	1.04	SQUIB DELUGE VALVE F009E SPUR. OPENING [#7]
E50-SQV-CO-F009H	3.50E-03	1.57E-04	1.04	SQUIB DELUGE VALVE F009H SPUR. OPENING [#7]
E50-SQV-CO-F009I	3.50E-03	1.57E-04	1.04	SQUIB DELUGE VALVE F009I SPUR. OPENING [#7]
E50-SQV-CO-F009L	3.50E-03	1.57E-04	1.04	SQUIB DELUGE VALVE F009L SPUR. OPENING [#7]
E50-STR-CF-SPPLUG	3.75E-04	1.03E-04	1.27	CCF FILTER/STRAINER IN PSP TO PLUG

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
E50-UV_-OC-F003A	1.75E-03	2.78E-05	1.02	CHECK VALVE F003A FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003D	1.75E-03	2.78E-05	1.02	CHECK VALVE F003D FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003E	1.75E-03	2.78E-05	1.02	CHECK VALVE F003E FAILS TO REMAIN OPEN OR PLUG
E50-UV_-OC-F003H	1.75E-03	2.78E-05	1.02	CHECK VALVE F003H FAILS TO REMAIN OPEN OR PLUG
G21-ACV-CC-F332	2.00E-03	9.15E-05	1.05	AOV F332 FAILS TO OPERATE TO NOT DEENERG.POS.
G21-UV_-CC-F333	1.60E-03	7.29E-05	1.05	CHECK VALVE F333 FAILS TO OPEN
G21-UV_-TM-F332/333	8.00E-04	2.23E-05	1.03	MAINTENANCE FOR CV F332 OR CV F333
G21-XHE-MH-F334	4.80E-02	3.84E-03	1.08	MISPOSITION OF VALVE F334
G31-MOV-CC-F009B	4.00E-03	7.18E-06	1	MOTOR OPER. VALVE F009B FAILS TO OPEN
G31-MOV-CC-F020B	4.00E-03	7.18E-06	1	MOTOR OPER. VALVE F020B FAILS TO OPEN
G31-MOV-CC-F030B	4.00E-03	7.18E-06	1	AIR OPER. VALVE F030B FAILS TO OPEN
G31-XHE-FO-SDC	1.77E-02	3.57E-04	1.02	OPERATOR FAILS TO ACTUATE SDC MODE
H23-EMS-CF-ALL	1.80E-06	2.31E-06	2.27	CCF OF ESSENTIAL MULTIPLEXING SYSTEM DIV 1/2/3/4
H23-EMS-CF-DIDALL	1.80E-06	6.31E-06	4.5	CCF OF ALL DIVISION OF THE EMS
H23-EMS-FC-DIVADID	6.00E-04	1.23E-04	1.21	ESSENTIAL MULTIPLEXING SYSTEM DIV A (DID) FAILS TO FUNCTION
H23-EMS-FC-DIVBDID	6.00E-04	1.23E-04	1.21	ESSENTIAL MULTIPLEXING SYSTEM DIV B (DID) FAILS TO FUNCTION
H23-RMU-FC-10A11	3.00E-04	5.90E-05	1.2	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-10A21	3.00E-04	5.90E-05	1.2	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF1ADID	3.00E-04	5.90E-05	1.2	1ST DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF1BDID	3.00E-04	5.90E-05	1.2	1ST DIV B (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF2ADID	3.00E-04	5.90E-05	1.2	2ND DIV A (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-ESF2BDID	3.00E-04	5.90E-05	1.2	2ND DIV B (DID) ESF REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-N038B	3.00E-04	2.19E-04	1.73	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-P21N038A	3.00E-04	2.19E-04	1.73	REMOTE MULTIPLEXING UNIT FAILS TO FUNCTION
H23-RMU-FC-R101	3.00E-04	5.90E-05	1.2	DTM/TLU 001 OR MUX INTERFACE FAIL TO TRIP (2Y TEST)

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
H23-RMU-FC-R102	3.00E-04	5.90E-05	1.2	DTM/TLU 002 OR MUX INTERFACE FAIL TO TRIP (2Y TEST)
P21-ACV-CF-F022/25A	5.00E-05	3.66E-05	1.73	CCF VALV ACV F022A/ F025A TRAIN A
P21-ACV-CF-F022/25B	5.00E-05	3.66E-05	1.73	CCF VALV ACV F022B/F025B TRAIN B
P21-ACV-FT-F022A	2.00E-03	1.65E-03	1.82	AIR OPERATED VALVE F022A FAILS TO TRANSFER
P21-ACV-FT-F022B	2.00E-03	1.65E-03	1.82	AIR OPERATED VALVE F022B FAILS TO TRANSFER
P21-ACV-FT-F025A	2.00E-03	1.65E-03	1.82	AIR OPERATED VALVE F025A FAILS TO TRANSFER
P21-ACV-FT-F025B	2.00E-03	1.65E-03	1.82	AIR OPERATED VALVE F025B FAILS TO TRANSFER
P21-MCB-OO-C001A	1.00E-03	8.94E-06	1.01	CIRCUIT BREAKER OF PUMP C001A FAILS TO CLOSE
P21-MCB-OO-C001B	1.00E-03	8.94E-06	1.01	CIRCUIT BREAKER OF PM C001B FAILS TO CLOSE
P21-MCB-OO-C002A	1.00E-03	8.94E-06	1.01	MEDIUM VOLTAGE CIRCUIT BREAKER FAILS TO CLOSE
P21-MCB-OO-C002B	1.00E-03	8.94E-06	1.01	MEDIUM VOLTAGE CIRCUIT BREAKER FAILS TO CLOSE
P21-MCB-OO-C003A	1.00E-03	8.94E-06	1.01	MEDIUM VOLTAGE CIRCUIT BREAKER FAILS TO CLOSE
P21-MCB-OO-C003B	1.00E-03	8.94E-06	1.01	MEDIUM VOLTAGE CIRCUIT BREAKER FAILS TO CLOSE
P21-MOV-CC-F039B	4.00E-03	7.18E-06	1	MOTOR OPERATED VALVE P21-F039B FAILS TO OPEN
P21-MOV-CC-F040B	4.00E-03	7.18E-06	1	MOTOR OPERATED VALVE P21-F040B FAILS TO OPEN
P21-MP -CR-TRAINAB	1.80E-05	1.01E-05	1.56	CCF TO RUN PUMPS TRAINS A AND B
P21-MP -CS-TRAINAB	1.95E-04	1.43E-04	1.73	CCF TO START PUMPS TRAINS A AND B
P21-MP -FS-C001A	1.30E-03	1.16E-05	1.01	MOTOR DRIVEN PUMP C001A FAILS TO START
P21-MP -FS-C001B	1.30E-03	1.16E-05	1.01	MOTOR-DRIVEN PUMP C001B FAILS TO START
P21-MP -FS-C002A	1.30E-03	1.16E-05	1.01	MOTOR-DRIVEN PUMP (ALL TYPES) FAILS TO START
P21-MP -FS-C002B	1.30E-03	1.16E-05	1.01	MOTOR-DRIVEN PUMP C002B FAILS TO START
P21-MP -FS-C003A	1.30E-03	1.16E-05	1.01	MOTOR-DRIVEN PUMP C0003A FAILS TO START
P21-MP -FS-C003B	1.30E-03	1.16E-05	1.01	MOTOR-DRIVEN PUMP C003B FAILS TO START
P21-MP -TM-C002A	2.00E-03	2.76E-05	1.01	PUMP C002A IN MAINTENANCE
P21-MP -TM-C002B	2.00E-03	2.76E-05	1.01	PUMP C002B IN MAINTENANCE

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
P21-TT -NO-N038B	8.40E-06	4.79E-06	1.57	TEMPERATURE XMTR FAILS TO RESPOND TO CHANGE IN TEMPERATURE
P21-TT -NO-P21N038A	8.40E-06	4.79E-06	1.57	TEMPERATURE XMTR FAILS TO RESPOND TO CHANGE IN TEMPERATURE
P21-XHE-FO-STDBYPUMP	2.69E-01	2.58E-03	1.01	OP. FAILS MAN. ACT. OF STDBY PUMP WHEN AUT. ACTUATION FAIL
P30-XHE-MH-F015	4.80E-02	2.25E-04	1	MISPOSITION OF VALVE F01T
P41-MP -CS-2ALL	4.29E-05	3.14E-05	1.73	CCF TO START 2 PUMPS TRAINS A AND B
P41-STR-CF-2ALL	1.07E-05	6.07E-06	1.56	CCF 2 STRAINERS PLUGGED
P52-CMP-CS-C001AB	1.71E-03	1.70E-05	1.01	CCF TO START COMPRESSORS LINES 1 & 2
P52-CMP-FS-C001A	2.00E-02	8.54E-06	1	MOTOR-DRIVEN AIR COMPRESS. C001A FAILS TO START
P52-CMP-FS-C001B	2.00E-02	8.54E-06	1	MOTOR-DRIVEN AIR COMPRESS. C001B FAILS TO START
P52-XHE-FO-IAS/SAS	1.61E-02	6.86E-06	1	OPER. FAILS TO REC. NEED FOR MANUAL INTERV. ON IAS/SAS
R10-BAC-LP-500KVMAIN	4.80E-06	5.07E-06	2.05	500 KV MAIN DISTRIBUTION BUS FAILS DURING OPERATION
R10-CBU-FC-PRE500KV	7.20E-05	7.76E-05	2.08	500KV TRANSMISSION LINE FAILS
R11-MCB-CC-XFRMAA2	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER FROM XFRM-A FAILS TO OPEN
R11-MCB-CC-XFRMBB2	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER FROM XFRM-B FAILS TO OPEN
R11-MCB-CF-69CLOSE	9.29E-05	1.92E-05	1.21	CCF CIRCUIT BREAKERS 6.9 KV TO CLOSE
R11-SYS-FF-NORS5	3.00E-01	7.22E-03	1.02	FAILURE IN OFFSITE POWER RECOVERY (MODE 5)
R11-SYS-FF-NORS6	2.82E-01	3.03E-01	1.77	FAILURE IN OFFSITE POWER RECOVERY (MODE 6)
R13-INV-FC-R13A1	4.80E-04	9.87E-05	1.21	INVERTER TO R13-A1 FAILS
R13-INV-FC-R13A2	4.80E-04	1.93E-04	1.4	INVERTER TO R13-A2 FAILS
R13-INV-FC-R13B1	4.80E-04	9.87E-05	1.21	INVERTER TO R13-B1 FAILS
R13-INV-FC-R13B2	4.80E-04	1.93E-04	1.4	INVERTER TO R13-B2 FAILS
R13-LCB-CO-FR13A21	1.44E-05	8.14E-06	1.56	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-FR13B21	1.44E-05	8.14E-06	1.56	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13A21	1.44E-05	8.14E-06	1.56	CIRCUIT BREAKER OPENS SPURIOUSLY
R13-LCB-CO-R13B21	1.44E-05	8.14E-06	1.56	CIRCUIT BREAKER OPENS SPURIOUSLY

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
R13-LCB-CO-TOR13A2	1.44E-05	8.14E-06	1.56	CIRCUIT BREAKER TO R13-A2 OPENS SPURIOUSLY
R13-LCB-CO-TOR13B2	1.44E-05	8.14E-06	1.56	CIRCUIT BREAKER TO R13-B2 OPENS SPURIOUSLY
R13-XFL-LP-R13A21	1.92E-05	1.09E-05	1.56	TRANSFORMER FAILS DURING OPERATION
R13-XFL-LP-R13B21	1.92E-05	1.09E-05	1.56	TRANSFORMER FAILS DURING OPERATION
R16-BT_-CF-ALLBATT	9.00E-06	3.03E-01	3.37E+04	BATTERY CCF #2
R16-BT_-LP-R16BTA	5.00E-04	4.47E-06	1.01	BATTERY R16-BTA FAILS TO PROVIDE OUTPUT
R16-BT_-LP-R16BTA1	5.00E-04	1.03E-04	1.21	BATTERY R16-BTA1 FAILS TO PROVIDE OUTPUT
R16-BT_-LP-R16BTA2	5.00E-04	2.01E-04	1.4	BATTERY R16-BTA2 FAILS TO PROVIDE OUTPUT
R16-BT_-LP-R16BTB	5.00E-04	4.47E-06	1.01	BATTERY R16-BTB FAILS TO PROVIDE OUTPUT
R16-BT_-LP-R16BTB1	5.00E-04	1.03E-04	1.21	BATTERY R16-BTB1 FAILS TO PROVIDE OUTPUT
R16-BT_-LP-R16BTB2	5.00E-04	2.01E-04	1.4	BATTERY R16-BTB2 FAILS TO PROVIDE OUTPUT
R16-BT_-TM-R16BTA	1.00E-03	8.94E-06	1.01	BATTERY R16-BTA IN TEST
R16-BT_-TM-R16BTA1	1.00E-03	2.06E-04	1.21	BATTERY R16-BTA1 IN TEST
R16-BT_-TM-R16BTA2	1.00E-03	4.03E-04	1.4	BATTERY R16-BTA2 IN TEST
R16-BT_-TM-R16BTB	1.00E-03	8.94E-06	1.01	BATTERY R16-BTB IN TEST
R16-BT_-TM-R16BTB1	1.00E-03	2.06E-04	1.21	BATTERY R16-BTB1 IN TEST
R16-BT_-TM-R16BTB2	1.00E-03	4.03E-04	1.4	BATTERY R16-BTB2 IN TEST
R21-DG_-CR-ALLDG	4.44E-03	1.19E-03	1.27	CCF OF DIESEL GENERATORS TO RUN
R21-DG_-CS-ALLDG	8.52E-04	2.10E-04	1.25	CCF OF DIESEL GENERATORS TO START AND LOAD
R21-DG_-FR-DGA	5.60E-02	1.97E-03	1.03	DIESEL GENERATOR "A" FAILS TO RUN GIVEN START
R21-DG_-FR-DGB	5.60E-02	1.99E-03	1.03	DIESEL GENERATOR "B" FAILS TO RUN GIVEN START
R21-DG_-FS-DGA	1.40E-02	4.06E-04	1.03	DIESEL GENERATOR "A" FAILS TO START
R21-DG_-FS-DGB	1.40E-02	4.06E-04	1.03	D/G "B" FAILS TO START AND LOAD
R21-DG_-TM-DGA	6.00E-03	1.55E-04	1.03	STANDBY DIESEL GENERATOR "A" IN MAINTENANCE
R21-DG_-TM-DGB	6.00E-03	1.55E-04	1.03	STANDBY DIESEL GENERATOR "B" IN MAINTENANCE

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
R21-MCB-OO-DGAR11A2	1.00E-03	8.94E-06	1.01	CIRCUIT BREAKER FROM DG-A TO R11-A2 FAILS TO CLOSE
R21-MCB-OO-DGBR11B2	1.00E-03	8.94E-06	1.01	CIRCUIT BREAKER FROM DG-B TO R11-B2 FAILS TO CLOSE
R21-MP_-CR-FUELTRANS	3.72E-05	5.91E-06	1.16	CCF TO RUN MOTOR-DRIVEN FUEL TRANSFER PUMPS
R21-MP_-CS-FUELTRANS	1.71E-04	3.93E-05	1.23	CCF TO START MOTOR-DRIVEN FUEL TRANSFER PUMPS
R21-SYS-FC-AIRDG4	1.00E-03	8.94E-06	1.01	AIR STARTING SYSTEM FAILURE [#13]
R21-SYS-FC-AIRDG5	1.00E-03	8.94E-06	1.01	AIR STARTING SYSTEM FAILURE
R21-SYS-FC-FUELDG4	4.00E-03	9.50E-05	1.02	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
R21-SYS-FC-FUELDG5	4.00E-03	9.50E-05	1.02	FUEL OIL STORAGE & TRANSFER SYSTEM FAILURE [#14]
R22-MCB-CC-1LOAD1	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
R22-MCB-CC-1LOAD2	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
R22-MCB-CC-1LOAD3	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
R22-MCB-CC-1LOAD4	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
R22-MCB-CC-1LOAD5	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
R22-MCB-CC-2LOAD1	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 1 FAILS TO OPEN
R22-MCB-CC-2LOAD2	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 2 FAILS TO OPEN
R22-MCB-CC-2LOAD3	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 3 FAILS TO OPEN
R22-MCB-CC-2LOAD4	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 4 FAILS TO OPEN
R22-MCB-CC-2LOAD5	7.96E-03	2.06E-04	1.03	CIRCUIT BREAKER TO LOAD 5 FAILS TO OPEN
R22-RE_-FD-10A11	8.00E-04	1.64E-04	1.21	UNDERVOLTAGE RELAY FOR R22-10A11 FAILS TO OPERATE
R22-RE_-FD-10A21	8.00E-04	1.64E-04	1.21	UNDERVOLTAGE RELAY SENSING VOLTAGE ON BUS 10A21 FAILS
SH-LBTAF1	1.65E-09	2.97E-02	1.80E+07	LOCA BELOW TAF (MODE 6, UNFLOODED), VALUE FOR RWCU/SDC DRAINLINES
SH-LBTAF1F	6.73E-09	1.21E-01	1.80E+07	LOCA BELOW TAF (MODE 6, FLOODED), VALUE FOR RWCU/SDC DRAINLINES
SH-LBTAF2	5.78E-08	1.04E-01	1.80E+06	LOCA BELOW TAF (MODE 6, UNFLOODED), VALUE FOR INSTRUMENT LINES
SH-LBTAF2F	2.35E-07	4.22E-01	1.80E+06	LOCA BELOW TAF (MODE 6, FLOODED), VALUE FOR INSTRUMENT LINES
SH-LFWA	2.50E-09	1.02E-05	4.03E+03	LOCA IN FW-A (MODE 6, UNFLOODED)

Table 16.6-4

Internal Events Shutdown PRA Importance Measure Report

F-V and RAW Importance Measures Report
(F-V = Fussell-Vesely Importance Measure; RAW = Risk Achievement Worth Importance Measure)
Internal Event Shutdown Full Power
Core Damage Frequency = 5.56E-09

Event Name	Probability	F-V	RAW	Description
SH-LGDCS	3.20E-09	1.17E-04	3.65E+04	LOCA IN GDCS LINE (MODE 6, UNFLOODED)
SH-LOPP5	2.62E-03	7.22E-03	3.75	LOSS OF PREFERRED POWER (MODE 5)
SH-LOPP6	6.49E-04	3.14E-01	485.17	LOSS OF PREFERRED POWER (MODE 6, UNFLOODED)
SH-LOTHER	4.45E-08	3.28E-05	738.19	LOCA OTHER THAN FW OR GDCS (MODE 6, UNFLOODED)
SH-RC6	2.18E-01	9.85E-04	1	FAILURE IN RCCWS/PSWS RECOVERY (MODE 6, UNFLOODED)
SH-RLOC1	1.00E-01	1.51E-01	2.36	FAILURE TO CLOSE DRYWELL HATCHES (RWCU DRAINLINES BREAK)
SH-RLOC2	1.00E-02	5.26E-01	53.1	FAILURE TO CLOSE DRYWELL HATCHES (INSTR. LINES BREAK)
SH-RW5	2.29E-01	2.69E-04	1	FAILURE IN RWCU/SDC RECOVERY (MODE 5)
SH-RWCU5	7.38E-05	2.69E-04	4.64	LOSS OF BOTH RWCU/SDCS TRAINS (MODE 5)
SH-SW6	3.25E-06	9.85E-04	303.87	LOSS OF RCCWS/PSWS (MODE 6, UNFLOODED)
U43-SYS-FF-LPCI	2.40E-02	4.90E-04	1.02	U43 HARDWARE FAILURES
U43-SYS-FF-YARD	2.00E-03	2.54E-03	2.27	HARDWARE FAILURES IN YARD AREA
U43-XHE-FO-LPCIADS	1.61E-02	3.16E-04	1.02	OPERATOR FAILS TO ACTUATE U43 IN LPCI MODE AFTER ADS
U43-XHE-FO-YARD	1.77E-03	2.25E-03	2.27	OPERATOR FAILS TO MAKE UP FROM YARD AREA
XXX-XHE-FO-ICPCCS	1.61E-03	2.05E-03	2.27	OPERATOR FAILS TO RECOGNIZE NEED OF MAKE UP TO IC/PCCS POOLS
XXX-XHE-FO-LPMAKEUP	1.61E-01	1.46E-02	1.08	OP. FAILS TO RECOG. NEED FOR LOW PRESS. MAKEUP (LOCA)

Table 16.6-5

Maintenance Sensitivity Quantifications for Shutdown PRA

Sensitivity Case[(1) (2)]	CDF (per year)
Base Case Analysis	5.56E-09
CRD Train 'B' Out of Service	5.63E-09
EDG 'B' Out of Service	5.81E-09
GDCS Pool 'B' Out of Service	6.64E-09
CRD Train 'B' and GDCS Pool 'B" Out of Service	7.44E-09
CRD Train 'B', EDG 'B' and GDCS Pool 'B" Out of Service	9.89E-09

Notes:

(1) Equipment assumed out of service is assigned maintenance basic probabilities of 1.0. The maintenance terms for all other equipment are maintained at their shutdown PRA base values.

(2) The equipment out of service assumptions in these sensitivities are applied to all shutdown modes.

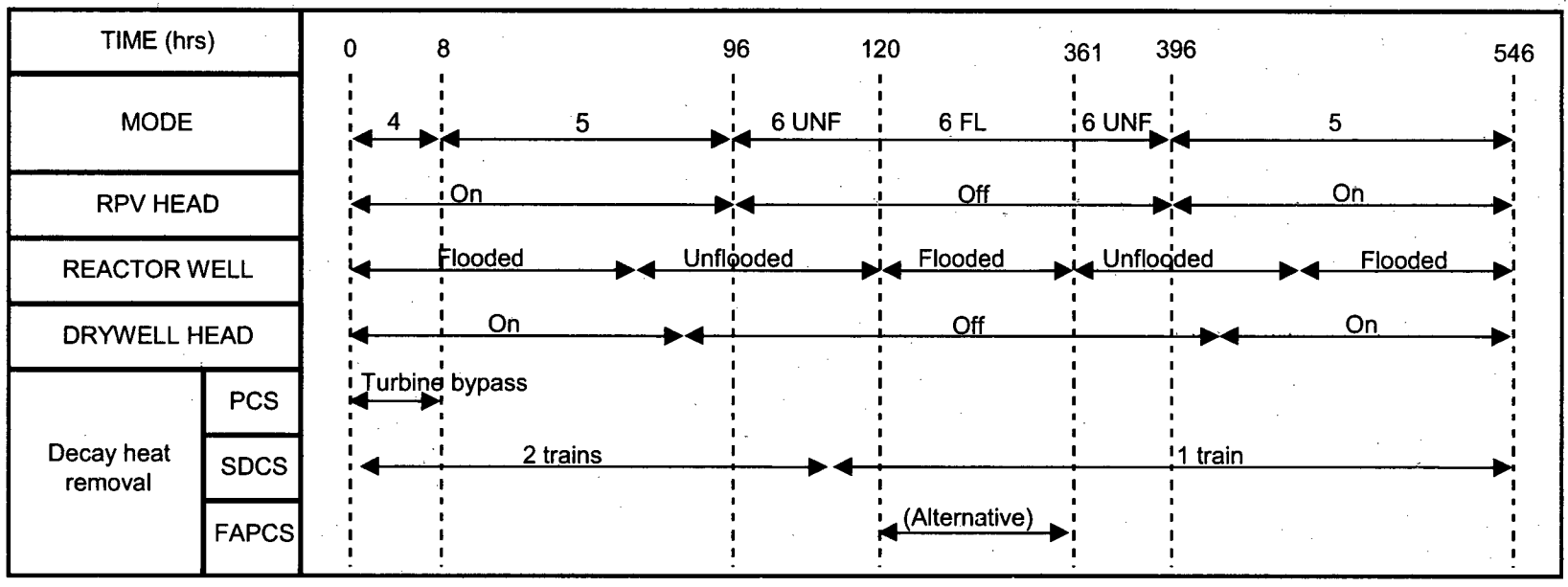

Figure 16.2-1. ESBWR Refuel Outage Plan for Shutdown PRA

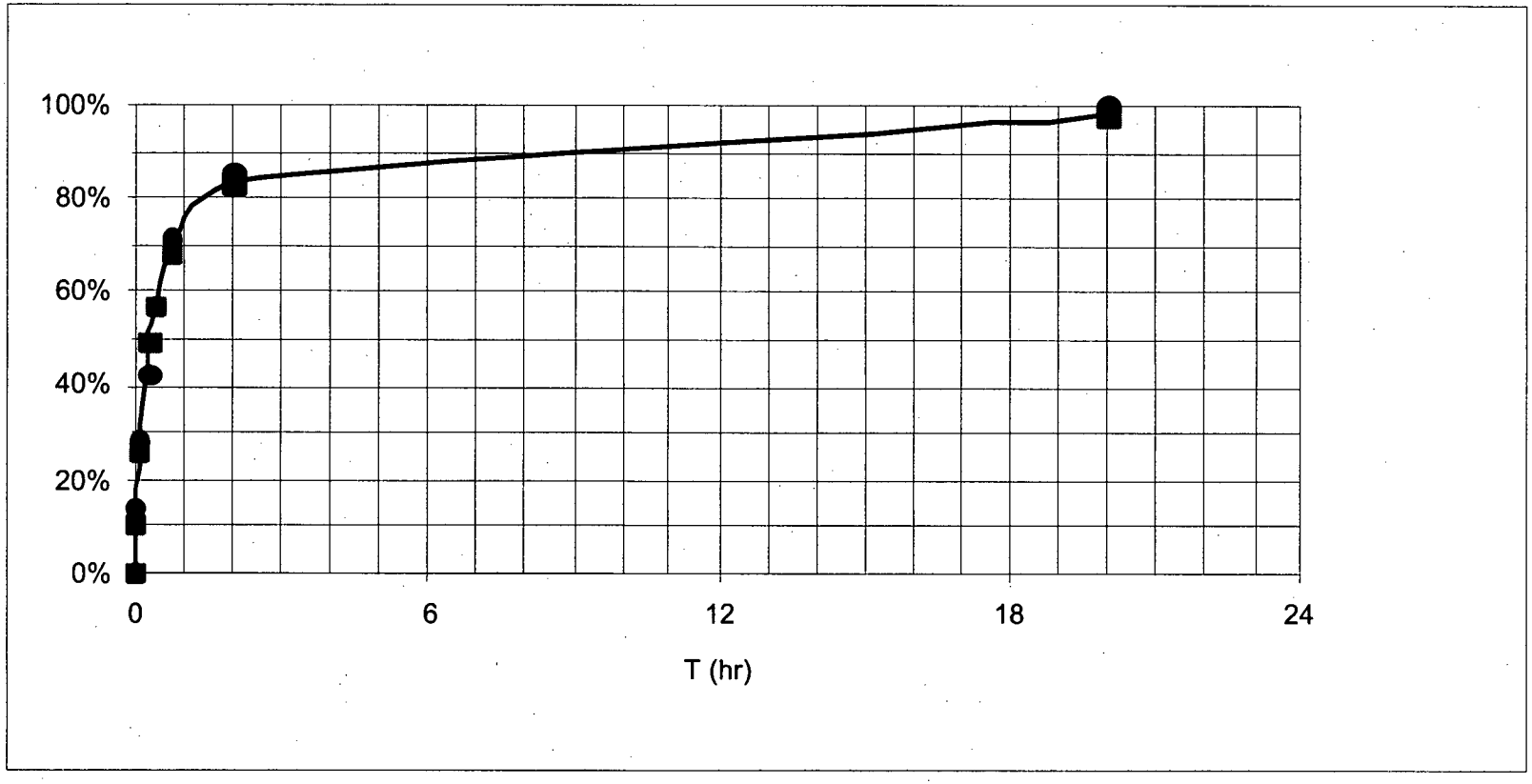

Figure 16.3-1. RWCU/SDCS Recovery Probability (Cumulative)

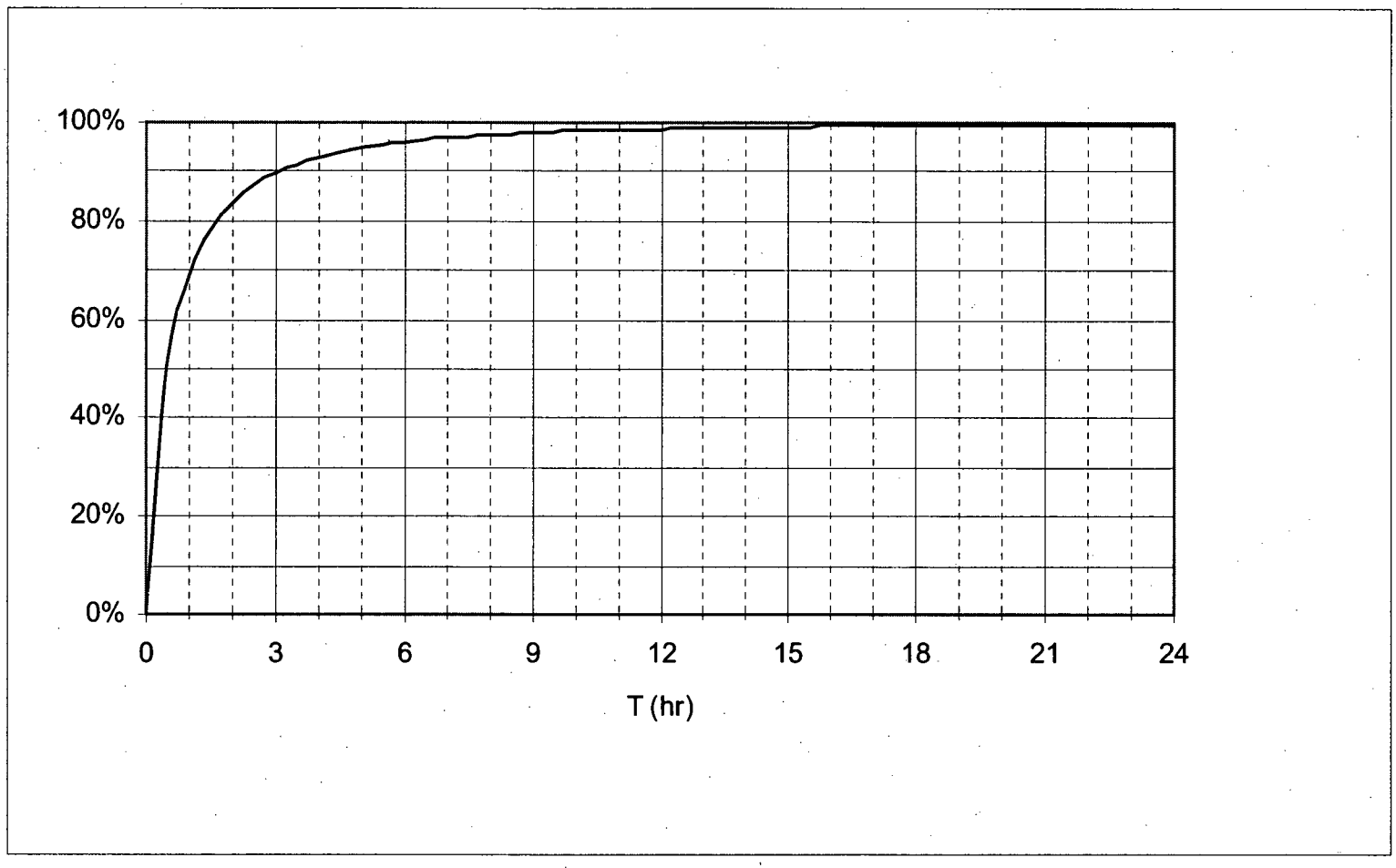

Figure 16.3-2. "Plant-Centered" LOPP Recovery Probability (Cumulative)

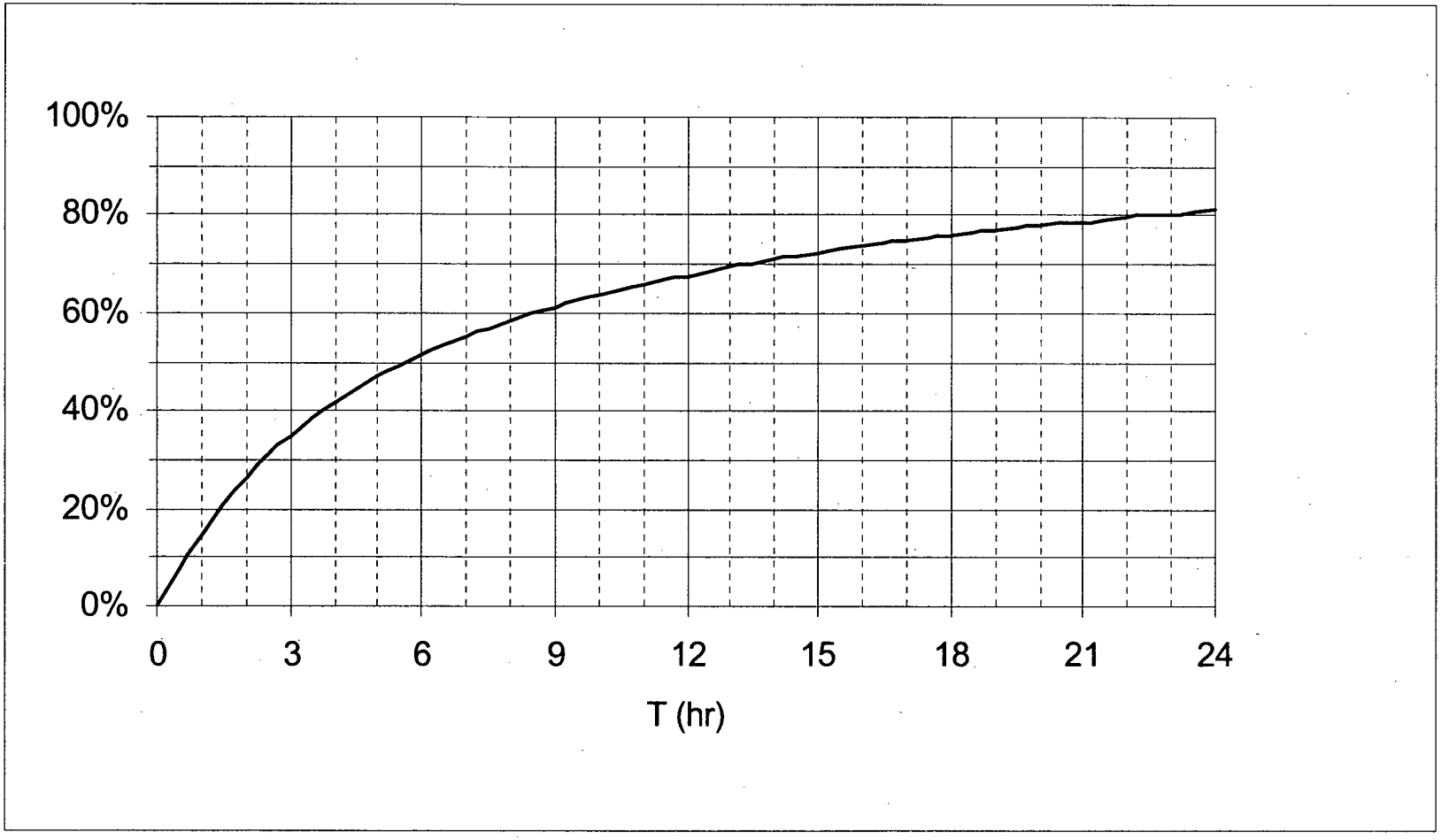

Figure 16.3-3. "External" LOOP Recovery Probability (Cumulative)

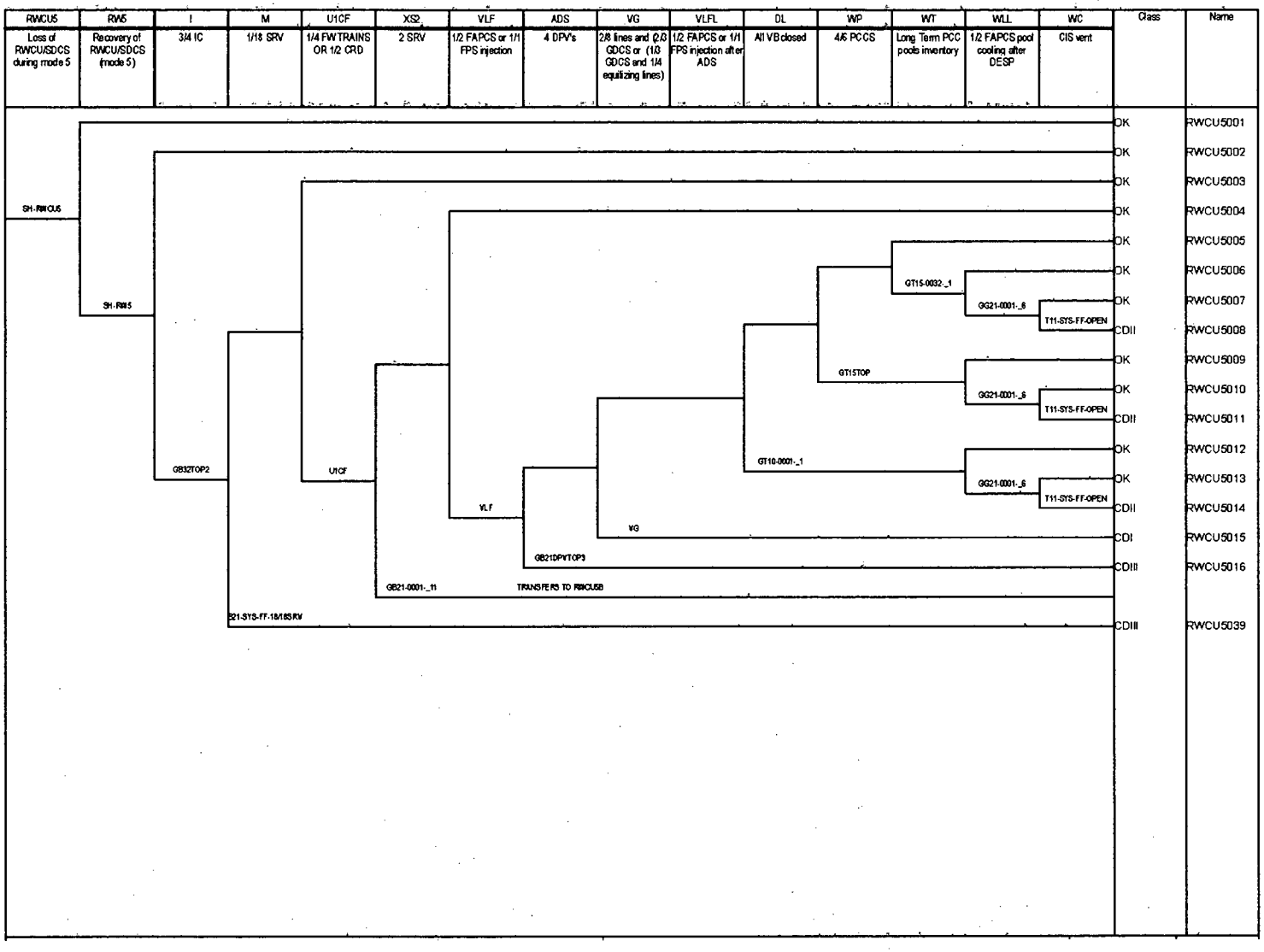

Figure 16.4-1a. Loss of Both RWCU/SDCS Trains (Mode 5) – RWCU5A

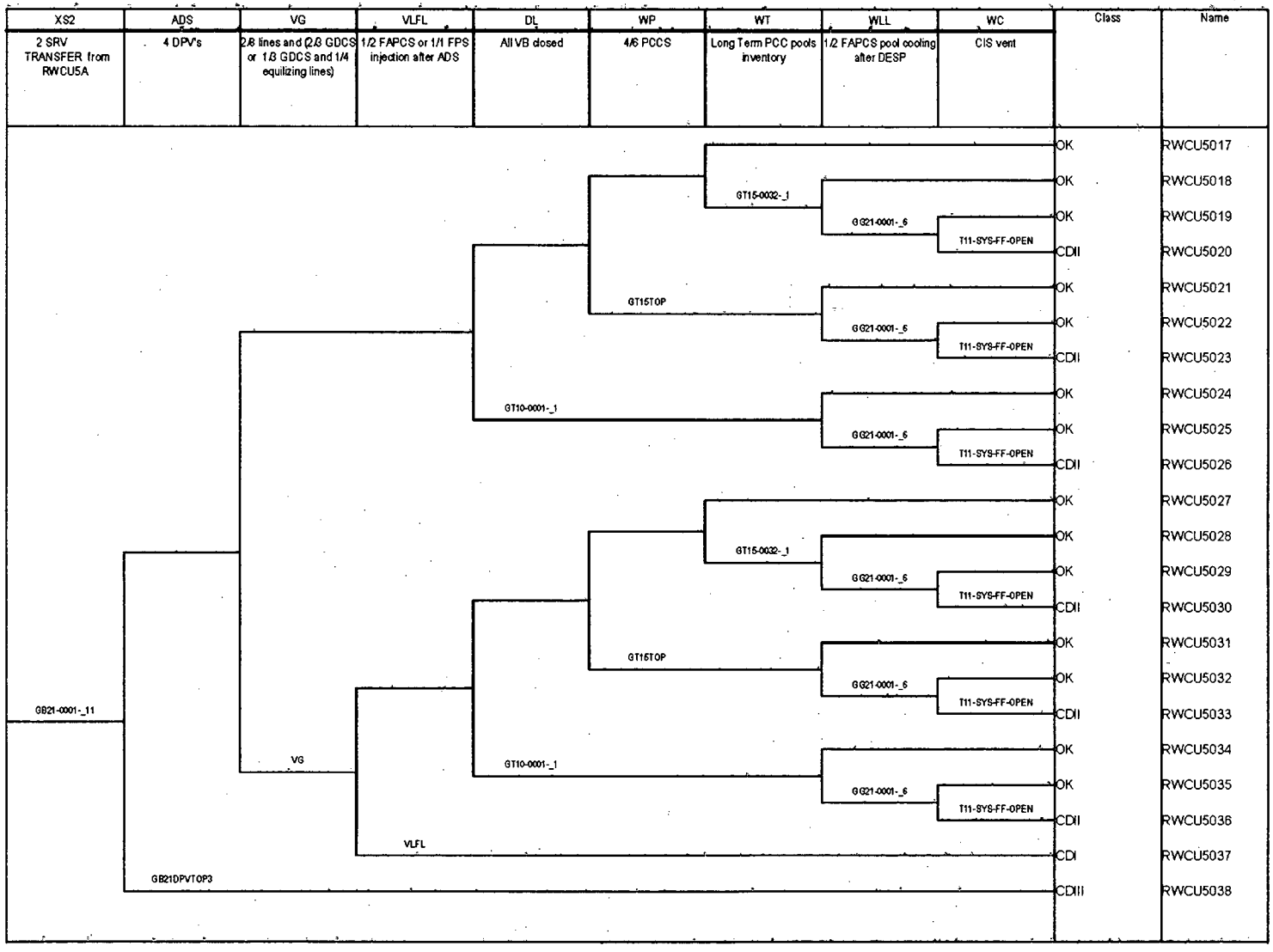

Figure 16.4-1b. Loss of Both RWCU/SDCS Trains (Mode 5) – RWCU5B

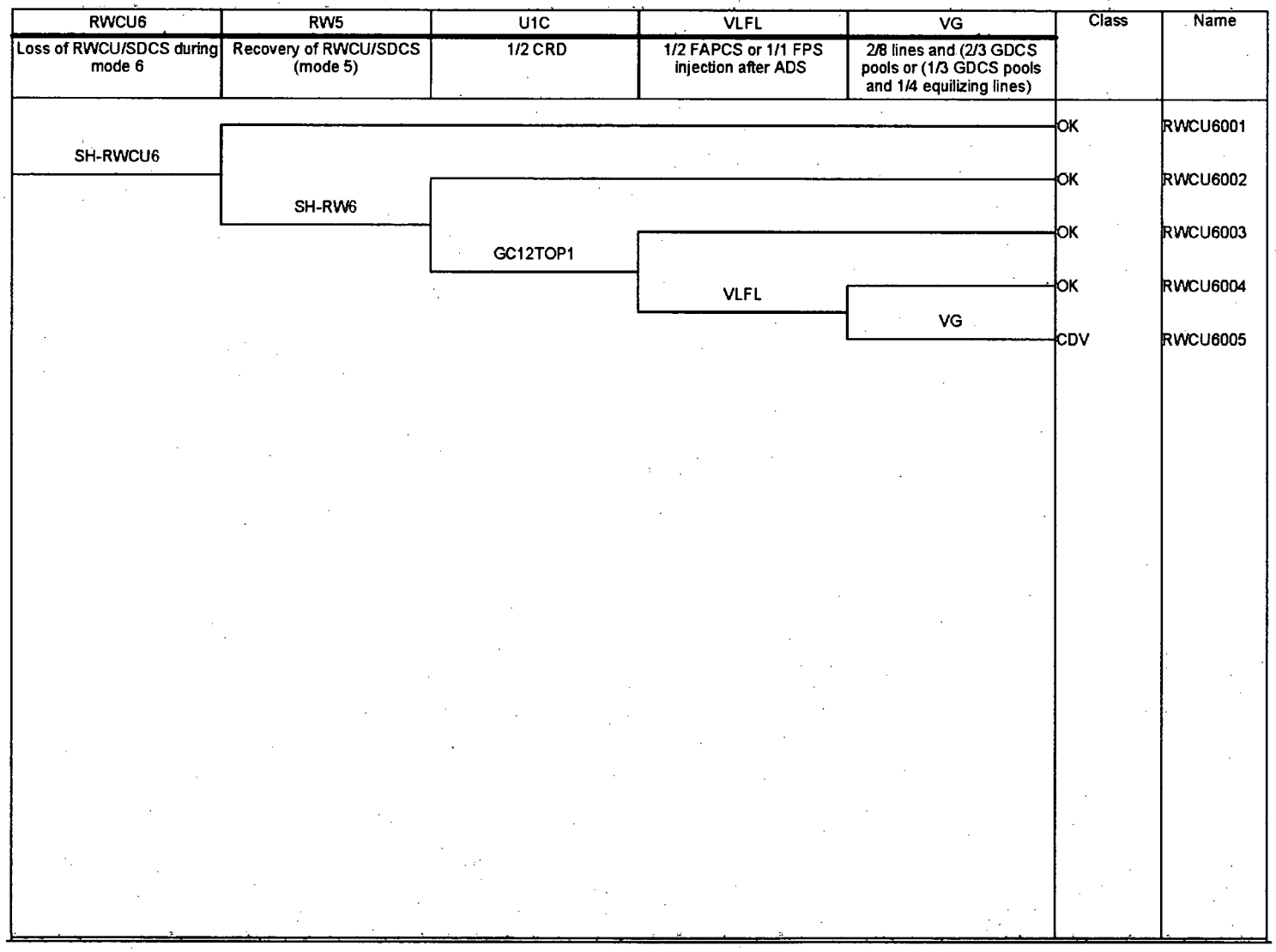

Figure 16.4-2. Loss of Both RWCU/SDCS Trains (Mode 6-Unflooded) – RWCU6

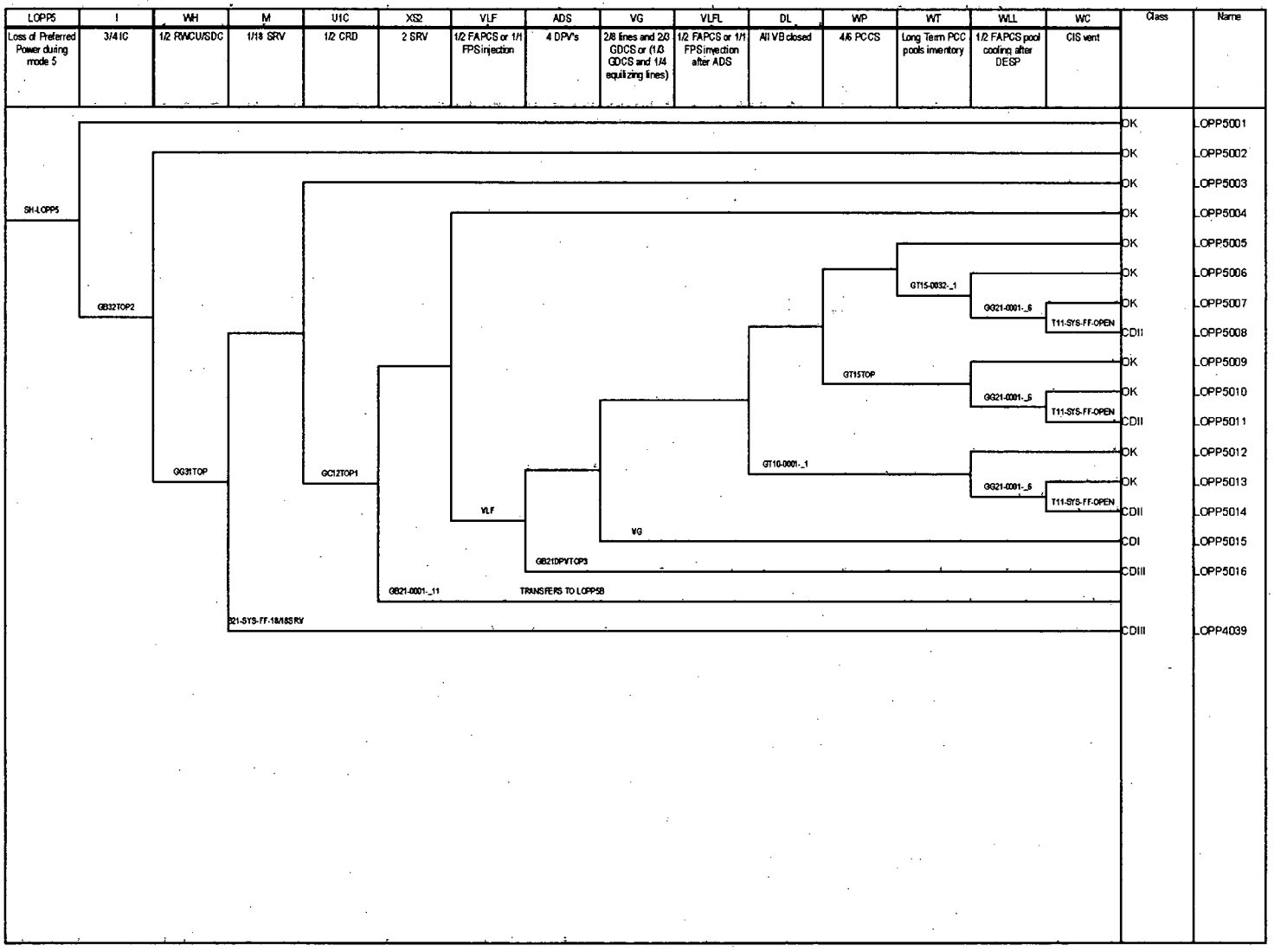

Figure 16.4-3a. Loss of Preferred Power (Mode 5) – LOPP5A

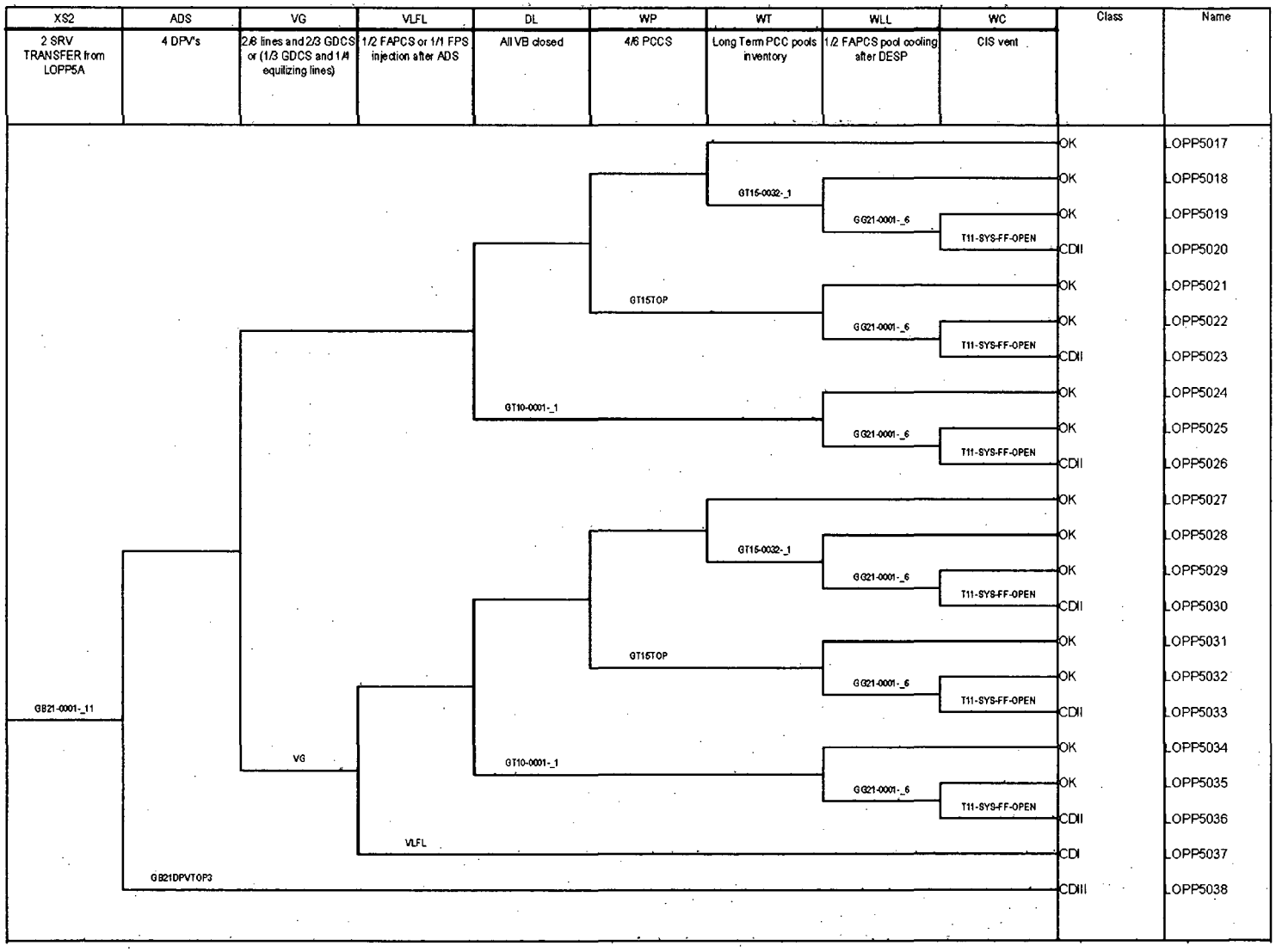

Figure 16.4-3b. Loss of Preferred Power (Mode 5) – LOPP5B

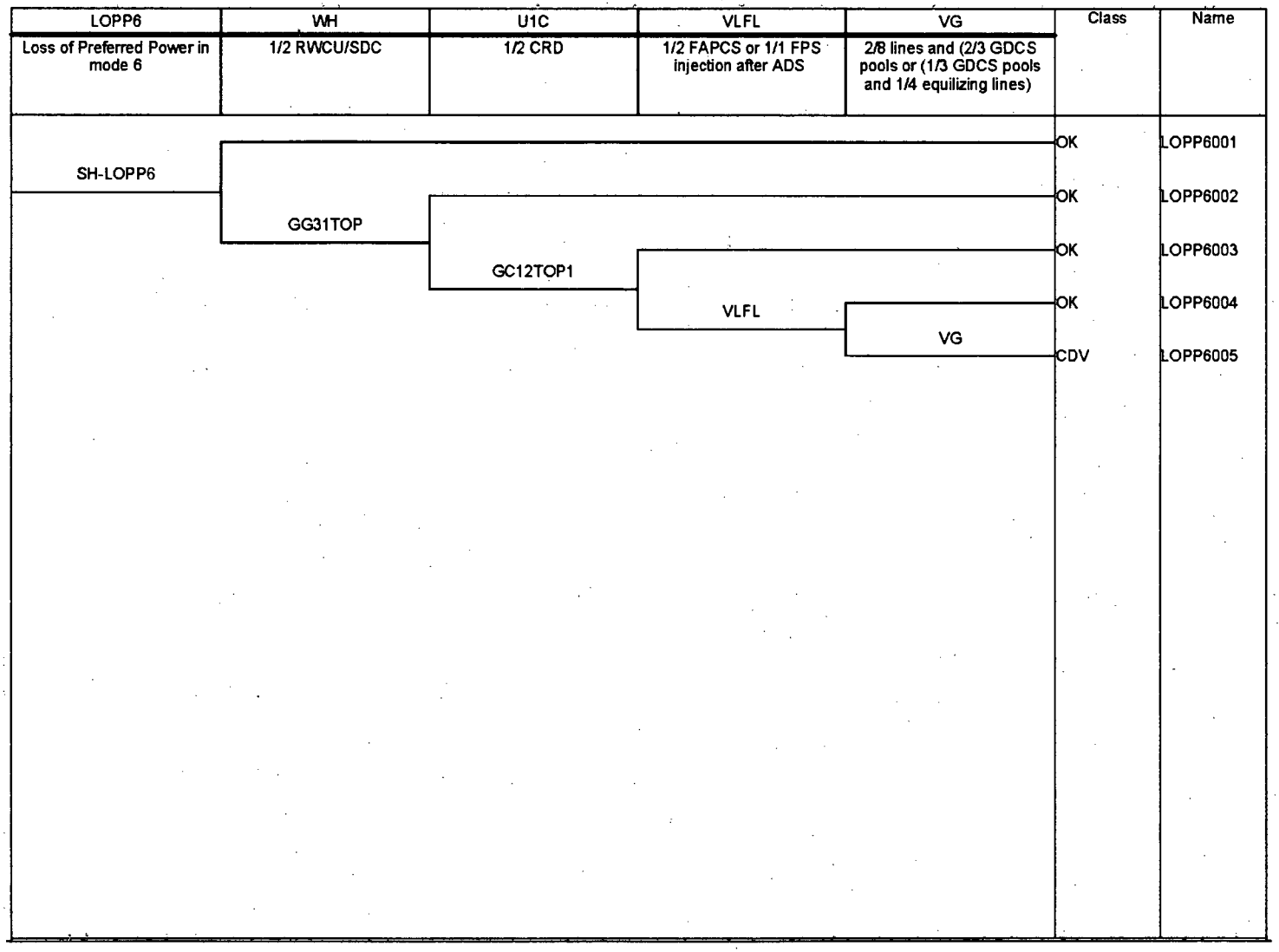

Figure 16.4-4. Loss of Preferred Power (Mode 6-Unflooded) – LOPP6

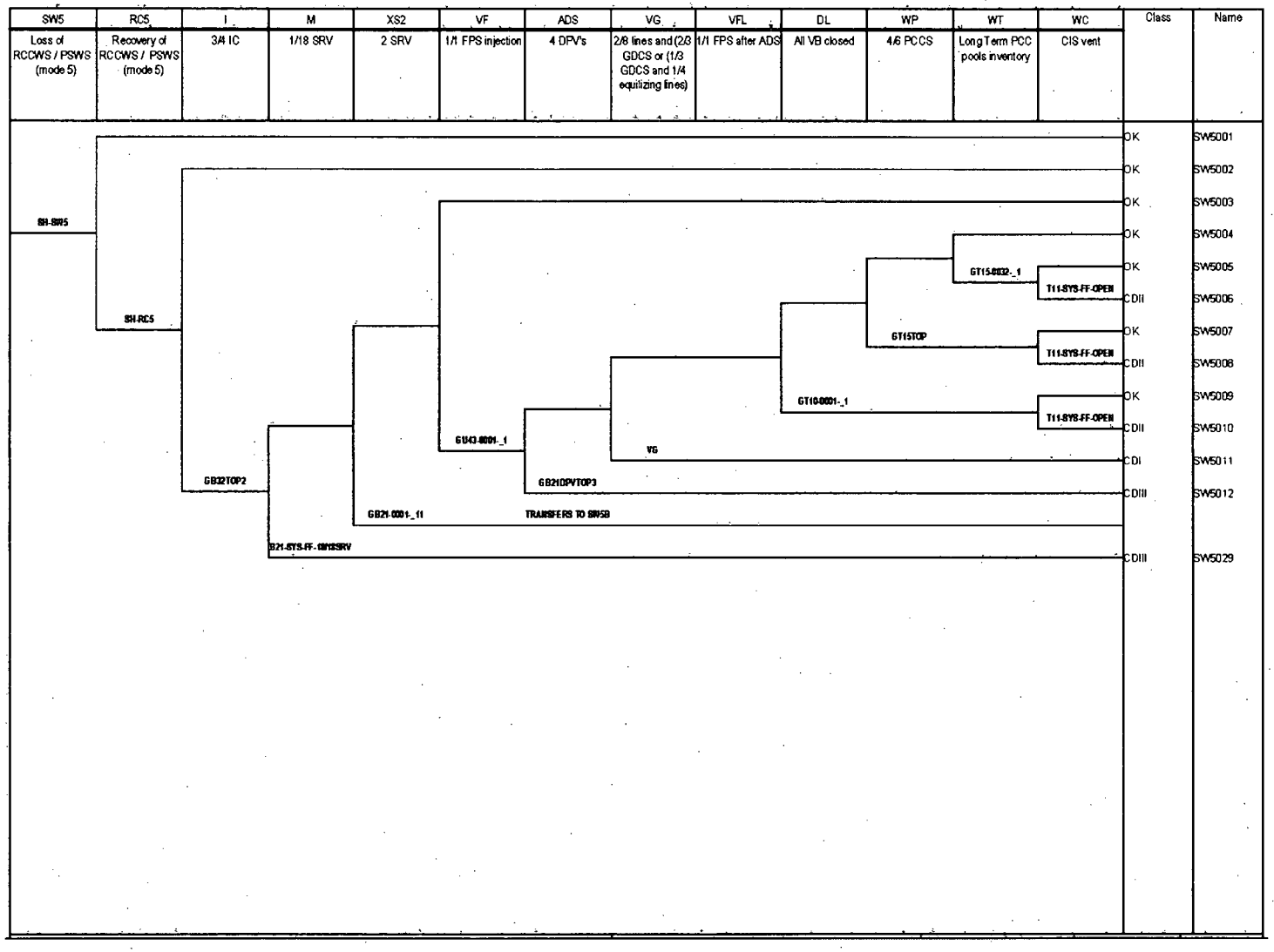

Figure 16.4-5a. Loss of RCCWS/PSWS (Mode 5) – SW5A

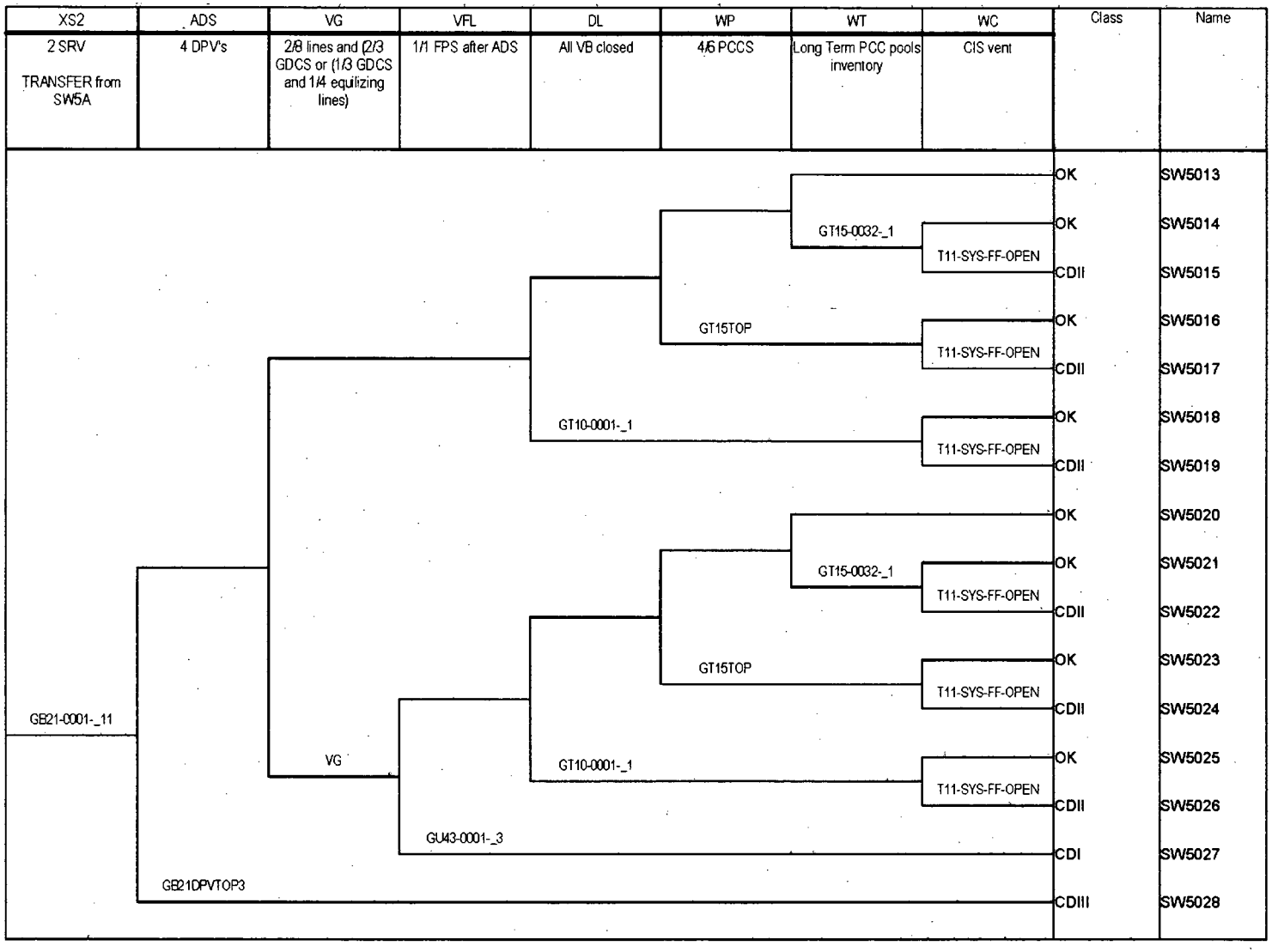

Figure 16.4-5b. Loss of RCCWS/PSWS (Mode 5) – SW5B

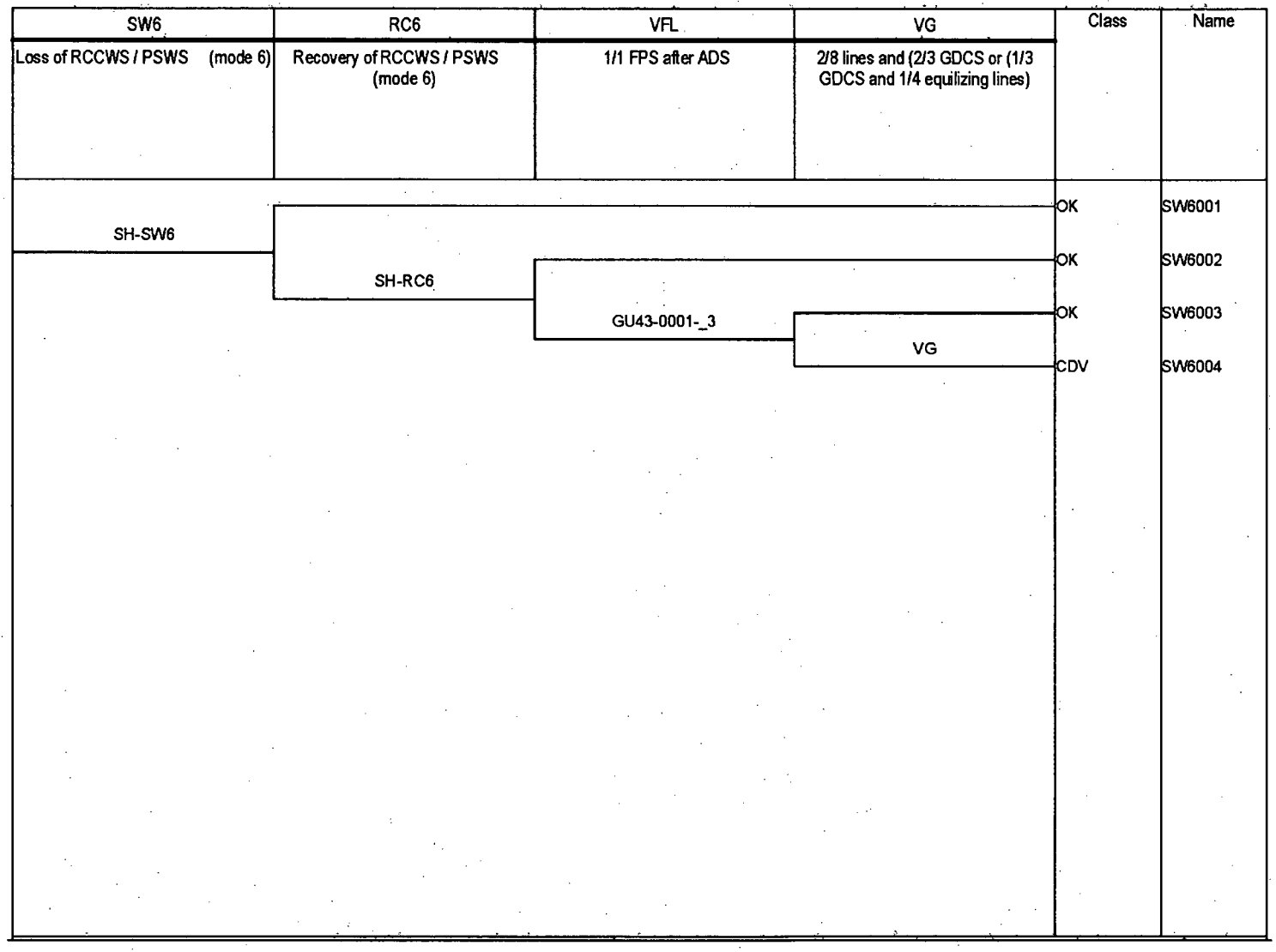

Figure 16.4-6. Loss of RCCWS/PSWS (Mode 6-Unflooded) – SW6

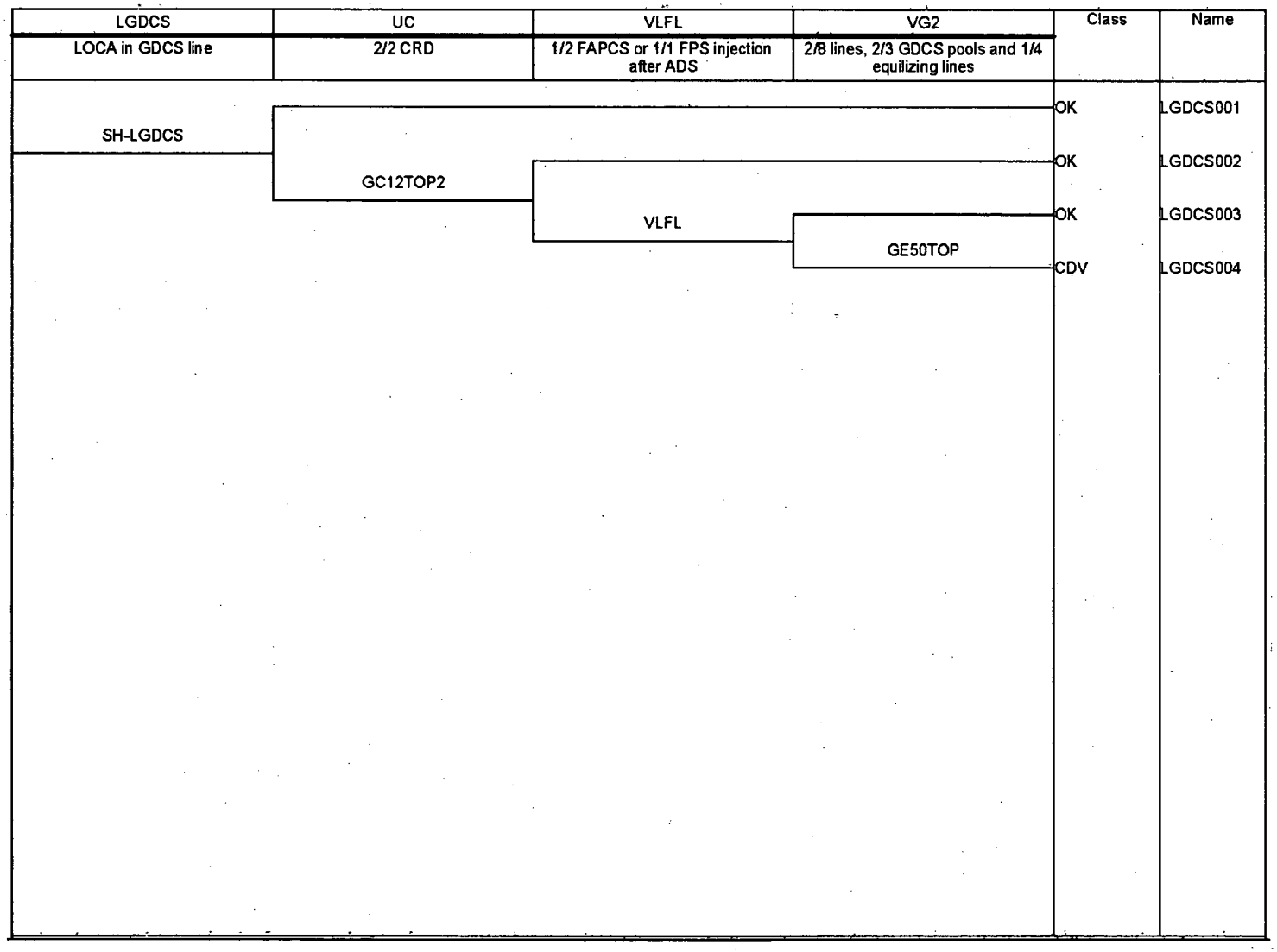

Figure 16.4-7. LOCA in GDCS Line (Mode 6-Unflooded) - LGDCS

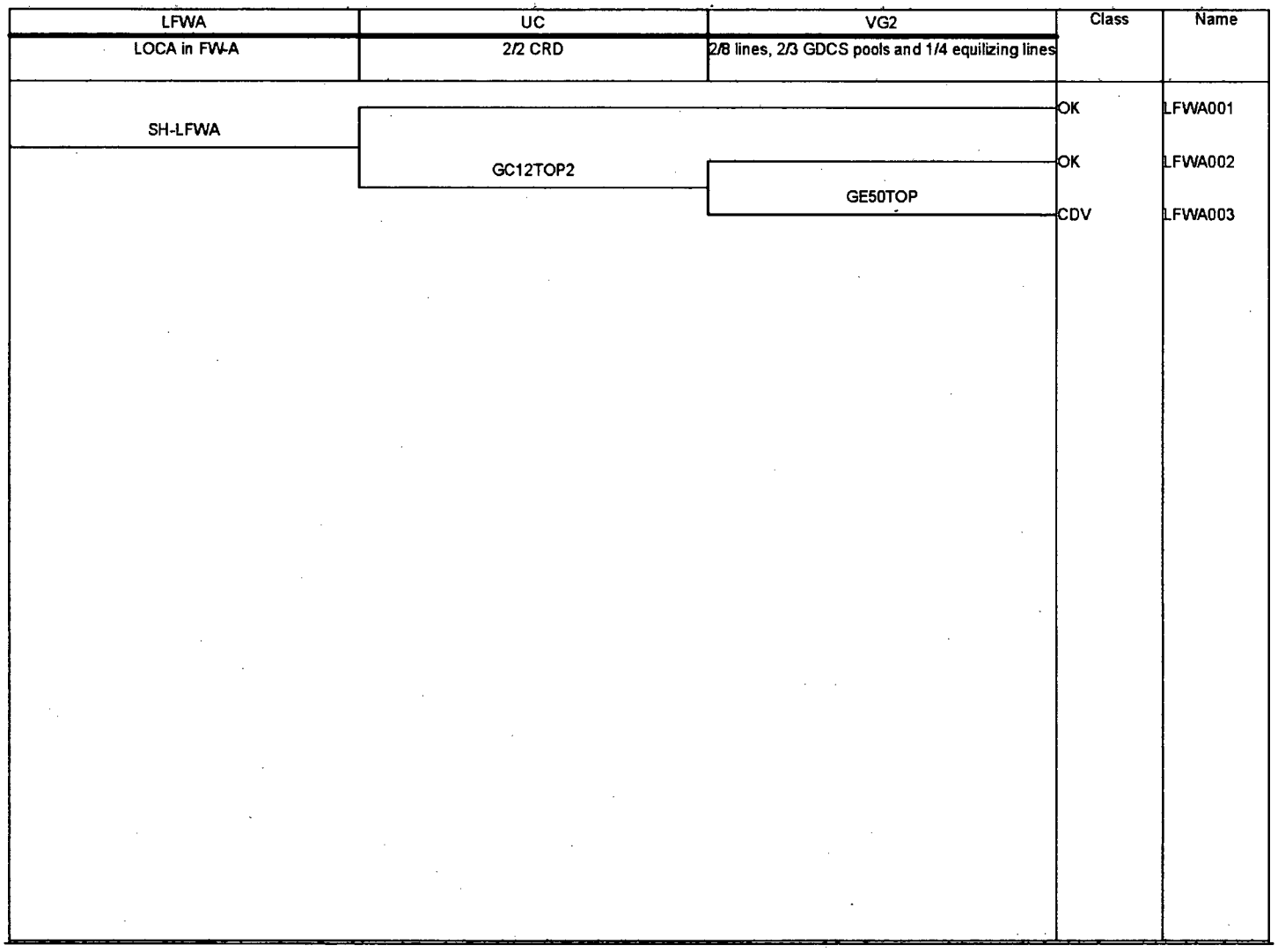

Figure 16.4-8. LOCA in FW-A (Mode 6-Unflooded) - LFWA

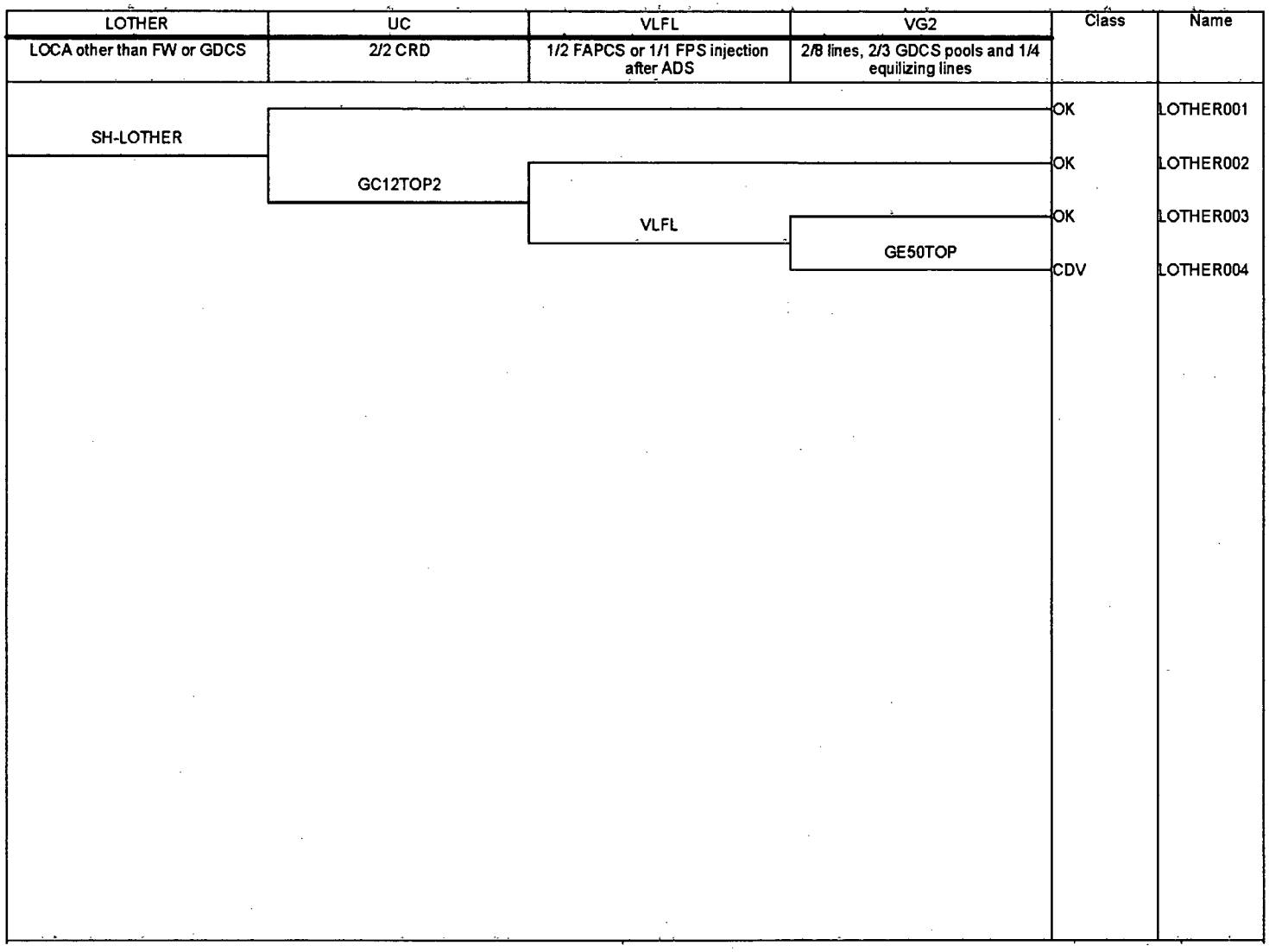

Figure 16.4-9. LOCA Other Than FW or GDCS (Mode 6-Unflooded) - LOTHER

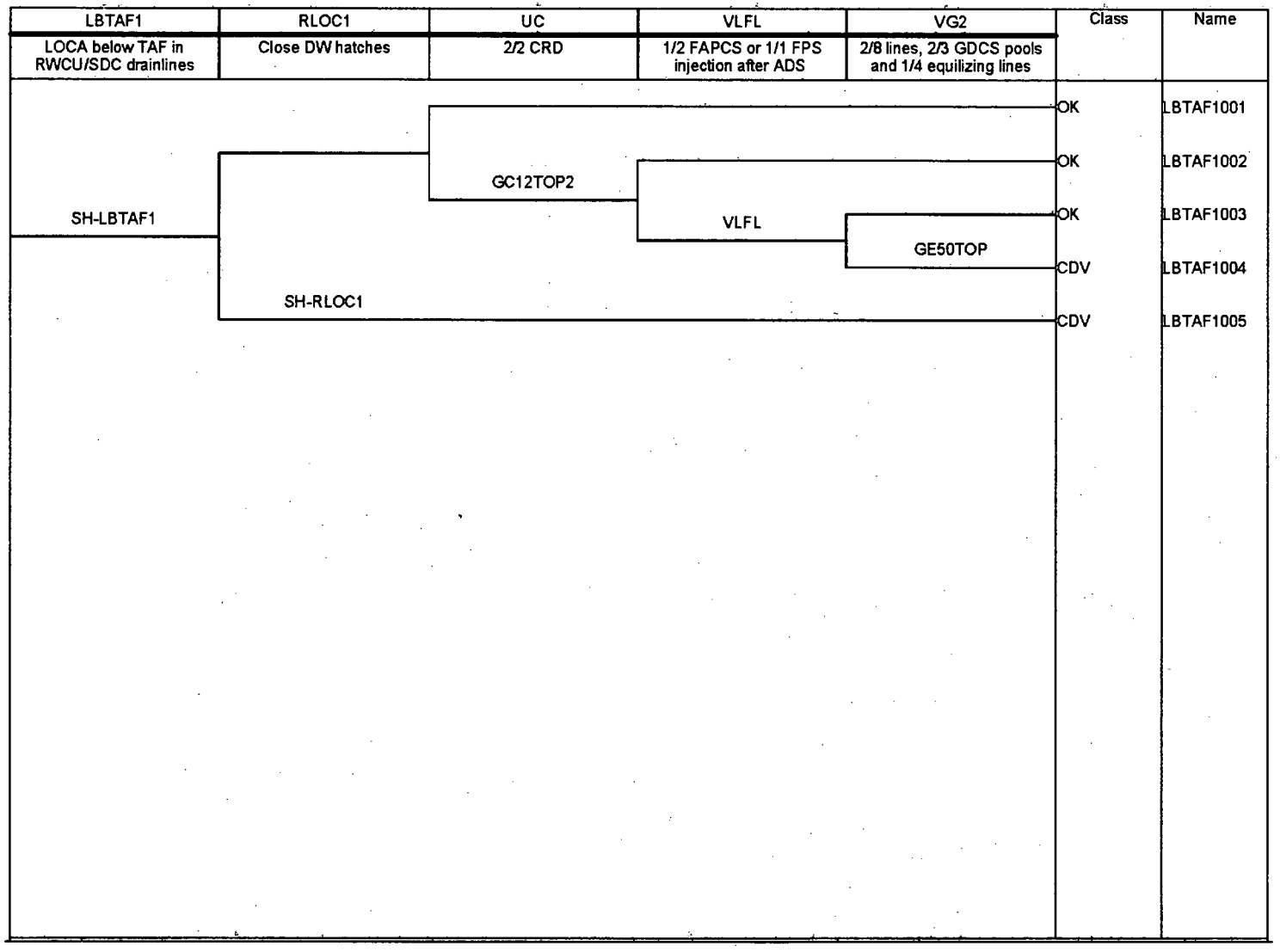

Figure 16.4-10. LOCA Below TAF in RWCU Drain Lines (Mode 6-Unflooded) – LBTAF1

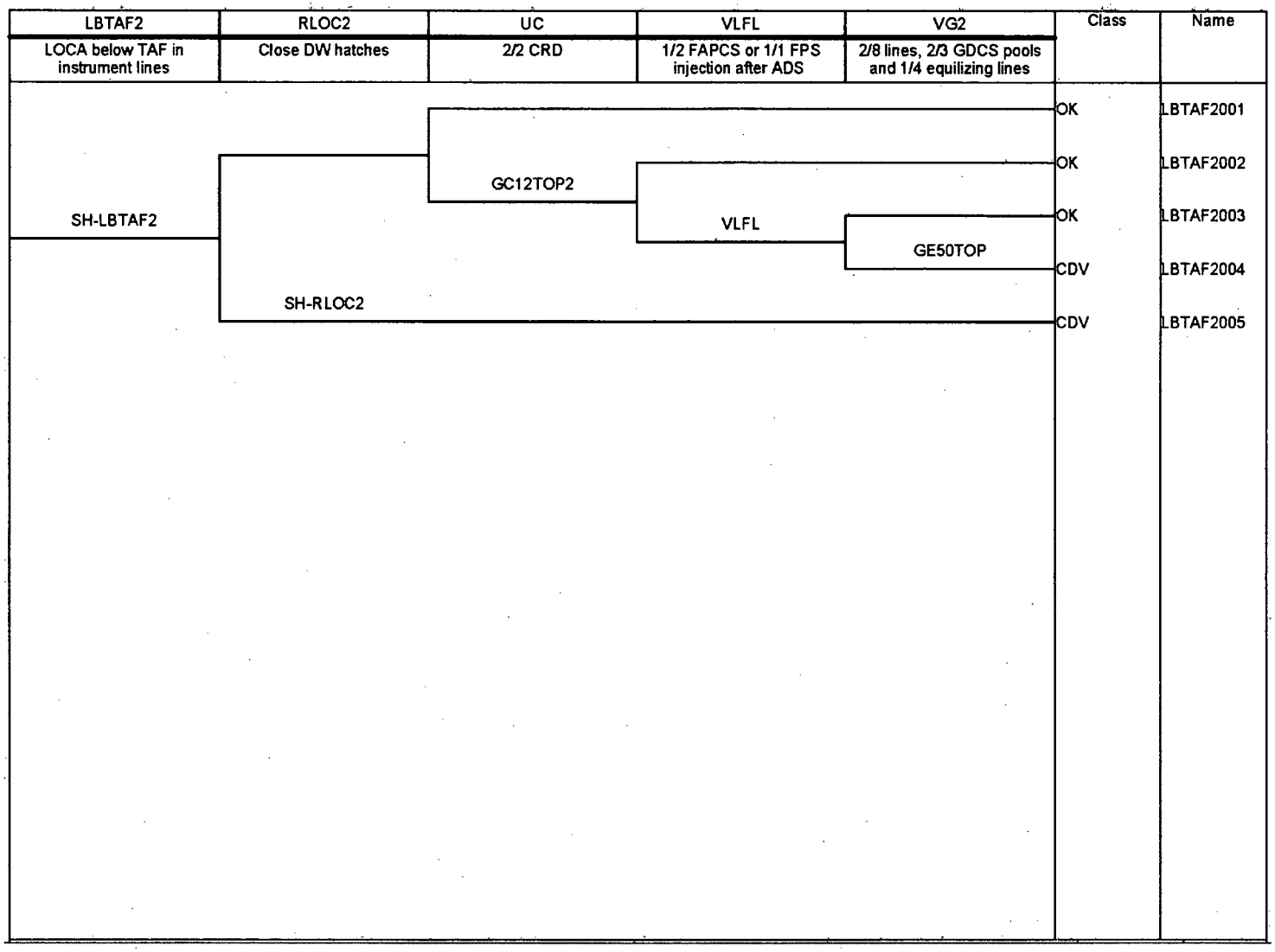

Figure 16.4-11. LOCA Below TAF in Instrument Lines (Mode 6-Unflooded) – LBTAF2

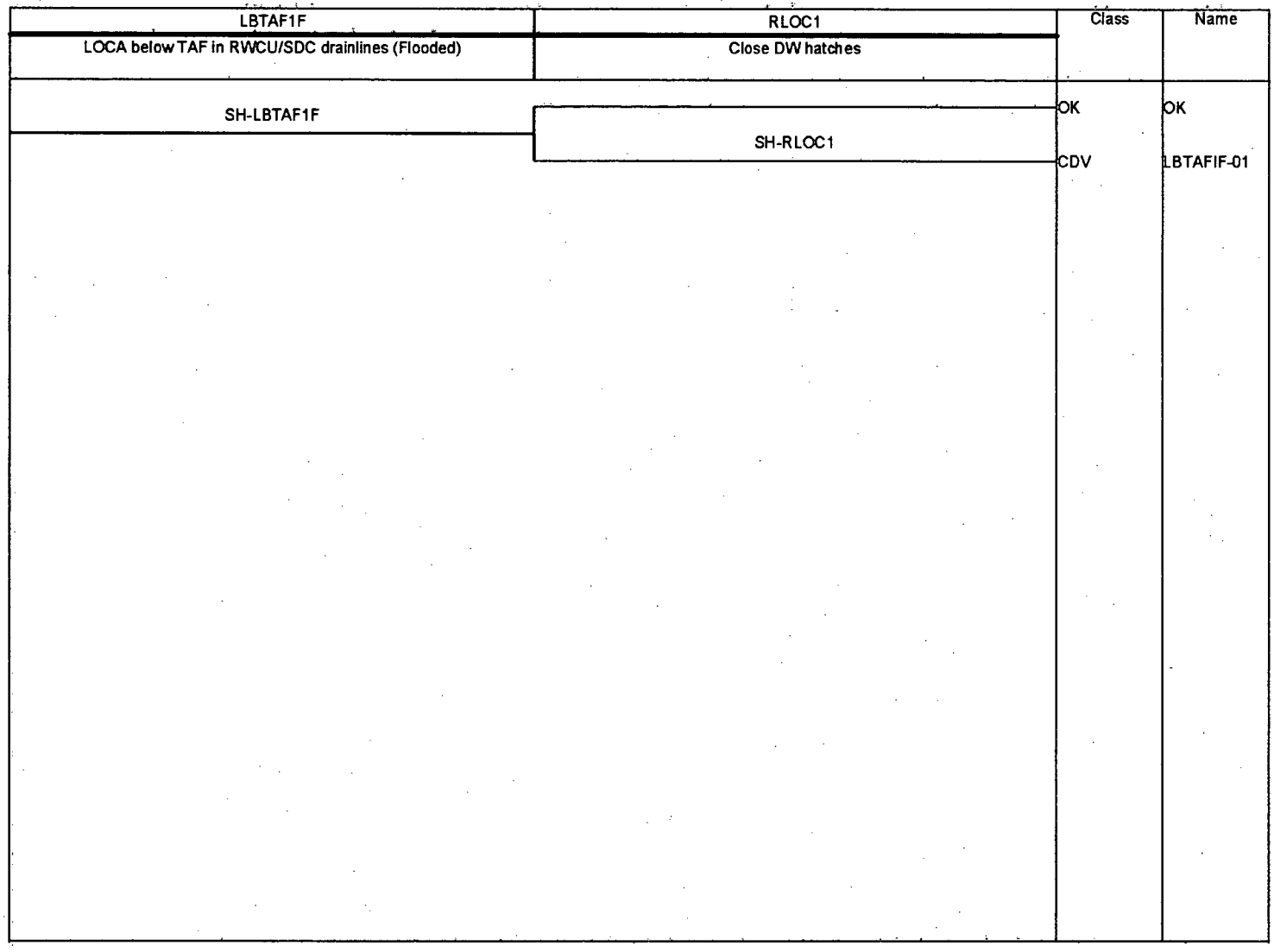

Figure 16.4-12. LOCA Below TAF in RWCU/SDC Drain Lines (Mode 6-Flooded) – LBTAF1F

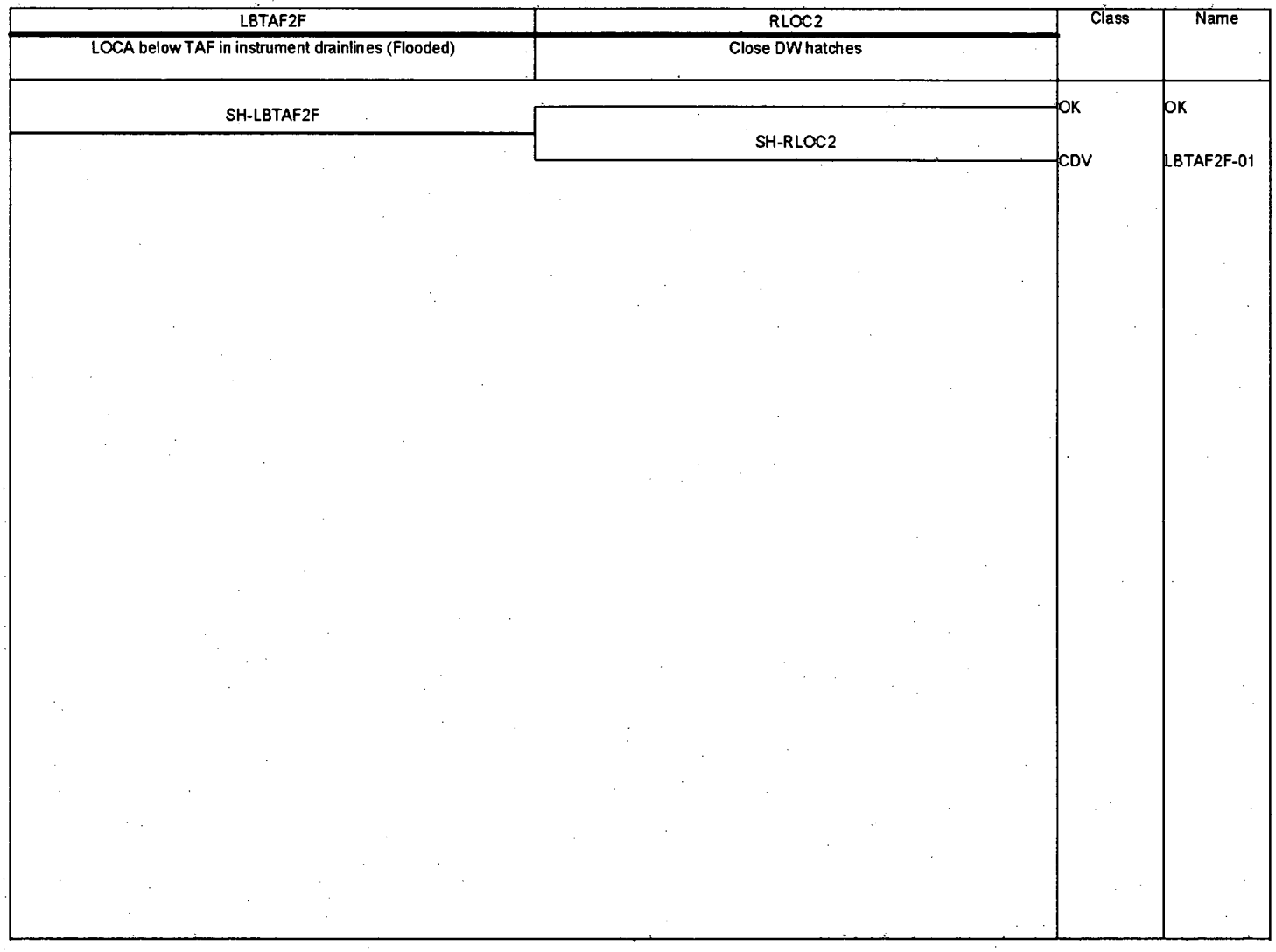

Figure 16.4-13. LOCA Below TAF in Instrument Lines (Mode 6-Flooded) – LBTAF2F