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Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1

Analysis of Core Damage Frequency from Internal Floods During Mid-loop Operations

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ABSTRACT

Traditionally, probabilistic risk assessments (PRA) of severe accidents in nuclear power plants have considered initiating events potentially occurring only during full power operation. Some previous screening analysis that were performed for other modes of operation suggested that risks during those modes were small relative to full power operation. However, more recent studies and operational experience have implied that accidents during low power and shutdown could be significant contributors to risk.

During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects being performed by Brookhaven National Laboratory (BNL) and Sandia National Laboratories (SNL). Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied.

The objectives of the program are to assess the risks of severe accidents initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The scope of the program includes that of a Level-3 PRA.

A phased approach was used in the Level-1 program. In Phase 1 which was completed in Fall 1991, a coarse screening analysis including internal fire and flood was performed for all plant operational states (POSS). The objective of the Phase 1 study was to identify potential vulnerable plant configurations, to characterize (on a high, medium, or low basis) the potential core damage accident scenarios, and to provide a foundation for a detailed Phase 2 analysis.

In Phase 2, mid-loop operation was selected as the plant configuration to be analyzed based on the results of the Phase 1 study. The objective of the Phase 2 study is to perform a detailed analysis of the potential accident scenarios that may occur during mid-loop operation, and compare the results with those of NUREG-1150. The scope of the Level-1 study includes plant damage state analysis and uncertainty analysis. Volume 1 summarizes the results of the study. Internal events analysis is documented in Volume 2. Internal fire and internal flood analyses are documented in Volumes 3 and 4. A separate study on seismic analysis, documented in Volume 5, was performed for the NRC by Future Resources Associated, Inc.. Volume 6 documents the accident progression, source terms, and consequence analysis.

In the Phase 2 study, system models applicable for shutdown conditions were developed and supporting thermal hydraulic analyses were performed to determine the timing of the accidents and success criteria for systems. Initiating events that may occur during mid-loop operations were identified and accident sequence event trees were developed and quantified. In the preliminary quantification of the mid-loop accident sequences, it was found that the decay heat at which the accident initiating event occurs is an important parameter that determines the success criteria for the mitigating functions, and time available for operator actions. In order to better account for the decay heat, a "time window" approach was developed. In this approach, time windows after shutdown were defined based on the success criteria established for the various methods that can be used to mitigate the accident. Within each time window, the decay heat and accident sequence timing are more accurately defined and new event trees developed and quantified accordingly. Statistical analysis of the past outage data was performed to determine the time at which a mid-loop condition is reached, and the duration of the mid-loop operation. Past outage data are used to determine the probability that an accident initiating event occurs in each of the time windows. This probability is used in the quantification of the accident sequences.

Abstract

The major objective of the Surry internal flood analysis was to provide an improved understanding of the core damage scenarios arising from internal flood-related events. The mean core damage frequency of the Surry plant due to internal flood events during mid-loop operations is $4.8\text{E-}06$ per year, and the 5th and 95th percentiles are $2.2\text{E-}07$ and $1.8\text{E-}05$ per year, respectively. Some limited sensitivity calculations were performed on three plant improvement options. The most significant result involves modifications of intake-level structure on the canal, which reduced core damage frequency contribution from floods in mid-loop by about 75%.

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EXECUTIVE SUMMARY

This report presents the results of an internal flood event analysis of the Surry Power Station Unit 1 for accidents initiated during mid-loop operations. This program was performed by Brookhaven National Laboratory as part of a full-scope internal event study for the Low Power and Shutdown program of the U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research (RES). The first phase of the Low Power and Shutdown study included a Level 1 internal event probabilistic risk assessment and a fire and flood analysis. Preliminary results were obtained for accident initiated during low power and shutdown operations. The first phase analysis also provided insights on potential accident scenarios and potentially vulnerable configurations during this particular operating mode. This portion of the program was completed in November 1991.

The second phase of the Low Power and Shutdown program has focused on a detailed analysis of mid-loop operation. This operating mode was deemed to be the most important risk contributor, based on the Phase 1 analysis as well as the number of incidents which occurred in mid-loop operations. This report documents the results and findings of the Phase 2 internal flood analysis. The results of the Level one internal event and fire analyses are reported separately in companion reports.

Surry Unit 1 was chosen as a representative pressurized water reactor (PWR) to be analyzed. The Surry plant was previously studied and analyzed in the Reactor Safety Study^[1] and NUREG-1150^[2] for full power operation. The plant site contains two PWRs each rated at 788 MW (electrical) capacity located near Surry, Virginia.

Objectives

The overall objective was to perform an analysis to support the Low Power and Shutdown program in developing a Level 1 internal flood event analysis for the shutdown operations of the Surry plant. Corresponding Level 1 internal event, fire and seismic analyses have also been performed and documented in separate volumes of the reports. Specific objectives of the study were to identify pertinent flood events with respect to the mid-loop operating modes, develop and quantify potential risk-significant scenarios, and identify potential and significant system failures as applicable to the Surry Power Station.

This report presents the Level 1 internal flood event analysis including accident scenario development, determination of spatial interconnections and their effects, estimation of the frequencies of internal flood events during mid-loop operations, modeling of accident sequences and determination of the frequency of scenarios involving system failures leading to severe core damage. Core damage is defined as a significant core uncover with fuel cladding failures. At the decay heat level during mid-loop operation, cladding failures are likely to occur when the water level in the core region is reduced to about 2.5 ft above the bottom of the reactor core. If reflooding of the core is not done immediately, fission product release from the fuel is expected to result.

Approach

The plant configuration may constantly change during low power and shutdown operating modes. This necessitated the definition of different outage types or plant operating states (POSs). In order to properly account for the time dependence of the decay heat, "time windows" were developed representing different decay heat levels combined with window-dependent success criteria. In each time window a probabilistic

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model was developed that included identification of initiating events, development and quantification of system fault and accident event trees, and calculation of uncertainties.

Outage Types, Plant Operational States, Time Windows

Similar to the internal analysis, the plant outages were grouped into the following different types: refueling, drained maintenance, and non-drained-maintenance. Mid-loop is the POS in which the reactor coolant level is lowered to the mid-plane of the hot leg. Three mid-loop POSs were selected for detailed analysis. Two of the POSs occur in refueling outage, POSs R6 and R10, and one in drained maintenance outage, POS D6. POS R6 represents a mid-loop operation starting early in the refueling outage, while POS R10 takes place at a relatively later time in a refueling outage due to additional maintenance actions. POS D6 is characterized by the highest decay heat level among the three mid-loop POSs since it could be required by unplanned maintenance activities when at full power.

The time dependence of the decay heat level and changes in success criteria during the shutdown operation was modeled using four time windows. For POSs R6 and D6, all four time windows were used; while for POS R10, only time windows 3 and 4 were needed.

Initiating Event Analysis

In order to develop and identify the root causes of various flood events, industry experience was reviewed. A plant-specific analysis was also performed to derive location-dependent initiating frequencies. The operating experience was reviewed with respect to its applicability to the Surry Power Station. This approach insured that any operating incident that has occurred or was studied in previous analyses was included and considered in the present study. The flood initiating frequencies were obtained based on the statistical analysis of actual operating events occurring at similar installations.

System Analysis, Flood Scenarios, Event Tree Development

The fault tree models developed for the internal event low power and shutdown study were reviewed and used in the internal flood event analysis. The system models affected by specific flood scenarios were appropriately modified to take into account the potential damage to equipment located in flood areas.

Specific human errors associated with the diagnosis of specific flood scenarios and with the actions required by the plant operator were developed based on the approach used in the internal event study. Human error probabilities (HEPs) were developed in two steps. In the first step, each flood event scenario was qualitatively defined in terms of required action, important factors affecting operator performance, and the consequences of the action not being successful. The second step contained the quantification process.

The quantitative evaluation of HEPs was done using the success likelihood method with seven performance shaping factors. The numerical model was calibrated by HEPs obtained from probabilities developed for well-established human actions.

Flood accident scenarios were developed based on information collected during a plant visit and walk-down, discussions with operating personnel, and review of the plant drawings. The flood accident scenarios were compared and mapped with some modifications to the previously developed internal event accident event

trees. This enabled a probabilistic risk analysis of the various flood scenarios using the same methodology as used for the internal event analysis.

Quantification

The accident sequence quantification was based on the flood event trees and the quantification of the core damage sequences was accomplished with the IRRAS^[3] code. The truncation limits were set at $1.0\text{E-}10$ for the system and event tree analyses at the cutset level.

Results and Conclusions

The major objective of the Surry internal flood analysis was to provide an improved understanding of the risk arising from internal flood-related events. The present analysis resulted in that the most dominant contributors to core damage due to internal floods are accident scenarios initiated in the Turbine Building leading to the draining of the intake canal. This potentially could result in a flood encompassing the plant Emergency Switchgear Rooms (ESGR) leading to a two unit loss of all emergency power (F1 and F2 scenarios).

The main results of the flood analysis are presented in Table S-1, listing the point estimate core damage frequencies of the analyzed operating states. The most dominant flood scenario, 85% of the total CDF, is the one occurring in the Turbine Building and overflowing the flood dikes at the unit ESGR causing the loss of all emergency power for the two units (F1 and F2 scenarios).

The Turbine Building internal flood accident scenarios account for approximately 85% of the total core damage frequency (CDF) due to internal floods. This result is mainly due to the specific features of the Surry circulating water system and may not be applicable to other plants. The second most dominating flood scenario involves flooding of the Safeguard/Auxiliary Building in combination with the unavailability of the Refueling Water Storage Tank (RWST). The contribution of these scenarios (F4 and F5) is approximately 13% of the total internal CDF. Again, these specific findings may not be generalized to other plants due to the plant specific nature of the actual involvement of these accident scenarios.

Plant-Specific Conclusions

The internal flood CDF is dominated by Turbine Building flood events. These events are primarily initiated by either valve or expansion joint failures in the main inlet lines of the circulating water system. These failures may lead to pipe ruptures upstream of the condenser water box and inlet valves. At Surry the circulating water system is gravity fed from a very large capacity intake canal and its isolation may not be accomplished in a timely manner. This is in contrast with other common design arrangement where dedicated pumps provide the required cooling water flow through the system. In these designs, stopping the pumps would effectively isolate the system limiting potential water outflow.

The potential draining of the intake canal inventory in the Turbine Building is dominant due to a plant-specific spatial interdependence. For both units the Emergency Switchgear Rooms are located in the Service Building on the same elevation as the Turbine Building basement. These areas are separated by a fire door with 2 foot high flood dikes in front of them. A large scale flood could potentially overflow the dikes and enter into the two unit ESGR, leading to the potential loss of emergency power in both units, including the

Executive Summary

loss of Residual Heat Removal (RHR) stub busses. The normal off-site power supply to the plant would not be affected since the normal SGR is located at higher elevation in the Service Building.

Another important contributor to the internal flood CDF is due to flood events originated or entering into the Auxiliary Building. These flood scenarios, mainly from supply pipe ruptures from the RWST, result in the loss of all Component Cooling Water (CCW) and consequently the RHR function at the plant. This coupled with the unavailability of the RWST inventory to be injected into the reactor core leads to core damage. Again, the plant-specific spatial arrangement of piping and equipment is the main reason for the development of the accident scenario and its risk significance.

Accident Sequence Conclusions

The most dominant sequences, F1B2W4R10 - 4, F1B2W2R6 - 4 and F1B2W3R6 - 3, represent large scale flooding of the ESGR initiated in the Turbine Building coupled with the inability to recover. The flood in the ESGR disables all equipment required for feed and bleed operations and thus only reflux cooling and/or gravity feed options may be utilized. However, the primary coolant loops are isolated 70 % in time window 2 and 100% in time windows 3 and 4, respectively. In these sequences the pressurizer safety valves are not removed which prevents the use of the gravity feed options. Therefore, these sequences are effectively nonrecoverable except by some "ad hoc" means, for which no credit was given in these analyses.

The second group of accident sequences, F2B2W4R10 - 4, F2B2W2R6 - 4 and F2B2W3R6 - 3, are similar to the first group with the addition of the postulated difficulties in diagnosing accident conditions due to potential damage to the DC panels (instrumentation signals) in the ESGR.

The next most important group of sequences are associated with Auxiliary Building floods, F5R3W2R6 - 5 and F4R3W2R6 - 5. In both cases, the flood is initiated by a pipe rupture draining a large fraction of the RWST inventory into the Safeguard or Auxiliary Building. The flood would eventually collect in the Auxiliary Building basement leading to a loss of component cooling water and subsequently a loss of RHR event. Forced feed and bleed is unavailable since the RWST must be isolated. In these sequences, either the reactor coolant system (RCS) loops are isolated or other malfunction prevents the utilization of the steam generators through the reflux cooling technique.

Uncertainty Considerations

The probabilistic assessment and accident sequence modeling of the plant involves the combination of many individual events representing initiating frequencies, component and operator failures. The core damage frequency estimates are derived by using these individual events which, of themselves, frequently have significant uncertainties. The probabilistic accident sequence model may be used to develop importance measures and to calculate the appropriate uncertainty distributions of the individual and the sum of the accident sequence core damage frequencies.

The main results of the uncertainty analysis are shown in Table S-2, indicating the uncertainty bounds of the core damage frequency due to internal floods. The important measures of the uncertainty distribution are the 5%, mean and 95% values at 2.2E-07, 4.8E-06 and 1.8E-05/yr, respectively.

Other Considerations

Important recovery options are related to the long term operation of the reflux cooling method by replenishing the steam generators and to the establishment of backup charging flow from Unit 2. The analysis also allowed credit for uncertainty in the success criterion used for the reflux cooling.

In general, the core damage frequency contribution from flood events during mid-loop operation is relatively significant and is dominated by potential flood events into the ESGR coupled with loop isolation during time windows 2, 3, and 4.

Sensitivity calculations were also completed for a number of proposed improvement options and the point estimate CDF results are summarized in Table S-3. The most effective analyzed options are the installation of watertight doors on the ESGR (Option 2) and modification of the intake structure (Option 3), which are capable of reducing the CDF contribution in mid-loop by 57% and 75%, respectively i.e., $2.2\text{E-}06/\text{yr}$ and $1.3\text{E-}06/\text{yr}$ from the base case of $5.1\text{E-}06/\text{yr}$.

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3. K. D. Russel, et. al., "Systems Analysis Programs for Hands-On Integrated Reliability Evaluations (SAPHIRE)" NUREG/CR-6116, EGG-2716, Volume 2, "Integrated Reliability and Risk Analysis System (IRRAS), Reference Manual", July 1994.

Executive Summary

Table S-1 Summary of Point Estimate CDFs for Flood Events (/yr)

Scenario	Core Damage Frequency w/ Recovery			
	POS 6 Refueling	POS 6 Drained	POS 10 Refueling	Total
Turbine Building F1	1.9E-06	9.3E-08	1.5E-06	3.5E-06
Turbine Building F2	4.5E-07	2.2E-08	3.6E-07	8.3E-07
Auxiliary Building F3	4.7E-08	4.3E-08	1.2E-08	1.0E-07
Auxiliary Building F4	1.6E-07	5.7E-08	6.7E-08	2.8E-07
Safeguard Area F5	2.0E-07	8.9E-08	9.4E-08	3.8E-07
Spray in Containment F6	-	-	-	-
Mechanical Equipment Room No. #3 - F7	1.0E-08	1.5E-08	7.8E-09	3.3E-08
Total-Flood	2.8E-06	3.2E-07	2.0E-06	5.1E-06
Total-Internal Events	1.5E-06	3.1E-06	3.1E-07	4.9E-06

Table S-2 Results of the Flood Uncertainty Analysis

Flood Analysis	Flood Analysis Mid-Loop Operation (CDF/yr while at mid-loop)	Internal Events Analysis Mid-Loop Operations (CDF/yr while at mid-loop)
Mean*	4.8E-06	4.9E-06
5th Percentile	2.2E-07	4.8E-07
50th Percentile	1.7E-06	2.1E-06
95th Percentile	1.8E-05	1.5E-05
Error Factor	9.0	5.7
Point Estimate	5.1E-06	5.1E-06

* NUREG-1150 reported no flood sequences surviving the cutoff criterion of 1.0E-08.

Executive Summary

Table S-3 Core Damage Frequencies for Flood Events Sensitivity Analysis

Options	Core Damage Frequency Per Year (with recovery)				
	POS 6 Drained	POS 6 Refueling	POS 10 Refueling	Total	Δ CDF (Base-Total)
1 - Relocation of Sump Pump Power Supply	2.8E-07	1.8E-06	1.3E-06	3.4E-06	1.8E-06
2 - Watertight Door on ESGR	2.5E-07	1.2E-06	7.1E-07	2.2E-06	2.9E-06
3 - Modification of Intake Level Structure	2.3E-07	7.5E-07	3.1E-07	1.3E-06	3.8E-06
Base Case-Internal Flood Events	3.2E-07	2.8E-06	2.0E-06	5.1E-06	-

FOREWORD

(NUREG/CR-6143 and 6144) Low Power and Shutdown Probabilistic Risk Assessment Program

Traditionally, probabilistic risk assessments (PRA) of severe accidents in nuclear power plants have considered initiating events potentially occurring only during full power operation. Some previous screening analysis that were performed for other modes of operation suggested that risks during those modes were small relative to full power operation. However, more recent studies and operational experience have implied that accidents during low power and shutdown could be significant contributors to risk.

During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects performed by Brookhaven National Laboratory (BNL) and Sandia National Laboratories (SNL), with the seismic analysis performed by Future Resources Associates. Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied.

The objectives of the program are to assess the risks of severe accidents due to internal events, internal fires, internal floods, and seismic events initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The scope of the program includes that of a level-3 PRA.

The results of the program are documented in two reports, NUREG/CR-6143 and 6144. The reports are organized as follows:

For Grand Gulf:

NUREG/CR-6143 - Evaluation of Potential Severe Accidents during Low Power and Shutdown Operations at Grand Gulf, Unit 1

Volume 1: Summary of Results

Volume 2: Analysis of Core Damage Frequency from Internal Events for Operational State 5 During a Refueling Outage

Part 1: Main Report

Part 1A: Sections 1 - 9

Part 1B: Section 10

Part 1C: Sections 11 - 14

Part 2: Internal Events Appendices A to H

Part 3: Internal Events Appendices I and J

Part 4: Internal Events Appendices K to M

Volume 3: Analysis of Core Damage Frequency from Internal Fire Events for Plant Operational State 5 During a Refueling Outage

- Volume 4: Analysis of Core Damage Frequency from Internal Flooding Events for Plant Operational State 5 During a Refueling Outage
- Volume 5: Analysis of Core Damage Frequency from Seismic Events for Plant Operational State 5 During a Refueling Outage
- Volume 6: Evaluation of Severe Accident Risks for Plant Operational State 5 During a Refueling Outage
 - Part 1: Main Report
 - Part 2: Supporting MELCOR Calculations

For Surry:

NUREG/CR-6144- Evaluation of Potential Severe Accidents during Low Power and Shutdown Operations at Surry Unit-1

- Volume 1: Summary of Results
- Volume 2: Analysis of Core Damage Frequency from Internal Events during Mid-loop Operations
 - Part 1: Main Report
 - Part 1A: Chapters 1 - 6
 - Part 1B: Chapters 7 - 12
 - Part 2: Internal Events Appendices A to D
 - Part 3: Internal Events Appendix E
 - Part 3A: Sections E.1 - E.8
 - Part 3B: Sections E.9 - E.16
 - Part 4: Internal Events Appendices F to H
 - Part 5: Internal Events Appendix I
- Volume 3: Analysis of Core Damage Frequency from Internal Fires during Mid-loop Operations
 - Part 1: Main Report
 - Part 2: Appendices
- Volume 4: Analysis of Core Damage Frequency from Internal Floods during Mid-loop Operations
- Volume 5: Analysis of Core Damage Frequency from Seismic Events during Mid-loop Operations
- Volume 6: Evaluation of Severe Accident Risks during Mid-loop Operations
 - Part 1: Main Report
 - Part 2: Appendices

1. INTRODUCTION AND OVERVIEW

1.1 Scope of the Study

The study documented in this report is the continuation of the internal event Level 1 work of the low power and shutdown accident frequency analysis of the Surry Nuclear Power Plant. It contains the results of the internal flood analysis and excludes external flood events. The work was performed by Brookhaven National Laboratory for the Nuclear Regulatory Commission Office of Nuclear Regulatory Research. The main objective of the study is to determine the internal flood contribution to the core damage frequency estimates of a pressurized water reactor during low power and shutdown conditions. The study has concentrated on the various operational conditions during shutdown operation, determined the dominant flood accident sequences and important scenarios, and analyzed the contribution of the various accident scenarios in terms of their importance to the core damage frequency and risk.

The main objectives of the internal flood analysis are:

- to assess the frequency of severe accidents initiated by internal flood events focusing on specific shutdown operational states
- to compare the estimated core damage frequencies, important accident scenarios and dominant contributors and the main results to comparable accident events of the full power operations as assessed in the NUREG-1150 study for Surry Unit 1.

1.2 Phase 1a Results

In the Phase 1a internal event study, a coarse internal flood screening analysis was completed. The study was limited only to a few plant operational states, involving mid-loop operation, i.e., POS 6 in refueling and drained maintenance and POS 10 in refueling mode of operation. The coarse screening analysis identified the most vulnerable flood areas and screened out certain areas that do not have significant impact. Spatial interaction between connected areas and also the effect of flood on various equipment has been conservatively considered. Simplified flood event trees were developed and quantification was accomplished by assuming certain time evolution of the accident scenarios and the condition of the containment.

The main results of the coarse screening analysis are summarized in Table 1-1. The core damage frequency contribution was estimated to be significant for the Turbine Building, Safeguard Area, and for certain scenarios in the Auxiliary Building and the Emergency Switchgear and Relay Room. It was estimated that all of the internal flood events would lead to early cored damage with an open containment.

1.3 Methodology Overview

The methodology of the internal flood event analysis is based on previously utilized approaches in probabilistic safety analysis works, especially the methodology used in the full power study of NUREG-1150 and the plant-specific Individual Plant Examination (IPE) study of the Surry Plant. The basic steps in the analysis involve the following:

- identification of flood areas
spatial interaction of flood areas

Introduction and Overview

- flood event frequency analysis
flood damage states
- location and scenario identification
- plant response analysis
accident scenarios, sequences, and frequencies

The internal flood analysis utilized the system fault trees and event trees developed for the internal event study. The flood events were categorized as to their effect on the residual heat removal system and were mapped to the corresponding internal event tree. The event trees were modified to take into account the specific accident evolution of the flood event. In addition, the system fault trees were also modified according to the effects of the flood on equipment used to mitigate the accident. The relevant human error probabilities were also modified as timing and potential spatial interactions complicated the accident progression.

1.4 Internal Event Results

The Phase 2 flood analysis documented in this report relied on the system fault and event trees developed for the internal event study. That portion of the work documented in Reference 1 was the basis of the numerical quantification of the system and accident progression portion of the internal flood analysis. For further reference the main results of the Phase 2 internal event analysis are presented in Table 1-2. The most dominant operating state from the perspective of risk contribution is the POS 6 drained maintenance configuration, since the number of mitigating systems or alternate heat removal methods are most limited in this POS.

1.5 Organization of the Report

The report is organized along the methodological steps of the internal flood analysis. In the next section, the methodology of the flood event analysis is discussed in more detail. In Section 3, the flood areas are identified and the effect of floods is investigated. In Section 4, the flood frequency is derived in each specific location for the respective POSs. Section 5 contains the scenario development, and discussion about the event trees used to analyze flood accident scenarios as well as discussion in the modification to the system fault trees and the internal event trees. Section 6 presents the quantification and the results. The final section discusses the insights and the conclusion of the internal flood study.

1.6 Plant Visits

In order to become familiar with the specific plant locations as well as assess the potential for various flood damage scenarios and evaluate the design capabilities of the flood protection devices, a team of analysts undertook numerous site visits. These plant visits were extremely valuable in establishing the analytical work and relating the various assumptions used in the study. Special emphasis was put on investigating the potential spatial interconnections between various plant locations. The effectiveness of certain flood protection devices was also evaluated. Discussion with plant personnel about flood preventive measures, and potential procedural and hardware improvements was also helpful.

1.7 References

1. Chu, T-L., et.al., "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry Unit-1: Analysis of Core Damage Frequency from Internal Events During Mid-Loop Operations." NUREG/CR-6144, Volume 2, June 1994.
2. Virginia Power, Surry Nuclear Power Plant, Individual Plant Examination Program, Appendix E: Internal Flooding. Internal Flooding Analysis for the Individual Plant Examinations, Supplemental Report, Surry Units 1 and 2, Virginia Electric and Power Company, November 1991.

Table 1-1 Internal Flood Events Summary of Coarse Screening Analysis

Areas or Building	Lowest Elevation	Frequency of Flood /yr POS 6 Refueling	Seq. #	CDF	Timing	Containment
Emergency Switchgear and Relay Room	9'-6"	3.00E-05	3	Low	Early	Open
			4	High	Early	Open
Containment	-27'-7"	6.18E-06	4	Low	Early	Open
			7	Low	Early	Open
Auxiliary Building	2'	1.88E-05	3	Low	Early	Open
			5	High	Early	Open
Safeguard Area	-27'-7"	1.50E-05		High	Early	Open
Turbine Building	9'-6"	7.52E-05		High	Early	Open

Table 1-2 Internal Event Analysis Summary

	Initiating Event	IE Frequency	Core-Damage Frequency (per year)			
1.	Loss of RHR		R6	R10	D6	Total
	RHR2A-Over Draining	1.6E-02/Demand	1.8E-7	5.3E-8	2.6E-7	4.9E-7
	RHR2B-Failure to Maintain Level	1.2E-05/hr	2.1E-08	2.0E-8	2.9E-8	7.0E-8
	RHR3-Non-Recoverable Loss of RHR	4.1E-06/hr	1.5E-7	8.4E-9	3.0E-7	4.6E-7
	RHR4-Non-Recoverable Loss of Operating Train of RHR	5.3E-06/hr	7.6E-9	1.2E-9	2.3E-8	3.2E-8
	RHR5-Recoverable Loss of RHR	2.1E-05/hr	4.0E-8	4.1E-09	9.3E-8	1.4E-7
2.	LOOP-Loss of Offsite Power	7.0E-06/hr				
	L1-Both 1H and 1J Energized	6.2E-06/hr	3.3E-7	7.0E-8	7.6E-7	1.2E-6
	L2-1H and 2H energized, not 1J	7.4E-07/hr	1.0E-7	1.3E-8	1.7E-7	2.9E-7
	L3-1H energized, not 1J, unit 2 blackout	3.8E-08/hr	4.2E-8	1.3E-8	9.9E-8	1.5E-7
	B1-Unit 1 Black Out	2.0E-08/hr	4.8E-8	1.1E-8	1.7E-7	2.3E-7
	B2-2 Unit Blackout	3.2E-09/hr	3.8E-8	4.2E-8	1.1E-7	1.9E-7
3.	4KV-Loss of 4kv Bus	2.1E-05/hr	1.4E-7	1.9E-8	2.4E-7	4.0E-7
4.	VITAL-Loss of Vital Bus	5.6E-06/hr	2.8E-8	5.1E-9	7.3E-8	1.1E-7
5.	AIR-Loss of Outside Instrument Air	2.1E-6/hr	7.9E-10	-	3.2E-9	4.0E-9
6.	CCW-Loss of CCW	3.8E-06/hr	6.3E-8	1.1E-10	2.1E-7	2.7E-7
7.	SWGR-Loss of Emergency Switchgear Room Cooling	1.8E-08/hr	3.6E-8	1.2E-8	7.4E-8	1.2E-7
8.	ESFAS-Inadvertent Safety Feature Actuation	1.1E-04/hr	2.7E-7	2.7E-8	6.8E-7	9.8E-7
9.	Dilute-Boron Dilution (estimated CDF)	2.0E-07/hr				6.8E-08
TOTAL			1.5E-6	3.0E-7	3.3E-6	5.1E-6*

* Not including boron dilution

2. METHODOLOGY

2.1 Introduction

The coarse screening analysis of the potential internal flood events at the Surry Power Plant identified several scenarios with relatively high risk significant contributions. In the second phase of the flood analysis, a comprehensive detailed evaluation of the specific flood scenarios was undertaken based on the results of the coarse screening study. The analysis initially concentrated on mid-loop operations (POS 6 refueling and drained maintenance, POS 10 refueling) and the internal flood initiated contribution to the CDF has been quantified in these operating states only.

The mid-loop operational mode was selected, since the RCS inventory is at its lowest level with appreciable decay heat level. In the internal flood analysis specific attention has been paid to flood prevention devices which protect against or limit the consequences of any flood damage including floor plugs, dikes and reverse flow preventers.

The methodology is based on previously utilized approaches in previous probabilistic risk assessment work including the NUREG-1150 study and the recently completed IPE study of the Surry plant. Both of these studies provided large amounts of information required for the flood analysis. The information contained in these studies was confirmed and used whenever it was deemed appropriate.

Specific effort was made to identify potential flood propagation pathways between interconnected areas. The interconnection may be caused by doors or stairways, floor drains or other openings. It was assumed that immersion of equipment is the predominant failure mechanism due to flood and the effect of spraying or splashing is not considered presently except in the containment with respect to the operation of the RHR system.

The methodology of the flood analysis may be summarized as follows with the detailed description of each area given in subsequent sections:

- identification of flood areas
interconnection between flood areas
- internal flood frequency analysis
flood damage states
- location and scenario identification
- plant response analysis
flood event trees, system fault tree modification
accident sequence quantification

2.2 Identification of Flood Areas

The areas defined in the coarse screening analysis were used as the basis for the second phase effort. The potential pathways for flood propagation were identified using the information obtained during a plant visit as well as information available from the NUREG-1150 and IPE studies. The spatial interactions and the

Methodology

various pathways between high risk areas i.e., Turbine Building and Emergency Switchgear Room and Auxiliary Building were inspected and evaluated for potential flood damage.

2.3 Initiating Frequency Analysis

The initiating frequency data was developed based on actual flooding events and updated to include plant-specific features and data. The data was gathered from various sources including the IPE Surry flood analysis, industry sources, licensing event reports (LERs).

In some cases, plant specific models were developed especially with regard to the most important circulating water (CW) and service water (SW) lines in the Turbine Building. These two sources of flood are estimated to dominate the risk, requiring special treatment. The most dominant failure mechanism for large pipes is pipe rupture due to water hammer events.

Generic pipe failure data and models were used when plant-specific data was unavailable with the exception of the CW and SW lines. The effects of flood barriers and other mitigating mechanisms were also considered in the development of damage states.

The equipment damage due to internal flood was determined as a function of flood level. Similar to the coarse screening analysis, the effect of spraying, splashing, and dripping is initially neglected. The flood level depends on various factors such as the rate of leaking, area of interconnections, drainage pathways, and potential mitigating actions.

In order to take these factors into account, simple flood damage categories or damage states were developed. The damage states effectively incorporate the time dependency of the flood event and any potential mitigating or recovery actions. The damage states reflect a particular flood-exceeding frequency at a particular location with a predefined equipment damage level. This allows the incorporation of any partial failures due to flooding or differentiation between equipment damages at a particular location.

The flood initiating frequencies were developed to incorporate simple recovery actions as expected from the existing experience or data base. In addition, the data base is examined for its applicability for the Surry plant and is modified to take into account certain plant-specific features.

2.4 Location and Scenario Identification

The coarse screening analysis identified flood areas along the line of the fire analysis. This classification was further analyzed with regard to the risk importance of scenarios and the specific equipment locations. The flood areas may further be localized or subdivided depending on the specific sources, barriers, drain and sump systems, etc.

The flood sources in each location were identified and related to the corresponding frontline system so that the affected equipment and the potential damage could be identified. In the first stage of this analysis only the mid-loop operational mode (POS 6 refueling and drained maintenance, POS 10 refueling) is modeled, therefore potential flood damage to the RHR system/equipment and its support is the primary focus of the scenario identification. Thus the flood scenarios are limited to the extent of their effect on the RHR or any support system [including station black-out (SBO)].

The identification of the potential scenarios and flood locations was accomplished by initially using the general arrangement diagrams using the RHR system fault tree developed for the internal event analysis. The fault tree identifies all equipment and support components required for the RHR system operation. These were located and identified on the plant drawings and correlated with the flood areas as identified during the analysis.

The scenario development also included the identification of potential propagation pathways and their physical nature (doors, stairways, etc.) which may limit the flood rate. In addition, drainage potential and other mitigating features which could help in the recovery process were also identified.

Once the flood scenarios were identified, the effect on other frontline systems or their components was determined. This was limited to only those systems which were required to prevent core damage and are identified by examining the internal event trees for the loss of RHR function and/or station blackout. The appropriate equipment and/or its support were located and placed in the appropriate flood areas.

The quantification takes into account the rate of water flow into the area or height of the flood and establishes generally a critical flood level in each specific plant area. The time available for any recovery action is estimated by defining the critical volume and the applicable flow rate. This approach allows the incorporation of simple recovery effects in the quantification without greatly modifying the existing fault trees and internal event trees.

2.5 Plant Response, Accident Sequence Frequencies

The quantification process utilizes the appropriately modified internal event tree models. The various flood events are connected to the appropriate event tree, which were modified to reflect the potential effects of the flood.

In this phase, only the mid-loop operational mode (POS 6 and POS 10) is modeled corresponding to the loss of the RHR system or station blackout event tree. The frontline systems required to prevent core damage were modified to reflect the actual flood scenario. The system fault trees were also modified, if required.

The event trees were quantified for the analyzed flood scenarios and flood damage state frequency. The effect of recovery and potential human actions may initially be considered in the derivation of the damage state frequency. The human reliability analysis (HRA) modeling was completed to include diagnostic and actuation human errors associated with the internal flood events and the corresponding mitigating systems. Potential recovery action was also considered after the dominant accident sequence scenarios and the prospective recovery actions were identified.

3. IDENTIFICATION AND INTERCONNECTION OF FLOOD AREAS

3.1 Introduction

The coarse screening analysis has identified several areas, listed in Table 3-1, as potentially significant sources of internal flood risk. The analysis determined that the risk contribution from floods originating in these areas is not negligible and must be analyzed in more detail to identify the core damage frequency contributions. The coarse screening analysis utilized relatively conservative quantification methodology without identifying the plant-specific features and details. Table 3-1 identifies the results of the coarse screening analysis indicating the flood initiating frequency and the consequent CDF contribution.

Other areas were also considered, but screened out due to little equipment damage by a flood in that area. In the following two sections, these areas are further discussed with respect to the potential sources of flood and the interaction between areas or flood propagation pathways. The equipment located in the affected or interconnected area is identified in the following section. This serves as the basis for identifying the potential damage caused by a flood event.

The following areas are discussed further:

- Turbine Building
- Emergency Switchgear and Relay Room
- Auxiliary Building
- Safeguard Area
- Containment
- Mechanical Equipment Room No. #3

3.2 Flood Sources, Protection Devices and Floor Drain Systems

The possible sources of internal floods and potential interactions between different areas were derived from various sources of information. The NUREG-1150, the IPE study, plant drawings, and walkdowns were extremely helpful in determining the potential flood sources as well as the propagation pathways including floor drain systems, pipe tunnels, stairwells, and ventilation openings.

3.2.1 Turbine Building

The potential flooding sources in the Turbine Building have the largest potential for flood risk contribution due to their size and volume. The building has the largest floor area, the most extensive sump arrangements, and a large capacity of dewatering capability.

The single most important large source is connected with the intake canal through the CW and SW systems. The CW system has four 96" diameter pipes at the inlet and outlet of the main condenser. The 36" SW system supply is taken from the CW inlet sections providing coolant to various heat exchangers.

The CW and SW systems are gravity feed from the intake canal that contains 29 million gallons of water. Given an opening in the inlet or outlet piping of the CW or SW system, the intake canal may drain into the Turbine Building resulting in a flood scenario with potentially huge quantities of water collecting inside the building.

Identification and Interconnection of Flood Areas

The four 96" diameter CW inlet lines (per unit) connect the intake canal with the main condenser. Each pipe enters the building from the condenser pit and rises 18" before connecting to the inlet motor-operated valve and an expansion joint. After the expansion joint, the pipe is connected to the condenser water box. The expansion joints are shielded by metal plates that would limit or reduce the leakage rate if a rupture were to develop.

The expansion joints are deemed to be the most vulnerable sections and potentially susceptible to pipe break due to water hammer or other mechanisms. The inlet and outlet isolation valves can be used to isolate a break in the system. The SW system also includes motor-operated valves (MOV-SW101A,B, SW102A,B, SW103A,B,C,D) to stop and isolate the SW system, if required.

Two air-operated vacuum breaker valves are mounted on each condenser outlet waterbox at the highest point in the CW system. These valves are designed to interrupt the siphon action of CW flowing through the condenser and conserve canal inventory during fire events which may prevent the closing of the inlet and outlet valves.

The circulating water lines can be isolated at the high-level intake structure by inserting stop logs. The stop logs are used to isolate the inlet lines to allow maintenance to be performed. The time required to insert the stop logs varies depending on the availability of trained personnel and the conditions at the canal inlet. Due to the estimated time involved, it is not likely that the stop logs would be an effective means of isolating the circulating water lines in a short period of time. Long-term isolation may also be difficult, since the stop logs are not designed to be inserted against full flow which may prevent their movement in the track mechanism.

Other sources of water are related to the various systems located in the Turbine Building. However, their capacity and flow rate is limited with comparison to the CW and SW system. The secondary side, that is the main feedwater (MFW), condensate and main steam system, is estimated to contain about 300,000 gallons of water and the maximum flow rate is about 20,000 gpm.

Additional sources of water are connected with the Fire Protection system and Condensate Storage Tank. However, the flow rate through these piping connections is relatively limited and has isolation capability.

The plant has a number of flood protection devices installed that protect certain equipment and areas in case of flood events. The CW pipe expansion joints are surrounded by steel expansion plates which would restrict water flow given the failure of the expansion joints.

The Turbine Building ground floor is connected to a number of other adjoining plant areas. The entrance to the Emergency Switchgear and Relay Room of both units is located on this elevation through a double fire door. There is an open pipe tunnel connecting the Turbine Building ground floor (Elevation 9'-6") to the Auxiliary Building basement (Elevation 2'). There is also a connection to battery room 2B and the charging pump service water pump room through closed fire doors.

There are flood dikes at the entrance to the ESGR and the Auxiliary Building Tunnel. In addition, a splash guard is installed above the ESGR entrance door to prevent fire water from entering the ESGR. The ground floor connection to battery room 2B and charging pump service water pump room has no dike installed around them. Flood dikes surround the SW valve pits in the Turbine Building. The floor drains in the Electrical Tunnels, the ESGR, and the Mechanical Equipment Room are fitted with check valves that prevent backflow of water from the Turbine Building.

The Turbine Building, shared by both units, has three separate floor drain systems. The Unit 1 part of the building is separated from that of Unit 2 by walls and fire doors, with the exception that they share one of the floor drain systems. Each floor drain system has three 1300 gpm sump pumps. Each unit has one dedicated floor drain system. The dedicated floor drain is connected to the Amertap pit. This pit is the lowest part of the turbine building. It has approximately 80,000 gallon capacity.

The third floor drain system is shared by both units. This shared system is also connected to the floor drain system for the Service Building as well as the condenser pits of both units. The drain lines from the sumps in the Service Building have anti-flow reversal devices that should prevent back flow into the Service Building. The electrical motor control center of the drain sump pumps is also located on the ground elevation. It is expected that any water accumulation in excess of the various pits and dewatering capacity of the sump pumps would disable the electrical supply to the sump pumps itself.

The condenser pit is connected to the Amertap pit. The service water valve pits and manway pits are water-proofed/sealed and are equipped with a 2' metal dike separating them from the rest of the Turbine Building floor.

3.2.2 Emergency Switchgear Room and Relay Room

This room has a 9" deep trench in the floor. It contains five 3" diameter lines of the charging pump service water system and four 2" lines containing water for the control room and relay room air conditioning system.

The Unit 1 ESGR is connected to the Unit 2 ESGR through a normally open heavy duty fire door, which may be closed by a pull-chain device to limit water ingress from the adjoining Turbine Building. The mechanical equipment room is connected to the Unit 2 ESGR by a fire door with a 2' dike. The Unit 1 ESGR is connected to the Unit 1 cable vault and tunnel area through a door with a 18" flood dike.

Elevation 9'-6" of the Service Building containing the ESGR has one floor drain system that is connected to the Turbine Building floor drain system. Higher elevations have drains to the Turbine Building floor drain system or sewer system. Mechanical Equipment Room No. #3 has three floor drains that are connected with the floor drain system of the Turbine Building. These drains have anti-reverse flow devices to prevent backflow. There are pipes that connect this room with the Emergency Relay Room and higher elevations of the Service Building. They are either Halon system pipes or soil waste or vent lines.

3.2.3 Auxiliary Building

The Auxiliary Building houses normal and emergency equipment required for the operation of the units. The building is shared by both units and houses equipment primarily of the Chemical Volume and Control System (CVCS), Component Cooling Water System and the High Pressure Safety Injection System (HPI).

The primary sources of water are essentially related to the various systems located inside the Auxiliary Building. Most of these systems contain relatively small amounts of water or the maximum piping size is limited to 2"-4". The two major water sources are:

Identification and Interconnection of Flood Areas

Refueling Water Storage Tank Supplies

The Refueling Water Storage Tank pipe connections and supply lines to the Charging Pumps are normally isolated, however, a random pipe rupture of the 10" and 8" lines may be a flood source with sufficient capacity to reach critical flood height. Any pipe break inside the building may be isolated at the RWST outlet by closing a manual valve. The maximum flood discharge rate was estimated in the IPE analysis at around 15,000 gpm based on the hydrostatic head involving the full rupture of a 10" supply line.

Fire Protection System

The fire protection piping inside the Auxiliary Building supplies water to the hose reels through 4" pipes. One 6" diameter pipe runs to a ventilation unit at a higher elevation. The system is pressurized by a jockey pump and, given a reduction in pressure, the main fire water pumps would start automatically. Water discharged at higher elevations would find its way through gratings, floor opening and stairways down to the 2' elevation. This elevation contains the major safety-related equipment such as the Charging Pumps and CCW Pumps. Floods due to a pipe break in the Fire Protection System may be easily isolated by simply stopping the fire suppression pumps and/or isolating the piping headers by closing the appropriate manual valves.

The Auxiliary Building has one floor drain system that connects the charging pump cubicles with the rest of the building (all levels). High level in the building sump is alarmed in the control room. There are large openings in the floor at higher elevations. At the entrance of the Charging Pump cubicles, 2' flood dikes are installed to prevent the entering of any flood water accumulating at the 13' level. Anti-reverse flow devices are installed in the drain lines of the charging pump cubicles. The charging pump cubicles do not have any large openings such as doors, except for the floor drain, up to 11' 6" elevation. Between the charging pump cubicles, there are pipe route openings at approximately 4' from the floor connecting the cubicles to the rest of the Auxiliary Building. It was estimated that $\approx 18"$ of water in the open floor of the Auxiliary Building will cause shorts in the CCW pump motors. The charging pumps would not be affected by this type of flood if the anti-reverse flow devices do not fail in the drain lines.

The piping from the RWST is primarily located in the charging pump cubicles and any rupture inside the cubicles would lead to the loss of two or three charging/high pressure injection pumps as well as flooding in the outside open areas with the consequent loss of the CCW system (at $\approx 18"$).

3.2.4 Safeguard Area

This area has a large number of sources of water for flooding. The main steam lines, feedwater lines, and eight 24" SW lines to the recirculation spray heat exchangers inside the containment all pass through this area. The containment spray pumps and low head injection pumps, located in this area, take suction from RWST, and the auxiliary feedwater pumps, also located in the safeguard area, take suction from the condensate storage tank.

The main steam and feedwater lines are automatically isolated after a pipe break, limiting the sources of flooding. The SW lines providing the heat removal function to the recirculation spray heat exchangers are normally isolated and cannot be a major source of flooding due to the limited water capacity of the pipe. The two major sources of flood that may provide a sufficient amount of water are the piping lines connected to the RWST or to the Emergency Condensate Storage Tank.

RWST System Piping

The Containment Spray Pumps are provided by 12" and 8" supply lines which are normally pressurized from the RWST. The Low Head Safety Injection System piping is also supplied from the RWST and pressurized by the static head in the tank. All these lines may be isolated at the RWST outlet, however, the precise determination of the actual break may be difficult, requiring the closure of all three RWST outlet valves.

Auxiliary Feedwater Piping

The AFW pumps are normally supplied from the Emergency Condensate Storage Tank. This tank is capable of discharging about 110,000 gallons of water through the pump suction lines. The maximum discharge flow is estimated at 350 gpm based on the pipe sizes and the static head available in the tank.

The safeguard area consists of and may be divided into two sub-areas: main steam valve house and low head recirculation pump area. The main steam valve house has three levels at 26'-6", 12' and relative elevation -27'-7". The containment spray pumps and auxiliary feed pumps are at elevation 26'-6". Above these pumps and below the roof at elevation 47'-4" are the main steam trip valves, associated bypass valves, and steam generator pressure operated relief valves (PORVs). The SW supply lines and valves for the recirculation spray heat exchangers are at the 12' elevation.

The low head recirculation spray pump area contains valves, pumps and motors. The motors of the low head safety injection pumps, and outside containment recirculation spray pumps are at 12' elevation. The pumps of the low head injection pumps and containment recirculation spray pumps are at relative elevation -27'-7". These pumps are connected to their motors through long shafts. The floors at different elevations in the safeguard area are connected by openings in the floor for ladders and pump shafts.

The area housing the low head injection piping and valves is connected to the area containing the AFW pumps through a pipe tunnel opening allowing a flood in one area to enter the other. The sub-area containing the AFW equipment is connected to the Auxiliary Building through a sealed pipe tunnel which leads to the 2' elevation of that building. Flood detection sensors are installed in the low head recirculation pump area and in the tunnel connecting to the auxiliary building.

3.2.5 Containment

The RHR pumps are located at the relative elevation -13'-0" elevation of the containment building 14' above the basement of the containment which is at -27'-7". Only a very large flood in excess of a few thousand gallons can fill up the containment to 14' height causing the loss of the RHR pump motors. However, a leak and consequent spraying near the pump motors may result in an adverse impact on the motors. A leak or rupture of the reactor coolant system is considered and modeled as a large loss of coolant accident (LOCA).

Three scenarios are possible, a spurious actuation of the containment spray system, failure of the cavity seal during refueling, and failure in the SW lines to the recirculation spray heat exchangers. On May 17, 1988, a failure of cavity seal did occur at Unit 1. Such failure is modeled in the loss of off-site power event trees of the internal event analysis. In the plant's response to I.E. Bulletin 84-03, it was stated that the RHR system can still continue operating, given a seal failure. Therefore, such a scenario was not considered in the flood analysis. Inadvertent actuation of containment spray is considered as a loss of RHR event, and is analyzed

Identification and Interconnection of Flood Areas

in the loss of RHR event trees discussed again in the internal event analysis. Therefore, inadvertent actuation of containment spray is not considered in the flood analysis.

The SW lines supplying the recirculation spray heat exchangers are the most likely cause of flood in the containment. However, these lines are normally kept isolated by MOV-SW103A-D. The water volume available in the SW pipes is estimated to be insufficient to cause large scale flooding inside the containment that would affect RHR equipment at the -13'-0" relative elevation.

The containment drainage system is designed to direct all leakages into the containment sump located on the bottom of the building. It is monitored in the control room for increasing level.

3.2.6 Mechanical Equipment Room No. #3

The Mechanical Equipment Room No. #3 is located on Elevation 9'-6" next to the plant ESGR and the Turbine Building. The room houses chillers, pumps, and valves associated with the control/relay room air conditioning system. The Charging Pump Service Water system pumps are also located here. Potential source of flooding is due to the SW supply lines to the chillers and pumps.

The entrance to the ESGR is protected by a flood dike and a connecting pipe tunnel is sealed to prevent water entering the electrical area. A flood sensor providing an alarm in the control room is also installed. The SW lines are connected to the inlet canal providing a potential source of flood water in this area.

3.3 Building Layouts, Flood Propagation Pathways, Impact on Equipment

3.3.1 Turbine Building

The Turbine Building primarily houses equipment of the Power Conversion System which has no safety function. This building has the most sources of water. The equipment in the building that are needed for decay heat removal or mitigation of any initiating event are the instrument air compressors, SW valves and pipes, and cables for train A of safety injection, containment spray, RHR, and motor-driven auxiliary feed water pumps. A flood in this building can enter Battery Room 2B and charging pump SW pump room through the bottom of the doors. Failure of the anti-reverse flow device can cause a flood to propagate to the ESGR. A large flood can propagate from this building to the Auxiliary Building through the pipe tunnel used by the CCW system. A flood that exceeds 2' level in the building can propagate to the ESGRs, Mechanical Equipment Room No. #3 and cable vault and tunnel.

The building is shared between the two units, however, there is a dividing wall which extends up to the 58'-6" elevation. There are several nonwatertight interconnecting doorways, including three on the lowest level, and a common drain system.

The primary propagation pathways required to be analyzed are the overflow of a 2' flood dike protecting the ESGR. The door connecting the Turbine Building with the ESGR area is assumed to open under static pressure. The water would initially enter the Unit 2 ESGR and eventually would overflow a 3" curb at the entrance of the Unit 1 ESGR. The cable vaults and tunnels are protected at the back of the ESGR by 18" flood dikes.

The other important interconnection is through the pipe tunnel connecting the Turbine Building ground floor at the 9'-6" elevation with the Auxiliary Building at the 2' elevation. The entrance of the pipe tunnel in the Turbine Building is protected by a 2' flood dike. Given a flood event providing a sufficient amount of water, the 2' dike may be overflowed and water may enter into the Auxiliary Building at the 2' elevation.

The most important impact of a limited flood in the Turbine Building is the potential loss of instrument air supply and the potential effects on the operation of the SW valves. However, a major flood event which would overflow into the ESGR and Auxiliary Building is expected to have a major impact. The effects of this type of flood propagation is discussed in the next sections.

The instrument air compressors are located 3' above the floor level and their function is to back up normal service air supply to the SG PORVs. The primary air supply to the PORVs is from the service air compressors located outside in the yard area.

The SW supply to the recirculation heat exchangers may also be affected after a flood event. However, the need for these heat exchangers is rather limited and required only for long-term sequences with RHR and AFW system failures.

3.3.2 Emergency Switchgear and Relay Room, Cable Vault and Tunnels

The Unit 1 ESGR is connected to a number of other areas including the cable vault and tunnel through a door which has an 18" flood dike. There is a door opening to the Unit 2 ESGR that has a 3" curb. There is a direct connection to the Turbine Building through the floor drain system. The drain lines for this area are equipped with anti-reverse flow devices. The Unit 2 ESGR is connected to the Turbine Building through a fire door. A 2' dike is installed in front of the door inside the Turbine Building to prevent the propagation of any flood.

A flood propagating into the ESGR could affect all the safety related 4 kV and 125 VDC power supplies, 480 V buses, motor control center (MCCs) and DC switchboards. The cable vault contains a large number of cables for safety equipment and the following could be affected:

- HHSI suction train A, B
- HHSI discharge train C
- CS discharge train A, B
- PORV train A, B
- RS-SW train A (1/2), B (1/2)

3.3.3 Auxiliary Building

The basement of the Auxiliary Building (Elevation 2'-0") houses the six charging pumps which also serve as high head safety injection (SI) pumps and CCW pumps for both units. The charging pumps are each in an enclosed compartment of its own. These compartments are connected with each other and the rest of the building with open pipe penetrations at approximately 4' above the floor. The compartments are separated from the rest of the building by walls which extend up to elevation 13'-0" where flood dikes are installed at the cubicle openings. The floor drain system also connects the compartments with the rest of the Auxiliary Building where anti-reverse flow devices were recently installed.

Identification and Interconnection of Flood Areas

The charging pump cubicles are protected against flood by 2' dikes installed at the entrance at elevation 13'-0". However, any flood at this elevation is expected to find its way to the 2'-0" elevation and collect on the basement floor.

The Auxiliary Building is connected to the Turbine Building through a pipe tunnel whose entrance at the Turbine Building is protected by a 2' dike. Therefore, a very large flood in the Turbine Building or a flood localized at the entrance to the pipe tunnel is needed for a flood to affect the Auxiliary Building.

The CCW pumps and their electrical motors are installed on a concrete pedestal about 18" height. A flood in the auxiliary building has to be of sufficient extent that the water level reaches this height causing the failure of the CCW system. The CCW system provides direct heat removal to the RHR heat exchangers, and thus its loss would lead to the loss of the RHR system. The RHR pump seals are cooled also by the CCW system, however, the loss of this cooling function will not directly lead to the heat removal capability and does not have to be further considered.

A major flood due to rupture of the RWST piping would most likely occur inside the charging pump cubicles leading to the loss of two or three charging pumps. The water would flow through the drain lines into the outside open area and eventually would short out the CCW pump motors when flood levels reach about 18".

3.3.4 Safeguard Area

The Safeguard Area contains a number of safety-related pumps and valves located next to the containment. The Safeguard Area has a sump at the 12' elevation. A flood at this elevation can potentially fail the low head safety injection pumps and outside containment recirculation spray pumps. A pipe tunnel at elevation 11'-6" exists between this area and the auxiliary building. It is sealed by foam for fire protection purposes. In the flood analysis, it was assumed that the seal is not a flood barrier.

The area may be divided between two sub-areas: one containing the low head safety injection pumps and the other mainly containing equipment and piping related to the main steam and AFW system. The two sub-areas communicate through a pipe trough opening at the 16'-9" elevation. The connection between the safeguard area and the pipe tunnel leading to the Auxiliary Building is at the 11'-6" elevation.

The flood may originate in the low head safety injection sub-area, in which case, the water has to rise to the 16'-9" elevation to overflow into the AFW equipment area and then through the pipe tunnel into the Auxiliary Building. Floods originating in the AFW equipment sub-area may flow directly into the Auxiliary Building once the fire barrier is penetrated by the water at the pipe tunnel entrance. A flood in these locations would eventually spill over onto the Auxiliary Building floor affecting the operation of the CCW pumps leading to the potential loss of the RHR system. The pipe tunnel discharges onto the 2' elevation of the Auxiliary Building where the water may collect.

3.3.5 Containment

The RHR pumps are located on the -13'-0" relative elevation 14' above the bottom of the containment building. The volume in the SW or CCW system piping is not sufficient to fill up the containment to the RHR pump level. Indirect loss of the RHR system is considered through incidental spray on the RHR pump motor.

3.3.6 Mechanical Equipment Room No. #3

A potentially large flood in this location may overflow the flood dikes installed at the entrance to the ESGR and would cause first loss of AC power on Unit 2 and subsequently, given sufficient water volume, on Unit 2. The consequences of the event are similar to a large Turbine Building flood entering the ESGR. As the water enters into the ESGR, the MCCs and 480 V buses and finally the 4 kV buses are expected to be lost. This leads to the loss of the RHR system combined with an electrical blackout of the units.

Identification and Interconnection of Flood Areas

Table 3-1 Summary of Coarse Screening Analysis

Location	Frequency of Flood	Sequence No.	Core Damage Frequency
Emergency Switchgear and Relay Room	3.00 E-05	3 4	Low High
Containment	6.18-06	4 7	Low Low
Auxiliary Building	1.88E-05	3 5	Low High
Safeguard Area	1.50E-05		High
Turbine Building	7.52E-05		High

4. INITIATING FREQUENCY ANALYSIS

4.1 Introduction

The initiating frequencies for the various buildings may be determined by using different approaches. The two most common approaches are 1) based on the statistical analysis of actual events occurring at similar installations or b) utilizing a fault tree method.

The first technique collects data from actual events and through statistical and engineering techniques tries to develop a data base specific for the plant. Through simple statistical arguments the frequency is then determined as the ratio of applicable events to some time base. The difficulty with this approach is that the physical arrangements and engineering design differences between the various installations may invalidate some of the actual events as not fully applicable to the specific plant.

The fault tree method relies on the simple assumption that potential failures of systems comprised of a number of components may be obtained by combining the various failure modes of the individual components. The underlying assumption is that the component failure rates are better known than that of the system failure rate and the proper combination of the component failure modes and mechanisms may give an indication on the total system failure rate.

The difficulty of this approach lies in the quality of the component failure data and the actual analytical model of the system describing the potential failure modes. In general, it is difficult to determine whether the component or system failure rate data is the more reliable and whether all failure modes are represented by the data. Similarly, the analytical model has to take into account the most important failure modes that can seriously affect the operation or functioning of the system.

In this study, similar to the internal event initiating frequency analysis, the first method was selected whenever possible. The operating events related to flood scenarios were collected, reviewed, and applied to the Surry-specific conditions. This was especially important with respect to the Turbine Building flood scenarios that are deemed to be the most dominant flood sequences.

The most important sources of data were LER reports, previous PRA analyses, the recent IPE flood analysis of the Surry plant, and numerous NUREG reports.

There are a large number of flood scenarios initiated by random pipe rupture resulting in a break opening with a certain leak rate. Actual operating experiences in this area are not very reliable and consequently an analytical approach was used (Thomas-model). However, it must be recognized that the bases of the analytical model are actual plant operating experiences and the analytical formula is simply fit to represent available information.

4.2 Turbine Building

The potential flood events emanating in the Turbine Building are related to the CW or SW piping. Both of these systems are constructed as large diameter low carbon steel piping and largely similar to other power plant installations. The actual physical arrangement at Surry is somewhat different in that gravity flow is used throughout the system which generally operates at a lower pressure as compared to pumped arrangements.

The main disadvantage of the gravity system is the potential for draining down the inlet canal for loss of circulating water pump function, and the potential for draining the intake canal volume into the building if a pipe or component break occurs. Figure 4-1 indicates the general cross section of the plant indicating the relative position of the Turbine Building, the intake canal, and the discharge section, and Figure 4-2 indicates the relative position of the CW inlet and outlet piping at the condenser. Figures 4-3a and 4-3b present the arrangement of the flood dikes inside the Turbine Building, the ESGR and the Mechanical Equipment Room No. #3, as well as at the entrance to the Cable Tunnel.

Initiating Frequency Analysis

Table 4-1 lists the events which were considered in the analysis. The data was collected from a number of sources such as the LER data base, the IPE analysis^[4-1], a time period covering essentially 1980 to present with the addition of significant events from earlier time periods. A number of events effectively represents spraying incidents (1st, 2nd, 4th) and is not considered in the data representing large flood events. The feedwater line break incident on 12/09/86 at Unit 2, Surry (Event # 2) was one of the minor events in the Turbine Building. For the other events the flow rate and the total accumulation are listed along with a short description of the underlying cause leading to the flood release.

In some cases, the values are engineering estimates, since the event descriptions were not detailed enough. An important attribute of each event is the recovery characteristics, which is also estimated and noted in the last column.

The compilation of the data did not include a number of flood events which were judged to be not applicable to the Surry plant. These generally involved different valve operator types (06/72, Quad Cities - hydraulic operator; 10/10/76, Oconee 3 - air operator), pump start transients (04/77, Three Mile Island 1), or foreign plants which are excluded from the U.S. data bases.

In general the data base is not as extensive as for specific component types which is expected, since large scale flood events are relatively rare. This type of system failure involves the combination or gross failure of one or several components and additionally, possible human errors. However, it is sufficiently robust and diverse that certain conclusions may be drawn even from this limited experience.

The data were further categorized to estimate the relative frequency of the different flood rates. Table 4-2 lists the respective flood rate intervals, the number of events (N), and their relative fractions (FR_i). The other columns deal with the recovery characteristics of the events which are discussed further below. Three events from Table 4-1 were treated somewhat differently from the others due to their component and plant-specific nature. These events are not fully applicable to the Surry plant, however, using engineering judgement one may be able to extrapolate to the Surry-specific data base from these occurrences.

Event # 6, LaSalle: In this case, the valve operator mounting bolts were not properly torqued. When these bolts became loose and failed due to fatigue, the valve disk was permitted to rotate freely shut resulting in a water hammer that ruptured the rubber expansion joint. At Surry, the valve operators and their mountings are properly sized and there is a high degree of assurance that the bolts are torqued. This allows us to utilize a correction factor of $CF = .1$. In addition, the valves are positioned fully open and the disks do not experience significant turbulence resulting in balanced forces. A correction factor may also be applied to take this effect into account, $CF = .2$. The combination of these correction factors $CF = .1 \times .2 = .02$ was applied to Event #6.

Event # 7, South Texas: The 96" discharge valve operator cap screws failed due to fatigue caused by a drive sleeve periodically hitting a mechanical stop and the combination of vibrations caused by turbulent flow. The valve disk became separated from the operator, allowing it to swing closed causing a water hammer. At Surry, the operator is of a different design (Limiter) with a lock pin preventing a stop. There is a reduced likelihood of separation which is accounted for by applying a reduction factor of $CF = .1$.

Event # 8, Palo Verde: One of the four cap screws backed out and the others sheared causing the butterfly valve to swing shut resulting in a water hammer event. This is similar to the previous event and the differences are also similar. The operator is different with six instead of four bolts and the stopping mechanism is also different, reducing the likelihood of fatigue failure resulting in an engineering reduction factor of $CF = .1$.

A pathway for gravity draining of the canal to the Turbine Building can occur in several ways:

- a. Failure of the expansion joints or other components in the circulating water lines and SW lines, or

b. Maintenance activities causing inadvertent opening of an open pathway to or inside the Turbine Building.

The primary damage mechanism due to a large scale flood in the Turbine Building is the flooding of the ESGR leading to the potential loss of all 4 kV, 480 V and 125 VDC electrical safety power supplies. The flood events listed in Table 4-1 indicate that the leak rate in a flood event or the total volume of water discharged encompasses a relatively wide spectrum. There were events with relatively large flow rate, but for a short duration of time, and there were events with small leak rates for short and long periods of recovery times.

This indicates that flood events and the expected flood frequency must be characterized by these attributes. In the Turbine Building two separate categories of flood frequency are derived:

Category 1 - Large flood - > 3600 gpm

These flood events result in the flooding of the Turbine Building up to and beyond the 11'-6" elevation. The 2' dikes to the Auxiliary Building Tunnel and the ESGR are overflowed resulting in equipment damage at those locations.

Category 2 - Medium flood - 3600 gpm

These events result in the flooding of the SW valve pit and damage to the SW valves supplying the recirculation spray heat exchangers.

The critical water volume corresponding to these categories may be estimated by taking into account the potential drainage pathways, sump pump capacities, and the volume of the building. The progress of flooding originated from CW/SW lines initially is assumed to collect and fill up the valve pits in the Unit 1 portion of the Turbine Building. In the next stage the water would collect on the building floor and spill over to the other units through the interconnecting doorways. Operable floor sump pumps would remove water at the rate of 1300 gpm per pumps. The increasing water height eventually would trip the sump pumps when it reached the sump pump power supply cabinet (estimated at $\approx 8''$). With further leakage, the water level would reach the height of the flood dikes and overflow into the ESGR and Auxiliary Building.

The unit volumes were estimated by utilizing information from plant drawings and are as follows:

Volume of Unit 1 & 2 buildings	2 x 460,000 gal
Volume of Unit 1 & 2 pits	2 x 200,000 gal
Volume of ESGR up to 18"	20,000 gal
Total Volume Unit 1+ESGR	680,000 gal
Unit 2	660,000 gal

The IPE estimated these volumes at 712,582 gal for Unit 1 and 696,832 gal for Unit 2, which is relatively close. This is the critical flood volume which will cause damage in the ESGR. The Auxiliary Building requires additional water volume due to the large open floor arrangement. The effect of drain and sump pump dewatering rate is not taken into account at this point. The critical volume simply indicates that given a flood event, what amount of water has to collect in the Turbine Building to overflow the flood dikes and damage equipment located in the ESGR.

An additional consideration for very large flood categories is the question of isolation capability. The Turbine Building is at a lower elevation (9'-6") than the intake canal ($\approx 29'$ -25') and a postulated break at or upstream of the inlet isolation valve body is not easily isolable. Stop logs may be inserted at the intake canal entrance,

Initiating Frequency Analysis

however, this cannot be quickly accomplished. In this scenario, the potential for recovery in the first few hours of the accident is relatively small. This contrasts with other events, where the inlet valve may remain intact and its closure may terminate any flood event in a relatively short period of time.

The essential difference is in the recovery model and usually this is taken into account by separating the large flood scenarios into two distinct groups, namely nonisolable and isolable, and assigning different recovery probabilities to the two groups. Normally, the nonrecoverable category would have $P(\text{failure to recover})=1$. This approach is consistent with static fault tree modeling and does not take into account the time dependent behavior of the events as represented by the statistical data.

In this study, the recovery behavior was derived from the operating experience by noting the nonrecovery fractions as a function of time. The nonrecovery fraction, NR, represents the fraction of the total events which did not recover for a certain time. This is similar to the approach taken in quantifying the loss of off-site power recovery behavior. Table 4-3 lists the values which were derived from the recovery data of the flood events listed in Table 4-1.

The initiating frequency for Category 1 events is determined by considering the fraction of flood events discharging at least the critical volume in the Turbine Building. In this formulation, the recovery potential for each category of events is incorporated in the initiating frequency. For example, small leak rate flood events have a longer time to recover, thus its nonrecovery probability is relatively small. However, large or nonisolable flood events will have nonrecovery probabilities close to unity (fail to recover).

The formulation may be expressed as:

$$f(\text{Category 1}) = \sum_i f(\text{flood}) * FR_i * NR_i = f(\text{flood}) * CP(\text{flood/damage})$$

where

$f(\text{Category 1})$ = Frequency of floods which discharge the critical volume into the Turbine Building irrespective of the discharge rate

$f(\text{flood})$ = Frequency of all flood events in the Turbine Building

FR_i = Relative fraction of all flood events in the i-th leak rate range

NR_i = Nonrecovery probability of the i-th leak rate range

$CP(\text{flood/damage})$ = Conditional probability of flood damage given a flood event

Table 4-2 lists the corresponding values for the above variables in each flood range. The critical times associated with each flood range are based on the total volumetric estimate and was set at $\approx 700,000$ gal for Unit 1 and an additional 680,000 gal for the Unit 2 areas, reflecting a compromise between the estimated values of this and the IPE study.

The critical time estimates comprise of a number of factors related to the building volumes. The estimate for the Turbine Building volume and the ESGR together with the flow rate in a given category was used to determine the approximate timing of the flood scenario. The Surry plant recently instituted an improved reliability program for the Turbine Building sump pumps. It is claimed that the reliability of these sump pumps is improved to such a degree that 7 of the 9 pumps would be operable in a flood event. Presently, this study has taken credit for 7 operating sump pumps of the 9. This increases the dewatering capacity, but only for a period of time, since the power supply for the sump pumps is located on the same elevation shorting out for increasing water level. The mitigating effects of the sump pump dewatering capabilities are not expected to be large since a) the sump pumps are decapacitated when the water level reaches the power supply cabinet

(8") and shorts out the pumps, and b) flood events with damage potential are dominated by rare, but large leak rates where the dewatering capacity is not sufficiently large to cope with the large scale leakage.

As it will be seen, the most dominant contribution to the conditional probability to flood damage given a flood event arises from the very large flow rate type of flood scenarios, 25,000 gpm or larger. In these cases, the dewatering capability is significant.

The nonrecovery probabilities for small leak rates are relatively small which reflect the statistical experience. In this event isolation capability is rarely lost and ample time is available to discover and isolate the events before the critical discharge volume is reached.

The very large flooding category is more problematic, since there are few data points in this range and these were adjusted to reflect Surry-specific features. The general recovery characteristics are not totally applicable for the events, especially in the last two flood rate categories, 25-50,000 and 50,000-200,000 gal. Here the recovery curve was adjusted upward to reflect the nonisolable potential for these events.

In the range of 25-50,000 gpm, the nonrecovery probability value was set at .9 and the available time before the critical volume is about 40-50 min. If the motor-operated valves are operable then the operator may attempt to close them from the control room. Local operation of the valve is possible, but may take about one hr and with the condition in the Turbine Building this action is rather unlikely.

In the last category, 50-200,000 gpm, the flow rate is so large that the critical time is about 15 min and these events are beyond any isolation capability in the short run. However, even these events may be isolated by installation of the stop logs, but not in time to prevent the overflowing of the 2' dikes at the entrance of the ESGR and Auxiliary Building Tunnel.

The total conditional probability of damage due to flood events is $CP(\text{flood/damage}) = 2.3E-02$, listed in Table 4-2. The flood frequency is obtained by noting that the total accumulated time of operating nuclear power plants (turbine buildings/CW systems) is 1463 yr (derived by noting the number of operating power plants), thus

$$f(\text{flood}) = \text{Flood Events/Plant years} = 7.22/1463 = 4.9 \times 10^{-3}/\text{yr}$$

and the Category 1 frequency due to CW floods are

$$f_{\text{CW}}(\text{Category 1}) = f(\text{flood}) * CP(\text{flood/damage})$$

$$f_{\text{CW}}(\text{Category 1}) = 1.2 \times 10^{-4}/\text{yr}$$

The other group of flood events with dominant contribution in the Turbine Building is due to events related to the SW system. SW is supplied to a number of heat exchangers through 42" and 48" diameter pipes which take off from the CW inlet pipes in the Turbine Building. The sections of the SW piping vulnerable to flood incidents are mostly located in the valve pits (inlet of CCW heat exchangers) which contain isolation valves and expansion joints.

The events serving as the data base for SW flood/leak incidents are listed in Table 4-3. The majority of cases are relatively benign small leak events without serious consequences to plant operation. The events may be classified according to the discharge rate as follows:

Initiating Frequency Analysis

Discharge Range gpm	SW Flood Events N	Relative Fractions FR
0-100	15	.75
100-1000	4	.20
>1000	1	.05
Total	20	1.

The yearly frequency of flood events may be determined as

$$f_{sw}(\text{small, 0-1000 gpm}) = N(\text{total}) * FR(0-1000)/1463 = 1.3 \times 10^{-02}/\text{yr}$$

$$f_{sw}(\text{large, >1000 gpm}) = N(\text{total}) * FR(>1000)/1463 = 6.8 \times 10^{-04}/\text{yr}$$

where the value 1463 represents the total operating time for the nuclear power plants.

The recovery characteristics of these events fall into two distinct groups. The relatively small flow rate events are discovered generally at a later period, but their isolation is easily accomplished. However, events with larger flow rates tend to be recognized sooner and their isolation seems to be accomplished at a much earlier time period. The corresponding time periods for average recovery times are 1-2 hr for smaller flow rates (0-1000 gpm) and ≈ 30 min for events larger than 1000 gpm.

The data represents essentially those events where isolation capability was not affected and the operator was able to act once the nature of the flood event was recognized. At Surry, there is a possibility of nonisolable failures of the SW system, such as the failure of expansion joints upstream of the main isolation valves. In such case no isolation capability exists besides the installation of the stop logs at the inlet of the intake canal. However, this may take a relatively long time period of 10-24 hr.

There were two events related to expansion joints failures, which is about 10 % of the total (2/20), which would result in a frequency of expansion joint failures for larger than 1000 gpm leak rate as $f = 6.8 \times 10^{-05}/\text{yr}$. However, failures which may be classified as nonisolable must involve a large scale rupture of the expansion joints.

The conditional probability that the expansion joint will experience a large rupture given a flood event with leak rate >1000 gpm is estimated at $P(\text{full rupture}) = .5$. This is based on previous work done for interfacing LOCA studies (NUREG/CR-5102) and considering the type of material and expected stresses. The nonrecovery factor for this type of event is relatively high and estimated based on the available time and critical volume ($\approx 700,000$ gallons) at $P(\text{nonrecovery}) = .7$

The estimated frequency of expansion joint failures which result in reaching the critical flood volume is

$$f_{sw}(\text{Category 1/exp. joint-SW}) = f_{sw}(\text{large, >1000 gpm}) * P(\text{exp joint}) * P(\text{rupture}) * P(\text{nonrecovery})$$

$$f_{sw}(\text{Category 1/exp joint-SW}) = 2.4 \times 10^{-05}/\text{yr}$$

There are other causes of failures which could lead to large scale flood events and these may be estimated from the data by extrapolating a flow exceedance plot based on the events listed in Table 4-3. The frequency of the events exceeding a certain flow rate may be plotted on a logarithmic scale and fitted with a curve. By extrapolating this curve to higher flow rates, an estimate may be obtained for larger flow rates. This method assumes a log-log relationship between flow rates and occurrence rate which is found to be fairly representative of this type of event.

The following table indicates the results from this process which are the frequency of flood events for the different exceedance flow group rates:

Exceedance Flow Rate gpm	Frequency /yr	Nonrecovery Probability NR
> 1000-10,000	2.0E-04	.001
10,000-20,000	9.0E-05	.05
20,000-40,000	5.0E-05	.4
> 40,000	2.0E-05	.75

The nonrecovery probability values indicated in the last column were derived from the same relationships as established for the CW events assuming that the critical flood volume is also the same as previously estimated.

The total frequency of SW-related flood events other than expansion joint failures is obtained as the sum of the individual flood group frequencies weighed with the nonrecovery factor:

$$f_{\text{SW}}(\text{Category 1/other-SW}) = \sum f(\text{SW/flood})_i * \text{NR}_i$$

$$f_{\text{SW}}(\text{Category 1/other-SW}) = 4.0\text{E-}05/\text{yr}$$

The total SW-related flood event frequency is the sum of the failure frequency for expansion joints and from all other causes:

$$f_{\text{SW}}(\text{Category 1}) = f_{\text{SW}}(\text{Category 1/exp joint-SW}) + f_{\text{SW}}(\text{Category 1/other-SW})$$

$$f_{\text{SW}}(\text{Category 1}) = 6.4\text{E-}05/\text{yr}.$$

The Turbine Building Category 1 flood event frequency is the sum of the CW and SW flood event frequencies:

$$f(\text{TB - Category 1}) = f_{\text{CW}}(\text{Category 1}) + f_{\text{SW}}(\text{Category 1})$$

$$f(\text{TB - Category 1}) = 1.9\text{E-}04/\text{yr}$$

which was used as the mean value of a prior distribution (assuming an error factor of 10) based on generic data.

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A Bayesian updating was performed using the above obtained prior distribution, and no events in 35.5 years as the plant-specific evidence. The posterior distribution has a mean frequency of $1.8\text{E-}04$ per year (error factor of 7.4). Assuming that this frequency applies to any plant condition (or POS), it converts to a frequency of

$$f(\text{TB - Category 1}) = 2.1\text{E-}08/\text{hr.}$$

The duration of the mid-loop POSs may be used to calculate the expected Category 1 failure probability in the respective operating states:

$$\text{POS 6 Refueling} \quad - \quad f(\text{TB - Category 1}) = 5.0\text{E-}06,$$

$$\text{POS 6 Drained Maintenance} \quad - \quad f(\text{TB - Category 1}) = 5.3\text{E-}06,$$

$$\text{POS 10 Refueling} \quad - \quad f(\text{TB - Category 1}) = 9.6\text{E-}06.$$

An other class of flood events is the one which affects only the SW isolation valves supplying the Recirculation Heat Exchangers. The amount of flood required is around 3600 gpm and its frequency may be estimated from the SW exceedance curve. The estimated frequency of flood events which appear with 3600 gpm is $f(\text{Category 2}) = 1.0\text{E-}05/\text{yr}$.

The nonrecovery rate for this type of flood event is estimated at $\text{NR} = .1$. Combining the estimated Category 2 flood frequency with the nonrecovery probability and performing a Bayesian updating, one finally obtains the flood frequency for Category 2 as

$$f(\text{TB - Category 2}) = 1.1\text{E-}10/\text{hr.}$$

The consequences of this type of flood event is the potential loss of the inside recirculation heat exchangers. From the perspective of loss of RHR accident, this is relatively insignificant, since those heat exchangers are required only for long-lasting accidents to delay containment failure.

4.3 Emergency Switchgear and Relay Room

Due to limited sources of water in this area, flood damage is expected to be due to propagation of flood from the adjacent Turbine Building. Category 1 flood events in the Turbine Building are such that the protecting 2' dikes are overflowed and water enters into the ESGR area.

The amount of flood was also estimated in the previous section at $\approx 700,000$ gallons. At this level the flood would enter the ESGR and reach a height of about 4". At that level the 480 V buses and MCCs would short out and most likely cause the tripping of the 4 kV safety buses. DC power would fail when the flood reaches 12". Given a flood in this area, it was conservatively assumed that every piece of equipment in the area and the cable vault and tunnels would fail. As a result, a two-unit station blackout would occur and the only means to mitigate the flood is gravity feed from the RWST.

4.4 Auxiliary Building

Due to the large size of the building as well as the separation of the charging pumps from the rest of the building by compartments, a large flood would be needed to cause simultaneous damage of all the charging and CCW pumps in the building. Based on a limited review of the plant experience, no significant flooding in the building was identified.

The data in Table 4-4 indicates a limited number of flood events which occurred in Auxiliary Buildings of nuclear power plants. The data seems to indicate that large scale flooding is not a common occurrence. However, a leak rate dependent exceedance curve may still be constructed from the data and the curve can be extrapolated linearly (log-frequency vs. log-leak rate/gpm) to estimate the expected frequency of floods with higher leak rate.

The results of this process are summarized in the following:

$$f(> 1000 \text{ gpm}) = 1.5 \times 10^{-04} / \text{yr}$$

$$f(> 3000 \text{ gpm}) = 8.0 \times 10^{-05} / \text{yr}$$

$$f(> 10,000 \text{ gpm}) = 4.0 \times 10^{-05} / \text{yr}$$

Three categories of flood levels were established to deal with the different time scale and potential recovery actions. The critical flood height is estimated based on the location of the critical equipment in the Auxiliary Building, such as the charging and CCW pumps. The critical volume is estimated at 135,000 gal and the corresponding flood height would be 18.5". At that level the CCW pump motors, which are installed on a concrete pedestal, would most likely be shorted out. For a large scale flood in the Auxiliary Building basement due to a supply line rupture to the RWST, the charging pump cubicles would be overflowed causing the subsequent failure of all charging pumps. The flood would enter the open area and could short out the CCW pump motors once the flood height reaches 18.5".

The data in Table 4-5 do not represent flood events due to pipe rupture which may be a significant contributor to the total flood frequency. The most vulnerable piping systems in the Auxiliary Building are predominantly low pressure pipes pressurized by static head from the RWST or by the fire protection system pumps. The pipe rupture frequency may be estimated by utilizing the semi-analytical Thomas model. In this respect, the present analysis relies on the results of the IPE study which used the same approach to estimate the frequency of large scale rupture of piping in the Auxiliary Building.

The data and the modeling approach in the IPE study were reviewed and confirmatory calculations were completed to check its validity and application. It was found to be a reasonable approach predicting realistic pipe rupture frequencies. The following values were used for the different pipe and valve sizes:

Size	Pipe Rupture Frequency/yr	Valve Rupture Frequency/yr
10"	7.5×10^{-05}	-
8"	1.3×10^{-04}	2.0×10^{-04}
6"	1.9×10^{-04}	1.9×10^{-05}
4"	7.0×10^{-04}	3.2×10^{-05}

The Thomas model predicts the frequency of pipe break, but this still has to be further distributed between different break sizes which result in different leak rates. The following relative values $P(x \text{ gpm}) = \text{conditional}$

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probability that a pipe break results in x gpm] were used, $P(1000 \text{ gpm})=.6$, $P(3000 \text{ gpm})=.3$ and $P(10,000 \text{ gpm})=.1$ and the final pipe break frequencies are as follows:

$$f(1000 \text{ gpm} - \text{pipe}) = 2.4 \times 10^{-4} / \text{yr}$$

$$f(3000 \text{ gpm} - \text{pipe}) = 3.0 \times 10^{-4} / \text{yr}$$

$$f(10,000 \text{ gpm} - \text{pipe}) = 7.5 \times 10^{-6} / \text{yr}$$

The nonrecovery factors or the effect of potential recovery actions by the operators may be taken into account at this level. The numerical values are based on the available time which is derived from the flood rate and the critical flood volume and also considers the potential drainage pathways,

Category	Time Probability	Nonrecovery
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f(1000)	1.5 hr	.1
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f(3000)	.75 hr	.2
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f(10,000)	13 min	.9
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The total flood frequency in the Auxiliary Building is obtained for each category by combining the flood frequency components (pipe break frequency and operating experience) and the nonrecovery probabilities to arrive the final estimates as:

Flow rate (gpm)	Frequency /hr	POS 6 Refueling	POS 6 Drained Maintenance	POS 10 Refueling
f(1,000)	4.45E-09	1.06E-06	1.14E-06	1.98E-06
f(3,000)	8.68E-09	2.07E-06	2.21E-06	3.85E-06
f(10,000)	4.91E-09	1.15E-06	1.24E-06	2.15E-06
Total		4.28E-06	4.59E-06	7.98E-06
Total w/ RWST		2.48E-06	2.65E-06	4.62E-06
Total w/o RWST		1.82E-06	1.95E-06	3.4E-06

The above rates can be further divided according to the additional criterion of RWST availability (listed as with or without RWST). The question of RWST availability is important from the accident progression point of view, since the low pressure injection system as well as the gravity feed method of heat removal is dependent on the water source available through the RWST.

4.5 Safeguard Area

The Safeguard Area has two separated compartments with a number of piping systems pressurized by the RWST static head. The main contribution to the frequency of flood with a potential for damage is expected to arise from scenarios involving large pipe ruptures.

The pipe break frequencies of the low pressure pipes are developed again using the Thomas-model approach utilizing some of the results of the IPE analysis. The information developed and used in the IPE study was again checked and confirmatory calculations were performed.

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Three different flood categories were established, f(1000 gpm), f(3000 gpm), and f(10,000 gpm). The Safeguard Area communicates with the Auxiliary Building through a pipe tunnel and this serves as the main propagation pathway.

The dominant failure scenario is a flood of sufficient size and duration to flood the Auxiliary Building through the pipe tunnel up to the 18.5" level. At that point the CCW and charging pumps are assumed to fail.

The pipe break frequencies for the different pipe sizes are the following:

Category	Pipe break Frequency	Nonrecovery Probability
f(1000 gpm)	$6.6 \times 10^{-04}/\text{yr}$	.001
f(3000 gpm)	$3.8 \times 10^{-04}/\text{yr}$	.1
f(10,000 gpm)	$5.5 \times 10^{-05}/\text{yr}$	.9

The nonrecovery probabilities were derived by considering the critical water volume, available time, and the isolation capability of the supply pipes existing at the RWST outlet.

The final flood frequencies for the different categories are obtained by combining the pipe break frequency with the nonrecovery probability to arrive at the frequency of flood with damage in the respective category:

Flow rate (gpm)	Frequency /hr	POS 6 Refueling	POS 6 Drained Maintenance	POS 10 Refueling
f(1,000)	7.53E-10	1.79E-07	1.92E-07	3.35E-07
f(3,000)	4.34E-09	1.03E-06	1.11E-06	1.93E-06
f(10,000)	5.59E-09	1.33E-06	1.43E-06	2.48E-06
Total		2.54E-06	2.73E-06	4.75E-06

4.6 Containment

As discussed previously, the failure of the SW lines to the recirculation spray heat exchangers is the most significant cause of flood in the containment. However, these lines are normally isolated by the SW isolation motor-operated valves (MOVs) located in the Turbine Building SW valve pits. It is estimated that the water volume contained in the SW piping is not sufficient to cause large-scale flooding in the containment which would affect the operation of the RHR pumps.

However, a potential break near the RHR pump motors may affect their operation, if the leak sprays on the electrical parts. Table 4-5 lists a number of spray events inside the containment and these were utilized to estimate the frequency of loss of RHR pumps due to this specific failure mechanism.

The following formulation was used:

$$f(\text{spray at RHR pumps}) = f(\text{spray in containment}) * P_{\text{pipe}} * P_{\text{location}}$$

where

$$f(\text{spray in containment}) = \text{frequency of spray events in containment}$$

P_{pipe} = fraction of pipe length around the RHR pump motors relative to the total pipe length in containment

P_{location} = conditional probability that the spray, once it occurred near the RHR, affects the RHR pump motor

The value of $f(\text{spray in containment})$ is estimated based on the data in Table 4-5, $f(\text{spray in containment}) = 2.0\text{E-}03/\text{yr}$. $P_{\text{pipe}} = .1$ is selected based on the review of piping drawings and P_{location} is estimated also at .1. The spray frequency is obtained as the combination of these factors:

$$f(\text{spray at RHR motor}) = 2.0\text{E-}05/\text{yr} = 2.3\text{E-}09/\text{hr}$$

or the failure probability in the operating states:

$$\text{POS 6 Refueling - } f(\text{spray at RHR motor}) = 5.43\text{E-}07$$

$$\text{POS 6 Drained Maintenance - } f(\text{spray at RHR motor}) = 5.82\text{E-}07$$

$$\text{POS 10 Refueling - } f(\text{spray at RHR motor}) = 1.01\text{E-}06$$

4.7 Mechanical Equipment Room No. #3

The Mechanical Equipment Room (MER) is a relatively small area where the primary mechanism for any flood event is expected to be due to pipe ruptures in the SW supply lines. The SW lines may be isolated outside the MER in the Turbine Building. There are a number of 6" and 4" pipe segments and supply headers

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which would dominate the flood risk. Operation Response Procedures exist (O-AP-13.00) which give instructions to the operator upon receiving HI level flood alarms.

The critical elements in the flood frequency analysis are the frequency of expected rupture or leak, the size of the rupture, and the available time before damage occurs. The damage time may be established by estimating the critical water volume required to flood the Unit 1 ESGR. The water volume inside the MER up to 2' height (flood dike) is about 10,000 gal which was derived by reviewing engineering drawings and documents. An additional 20,000 gal is required to flood the Unit 1 ESGR which was estimated at the Turbine Building flood scenarios. Thus, the total of about 30,000 gal is necessary to disrupt the operation of the RHR system and cause further damage by effectively disabling the station safety power supplies.

The pipe rupture probability analysis of the IPE study (Ref. 1) has been reviewed and utilized to derive the pipe rupture frequency data as indicated in Table 4-6. The SW lines may be isolated outside the MER and any flood would be alarmed in the control room. The nonrecovery factors are also listed in Table 4-6 and reflect the probability of operator error to correctly diagnose and act upon a flood event in the MER. The last column in Table 4-6 is the initiating frequency of flood events which result in damage to the electrical components in the ESGR. The total initiating frequency of $f(\text{flood in MER}) = 7.3\text{E-}07/\text{hr}$ may be converted to the appropriate values in the respective operating states to obtain

POS 6 Refueling -	$f(\text{flood in MER}) = 2.1\text{E-}08$
POS 6 Drained Maintenance -	$f(\text{flood in MER}) = 1.9\text{E-}08$
POS 10 Refueling -	$f(\text{flood in MER}) = 3.7\text{E-}08$

4.8 Flood Initiating Frequency - Summary

Table 4-7 summarizes the flood initiating frequencies for the different locations and categories. In general, these frequencies were calculated to represent a wide spectrum of flow rates and also include actual recovery processes which were established using operating experience. The resulting flood frequencies, in effect, represent expected flood occurrences which could cause damage to safety areas and equipment housed in those locations. Flood events in the Turbine Building are expected to have the most significant consequences due to the potential for overflowing the ESGR causing plant blackout and the loss of all safety-related electrical supplies. This category of flood events seems to be the most likely one as compared to the other potential flood locations due primarily to the isolation difficulty of these type of events.

4.9 References

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Internal Flooding Analysis for the Individual Plant Examination, Supplemental Report, Surry Units 1 and 2, Virginia Electric and Power Company, November 1991.
2. "NUREG-1150, External Event Risk Analyses, Surry Power Station," NUREG/CR-4550, Revision 1/Volume 3.
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4. Nuclear Power Experience, NPE, published by the S.M. Stoller Corp.
- 4-5 "Oconee PRA, A Probabilistic Risk Assessment of Oconee Unit 3," NSAC-60, June 1984.
- 4-6 DOE/RECON, Nuclear Safety Information Center, 1963 to present.
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Drawings No. CS5238

Figure 4.1 Surry Nuclear Power Plant Cross Sectional View

[illegible]

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Table 4-1 Turbine Building Flood Events Circulating Water System

#	Date	Plant	Leaking Component	Description	Flow Rate gpm	Total Disch. gals.	Isol. Time
1	10/27/87	Surry 1	Reheater leaks	Leak drains to flood control panel, main CW valves close	small	small	
2	12/09/86	Surry 2	Pipe	18' suction of MFWP ruptured engulfing equipment		large	
3	11/22/89	Surry 2		Flood protection dike for SW MOV has been removed, maintenance problem		none	
4	03/09/85	Trojan	Pipe	Pipe rupture releasing steam/water, actuating fire deluge system, damage to secondary equipment			
5	08/08/86	Catawba 1	Condenser	Condenser outlet valve leaked, manual operator failed, valve opened fully, water overflowed through open manway door. Condenser cooling pumps secured to control flooding		severe	~ 15 min
6	05/31/85	LaSalle	Rubber expansion joint	Water hammer due to sudden closure of a butterfly valve. Valve operator mounting bolts not properly torqued	2,000	600,000	5 hrs
7	03/17/87	South Texas 1	Pump casing discharge elbow	Sudden closure of discharge valve, water hammer, pump casing failed		severe (300,000)	small
8	06/28/87	Palo Verde 1	Piping/water box	Sudden closure of butterfly valve, water hammer. Failure of bolts		severe (500,000)	15 min

Table 4-1 Turbine Building Flood Events Circulating Water System (continued)

#	Date	Plant	Leaking Component	Description	Flow Rate gpm	Total Disch. gals.	Isol. Time
9	04/07/88	Fort St. Vrain	Expansion joint	Long tear in expansion joint due to aging	15,000	300,000	20 min
10	01/14/84	Peach Bottom 3	Valve	Improper valve line up during maintenance	3,000	200,000	1.1 hr
11	09/17/86	Brunswick 1	Sight glass	Rupture of sight glass, flooding pit		severe (150,000)	.5 hr
12	12/23/87	Susquehanna 1	Gasket	Leaking gasket on condenser manway		severe (60,000)	12 min
13	06/74	Duane Arnold	Valve	Backwash valve failure during backwash process		12,000	~ 12 min
14	10/78	Surry 2	Valve	Valve malfunction during maintenance		small	

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Table 4-2 Fractional Distribution of CW Events and Recovery Characteristics

Flow Range gpm	Flood Events N	Relative Fraction FR _i	Critical* Time t _r	Nonrecovery Probability NR _i	NR _i x FR _i
0-2000	1.02 [#]	.14	> 24 hr	negligible	negligible
2-5000	3	.42	10 hr	negligible	negligible
5-10,000	2	.28	3 hr	.001	2.8E-04
10-25,000	1	.14	105 min	.03	4.2E-03
25-50,000	.1 [#]	.01	40 min	.9	9.0E-03
50-200,000	.1 [#]	.01	15 min	1.	1.0E-02
TOTAL	7.22				2.3E-02

* - Critical Flood Volume ≈ 700,000 (Unit 1+ESGR) + 680,000 (Unit 2) gal

- The Number of Events were Modified by Appropriate Correction Factors, CF, Ranging .1-.2, (See Text)

Table 4-3 Service Water System Flood Events

#	Date	Plant	Leaking Component	Description	Flow Rate (gpm)	Total Disch. (gals.)
1	06/75	Surry 2	Pump seal	Pump developed seal leak	small	small
2	04/19/89	River Bend	Freeze seal	Loss of cooling to freeze seal during maintenance	1250	15000
3	05/08/90	Clinton 1	Expansion joint	Expansion joint develops a leak, pipe supports damaged		small
4	06/16/86	Surry	Expansion joint	Corrosion of metal weld		small
5	07/28/88	Susquehanna 2	Pipe cap	1/2" drain cap ejected		small
6	06/17/85	Quad Cities 1	Vent line	Vent line breaks, pump room partially filled		small
7	02/91	Palisades	Pipe	Pinhole leak through pipe		small
8		Pilgrim	Pipe	Corrosion, pinhole leaks		small
9	09/08/87	Susquehanna 1	Pipe	Flexible pipes had pinhole leaks, spraying water		small
10	05/26/82	Salem 2	Seam weld	Failed motor cooler seam weld	100	5,000
11	06/23/81	Salem 2	Pipe cap	1/2" pipe cap broken off	25	12,000
12	10/17/80	Indian Point 2	Cooling coil	Containment Fan coolers leak, sump pump continuously running	small	100,000
13	02/27/90	ANO 1	Cooling coil	Cooling coils leaks		small
14	11/19/87	Robinson 2	Cooling coil	Cooling coil leaks		small

Table 4-3 Service Water System Flood Events (continued)

#	Date	Plant	Leaking Component	Description	Flow Rate (gpm)	Total Disch. (gals.)
15	12/06/87	Salem 1	Cooling coil	Cooling coil leaks		small
16	05/14/87	Salem 1	Cooling coil	Cooling coil leaks		small

Table 4-4 Auxiliary Building Flood Events

#	DATE	PLANT	LEAKING COMPONENT	DESCRIPTION	FLOW RATE gpm	TOTAL DISCH gals.
1	10/28/85	Waterford 3	Pipe flange	Steam leak near MFWP actuated the deluge system, spraying on control cabinet causing pump trip	small	small
2	01/23/88	Palo Verde 1		Fire suppression water discharge into protected area		
3	02/20/90	Turkey Point 3	pump seal	Pump failure in SF pool area created 18 gpm leak. Drain system partially clogged, water collects in HX room	18	3"small in room
4	09/05/89	McGuire 1	heat exchanger	Heat exchanger leaks into building		10,000
5	03/14/89	Sheron Harris 1		Fire suppression system sprays on MFWP causing internal shorts		small
6	01/29/87	Braidwood 1		Floor drain clogged, water backs up into upper cable spreading room. Water leaks through seals into control room.		small
7	13/08/84	Indian Point 2	valve	SW valve partially removed, developing a leak filling the pump room. Floor drain has insufficient capacity. Two CCW pump failed, SW pumps tripped to stop flooding.		large
8	04/19/89	River Bend	freeze plug	Failure of freeze plug	1250	15,000
9	04/78	Browns Ferry 3		Weld fatigue causing joint failure. Condensate spill onto core spray pump room floor.		80,000

Table 4-4 Auxiliary Building Flood Events

#	DATE	PLANT	LEAKING COMPONENT	DESCRIPTION	FLOW RATE gpm	TOTAL DISCH gals.
10	07/77	Brunswick 1	Flange rupture	Flange gasket rupture in the SW system. Pump and valve damage		large
11	11/77	Brunswick 1	Drain	Water accumulates due to backflow through drain system, oil pump shorts out		small
12	11/77	Dresden 2		River water spilled from HX outlet valve during test		3.5' in room
13	05/77	Trojan Arnold		SF pool demineralizer head gasket fails, large spill		large
14	10/74	Oconee		Operator failed to isolate LPCI header, water accumulates in pump room		3' in room

Table 4-5 Containment Building Spray Events

Date	Plant	Description	Total Release
03/24/87	Calvert Cliffs 2	Coolant was spraying from two pinholes	small
07/19/86	LaCross	Water splashed off pipe, solenoid malfunction	small
04/10/90	Cook 1	Steam and water from SG blowdown permeated a fire detection control panel	small
09/03/89	Catawba 2	Radiation monitor being sprayed	small

Table 4-6 Flood Initiating Frequency Mechanical Equipment Room #3

Flood Category gpm	Pipe Rupture Frequency (/yr)	Critical Time (min)	Nonrecovery Factor	Flood Initiating Frequency w/ Recovery (/yr)
2600	2.2E-5	16	.01	2.2E-07
- 1300	7.5E-05	30	.006	4.5E-07
- 650	1.1E-04	60	.0005	5.5E-08
- 325	2.4E-4	126	Negl.	Negl.
< 150	2.9E-3	> 200	Negl.	Negl.
Total				7.3E-07

Table 4-7 Flood Initiating Frequency Summary

Location	Flood Frequency per yr
Turbine Building	
Category 1	1.8E-04
Category 2	1.0E-05
Auxiliary Building	
w/ RWST	9.1E-05
w/o RWST	6.7E-05
Safeguard Area	9.3E-05
Containment RHR motor spray	2.0E-05
Mechanical Equipment Room No. #3	7.3E-07

5. Scenario Development

5.1 Introduction

Accident scenarios due to flood events were developed by considering the internal event accident scenarios and their corresponding event trees. The flood events were examined with respect to the operating state and configuration and the actual effect on the decay heat removal function as represented by the RHR system. The flood events and the corresponding scenarios were mapped to those event trees which represented similar accident progression characteristics. Modifications were made to remove or add additional events as required. The system fault trees were also modified to take into account the effect of the actual flood event on the equipment located in the area.

The equipment flood fragility values were selected based on simple criteria. Electrical equipment is assumed to fail if the flood height reaches the location of any electrical component. Pumps, valves, or any other mechanical device without electrical connection or supply is assumed to operate even in flooded conditions. This primarily involves manually operated valves or inline check valves. Centrifugal pumps are normally mounted with their electrical motors on the same pedestal and assumed to fail. However, vertically mounted pumps with extended shafts may have their motors located at higher elevation and are not as susceptible to flooding which occurs at lower elevations.

The flood scenario development also included some time estimates regarding operator actions and estimation of potential recovery options available to the operator. This enabled the proper determination of the corresponding human error rates. The flood scenarios at the different locations were not subdivided to smaller locations inside the specific buildings due to the open floor arrangements in both the Turbine and Auxiliary Buildings. The Safeguard Area was also handled as one unit, since only the overflow into the Auxiliary Building represents potential risk significant contribution. Based on these considerations, the following flood scenarios were developed for detailed analysis:

1. Turbine Building Flood - Large Category 1 flood and the dikes at the ESGR and Auxiliary Pipe Tunnel are overflowed.
2. Auxiliary Building Flood - Flood in the Auxiliary Building collects in the basement and leads to equipment loss.
3. Safeguard Area Flood - Large flood in the Safeguard Area overflows into the Auxiliary Building leading to equipment loss.
4. Spray in Containment - One train of the RHR is lost due to direct spray on the RHR motors.
5. Mechanical Equipment Room No. #3 - Flood in the MER, overflowing into the unit ESGR leading to a two-unit station blackout.

5.2 Event Tree Approach and Assumptions, Time Window Approach

The event trees developed for the internal event analysis were reviewed for their applicability to the flood events. The Surry plant developed and modified certain procedures to account for the possibility of flood events. These were also reviewed and incorporated into the system logic. The conditions at shutdown were also reviewed for their applicability and were found that the flood events as determined in this study are not

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specifically shutdown-related. However, the event trees in the internal event study were specifically developed for the shutdown conditions. The expected responses to adverse conditions due to flood events were discussed with plant personnel during the site visit and possible operator actions were analyzed in detail. The flood event tree structures are essentially the same as for the internal events to maintain consistency and compatibility.

In this PRA study, a mission time of 24 hr is used. That is, it is assumed that if the operators are able to prevent core damage from taking place during the first 24 hr subsequent to an initiating event, then core damage can be avoided due to the additional help that would become available. Thermal hydraulic calculations are used to determine the success criteria of the various systems or mitigation functions based on the 24-hr mission time. In addition, the calculations determine the timing of the accident scenarios and the time available for the operators to perform the needed actions.

Table 5-1 summarizes the success criteria as a functions of the decay heat. Table 5-2 summarizes the success criteria for the time windows and the timing of the important events that determine the time available for operator actions. Table 5-2 differs from Table 5-1 in the success criteria for feed and bleed. Table 5-1 shows the success criteria based on Virginia Power technical report 865 which is intended to maintain subcooling in the RCS to allow restoration of RHR, and is conservative regarding preventing core damage. Table 5-1 is more realistic and is used in the PRA analysis.

Gravity feed from RWST Gravity feed from RWST is established by opening the low head injection flow path from RWST to the RCS cold legs or hot legs. The RCS must be vented by removing the safety valves (SVs) on the pressurizer such that the gravity flow can be established. Depending on the decay heat level and the number of SVs removed, gravity feed may or may not provide 24 hr of cooling subsequent to the initiating event. The analysis documented in Section 5.1 of Reference 1 found that with 1 SV removed approximately 32 days after shutdown (5 MW decay heat), core damage takes place after 24 hr. Therefore, 32 days was chosen to be a boundary of the time windows. In the PRA model, for an accident initiating event that takes place after 32 days after shutdown, gravity feed from RWST is sufficient to terminate the accident. For accidents that start before 32 days after shutdown, gravity feed from RWST would provide some additional time for operators to restore failed mitigation systems. The additional amount of time for each of the time windows is listed in Table 5-2. These times are the estimated delays in core damage based on modeling of gravity feed with the MELCOR computer code, and the amount of time that subcooling is maintained as estimated in Attachment 9 of AP 27.00. Operator recovery using these times is modeled as recovery actions in the event tree analysis. The time available for the operators to establish gravity feed is assumed to be the same as time to core uncover.

Feed and Spill Section 5.2 of Reference 1 documents the determination of success criteria of the feed-and-spill operation. There, both the Virginia Power Technical Report 865 and BNL analysis are discussed. Table 5-2 summarizes the success criteria. It is based on the Virginia Power Technical Report 865 which is the basis of AP 27.00. In AP 27.00, LHSI to hot legs is the preferred method for feed and spill. If hot leg injection is not available, then cold leg injection is used. If low pressure injection system (LHSI) is not available, then the high pressure injection system (HHSI) is used. Similar to LHSI, HHSI prefers hot leg injection to cold leg injection. The necessary number of PORVs is specified as a function of the time after shutdown. The operators are expected to throttle the injection flow to maintain 200 F⁰ at the core exit thermal couple. It should be mentioned that the success criteria in the Virginia Power technical report is intended to maintain subcooling in the RCS. In reality, more relaxed success criteria is sufficient for preventing core damage. For example, the Virginia Power technical report requires that two charging pumps and two PORVs would be

needed for feed and spill during the first 129 hours. If only one charging pump and 1 PORV are available, feed and bleed should be sufficient to keep the core covered as long as water is available in the RWST. The success criteria of Table 5-2 is used in this study.

In order to account for the low shutoff head of the LHSI pumps, the time at which RCS pressure reaches 165 psia was determined and used as the time available for an operator to use LHSI. For HHSI, it is assumed that the time to core damage is the time available. In the high level fault trees, two separate human error events are used.

Recirculation Table 5-2 lists the time to RWST depletion for each of the time windows. As the level in the RWST becomes low, the operators are instructed to establish either RWST cross connect or high head recirculation. Section 5.2 of Reference 1 estimated that approximately 10 days after shutdown, recirculation is not needed. The calculation shows that with successful feed and spill, core damage will not occur within 24 hr after the loss of an RHR initiating event. Therefore, high pressure recirculation is needed only during the first 10 days after shutdown. This 10 days is used to define the boundary of Time Windows 2 and 3. In Window 1, two RWSTs are not enough to support 24 hr of feed-and-spill operation. Therefore, recirculation is needed. In Window 2, a cross connect of RWST provides 24 hr of feed-and-spill operation. In the fault trees for recirculation in Window 2, cross connection of RWSTs is taken into account.

AP27.00 provides instructions on how high pressure recirculation can be established, and states the possible need for the spray recirculation heat exchangers. High pressure recirculation is done by using the low pressure injection pump to take suction from the containment sump, and discharge to the suction of the high pressure injection system. In the fault tree analysis, two alternative methods of recirculation are also modeled. They are low pressure feed and steam taking suction from the containment sump, and low pressure feed and spill taking suction from the sump. In these modes of operation, only low head injection is needed. The feed and steam mode requires that the safety valves be removed to provide sufficient vent path, and does not require cooling of the sump water. The feed-and-spill operation requires operation of the spray recirculation systems to cool the water in the sump, such that subcooling in the reactor vessel can be established.

Spray Recirculation In Section 5.2 of Reference 1, it is estimated that during the first 10 days after shutdown, the RWST inventory is not sufficient for feed and spill and recirculation is needed. Recirculation would introduce steam into the containment, and the potential of containment failure exists. In the Level 1 PRA, it is assumed that if spray recirculation is not available, then containment would fail. The impact of containment failure on recirculation is that a small probability, 0.02, exists that the low head pumps would lose their needed net positive suction head. This failure cause is similar to the failure mode considered in NUREG-1150: Failure of recirculation is modeled as a potential failure mode of the low head injection pumps.

Another function of the spray recirculation systems is to support the low pressure recirculation operation by taking suction from the containment sump. It cools the containment sump water to make it possible to maintain subcooling in the reactor vessel.

Reflux Cooling The success criteria for reflux cooling was based on the Virginia Power Technical Report 865. It is also specified in AP 27.00. There, the number of steam generators (SGs) needed is specified as a function of decay heat. It is known that the success criteria is conservative. Because it is specified in the procedure, it is assumed that the operators would follow the procedure. As part of the procedure for establishing reflux cooling, the operators are supposed to close the vessel head vent and PORVs to ensure that

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there is no inventory loss through these openings. In Section 5.3 of Reference 1, it was estimated that the leakage through the tygon tube connected to the vessel head is insignificant. If the Pressure Relief Tank (PRT) rupture disks are ruptured, the leakage through an open PORV is large enough to lead to core damage in a few hours. If reflux cooling is established before the PRT is ruptured, the PRT becomes a part of the RCS boundary, and no significant inventory loss is expected. Therefore, if the operators can establish reflux cooling by venting the secondary side of the SGs before PRT rupture disks rupture, then there is no need to close the PORVs. If reflux cooling is established after the PRT ruptures, then it is necessary to close the PORVs to prevent inventory loss. It is assumed that reflux cooling is sufficient to remove decay heat if it is established before core uncover occurs. Given that reflux cooling is established, the SG inventory is sufficient for approximately 10 hours. (See Table 5-2.) Feeding the SG after the inventory becomes low is modeled as a long-term operator actions.

Event Tree Nomenclature

- (1) The name of an event tree consists of four parts: the flood scenario, the initiating event, window number and POS. For example, "F1R3WIR6" represents the event tree for nonrecoverable loss of RHR (R3) in Window 1 (W1) in POS 6 of a refueling outage (R6) in Flood Scenario F1.

Flood Scenario

F1-Turbine Building Flood Scenario 1
F2-Turbine Building Flood Scenario 2
F3-Auxiliary Building Flood Scenario 3
F4-Auxiliary Building Flood Scenario 4
F5-Safeguard Area Flood Scenario 5
F6-Containment Flood Scenario 6
F7-Mechanical Equipment Room 3, Flood Scenario 7

Initiating Event

R3-Nonrecoverable loss of RHR
R4-nonrecoverable loss of operating train of RHR
B2-2 Unit blackout

POS and Outage Type

R6-POS 6 of a refueling outage
R10-POS 10 of a refueling outage
D6-POS 6 of a drained maintenance outage

Window Number

W1-Window 1
W2-Window 2
W3-Window 3
W4-Window 4

- (2) The names of event tree top events are chosen by adding a prefix to the event tree name (without the POS and flood scenario POS designator) to represent the generic type of the top event. For example, "SR3W1" has a prefix of "S" to indicate the reflux cooling method. The high level fault trees were built in such a way that they depend on the initiating event and time window, but independent of the POSs. Therefore, the POS designators are not needed in naming the top events. The following is a list of the prefixes for the generic top events.

I-Initiating Event Frequency Calculation
H-Recovery of Support System Failures
M-RCS Makeup
R-Restore RHR
V-RCS Vented
F-RCS Feed and Bleed
S-Steam Generator Feed and Bleed
G-Gravity Feed from RWST
N-Recovery of Off-Site Power
C-High Pressure Recirculation
P-Spray Recirculation-both ISR and OSR

- (3) The names of human error events modeled in the system fault trees follow the convention of NUREG/CR-4550. The name of high level human error events consists of the following fields separated by hyphens:
- (a) The first letter in the name is either "D" representing failure to Dispose, or a letter representing failure to take action in a top event, "F", "G", etc.
 - (b) Name of event tree
 - (c) A one-letter prefix representing the specific failure of the generic top event type

For example, SF5W1S2 represents a sequence in the event tree "F5W1," where the operator fails to establish reflux cooling in Window 1. In this example, "S2" represents bleeding the SGs prior to rupture of the PRT rupture disk. DF5W1 represents failure to diagnose a event F5 (flood in the Safeguard Area overflowing into the Auxiliary Building) in Window 1, such that core damage results. The human error probabilities (HEPs) are dependent on the specific flood scenario, which is incorporated into the numerical model through "change sets." In this case, the numerical values of the HEPs are always set for each separate flood scenario before each run without changing the designators.

Basic event failures representing the flood-related failure of certain components were also introduced in the system fault trees. The names were derived from the basic event names already established by adding an FL designator upfront and removing the failure-specific designator from the basic event. For example, the basic event representing the failure of charging pump 1B to start is HPI-MDP-FS-CH1B. The flood basic event disabling this pump for a flood becomes FL-HPI-MDP-CH1B. All other conventions used in the internal event analysis were adhered to. The human error designator was not specifically changed for the flood, however, its value was appropriately adjusted to reflect the flood-specific situation, timing, and prospective recovery options. The success criterion used in the internal event study was also utilized for the flood analysis with special emphasis on the unavailability of certain systems in flood events which limit the options available to the operator for alternate heat removal.

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Following the IPE analysis, the plant has initiated and completed a number of modifications in order to reduce the risk impact of expected flood events. The present analysis has also incorporated some of these modifications as follows:

- Procedural modifications to identify the location of specific CW/SW flood sources and perform necessary mitigating actions such as closing isolation valves, opening/closing doors, etc.
- Inspection program was designed and placed to determine the status of the CW/SW expansion joints and simultaneously a replacement program for the expansion joints material was also established.
- Program for periodic verification of proper-strength bolts on CW isolation valve operators, positive locking devices, periodic visual inspection of operator-to-body bolted connections.
- Inspection program for the Limitorque operator.
- Installation of anti-reverse backflow devices in drain lines from the ESGR, MER, Electrical Tunnels to the Turbine Building, from the charging pump cubicles to the Auxiliary Building sump.
- Two pipe penetrations between the charging pump cubicles and the rest of the Auxiliary Building were sealed.

In addition, the plant has proposed other design modifications and changes which are presently going through various design evaluations. Some of these were selected for further sensitivity studies and documented in Section 6.

5.3 Human Interface Analysis

The approach used for the evaluation of operator actions in response to the flood initiating events is the same as that used for the internal event analysis^[5-1]. The dynamic operator actions analyzed in this study are listed in Table 5-1 (i.e., fault tree high level human action events). All of the human actions with unique numerical values are quantified, according to the descriptions in Table 5-1. A number of human error actions defined in Table 5-1 have similar numerical values and they are used with the appropriate values derived for the similar human error event in the event sequence quantification.

Human errors and human solutions are a vital part of nuclear power plant operation and accident response. In fact, the causes for nearly all plant problems can ultimately be traced to some form of human fallibility, and nearly all plant problems can be solved by humans if they are provided with the appropriate information, guidance, and tools. Within the context of this study, however, the evaluation of human errors encompasses only those actions accomplished within the plant that directly

- impact the availability of support or safety systems at the time of the initiating event
- mitigate against core damage during the sequence of events following the initiating event

With this in mind, the following types of human actions are evaluated:

- **Routine Actions before an Initiating Event.** Routine actions considered in the PRA involve restoring a component or flow path to normal after completing the testing, inspection, or maintenance and ensuring that the sensing equipment is correctly aligned and calibrated for automatic response to emergency actuation conditions. Errors that are important to plant risk leave safety-related equipment disabled or in an undetected, misaligned state, causing it to be unavailable to accomplish its function on demand during an event sequence.

- **Actions that Can Cause Initiating Events.** Actions that can initiate plant transients are implicitly accounted for in the quantification of initiating event frequencies to the extent that these human actions are the cause of such events. Generic plant data are used to assign total initiating event frequencies of which human errors are only one cause. Therefore, these types of human actions are accounted for in the initiating event analysis and are not discussed here further.
- **Dynamic Operator Actions Accomplished during the Plant Response to an Initiator.** Guided by the plant abnormal and emergency response procedures, the operators make active decisions and take appropriate actions in response to a complex series of stimuli during the sequence of events following an initiator. They are scenario specific and include well-defined tasks for manual initiation, control, and alignment of plant emergency equipment or selected backup systems. Usually, the operators must complete a particular activity within a specified period of time to avoid an unfavorable change in the state of the plant. These actions are an integral part of the plant response to the initiating event.
- **Recovery Actions.** Recovery actions generally involve recovery from failures that completely or partially disable the standard system response during a plant transient. They generally involve alignment of alternate systems or repair and restoration of the failed system. They may be well defined in procedures or based on general guidance and the training and knowledge of the operators and plant staff. For the purposes of this study, recovery actions are those identified through the first quantification, after the dominant scenarios have been identified.

5.3.1 Incorporation of Human Actions into the Plant Model

The approach to human interaction modeling provides a systematic and consistent framework for identifying, evaluating, and documenting human responses at all levels of the study. The approach emphasizes a detailed interview with plant operators and a thorough review of their procedures.

Quantified (HEP) can be incorporated into the plant model in a number of ways, depending on the influence of the action on other events in the sequence and, in particular, how they impact the quantification of other events. The potential dependencies of HEPs on other elements of the plant model can strongly affect how the action and subsequent events are quantified. There are three general types, as follows:

- **Plant-human dependency** accounts for the impact of the plant instrumentation and other performance indications on the ability of the operators to accomplish the action. They are scenario dependent and influence the degree of difficulty that the operators face when responding to the scenario.
- **Human-plant dependency** accounts for those actions that can cause more than one system to fail. The event trees that are used to express the plant response to an initiating event can serve as a vehicle to represent these dependencies.
- **Human-human dependency** involves the increased potential for making a series of errors once the first error is made.

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Depending on the type of dependency involved, any one of the following approaches can be used to incorporate human actions into the overall risk model:

- An action may be included within the system fault trees if the human error affects subsequent events in the sequence in the same way as hardware causes of system failure. Errors that occur before the initiating event, and some dynamic operator actions, fall into this category.
- If failure of an operator action that fails a system has a different effect on the subsequent response of the plant than a hardware failure, a separate top event may be used to represent the human action. Dynamic operator actions may, but not always, fall into this category.
- Recovery actions are often appended to accident sequence cutsets as separate basic events. In this way, they can be made very cutset-specific and not alter the remainder of the model.

5.3.2 Routine Actions before an Initiating Event

Routine human actions considered in the PRA are system-specific activities performed by one or more operations staff members as part of their normal workday duties to align a safety function properly before leaving it in its ready condition. These include:

- realignment of a component or flow path to normal after completing the testing, inspection, or maintenance
- removal of jumpers or other temporary system alterations to restore it back to service
- calibration and alignment of sensing equipment to ensure proper automatic response to emergency actuation conditions

Errors that are important to plant risk cause the system to be unavailable to accomplish its function properly following an initiating event. Failure modes that could produce this condition involve, primarily, leaving safety-related equipment disabled or in an undetected misaligned state, causing it to fail to operate upon demand.

The system analyst is responsible for evaluating routine actions that cause equipment unavailability. This approach is used because the system analyst is most familiar with the equipment, its location, control room alarms and indications, and details of all procedures and other guidance impacting the maintenance and surveillance testing of the system.

Normally, only surveillance procedures are evaluated to identify specific causes of equipment unavailability. Maintenance procedures are evaluated only if the operability of the system is not verified by a surveillance procedure at the conclusion of the maintenance or repair activity.

5.3.3 Methodology for Evaluation of Dynamic Operator Actions and Recovery Actions

Dynamic operator actions and recovery actions that take place following an initiator are identified and qualitatively described during the construction of the plant model event trees and quantification of the accident sequence, respectively. The licensed plant operators were consulted for evaluation and feedback on the

process for restoring RHR cooling and establishing alternate decay heat removal. The qualitative descriptions for the operator actions are expanded to account for all factors significant to quantification. The methodology laid out in this section is an abbreviated approach to adapt to project schedule and scope. Rather than evaluation by teams of operators, quantification is based on the judgment of the analysts. Because of similarity in assigned weights, only one calibration group was used.

The following describes the qualitative process by which the actions are identified and the procedure used for evaluations within the context of the success failure likelihood (SLIM-MAUDE) index methodology.

5.3.3.1 Qualitative Evaluation

The purposes of the qualitative evaluation are to,

- Identify dynamic operator actions to include in the event tree sequence evaluation
- Identify recovery actions to realistically model the accident sequence
- Ensure that the impact of the success or failure of those actions is properly modeled
- Develop descriptions of those actions in a form that will facilitate evaluation

During event tree construction and accident sequence evaluation, a variety of operator tasks are considered for inclusion in the model. These include

- Manual actions required in abnormal and emergency procedures to prevent core damage following an initiating event
- Control of preferred cooling systems
- Backup of automatically controlled systems
- Immediate response to failures of active systems

Once individual actions are identified for evaluation, the action boundary conditions, success criteria, and event scenario timing are identified and recorded on the Operator Response Forms. The purpose of this form is to provide a consistent format to convey the context of the action to the evaluation team who will analyze its degree of difficulty, and to provide a short summary of what is required to accomplish it. The available thermodynamic calculations supporting the timing considerations and arguments supporting engineering judgments regarding timing are contained in Chapter 5 of Reference 1.

The first two sections of the form set up the situation facing the operators. They describe where in the event tree model this action will take place and what indications the operators are expected to respond to in the control room. The next three sections describe what is involved in accomplishing the action, the relevant training and experiences, and those factors that compete for the operators' attention or divert them from the task. Two sections are then provided to describe what happens in the event sequence model if the action succeeds or fails. Finally, the time frame over which the action can be expected to be accomplished is addressed.

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Plant-human dependencies are described explicitly on the Operator Response Form, both in the section that relates the action to the plant model and in the discussion of required actions and competing factors. This permits the assessment team to understand the context of the action during the quantification of the action so that the dependencies can be reflected properly in the final error frequency.

The Operator Response Form presents human-human dependencies by asking the assessment team to identify with the situation at hand and to consider how an operating team may have made previous errors from which they must recover. They are then asked to identify ways to recognize and recover from previous errors when quantifying the dependent action.

5.3.3.2 Quantitative Evaluation

This study uses an adaptation of the success likelihood index methodology (SLIM) to elicit judgment and to convert the operator evaluations into quantitative error frequencies. SLIM is based on the following assumptions:

- The likelihood of operator error in a particular situation depends on the combined effects of a relatively small set of performance-shaping factors (PSF) that influence the operator's ability to accomplish the action successfully.
- Evaluators can address each of these PSFs independently so that the overall evaluation can be expressed as the sum of the results of each PSF to form a numerical likelihood index.
- The actual quantitative error rate is related to the numerical likelihood index by a logarithmic relationship.
- The logarithmic relationship can be calibrated on a situational basis by use of appropriately selected calibration tasks having generally accepted error rates.

The SLIM procedure was adapted by defining a small set of generic PSFs that are judged to encompass the major focuses of cognitive activity. Seven PSFs have been chosen to relate the impact of the following

- Conditions of the work setting under which the action must be accomplished. The PSFs are as follows:
 - significant preceding and concurrent actions
 - plant interface and indications
 - adequacy of time to accomplish the action
- Requirements of the task itself. The PSFs are as follows:
 - procedural guidance
 - complexity of the task relative to resources, coordination, and location

- Psychological and cognitive condition of the operators. The PSFs are as follows:

- training and experience relative to the action
- stress due to the situation and environmental conditions

Performance-shaping factors are rated against two criteria:

- A **score** relates the degree to which the conditions of PSF help or hinder the operator to perform the action.
- A **weight** relates the relative influence of each PSF on the likelihood of the success of the action.

The evaluation of dynamic human errors with SLIM is made consistent by the development of a set of forms and instructions to explain and expand on the rating procedures for the PSFs.

The SLIM methodology has been modified so that the evaluators scale the degree of difficulty, rather than the potential for success, when they score the action. This change in orientation produces a failure likelihood index (FLI) rather than a success likelihood index. This approach has the advantage of quantitatively highlighting the causes of operator difficulty. A high score combined with a high weight produces a large FLI compared to other ratings. This permits efficient analysis of the potential problem areas and trends.

The independence of the PSFs is addressed by the definition at the top of each evaluation form that emphasizes the different aspects of the cognitive process that each PSF is intended to address. Another major premise of the SLIM methodology is that the evaluation team can rate the weight and score independently.

During evaluation of the operator actions, the evaluation team is also requested to consider a number of possible errors. These include:

- **Nonresponse Errors, Also Called Errors of Omission.** This would include problems generated by both the plant interface and the competition of other actions.
- **Time and Resource Limitations.** For certain actions, the operators are requested to identify the number of people and the coordination required to get the job done. The degree of difficulty will then be impacted by the personnel and communications they have available.
- **Nonviable Errors.** Under some conditions, the operators may correctly diagnose the accident scenario but select the wrong response. These errors are believed to be governed by operator slips, e.g., selecting the wrong controls for the tasks. The control room feedback problems that could keep such errors from being detected are also considered.

5.3.3.3 Quantification Process

The quantification process is done in a series of stages.

First, a normalized weight for each PSF is obtained by dividing the weight assigned by the evaluation team by the total of all the weights for that particular action.

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The FLI is calculated by multiplying the normalized weight of the PSF by its score and adding that result to similar results for the other PSFs, or

$$FLI = \sum w_i S_i$$

where

i = PSF that has an influence on the error rate of the action.

w_i = weight of PSF _{i} , normalized so that $\sum w_i = 1$.

S_i = degree of difficulty score for PSF _{i} , from 0 to 10.

The error rate of each action is estimated by comparing the overall FLI to a correlation that follows the relationship:

$$\text{Logarithm (human error rate)} = A + B(FLI)$$

The coefficients of the correlation are obtained from a least squares fit of the FLI of calibration actions that have reasonable or generally accepted error rates in the industry.

To provide error rates that are consistent with other studies, the calibration of the human error rate model uses well-defined actions obtained from evaluations for other PRAs and other statistical or analytical evidence of failure frequencies for these actions. The calibration procedure should ensure that the numerical error rate estimates are realistic and consistent with available data, observed human behavior, and the results from comparable expert evaluations of similar activities.

The use of some combinations of calibration actions may produce human error rates of 1.0 per demand for FLI values of less than 10. When this occurs, all actions with an FLI above that value are quantified as being guaranteed to fail.

5.3.3.4 Summary

The error rates resulting from the evaluation and the quantification are displayed in tabular format. This permits easy review, comparison, and identification of the most important factors influencing each assessment.

It is important to recognize that the quantification of human error rates is only a small portion of the information obtained from the SLIM approach. The trends of weights and scores provide much valuable information regarding the evaluator's judgment with respect to the focus of safety-related actions and the difficulties involved in accomplishing them.

Table 5.3 gives the definition of the various dynamic human actions for the flood initiating events. The quantification process and the weights and scoring for the PSFs are listed in Table 5.4.

5.3.4 Actions while at Mid-Loop

Several hundred specific actions are considered in this analysis, and over 150 are quantified directly. Others are assigned HEPs equal to one of those actually quantified directly because of similarities in required response, cues, timing, and all other factors.

The large number of specific action scenarios are actually special cases of a small number of functional responses defined by plant procedures and colored by special conditions of the sequence of events that leads to the need for action. To aid in understanding the many special cases, we organize their presentation under the following topics:

- Human Responses
 - global actions
 - primary cognitive response
 - specific activities
 - recovery actions
- Factors Affecting Response
 - initiating event
 - previous/concurrent hardware failures and human actions
 - other performance shaping factors

5.4 Turbine Building Flood Events - Flood Scenarios 1, 2

Flood events in the Turbine Building have been classed into two categories:

- Category 1 events are large scale flood occurrences, where the dewatering capacity of the building sump pumps is insufficient. The events are initiated by the rupture of one of the expansion joints in the CW or SW system. The resulting leak may not be isolated in sufficient time to prevent the overflow of the flood dikes in front of the unit ESGR. The Amertap, SW valve pits, and the building sump pits are filled and as the water level rises, the sump pump motor control center is shorted, stopping the building sump pumps. The flood in the Turbine Building itself has no significant safety impact as most of the equipment is non-safety-related or would not compromise the operation of the RHR system.
- Category 2 flood events flood the SW valve pit compromising the operation of the recirculation heat exchangers. The use of these heat exchangers is required only in long-term accident sequences to mitigate containment failure. It does not directly affect the operation of the RHR system and as such does not lead to loss of decay heat removal. For this reason, this type of flood event is not analyzed further.

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The Category 1 flood events eventually overflow the flood dikes and water enters into the unit ESGR and the Auxiliary Building Pipe Tunnel. The most significant damage arises from water entering into the ESGR before any appreciable water can collect in the Auxiliary Building basement. The amount of water required to cause damage in the Auxiliary Building is larger than that required for the ESGR. Therefore, the flood scenario may neglect the damage caused in the Auxiliary Building.

As the water enters into the unit ESGR, it is expected that a number of electrical equipment housed in cabinets will short out rendering the associated equipment unavailable. Based on the field inspection, it is estimated that all 480 V buses and numerous MCCs will short out as the water level reaches about 4". This will most likely cause the loss of all 4 kV buses leading to a unit station blackout. The unit DC power is expected to be lost as the water level further increases to about 12".

Therefore, two sub-scenarios are discussed:

- Scenario 1: Event Trees, F1B2W1R6, F1B2W1D6,
F1B2W2R6, F1B2W2D6,
F1B2W3R6, F1B2W3D6, F1B2W3R10,
F1B1W4R6, F1B2W4D6, F1B2W4R10

Two-unit station blackout with instrumentation power available providing power to certain safety related instrumentation and indication. The unit non-safety-related power supplies may be used to provide power to certain non-safety-related equipment, however, the actual extent of remaining power supplies is uncertain. Therefore, a two-unit complete station blackout is conservatively assumed and the corresponding internal event tree B2R6, B2D6, and B2R10 was used to describe Scenario 1a. The relative probability of this scenario is estimated at $P(\text{Scenario 1a}) = .8$ given that the flood enters the ESGR.

- Scenario 2: Event Trees, F1B2W1R6, F2B2W1D6,
F2B2W2R6, F2B2W2D6,
F2B2W3R6, F2B2W3D6, F2B2W3R10,
F2B2W4R6, F2B2W4D6, F2B2W4R10

Two-unit station blackout with instrumentation unavailable or unreliable. In this case the flood height inside the ESGR reaches the DC fuse panel causing the partial or total loss of the DC power which eventually leads to the loss of instrumentation. The scenario is again described by the properly modified station blackout event trees with the human errors describing the difficulties related to the instrumentation control and indications. The relative probability of this scenario is estimated at $P(\text{Scenario 1b}) = .2$.

Figures 5-1-10 and 5-11-20 represent the flood events trees for flood Scenarios F1 and F2, respectively. The top events for the flood event trees for these scenarios are briefly summarized in the following. The event tree structure for the flood events is such that systems which are failed by the initial conditions are not included. However, these may be utilized in the recovery phase and thus, will also be summarized at the end of each event tree top event description.

IB2W1, IB2W2, IB2W3 , IB2W4 - Flood Initiator

These top events represent the flood occurrence probability in the respective POSs (R6 - POS 6 Refueling, D6 - POS 6 Drained Maintenance, R10 - POS 10 Refueling). The flood frequency was derived based on the operating experience and is discussed in Section 3. The combination of this top event with the event tree initiator gives the flood frequency in the corresponding POS.

VW1, VW2, VW3, VW4 - RCS Initially Vented

This top event represents the probability that the RCS is initially vented through the removal of the pressurizer safety valves. The probability was estimated at 0.01 in Window 1, 0.05 in Window 2, .9 in Window 3, and .3 in Window 4, which is the same as used in the internal event analysis. Gravity feed may only be accomplished if the RCS is vented, however, reflux cooling is not possible in this plant configuration.

GB2W1, GB2W2, GB2W3, GB2W4 - Gravity Feed from RWST

The low pressure injection pathway may be utilized to gravity feed the RCS from the RWST by opening a normally closed valve. The success of this top event requires that the RCS be vented. In most cases it provides additional time to provide alternate means of heat removal.

SB2W1, SB2W2, SB2W3, SB2W4 - Steam Generator Feed and Bleed

This top event, representing the possibility of using reflux cooling method to remove decay heat is not included in the event trees, since initially it failed (depends on the semi-vital bus located in the ESGR). However, the system may be used in the recovery phase, if instrument air can be reestablished. It requires the operation of the secondary side relief through the SG PORVs or steam dump to the main condenser or to the turbine deck. The operation of the steam dump valves requires instrument air and DC power, which may be lost during a station blackout situation due to a flood event in the Turbine Building. The instrument air compressors have alternate diesel-driven compressors installed in the yard area, which may be started to provide instrument air.

5.5 Auxiliary Building Flood Events - Flood Scenarios 3, 4

Large scale flood events in the Auxiliary Building are primarily due to pipe ruptures in the building connected to either the fire water system or to the water source from the RWST. The RWST is the main source of supply for various safety systems which serve as alternate or backup heat removal systems to the RHR system. Therefore, the availability of the RWST is an important characteristic of each accident scenario. Accordingly, the flood events in the Auxiliary Building are separated into two categories with and without RWST supply availability.

The open structure of the building assures that any flood originating even at higher elevations eventually will drain to the basement at Elevation 2'. Flood levels reaching the CCW pumps would disable the CCW system on both units and consequently the operating RHR system would also be disabled by losing heat rejection capability in the RHR heat exchangers.

Scenario Development

A large flood inside the charging pump cubicles would disable the charging pumps and in addition, a number of motor operated valves in the HPI system would also become disabled assuming that the operators would not operate under a wet environment. A potential alternate heat removal technique is to utilize the SG recirculation system to transfer heat to the CCW system from the SGs. However, this system also becomes unavailable, since the CCW system itself is disabled by the flood and also the recirculation pumps are located in the same 2' elevation losing their function.

The flood scenarios in the Auxiliary Building have been modeled by utilizing the nonrecoverable loss of RHR internal event trees RHR3. The flood event trees corresponding to these two scenarios are presented in Figure 5-21-40 for the three operating configuration, POS 6 Refueling, Drained maintenance and POS 10 Refueling. The top events on these event trees are essentially the same as for the internal events with the exception of the high level HEPs and that the system fault trees are modified to take into account equipment damaged by the flood event.

- Scenario 3: Event Trees, F3R3W1D6, F3R3W1R6,
F3R3W2D6, F3R3W2R6,
F3R3W3D6, F3R3W3R6, F3R3W3R1,
F3R3W4D6, F3R3W4R6, F3R3W4R1

Large scale flood in the Auxiliary Building basement with the RWST available. A number of CCW, SG recirculation pumps, and a few motor operated valves become unavailable. The event trees are presented in Figures 5-21-30.

- Scenario 4: Event Trees, F4R3W1D6, F4R3W1R6,
F4R3W2D6, F4R3W2R6,
F4R3W3D6, F4R3W3R6, F4R3W3R1,
F4R3W4D6, F4R3W4R6, F4R3WR1

Large scale flood in the Auxiliary Building basement inside the charging pump cubicles with the RWST unavailable. The overflowing flood from the cubicles cause the failure of the charging, CCW and SG recirculation pumps, and motor operated valves in the HPI system also become unavailable. Isolation of the flood still causes the loss of charging and low pressure injection function due to the unavailability of the RWST. The event trees are presented in Figures 5-31-40.

IR3W1, IR3W2, IR3W3, IR3W4 - Initiating Event IR4W1, IR4W2, IR4W3, IR4W4

This event in combination of the initiating event represents the flood frequency in the respective POS and time window which is expected to occur in the Auxiliary Building.

VW1, VW2, VW3, VW4 - RCS Initially Vented

This event represents the conditions that the RCS is vented through the removal of the pressurizer safety valves. The resulting opening is required for successful operation of the gravity feed method. However, if the RCS is open, the reflux cooling mode of heat removal through the SG cannot be accomplished. The event is estimated to have the probability value of 0.01 (W1), .05 (W2), .9 (W3), and .3 (W4).

SR3W1, SR3W2, SR3W3, SR3W4 - Steam Generator Feed and Bleed
SR4W1, SR4W2, SR3W3, SR4W4

This event represents the successful use of the reflux cooling method which is possible when the RCS loops are not isolated and the secondary side of the SGs is filled. The steam generated in the secondary side has to be relieved through either the secondary side PORVs or the steam dump valves.

FR3W1, FR3W2, FR3W3, FR3W4 - Primary Feed and Bleed

This top event represents the primary feed and bleed function using the charging or the low pressure injection pumps. In this mode, water is injected into the system from the RWST and is allowed to bleed through the PORVs. The PORVs are open with the block valves deenergized. The charging pump cubicles have an opening about 4' from the basement floor and the charging pumps may be disabled when the water level reaches that elevation. This top event is present only in Scenario 3, since it is failed in Scenario 4 due to the unavailability of the RWST. The Unit 2 charging pumps and RWST may be available and is considered in the recovery phase of the analysis.

GR3W1, GR3W2, GR3W3, GR3W4 - Gravity Feed from RWST

If the pressurizer safety valves are removed, gravity feed is a viable option for delaying boiling in the core. This may be accomplished by opening a normally closed valve in the low pressure injection line and allowing the RWST water to gravity drain into the RCS. This will delay core heatup by hours after that period alternate heat removal method has to be found or reestablished. Timing was established by system thermal-hydraulic calculations taking into account decay heat generation and the static head in the RWST. Cross connection to the Unit 2 RWST is also considered. The top event is failed in Scenario 4, since the RWST is unavailable for feed and bleed. It is still present in the event tree for calculational reasons in order to correctly calculate the total CDF due to the initiating event.

5.6 Safeguard Area Flood Events - Flood Scenario 5

The potentially risk significant flood events originating in this are those which spill over into the Auxiliary Building through a pipe tunnel connecting the two areas. In particular, flood events in the sub-area containing the valves and piping of the low pressure injection system are of interest due to the potential loss of the low pressure injection path. These floods have to first spill over to the other sub-area in the Safeguard Area through a pipe opening and then could overflow into the Auxiliary Building.

The scenario is similar to the Auxiliary Building flood scenarios, except for the additional equipment damage in the Safeguard Area itself. From the safety point of view, only the low pressure injection and the AFW system must be considered. The AFW system located in the other sub-area is required for secondary side heat removal and is modeled in the event trees (reflux cooling top event, function "S").

The event trees used for this scenario are the nonrecoverable Loss of RHR or RHR3 trees used in the Auxiliary Building analysis. The effect of flood in the Safeguard Area is treated through changes in the system fault trees by setting the components affected by flood to a definite failed state.

- Scenario 5: Event Trees, F5R3W1D6, F5R3W1R6,
F5R3W2D6, F5R3W2R6,

Scenario Development

F5R3W3D6, F5R3W3R6, F5R3W3R10,
F5R3W4D6, F5R3W4R6, F5R3W4R10

Large scale flood in the Safeguard Area due to rupture in the RWST supply line. The flood source RWST is unavailable for supplying water to the RCS, the closed discharge valves LPI-1890B/C are flooded and may not be remotely or manually operated. The flood overflows into the Auxiliary Building, flooding the basement and disabling the CCW system and a number of motor operated valves and other secondary systems. In this scenario, forced feed and bleed and/or gravity feed is unavailable in this scenario due to the unavailability of the RWST. The event trees are presented in Figures 5-41-50.

5.7 Containment Spray Events - Flood Scenario 6

The spray event is postulated to occur in the containment disabling the operating RHR train. This event has no other effect and can be analyzed with the Loss of Operating Train of RHR (RHR4) event tree of the internal event analysis. It effectively represents failures that may not be recovered within the time frame of accident scenarios that may result.

- Scenario 6: Event Trees, F6R4W1D6, F6R4W1R6,
F6R4W2D6, F6R4W2R6,
F6R4W3D6, F6R4W3R6, F6R4W3R10,
F6R4W4D6, F6R4W4R6, F6R4W4R10

All the top events in these event trees are identical to the previously discussed event trees with the exception of RR4W1, RR4W2, RR4W3, RR4W4. The event trees are presented in Figures 5-51-60.

RR4W1, RR4W2, RR4W3, RR4W4 - Restoration of RHR

This top event represents the restoration of the RHR after a spray event. This involves the local venting of the RHR pumps, verifying the heat sink and the restart of an RHR pump.

5.8 Mechanical Equipment Room No. #3. - Flood Scenario 7

Flood events occurring in this area would overflow the flood dikes at the entrance to the plant ESGR area and eventually cause the loss of all AC power. The consequences of this flood scenario is identical to the Turbine Building flood events (Flood Scenario 1) and are analyzed in a similar manner. In order to simplify the analysis, the same event trees were utilized to determine the CDF contribution from this flood scenario with appropriate changes in the data (Fig. 5-61-70).

5.9 References

1. Chu, T-L., et.al., "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry Unit-1: Analysis of Core Damage Frequency from Internal Events During Mid-Loop Operations." NUREG/CR-6144, Volume 2, June 1994.

2. **Virginia Power, Surry Nuclear Power Plant, Individual Plant Examination Program, Appendix E: Internal Flooding.**
Internal Flooding Analysis for the Individual Plant Examination, Supplemental Report, Surry Units 1 and 2, Virginia Electric and Power Company, November 1991.

UNITY	F1IB2W1	SEQ #	END-S'
<p data-bbox="446 869 1032 1101">Fig. 5.1 TURBINE BLDG FLOOD SCENARIO 1 F 1B2W 1D6</p>		1 2	@ CD

UNITY	F1IB2W1	VW1	F1GB2W1	SEQ #	END-S
<p>Fig. 5.2 TURBINE BLDG FLOOD SCENARIO 1 F1B2W1R6</p>				1 2 3 4	@ OK CD CD

	UNITY	F1IB2W2	SEQ #	END-STATE-NAMES
<p>Fig. 5.3 TURBINE BLDG FLOOD SCENARIO 1 F1B2W2D6</p>			1 2	@ CD

UNITY	F1IB2W2	VW2	F1GB2W2	SEQ #	END
<p>Fig. 5.4 TURBINE BLDG FLOOD SCENARIO 1 F1B2W2R6</p>				1 2 3 4	@ OK CD CD

	UNITY	F1IB2W3	SEQ #	END-STATE-NAMES
<p>Fig. 5.5 TURBINE BLDG FLOOD SCENARIO 1 F1B2W3D6</p>			1 2	@ CD

UNITY	F1IB2W3	VW3	F1GB2W3	SEQ #	END—
<p>Fig. 5.6 TURBINE BLDG FLOOD SCENARIO 1 F1B2W3R10</p>				1 2 3 4	@ OK CD CD

UNITY	F1IB2W3	VW3	F1GB2W3	SEQ #	END-ST
<p>Fig. 5.7 TURBINE BLDG FLOOD SCENARIO 1 F1B2W3R6</p>				1 2 3 4	@ OK CD CD

UNITY	F1IB2W4	SEQ #	END-S
1 2	@ CD

Fig. 5.8
TURBINE BLDG
FLOOD SCENARIO 1
F1B2W4D6

UNITY	F1IB2W4	VW4	F1GB2W4	SEQ #	END
<p>Fig. 5.9 TURBINE BLDG FLOOD SCENARIO 1 F1B2W4R10</p>				1 2 3 4	@ @ CD CD

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UNITY	F1IB2W4	VW4	F1GB2W4	SEQ #	END
<p>Fig. 5.10 TURBINE BLDG FLOOD SCENARIO 1 F1B2W4R6</p>				1 2 3 4	@ @ CD CD

UNITY	F2IB2W1	SEQ #	END
<p data-bbox="422 879 1058 1117">Fig. 5.11 TURBINE BLDG FLOOD SCENARIO 2 F2B2W1D6</p>		<p data-bbox="1435 756 1479 868">1 2</p>	<p data-bbox="1754 740 1841 868">@ CD</p>

UNITY	F2IB2W1	VW1	F2GB2W1	SEQ #	END-
<p>Fig. 5.12 TURBINE BLDG FLOOD SCENARIO 2 F2B2W1R6</p>				1 2 3 4	@ OK CD CD

	UNITY	F2IB2W2	SEQ #	END-STATE-NAMES
<p>Fig. 5.13 TURBINE BLDG FLOOD SCENARIO 2 F2B2W2D6</p>			1 2	@ CD

UNITY	F2IB2W2	VW2	F2GB2W2	SEQ #	END-STA
<p>Fig. 5.14 TURBINE BLDG FLOOD SCENARIO 2 F2B2W2R6</p>				1 2 3 4	@ OK CD CD

	UNITY	F2IB2W3	SEQ #	END-STATE-NAMES
<p>Fig. 5.15 TURBINE BLDG FLOOD SCENARIO 2 F2B2W3D6</p>			1 2	@ CD

UNITY	F2IB2W3	VW3	F2GB2W3	SEQ #	END-STATE-NA
<p>Fig. 5.16 TURBINE BLDG FLOOD SCENARIO 2 F2B2W3R10</p>				1 2 3 4	@ OK CD CD

UNITY	F2IB2W3	VW3	F2GB2W3	SEQ #	END-ST
<p>Fig. 5.17 TURBINE BLDG FLOOD SCENARIO 2 F2B2W3R6</p>				1 2 3 4	@ OK CD CD

UNITY	F2IB2W4	SEQ #	END-S
<p data-bbox="427 868 1044 1098">Fig. 5.18 TURBINE BLDG FLOOD SCENARIO 2 F2B2W4D6</p>		1 2	@ CD

UNITY	F2IB2W4	VW4	F2GB2W4	SEQ #	END
<p>Fig. 5.19 TURBINE BLDG FLOOD SCENARIO 2 F2B2W4R10</p>				1 2 3 4	@ @ CD CD

UNITY	F2IB2W4	VW4	F2GB2W4	SEQ #	END
<div data-bbox="336 722 1519 845"> </div> <div data-bbox="506 842 919 1002"> <p>Fig. 5.20 TURBINE BLDG FLOOD SCENARIO 2 F2B2W4R6</p> </div>				<div data-bbox="1583 708 1617 861"> <p>1 2 3 4</p> </div>	<div data-bbox="1804 699 1868 861"> <p>@ @ CD CD</p> </div>

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UNITY	F3IR3W1	F3FR3W1V	F3CR3W1V	SEQ #	END
<div data-bbox="198 810 226 861" data-label="Text">S-40</div> <div data-bbox="763 986 1110 1117" data-label="Caption"> <p>Fig. 5.21 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W1D6</p> </div>				<div data-bbox="1384 817 1412 941" data-label="Text"> 1 2 3 4 </div>	<div data-bbox="1884 817 1942 941" data-label="Text"> OK OK CD CD </div>

UNITY	F3IR3W1	VW1	F3SR3W1	F3PR3W1	F3GR3W1	F3CR3W1	SEQ #	END-ST
<p>Fig. 5.22 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W1R6</p>							1 2 3 4 5 6 7 8 9	OK OK CD CD CD OK OK CD CD

UNITY	F3IR3W2	F3SR3W2	F3FR3W2V	F3CR3W2V	SEQ #	END-ST
<p>Fig. 5.23 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W2D6</p>					<p>1 2 3 4 5</p>	<p>OK OK OK CD CD</p>

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UNITY	F3IR3W2	VW2	F3SR3W2	F3FR3W2	F3GR3W2	F3CR3W2	SEQ #	END-S
							1 2 3 4 5 6 7 8 9	OK OK CD CD CD CD OK OK CD CD

Fig. 5.24
AUXILIARY BUILDING
FLOOD SCENARIO 3
F3R3W2R6

UNITY	F3IR3W3	F3SR3W3	F3FR3W3	SEQ #	END-ST
<p>Fig. 5.25 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W3D6</p>				1 2 3 4	OK OK OK CD

UNITY	F3IR3W3	VW3	F3FR3W3	F3GR3W3	SEQ #	END-S
<div> <div>SAS</div> <p>Fig. 5.26 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W3R1</p> </div>					1 2 3 4 5 6	OK OK CD CD OK CD

UNITY	F3IR3W3	VW3	F3FR3W3	F3GR3W3	SEQ #	END-S
<p>Fig. 5.27 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W3R6</p>					1 2 3 4 5 6	OK OK CD CD OK CD

UNITY	F3IR3W4	F3SR3W4	F3FR3W4V	SEQ #	END
<p>Fig. 5.28 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W4D6</p>				1 2 3 4	OK OK OK CD

UNITY	F3IR3W4	VW4	F3FR3W4	F3GR3W4	SEQ #	END-S
<p>Fig. 5.29 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W4R1</p>						OK OK OK CD OK CD
1 2 3 4 5 6						

UNITY	F3IR3W4	VW4	F3FR3W4	F3GR3W4	SEQ #	END-S
<p>Fig. 5.30 AUXILIARY BUILDING FLOOD SCENARIO 3 F3R3W4R6</p>					1 2 3 4 5 6	OK OK OK CD OK CD

UNITY	F4IR3W1	SEQ #	END-STATE-NAMES
<div> </div> <div>Fig. 5.31 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W1D6</div>		<div>1 2</div>	<div>OK CD</div>

5-50

UNITY	F4IR3W1	VW1	F4SR3W1	F4GR3W1	SEQ #	END-ST.
<p>Fig. 5.32 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W1R6</p>					<p>1 2 3 4 5</p>	<p>OK OK CD OK CD</p>

UNITY	F4IR3W2	F4SR3W2	SEQ #	END-STATE-NAME
<p data-bbox="506 798 980 981">Fig. 5.33 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W2D6</p>			<p data-bbox="1142 646 1175 742">1 2 3</p>	<p data-bbox="1655 646 1714 742">OK OK CD</p>

UNITY	F4IR3W2	VW2	F4SR3W2	F4GR3W2	SEQ #	END-STAT
1 2 3 4 5	OK OK CD OK CD

Fig. 5.34
AUXILIARY BUILDING
FLOOD SCENARIO 4
F4R3W2R6

UNITY	F4IR3W3	F4SR3W3	SEQ #	END-S
<div data-bbox="314 715 1176 798"> </div> <div data-bbox="563 925 1095 1133"> <p>Fig. 5.35 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W3D6</p> </div>			<div data-bbox="1234 694 1276 805"> <p>1 2 3</p> </div>	<div data-bbox="1808 694 1883 805"> <p>OK OK CD</p> </div>

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5-55

UNITY	F4IR3W3	VW3	F4GR3W3	SEQ #	END-
<p>Fig. 5.36 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W3R1</p>				1 2 3 4	OK OK CD CD

UNITY	F4IR3W3	VW3	F4GR3W3	SEQ #	END-STA
<div data-bbox="297 746 1267 849"> </div> <div data-bbox="470 896 922 1066"> <p>Fig. 5.37 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W3R6</p> </div>				<div data-bbox="1310 730 1353 858"> <p>1 2 3 4</p> </div>	<div data-bbox="1793 730 1858 858"> <p>OK OK CD CD</p> </div>

UNITY	F4IR3W4	F4SR3W4	SEQ #	END-S'
<p data-bbox="584 708 978 855">Fig. 5.38 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W4D6</p>			<p data-bbox="1252 533 1284 639">1 2 3</p>	<p data-bbox="1819 533 1884 644">OK OK CD</p>

NITY	F4IR3W4	VW4	F4GR3W4	SEQ #	END-STA
<div> </div> <div> <p>Fig. 5.39 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W4R1</p> </div>				<div> 1 2 3 4 </div>	<div> OK OK CD CD </div>

UNITY	F4IR3W4	VW4	F4GR3W4	SEQ #	END
<p>Fig. 5.40 AUXILIARY BUILDING FLOOD SCENARIO 4 F4R3W4R6</p>				1 2 3 4	OK OK CD CD

5-60

	UNITY	F5IR3W1	SEQ #	END-STA
<p>Fig. 5.41 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W1D6</p>			1 2	OK CD

UNITY	F51R3W1	VW1	F5SR3W1	F5GR3W1	SEQ #	END-STA
<p>Fig. 5.42 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W1R6</p>					1 2 3 4 5	OK OK CD OK CD

UNITY	F5IR3W2	F5SR3W2	SEQ #	END
<p data-bbox="579 1007 1142 1203">Fig. 5.43 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W2D6</p>			<p data-bbox="1291 727 1323 831">1 2 3</p>	<p data-bbox="1862 727 1927 831">OK OK CD</p>

UNITY	F5IR3W2	VW2	F5SR3W2	F5GR3W2	SEQ #	END-S
<p>Fig. 5.44 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W2R6</p>					1 2 3 4 5	OK OK CD OK CD

UNITY	F5IR3W3	F5SR3W3	SEQ #	END
<p data-bbox="584 938 1151 1138">Fig. 5.45 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W3D6</p>			<p data-bbox="1302 802 1334 911">1 2 3</p>	<p data-bbox="1877 802 1942 911">OK OK CD</p>

5-55

UNITY	F5IR3W3	VW3	F5GR3W3	SEQ #	END-
<p data-bbox="735 963 1095 1089">Fig. 5.46 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W3R1</p>				<p data-bbox="1375 678 1403 800">1 2 3 4</p>	<p data-bbox="1856 675 1914 800">OK OK CD CD</p>

UNITY	F5IR3W3	VW3	F5GR3W3	SEQ #	END-
<p data-bbox="793 973 1276 1142">Fig. 5.47 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W3R6</p>				<p data-bbox="1392 727 1418 852">1 2 3 4</p>	<p data-bbox="1884 721 1940 852">OK OK CD CD</p>

UNITY	F5IR3W4	F5SR3W4	SEQ #	END-
<p data-bbox="528 817 950 963">Fig. 5.48 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W4D6</p>			<p data-bbox="1278 635 1310 740">1 2 3</p>	<p data-bbox="1845 635 1910 740">OK OK CD</p>

UNITY	F5IR3W4	VW4	F5GR3W4	SEQ #	END
<p>Fig. 5.49 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W4R1</p>				1 2 3 4	OK OK CD CD

UNITY	F5IR3W4	VW4	F5GR3W4	SEQ #	END-ST
<div data-bbox="355 646 1304 750"> </div> <div data-bbox="722 813 1088 949"> <p>Fig. 5.50 SAFEGUARD BUILDING FLOOD SCENARIO 5 F5R3W4R6</p> </div>				<div data-bbox="1347 630 1390 758"> <p>1 2 3 4</p> </div>	<div data-bbox="1821 630 1897 758"> <p>OK OK CD CD</p> </div>

UNITY	IR4W1	RR4W1	FR4W1V	CR4W1V	SEQ #	END-STATE-NAMES
<p>Fig. 5.51 CONTAINMENT SPRAY EVENT TREE F6R4W1D6</p>					1 2 3 4 5	OK OK OK CD CD

UNITY	IR4W1	RR4W1	VW1	SR4W1	PR4W1	GR4W1	CR4W1	SEQ #	END-STATE-NAMES
<p style="text-align: center;">Fig. 5.52 CONTAINMENT SPRAY EVENT TREE F6R4W1R6</p>								1	OK OK OK CD CD CD OK OK CD CD
								2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	
								10	

UNITY	IR4W2	RR4W2	SR4W2	PR4W2V	CR4W2V	SEQ #	END-STATE-NAMES
						1 2 3 4 5 6	OK OK OK OK CD CD

OK
OK
OK
OK
CD
CD

1
2
3
4
5
6

Fig. 5.53
CONTAINMENT SPRAY
EVENT TREE
F6R4W2D6

UNITY	IR4W2	RR4W2	VW2	SR4W2	FR4W2	GR4W2	CR4W2	SEQ #	END-STATE-NAMES
<p>Fig. 5.54 CONTAINMENT SPRAY EVENT TREE F6R4W2R6</p>								1 2 3 4 5 6 7 8 9 10	OK OK OK CD CD CD CD OK OK CD CD

UNITY	IR4W3	RR4W3	SR4W3	PR4W3V	SEQ #	END-STATE-NAMES
<p>Fig. 5.55 CONTAINMENT SPRAY EVENT TREE F6R4W3D6</p>					1 2 3 4 5	OK OK OK OK CD

UNITY	IR4W3	RR4W3	VW3	FR4W3	GR4W3	SEQ #	END-STATE-NAMES
1 2 3 4 5 6 7	OK OK OK CD CD OK CD

UNITY	IR4W3	RR4W3	VW3	FR4W3	GR4W3	SEQ #	END
<p>Fig. 5.57 CONTAINMENT SPRAY EVENT TREE F6R4W3R6</p>						1 2 3 4 5 6 7	OK OK OK CD CD OK CD

UNITY	IR4W4	RR4W4	SR4W4	PR4W4V	SEQ #	END-STATE-NAMES
					1	OK
					2	OK
					3	OK
					4	OK
					5	CD

Fig. 5.58
CONTAINMENT SPRAY
EVENT TREE
F6R4W4D6

UNITY	IR4W4	RR4W4	VW4	PR1W4	CR4W4	SEQ #	END-STATE-NAMES
<p>Fig. 5.59 CONTAINMENT SPRAY EVENT TREE F6R4W4R10</p>							OK OK OK OK CD OK CD

UNITY	IR4W4	RR4W4	VW4	FR4W4	GR4W4	SEQ #	END-STATE-NAMES
						<div> <p>Fig. 5.60 CONTAINMENT SPRAY EVENT TREE F6R4W4R6</p> </div>	<div> <p>OK OK OK OK CD OK CD</p> </div>

UNITY	F71B2W1	VW1	F7GB2W1	SEQ #	END
<div>Fig. 5.62 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W1R6</div>				1	@
				2	OK
				3	CD
				4	CD

Fig. 5.62
MECH EQ RM 3
FLOOD SCENARIO 7
F7B2W1R6

	UNITY	F71B2W2	SEQ #	END-STATE-NAMES
	<div data-bbox="706 1382 751 1699"> </div> <div data-bbox="917 1146 1144 1747"> <p>Fig. 5.63 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W2D6</p> </div>		<div data-bbox="683 950 764 982"> <p>1 2</p> </div>	<div data-bbox="673 694 764 764"> <p>@ CD</p> </div>

UNITY	F7IB2W2	VW2	F7GB2W2	SEQ #	END
<p>Fig. 5.64 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W2R6</p>				1 2 3 4	@ OK CD CD

	UNITY	F71B2W3	SEQ #	END-STATE-NAMES
1 2	@ CD
Fig. 5.65 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W3D6				

	UNITY	F7IB2W3	VW3	F7GB2W3	SEQ #	END-ST
					<div data-bbox="385 762 1526 882"> </div>	<div data-bbox="642 949 916 1050"> <p>Fig. 5.66 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W3R10</p> </div> <div data-bbox="1793 735 1862 890"> <p>@ OK CD CD</p> </div>

UNITY	F7IB2W3	VW3	F7GB2W3	SEQ #	END
<p>Fig. 5.67 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W3R6</p>				1 2 3 4	@ OK CD CD

UNITY	F71B2W4	SEQ #	END
<div data-bbox="442 772 1372 836"> </div> <div data-bbox="442 847 880 1015">Fig. 5.68 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W4D6</div>		1 2	@ CD

UNITY	F7IB2W4	VW4	F7GB2W4	SEQ #	END-S
<p>Fig. 5.69 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W4R10</p>				1 2 3 4	@ @ CD CD

	UNITY	F7IB2W4	VW4	F7GB2W4	SEQ #	END
<p data-bbox="584 959 858 1065">Fig. 5.70 MECH EQ RM 3 FLOOD SCENARIO 7 F7B2W4R6</p>					<p data-bbox="1655 812 1690 959">1 2 3 4</p>	<p data-bbox="1877 802 1942 959">@ @ CD CD</p>

Scenario Development

Table 5-1 Success Criteria for Mitigating Features

Feature	Time Window	Success Criteria	
Reflux Cooling		Short Term	Long Term
	< 75 hours	3 SGs	AFW to 3 SGs
	>= 75 hours and < 475 hours	2 SGs	AFW to 2 SGs
	>= 475 hours	1 SG	AFW to 1 SG
Feed and Spill	< 107 hours	1LHSI * (SV removed + 2PORV)	
	> 107 hours	1LHSI *(SV removed + 1 PORV)	
	< 129 hours	2HHSI*(SV removed + 2 PORV)	
	> 129 and < 138 hours	1HHSI*(SV removed + 2 PORV)	
	>= 138 hours	1HHSI * (SV removed + 1 PORV)	
Gravity Feed	< 70 hours	at least 1 SV removed , less than 1 hour of subcooling	
	> 70 hours and < 150 hours	at least 1 SV removed, 2 hours of subcooling	
	> 150 hours and less than 768 hours	at least 1 SV removed, 3 hours of subcooling	
	>= 768 hours	at least 1 SV removed, sufficient for 24 hours	
Recirculation	< = 3 days	needed	
	> 3 days and <=10 days	not needed if RWSTs are cross tied, otherwise needed	
	> 10 days	not needed	
Spray Recirculation	<= 3 days	needed to prevent recirculation failure	
	> 3 days and <=10 days	not needed if RWSTs are cross tied, otherwise needed to prevent recirculation failure	
	> 10 days	not needed	

Table 5-2 Definition and Characterization of Time Windows

	Window 1	Window 2	Window 3	Window 4
Definition	<= 75 hours	> 75 hours and <= 240 hours	> 240 hours and <= 32 days	> 32days
Representative Decay Heat	13.23 MW (2 days)*	10 MW(5 days)	7 MW(12 days)	5 MW(32 days)
Success Criteria				
Reflux Cooling	3 SGs	2 SG	2 SG	1 SG
Feed and Bleed				
LHSI	1LHSI*(SV removed + 2 PORV)	1LHSI*(SV removed + 2 PORV)	1LHSI *(SV removed + 1PORV)	1LHSI *(SV removed + 1PORV)
HHSI	1HHSI*(SV removed + 1 PORV)	1HHSI*(SV removed + 1 PORV)	1HHSI*(SV removed + 1 PORV)	1HHSI*(SV removed + 1 PORV)
Gravity Feed	1 SV removed * LHSI flow path provides 4.3 hours for operator actions (with less than 2 hours of subcooling)	1 SV removed * LHSI flow path provides 6.5 hours for operator actions (with 2 hours of subcooling)	1 SV removed * LHSI flow path provides 12 hours for operator actions (with 2 hours of subcooling)	1 SV removed * LHSI flow path provides sufficient cooling for 24 hours (with more than 3 hours of subcooling)
Recirculation	needed(HPR + LPF&Steam + LPF&Spill)	1 RWST,needed	not needed	not needed
		2 RWST, not needed		
Recirculation Spray	needed	1 RWST,needed	not needed	not needed
		2 RWST,not needed		
Probability that IE Occurs in the Window (RHR2A based on time to mid-loop)				
D6	1.17E-01 (0.31)	0.536 (0.454)	0.375 (0.21)	7.20E-02 (2.6E-02)
R6	1.7E-02 (5.82E-02)	0.543 (0.7)	0.41 (0.24)	3.4E-02 (1.48E-03)
R10	0.0	0.0	0.016 (2.2E-02)	9.84E-01 (0.98)

Definition and Characterization of Time Windows

	Window 1	Window 2	Window 3	Window 4
Decay Heat	13.23 MW(2days)	10 MW(5 days)	7 MW(12 days)	5 MW(32 days)
Time to Boiling	15 min	20 min	27 min	37 min
Time to Tygon Tube Rupture(40 psia)	23 min	31 min	43 min	59 min
Time to PRT Rupture(100 psig)	51 min	63 min	78 min	96 min
Time to 165 psia	41 min with 2 PORV 43 min with 1 PORV	63 min with 2 PORV 60 min with 1 PORV	227 min with 2 PORV 89 min with 1 PORV	352 min with 2 PORV 147 min with 1 PORV
Time to 615 psig	145 min with 1 PORV - with two	-	-	-
Time to RWST Depletion	10 hrs	13.5 hrs	18.7 hrs	38.6 hrs
Time to AFW Initiation(with 25% SG inventory remaining)	743 min	669 min	925 min	628 min
Time to Core Uncovery	120 min	157 min	209 min	273 min
Time to Core Damage	219 min	297 min	411 min	557 min

Table 5-3 Definition of Dynamic Human Actions Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
DF2W1 DF2W2 DF2W3 DF2W4	Same as F1 with DC Power/Panels Shorted	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	Same as F1 with No DC Power. Instrumentation may be erratic.
DF3W1 DF3W2 DF3W3 DF3W4	Diagnose the loss of RHR due to damage to CCW pumps, charging pumps, and HHSI MOVs by large Auxiliary Building flood at mid-loop in W1/W2/W3/W4 of refueling outages.	D-R3W1-XHE D-R3W2-XHE D-R3W3-XHE D-R3W4-XHE	All 4 CCW pumps, all 3 charging pumps, and HHSI MOVs (e.g., RWST suction valve 1115D, VCT suction isolation valve 1115E, cold leg injection valves 1842 and 1867C/D, hot leg injection valves 1869A/B, and LHSI to HHSI cross-connect valves 1863A/B) are disabled.
DF4W1 DF4W2 DF4W3 DF4W4	Diagnose the loss of RHR due to damage to CCW pumps, charging pumps, HHSI MOVs, and RWST water supply by large Auxiliary Building flood at mid-loop in W1/W2/W3/W4 of refueling outages.	D-R3W1-XHE D-R3W2-XHE D-R3W3-XHE D-R3W3-XHE	All 4 CCW pumps, all 3 charging pumps, HHSI MOVs (e.g., RWST suction valve 1115D, VCT suction isolation valve 1115E, cold leg injection valves 1842 and 1867C/D, hot leg injection valves 1869A/B, and LHSI to HHSI cross-connect valves 1863A/B), and RWST water supply are disabled.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
DF5W1 DF5W2 DF5W3 DF5W4	Diagnose the loss of RHR due to damage to CCW pumps, charging pumps, HHSI MOVs, LHSI pumps, and RWST water supply by large safeguard area flood overflowing to the Auxiliary Building basement at mid-loop in W1/W2/W3/W4 of refueling outages.	D-R3W1-XHE D-R3W2-XHE D-R3W3-XHE D-R3W4-XHE	All 4 CCW pumps, all 3 charging pumps, HHSI MOVs (e.g., RWST suction valve 1115D, VCT suction isolation valve 1115E, cold leg injection valves 1842 and 1867C/D, hot leg injection valves 1869A/B, and LHSI to HHSI cross-connect valves 1863A/B), LHSI pumps, and RWST water supply are disabled.
DF6W1 DF6W2 DF6W3 DF6W4	Diagnose the loss of RHR due to damage to the operating RHR pump by spray inside the containment at mid-loop in POS 6 of refueling outages.	D-R4W1-XHE D-R4W2-XHE D-R4W3-XHE D-R4W4-XHE	One RHR train is lost due to damage to the operating RHR pump by spray inside the containment.
DF7W1 DF7W2 DF7W3 DF7W4	Diagnose the loss of RHR due to damage to all 4 kV and 480 V buses by a flood from MER No. #3.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The flood in MER No. #3 overflow: The dikes and causes damage in the ESGR Electrical Equipment cost. SG PORVs and instrumentation available.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
GF1W1 GF1W2 GF1W3 GF1W4	Establish gravity feed following loss of RHR due to flood in ESGR loss of all 4 KV & 48V buses.	A-B2W1-XHE-G-4 A-B2W2-XHE-G-4 A-B2W3-XHE-G-4 A-B2W4-XHE-G-4	Loss of all 4 kV and 480 V buses.
GF2W1 GF2W2 GF2W3 GF2W4	Same as GF1W x event with erratic instrumentation		Loss of all 4 kV and 480 V buses, DC buses.

Table S-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
SF3W1 SF3W2 SF3W3 SF3W4	Establish SG bleed and feed following loss of RHR due to damage to CCW pumps, charging pumps, and HHSI MOVs by large Auxiliary Building flood at mid-loop.	A-R3W1-XHE-S1-9 A-R3W2-XHE-S1-9 A-R3W3-XHE-S1-8 A-R3W4-XHE-S1-8 A-R3W1-XHE-S2-9 A-R3W2-XHE-S1-9 A-R3W3-XHE-S1-8 A-R3W4-XHE-S1-8 A-R3W1-XHE-SF-9 A-R3W2-XHE-SF-9 A-R3W3-XHE-SF-8 A-R3W4-XHE-SF-8	All 4 CCW pumps, all 3 charging pumps and HHSI MOVs (e.g., RWST suction valve 1115D, VCT suction isolation valve 1115E, cold leg injection valves 1842 and 1867C/D, hot leg injection valves 1869A/B, and LHSI to HHSI cross-connect valves 1863A/B) are disabled.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
FF3W1 FF3W2 FF3W3 FF3W4	Align primary feed and bleed following loss of RHR due to damage to CCW pumps, charging pumps, and HHSI MOVs by large Auxiliary Building flood at mid-loop in POS 6 of refueling outages.	A-R3W1-XHE-FH-4 A-R3W2-XHE-FH-4 A-R3W3-XHE-FH-3 A-R3W4-XHE-FH-3 A-R3W1-XHE-FH-9 A-R3W2-XHE-FH-9 A-R3W3-XHE-FH-7 A-R3W4-XHE-FH-7 <hr/> A-R3W1-XHE-FL-4 A-R3W2-XHE-FL-4 A-R3W3-XHE-FL-3 A-R3W4-XHE-FL-3 A-R3W1-XHE-FL-9 A-R3W2-XHE-FL-9 A-R3W3-XHE-FL-7 A-R3W4-XHE-FL-7	

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
GF3W1 GF3W2 GF3W3 GF3W4	Establish gravity feed from RWST after failure to establish primary feed and bleed following loss of RHR due to damage to CCW pumps, charging pumps, and HHSI MOVs by large Auxiliary Building flood at mid-loop in refueling outages.	A-R3W1-XHE-G-5 A-R3W3-XHE-G-5 A-R3W3-XHE-G-4 A-R3W4-XHE-G-4	All 4 CCW pumps and MOVs (1115D, 1115E, 1842, 1867 C/D, 1869 A/B, 1863 A/B) disabled
SF4W1 SF4W2 SF4W3 SF4W5	Establish SG bleed and feed following loss of RHR due to damage to CCW pumps, charging pumps, HHSI MOVs, and RWST water supply by large Auxiliary Building flood at mid-loop in POS 6 of refueling outages.	A-R4W1-XHE-S1-8 A-R3W2-XHE-S1-8 A-R3W3-XHE-S1-7 A-R3W4-XHE-S1-7 A-R4W1-XHE-S2-8 A-R4W2-XHE-S2-8 A-R4W3-XHE-S2-7 A-R4W4-XHE-S2-7 A-R4W1-XHE-SF-8 A-R4W2-XHE-SF-8 A-R4W3-XHE-SF-7 A-R4W4-XHE-SF-7	All 4 CCW pumps, all 3 charging pumps, HHSI MOVs (e.g., RWST suction valve 1115D, VCT suction isolation valve 1115E, cold leg injection valves 1842 and 1867C/D, hot leg injection valves 1869A/B, and LHSI to HHSI cross-connect valves 1863A/B), and RWST water supply are disabled.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
CF3W1 CF3W2 CF3W3 CF3W4	Establish recirculation cooling.	A-R3W1-XHE-C-3 A-R3W2-XHE-C-3 A-R3W1-XHE-C-8 A-R3W2-XHE-C-8	
PF3W1 PF3W2	Establish recirculation spray.	A-R3W1-XHE-P-3 A-R3W2-XHE-P-3 A-R3W2-XHE-X	
SF5W1 SF5W2 SF5W3 SF5W4	Establish SG bleed and feed following loss of RHR due to damage to CCW pumps, charging pumps, HHSI MOVs, LHSI pumps, and RWST water supply by large Safeguard Area flood overflowing to the Auxiliary Building at mid-loop in refueling outages.		All 4 CCW pumps, all 3 charging pumps, HHSI MOVs (e.g., RWST suction valve 1115D, VCT suction isolation valve 1115E, cold leg injection valves 1842 and 1867C/D, hot leg injection valves 1869A/B, and LHSI to HHSI cross-connect valves 1863A/B), both LHSI pumps, and RWST water supply are disabled.
RF6W1 RF6W2 RF6W3 RF6W4	Restore RHR cooling following a recoverable loss of RHR due to damage to the operating RHR pump by spray inside the containment at mid-loop in refueling outages.	A-R4W1-XHE-R-4 A-R4W2-XHE-R-4 A-R4W3-XHE-R-4 A-R4W4-XHE-R-4	Train A RHR is lost due to spray damage to the operating RHR pump.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG FORVs and instrumentation are still available.
SF6W1 SF6W2 SF6W3 SF6W4	Establish SG bleed and feed after failure to restore RHR following a recoverable loss of RHR due to damage to the operating RHR pump by spray inside the containment at mid-loop in refueling outages.	A-R4W1-XHE-S1-9 A-R4W2-XHE-S1-9 A-R4W3-XHE-S1-8 A-R4W4-XHE-S1-8 A-R4W1-XHE-S2-9 A-R4W2-XHE-S2-9 A-R4W1-XHE-S2-8 A-R4W1-XHE-S2-8 A-R4W1-XHE-SF-9 A-R4W2-XHE-SF-9 A-R4W3-XHE-SF-8 A-R4W4-XHE-SF-8	Same equipment failures as for RF6Wx.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
FF6W1 FF6W2 FF6W3 FF6W4	Align primary feed and bleed after failure to restore RHR following a recoverable loss of RHR due to damage to the operating RHR pump by spray inside the containment at mid-loop in refueling outages.	A-R4W1-XHE-FH-5 A-R4W2-XHE-FH-5 A-R4W3-XHE-FH-4 A-R4W4-XHE-FH-4 A-R4W1-XHE-FH-10 A-R4W2-XHE-FH-10 A-R4W2-XHE-FH-8 A-R4W2-XHE-FH-8	HPI feed and bleed.
		A-R4W1-XHE-FL-5 A-R4W2-XHE-FL-5 A-R4W3-XHE-FL-4 A-R4W4-XHE-FL-4 A-R4W1-XHE-FL-10 A-R4W2-XHE-FL-10 A-R4W3-XHE-FL-8 A-R4W4-XHE-FL-8	LPI feed and bleed.

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
GF6W1 GR6W2 GR6W3 GR6W4	Establish gravity feed from RWST after failure to restore RHR and establish primary feed and bleed following a recoverable loss of RHR due to damage to the operating RHR pump by spray inside the containment at mid-loop in POS 6 of refueling outages.	A-R4W1-XHE-G-6 A-R4W2-XHE-G-6 A-R4W3-XHE-G-5 A-R4W3-XHE-G-5	Train A of RHR is lost due to spray damage to the operating pump.
CF6W1 CF6W2	Establish recirculation function.	A-R4W1-XHE-C-4 A-R4W2-XHE-C-4 A-R4W1-XHE-C-9 A-R4W2-XHE-C-9	
PF6W1 PF6W2	Establish recirculation sprays.	A-R4W1-XHE-P-4 A-R4W2-XHE-P-4 A-R4W2-XHE-X	
DF7W1 DF7W2 DF7W3 DF7W4	Same as F1 events.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	

Table 5-3 (Continued)
Definition of Dynamic Human Actions
Flood Initiating Events

Event	Title of Action	Action Designator	Remarks
DF1W1 DF1W2 DF1W3 DF1W4	Diagnose the loss of RHR and two-unit station blackout (with instrumentation available) due to damage to all 4 kV and 480 V buses by large Turbine Building flood at mid-loop in W1/W2/W3/W4 refueling outages.	D-B2W1-XHE D-B2W2-XHE D-B2W3-XHE D-B2W4-XHE	The large flood in the Turbine building overflows the flood dikes at the ESGRs and Auxiliary Building Pipe Tunnel and results in flooding of majority of the electrical equipment in ESGR for both units. All 4 kV and 480 V buses are lost (i.e., two-unit station blackout). SG PORVs and instrumentation are still available.
GF7W1 GF7W2 GF7W3 GF7W4	Same as F1 Events.	A-B2W1-XHE-6-4 A-B2W2-XHE-G-4 A-B2W3-XHE-G-4 A-B2W4-XHE-G-4	

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Actions							
DF1W1							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	5	10	2	5	5	10
P(Fail)=	1.68E-02						
DF1W2/W3							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	5	10	2	5	5	9
P(Fail)=	1.28E-02						
DF1W4							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	5	5	2	5	5	8
P(Fail)=	1.24E-03						
DF3W1							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Score	1	4	9	3	4	3	9
P(Fail)=	1.63E-03						
DF3W2/W3							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	4	8	3	4	3	7
P(Fail)=	6.24E-04						
DF3W4							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	4	5	3	4	3	6
P(Fail)=	1.38E-04						
DF5W1							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	5	10	3	5	4	10
P(Fail)=	1.28E-02						
DF5W2/W3							

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	5	9	3	5	4	9
P(Fail)=	6.44E-03						
DF5W4							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	5	5	3	5	4	8
P(Fail)=	9.42E-04						
DF6W1							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	2	7	2	2	2	6
P(Fail)=	2.65E-05						
DF6W2/W3							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	2	5	2	2	2	5
P(Fail)=	8.84E-06						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
DF6W4							
Weight	0	0.24	0.18	0.12	0.12	0.24	0.12
Score	1	2	2	2	2	2	4
P(Fail)=	1.95E-06						
GF1W1 GF3W1							
Weight	0.19	0.1	0.14	0.14	0.1	0.19	0.14
Score	9	6	9	4	6	5	10
P(Fail)=	1.59E-01						
GF1W2/W3 GF3W2/W3							
Weight	0.19	0.1	0.14	0.14	0.1	0.19	0.14
Score	9	6	7	4	6	5	10
P(Fail)=	8.28E-02						
GF1W4 GF3W4							
Weight	0.19	0.1	0.14	0.14	0.1	0.19	0.14
Score	9	6	4	4	6	5	10

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
P(Fail)=	3.11E-02						
GF2W1							
Weight	0.19	0.1	0.14	0.14	0.1	0.19	0.14
Score	10	7	9	5	7	6	10
P(Fail)=	8.55E-01						
GF2W2/W3							
Weight	0.19	0.1	0.14	0.14	0.1	0.19	0.14
Score	9	7	8	4	7	5	10
P(Fail)=	1.83E-01						
GF2W4							
Weight	0.19	0.1	0.14	0.14	0.1	0.19	0.14
Score	8	6	6	4	6	5	10
P(Fail)=	3.83E-02						
GF6W1							
Weight	0.19	0.09	0.19	0.14	0.09	0.19	0.09

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Score	7	5	7	4	6	2	9
P(Fail)=	4.08E-03						
GF6W2/W3							
Weight	0.2	0.1	0.15	0.15	0.1	0.2	0.1
Score	7	5	5	4	6	2	7
P(Fail)=	1.10E-03						
GF6W4							
Weight	0.21	0.11	0.11	0.16	0.11	0.21	0.11
Score	7	5	3	4	6	2	5
P(Fail)=	4.13E-04						
SF1W1S1							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	9	4	5	7	10
P(Fail)=	4.83E-1						
SF1W2/W3S1							

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	7	4	5	7	10
P(Fail)=	2.17E-01						
SF1W4S1							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	5	4	5	7	9
P(Fail)=	7.16E-02						
SF1W1S2							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	9	4	5	7	10
P(Fail)=	4.83E-01						
SF1W2/W3S 2							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	7	4	5	7	10
P(Fail)=	2.17E-01						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
SF1W4S2							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	5	4	5	7	9
P(Fail)=	7.16E-02						
SF1W1SF							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	9	4	5	7	10
P(Fail)=	4.83E-01						
SF1W2/W3S F							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	7	4	5	7	10
P(Fail)=	2.17E-01						
SF1W4SF							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	5	4	5	7	9
P(Fail)=	7.16E-02						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
SF3W1S2							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	10	8	9	3	3	7	10
P(Fail)=	4.15E-01						
SF3W2/W3S 2							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	8	3	3	7	10
P(Fail)=	1.18E-01						
SF3W4S2							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	7	3	3	7	10
P(Fail)=	7.72E-02						
SF3W1S1							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	8	3	3	7	10

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
P(Fail)=	1.18E-01						
SF3W2/W3S 1							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	6	3	3	7	10
P(Fail)=	5.07E-02						
SF3W4S1							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	4	3	3	7	9
P(Fail)=	1.58E-02						
SF3W1SF							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	5	3	3	7	7
P(Fail)=	1.25E-02						
SF3W2/W3S F							

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	4	3	3	7	7
P(Fail)=	6.21E-03						
SF3W4SF							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	3	3	3	7	7
P(Fail)=	5.40E-03						
SF5W1S2							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	10	8	10	3	3	7	10
P(Fail)=	6.31E-01						
SF5W2/W3S 2							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	10	3	3	7	10
P(Fail)=	2.72E-01						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
SF5W4S2							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	8	3	3	7	10
P(Fail)=	1.18E-01						
SF5W1S1							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	9	3	4	7	9
P(Fail)=	1.79E-01						
SF5W2/W3S 1							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	7	3	4	7	9
P(Fail)=	7.72E-02						
SF5W4S1							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	8	8	5	3	4	7	9
P(Fail)=	3.33E-02						

Table S-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
SF5W1SF							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	7	8	6	3	4	7	7
P(Fail)=	1.73E-02						
SF5W2/W3S F							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	7	8	5	3	4	7	7
P(Fail)=	1.14E-02						
SF5W4SF							
Weight	0.18	0.09	0.18	0.09	0.14	0.18	0.14
Score	7	8	4	3	4	7	7
P(Fail)=	7.48E-03						
SF1W1S1							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	9	4	5	7	10

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
P(Fail)=	4.83E-01						
SF1W2/W3S 1							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	7	4	5	7	10
P(Fail)=	2.17E-01						
SF1W4S1							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	5	4	5	7	10
P(Fail)=	9.73E-02						
SF1W1S2							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	10	4	5	7	10
P(Fail)=	7.22E-01						
SF1W2/W3S 2							

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	8	4	5	7	10
P(Fail)=	3.24E-01						
SF1W4S2							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	9	8	6	4	5	7	10
P(Fail)=	1.45E-01						
SF1W1SF							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	8	8	8	4	6	7	7
P(Fail)=	1.29E-01						
SF1W2/W3S F							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	8	8	6	4	6	7	7
P(Fail)=	5.79E-02						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
SF1W4SF							
Weight	0.17	0.09	0.17	0.09	0.17	0.17	0.13
Score	8	8	4	4	6	7	7
P(Fail)=	2.60E-02						
SF6W1S1							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	7	3	3	6	9
P(Fail)=	8.48E-03						
SF6W2/W3S 1							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	5	3	3	6	9
P(Fail)=	2.83E-03						
SF6W4S1							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	3	3	3	6	9
P(Fail)=	9.42E-04						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
SF6W1S2							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	9	3	3	6	10
P(Fail)=	3.35E-02						
SF6W2/W3S ₂							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	7	3	3	6	10
P(Fail)=	1.12E-02						
SF6W4S2							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	5	3	3	6	10
P(Fail)=	3.72E-03						
SF6W1SF							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	7	3	3	6	7

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
P(Fail)=	4.89E-03						
SF6W2/W3S _F							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	5	3	3	6	7
P(Fail)=	1.63E-03						
SF6W4SF							
Weight	0	0.12	0.24	0.12	0.18	0.24	0.12
Score	6	7	3	3	3	6	7
P(Fail)=	5.44E-04						
FF3W1FH							
Weight	0.19	0.1	0.19	0.1	0.1	0.19	0.14
Score	7	6	8	4	8	5	9
P(Fail)=	8.13E-02						
FF3W2/W3F _H							

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Weight	0.2	0.1	0.15	0.1	0.1	0.2	0.15
Score	7	6	6	4	8	5	9
P(Fail)=	3.66E-02						
FF3W4FH							
Weight	0.21	0.11	0.11	0.11	0.11	0.21	0.16
Score	7	6	4	4	8	5	8
P(Fail)=	1.61E-02						
FF3W1FL							
Weight	0.19	0.1	0.19	0.1	0.1	0.19	0.14
Score	9	6	8	4	8	5	9
P(Fail)=	1.96E-01						
FF3W2/W3F L							
Weight	0.2	0.1	0.15	0.1	0.1	0.2	0.15
Score	9	6	6	4	8	5	9
P(Fail)=	9.31E-02						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
FF3W4FL							
Weight	0.21	0.11	0.11	0.11	0.11	0.21	0.16
Score	9	6	4	4	8	5	8
P(Fail)=	4.21E-02						
FF6W1FH							
Weight	0.17	0.08	0.17	0.08	0.17	0.17	0.17
Score	6	6	9	5	8	3	9
P(Fail)=	7.59E-02						
FF6W2/W3F H							
Weight	0.19	0.1	0.19	0.1	0.1	0.19	0.14
Score	6	6	5	5	8	3	6
P(Fail)=	2.78E-03						
FF6W4FH							
Weight	0.11	0.11	0.22	0.11	0.06	0.22	0.17
Score	6	6	3	5	8	3	4
P(Fail)=	2.72E-04						

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
FF6W1FL							
Weight	0.17	0.08	0.17	0.08	0.17	0.17	0.17
Score	8	6	9	5	8	3	9
P(Fail)=	1.66E-01						
FF6W2/W3FL							
Weight	0.19	0.1	0.19	0.1	0.1	0.19	0.14
Score	8	6	5	5	8	3	6
P(Fail)=	6.70E-03						
FF6W4FL							
Weight	0.11	0.11	0.22	0.11	0.06	0.22	0.17
Score	8	6	3	5	8	3	4
P(Fail)=	4.54E-04						
RF6W1R							
Weight	0.09	0.14	0.18	0.09	0.14	0.18	0.18
Score	2	6	7	2	8	4	7

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Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
P(Fail)=	4.58E-03						
RF6W2/W3 R							
Weight	0.1	0.14	0.19	0.1	0.14	0.19	0.14
Score	2	5	5	2	7	4	6
P(Fail)=	5.23E-04						
RF6W4R							
Weight	0.11	0.17	0.11	0.11	0.17	0.22	0.11
Score	2	5	3	2	7	4	4
P(Fail)=	1.63E-04						
CF3W1C3							
Weight	0.2	0.08	0.2	0.14	0.14	0.08	0.14
Score	7	5	7	5	7	5	8
P(Fail)=	4.42E-02						
CF3W2C3							
Weight	0.2	0.08	0.2	0.14	0.14	0.08	0.14

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Score	7	5	5	5	7	5	7
P(Fail)=	1.22E-02						
CF3W2x							
Weight	0.2	0.08	0.2	0.08	0.1	0.08	0.2
Score	7	5	3	3	3	3	7
P(Fail)=	9.20E-04						
PF3W1P							
Weight	0.17	0.08	0.17	0.08	0.17	0.17	0.17
Score	6	6	7	3	8	3	9
P(Fail)=	2.39E-02						
PF3W2P							
Weight	0.17	0.08	0.17	0.08	0.17	0.17	0.17
Score	6	6	5	3	8	3	9
P(Fail)=	1.09E-02						
PF6W1P							

Table 5-4 Evaluation of Dynamic Human Actions Flood Initiating Events (continued)

	Preceding Action	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Weight	0.17	0.08	0.17	0.08	0.17	0.17	0.17
Score	6	6	7	3	8	3	5
P(Fail)=	4.96E-03						
PF6W2P							
Weight	0.17	0.08	0.17	0.08	0.17	0.17	0.17
Score	6	6	5	3	8	3	5
P(Fail)=	1.24E-03						

6. ACCIDENT SEQUENCE AND SENSITIVITY CALCULATIONS

6.1 Accident Sequence Quantifications

The core damage sequences were quantified with the IRRAS code similarly to the internal event analysis. Truncation limits were also set at $1.00\text{E}-10$ both for the system and event tree analysis at the cutset level. The flood analysis event trees were generally the same as those used in the internal event analysis and were slightly modified as needed. This enabled the use of the same high level fault trees which were previously developed. The necessary modifications were entered through modifying the system fault trees either by setting certain failure rates to definite fault (true) or by adding flood-specific basic event failures. These accounted for the effects of flood on certain locations and equipment.

Recovery factors were applied to individual cutsets again using the IRRAS code by specifying rules that defined their applicability. The results of the analysis are listed in Tables 6-1 through 6-9 indicating the frequency of each core damage sequence before and after recovery actions. Sequences below $1.00\text{E}-10$ per year are not listed. The following recovery actions were modeled.

Reflux Cooling - R-B2W1-XHE-S, R-B2W2-XHE-S, R-B2W3-XHE-S, R-B2W4-XHE-S. The long-term failure of the AFW system disables the reflux cooling method after the initial inventory in the SGs is utilized (~10 hr). However, alternate means to provide AFW flow exists and may be recovered in the initial ~10 hr time period. This may be accomplished by initiating the fire water pumps. Table 6-1 lists the recovery factors in each time window.

Cross Connecting the Unit Charging Systems - R-R3W1-XHE-F, R-R3W2-XHE-F, R-R3W3-XHE-F, R-R3W4-XHE-F. A large-scale flood inside the charging pump cubicles or one including the rupture of RWST supply pipes may disable the Unit 1 charging system. However, cross connection to the Unit 2 charging system may be utilized to establish the feed-and-bleed method of heat removal. This also requires the opening of at least one of the PORVs (if the safety valves are not removed). Table 6-1 lists the appropriate recovery factors in each time window.

Uncertainty in Reflux Cooling Criterion - R-B2W1-XHE-A, R-R3W1-XHE-A. Analyses by Westinghouse, Idaho National Engineering Laboratory, and BNL indicate that one SG may be adequate for reflux cooling at all times. The model has followed the plant procedure (AP.27), which is more restrictive demanding 3 SGs in Time Window 1 and 2 in Time Window 2. This restrictive and therefore conservative modeling was taken into consideration by applying a "recovery" factor. This is not a purely recovery factor, but simply takes into account the uncertainty related to the modeling. Its value was selected at $R-B2/R3W1-XHE-A=.1$ consistent with the internal event analyses.

6.2 Sensitivity Calculations

As a result of the IPE analysis, Virginia Power has proposed a number of modifications to reduce the risk from flood-related events. The proposed changes involve certain hardware modifications as well as improved procedural or operating practices. Sensitivity calculations were performed to quantify the projected effects of the proposed changes which could serve as a basis for any further cost-benefit type of analysis. In the following a brief summary is given of those proposed modifications which were analyzed in the present study:

Option 1: Turbine Building Sump Pumps Long-Term Operability

The power supply of the sump pumps is expected to be shorted out given an increasing water level in the Turbine Building. This is estimated to occur at about the 8" water level. The power supply cabinet may be located at higher elevation to ensure continued operation of the sump pumps for increasing water level in the building. This option is effectively reflects the modification of relocating the electrical cabinet. The results of the calculations are listed in Table 6-9 indicating the relatively insignificant risk reduction potential (34%

Accident Sequence and Sensitivity Calculations

of the total CDF) of Option 1. This is primarily due to the dominant contributions of large-scale floods where the dewatering capacity is irrelevant.

Option 2: Watertight Door between the Turbine Building and ESGR

The fire door connecting the Turbine Building and the ESGR for the plant may be modified to be watertight up to 6'. This would delay considerably the water ingress into the ESGR. The pipe tunnel connecting to the Auxiliary Building would be flooded after the flood dikes are overflowed at 2'. The flood scenario, would start first with a flood in the Auxiliary Building, where about 135,000 gal are required to disable the CCW system leading to the loss of RHR function. After a while, if the flood may not be isolated and the water level reaches 6', the Unit ESGR would be flooded. For the different flood rates, the time evolution is somewhat different in the two buildings. The ratio of the time periods resulting in critical flood volumes in the Auxiliary Building and ESGR, respectively, is close to a factor of two and to a good approximation this ratio is independent of the flood rate. That is, if the Auxiliary Building is flooded in 45 min (135,000 gal leak) then the ESGR will be flooded in 90 min. It is also estimated that for these large flood rates the recovery potential is very poor, therefore, the ESGR will eventually be flooded.

This enables the use of only one class of event trees (F1B2WxD6/R6/R10) representing the Flood Scenarios in the ESGR. In this approach, the time period while only the Auxiliary Building is flooded, but not the ESGR, is modeled with the F1B2Wx trees. This method is conservative, because these event trees assume that forced feed and bleed is unavailable, and in reality, this function is available for a certain time period before the ESGR is flooded. Using the Flood Scenario 1 event trees is slightly conservative, but this represents only a fraction of the total mission time (5% at the smallest leak rate), that is judged to be insignificant. The results listed in Table 6-9 indicate that this option is capable of reducing the CDF contribution in mid-loop operations by about 57% from 5.11E-06 to 2.18E-06.

Option 3: Modification of Intake Level Structure

The plant is also considering a modification to the intake level structure which would enable personnel to close or isolate the inlet water canal in a short notice. This may be accomplished by modified sliding gates or permanently installed isolation valves. This would effectively ensure a positive isolation outside the Turbine Building reducing the risk from large-scale Turbine Building flood events. The calculated CDF is listed in Table 6-9 and this option is capable of reducing the total CDF in mid-loop operation by about 75% from 5.11E-06/yr to 1.29E-06/yr.

6.3 Uncertainty Analysis

In this section a brief summary is given on the sources and treatment of uncertainty for the flood analysis. Uncertainty is expressed as a quantitative bounding of the central value and is derived based on assumptions involved on parameters, modeling assumptions, and completeness of the analysis. Uncertainty in the parameter values is propagated through the quantification process obtaining the core damage estimates with numerical bounds.

6.3.1 Sources and Treatment of Uncertainties

The flood analysis primarily identified uncertainties in the area of parameter values, that is, modeling uncertainties were not explicitly handled. The parameters of interest are the individual component failure rates, initiating event frequencies and human error probabilities. Sources of parameter uncertainty include lack of data on component failure modes, interpretation of data and component records, and using industry-wide data for plant-specific analyses.

Parameter value uncertainties have been handled in this study similar to the NUREG-1150 study, that is, a probability distribution is defined on the value of the parameter such that the n th percentile of the distribution represents the value below which the analyst has a degree of belief of $n/100$ that the true value lies. This leads to a simple sequence quantification procedure using Monte-Carlo or other sampling techniques. The uncertainty ranges for the distributions are based on generic estimates. These range factors consider variations due to the failure properties of the components in different uses and environments as well as plant-to-plant variations.

6.3.2 Development of Parameter Distributions

Probabilistic distributions for parameter values were developed from several sources of information including data developed in NUREG-1150, plant-specific data, and past PRA analyses.

If sufficient plant-specific data were available for a particular component failure mode (primarily maintenance) then the mean value of the parameter distribution was based on plant-specific data. Generic estimates were used for the error factors. Most distributions are assumed to be log-normal distribution even the initiating event frequencies. The error factors for the latter one was obtained through Bayesian updating technique assuming uniform priors with wide ranges. The error factors for the HEPs were established using a simplified approach related to its estimated point value (if $HEP > .1$ $EF = 2$, $HEP > .01$ $EF = 5$, $HEP < .01$ $EF = 10$).

6.3.3 Quantification of Accident Sequence Uncertainty

The uncertainty of the parameter values was propagated through the accident sequence model using the IRRAS computer code using Monte-Carlo sampling techniques. First the minimal cutsets were generated for each event tree accident sequence. These minimal sequence cutsets were collected into a core damage cutset expression. The uncertainty quantification was accomplished on this core damage cutset. The model was not reanalyzed for each sample, that is, it was assumed that for each sample set of all parameters would result in the same cutset. The results are indicated in Table 6-10 with a mean value of CDF $6.24E-06/yr$ and the 5% and 95% are $3.21E-07/yr$ and $2.17E-05/yr$.

6.4 References

1. Virginia Power, Surry Nuclear Power Plant, Individual Plant Examination Program, Appendix E: Internal Flooding. Internal Flooding Analysis for the Individual Plant Examination, Supplemental Report, Surry Units 1 and 2, Virginia Electric and Power Company, November 1991.

Table 6-1 Evaluation of Recovery Human Actions Flood Initiating Events

	Preceding Actions	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
Recovery Actions							
R-R3W1-XHE-F							
Weight	0.17	0.12	0.17	0.12	0.12	0.12	0.17
Score	7	6	9	4	8	7	10
P(Fail)=	4.20E-01						
R-R3W2/W3-XHE-F							
Weight	0.17	0.12	0.17	0.12	0.12	0.12	0.17
Score	6	6	8	4	7	7	10
P(Fail)=	1.42E-01						
R-R3W4-XHE-F							
Weight	0.17	0.12	0.17	0.12	0.12	0.12	0.17
Score	5	6	7	4	7	7	10
P(Fail)=	6.36E-02						

Table 6-1 Evaluation of Recovery Human Actions Flood Initiating Events (continued)

	Preceding Actions	Plant Interfaces	Time Adequacy	Procedures	Complexity	Training/Exp	Stress
R-B2W1-XHE-S							
Weight	0.14	0.10	0.17	0.12	0.14	0.14	0.17
Score	7	6	9	4	4	5	10
P(Fail)=	6.31E-02						
R-R3W2/W3-XHE-S							
Weight	0.14	0.10	0.17	0.12	0.14	0.14	0.17
Score	6	6	6	4	4	5	8
P(Fail)=	8.95E-03						
R-R3W4-XHE-S							
Weight	0.14	0.10	0.17	0.12	0.14	0.14	0.17
Score	5	6	5	4	4	5	6
P(Fail)=	5.39E-04						

Table 6-2 Core Damage Frequencies of Flood Event Trees Flood in Turbine Building, Two-Unit SBO

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
F1B2W1D6	2	5.72E-07	5.72E-08	R-B2W1-XHE-A
F1B2W1R6	3	3.88E-10		
	4	3.84E-08	1.19E-08	R-B2W1-XHE-S
F1B2W2D6	2	2.13E-06	1.91E-08	R-B2W2-XHE-S
F1B2W2R6	3	6.20E-08		
	4	1.17E-06	8.28E-07	R-B2W2-XHE-S
F1B2W3D6	2	1.83E-06	1.64E-08	R-B2W3-XHE-S
F1B2W3R10	3	3.06E-08		
	4	3.40E-09		
F1B2W3R6	3	8.43E-07		
	4	9.36E-08		
F1B2W4D6	2	3.52E-07	1.90E-10	R-B2W4-XHE-S
F1B2W4R10	3	2.27E-08	3.22E-09	R-B2W4-XHE-G
	4	1.46E-06		
F1B2W4R6	3	7.22E-10		
	4	5.43E-08		
TOTAL		8.64E-06	3.49E-06	

Table 6-2 Core Damage Frequencies of Flood Event Trees Flood in Turbine Building, Two-Unit SBO (continued)

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
Recovery Actions	1	R-B2W1-XHE-S R-B2W2-XHE-S R-B2W3-XHE-S R-B2W4-XHE-S	Reflux Cooling	
	2	R-B2W3-XHE-G R-B2W4-XHE-G	Gravity Feed	
	3	R-B2W1-XHE-A	Uncertainty in Reflux Criterion	

Table 6-3 Core Damage Frequencies of Flood Event Trees Flood in Turbine Building, Two-Unit SBO

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Action
F2B2W1D6	2	1.36E-07	1.36E-08	R-B2W1-XHE-A
F2B2W1R6	3	-		
	4	9.13E-09	2.83E-09	R-B2W1-XHE-S
F2B2W2D6	2	5.06E-07	4.53E-09	R-B2W2-XHE-S
F2B2W2R6	3	1.47E-08		
	4	2.79E-07	1.96E-07	R-B2W2-XHE-S
F2B2W3D6	2	4.36E-07	3.90E-09	R-B2W3-XHE-S
F2B2W3R10	3	7.28E-09		
	4	8.09E-10		
F2B2W3R6	3	2.00E-07		
	4	2.22E-08		
F2B2W4D6	2	8.37E-08	5.93E-11	R-B2W4-XHE-S
F2B2W4R10	3	6.30E-09	6.27E-10	R-B2W4-XHE-G
	4	3.48E-07		
F2B2W4R6	3	2.10E-10		
	4	1.29E-08		
TOTAL		2.06E-06	8.29E-07	

Table 6-3 Core Damage Frequencies of Flood Event Trees Flood in Turbine Building, Two-Unit SBO (continued)

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Action
Recovery Actions	1	R-B2W1-XHE-S R-B2W2-XHE-S R-B2W3-XHE-S R-B2W4-XHE-S	Reflux Cooling	
	2	R-B2W3-XHE-G R-B2W4-XHE-G	Gravity Feed	
	3	R-B2W1-XHE-A	Uncertainty in Reflux Cooling Criterion	

Table 6-4
Core Damage Frequencies of Flood Event Trees
Flood in Auxiliary Building

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
F3R3W1D6	3	2.38E-08	2.38E-09	R-R3W1-XHE-A
	4	7.33E-08	7.87E-09	R-R3W1-XHE-R
F3R3W1R6	3	-		
	4	-		
	5	-		
	8	3.29E-10		
	9	1.99E-09		
F3R3W2D6	4	1.50E-08		
	5	1.33E-08		
F3R3W2R6	3	4.84E-09		
	4	-		
	5	1.61E-09		
	8	6.79E-08	1.40E-08	R-R3W2-XHE-F
	9	5.54E-08	1.26E-08	R-R3W2-XHE-F
F3R3W3D6	4	4.56E-09		
F3R3W3R10	3	-		
	4	7.38E-10		
	6	2.06E-10		

**Table 6-4 Core Damage Frequencies of Flood Event Trees
Flood in Auxiliary Building (continued)**

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
F3R3W3R6	3	-		
	4	2.26E-08	3.50E-09	R-R3W3-XHE-F
	6	5.84E-09		
F3R3W4D6	4	-		
F3R3W4R1C	4	8.06E-09		
	6	4.37E-08	2.90E-09	R-R3W4-XHE-F
F3R3W4R6	4	2.42E-10		
	6	1.59E-09		
TOTAL		3.45E-07	1.02E-07	
Recovery Actions	1	R-R3W1-XHE-A	Uncertainty in Reflux Cooling Criterion	
	2	R-R3W2-XHE-F R-R3W3-XHE-F R-R3W4-XHE-F	Cross- connecting Charging System to Unit 2	

Table 6-5
Core Damage Frequencies of Flood Event Trees
Flood in Auxiliary Building

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
F4R3W1D6	2	2.73E-07	2.73E-08	R-R3W1-XHE-A
F4R3W1R6	3	1.85E-10		
	5	8.53E-09		
F4R3W2D6	3	1.05E-07	1.49E-08	R-R3W2-XHE-F
F4R3W2R6	3	2.96E-08	4.21E-09	R-R3W2-XHE-F
	5	4.14E-07	7.64E-08	R-R3W2-XHE-F
F4R3W3D6	3	9.03E-08	1.27E-08	R-R3W3-XHE-F
F4R3W3R10	3	1.46E-08	2.08E-09	R-R3W3-XHE-F
	4	1.63E-09		
F4R3W3R6	3	4.03E-07	5.72E-08	R-R3W3-XHE-F
	4	4.47E-08	6.36E-09	R-R3W3-XHE-F
F4R3W4D6	3	2.20E-09		
F4R3W4R10	3	3.00E-07	1.91E-08	R-R3W4-XHE-F
	4	7.01E-07	4.46E-08	R-R3W4-XHE-F
F4R3W4R6	3	1.11E-08	7.08E-10	R-R3W4-XHE-F
	4	2.60E-08	1.65E-09	R-R3W4-XHE-F
TOTAL		2.42E-06	2.80E-07	
Recovery Actions	1	R-R3W1-XHE-F R-R3W2-XHE-F R-R3W3-XHE-F R-R3W4-XHE-F	Cross- connecting Charging System to Unit 2	
	2	R-R3W1-XHE-A	Uncertainty in Reflux Cooling Criterion	

Table 6-6
Core Damage Frequencies of Flood Event Trees
Flood in Safeguard Area

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
F5R3W1D6	2	3.83E-07	3.83E-08	R-R3W1-XHE-F
F5R3W1R6	3	2.59E-10		
	5	1.39E-08		
F5R3W2D6	3	7.76E-07	2.50E-08	R-R3W2-XHE-F
F5R3W2R6	3	4.14E-08	5.89E-09	R-R3W2-XHE-F
	5	5.96E-07	8.47E-08	R-R3W2-XHE-F
F5R3W3D6	3	1.50E-07	2.14E-08	R-R3W3-XHE-F
F5R3W3R10	3	2.05E-08	2.91E-09	R-R3W3-XHE-F
	4	2.28E-09		
F5R3W3R6	3	5.63E-07	8.00E-08	R-R3W3-XHE-F
	4	6.26E-08	8.89E-09	R-R3W3-XHE-F
F5R3W4D6	3	4.47E-09		
F5R3W4R10	3	4.20E-07	2.67E-08	R-R3W4-XHE-F
	4	9.81E-07	6.24E-08	R-R3W4-XHE-F
F5R3W4R6	3	1.55E-08	9.91E-10	R-R3W4-XHE-F
	4	3.63E-08	2.31E-09	R-R3W4-XHE-F
TOTAL		3.47E-06	3.81E-07	
Recovery Actions		R-R3W1-XHE-F R-R3W2-XHE-F R-R3W3-XHE-F R-R3W4-XHE-F	Cross- Connecting Charging System to Unit 2	

Table 6-7
Core Damage Frequencies of Flood Event Trees
Spray in Containment

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)
F6R4W1D6	4	-	
	5	-	
F6R4W1R6	4	-	
	5	-	
	6	-	
	9	-	
	10	-	
F6R4W2D6	5	-	
	6	-	
F6R4W2R6	4	-	
	5	-	
	6	-	
	9	-	
	10	-	
F6R4W3D6	5	-	
F6R4W3R10	4	-	
	5	-	
	7	-	
F6R4W3R6	4	-	
	5	-	
	7	-	

Table 6-7 (Continued)
Core Damage Frequencies of Flood Event Trees
Spray in Containment

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)
F6R4W4D6	5	-	
F6R4W4R10	5	-	
	7	-	
F6R4W4R6	5	-	
	7	-	
TOTAL		-	

**Table 6-8 Core Damage Frequencies of Flood Event Trees
Flood in Mechanical Equipment Room No. #3, Two-Unit SBO**

Event Tree	Sequence	Core Damage Frequency w/o Recovery (/yr)	Core Damage Frequency w/ Recovery (/yr)	Recovery Actions
F7B2W1D6	2	3.01E-09		
F7B2W1R6	3	-		
	4	2.02E-10		
F7B2W2D6	2	1.12E-08	1.00E-10	R-B2W2-XHE-S
F7B2W2R6	3	-		
	4	6.19E-09		
F7B2W3D6	2	9.65E-09		
F7B2W3R10	3	-		
	4	-		
F7B2W3R6	3	3.76E-10		
	4	4.92E-10		
F7B2W4D6	2	1.85E-09		
F7B2W4R10	3	1.02E-10		
	4	7.71E-09		
F7B2W4R6	3	-		
	4	2.85E-10		
TOTAL		4.38E-08	3.26E-08	
Recovery Actions	1	R-B2W2-XHE-S	Reflux Cooling	

**Table 6-9 Core Damage Frequencies for Flood Events
Sensitivity Cases**

Options	Core Damage Frequency w/ Recovery				Δ CDF (Base-Total)
	POS 6 Drained	POS 6 Refueling	POS 10 Refueling	Total	
1 - Relocation of Sump Pump Power Supply	2.77E-07	1.83E-06	1.25E-06	3.36E-06	1.75E-06
2 - Watertight Door on ESGR	2.49E-07	1.22E-06	7.13E-07	2.18E-06	2.93E-06
3 - Modification of Intake Level Structure	2.27E-07	7.52E-07	3.08E-07	1.29E-06	3.82E-06
Base Case-Internal Flood Events	3.19E-07	2.75E-06	2.04E-06	5.11E-06	-

Table 6-10
Core Damage Frequencies for Flood Events
Uncertainty Results

Flood Analysis	Core Damage Frequency (/yr)
Point Estimate	5.11E-06
Mean Value	4.80E-06
5% Value	2.18E-07
95% Value	1.78E-05
Median Value	1.71E-06

7. PLANT DAMAGE STATE ANALYSIS

In this section a brief summary is presented on the development and identification of plant damage states for Level 2 analysis. This process delineates the dominant core damage sequences and cutsets into plant damage states (PDSs). The plant damage state analysis involved the identification of detailed PDS categories using a seven state indicator. The event trees discussed in the previous sections assessed the severity of accident consequences, whether or not a core damage occurs. In order to assess the severity of accident consequences, the degree to which containment systems remain operable must also be determined.

7.1 Definition of Plant Damage State Indicators

A total of seven PDS indicators were used to identify the unique plant damage states. The number of cutsets comprising the flood analysis is limited to less than 500 cutsets above the truncation limit of $1.E-10$. This limited number of cutsets allowed to incorporate all of the cutsets into appropriate PDSs. The seven indicators address the following issues:

- Time of accident initiation
- Status of AC power
- Human error
- Status of RCS at onset of core damage
- Status of ECCS
- Status of recirculation spray system
- Status of RWST

The above PDS indicators question the status of various safety system and their actual state is indicated by various letters indicating the possible status of these variables. Table 7-1 lists a more detailed description of the indicators and their possible status with the appropriate letter designations.

7.2 PDS Analysis, Rules

The PDS analysis was based on the previous event tree analysis. All core damage sequences were identified and logic rules were developed to assign the flood sequence cutsets to the various PDSs. The rules were developed and applied in the IRRAS code. The code automatically assigned the flood cutsets into the appropriate PDS according to the specified rules. The final cutset assignment was manually verified to insure full consistency of the results. A total of 35 different PDSs were obtained.

The most dominant PDSs are designated as 2UNLUUN, 3UNLUUY and 4UNLUUN. All of these PDSs describe similar plant damage states with the exception of the status of the RWST and time windows. In general, these PDSs represent large scale flooding of the ESGR resulting in nonrecoverable loss of emergency power (simulated as two unit SBO). It does not involve any human error and mostly occurs in time window 2, 3 or 4, when the RCS may not reach high pressure. The loss of emergency power automatically disables the power for the ECCS and recirculation spray system equipment.

7.3 PDS Uncertainty Analysis

Uncertainty analysis were performed for each of the PDSs utilizing a Monte-Carlo sampling routine in the IRRAS code. The calculations for each PDS were done independently not accounting for effects represented by the sharing of many basic events through the PDSs. The results are listed in Table 7-2.

Table 7-1
Plant Damage State Definitions

PDS Indicator	Status Designator
Time of Accident Initiation	1 - Window 1 2 - Window 2 3 - Window 3 4 - Window 4
Status of AC Power	Y - Available U - Nonrecoverable blackout B - Recoverable blackout (using off-site power) F - Loss of 4 kV Bus
Human Error	N - No human error or nonrecoverable human error D - Diagnosis error A - Action error
Status of RCS at Onset of Core Damage	L - Low pressure G - 5% probability that pressure is high
Status of ECCS	U - Hardware Failure R - Recoverable if human error, LOSP, or 4 kV recovered C - Failure of recirculation
Status of Recirculation Spray System	R - Recoverable U - Nonrecoverable
Status of RWST	Y - Injected R - Recoverable, not injected N - Nonrecoverable, not injected

Table 7-2
Plant Damage States
Results of Uncertainty Analysis

	PDS	POINT	MEAN	5%	MEDIAN	95%
1	1UNGUUN	8.88E-08	6.97E-08	2.20E-09	2.12E-08	2.60E-07
2	1UNGUUY	3.88E-10	2.70E-10	6.96E-13	2.84E-11	1.05E-09
3	1YAGRUR	9.06E-09	9.03E-09	1.09E-10	2.09E-09	3.23E-08
4	1YAGRRY	1.96E-09	1.68E-09	1.14E-11	2.56E-10	5.97E-09
5	1YAGRUR	5.37E-08	5.98E-08	1.29E-09	1.35E-08	2.30E-07
6	1YAGRUY	1.85E-10	1.34E-10	4.24E-13	1.33E-11	4.27E-10
7	1YDGRUR	5.95E-10	5.41E-10	3.37E-12	1.08E-10	2.02E-09
8	1YNGRRR	1.11E-10	8.23E-11	1.06E-13	5.40E-12	3.33E-10
9	1YNGRRY	3.05E-10	2.01E-10	5.17E-13	2.11E-11	7.87E-10
10	1YNGRUR	7.35E-09	7.34E-09	4.73E-11	1.28E-09	2.97E-08
11	1YNGRUY	2.77E-08	2.88E-08	2.02E-10	4.37E-09	9.75E-08
12	2UNLUUN	1.05E-06	1.21E-06	2.65E-08	2.98E-07	4.47E-06
13	2UNLUUY	7.67E-08	6.05E-08	5.70E-10	1.48E-08	2.15E-07
14	2YALRRR	2.31E-08	2.09E-08	2.03E-10	4.88E-09	7.880E-08
15	2YALRRY	3.09E-09	2.92E-09	3.59E-11	6.55E-10	8.53E-09
16	2YALRUR	1.98E-07	1.89E-07	6.15E-09	6.19E-08	7.79E-07
17	2YALRUY	1.14E-08	1.03E-08	7.91E-11	2.01E-09	5.03E-08

Table 7-2 (Continued)
Plant Damage States
Results of Uncertainty Analysis

	PDS	POINT	MEAN	5%	MEDIAN	95%
19	2YDLRUR	3.49E-10	3.22E-10	3.92E-12	7.46E-11	1.14E-09
20	2YNLRRR	3.18E-09	3.11E-09	1.99E-11	4.52E-10	1.13E-08
21	2YNLRRY	8.01E-10	7.97E-10	5.17E-12	1.05E-10	2.84E-09
22	2YNLRUR	1.02E-08	1.27E-08	9.58E-11	1.86E-09	4.22E-08
23	2YNLRUY	1.85E-08	1.59E-08	1.97E-10	3.50E-09	6.73E-08
24	3UNLUUN	1.51E-07	1.84E-07	3.59E-09	4.82E-08	5.79E-07
25	3UNLUUY	1.08E-06	9.83E-07	2.19E-08	2.81E-07	3.92E-06
26	3YALRRR	1.35E-08	1.99E-08	1.96E-10	2.60E-09	3.70E-08
27	3YALRUR	1.94E-07	1.90E-07	6.47E-09	7.01E-08	6.79E-07
28	3YDLRRR	1.07E-09	9.42E-10	2.14E-11	2.85E-10	3.68E-09
29	3YNLRRR	1.82E-10	1.89E-10	1.72E-13	8.87E-12	4.39E-10
30	4UNLUUN	1.89E-06	1.99E-06	1.02E-08	2.34E-07	7.30E-06
31	4UNLUUR	4.88E-09	5.21E-09	1.94E-11	5.09E-10	1.23E-08
32	4YALRRR	1.10E-08	6.98E-09	4.47E-11	9.37E-10	2.86E-08
33	4YALRUR	1.65E-07	1.59E-07	1.93E-09	2.56E-08	5.76E-07
34	4YDLRRR	1.33E-10	1.06E-10	1.17E-13	7.41E-12	3.97E-10
35	4YNLRRR	1.62E-09	1.25E-09	2.14E-12	7.56E-11	4.38E-09

8. CONCLUSIONS AND SUMMARY

The major objective of the Surry internal flood analysis was to provide an improved understanding of the risk arising from internal flood related events. The present analysis concludes that the most dominant contributors to core damage due to internal floods are accident scenarios initiated in the Turbine Building draining the intake canal. This potentially could result in a flood encompassing the plant ESGRs leading to a two unit loss of all emergency power (F1 and F2 scenarios).

The Turbine Building internal flood accident scenarios account for approximately 85% of the total core damage frequency due to internal floods. This result is mainly due to the specific features of the Surry circulating water system and may not be applicable to other plants. The second most dominating flood scenario involves flooding of the Safeguard/Auxiliary Building in combination with the unavailability of the RWST. The contribution of these scenarios (F4 and F5) is approximately 13% of the total internal CDF. These specific findings again may not be generalized to other plants due to the plant-specific nature of the actual evolution of these accident scenarios.

8.1 Plant-Specific Conclusions

The internal flood CDF is dominated by Turbine Building flood events. These events are primarily initiated by either valve or expansion joint failures in the main inlet lines of the circulating water system. These failures may lead to pipe ruptures upstream of the condenser water box and inlet valves. At Surry the circulating water system is gravity fed from a very large capacity intake canal and its isolation may not be accomplished in a timely manner. This is in contrast with other common design arrangement where dedicated pumps provide the required cooling water flow through the system. In that case, by stopping the pumps would effectively isolate the system limiting potential water outflow.

The potential draining of the intake canal inventory in the Turbine Building is risk significant due to a plant-specific spatial interdependence. For both units the ESGRs are located in the Service Building on the same elevation as the Turbine Building basement. These areas are separated by a fire door with 2' high flood dikes in front of them. A large scale flood could potentially overflow the dikes enter into the two unit ESGR leading to the potential loss of both unit emergency power including the loss of RHR stub busses. The normal off-site power supply to the plant would not be affected since the normal SGR is located at higher elevation in the Service Building.

The next important contributor to internal flood CDF is due to flood events originated or entering into the Auxiliary Building. These flood scenarios, mainly supply pipe ruptures from the RWST, result in the loss of all CCW and consequently RHR function at the plant. This coupled with the unavailability of the RWST inventory to be injected into the reactor core leads to core damage. Again, the plant-specific spatial arrangement of piping and equipment is the main reason for the development of the accident scenario and its risk significance.

8.2 Accident Sequence Conclusions

The main results of the flood analysis are presented in Table 8-1 listing the core damage frequencies of the analyzed operating states. The most dominant flood scenario, 85% of the total CDF, is the one occurring in the Turbine Building and overflowing the flood dikes at the unit ESGR causing the loss of all emergency power for the two units (F1 and F2 scenarios).

Conclusions and Summary

The most dominant sequences, F1B2W4R10 - 4, F1B2W2R6 - 4 and F1B2W3R6 - 3, represent large scale flooding of the ESGR initiated in the Turbine Building coupled with the inability of recovering. The flood in the ESGR disables all equipment required for feed-and-bleed operations and thus only reflux cooling and/or gravity feed options may be utilized. However, the primary coolant loops are isolated 70 % in Time Window 2 and 100% of the time in Time Windows 3 and 4, respectively. In these sequences, the pressurizer safety valves are not removed which prevents the use of the gravity feed options. Therefore, these sequences are effectively nonrecoverable except by some "ad hoc" means, which is not taken into account in these analyses.

The second group of accident sequences, F2B2W4R10 - 4, F2B2W2R6 - 4 and F2B2W3R6 - 3, are similar as the first group with the addition of the postulated difficulties in diagnosing accident conditions due to potential damage to the DC panels (instrumentation signals) in the ESGR.

The next most important group of sequences are associated with Auxiliary Building floods, F5R3W2R6 - 5 and F4R3W2R6 - 5. In both cases, the flood is initiated by a pipe rupture draining a large fraction of the RWST inventory into the Safeguard or Auxiliary Building. The flood would eventually collect in the Auxiliary Building basement leading to a loss of CCW and RHR event. Forced feed and bleed is unavailable since the RWST must be isolated. In these sequences, either the RCS loops are isolated or other malfunction prevents the utilization of the steam generators through the reflux cooling technique.

8.3 Uncertainty Considerations

The probabilistic assessment and accident sequence modeling of the plant involves the combination of many individual events representing initiating frequencies, component and operator failures. The core damage frequency estimates are derived by using these individual events which of themselves have in many cases significant uncertainties. The probabilistic accident sequence model may be used to develop importance measures and to calculate the appropriate uncertainty distribution of the individual and the sum of the accident sequence core damage frequencies.

These uncertainty analyses have been completed and the main results of these calculations are listed in Table 8-2 indicating the uncertainty bounds of the core damage frequency due to internal floods. The important measures of the uncertainty distribution are the 5%, mean and 95% values at $2.18\text{E-}07$, $4.80\text{E-}06$ and $1.78\text{E-}05/\text{yr}$, respectively. The mean and point value estimate of the CDF are $4.80\text{E-}06$ and $5.11\text{E-}06/\text{yr}$.

8.4 Other Considerations

Important recovery options are related to the long-term operation of the reflux cooling method (AFW supply) and to the establishment of backup charging flow from Unit 2. The analysis also took credit for uncertainty in the success criterion used for the reflux cooling.

The flood initiating event analysis indicated that the shutdown and specifically the mid-loop operational period does not pose a unique flood risk with the exception of flood events coupled with loop isolation in Time Windows 2, 3 and 4. In general, the risk contribution from flood events is relatively significant and is dominated by potential flood events into the ESGR coupled with loop isolation.

Sensitivity calculations were also completed for a number of proposed options and the results are summarized in Table 8-3. The most effective analyzed options are the installation of watertight doors on the ESGR

Conclusions and Summary

(Option 2) and modification of the intake structure (Option 3), which are capable of reducing the CDF contribution in mid-loop by 57 and 75%, respectively, i.e., $2.18\text{E-}06/\text{yr}$ and $1.29\text{E-}06/\text{yr}$ from the base $5.11\text{E-}06/\text{yr}$.

Conclusions and Summary

Table 8-1
Core Damage Frequencies for Flood Events
Summary

Scenario	Core Damage Frequency w/ Recovery			
	POS 6 Refueling	POS 6 Drained	POS 10 Refueling	Total
Turbine Building F1	1.89E-06	9.29E-08	1.50E-06	3.49E-06
Turbine Building F2	4.49E-07	2.21E-08	3.57E-07	8.28E-07
Auxiliary Building F3	4.65E-08	4.31E-08	1.19E-08	1.02E-07
Auxiliary Building F4	1.55E-07	5.71E-08	6.74E-08	2.80E-07
Safeguard Area F5	1.97E-07	8.92E-08	9.43E-08	3.81E-07
Spray in Containment F6	-	-	-	-
Mechanical Equipment Room No. #3 - F7	1.02E-08	1.46E-08	7.81E-09	3.26E-08
Total-Flood	2.75E-06	3.19E-07	2.04E-06	5.11E-06
Total-Internal Events	1.45E-06	3.12E-06	3.12E-07	4.88E-06

Table 8-2
Core Damage Frequencies for Flood Events
Uncertainty Results

Flood Analysis	Core Damage Frequency (/yr)
Point Estimate	5.11E-06
Mean Value	4.80E-06
5% Value	2.18E-07
95% Value	1.78E-05
Median Value	1.71E-06

Conclusions and Summary

Table 8-3
Core Damage Frequencies for Flood Events
Sensitivity Cases, Summary

Options	Core Damage Frequency w/ Recovery				Δ CDF (Base-Total)
	POS 6 Drained	POS 6 Refueling	POS 10 Refueling	Total	
1 - Relocation of Sum Pump Power Supply	2.77E-07	1.83E-06	1.25E-06	3.36E-06	1.75E-06
2 - Watertight Door on ESGR	2.49E-07	1.22E-06	7.13E-07	2.18E-06	2.93E-06
3 - Modification of Intake Level Structure	2.27E-07	7.52E-07	3.08E-07	1.29E-06	3.82E-06
Base Case-Internal Flood Events	3.19E-07	2.75E-06	2.04E-06	5.11E-06	-

**Appendix A
Equipment Locations**

Appendix A Equipment Locations

Tag #	Description
Containment	
Elevation : -27'-7"	
Recirculation Spray Pumps	Top of containment sump screen
HCV - 1310A	
MOV -1701	
FCV - 1605	
MCV - 1758	
MOV - 1720 A & B	
LT - 1797	Steam Generator level monitor
1 - RH - 25	
1 - RH - 29	
RS coolers	HX inside crane wall, SW side of Containment
Accumulators	
MOV - 1865 A/B/C	Accumulator discharge valves
Sump Pumps	(1) in-core instrumentation room, (2) containment sump, (3) primary vent, (4) primary drain transfer pump
Primary drain transfer tank and HX 1-IA-TK-2A/B	Compressed air tanks near accumulator 1A
Elevation : -13'-0"	
1-RHR-P-1A,1B	RHR pumps + motors
1-CC-185	
1-CC-182	
1-CC-178	
1-CC-181	
1-CC-110	

Appendix A Equipment Locations

Tag #	Description
1-CC-112	
1-CC-122	
1-CC-118	
Excess letdown HX	
Elevation : -3'-6"	
LCV - 1460 A,B	Letdown isolation
MCV - 1200 A,B,C	Letdown isolation
MCV - 1142	
MOV - 1700	
PT - 1402-1 PT - 1449 TE - 1413-2,1423-2,1433-1 TE - 1410-A,1420-A,1430 LT - 1477A,1487A	Instrumentation
Regenerative HX	Behind PRT
Elevation : 18'-4"	
PT-MS137A,B	Steam Generator pressure
LT-1459A,1461	Pressurizer Level
RCPC-4C	Communication antenna
Elevation : 47'-4"	
MOV-FW-151 A,B,C,D,E	AFW valves
SV-1551 A,B,C	Pressurizer Safety Valves
Safeguards Area	
Elevation : -3'-6"	

Appendix A Equipment Locations

Tag #	Description
AFW-1-FW-P-4A,B	AFW Booster Pumps
PT-MS-101 A,B,C EP-MS-101 A,B,C	Regulators
1-IA-C-4A/B	Instrument Air
1-IA-D-4A/B	Instrument Air
Elevation : -27' Valve Pit	
LHSI pumps	
MOV-1860 A/B	
Valve pit leakoff pot	
Elevation : 12'	
RS pumps	
MOV -18621 A/B	
MOV -1864 A/B	
MOV -1890 A/B/C	
Safeguard area sump pumps	
Elevation : 19'	
MOV - 1885 A/B/C/D	
Elevation : 18'-4"	
MOV-CS101A	
1-CS-P-1A, 1B	Containment Spray Pumps
MOV-CS-100A	
1-FW-P-2, 3A, 3B	AFW Pumps Turbine + 2 Motor Driven
PCV-MS102A, B	Steam to AFW Pumps

Appendix A Equipment Locations

Tag #	Description
RV-MS101A, B, C	SG PORV
MOV-260A, B	AFW Cross-connect valves
TV-MS-101A, B, C	Main Steam Isolation Valves
1-FW-288, 119, 120, 185, 169, 140 -154, 184	
1-RS-P-2A, B	Recirculation Spray Pumps
1-SI-P-1A, 1B	SI Pumps
Refueling Recirculation Pumps	
PT-1474, 1485, 1496 PT-MS137A, B	SG Pressure Instrumentation
Auxiliary Building	
Elevation : 2'-0"	
MOV-1275 A,B,C	
MOV-1289 A/B	
FCV-1172	
MOV-1373	
1-CH-728	Charging Xconnect
2-CH-447	Charging Xconnect
1-CH-294,297,300	Seal water supply
TV-CC-109A,B MOV-1370	
MOV-1381	
MOV-1286 A/B/C	
MOV-1267A,1269A,1270A	
1-CH-P-1A,B,C	Charging pumps
TCV-SW108A/B/C	
1-CC-P-1A/B/C/D	CCW pumps
1-CC-P-2A/B	Charging pump cooling water pump

Appendix A Equipment Locations

Tag #	Description
TV-SI-102 A/B	
HCV-1186	
1-CC-104,108	
MOV-1287A/B/C	
1-RT-P-1A/B/C	SG recirc. and transfer pumps
1-RT-AX-1A/B/C	SG recirc. and transfer coolers
Charging pump seal cooling surge tank	
Intermediate seal coolers	
Charging pump lube oil coolers	
CH/HHSI pumps	in charging pump cubicles
MOV-1115 D/E MOV-1863 A/B MOV-1867 C/D MOV-1869 A/B MOV-1842	HHSI suction from RWST, in "C" CH pump cubicle. (LHSI to HHSI XTIE) in "B" CH pump cubicle, upper level. (HHSI to cold leg) penetration area (HHSI to hot leg) penetration area (HHSI to cold leg) penetration area
Non-regenerative HX	
Letdown filter	
Seal water injection filters	
Seal water HX	
Aux. Bldg. sump pumps	
Elevation : 13'-0"	
LCV-1115E(C)	
MOD-101A/B/C	
RCPC-4C	Communication Antenna
RV-MS-10.A/B/C	SG PORV isolation panel
LCV-1115D	Charging pump suction from RWST

Appendix A Equipment Locations

Tag #	Description
LCV-1115B	Charging pump suction from RWST
480 MCC 1H1-2	
480 MCC 1J1-2	
Non-regenerative HX (first & second floor)	
Demineralizes	
RCS filter	
Seal water return filter	
Boric Acid Tank (2nd & 3rd fl)	
Boric Acid Batching Tank	
Boric Acid Transfer pump	
Boric Acid Filter	
Elevation 27'-6"	
HT-T-2A3	Heat tracing distr. panel
Emergency communication PWR XFER SW	
1-CD-E-1A/B/C	Aux. Bldg. 3rd Fl. west side
CCW surge tank	
chemical addition tank	
1-CV-P-1A/B	chilled CCW pumps
1-CV-HX-1A/B	chilled CCW coolers
containment vacuum pump	
Hydrostatic Test pump	
Radiation monitors CH-128/129	
Volume Control Tank	
Chemical Mixing Tank	
MCC-1A2-1 (West)	

Appendix A Equipment Locations

Tag #	Description
MCC-1C2-1	
Elevation : 45'-10"	
AOD-VS-103A/B	
AOD-VS-101A/B	
MOD-VS-100A/B	
AOD-VS-107A/B	
AOD-VS-108	
AOD-VS-111A/B	
MOD-VS-58A/B	
1-VS-F-9A/B	Exhaust fan
1-VS-F-58A/B	Filtered exhaust fan
1-VS-DMP-60A/B,61A/B	
Starter 588 for 1-VS-F-58B	
Telecommunication system repeaters	
Containment vacuum air ejector	47' Level
Service Building	
Elevation 58'-0" Unit 1 Switchgear Room	
4160 VAC Bus 1A, 1B, 1C	
Transfer Bus D,E,F	
480 VAC Bus 1A1,1A2 480 VAC Bus 1B1,1B2 480 VAC Bus 1C1,1C2	
MCC-1B2-1	(West)
MCC-1C1-2	(West)

Appendix A Equipment Locations

Tag #	Description
Elevation : 42', 45', 47' Mech. Eq. Room 1 & 2	
PNL REM & RMP-1	Remote monitoring panel
1-VS-E-3A/B	Central chiller
1-VS-247	
1-VS-251	
1-VS-E-3A/B	Power transfer cabinet
1-VS-P-3A/B	Central chilled water pump
Antenna for station operations	
1-repeater-AE, 1-Repeater-A	Telecommunication repeaters
FW regulating valves	
FW regulating bypass valves	
MOV-154 A/B/C	
water source/chillers cable spreading & Mech. Eq. Room Penetration to MCR	Sealed
Elevation 27'-0" MCR + Computer Room	
Vital Bus CAB 1-1 1-III 1-IV 1-III	
1-SVB-1-Semi-vital bus & transformer	
1-VS-AC-1,2,8,9	Air conditioning
Diesel-Generator Area	
Emergency DG-1/2/3	
Emergency DG control cab-1/2/3	
DIP-DGRM-Local control panel 1/2	

Appendix A Equipment Locations

Tag #	Description
1-EE-EG-1/2 2-EE-EG-1	Control cabinet
MCC-1H1-1A	
MCC-1J1-1A	
MCC-2H1-1A	
Elevation - 9'-6" Emergency Switchgear Room	
4160 VAC Emergency buses 1H/1J	
480 VAC Emergency buses 1H/1J	
480 Emergency buses 1H1/1J1	(includes Stub bus 1H/1J)
MCC 1H1-1 and 1J1-1	
Vital buses 1-IA, IIA, IIIA, IVA	
DC Buses 1A, 1B, DC Sub panel 1B	
Station Batteries 1A, 1B	
UPS 1B-1, 1B2	
UPS 1A1, 1A-2	
Generator relay cabinet	
Aux SHTD PNL	
Elevation 9'-6" Mechanical Eq Rm No. #3	
2-SW-443	CPSW pump cross-connect
1-SW-P-108	Charging PMP SW Pump
1-VS-P-1C	Condenser water pump
PCV-SW-100C	
2-IA-1106/1107/1108/1109	Vacuum Breaker Trip Valves
MOV-PG-107C	
1-VS-E-4C	Chiller

Appendix A Equipment Locations

Tag #	Description
1-VS-P-2C	Chilled water pump
Turbine Building	
Elevation 9'and 6" Mechanical Eq. Room 3	
1-SW-269	CPSW Cross Connect
1-SW-P-10A/B	Charging PMP SW pump
Elevation, Ground Floor : 9'-6"	
MOV-SW-181 A/B MOV-SW-182 A/B	
MOV-CW-180 A/B/C/D	
MCC-1A1-2, 1A2-3	(West)
MCC-1B1-3	(West)
MCC-1B2-2	(East)
1-BD-E-1A,1B,2A,2B,1C,2C	Blowdown HX (East wall)
Main FW pumps	
MOV-150 A/B	FW valves, West
FCV-150 A/B	next to MFW pumps
FW heaters-vertically in basement	
CCW HX	
Component cooling radiation monitors	
BC-P-1A/B	Brg cooling water pump
BC-P-2	
BRG coolers	
SW-P-4A/B	SW pumps
Condensate pumps	

Appendix A Equipment Locations

Tag #	Description
Elevation : 29', 35', 50' Mezzanine	
1-AS-3, 19,28	
MOV-CW-186A/B/C/D	
TCV-MS-105A/B, 106A/B 107A/B, 108A/B	Steam Dump Valves
FCV-MS-104A/B/C/D	
PCV-AS-108	
1-VP-AOV-220E1/E2/F1/F2 1-VP-AOV-220G1/G2/H1/H2	Vacuum Breakers
MCC-1A2-2	West
MCC-1C2-2	West
1-CD-REF-1A/B	Chilled water, northwest corner
1-CD-P-4A/B/C	Chilled water circulating pump
1-SW-P-13A/B	in Mech. Eq. Room 3
Gland seal condenser Main air ejectors Hogger ejectors	
Elevation : 58'6" Operating Floor	
TV-MS-1,2,3,4	Turbine stop valve
1-CD-TK-1A/B	chilled water tank - north
Intake Structure	
1-CW-P-1A/B/C/D 1-CW-P-2A/B/C/D	Circulating water pumps
1-SW-P-1A/B/C	
Control Panel P-1A/B/C	

Appendix B
High Level System Fault Trees

Gravity from RWST in B2, Window 1

B-2

Gravity from RWST in B2, Window 2

B-3

Gravity from RWST in B2, Window 3

Gravity from RWST in B2, Window 4

B-5

1 Top Event for B2 LOSP – B2 in Window 1

I Top Event for B2 LOSP – B2 in Window 2

1 Top Event for B2 LOSP – B2 in Window 3

B-8

I Top Event for B2 LOSP – B2 in Window 4

B-9

Gravity from RWST in B2, Window 1

Gravity from RWST in B2, Window 1

Gravity from RWST in B2, Window 3

Gravity from RWST in B2, Window 4

B-13

I Top Event for B2 LOSP – B2 in Window 2

I Top Event for B2 LOSP – B2 in Window 3

I Top Event for B2 LOSP – B2 in Window 4

Failure of High Pressure Recirculation in Window 1

B-18

B-19

Failure of High Pressure Recirculation in Window 2

B-21

Feed and Bleed the RCS in RHR3, Window 1

Feed and Bleed the RCS with V failed in RHR3, Window 1

B-24

Feed and Bleed the RCS with V failed in RHR3, Window 2

Feed and Bleed the RCS in RHR3, Window 3

Feed and Bleed the RCS with V failed in RHR3, Window 3

Feed and Bleed the RCS in RHR3, Window 4

Feed and Bleed the RCS with V failed in RHR2B, Window 4

Gravity from RWST in RHR3, Window 1

Gravity from RWST in RHR3, Window 1

Gravity from RWST in RHR3, Window 3

Gravity from RWST in RHR3, Window 4

B-34

1 Top Event for Loss of RHR- R3 in Window 3

B-36

Top Event for Loss of RHR in Window 4

B-37

Failure of Recirculation Spray in Window 1—cause HPR failure

Failure of Recirculation Spray in Window 1—cause HPR failure

Failure of Recirculation Spray in Window 2—cause HPR failure

Failure of Recirculation Spray in Window 2—cause HPR failure

Reflux Cooling in Window 1

B-42

Reflux Cooling in Window 2

Reflux Cooling in Window 3

B-45

Gravity from RWST in RHR3, Window 1

Gravity from RWST in RHR3, Window 1

Gravity from RWST in RHR3, Window 3

Gravity from RWST in RHR3, Window 4

1 Top Event for Loss of RHR - R3 in Window 1

1 Top Event for Loss of RHR-R3 in Window 2

B-51

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

4 of 5

I Top Event for Loss of RHR- R3 in Window 3

B-52

[illegible]

Reflux Cooling in Window 1

B-54

Reflux Cooling in Window 2

Reflux Cooling in Window 3

B-56

Reflux Cooling in Window 4

B-57

Gravity from RWST in RHR3, Window 1

Gravity from RWST in RHR3, Window 1

Gravity from RWST in RHR3, Window 3

B-60

Gravity from RWST in RHR3, Window 4

I Top Event for Loss of RHR- R3 in Window 1

1 Top Event for Loss of RHR- R3 in Window 3

B-64

I Top Event for Loss of RHR in Window 4

B-65

Reflux Cooling in Window 1

B-66

Reflux Cooling in Window 2

B-67

Reflux Cooling in Window 3

B-68

Reflux Cooling in Window 4

B-69

Failure of High Pressure Recirculation in Window 1

B-70

Failure of High Pressure Recirculation in Window 1

B-71

Failure of High Pressure Recirculation in Window 2

Failure of High Pressure Recirculation in Window 2

B-73

Feed and Bleed the RCS in RHR4, Window 1

Feed and Bleed the RCS with V Failed in RHR4, Window 1

Feed and Bleed the RCS in RHR4, Window 2

Feed and Bleed the RCS with V Failed in RHR4, Window 2

Feed and Bleed the RCS in RHR5, Window 3

Feed and Bleed the RCS with V Failed in RHR4, Window 3

Feed and Bleed the RCS in RHR4, Window 4

Gravity from RWST in RHR4, Window 1

Gravity from RWST in RHR4, Window 2

Gravity from RWST in RHR5, Window 3

B-83

Gravity from RWST in RHR4, Window 4

I Top Event for Loss of RHR- R4 in Window 1

B-85

I Top Event for Loss of RHR- R4 in Window 2

I Top Event for Loss of RHR-4 in Window 3

B-87

I Top Event for Loss of RHR-4 in Window 4

Failure of Recirculation Spray in Window 1 due to HPR failure

Failure of Recirculation Spray in Window 1—cause HPR failure

Failure of Recirculation Spray in Window 2-cause HPR failure

Failure of Recirculation Spray in Window 2—cause HPR failure

Restore RHR given RHR4 in Window 1

Restore RHR given RHR4 in Window 2

Restore RHR given RHR4 in Window 3

Restore RHR given RHR4 in Window 4

Reflux Cooling in window 1

Reflux Cooling in window 2

Reflux Cooling in window 4

Reflux Cooling in window 4

B-100

Safety Valves not Removed in Window 1

Safety Valves not Removed in Window 2

Safety Valves not Removed in Window 3

Safety Valves not Removed in Window 4

Gravity from RWST in B2, Window 1

B-105

Gravity from RWST in B2, Window 2

Gravity from RWST in B2, Window 3

Gravity from RWST in B2, Window 4

B-109

I Top Event for B2 LOSP – B2 in Window 2

I Top Event for B2 LOSP – B2 in Window 3

B-111

I Top Event for B2 LOSP – B2 in Window 4

Appendix C

Flow Exceedance Frequency Curves

Exceedance Frequency

Turb. Bldg. - SW Events

Exceedance Frequency

Aux. Bldg.

Appendix D
Dominant Cutsets and Basic Event Importance

Appendix D.1
Dominant Cutsets without Recovery Actions

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
1	12.5	12.5	2.135E-006	UNITY, FREQ-F1B2, PROB-W2D6, DR-MT, DURATION-D6
2	23.2	10.7	1.836E-006	UNITY, FREQ-F1B2, PROB-W3D6, DR-MT, DURATION-D6
3	31.9	8.6	1.468E-006	UNITY, REFUEL, FREQ-F1B2, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
4	38.8	6.9	1.179E-006	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, /PZR-SV-REMOVEDW2, PROB-W2R6
5	44.5	5.7	9.817E-007	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F5RHR3, FRAC-POS10, DURATION-R10
6	49.5	4.9	8.431E-007	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, PZR-SV-REMOVEDW3, PROB-W3R6
7	53.6	4.1	7.019E-007	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F4RHR3, FRAC-POS10, DURATION-R10
8	57.0	3.3	5.728E-007	UNITY, FREQ-F1B2, PROB-W1D6, DR-MT, DURATION-D6
9	60.3	3.3	5.638E-007	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F5RHR3
10	63.5	3.2	5.517E-007	UNITY, LOOPISOLATED2R6, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
11	66.5	2.9	5.070E-007	UNITY, PROB-W2D6, FREQ-F2B2, DR-MT, DURATION-D6
12	69.0	2.5	4.361E-007	UNITY, PROB-W3D6, FREQ-F2B2, DR-MT, DURATION-D6
13	71.5	2.4	4.207E-007	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F5RHR3, FRAC-POS10, DURATION-R10
14	73.9	2.3	4.031E-007	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F4RHR3
15	76.2	2.3	3.945E-007	UNITY, LOOPISOLATED2R6, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
16	78.4	2.2	3.831E-007	UNITY, PROB-W1D6, FREQ-F5RHR3, DR-MT, DURATION-D6
17	80.5	2.0	3.525E-007	UNITY, FREQ-F1B2, PROB-W4D6, DR-MT, DURATION-D6
18	82.5	2.0	3.486E-007	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F2B2, FRAC-POS10, DURATION-R10
19	84.3	1.7	3.008E-007	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F4RHR3, FRAC-POS10, DURATION-R10
20	85.9	1.6	2.799E-007	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F2B2
21	87.6	1.6	2.739E-007	UNITY, PROB-W1D6, FREQ-F4RHR3, DR-MT, DURATION-D6
22	88.7	1.1	2.002E-007	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F2B2
23	89.5	0.8	1.360E-007	UNITY, PROB-W1D6, FREQ-F2B2, DR-MT, DURATION-D6
24	90.1	0.5	9.368E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, /PZR-SV-REMOVEDW3, PROB-W3R6
25	90.6	0.4	8.372E-008	UNITY, PROB-W4D6, FREQ-F2B2, DR-MT, DURATION-D6
26	91.0	0.4	7.074E-008	UNITY, FREQ-F3RHR3, PROB-W1D6, A-F3R3W1-X-FL-9, DR-MT, DURATION-D6
27	91.4	0.3	6.265E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F5RHR3
28	91.7	0.3	6.203E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
29	92.0	0.3	5.438E-008	PZR-SV-REMOVEDW2, PROB-W2R6
30	92.3	0.3	5.363E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, /PZR-SV-REMOVEDW4, PROB-W4R6
31	92.6	0.2	4.987E-008	UNITY, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, LPR-CCF-PG-SUMP2
32	92.9	0.2	4.479E-008	UNITY, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-9
33	93.1	0.2	4.148E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F4RHR3
34	93.4	0.2	4.008E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
35	93.6	0.2	3.845E-008	UNITY, REFUEL, FREQ-F3RHR3, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, A-F3R3W4-X-FL-7, DURATION-R10
36	93.8	0.2	3.637E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, PROB-W1R6, /PZR-SV-REMOVEDW1
37	94.0	0.1	3.283E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F5RHR3
38	94.2	0.1	3.283E-008	UNITY, SGB-DRAINED-R, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
39	94.4	0.1	3.069E-008	UNITY, SGA-DRAINED-R, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
40	94.6	0.1	3.006E-008	UNITY, REFUEL, FREQ-F1B2, PZR-SV-REMOVEDW3, PROB-W3R10, FRAC-POS10, DURATION-R10
41	94.7	0.1	2.966E-008	UNITY, PROB-W2D6, FREQ-F5RHR3, DR-MT, A-F5R3W2-X-S1-8, A-F5R3W2-X-S2-8, DURATION-D6
42	94.9	0.1	2.824E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
43	95.1	0.1	2.824E-008	UNITY, SGB-DRAINED-R, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
44	95.2	0.1	2.600E-008	UNITY, SGA-DRAINED-R, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
45	95.4	0.1	2.586E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F4RHR3
46	95.5	0.1	2.347E-008	UNITY, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6, A-F5R3W3-X-S1-7, A-F5R3W3-X-S2-7
47	95.6	0.1	2.347E-008	UNITY, SGB-DRAINED-R, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
48	95.8	0.1	2.225E-008	UNITY, SGA-DRAINED-R, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
49	95.9	0.1	2.052E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F2B2
50	96.0	0.1	2.028E-008	UNITY, REFUEL, PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F5RHR3, FRAC-POS10, DURATION-R10
				UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6,

Partition Cut Set Report

Family->FLOOD/WINDOW

Mincut Upper Bound -> 1.704E-005

End State ->CD

This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
51	96.1	0.1	2.019E-008	PZR-SV-REMOVEDW3, PROB-W3R6, A-F3R3W3-X-FL-3, UNITY, SGB-DRAINED-R, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
52	96.3	0.1	2.019E-008	UNITY, SGA-DRAINED-R, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
53	96.4	0.1	1.950E-008	UNITY, REFUEL, A-F1B2W4-X-G-4, FREQ-F1B2, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
54	96.5	0.1	1.660E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3, A-F5R3W2-X-S1-8, A-F5R3W2-X-S2-8
55	96.6	0.1	1.638E-008	UNITY, FREQ-F3RHR3, PROB-W1D6, DR-MT, DURATION-D6, A-F3R3W1-X-C-8
56	96.7	0.0	1.570E-008	UNITY, PROB-W2D6, FREQ-F5RHR3, DR-MT, A-F5R3W2-X-SF-8, DURATION-D6
57	96.7	0.0	1.559E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F5RHR3
58	96.8	0.0	1.473E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F2B2
59	96.9	0.0	1.467E-008	UNITY, REFUEL, PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F4RHR3, FRAC-POS10, DURATION-R10
60	97.0	0.0	1.351E-008	UNITY, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6, A-F5R3W3-X-SF-7
61	97.1	0.0	1.291E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F2B2
62	97.1	0.0	1.122E-008	UNITY, PROB-W2D6, FREQ-F7B2, DR-MT, DURATION-D6
63	97.2	0.0	1.114E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F4RHR3
64	97.3	0.0	1.071E-008	UNITY, MSS-AOV-FC-101B, MSS-NRV-MA-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
65	97.3	0.0	1.071E-008	UNITY, MSS-AOV-FC-101A, MSS-NRV-MA-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
66	97.4	0.0	9.650E-009	UNITY, PROB-W3D6, FREQ-F7B2, DR-MT, DURATION-D6
67	97.4	0.0	9.369E-009	UNITY, PROB-W2D6, FREQ-F4RHR3, A-F4R3W2-X-S1-8, A-F4R3W2-X-S2-8, DR-MT, DURATION-D6
68	97.5	0.0	9.209E-009	UNITY, MSS-AOV-FC-101B, MSS-NRV-MA-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
69	97.6	0.0	9.209E-009	UNITY, MSS-AOV-FC-101A, MSS-NRV-MA-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
70	97.6	0.0	9.136E-009	UNITY, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6, D-F5R3W2-XHE
71	97.7	0.0	9.133E-009	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F2B2
72	97.7	0.0	8.880E-009	UNITY, PROB-W2D6, FREQ-F4RHR3, A-F4R3W2-X-SF-8, DR-MT, DURATION-D6
73	97.8	0.0	8.670E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3, A-F5R3W2-X-SF-8

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
74	97.8	0.0	8.059E-009	UNITY, PROB-W3D6, FREQ-F4RHR3, A-F4R3W3-X-S1-7, A-F4R3W3-X-S2-7, DR-MT, DURATION-D6
75	97.9	0.0	7.858E-009	UNITY, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6, D-F5R3W3-XHE
76	97.9	0.0	7.716E-009	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F7B2, FRAC-POS10, DURATION-R10
77	97.9	0.0	7.715E-009	UNITY, REFUEL, DURATION-R6, PROB-W1R6, LOOPISOLATED1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
78	98.0	0.0	7.655E-009	UNITY, MSS-AOV-FC-101B, MSS-NRV-MA-101B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
79	98.0	0.0	7.655E-009	UNITY, MSS-AOV-FC-101A, MSS-NRV-MA-101A, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
80	98.1	0.0	7.637E-009	UNITY, PROB-W3D6, FREQ-F4RHR3, A-F4R3W3-X-SF-7, DR-MT, DURATION-D6
81	98.1	0.0	7.289E-009	UNITY, REFUEL, PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F2B2, FRAC-POS10, DURATION-R10
82	98.2	0.0	6.584E-009	UNITY, MSS-AOV-FC-101B, MSS-NRV-MA-101B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
83	98.2	0.0	6.584E-009	UNITY, MSS-AOV-FC-101A, MSS-NRV-MA-101A, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
84	98.2	0.0	6.543E-009	UNITY, REFUEL, FREQ-F3RHR3, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, A-F3R3W4-X-FL-4, DURATION-R10
85	98.3	0.0	6.542E-009	UNITY, REFUEL, SGS-DRAINED-R, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
86	98.3	0.0	6.435E-009	UNITY, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-C-8
87	98.4	0.0	6.195E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F7B2
88	98.4	0.0	5.678E-009	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, A-F2B2W4-X-G-4, FREQ-F2B2, FRAC-POS10, DURATION-R10
89	98.4	0.0	5.663E-009	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, A-F3R3W3-X-FL-7
90	98.4	0.0	5.516E-009	UNITY, REFUEL, DURATION-R6, PROB-W1R6, LOOPISOLATED1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
91	98.5	0.0	5.173E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3, A-F4R3W2-X-S1-8, A-F4R3W2-X-S2-8
92	98.5	0.0	5.044E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3, D-F5R3W2-XHE
93	98.5	0.0	4.903E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3, A-F4R3W2-X-SF-8
94	98.6	0.0	4.741E-009	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
95	98.6	0.0	4.677E-009	UNITY, REFUEL, SGS-DRAINED-R, DURATION-R6,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
96	98.6	0.0	4.078E-009	/PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
97	98.6	0.0	4.032E-009	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
98	98.7	0.0	3.723E-009	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, LPR-CCF-PG-SUMP2
99	98.7	0.0	3.569E-009	UNITY, FREQ-F3RHR3, PROB-W1D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP1
100	98.7	0.0	3.569E-009	UNITY, MSS-NRV-MA-101B, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
101	98.7	0.0	3.410E-009	UNITY, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
102	98.7	0.0	3.390E-009	UNITY, REFUEL, FREQ-F1B2, /PZR-SV-REMOVEDW3, PROB-W3R10, FRAC-POS10, DURATION-R10
103	98.8	0.0	3.191E-009	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
104	98.8	0.0	3.191E-009	UNITY, FREQ-F3RHR3, SGB-DRAINED-R, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
105	98.8	0.0	3.070E-009	UNITY, FREQ-F3RHR3, SGA-DRAINED-R, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
106	98.8	0.0	3.070E-009	UNITY, MSS-NRV-MA-101B, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
107	98.8	0.0	3.011E-009	UNITY, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
108	98.9	0.0	2.968E-009	UNITY, PROB-W1D6, FREQ-F7B2, DR-MT, DURATION-D6
109	98.9	0.0	2.968E-009	UNITY, FREQ-F3RHR3, SGB-DRAINED-R, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
110	98.9	0.0	2.916E-009	UNITY, FREQ-F3RHR3, SGA-DRAINED-R, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
111	98.9	0.0	2.916E-009	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3, A-F5R3W1-X-S1-8, A-F5R3W1-X-S2-8
112	98.9	0.0	2.863E-009	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
113	98.9	0.0	2.789E-009	UNITY, REFUEL, LPI-MDP-FS-S11B, FREQ-F3RHR3, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
114	99.0	0.0	2.784E-009	UNITY, LOOPISOLATED2R6, REFUEL, LPR-MOV-FT-1862B, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6
115	99.0	0.0	2.784E-009	UNITY, MSS-AOV-FC-101B, SSHR-AOV-XHE-105, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
116	99.0	0.0	2.618E-009	UNITY, MSS-AOV-FC-101A, SSHR-AOV-XHE-105, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
117	99.0	0.0	2.552E-009	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
				UNITY, MSS-NRV-MA-101B, MSS-AOV-MA-101B,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
118	99.0	0.0	2.552E-009	PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6 UNITY, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
119	99.0	0.0	2.394E-009	UNITY, MSS-AOV-FC-101B, SSHR-AOV-XHE-105, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
120	99.0	0.0	2.394E-009	UNITY, MSS-AOV-FC-101A, SSHR-AOV-XHE-105, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
121	99.1	0.0	2.280E-009	UNITY, REFUEL, /PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F5RHR3, FRAC-POS10, DURATION-R10
122	99.1	0.0	2.195E-009	UNITY, MSS-NRV-MA-101B, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
123	99.1	0.0	2.195E-009	UNITY, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
124	99.1	0.0	2.141E-009	UNITY, MSS-AOV-FC-101B, CIR-COND-UNAVLBL, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
125	99.1	0.0	2.141E-009	UNITY, MSS-AOV-FC-101A, CIR-COND-UNAVLBL, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
126	99.1	0.0	1.990E-009	UNITY, MSS-AOV-FC-101B, SSHR-AOV-XHE-105, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
127	99.1	0.0	1.990E-009	UNITY, MSS-AOV-FC-101A, SSHR-AOV-XHE-105, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
128	99.1	0.0	1.936E-009	UNITY, LPR-MOV-FT-1862B, FREQ-F3RHR3, PROB-W1D6, DR-MT, DURATION-D6
129	99.2	0.0	1.887E-009	UNITY, REFUEL, LPR-MOV-FT-1890B, FREQ-F1B2, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
130	99.2	0.0	1.872E-009	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
131	99.2	0.0	1.853E-009	UNITY, PROB-W4D6, FREQ-F7B2, DR-MT, DURATION-D6
132	99.2	0.0	1.842E-009	UNITY, MSS-AOV-FC-101B, CIR-COND-UNAVLBL, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
133	99.2	0.0	1.842E-009	UNITY, MSS-AOV-FC-101A, CIR-COND-UNAVLBL, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
134	99.2	0.0	1.768E-009	UNITY, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6, A-F5R3W4-X-SF-7
135	99.2	0.0	1.712E-009	UNITY, MSS-AOV-FC-101B, SSHR-AOV-XHE-105, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
136	99.2	0.0	1.712E-009	UNITY, MSS-AOV-FC-101A, SSHR-AOV-XHE-105, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
137	99.2	0.0	1.644E-009	UNITY, REFUEL, LPI-MDP-FS-SI1B, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6
138	99.2	0.0	1.630E-009	UNITY, REFUEL, /PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F4RHR3, FRAC-POS10, DURATION-R10
139	99.3	0.0	1.609E-009	UNITY, LOOPISOLATED2R6, REFUEL, LPR-MOV-FT-1860B, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
140	99.3	0.0	1.609E-009	UNITY, LOOPISOLATED2R6, REFUEL, LPI-MDP-FS-SI1B, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6
141	99.3	0.0	1.531E-009	UNITY, MSS-AOV-FC-101B, CIR-COND-UNAVLBL, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
142	99.3	0.0	1.531E-009	UNITY, MSS-AOV-FC-101A, CIR-COND-UNAVLBL, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
143	99.3	0.0	1.505E-009	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
144	99.3	0.0	1.492E-009	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-4
145	99.3	0.0	1.485E-009	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6, A-F3R3W4-X-FL-7
146	99.3	0.0	1.428E-009	UNITY, PROB-W2D6, SGS-DRAINED-CSD, FREQ-F5RHR3, DR-MT, DURATION-D6
147	99.3	0.0	1.428E-009	UNITY, AFW-CKV-OO-CV142, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
148	99.3	0.0	1.425E-009	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PROB-W1R6, LOOPISOLATED1R6, /PZR-SV-REMOVEDW1, A-F3R3W1-X-FL-9
149	99.3	0.0	1.317E-009	UNITY, MSS-AOV-FC-101B, CIR-COND-UNAVLBL, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
150	99.4	0.0	1.317E-009	UNITY, MSS-AOV-FC-101A, CIR-COND-UNAVLBL, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
151	99.4	0.0	1.295E-009	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
152	99.4	0.0	1.274E-009	UNITY, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-S1-8, A-F3R3W2-X-S2-8, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
153	99.4	0.0	1.228E-009	UNITY, PROB-W3D6, SGS-DRAINED-CSD, FREQ-F5RHR3, DR-MT, DURATION-D6
154	99.4	0.0	1.228E-009	UNITY, AFW-CKV-OO-CV142, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
155	99.4	0.0	1.227E-009	UNITY, REFUEL, LPI-MDP-FS-SI1B, FREQ-F3RHR3, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
156	99.4	0.0	1.185E-009	UNITY, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, A-F3R3W2-X-S1-8, A-F3R3W2-X-S2-8, DR-MT, DURATION-D6
157	99.4	0.0	1.138E-009	UNITY, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-SF-8, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
158	99.4	0.0	1.117E-009	UNITY, LPI-MDP-FS-SI1B, FREQ-F3RHR3, PROB-W1D6, DR-MT, DURATION-D6
159	99.4	0.0	1.117E-009	UNITY, LPR-MOV-FT-1860B, FREQ-F3RHR3, PROB-W1D6, DR-MT, DURATION-D6
160	99.4	0.0	1.076E-009	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
161	99.4	0.0	1.073E-009	UNITY, LOOPISOLATED2R6, REFUEL, PPS-MOV-FT-1536, FREQ-F3RHR3, DURATION-R6, PORV-PATH-CLSD, /PZR-SV-REMOVEDW2, PROB-W2R6
162	99.4	0.0	1.058E-009	UNITY, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, A-F3R3W2-X-SF-8, DR-MT, DURATION-D6
163	99.4	0.0	1.041E-009	UNITY, MSS-AOV-FC-101B, FREQ-F3RHR3, MSS-NRV-MA-101B, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
164	99.4	0.0	1.041E-009	UNITY, MSS-AOV-FC-101A, FREQ-F3RHR3, MSS-NRV-MA-101A, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
165	99.5	0.0	1.021E-009	UNITY, PROB-W2D6, SGS-DRAINED-CSD, FREQ-F4RHR3, DR-MT, DURATION-D6
166	99.5	0.0	1.021E-009	UNITY, AFW-CKV-OO-CV142, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
167	99.5	0.0	1.016E-009	UNITY, FREQ-F3RHR3, SGB-DRAINED-R, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
168	99.5	0.0	1.016E-009	UNITY, FREQ-F3RHR3, SGA-DRAINED-R, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
169	99.5	0.0	9.678E-010	UNITY, MSS-AOV-FC-101B, FREQ-F3RHR3, MSS-NRV-MA-101B, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
170	99.5	0.0	9.678E-010	UNITY, MSS-AOV-FC-101A, FREQ-F3RHR3, MSS-NRV-MA-101A, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
171	99.5	0.0	9.279E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
172	99.5	0.0	9.279E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
173	99.5	0.0	9.270E-010	UNITY, PROB-W4D6, FREQ-F4RHR3, DR-MT, A-F4R3W4-X-SF-7, DURATION-D6
174	99.5	0.0	9.266E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3, A-F4R3W1-X-S1-8, A-F4R3W1-X-S2-8
175	99.5	0.0	9.256E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
176	99.5	0.0	8.778E-010	UNITY, PROB-W3D6, SGS-DRAINED-CSD, FREQ-F4RHR3, DR-MT, DURATION-D6
177	99.5	0.0	8.778E-010	UNITY, AFW-CKV-OO-CV142, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
178	99.5	0.0	8.603E-010	UNITY, FREQ-F3RHR3, PROB-W2D6, D-F3R3W2-XHE, DR-MT, DURATION-D6
179	99.5	0.0	8.557E-010	UNITY, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6, A-F5R3W4-X-S1-7, A-F5R3W4-X-S2-7
180	99.5	0.0	8.311E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
181	99.5	0.0	8.099E-010	UNITY, REFUEL, /PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F2B2, FRAC-POS10, DURATION-R10
182	99.5	0.0	7.981E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
183	99.5	0.0	7.981E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
184	99.6	0.0	7.882E-010	UNITY, AFW-CKV-OO-CV142, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
185	99.6	0.0	7.830E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6
186	99.6	0.0	7.550E-010	UNITY, REFUEL, D-F1B2W4-XHE, FREQ-F1B2, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
187	99.6	0.0	7.447E-010	UNITY, PPS-MOV-FT-1536, FREQ-F3RHR3, PORV-PATH-CLSD, PROB-W1D6, DR-MT, DURATION-D6
188	99.6	0.0	7.399E-010	UNITY, FREQ-F3RHR3, PROB-W3D6, D-F3R3W3-XHE, DR-MT, DURATION-D6
189	99.6	0.0	7.381E-010	UNITY, REFUEL, FREQ-F3RHR3, PZR-SV-REMOVEDW3, PROB-W3R10, A-F3R3W3-X-FL-3, FRAC-POS10, DURATION-R10
190	99.6	0.0	7.225E-010	UNITY, REFUEL, DURATION-R6, A-F1B2W4-X-G-4, FREQ-F1B2, PZR-SV-REMOVEDW4, PROB-W4R6
191	99.6	0.0	7.138E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
192	99.6	0.0	7.138E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
193	99.6	0.0	7.033E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-S1-8, A-F3R3W2-X-S2-8, LPR-CCF-PG-SUMP2
194	99.6	0.0	6.703E-010	UNITY, CON-VFC-RP-COREM, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, OSR-TRA-MA, ISR-TRA-MA, /PZR-SV-REMOVEDW2, PROB-W2R6
195	99.6	0.0	6.634E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
196	99.6	0.0	6.634E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
197	99.6	0.0	6.540E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-9, A-F3R3W2-X-S1-8, A-F3R3W2-X-S2-8
198	99.6	0.0	6.424E-010	UNITY, MSS-AOV-FC-101B, MSS-NRV-FT-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
199	99.6	0.0	6.424E-010	UNITY, MSS-AOV-FC-101A, MSS-NRV-FT-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
200	99.6	0.0	6.359E-010	UNITY, REFUEL, SGS-DRAINED-R, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, LPR-CCF-PG-SUMP2
201	99.6	0.0	6.328E-010	UNITY, PROB-W2D6, FREQ-F4RHR3, D-F4R3W2-XHE,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
202	99.6	0.0	6.282E-010	DR-MT, DURATION-D6 UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-SF-8, LPR-CCF-PG-SUMP2
203	99.6	0.0	6.139E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
204	99.6	0.0	6.139E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
205	99.6	0.0	5.957E-010	UNITY, FREQ-F3RHR3, PROB-W1D6, D-F3R3W1-XHE, DR-MT, DURATION-D6
206	99.6	0.0	5.942E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
207	99.6	0.0	5.915E-010	UNITY, REFUEL, DURATION-R6, SGC-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
208	99.6	0.0	5.915E-010	UNITY, REFUEL, DURATION-R6, SGB-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
209	99.6	0.0	5.915E-010	UNITY, REFUEL, DURATION-R6, SGA-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
210	99.7	0.0	5.914E-010	UNITY, REFUEL, SGS-DRAINED-R, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-9
211	99.7	0.0	5.842E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-9, A-F3R3W2-X-SF-8
212	99.7	0.0	5.706E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
213	99.7	0.0	5.706E-010	UNITY, SSHR-AOV-XHE-105, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
214	99.7	0.0	5.635E-010	UNITY, AFW-CKV-OO-CV142, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
215	99.7	0.0	5.598E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, PROB-W4D6, FREQ-F4RHR3, DR-MT, DURATION-D6
216	99.7	0.0	5.525E-010	UNITY, MSS-AOV-FC-101B, MSS-NRV-FT-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
217	99.7	0.0	5.525E-010	UNITY, MSS-AOV-FC-101A, MSS-NRV-FT-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
218	99.7	0.0	5.482E-010	UNITY, SAS-CPS-FR-1SAC1, IAS-CPS-FS-IAC-1, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
219	99.7	0.0	5.482E-010	UNITY, SAS-CPS-FR-2SAC1, IAS-CPS-FS-IAC-1, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
220	99.7	0.0	5.443E-010	UNITY, PROB-W3D6, FREQ-F4RHR3, D-F4R3W3-XHE, DR-MT, DURATION-D6
221	99.7	0.0	5.103E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
222	99.7	0.0	5.103E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
223	99.7	0.0	4.996E-010	UNITY, AFW-CCF-FS-FW3AB, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
224	99.7	0.0	4.924E-010	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F7B2
225	99.7	0.0	4.839E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-C-3
226	99.7	0.0	4.750E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, D-F3R3W2-XHE
227	99.7	0.0	4.715E-010	UNITY, SAS-CPS-FR-1SAC1, IAS-CPS-FS-IAC-1, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
228	99.7	0.0	4.715E-010	UNITY, SAS-CPS-FR-2SAC1, IAS-CPS-FS-IAC-1, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
229	99.7	0.0	4.654E-010	UNITY, CON-VFC-RP-COREM, FREQ-F3RHR3, OSR-TRA-MA, ISR-TRA-MA, PROB-W1D6, DR-MT, DURATION-D6
230	99.7	0.0	4.608E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, FREQ-F3RHR3, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
231	99.7	0.0	4.593E-010	UNITY, MSS-AOV-FC-101B, MSS-NRV-FT-101B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
232	99.7	0.0	4.593E-010	UNITY, MSS-AOV-FC-101A, MSS-NRV-FT-101A, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
233	99.7	0.0	4.483E-010	UNITY, REFUEL, LPR-MOV-FT-1890B, PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F2B2, FRAC-POS10, DURATION-R10
234	99.7	0.0	4.389E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
235	99.7	0.0	4.389E-010	UNITY, CIR-COND-UNAVLBL, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
236	99.7	0.0	4.372E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3, A-F5R3W1-X-SF-8
237	99.7	0.0	4.297E-010	UNITY, AFW-CCF-FS-FW3AB, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
238	99.7	0.0	4.294E-010	UNITY, REFUEL, LPI-CCF-FS-SI1AB, FREQ-F3RHR3, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
239	99.7	0.0	4.286E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
240	99.7	0.0	4.229E-010	UNITY, REFUEL, DURATION-R6, SGC-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
241	99.7	0.0	4.229E-010	UNITY, REFUEL, DURATION-R6, SGB-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
242	99.7	0.0	4.229E-010	UNITY, REFUEL, DURATION-R6, SGA-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
243	99.7	0.0	4.170E-010	UNITY, REFUEL, DURATION-R6, SGB-DRAINED-R, SGC-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
244	99.7	0.0	4.170E-010	FREQ-F5RHR3 UNITY, REFUEL, DURATION-R6, SGA-DRAINED-R, SGC-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
245	99.8	0.0	4.170E-010	UNITY, REFUEL, DURATION-R6, SGA-DRAINED-R, SGB-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
246	99.8	0.0	4.152E-010	UNITY, REFUEL, LPR-MOV-PG-1830B, FREQ-F1B2, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
247	99.8	0.0	4.054E-010	UNITY, FREQ-F3RHR3, PROB-W3D6, A-F3R3W3-X-FL-3, A-F3R3W3-X-S1-7, A-F3R3W3-X-S2-7, DR-MT, DURATION-D6
248	99.8	0.0	3.950E-010	UNITY, MSS-AOV-FC-101B, MSS-NRV-FT-101B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
249	99.8	0.0	3.950E-010	UNITY, MSS-AOV-FC-101A, MSS-NRV-FT-101A, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
250	99.8	0.0	3.919E-010	UNITY, SAS-CPS-FR-1SAC1, IAS-CPS-FS-IAC-1, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
251	99.8	0.0	3.919E-010	UNITY, SAS-CPS-FR-2SAC1, IAS-CPS-FS-IAC-1, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
252	99.8	0.0	3.884E-010	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, PROB-W1R6, PZR-SV-REMOVEDW1
253	99.8	0.0	3.830E-010	UNITY, FREQ-F3RHR3, SGB-DRAINED-R, PROB-W2D6, DR-MT, DURATION-D6, A-F3R3W2-X-C-8
254	99.8	0.0	3.830E-010	UNITY, FREQ-F3RHR3, SGA-DRAINED-R, PROB-W2D6, DR-MT, DURATION-D6, A-F3R3W2-X-C-8
255	99.8	0.0	3.767E-010	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F7B2, A-F7B2W3-X-G-4
256	99.8	0.0	3.712E-010	UNITY, AFW-MOV-CC-151, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
257	99.8	0.0	3.621E-010	UNITY, FREQ-F3RHR3, PROB-W3D6, A-F3R3W3-X-FL-3, A-F3R3W3-X-SF-7, DR-MT, DURATION-D6
258	99.8	0.0	3.572E-010	UNITY, AFW-CCF-FS-FW3AB, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
259	99.8	0.0	3.494E-010	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3, D-F4R3W2-XHE
260	99.8	0.0	3.469E-010	UNITY, FREQ-F3RHR3, MSS-NRV-MA-101B, MSS-AOV-MA-101B, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
261	99.8	0.0	3.469E-010	UNITY, FREQ-F3RHR3, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
262	99.8	0.0	3.398E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, D-F3R3W3-XHE
263	99.8	0.0	3.371E-010	UNITY, SAS-CPS-FR-1SAC1, IAS-CPS-FS-IAC-1, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6

Partition Cut Set Report

Family->FLOOD/WINDOW

Mincut Upper Bound -> 1.704E-005

End State ->CD

This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
264	99.8	0.0	3.371E-010	UNITY, SAS-CPS-FR-2SAC1, IAS-CPS-FS-IAC-1, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
265	99.8	0.0	3.343E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3, D-F5R3W1-XHE
266	99.8	0.0	3.312E-010	UNITY, MSS-AOV-FC-101B, FREQ-F3RHR3, MSS-NRV-MA-101B, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
267	99.8	0.0	3.312E-010	UNITY, MSS-AOV-FC-101A, FREQ-F3RHR3, MSS-NRV-MA-101A, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
268	99.8	0.0	3.299E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PROB-W1R6, LOOPISOLATED1R6, /PZR-SV-REMOVEDW1, A-F3R3W1-X-C-8
269	99.8	0.0	3.226E-010	UNITY, FREQ-F3RHR3, MSS-NRV-MA-101B, MSS-AOV-MA-101B, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
270	99.8	0.0	3.226E-010	UNITY, FREQ-F3RHR3, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
271	99.8	0.0	3.192E-010	UNITY, AFW-MOV-CC-151, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
272	99.8	0.0	3.072E-010	UNITY, AFW-CCF-FS-FW3AB, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
273	99.8	0.0	3.027E-010	UNITY, REFUEL, DURATION-R6, SAS-CPS-FR-2SAC1, IAS-CPS-FS-IAC-1, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
274	99.8	0.0	3.027E-010	UNITY, REFUEL, DURATION-R6, SAS-CPS-FR-1SAC1, IAS-CPS-FS-IAC-1, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
275	99.8	0.0	2.981E-010	UNITY, REFUEL, DURATION-R6, SGB-DRAINED-R, SGC-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
276	99.8	0.0	2.981E-010	UNITY, REFUEL, DURATION-R6, SGA-DRAINED-R, SGC-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
277	99.8	0.0	2.981E-010	UNITY, REFUEL, DURATION-R6, SGA-DRAINED-R, SGB-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
278	99.8	0.0	2.858E-010	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F7B2
279	99.8	0.0	2.759E-010	UNITY, AFW-CCF-FS-FW3AB, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
280	99.8	0.0	2.706E-010	UNITY, MSS-AOV-FC-101B, SSHR-AOV-XHE-105, FREQ-F3RHR3, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
281	99.8	0.0	2.706E-010	UNITY, MSS-AOV-FC-101A, SSHR-AOV-XHE-105, FREQ-F3RHR3, PROB-W2D6, DR-MT, DURATION-D6,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
282	99.8	0.0	2.654E-010	LPR-CCF-PG-SUMP2 UNITY, AFW-MOV-CC-151, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
283	99.8	0.0	2.598E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, PZR-SV-REMOVEDW1, FREQ-F5RHR3
284	99.8	0.0	2.574E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3, A-F4R3W1-X-SF-8
285	99.8	0.0	2.544E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, LPR-CCF-PG-SUMP2
286	99.8	0.0	2.516E-010	UNITY, MSS-AOV-FC-101B, SSHR-AOV-XHE-105, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
287	99.8	0.0	2.516E-010	UNITY, MSS-AOV-FC-101A, SSHR-AOV-XHE-105, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
288	99.8	0.0	2.486E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6
289	99.8	0.0	2.481E-010	UNITY, REFUEL, LPR-CCF-FT-890AB, FREQ-F3RHR3, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
290	99.8	0.0	2.466E-010	UNITY, REFUEL, LPI-CCF-FS-S11AB, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6
291	99.8	0.0	2.424E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW4, PROB-W4R6, A-F3R3W4-X-FL-4
292	99.8	0.0	2.413E-010	UNITY, LOOPISOLATED2R6, REFUEL, LPI-CCF-FS-S11AB, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6
293	99.8	0.0	2.393E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, A-F3R3W1-X-FL-9, A-F3R3W1-X-S1-8, A-F3R3W1-X-S2-8
294	99.8	0.0	2.385E-010	UNITY, LOSEP, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
295	99.8	0.0	2.366E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-9
296	99.8	0.0	2.357E-010	UNITY, PROB-W4D6, SGS-DRAINED-CSD, FREQ-F5RHR3, DR-MT, DURATION-D6
297	99.8	0.0	2.357E-010	UNITY, AFW-CKV-OO-CV142, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6
298	99.8	0.0	2.305E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101C, SSHR-AOV-XHE-105, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
299	99.8	0.0	2.305E-010	UNITY, REFUEL, MSS-AOV-FC-101B, MSS-AOV-FC-101C, SSHR-AOV-XHE-105, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
300	99.9	0.0	2.305E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101B,

Partition Cut Set Report

Family->FLOOD/WINDOW

Mincut Upper Bound -> 1.704E-005

End State ->CD

This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
301	99.9	0.0	2.282E-010	SSHR-AOV-XHE-105, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
302	99.9	0.0	2.216E-010	UNITY, AFW-MOV-CC-151, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
303	99.9	0.0	2.164E-010	UNITY, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6, D-F5R3W4-XHE
304	99.9	0.0	2.164E-010	UNITY, REFUEL, DURATION-R6, SAS-CPS-FR-1SAC1, IAS-CPS-FS-IAC-1, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
305	99.9	0.0	2.141E-010	UNITY, REFUEL, DURATION-R6, SAS-CPS-FR-2SAC1, IAS-CPS-FS-IAC-1, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
306	99.9	0.0	2.141E-010	UNITY, AFW-PSF-FC-XCONN, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
307	99.9	0.0	2.141E-010	UNITY, MSS-NRV-FT-101B, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
308	99.9	0.0	2.134E-010	UNITY, MSS-NRV-FT-101A, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
309	99.9	0.0	2.103E-010	UNITY, REFUEL, SGS-DRAINED-R, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
310	99.9	0.0	2.097E-010	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW4, PROB-W4R6, A-F2B2W4-X-G-4, FREQ-F2B2
311	99.9	0.0	2.081E-010	UNITY, REFUEL, LPR-MOV-FT-1862B, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6
312	99.9	0.0	2.081E-010	UNITY, MSS-AOV-FC-101B, FREQ-F3RHR3, CIR-COND-UNAVLBL, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
313	99.9	0.0	2.076E-010	UNITY, MSS-AOV-FC-101A, FREQ-F3RHR3, CIR-COND-UNAVLBL, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
314	99.9	0.0	2.061E-010	UNITY, PROB-W4D6, FREQ-F4RHR3, A-F4R3W4-X-S1-7, DR-MT, A-F4R3W4-X-S2-7, DURATION-D6
315	99.9	0.0	2.051E-010	UNITY, REFUEL, FREQ-F3RHR3, /PZR-SV-REMOVEDW3, PROB-W3R10, A-F3R3W3-X-FL-7, FRAC-POS10, DURATION-R10
316	99.9	0.0	2.049E-010	UNITY, LOSEP, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
317	99.9	0.0	2.021E-010	UNITY, REFUEL, DURATION-R6, AFW-MOV-CC-151, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
318	99.9	0.0	1.972E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F7B2
319	99.9	0.0	1.936E-010	UNITY, AFW-CCF-FS-FW3AB, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
320	99.9	0.0	1.936E-010	UNITY, MSS-AOV-FC-101B, FREQ-F3RHR3, CIR-COND-UNAVLBL, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
				UNITY, MSS-AOV-FC-101A, FREQ-F3RHR3,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
321	99.9	0.0	1.929E-010	CIR-COND-UNAVLBL, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6 UNITY, REFUEL, MSS-AOV-FC-101C, DURATION-R6, MSS-NRV-MA-101C, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
322	99.9	0.0	1.929E-010	UNITY, REFUEL, MSS-AOV-FC-101B, DURATION-R6, MSS-NRV-MA-101B, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
323	99.9	0.0	1.929E-010	UNITY, REFUEL, MSS-AOV-FC-101A, DURATION-R6, MSS-NRV-MA-101A, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
324	99.9	0.0	1.857E-010	UNITY, REFUEL, DURATION-R6, PROB-W1R6, PZR-SV-REMOVEDW1, FREQ-F4RHR3
325	99.9	0.0	1.842E-010	UNITY, AFW-PSF-FC-XCONN, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
326	99.9	0.0	1.842E-010	UNITY, MSS-NRV-FT-101B, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
327	99.9	0.0	1.842E-010	UNITY, MSS-NRV-FT-101A, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
328	99.9	0.0	1.840E-010	UNITY, REFUEL, LPI-CCF-FS-SI1AB, FREQ-F3RHR3, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
329	99.9	0.0	1.827E-010	UNITY, REFUEL, LPI-MDP-FS-SI1B, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6
330	99.9	0.0	1.793E-010	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, D-F2B2W4-XHE, FREQ-F2B2, FRAC-POS10, DURATION-R10
331	99.9	0.0	1.787E-010	UNITY, CON-VFC-RP-COREM, FREQ-F3RHR3, PROB-W1D6, DR-MT, DURATION-D6, A-F3R3W1-X-P-3
332	99.9	0.0	1.777E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, PROB-W4D6, FREQ-F4RHR3, DR-MT, DURATION-D6
333	99.9	0.0	1.773E-010	UNITY, REFUEL, MSS-AOV-FC-101B, MSS-AOV-FC-101C, DURATION-R6, CIR-COND-UNAVLBL, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
334	99.9	0.0	1.773E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101C, DURATION-R6, CIR-COND-UNAVLBL, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
335	99.9	0.0	1.773E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101B, DURATION-R6, CIR-COND-UNAVLBL, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
336	99.9	0.0	1.705E-010	UNITY, LOSP, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
337	99.9	0.0	1.685E-010	UNITY, PROB-W4D6, SGS-DRAINED-CSD, FREQ-F4RHR3, DR-MT, DURATION-D6
338	99.9	0.0	1.685E-010	UNITY, AFW-CKV-OO-CV142, PROB-W4D6, FREQ-F4RHR3, DR-MT, DURATION-D6
339	99.9	0.0	1.676E-010	UNITY, LPI-CCF-FS-SI1AB, FREQ-F3RHR3, PROB-W1D6,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
340	99.9	0.0	1.659E-010	DR-MT, DURATION-D6
341	99.9	0.0	1.659E-010	UNITY, LPR-MOV-FT-1862B, FREQ-F3RHR3, SGB-DRAINED-R, PROB-W2D6, DR-MT, DURATION-D6
342	99.9	0.0	1.648E-010	UNITY, LPR-MOV-FT-1862B, FREQ-F3RHR3, SGA-DRAINED-R, PROB-W2D6, DR-MT, DURATION-D6
343	99.9	0.0	1.648E-010	UNITY, REFUEL, MSS-AOV-FC-101B, MSS-AOV-FC-101C, SSSR-AOV-XHE-105, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
344	99.9	0.0	1.648E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101C, SSSR-AOV-XHE-105, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
345	99.9	0.0	1.636E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101B, SSSR-AOV-XHE-105, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
346	99.9	0.0	1.531E-010	UNITY, REFUEL, LPR-CCF-FT-890AB, FREQ-F1B2, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
347	99.9	0.0	1.531E-010	UNITY, AFW-PSF-FC-XCONN, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
348	99.9	0.0	1.531E-010	UNITY, MSS-NRV-FT-101B, MSS-AOV-MA-101B, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
349	99.9	0.0	1.528E-010	UNITY, MSS-NRV-FT-101A, MSS-AOV-MA-101A, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
350	99.9	0.0	1.526E-010	UNITY, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-S1-8, A-F3R3W2-X-S2-8, DR-MT, DURATION-D6, A-F3R3W2-X-C-8
351	99.9	0.0	1.467E-010	UNITY, REFUEL, SGS-DRAINED-R, DURATION-R6, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
352	99.9	0.0	1.466E-010	UNITY, AFW-MDP-FS-FW3A, AFW-MDP-MA-FW3B, FREQ-F3RHR3, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
353	99.9	0.0	1.465E-010	UNITY, LOSP, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
354	99.9	0.0	1.463E-010	UNITY, REFUEL, DURATION-R6, AFW-MOV-CC-151, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
355	99.9	0.0	1.428E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, FREQ-F3RHR3, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
356	99.9	0.0	1.428E-010	UNITY, AFW-CCF-LK-STMBD, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
357	99.9	0.0	1.428E-010	UNITY, AFW-CKV-FT-CV27, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
358	99.9	0.0	1.425E-010	UNITY, AFW-CKV-FT-CV58, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
359	99.9	0.0	1.394E-010	UNITY, REFUEL, LPR-CCF-FT-890AB, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6
				UNITY, LOOPISOLATED2R6, REFUEL,

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Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
360	99.9	0.0	1.394E-010	LPR-CCF-FT-862AB, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6 UNITY, LOOPISOLATED2R6, REFUEL, LPR-CCF-FT-860AB, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6
361	99.9	0.0	1.394E-010	UNITY, LOOPISOLATED2R6, REFUEL, LPR-CCF-FT-890AB, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6
362	99.9	0.0	1.388E-010	UNITY, FREQ-F3RHR3, PROB-W2D6, SGS-DRAINED-CSD, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
363	99.9	0.0	1.388E-010	UNITY, AFW-CKV-OO-CV142, FREQ-F3RHR3, PROB-W2D6, DR-MT, DURATION-D6, LPR-CCF-PG-SUMP2
364	99.9	0.0	1.379E-010	UNITY, REFUEL, MSS-AOV-FC-101B, DURATION-R6, MSS-NRV-MA-101B, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
365	99.9	0.0	1.379E-010	UNITY, REFUEL, MSS-AOV-FC-101C, DURATION-R6, MSS-NRV-MA-101C, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
366	99.9	0.0	1.379E-010	UNITY, REFUEL, MSS-AOV-FC-101A, DURATION-R6, MSS-NRV-MA-101A, PROB-W1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
367	99.9	0.0	1.365E-010	UNITY, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-SF-8, DR-MT, DURATION-D6, A-F3R3W2-X-C-8
368	99.9	0.0	1.361E-010	UNITY, AFW-MDP-MA-FW3A, AFW-MDP-MA-FW3B, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
369	99.9	0.0	1.360E-010	UNITY, REFUEL, MSS-AOV-FC-101B, DURATION-R6, MSS-NRV-MA-101B, SGC-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
370	99.9	0.0	1.360E-010	UNITY, REFUEL, MSS-AOV-FC-101C, DURATION-R6, MSS-NRV-MA-101C, SGB-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
371	99.9	0.0	1.360E-010	UNITY, REFUEL, MSS-AOV-FC-101C, DURATION-R6, MSS-NRV-MA-101C, SGA-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
372	99.9	0.0	1.360E-010	UNITY, REFUEL, MSS-AOV-FC-101A, DURATION-R6, MSS-NRV-MA-101A, SGC-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
373	99.9	0.0	1.360E-010	UNITY, REFUEL, MSS-AOV-FC-101B, DURATION-R6, MSS-NRV-MA-101B, SGA-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
374	99.9	0.0	1.360E-010	UNITY, REFUEL, MSS-AOV-FC-101A, DURATION-R6, MSS-NRV-MA-101A, SGB-DRAINED-R, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
375	99.9	0.0	1.355E-010	UNITY, AFW-MDP-FR-3A6HR, AFW-MDP-MA-FW3B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
376	99.9	0.0	1.336E-010	UNITY, PPS-MOV-OO-1536, PPS-SOV-OO-1456,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
377	99.9	0.0	1.336E-010	PROB-W2D6, FREQ-F5RHR3, DR-MT, A-F5R3W2-X-S1-8, DURATION-D6 UNITY, PPS-MOV-OO-1535, PPS-SOV-OO-1455C, PROB-W2D6, FREQ-F5RHR3, DR-MT, A-F5R3W2-X-S1-8, DURATION-D6
378	99.9	0.0	1.336E-010	UNITY, REFUEL, FREQ-F3RHR3, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, D-F3R3W4-XHE, DURATION-R10
379	99.9	0.0	1.317E-010	UNITY, MSS-NRV-FT-101B, MSS-AOV-MA-101B, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
380	99.9	0.0	1.317E-010	UNITY, AFW-PSF-FC-XCONN, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
381	99.9	0.0	1.317E-010	UNITY, MSS-NRV-FT-101A, MSS-AOV-MA-101A, PROB-W3D6, FREQ-F4RHR3, DR-MT, DURATION-D6
382	99.9	0.0	1.317E-010	UNITY, REFUEL, LOFP, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
383	99.9	0.0	1.290E-010	UNITY, FREQ-F3RHR3, PROB-W2D6, SGS-DRAINED-CSD, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
384	99.9	0.0	1.290E-010	UNITY, AFW-CKV-OO-CV142, FREQ-F3RHR3, PROB-W2D6, A-F3R3W2-X-FL-9, DR-MT, DURATION-D6
385	99.9	0.0	1.285E-010	UNITY, MSS-AOV-FC-101B, MSS-NRV-PG-101B, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
386	99.9	0.0	1.285E-010	UNITY, MSS-AOV-FC-101A, MSS-NRV-PG-101A, PROB-W2D6, FREQ-F5RHR3, DR-MT, DURATION-D6
387	99.9	0.0	1.268E-010	UNITY, REFUEL, MSS-AOV-FC-101B, MSS-AOV-FC-101C, DURATION-R6, CIR-COND-UNAVLBL, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
388	99.9	0.0	1.268E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101C, DURATION-R6, CIR-COND-UNAVLBL, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
389	99.9	0.0	1.268E-010	UNITY, REFUEL, MSS-AOV-FC-101A, MSS-AOV-FC-101B, DURATION-R6, CIR-COND-UNAVLBL, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3
390	99.9	0.0	1.249E-010	UNITY, MSS-AOV-FC-101B, FREQ-F3RHR3, MSS-NRV-MA-101B, PROB-W2D6, DR-MT, DURATION-D6, A-F3R3W2-X-C-8
391	99.9	0.0	1.249E-010	UNITY, MSS-AOV-FC-101A, FREQ-F3RHR3, MSS-NRV-MA-101A, PROB-W2D6, DR-MT, DURATION-D6, A-F3R3W2-X-C-8
392	99.9	0.0	1.247E-010	UNITY, SGA-DRAINED-R, SGB-DRAINED-R, PROB-W4D6, FREQ-F5RHR3, DR-MT, DURATION-D6
393	99.9	0.0	1.228E-010	UNITY, AFW-CKV-FT-CV27, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
394	99.9	0.0	1.228E-010	UNITY, AFW-CKV-FT-CV58, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
395	99.9	0.0	1.228E-010	UNITY, AFW-CCF-LK-STMBD, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6

Partition Cut Set Report

Family->FLOOD/WINDOW

End State ->CD

Mincut Upper Bound -> 1.704E-005

This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
396	99.9	0.0	1.210E-010	UNITY, REFUEL, LPR-MOV-FT-1860B, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6
397	99.9	0.0	1.210E-010	UNITY, REFUEL, LPI-MDP-FS-SI1B, FREQ-F3RHR3, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6
398	99.9	0.0	1.194E-010	UNITY, LOOPISOLATED2R6, CPC-MDP-FR-SW10A, CPC-MDP-MA-SW10B, REFUEL, FREQ-F3RHR3, DURATION-R6, OSR-TRA-MA, ISR-TRA-MA, /PZR-SV-REMOVEDW2, PROB-W2R6
399	99.9	0.0	1.182E-010	UNITY, AFW-PSF-FC-XCONN, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3
400	99.9	0.0	1.180E-010	UNITY, CON-VFC-RP-COREM, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-P-3
401	99.9	0.0	1.165E-010	UNITY, AFW-MDP-FR-3A6HR, AFW-MDP-MA-FW3B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
402	99.9	0.0	1.149E-010	UNITY, PPS-MOV-OO-1536, PPS-SOV-OO-1456, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6, A-F5R3W3-X-S1-7
403	99.9	0.0	1.149E-010	UNITY, PPS-MOV-OO-1535, PPS-SOV-OO-1455C, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6, A-F5R3W3-X-S1-7
404	99.9	0.0	1.105E-010	UNITY, MSS-AOV-FC-101B, MSS-NRV-PG-101B, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
405	99.9	0.0	1.105E-010	UNITY, MSS-AOV-FC-101A, MSS-NRV-PG-101A, PROB-W3D6, FREQ-F5RHR3, DR-MT, DURATION-D6
406	99.9	0.0	1.104E-010	UNITY, FREQ-F3RHR3, MSS-NRV-MA-101A, MSS-AOV-MA-101A, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
407	99.9	0.0	1.104E-010	UNITY, FREQ-F3RHR3, MSS-NRV-MA-101B, MSS-AOV-MA-101B, PROB-W3D6, A-F3R3W3-X-FL-3, DR-MT, DURATION-D6
408	100.0	0.0	1.092E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, SGB-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, A-F3R3W1-X-FL-9
409	100.0	0.0	1.092E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, SGC-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, A-F3R3W1-X-FL-9
410	100.0	0.0	1.092E-010	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, SGA-DRAINED-R, PROB-W1R6, /PZR-SV-REMOVEDW1, A-F3R3W1-X-FL-9
411	100.0	0.0	1.063E-010	UNITY, REFUEL, LPR-CCF-FT-890AB, FREQ-F3RHR3, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
412	100.0	0.0	1.060E-010	UNITY, REFUEL, LPI-MDP-FS-SI1B, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6
413	100.0	0.0	1.025E-010	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F7B2, FRAC-POS10, DURATION-R10,

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 1.704E-005

End State ->CD
This Partition -> 1.704E-005

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
414	100.0	0.0	1.021E-010	A-F7B2W4-X-G-4 UNITY, AFW-CKV-FT-CV27, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
415	100.0	0.0	1.021E-010	UNITY, AFW-CKV-FT-CV58, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
416	100.0	0.0	1.021E-010	UNITY, AFW-CCF-LK-STMBD, PROB-W2D6, FREQ-F4RHR3, DR-MT, DURATION-D6
417	100.0	0.0	1.019E-010	UNITY, CON-VFC-RP-COREM, LOOPISOLATED2R6, REFUEL, ISR-MDP-FS-RS1A, FREQ-F3RHR3, DURATION-R6, OSR-TRA-MA, /PZR-SV-REMOVEDW2, PROB-W2R6

Appendix D.2
Basic Event Importances Based on Cutsets without Recovery Actions

IMPORTANCE MEASURES REPORT (Alternate Cut Sets)
Family : FLOOD/WINDOW EndState : CD
Analysis : USER1
Case : ALTERNATE

(Sorted by Fussell-Vesley Importance)

Event Name	Num. of Occ.	Probability of Failure	Fussell- Vesely Importance	Risk Reduction Ratio	Risk Increase Ratio
UNITY	417	1.000E+000	1.000E+000	-----	1.000E+000
REFUEL	184	6.000E-001	5.657E-001	2.303E+000	1.377E+000
FREQ-F1B2	20	1.600E-008	5.099E-001	2.040E+000	1.238E+018
DR-MT	233	1.200E+000	4.343E-001	1.768E+000	9.276E-001
DURATION-D6	233	2.550E+002	4.343E-001	1.768E+000	5.674E-001
DURATION-R6	149	2.380E+002	3.080E-001	1.445E+000	6.933E-001
DURATION-R10	35	4.440E+002	2.577E-001	1.347E+000	7.429E-001
FRAC-POS10	35	5.000E-001	2.577E-001	1.347E+000	1.258E+000
PROB-W4R10	25	9.840E-001	2.529E-001	1.338E+000	1.004E+000
FREQ-F5RHR3	137	1.070E-003	2.037E-001	1.256E+000	5.866E+004
PROB-W2D6	117	4.360E-001	1.738E-001	1.210E+000	1.225E+000
PROB-W2R6	87	5.430E-001	1.616E-001	1.193E+000	1.136E+000
PROB-W3D6	83	3.750E-001	1.483E-001	1.174E+000	1.247E+000
FREQ-F4RHR3	113	7.650E-009	1.425E-001	1.166E+000	5.866E+004
PROB-W3R6	17	4.100E-001	1.328E-001	1.153E+000	1.191E+000
FREQ-F2B2	17	3.800E-009	1.212E-001	1.138E+000	2.938E+018
PROB-W1D6	16	1.170E-001	8.600E-002	1.094E+000	1.649E+000
LOOPISOLATED2R6	17	7.000E-001	6.247E-002	1.067E+000	1.027E+000
PROB-W4D6	17	7.200E-002	2.609E-002	1.027E+000	1.336E+000
FREQ-F3RHR3	119	1.040E-008	2.026E-002	1.021E+000	5.849E+004
PROB-W4R6	12	3.400E-002	9.353E-003	1.009E+000	1.266E+000
SGA-DRAINED-R	19	2.300E-002	6.771E-003	1.007E+000	1.288E+000
SGB-DRAINED-R	19	2.300E-002	6.771E-003	1.007E+000	1.288E+000
PROB-W3R10	10	1.600E-002	4.825E-003	1.005E+000	1.297E+000
PROB-W1R6	33	1.700E-002	4.309E-003	1.004E+000	1.249E+000
LPR-CCF-PG-SUMP2	22	1.000E-001	4.300E-003	1.004E+000	1.039E+000
A-F3R3W1-X-FL-9	6	1.900E-001	4.267E-003	1.004E+000	1.018E+000
A-F3R3W2-X-FL-9	21	9.300E-002	3.779E-003	1.004E+000	1.037E+000
MSS-AOV-FC-101A	38	1.500E-001	3.376E-003	1.003E+000	1.019E+000
MSS-AOV-FC-101B	38	1.500E-001	3.376E-003	1.003E+000	1.019E+000
MSS-NRV-MA-101B	19	5.000E-002	2.897E-003	1.003E+000	1.055E+000
MSS-NRV-MA-101A	19	5.000E-002	2.897E-003	1.003E+000	1.055E+000
A-F5R3W2-X-S1-8	4	7.800E-002	2.753E-003	1.003E+000	1.033E+000
A-F5R3W2-X-S2-8	2	2.700E-001	2.737E-003	1.003E+000	1.007E+000
A-F3R3W4-X-FL-7	2	4.200E-002	2.438E-003	1.002E+000	1.056E+000
FREQ-F7B2	11	8.410E-011	2.411E-003	1.002E+000	5.308E+016
AFW-MDP-MA-FW3B	25	5.272E-001	1.741E-003	1.002E+000	1.002E+000
A-F5R3W3-X-S1-7	3	7.800E-002	1.530E-003	1.002E+000	1.018E+000
SSHR-AOV-XHE-105	26	1.300E-002	1.520E-003	1.002E+000	1.115E+000
A-F5R3W3-X-S2-7	1	2.700E-001	1.517E-003	1.002E+000	1.004E+000
A-F3R3W3-X-FL-3	11	3.700E-002	1.457E-003	1.001E+000	1.038E+000
A-F5R3W2-X-SF-8	2	1.100E-002	1.430E-003	1.001E+000	1.129E+000
AFW-MDP-FS-FW3A	13	6.300E-003	1.319E-003	1.001E+000	1.208E+000
A-F1B2W4-X-G-4	2	3.100E-002	1.187E-003	1.001E+000	1.037E+000

IMPORTANCE MEASURES REPORT (Alternate Cut Sets)
 Family : FLOOD/WINDOW EndState : CD
 Analysis : USER1
 Case : ALTERNATE

(Sorted by Fussell-Vesley Importance)

Event Name	Num. of Occ.	Probability of Failure	Fussell- Vesely Importance	Risk Reduction Ratio	Risk Increase Ratio
CIR-COND-UNAVLBL	26	1.000E-002	1.169E-003	1.001E+000	1.116E+000
MSS-AOV-MA-101B	19	5.000E-002	1.061E-003	1.001E+000	1.020E+000
MSS-AOV-MA-101A	19	5.000E-002	1.061E-003	1.001E+000	1.020E+000
PZR-SV-REMOVEDW2	87	5.000E-002	1.026E-003	1.001E+000	1.019E+000
A-F3R3W1-X-C-8	2	4.400E-002	9.804E-004	1.001E+000	1.021E+000
LOOPISOLATED1R6	4	3.000E-001	8.791E-004	1.001E+000	1.002E+000
A-F4R3W2-X-S2-8	2	1.800E-001	8.531E-004	1.001E+000	1.004E+000
A-F4R3W2-X-S1-8	2	5.100E-002	8.531E-004	1.001E+000	1.016E+000
D-F5R3W2-XHE	2	6.400E-003	8.319E-004	1.001E+000	1.129E+000
A-F4R3W2-X-SF-8	2	8.700E-003	8.085E-004	1.001E+000	1.092E+000
A-F5R3W3-X-SF-7	1	1.100E-002	7.923E-004	1.001E+000	1.071E+000
SGS-DRAINED-R	6	8.300E-003	7.516E-004	1.001E+000	1.090E+000
LPI-MDP-FS-SI1B	8	3.000E-003	5.203E-004	1.001E+000	1.173E+000
A-F4R3W3-X-S2-7	1	1.800E-001	4.727E-004	1.000E+000	1.002E+000
A-F4R3W3-X-S1-7	1	5.100E-002	4.727E-004	1.000E+000	1.009E+000
D-F5R3W3-XHE	1	6.400E-003	4.610E-004	1.000E+000	1.072E+000
A-F3R3W2-X-C-8	7	1.200E-002	4.541E-004	1.000E+000	1.037E+000
A-F4R3W3-X-SF-7	1	8.700E-003	4.480E-004	1.000E+000	1.051E+000
AFW-MDP-MA-FW3A	10	2.000E-003	4.069E-004	1.000E+000	1.203E+000
A-F3R3W4-X-FL-4	2	1.600E-002	3.981E-004	1.000E+000	1.024E+000
AFW-CKV-OO-CV142	10	1.000E-003	3.859E-004	1.000E+000	1.385E+000
A-F2B2W4-X-G-4	2	3.800E-002	3.454E-004	1.000E+000	1.009E+000
A-F3R3W3-X-FL-7	2	9.300E-002	3.443E-004	1.000E+000	1.003E+000
LPR-MOV-FT-1862B	5	5.200E-003	3.089E-004	1.000E+000	1.059E+000
SGS-DRAINED-CSD	8	1.000E-003	3.066E-004	1.000E+000	1.306E+000
IAS-CPS-FS-IAC-1	12	8.000E-002	2.661E-004	1.000E+000	1.003E+000
A-F3R3W2-X-S1-8	5	5.100E-002	2.328E-004	1.000E+000	1.004E+000
A-F3R3W2-X-S2-8	5	1.800E-001	2.328E-004	1.000E+000	1.001E+000
LPR-CCF-PG-SUMP1	1	1.000E-002	2.184E-004	1.000E+000	1.022E+000
A-F3R3W2-X-SF-8	5	8.200E-003	2.080E-004	1.000E+000	1.025E+000
A-F5R3W1-X-S2-8	1	6.300E-001	1.711E-004	1.000E+000	1.000E+000
A-F5R3W1-X-S1-8	1	1.800E-001	1.711E-004	1.000E+000	1.001E+000
LPR-MOV-FT-1860B	3	3.000E-003	1.670E-004	1.000E+000	1.056E+000
SGC-DRAINED-R	9	2.300E-002	1.658E-004	1.000E+000	1.007E+000
MSS-NRV-FT-101B	8	3.000E-003	1.603E-004	1.000E+000	1.053E+000
MSS-NRV-FT-101A	8	3.000E-003	1.603E-004	1.000E+000	1.053E+000
LPR-MOV-FT-1890B	2	3.000E-003	1.370E-004	1.000E+000	1.046E+000
SAS-CPS-FR-2SAC1	6	4.800E-003	1.330E-004	1.000E+000	1.028E+000
SAS-CPS-FR-1SAC1	6	4.800E-003	1.330E-004	1.000E+000	1.028E+000
AFW-CCF-FS-FW3AB	6	3.500E-004	1.213E-004	1.000E+000	1.346E+000
MSS-AOV-FC-101C	12	1.500E-001	1.174E-004	1.000E+000	1.001E+000
PPS-MOV-FT-1536	2	4.000E-002	1.066E-004	1.000E+000	1.003E+000
PORV-PATH-CLSD	2	5.000E-002	1.066E-004	1.000E+000	1.002E+000
A-F5R3W4-X-SF-7	1	7.500E-003	1.037E-004	1.000E+000	1.014E+000

IMPORTANCE MEASURES REPORT (Alternate Cut Sets)
Family : FLOOD/WINDOW EndState : CD
Analysis : USER1
Case : ALTERNATE

(Sorted by Fussell-Vesley Importance)

Event Name	Num. of Occ.	Probability of Failure	Fussell- Vesely Importance	Risk Reduction Ratio	Risk Increase Ratio
AFW-MOV-CC-151	6	2.600E-004	9.007E-005	1.000E+000	1.346E+000
CON-VFC-RP-COREM	5	2.000E-002	9.001E-005	1.000E+000	1.004E+000
A-F3R3W2-X-FL-4	1	3.700E-002	8.752E-005	1.000E+000	1.002E+000
OSR-TRA-MA	4	2.500E-001	7.961E-005	1.000E+000	1.000E+000
D-F3R3W2-XHE	2	6.200E-004	7.833E-005	1.000E+000	1.126E+000
LPI-CCF-FS-SI1AB	5	4.500E-004	7.444E-005	1.000E+000	1.165E+000
ISR-TRA-MA	3	2.500E-001	7.363E-005	1.000E+000	1.000E+000
D-F3R3W3-XHE	2	6.200E-004	6.334E-005	1.000E+000	1.102E+000
D-F4R3W2-XHE	2	6.200E-004	5.762E-005	1.000E+000	1.093E+000
A-F4R3W4-X-SF-7	1	5.500E-003	5.438E-005	1.000E+000	1.010E+000
A-F4R3W1-X-S1-8	1	1.200E-001	5.436E-005	1.000E+000	1.000E+000
A-F4R3W1-X-S2-8	1	4.200E-001	5.436E-005	1.000E+000	1.000E+000
LOSP	5	1.670E-004	5.235E-005	1.000E+000	1.313E+000
A-F5R3W4-X-S1-7	1	3.300E-002	5.020E-005	1.000E+000	1.001E+000
A-F5R3W4-X-S2-7	1	1.100E-001	5.020E-005	1.000E+000	1.000E+000
AFW-PSF-FC-XCONN	5	1.500E-004	4.701E-005	1.000E+000	1.313E+000
LPR-CCF-FT-890AB	5	2.600E-004	4.692E-005	1.000E+000	1.180E+000
D-F1B2W4-XHE	1	1.200E-003	4.429E-005	1.000E+000	1.037E+000
MSS-NRV-MA-101C	4	5.000E-002	3.536E-005	1.000E+000	1.001E+000
D-F3R3W1-XHE	1	1.600E-003	3.495E-005	1.000E+000	1.022E+000
D-F4R3W3-XHE	1	6.200E-004	3.193E-005	1.000E+000	1.051E+000
A-F3R3W2-X-C-3	1	1.200E-002	2.838E-005	1.000E+000	1.002E+000
A-F5R3W1-X-SF-8	1	1.700E-002	2.565E-005	1.000E+000	1.001E+000
LPR-MOV-PG-1890B	1	6.600E-004	2.436E-005	1.000E+000	1.037E+000
A-F3R3W3-X-S1-7	1	5.100E-002	2.378E-005	1.000E+000	1.000E+000
A-F3R3W3-X-S2-7	1	1.800E-001	2.378E-005	1.000E+000	1.000E+000
A-F7B2W3-X-G-4	1	8.500E-002	2.210E-005	1.000E+000	1.000E+000
AFW-CKV-FT-CV27	3	1.000E-004	2.156E-005	1.000E+000	1.216E+000
AFW-CKV-FT-CV58	3	1.000E-004	2.156E-005	1.000E+000	1.216E+000
AFW-CCF-LK-STMBD	3	1.000E-004	2.156E-005	1.000E+000	1.216E+000
A-F3R3W3-X-SF-7	1	8.200E-003	2.124E-005	1.000E+000	1.003E+000
D-F5R3W1-XHE	1	1.300E-002	1.961E-005	1.000E+000	1.001E+000
A-F4R3W1-X-SF-8	1	1.400E-002	1.510E-005	1.000E+000	1.001E+000
AFW-MDP-FR-3A6HR	2	1.800E-004	1.478E-005	1.000E+000	1.082E+000
PPS-SOV-OO-1455C	2	3.000E-002	1.458E-005	1.000E+000	1.000E+000
PPS-MOV-OO-1535	2	4.000E-002	1.458E-005	1.000E+000	1.000E+000
PPS-MOV-OO-1536	2	4.000E-002	1.458E-005	1.000E+000	1.000E+000
PPS-SOV-OO-1456	2	3.000E-002	1.458E-005	1.000E+000	1.000E+000
A-F3R3W1-X-S1-8	1	1.200E-001	1.404E-005	1.000E+000	1.000E+000
A-F3R3W1-X-S2-8	1	4.200E-001	1.404E-005	1.000E+000	1.000E+000
MSS-NRV-PG-101A	2	6.000E-004	1.402E-005	1.000E+000	1.023E+000
MSS-NRV-PG-101B	2	6.000E-004	1.402E-005	1.000E+000	1.023E+000
D-F5R3W4-XHE	1	9.400E-004	1.300E-005	1.000E+000	1.014E+000
A-F4R3W4-X-S1-7	1	1.600E-002	1.218E-005	1.000E+000	1.001E+000

IMPORTANCE MEASURES REPORT (Alternate Cut Sets)
Family : FLOOD/WINDOW EndState : CD
Analysis : USER1
Case : ALTERNATE

(Sorted by Fussell-Vesley Importance)

Event Name	Num. of Occ.	Probability of Failure	Fussell- Vesely Importance	Risk Reduction Ratio	Risk Increase Ratio
A-F4R3W4-X-S2-7	1	7.700E-002	1.218E-005	1.000E+000	1.000E+000
D-F2B2W4-XHE	1	1.200E-003	1.052E-005	1.000E+000	1.009E+000
A-F3R3W1-X-P-3	1	2.400E-002	1.048E-005	1.000E+000	1.000E+000
LPR-CCF-FT-862AB	1	2.600E-004	8.179E-006	1.000E+000	1.031E+000
LPR-CCF-FT-860AB	1	2.600E-004	8.179E-006	1.000E+000	1.031E+000
D-F3R3W4-XHE	1	1.400E-004	7.837E-006	1.000E+000	1.056E+000
CPC-MDP-FR-SW10A	1	3.840E-003	7.002E-006	1.000E+000	1.002E+000
CPC-MDP-MA-SW10B	1	9.274E-001	7.002E-006	1.000E+000	1.000E+000
A-F3R3W2-X-P-3	1	1.100E-002	6.921E-006	1.000E+000	1.001E+000
A-F7B2W4-X-G-4	1	3.100E-002	6.014E-006	1.000E+000	1.000E+000
ISR-MDP-FS-RS1A	1	3.800E-002	5.977E-006	1.000E+000	1.000E+000
PZR-SV-REMOVEDW1	33	1.000E-002	5.891E-006	1.000E+000	1.001E+000
PZR-SV-REMOVEDW3	27	9.000E-001	-2.061E-003	9.979E-001	9.998E-001
PZR-SV-REMOVEDW4	37	3.000E-001	-4.645E-002	9.556E-001	8.916E-001

Appendix D.3
Dominant Cutsets with Recovery Actions

Partition Cut Set Report

Family->FLOOD/WINDOW
Mincut Upper Bound -> 5.111E-006

End State ->CD
This Partition -> 5.111E-006

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
1	28.7	28.7	1.468E-006	UNITY, REFUEL, FREQ-F1B2, /PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, DURATION-R10
2	45.2	16.4	8.431E-007	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, PZR-SV-REMOVEDW3, PROB-W3R6
3	61.4	16.2	8.286E-007	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, /PZR-SV-REMOVEDW2, PROB-W2R6, R-B2W2-XHE-S/R6
4	68.2	6.8	3.486E-007	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F2B2, FRAC-POS10, DURATION-R10
5	72.1	3.9	2.002E-007	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F2B2
6	76.0	3.8	1.968E-007	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F2B2, R-B2W2-XHE-S/R6
7	77.8	1.8	9.368E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, /PZR-SV-REMOVEDW3, PROB-W3R6
8	79.4	1.5	8.006E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F5RHR3, R-R3W3-XHE-F
9	80.9	1.5	7.835E-008	UNITY, LOOPISOLATED2R6, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3, R-R3W2-XHE-F
10	82.1	1.2	6.244E-008	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F5RHR3, FRAC-POS10, DURATION-R10, R-R3W4-XHE-F
11	83.3	1.2	6.203E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, PZR-SV-REMOVEDW2, PROB-W2R6
12	84.5	1.1	5.728E-008	UNITY, FREQ-F1B2, PROB-W1D6, DR-MT, DURATION-D6, R-B2W1-XHE-A
13	85.6	1.1	5.724E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F4RHR3, R-R3W3-XHE-F
14	86.7	1.1	5.601E-008	UNITY, LOOPISOLATED2R6, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3, R-R3W2-XHE-F
15	87.7	1.0	5.438E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, /PZR-SV-REMOVEDW4, PROB-W4R6
16	88.6	0.8	4.464E-008	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F4RHR3, FRAC-POS10, DURATION-R10, R-R3W4-XHE-F
17	89.4	0.7	3.831E-008	UNITY, PROB-W1D6, FREQ-F5RHR3, DR-MT, DURATION-D6, R-R3W1-XHE-A
18	90.0	0.6	3.069E-008	UNITY, REFUEL, FREQ-F1B2, PZR-SV-REMOVEDW3, PROB-W3R10, FRAC-POS10, DURATION-R10
19	90.5	0.5	2.739E-008	UNITY, PROB-W1D6, FREQ-F4RHR3, DR-MT, DURATION-D6, R-B2W1-XHE-A
20	91.0	0.5	2.676E-008	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F5RHR3, FRAC-POS10, DURATION-R10, R-R3W4-XHE-F
21	91.4	0.4	2.225E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F2B2

Partition Cut Set Report

Family->FLOOD/WINDOW

Mincut Upper Bound -> 5.111E-006

End State ->CD

This Partition -> 5.111E-006

Cut No.	% Total	% Cut Set	Frequency	Cut Sets
22	91.8	0.3	1.913E-008	UNITY, REFUEL, PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F4RHR3, FRAC-POS10, DURATION-R10, R-R3W4-XHE-F
23	92.2	0.3	1.911E-008	UNITY, FREQ-F1B2, PROB-W2D6, DR-MT, DURATION-D6, R-B2W2-XHE-S
24	92.5	0.3	1.643E-008	UNITY, FREQ-F1B2, PROB-W3D6, DR-MT, DURATION-D6, R-B2W3-XHE-S
25	92.8	0.2	1.473E-008	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F2B2
26	93.1	0.2	1.360E-008	UNITY, PROB-W1D6, FREQ-F2B2, DR-MT, DURATION-D6, R-B2W1-XHE-A
27	93.3	0.2	1.291E-008	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW4, PROB-W4R6, FREQ-F2B2
28	93.6	0.2	1.192E-008	UNITY, REFUEL, DURATION-R6, FREQ-F1B2, PROB-W1R6, /PZR-SV-REMOVEDW1, R-B2W1-XHE-S/R6
29	93.7	0.1	9.650E-009	UNITY, PROB-W3D6, FREQ-F7B2, DR-MT, DURATION-D6
30	93.9	0.1	8.896E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F5RHR3, R-R3W3-XHE-F
31	94.1	0.1	7.716E-009	UNITY, REFUEL, /PZR-SV-REMOVEDW4, PROB-W4R10, FREQ-F7B2, FRAC-POS10, DURATION-R10
32	94.2	0.1	7.715E-009	UNITY, REFUEL, DURATION-R6, PROB-W1R6, LOOPISOLATED1R6, /PZR-SV-REMOVEDW1, FREQ-F5RHR3
33	94.4	0.1	7.615E-009	UNITY, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, LPR-CCF-PG-SUMP2, R-R3W2-XHE-F
34	94.5	0.1	7.289E-009	UNITY, REFUEL, PZR-SV-REMOVEDW3, PROB-W3R10, FREQ-F2B2, FRAC-POS10, DURATION-R10
35	94.7	0.1	7.082E-009	UNITY, LOOPISOLATED2R6, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, A-F3R3W2-X-FL-9, R-R3W2-XHE-F
36	94.8	0.1	7.074E-009	UNITY, FREQ-F3RHR3, PROB-W1D6, A-F3R3W1-X-FL-9, DR-MT, DURATION-D6, R-B2W1-XHE-A
37	94.9	0.1	6.543E-009	UNITY, REFUEL, FREQ-F3RHR3, PZR-SV-REMOVEDW4, PROB-W4R10, FRAC-POS10, A-F3R3W4-X-FL-4, DURATION-R10
38	95.0	0.1	6.360E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, FREQ-F4RHR3, R-R3W3-XHE-F
39	95.2	0.1	6.195E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F7B2
40	95.3	0.1	5.891E-009	UNITY, REFUEL, DURATION-R6, PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F5RHR3, R-R3W2-XHE-F
41	95.4	0.1	5.663E-009	UNITY, REFUEL, FREQ-F3RHR3, DURATION-R6, /PZR-SV-REMOVEDW3, PROB-W3R6, A-F3R3W3-X-FL-7
42	95.5	0.1	5.516E-009	UNITY, REFUEL, DURATION-R6, PROB-W1R6, LOOPISOLATED1R6, /PZR-SV-REMOVEDW1, FREQ-F4RHR3
43	95.6	0.1	5.173E-009	UNITY, REFUEL, DURATION-R6, /PZR-SV-REMOVEDW2, PROB-W2R6, FREQ-F4RHR3, A-F4R3W2-X-S1-8,

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BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
721	MSS-NRV-FT-101B	1	3.000E-003	+0.000E+000	+0.000E+000
	NRV FAILS TO OPEN				
722	MSS-NRV-FT-101C	1	3.000E-003	+0.000E+000	+0.000E+000
	NRV FAILS TO OPEN				
723	MSS-NRV-MA-101A	1	5.000E-002	+0.000E+000	+0.000E+000
	NRV IN TEST OR MAINTENANCE				
724	MSS-NRV-MA-101B	1	5.000E-002	+0.000E+000	+0.000E+000
	NRV IN TEST OR MAINTENANCE				
725	MSS-NRV-MA-101C	1	5.000E-002	+0.000E+000	+0.000E+000
	NRV IN TEST OR MAINTENANCE				
726	MSS-NRV-PG-101A	1	6.000E-004	+0.000E+000	+0.000E+000
	NRV PLUGGED				
727	MSS-NRV-PG-101B	1	6.000E-004	+0.000E+000	+0.000E+000
	NRV PLUGGED				
728	MSS-NRV-PG-101C	1	6.000E-004	+0.000E+000	+0.000E+000
	NRV PLUGGED				
729	MSS-STV-FT-101A	1	1.000E-004	+0.000E+000	+0.000E+000
	MSTV FAILS TO OPEN				
730	MSS-STV-FT-101B	1	1.000E-004	+0.000E+000	+0.000E+000
	MSTV FAILS TO OPEN				
731	MSS-STV-FT-101C	1	1.000E-004	+0.000E+000	+0.000E+000
	MSTV FAILS TO OPEN				
732	MSS-STV-MA-101A	1	5.000E-002	+0.000E+000	+0.000E+000
	MSTV 101A IN TEST OR MAINTENANCE				
733	MSS-STV-MA-101B	1	5.000E-002	+0.000E+000	+0.000E+000
	MSTV 101B IN TEST OR MAINTENANCE				
734	MSS-STV-MA-101C	1	5.000E-002	+0.000E+000	+0.000E+000
	MSTV 101C IN TEST OR MAINTENANCE				
735	MSS-STV-PG-101A	1	4.000E-005	+0.000E+000	+0.000E+000
	MSTV PLUGGED				
736	MSS-STV-PG-101B	1	4.000E-005	+0.000E+000	+0.000E+000
	MSTV PLUGGED				
737	MSS-STV-PG-101C	1	4.000E-005	+0.000E+000	+0.000E+000
	MSTV PLUGGED				
738	MSS-XVM-MA-084	1	+0.000E+000	+0.000E+000	+0.000E+000
	MST-A BPV 084 TEST OR MAINTENANCE				
739	MSS-XVM-MA-116	1	+0.000E+000	+0.000E+000	+0.000E+000
	MST-B BPV 116 TEST OR MAINTENANCE				
740	MSS-XVM-MA-153	1	+0.000E+000	+0.000E+000	+0.000E+000
	MST-C BPV 153 TEST OR MAINTENANCE				
741	MSS-XVM-PG-084	1	4.400E-004	+0.000E+000	+0.000E+000
	MST-A BPV 084 PLUGGED				
742	MSS-XVM-PG-116	1	4.400E-004	+0.000E+000	+0.000E+000
	MST-B BPV 116 PLUGGED				
743	MSS-XVM-PG-153	1	4.400E-004	+0.000E+000	+0.000E+000
	MST-C BPV 153 PLUGGED				
744	MSS-XVM-XHE-BYPS	1	1.700E-003	+0.000E+000	+0.000E+000
	Operator Failure to Open MSTV Bypass Valves				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
745	NB2W1	1	1.000E+000	+0.000E+000	+0.000E+000
746	NB2W2	1	1.000E+000	+0.000E+000	+0.000E+000
747	NB2W3	1	1.000E+000	+0.000E+000	+0.000E+000
748	NB2W4	1	1.000E+000	+0.000E+000	+0.000E+000
749	NRAC-1HR	1	4.400E-001	+0.000E+000	+0.000E+000
	NON-RECOVERY AC PWR W/IN 1 HR OF LO SP				
750	NRAC-7HR	1	5.000E-002	+0.000E+000	+0.000E+000
	NON-RECOVERY AC PWR W/IN 7 HRS OF LO SP				
751	NRAC-HALFHR	1	6.000E-001	+0.000E+000	+0.000E+000
	NON-RECOVERY AC PWR W/IN 30 MIN OF LO SP				
752	OEP-BAC-ST-FDRD	1	9.000E-005	+0.000E+000	+0.000E+000
	RESERVE STATION SERVICE FEEDER D BUSWORK FAILS				
753	OEP-BAC-ST-FDRF	1	9.000E-005	+0.000E+000	+0.000E+000
	RESERVE STATION SERVICE FEEDER F BUSWORK FAILS				
754	OEP-CCF-FS-DG12	1	8.400E-004	+0.000E+000	+0.000E+000
	CC FAIL TO START 1 & 2 DGS				
755	OEP-CCF-FS-DG123	1	4.000E-004	+0.000E+000	+0.000E+000
	CC FAIL TO START ALL 3 DGS				
756	OEP-CCF-FS-DG13	1	8.400E-004	+0.000E+000	+0.000E+000
	CC FAIL TO START 1 & 3 DGS				
757	OEP-CCF-FS-DG23	1	8.400E-004	+0.000E+000	+0.000E+000
	CC FAIL TO START 2 & 3 DGS				
758	OEP-CRB-FT-15H3	1	3.000E-003	+0.000E+000	+0.000E+000
	DIESEL GEN #1 CKT BRKR 15H3 FAILS TO CLOSE				
759	OEP-CRB-FT-15J3	1	3.000E-003	+0.000E+000	+0.000E+000
	DIESEL GEN #3 CKT BRKR 15J3 FAILS TO CLOSE				
760	OEP-DGN-FC-DG3U2	1	3.400E-002	+0.000E+000	+0.000E+000
	DIESEL GEN #3 UNAVAIL ALIGNED TO UNIT 2				
761	OEP-DGN-FR-DG01	4	2.000E-003	2.000E-003	1.000E+000
	DG 1 FAILS TO RUN 1 HR				
762	OEP-DGN-FR-DG03	4	2.000E-003	2.000E-003	1.000E+000
	DG 3 FAILS TO RUN 1 HR				
763	OEP-DGN-FS-DG01	1	2.200E-002	+0.000E+000	+0.000E+000
	DIESEL GENERATOR #1 FAILS TO START				
764	OEP-DGN-FS-DG03	1	2.200E-002	+0.000E+000	+0.000E+000
	DIESEL GENERATOR #3 FAILS TO START				
765	OEP-DGN-MA-DG01	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON DIESEL GENERATOR 1 - STATE 6				
766	OEP-DGN-MA-DG03	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON DIESEL GENERATOR 3				
767	OEP-DGN-MA0DG01	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON DIESEL GENERATOR 1 - STATE 10				
768	OEP-DGN-MA0DG03	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON DIESEL GENERATOR 3 - STATE 10				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
769	OSR-CCF-FS-RS2AB	1	3.300E-004	+0.000E+000	+0.000E+000
	COMMON CAUSE FAIL TO START OSR MDPS				
770	OSR-CKV-FT-CV11	1	1.000E-004	+0.000E+000	+0.000E+000
	CHECK VALVE CV11 FAILS TO OPEN				
771	OSR-CKV-FT-CV17	1	1.000E-004	+0.000E+000	+0.000E+000
	CHECK VALVE CV17 FAILS TO OPEN				
772	OSR-MDP-FR-A24HR	4	7.200E-004	3.000E-005	2.400E+001
	OSR MDP RS2A FAILS TO RUN 24 HOURS				
773	OSR-MDP-FR-B24HR	4	7.200E-004	3.000E-005	2.400E+001
	OSR MDP RS2B FAILS TO RUN 24 HOURS				
774	OSR-MDP-FS-RS2A	1	3.000E-003	+0.000E+000	+0.000E+000
	OSR MDP RS2A FAILS TO START ON DEMAND				
775	OSR-MDP-FS-RS2B	1	3.000E-003	+0.000E+000	+0.000E+000
	OSR MDP RS2B FAILS TO START ON DEMAND				
776	OSR-MDP-MA-RS2A	1	2.000E-003	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON OSR MDPRS2A				
777	OSR-MDP-MA-RS2B	1	2.000E-003	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON OSR MDPRS2B				
778	OSR-MDP-OP-2AB	F	+0.000E+000	+0.000E+000	+0.000E+000
	NO OPER INIT OSR				
779	OSR-MOV-PG-155A	1	4.000E-005	+0.000E+000	+0.000E+000
	OSR MOTOR OPER VALVE 155A PLUGGED				
780	OSR-MOV-PG-155B	1	4.000E-005	+0.000E+000	+0.000E+000
	OSR MOTOR OPER VALVE 155B PLUGGED				
781	OSR-MOV-PG-156A	1	4.000E-005	+0.000E+000	+0.000E+000
	OSR MOTOR OPER VALVE 156A PLUGGED				
782	OSR-MOV-PG-156B	1	4.000E-005	+0.000E+000	+0.000E+000
	OSR MOTOR OPER VALVE 156B PLUGGED				
783	OSR-STR-PG-RS2A	4	7.200E-004	3.000E-005	2.400E+001
	OSR MDP RS2A SUMP STRAINER PLUGGED				
784	OSR-STR-PG-RS2B	4	7.200E-004	3.000E-005	2.400E+001
	OSR MDP RS2B SUMP STRAINER PLUGGED				
785	OSR-TRA-MA	1	2.500E-001	+0.000E+000	+0.000E+000
	TRAIN A MAINT UNAV.				
786	PCS-AOV-FT-BYP-A	1	1.000E-003	+0.000E+000	+0.000E+000
	A BYP TO TURB BYPASS FAILS TO OPEN				
787	PCS-AOV-FT-BYP-B	1	1.000E-003	+0.000E+000	+0.000E+000
	B BYP TO TURB BYPASS FAILS TO OPEN				
788	PCS-AOV-FT-BYPA	1	1.000E-003	+0.000E+000	+0.000E+000
	A BYPASS VALVE FAIL TO OPEN TCV 107/8 A				
789	PCS-AOV-FT-BYPB	1	1.000E-003	+0.000E+000	+0.000E+000
	B BYPASS VALVE FAIL TO OPEN TCV 107/8B				
790	PCS-AOV-FT-MSTVA	1	1.000E-003	+0.000E+000	+0.000E+000
	A BYPASS VALVE TCV 105/6 A FAILS TO OPEN				
791	PCS-AOV-FT-MSTVB	1	1.000E-003	+0.000E+000	+0.000E+000
	B BYPASS VALVE TCV 105/6 B FAILS TO OPEN				
792	PCS-AOV-PG-BYP-A	1	4.000E-005	1.000E-007	7.200E+002
	A BYP TO TURB BYPASS PLUGGED				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
793	PCS-AOV-PG-BYP-B	1	4.000E-005	1.000E-007	7.200E+002
	B BYP TO TURB BYPASS PLUGGED				
794	PCS-AOV-PG-BYPA	1	4.000E-005	+0.000E+000	+0.000E+000
	A BYPASS TCV 107/8 A PLUGGED				
795	PCS-AOV-PG-BYPB	1	4.000E-005	+0.000E+000	+0.000E+000
	B BYPASS TCV 107/8B PLUGGED				
796	PCS-AOV-PG-MSTVA	1	4.000E-005	1.000E-007	7.200E+002
	A BYPASS VALVE TCV 105/6 A PLUGGED				
797	PCS-AOV-PG-MSTVB	1	4.000E-005	1.000E-007	7.200E+002
	B BYPASS VALVE TCV 105/6 B PLUGGED				
798	PCS-CCF-FT-TRBYP	1	1.000E-004	+0.000E+000	+0.000E+000
	cc failure of bypass valves				
799	PORV-PATH-CLSD	1	5.000E-002	+0.000E+000	+0.000E+000
	porv pathway closed				
800	POS-D6	F	+0.000E+000	+0.000E+000	+0.000E+000
	POS 6 of a Drained Maintenance Outage				
801	POS-R10	F	+0.000E+000	+0.000E+000	+0.000E+000
	POS 10 of a Refueling Outage				
802	POS-R6	T	1.000E+000	+0.000E+000	+0.000E+000
	POS 6 of a Refueling Outage				
803	PPS-AOV-OC-1455C	1	7.500E-007	+0.000E+000	+0.000E+000
	PORV TRANSFERS CLOSED				
804	PPS-CCF-FT-15356	1	3.500E-003	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF PORV BLOCKING VALVES				
805	PPS-CCF-FT-PORV	1	7.000E-005	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF THE PORVS TO OPEN COMMON CAUSE				
806	PPS-CCF-FT-SRVS	1	7.000E-005	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF RCS SRVS TO OPEN				
807	PPS-MOV-FC-1535	1	3.000E-001	+0.000E+000	+0.000E+000
	BLOCK VALVE MOV 1535 SHUT DUE TO LEAKING PORV				
808	PPS-MOV-FC-1536	1	3.000E-001	+0.000E+000	+0.000E+000
	BLOCK VALVE MOV 1536 SHUT DUE TO LEAKING PORV				
809	PPS-MOV-FT-1535	1	4.000E-002	+0.000E+000	+0.000E+000
	PORV BLOCK VALVE 1535 FAILS TO OPEN				
810	PPS-MOV-FT-1536	1	4.000E-002	+0.000E+000	+0.000E+000
	PORV BLOCK VALVE 1536 FAILS TO OPEN				
811	PPS-MOV-OO-1535	1	4.000E-002	+0.000E+000	+0.000E+000
	PORV BLOCK VALVE 1535 FAILS TO CLOSE				
812	PPS-MOV-OO-1536	1	4.000E-002	+0.000E+000	+0.000E+000
	PORV BLOCK VALVE 1536 FAILS TO CLOSE				
813	PPS-MOV-PG-1535	1	4.000E-005	+0.000E+000	+0.000E+000
	PORV BLOCK VALVE 1535 PLUGGED				
814	PPS-MOV-PG-1536	1	4.000E-005	+0.000E+000	+0.000E+000
	PORV BLOCK VALVE 1536 PLUGGED				
815	PPS-OP-SET-SD	1	2.700E-003	+0.000E+000	+0.000E+000
	OPERS DON'T SET PORVS				
816	PPS-PCV-MA-1455C	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON PORV 1455C - STATE 6				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
817	PPS-PCV-MA-1456	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON PORV 1456 - STATE 6				
818	PPS-PCV-MA01455C	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON PORV 1455C - STATE 10				
819	PPS-PCV-MA01456	1	4.410E-002	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON PORV 1456 - STATE 10				
820	PPS-SOV-FT-1455C	1	1.000E-003	+0.000E+000	+0.000E+000
	PORV PCV1455C FAILS TO OPEN ON DEMAND				
821	PPS-SOV-FT-1456	1	1.000E-003	+0.000E+000	+0.000E+000
	PORV [CV1456 FAILS TO OPEN ON DEMAND				
822	PPS-SOV-OO-1455C	1	3.000E-002	+0.000E+000	+0.000E+000
	PORV PCV1455C FAILS TO RECLOSE				
823	PPS-SOV-OO-1456	1	3.000E-002	+0.000E+000	+0.000E+000
	PORV PCV1456 FAILS TO RECLOSE				
824	PPS-SRV-FT-1551A	1	1.000E-003	+0.000E+000	+0.000E+000
	SAFETY RELIEF VALVE 1551A FAILS TO OPEN SAFETY RELIEF OPEN				
825	PPS-SRV-FT-1551B	1	1.000E-003	+0.000E+000	+0.000E+000
	SAFETY RELIEF VALVE 1551B FAILS TO OPEN SAFETY RELIEF OPEN				
826	PPS-SRV-FT-1551C	1	1.000E-003	+0.000E+000	+0.000E+000
	SAFETY RELIEF VALVE 1551C FAILS TO OPEN SAFETY RELIEF OPEN				
827	PPS-XHE-FO-1PORV	F	+0.000E+000	+0.000E+000	+0.000E+000
	FAILURE OF THE OP TO OPEN ONE PORV				
828	PPS-XHE-FO-EMBOR	F	+0.000E+000	+0.000E+000	+0.000E+000
	OPER FAILS TO CORRECTLY PERFORM EMERG BORATION				
829	PPS-XHE-FO-PORVS	F	+0.000E+000	+0.000E+000	+0.000E+000
	FAILURE OF THE OPERATOR TO OPEN BOTH PORVS				
830	PPS-XHE-FO-UNBLK	F	+0.000E+000	+0.000E+000	+0.000E+000
	OPERATOR FAILS TO UNBLOCK RCS PORV IN ATWS				
831	PROB-W1D6	1	1.170E-001	+0.000E+000	+0.000E+000
	Probability that IE occurs in w1 given D6				
832	PROB-W1R10	F	+0.000E+000	+0.000E+000	+0.000E+000
	Probability that IE occurs in w1 given R10				
833	PROB-W1R6	1	1.700E-002	+0.000E+000	+0.000E+000
	Probability that IE occurs in w1 given R6				
834	PROB-W2D6	1	4.360E-001	+0.000E+000	+0.000E+000
	Probability that IE occurs in w1 given D6				
835	PROB-W2R10	F	+0.000E+000	+0.000E+000	+0.000E+000
	Probability that IE occurs in w1 given R10				
836	PROB-W2R6	1	5.430E-001	+0.000E+000	+0.000E+000
	Probability that IE occurs in w1 given R6				
837	PROB-W3D6	1	3.750E-001	+0.000E+000	+0.000E+000
	Probability that IE occurs in w3 given D6				
838	PROB-W3R10	1	1.600E-002	+0.000E+000	+0.000E+000
	Probability that IE occurs in w3 given R10				
839	PROB-W3R6	1	4.100E-001	+0.000E+000	+0.000E+000
	Probability that IE occurs in w3 given R6				
840	PROB-W4D6	1	7.200E-002	+0.000E+000	+0.000E+000
	Probability that IE occurs in W4 given D6				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
841	PROB-W4R10	1	9.840E-001	+0.000E+000	+0.000E+000
	Probability that IE occurs in W4 given R10				
842	PROB-W4R6	1	3.400E-002	+0.000E+000	+0.000E+000
	Probability that IE occurs in W4 given R6				
843	PZR-SV-REMOVED	1	1.000E-001	+0.000E+000	+0.000E+000
	PRESSURIZER SRV REMOVED				
844	PZR-SV-REMOVEDW	1	1.000E+000	+0.000E+000	+0.000E+000
	Event added by partition editor				
845	PZR-SV-REMOVEDW1	1	1.000E-002	+0.000E+000	+0.000E+000
	Pressurizer Safety Valves Removed in W1R				
846	PZR-SV-REMOVEDW2	1	5.000E-002	+0.000E+000	+0.000E+000
	Pressurizer Safety Valves Removed in W2R				
847	PZR-SV-REMOVEDW3	1	9.000E-001	+0.000E+000	+0.000E+000
	Pressurizer Safety Valves Removed in W3R				
848	PZR-SV-REMOVEDW4	1	3.000E-001	+0.000E+000	+0.000E+000
	Pressurizer Safety Valves Removed in W4R6				
849	QS-SBO	1	2.700E-001	+0.000E+000	+0.000E+000
	SG SRV/PORV STICK OPEN DURING SBO				
850	QS-UNIT2	1	1.600E-001	+0.000E+000	+0.000E+000
	UNIT 2 SG RELIEF STUCK OPEN DURING SBO				
851	R-B2W1-XHE-A	1	1.000E-001	+0.000E+000	+0.000E+000
	RECOVERY DUE TO UNCERTAIN SUCCESS CRITERION OF REFLUX				
852	R-B2W1-XHE-S/R6	1	3.100E-001	-----E----	-----E----
	recovery using reflux				
853	R-B2W2-XHE-S	1	8.950E-003	+0.000E+000	+0.000E+000
	RECOVER AFW TO ESTABLISH LONG TERM REFLUX/W2				
854	R-B2W2-XHE-S/R6	1	7.030E-001	+0.000E+000	+0.000E+000
	RECOVER AFW FOR REFLUX W2, IN R6 ISOLATION .7				
855	R-B2W3-XHE-G	1	1.270E-003	-----E----	-----E----
	recovery of gravity feed or other action				
856	R-B2W3-XHE-S	1	8.950E-003	+0.000E+000	+0.000E+000
	RECOVER AFW TO ESTABLISH LONG TERM REFLUX COOLING/W3				
857	R-B2W4-XHE-G	1	1.270E-003	-----E----	-----E----
	recovery of gravity feed or other action				
858	R-B2W4-XHE-S	1	5.390E-004	+0.000E+000	+0.000E+000
	RECOVER AFW TO ESTABLISH LONG TERM REFLUX COOLING/W4				
859	R-R3R6-XHE-G-4	1	2.400E-001	+0.000E+000	+0.000E+000
	Failure to Recover Given Successful Gravity Feed-RAR6				
860	R-R3W1-XHE-A	1	1.000E-001	-----E----	-----E----
	RECOVERY DUE TO UNCERTAINTY IN REFLUX CRITERION				
861	R-R3W1-XHE-F	1	4.200E-001	+0.000E+000	+0.000E+000
	RECOVER FEED AND BLEED, XCONNECTING TO UNIT 2 CHARGING/W1				
862	R-R3W2-XHE-F	1	1.420E-001	+0.000E+000	+0.000E+000
	RECOVER FEED AND BLEED, XCONNECTING TO UNIT 2 CHARGING/W2				
863	R-R3W3-XHE-F	1	1.420E-001	+0.000E+000	+0.000E+000
	RECOVER FEED AND BLEED, XCONNECTING TO UNIT 2 CHARGING/W3				
864	R-R3W4-XHE-F	1	6.360E-002	+0.000E+000	+0.000E+000
	RECOVER FEED AND BLEED, XCONNECTING TO UNIT 2 CHARGING/W4				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
865	R-R4R6-XHE-G-5	1	6.300E-001	+0.000E+000	+0.000E+000
	Failure to Recover Given Successful Gravity Feed-RAR6				
866	RCS-AOV-FT-1455A	1	1.000E-003	+0.000E+000	+0.000E+000
	FAILURE OF NORMAL SPRAY VLV 1455A TO OPEN				
867	RCS-AOV-FT-1455B	1	1.000E-003	+0.000E+000	+0.000E+000
	FAILURE OF NORMAL SPRAY VLV 1455B TO OPEN				
868	RCS-CCF-FT-455AB	1	1.000E-004	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF NORMAL SPRAY VLVS TO				
869	RCS-FCV-FT-AUXSP	1	1.000E-003	+0.000E+000	+0.000E+000
	FAILURE OF AUXILIARY SPRAY				
870	RCS-MDP-FR-RCPIA	4	3.000E-005	3.000E-005	1.000E+000
	RCP 1A FAILS TO RUN				
871	RCS-MDP-FR-RCPI C	4	3.000E-005	3.000E-005	1.000E+000
	RCP 1C FAILS TO RUN				
872	RCS-MDP-MA-RCPI C	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON RCP 1C - STATE 6				
873	RCS-MDP-MAORCPI C	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON RCP 1C - STATE 10				
874	RCS-XHE-FO-DPRES	F	+0.000E+000	+0.000E+000	+0.000E+000
	OPERATOR FAILS TO COOLDOWN AND DEPRESS				
875	RCS-XHE-FO-DPRT7	F	+0.000E+000	+0.000E+000	+0.000E+000
	OPERATOR FAILS COOLDOWN AND DPRES FOR SGTR				
876	REC-XHE-FO-SCOOL	1	1.250E-001	+0.000E+000	+0.000E+000
	OP FAILS TO GET RCP SEAL COOL DURING SBO				
877	REFUEL	1	6.000E-001	+0.000E+000	+0.000E+000
	Frequency of Refueling				
878	RHR-AOV-CO-1758	1	1.200E-005	5.000E-007	+0.000E+000
	AOV 1758 opens spuriously				
879	RHR-AOV-OC-1758	1	7.500E-007	+0.000E+000	+0.000E+000
	HCV-1758 FAILS SHUT.				
880	RHR-AOV-OO-1605	1	2.400E-006	+0.000E+000	+0.000E+000
	FCV-1605 TRANSFERS FULLY OPEN AND REMAINS OPEN				
881	RHR-ASF-PG-1605	1	3.000E-004	+0.000E+000	+0.000E+000
	RHR FLOW ORIFICE PLUGGED.				
882	RHR-CCF-FS-MDPAB	1	4.500E-004	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF MDP 1A AND 1B TO START				
883	RHR-CCF-FT-720AB	1	2.600E-004	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF RHR MOVES 1720A 1720B				
884	RHR-CKV-FT-CV11	1	1.000E-004	+0.000E+000	+0.000E+000
	CHECK VALVE CV11 FAILS TO OPEN				
885	RHR-CKV-FT-CV5	1	1.000E-004	+0.000E+000	+0.000E+000
	CHECK VALVE CV5 FAILS TO OPEN				
886	RHR-CKV-OO-CV11	1	1.000E-003	+0.000E+000	+0.000E+000
	BACKFLOW THROUGH CV11				
887	RHR-CKV-OO-CV5	1	1.000E-003	+0.000E+000	+0.000E+000
	BACKFLOW THROUGH CV5				
888	RHR-HTX-LK-E1A	4	7.200E-005	3.000E-006	2.400E+001
	RHR HEAT EXCHANGER E1A TUBE LEAKS				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
889	RHR-HTX-LK-E1B	4	7.200E-005	3.000E-006	2.400E+001
	RHR HEAT EXCHANGER E1B TUBE LEAKS				
890	RHR-HTX-PG-E1A	4	1.368E-004	5.700E-006	2.400E+001
	RHR HEAT EXCHANGER E1A PLUGGED				
891	RHR-HTX-PG-E1B	4	1.368E-004	5.700E-006	2.400E+001
	RHR HEAT EXCHANGER E1B PLUGGED.				
892	RHR-MDP-FR-A24HR	4	7.200E-004	3.000E-005	2.400E+001
	RHR MDP 1A FAILS TO RUN 24 HOURS				
893	RHR-MDP-FR-B24HR	4	7.200E-004	3.000E-005	2.400E+001
	RHR MDP 1B FAILS TO RUN FOR 24 HOURS				
894	RHR-MDP-FS-RHR1A	1	3.000E-003	+0.000E+000	+0.000E+000
	RHR MDP 1A FAILS TO START ON DEMAND				
895	RHR-MDP-FS-RHR1B	1	3.000E-003	+0.000E+000	+0.000E+000
	RHR MDP 1B FAILS TO START ON DEMAND				
896	RHR-MDP-MA-RHR1B	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON RHR PUMP 1B - STATE 6				
897	RHR-MDP-MAORHR1B	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON RHR PUMP 1B - STATE 10				
898	RHR-MOV-FT-1700	1	3.000E-003	+0.000E+000	+0.000E+000
	RHR MOV 1700 FAILS TO OPERATE ON DEMAND				
899	RHR-MOV-FT-1701	1	3.000E-003	+0.000E+000	+0.000E+000
	RHR MOV 1701 FAILS TO OPEN ON DEMAND				
900	RHR-MOV-FT-1720A	1	3.000E-003	+0.000E+000	+0.000E+000
	RHR MOV 1720A FAILS TO OPERATE ON DEMAND.				
901	RHR-MOV-FT-1720B	1	3.000E-003	+0.000E+000	+0.000E+000
	RHR MOV 1720B FAILS TO OPERATE ON DEMAND.				
902	RHR-MOV-MA-1720A	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON RHR MOV 1720A - STATE 6				
903	RHR-MOV-MA01720A	F	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON RHR MOV 1720A - STATE 10				
904	RHR-MOV-PG-1700	1	4.400E-004	1.000E-007	8.760E+003
	RHR MOTOR OPERATED VALVE 1700 PLUGGED				
905	RHR-MOV-PG-1701	1	4.400E-004	1.000E-007	8.760E+003
	RHR MOTOR OPER VALVE 1701 PLUGGED				
906	RHR-MOV-PG-1720A	1	4.400E-004	1.000E-007	8.760E+003
	RHR MOTOR OPERATED VALVE 1720A PLUGGED.				
907	RHR-MOV-PG-1720B	1	4.400E-004	1.000E-007	8.760E+003
	RHR MOTOR OPERATED VALVE 1720B PLUGGED.				
908	RHR-SRV-CO-1721	4	9.360E-005	3.900E-006	2.400E+001
	SRV-1721 RELIEF VALVE INADVERTENT OPEN.				
909	RHR-XMV-FT-XV20	1	1.000E-004	+0.000E+000	+0.000E+000
	Manual Valve RH-20 Fails to Open				
910	RHR-XMV-FT-XV24	1	1.000E-004	+0.000E+000	+0.000E+000
	Manual Valve RH-24 Fails to Open				
911	RHR-XVM-PG-XV12	1	4.400E-004	1.000E-007	8.760E+003
	MANUAL VALVE XV12 PLUGGED				
912	RHR-XVM-PG-XV15	1	4.400E-004	1.000E-007	8.760E+003
	MANUAL VALVE XV15 PLUGGED				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
913	RHR-XVM-PG-XV19 MANUAL VALVE XV19 PLUGGED	1	4.400E-004	1.000E-007	8.760E+003
914	RHR-XVM-PG-XV2 MANUAL VALVE XV2 PLUGGED	1	4.400E-004	1.000E-007	8.760E+003
915	RHR-XVM-PG-XV20 MANUAL VALVE XV20 PLUGGED	1	4.400E-004	1.000E-007	8.760E+003
916	RHR-XVM-PG-XV24 MANUAL VALVE XV24 PLUGGED	1	4.400E-004	1.000E-007	8.760E+003
917	RHR-XVM-PG-XV6 MANUAL VALVE XV6 PLUGGED	1	4.400E-004	1.000E-007	8.760E+003
918	RHR-XVM-PG-XV8 MANUAL VALVE XV8 PLUGGED	1	4.400E-004	1.000E-007	8.760E+003
919	RMT-ACT-FA-RMTSA NO SIGNAL FROM RMTS TRAIN A	F	+0.000E+000	+0.000E+000	+0.000E+000
920	RMT-ACT-FA-RMTSB NO SIGNAL FROM RMTS TRAIN B	F	+0.000E+000	+0.000E+000	+0.000E+000
921	RMT-CCF-FA-MSCAL COMMON CAUSE FAILURE RMT DUE TO MISCALIBRATION	F	+0.000E+000	+0.000E+000	+0.000E+000
922	PWT-TNK-LF-RWST Insuff. water available from the RWST	1	2.700E-006	+0.000E+000	+0.000E+000
923	SAS-CCF-FR-SAC1 COMMON CAUSE FAILURE OF SA COMPRESSORS TO RUN	2	4.800E-004	2.000E-005	+0.000E+000
924	SAS-CPS-FR-1SAC1 SERVICE AIR COMPRESSOR 1-SA-C-1 FAILS TO RUN	2	4.800E-003	2.000E-004	+0.000E+000
925	SAS-CPS-FR-2SAC1 SERVICE AIR COMPRESSOR 2-SA-C-1 FAILS TO RUN	2	4.800E-003	2.000E-004	+0.000E+000
926	SAS-CPS-FS-2SAC1 SERVICE AIR COMPRESSOR 2-SA-C-1 FAILS TO START	1	8.000E-002	+0.000E+000	+0.000E+000
927	SEMI-VIT-BUS FAILURE OF SEMI-VITAL BUS	1	1.000E-005	+0.000E+000	+0.000E+000
928	SGA-DRAINED-R SG A SECONDARY SIDE DRAINED	1	2.300E-002	+0.000E+000	+0.000E+000
929	SGB-DRAINED-R SG B DRAINED	1	2.300E-002	+0.000E+000	+0.000E+000
930	SGC-DRAINED-R SG C DRAINED	1	2.300E-002	+0.000E+000	+0.000E+000
931	SGRT-AOV-LK-100A INSTRUMENT AIR LEAKS AT TV-BD-100A	1	2.400E-005	+0.000E+000	+0.000E+000
932	SGRT-AOV-LK-100B INSTRUMENT AIR LEAK AT TV-BD-100B	1	2.400E-005	+0.000E+000	+0.000E+000
933	SGRT-AOV-LK-100C INSTRUMENT AIR LEAKS AT TV-BD-100C	1	2.400E-005	+0.000E+000	+0.000E+000
934	SGRT-AOV-LK-100D INSTRUMENT AIR LEAK AT TV-BD-100D	1	2.400E-005	+0.000E+000	+0.000E+000
935	SGRT-AOV-LK-100E INSTRUMENT AIR LEAKS AT TV-BD-100E	1	2.400E-005	+0.000E+000	+0.000E+000
936	SGRT-AOV-LK-100F INSTRUMENT AIR LEAK AT TV-BD-100F	1	2.400E-005	+0.000E+000	+0.000E+000

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
937	SGRT-AOV-OC-100A	1	7.500E-007	+0.000E+000	+0.000E+000
	TV-BD-100A TRANSFERS CLOSED				
938	SGRT-AOV-OC-100B	1	7.500E-007	+0.000E+000	+0.000E+000
	TV-BD-100B TRANSFERS CLOSED				
939	SGRT-AOV-OC-100C	1	7.500E-007	+0.000E+000	+0.000E+000
	TV-BD-100C TRANSFERS CLOSED				
940	SGRT-AOV-OC-100D	1	7.500E-007	+0.000E+000	+0.000E+000
	TV-BD-100D TRANSFERS CLOSED				
941	SGRT-AOV-OC-100E	1	7.500E-007	+0.000E+000	+0.000E+000
	TV-BD-100E TRANSFERS CLOSED				
942	SGRT-AOV-OC-100F	1	7.500E-007	+0.000E+000	+0.000E+000
	TV-BD-100F TRANSFERS CLOSED				
943	SGRT-AOV-PG-100A	1	4.000E-005	+0.000E+000	+0.000E+000
	TV-BD-100A PLUGGED				
944	SGRT-AOV-PG-100B	1	4.000E-005	+0.000E+000	+0.000E+000
	TV-BD-100B PLUGGED				
945	SGRT-AOV-PG-100C	1	4.000E-005	+0.000E+000	+0.000E+000
	TV-BD-100C PLUGGED				
946	SGRT-AOV-PG-100D	1	4.000E-005	+0.000E+000	+0.000E+000
	TV-BD-100D PLUGGED				
947	SGRT-AOV-PG-100E	1	4.000E-005	+0.000E+000	+0.000E+000
	TV-BD-100E PLUGGED				
948	SGRT-AOV-PG-100F	1	4.000E-005	+0.000E+000	+0.000E+000
	TV-BD-100F PLUGGED				
949	SGRT-CKV-FO-CMFA	1	1.000E-003	+0.000E+000	+0.000E+000
	Failure of Check Valve to Chem feed to Open				
950	SGRT-CKV-FO-CMFB	1	1.000E-003	+0.000E+000	+0.000E+000
	Failure of Check Valve to Chem feed to Open				
951	SGRT-CKV-FO-CMFC	1	1.000E-003	+0.000E+000	+0.000E+000
	Failure of Check Valve to Chem feed to Open				
952	SGRT-CKV-FT-RT11	1	1.000E-004	+0.000E+000	+0.000E+000
	RT-11 FAIL TO OPEN				
953	SGRT-CKV-FT-RT30	1	1.000E-004	+0.000E+000	+0.000E+000
	RT-30 FAIL TO OPEN				
954	SGRT-CKV-FT-RT49	1	1.000E-004	+0.000E+000	+0.000E+000
	RT-49 FAIL TO OPEN				
955	SGRT-HTX-LK-E1A	1	7.200E-005	+0.000E+000	+0.000E+000
	HTX RT-E1A LEAKING				
956	SGRT-HTX-LK-E1B	1	7.200E-005	+0.000E+000	+0.000E+000
	HTX RT-E1B LEAKING				
957	SGRT-HTX-LK-E1C	1	7.200E-005	+0.000E+000	+0.000E+000
	HTX RT-E1C LEAKING				
958	SGRT-HTX-MA-E1A	1	2.000E-004	+0.000E+000	+0.000E+000
	HTX RT-E1A IN MAINTENANCE				
959	SGRT-HTX-MA-E1B	1	2.000E-004	+0.000E+000	+0.000E+000
	HTX RT-E1B IN MAINTENANCE				
960	SGRT-HTX-MA-E1C	1	2.000E-004	+0.000E+000	+0.000E+000
	HTX RT-E1C IN MAINTENANCE				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
961	SGRT-HTX-PG-E1A	1	1.400E-004	+0.000E+000	+0.000E+000
	HTX RT-E1A PLUGGED				
962	SGRT-HTX-PG-E1B	1	1.400E-004	+0.000E+000	+0.000E+000
	HTX RT-E1B PLUGGED				
963	SGRT-HTX-PG-E1C	1	1.400E-004	+0.000E+000	+0.000E+000
	HTX RT-E1C PLUGGED				
964	SGRT-MV-PG-150	1	4.000E-005	+0.000E+000	+0.000E+000
	MV 150 PLUGGED				
965	SGRT-MV-PG-160	1	4.000E-005	+0.000E+000	+0.000E+000
	MV 160 PLUGGED				
966	SGRT-MV-PG-170	1	4.000E-005	+0.000E+000	+0.000E+000
	MV 170 PLUGGED				
967	SGRT-MV-PG-BD1	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-1 PLUGGED				
968	SGRT-MV-PG-BD11	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-11 PLUGGED				
969	SGRT-MV-PG-BD12	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-12 PLUGGED				
970	SGRT-MV-PG-BD14	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-14 PLUGGED				
971	SGRT-MV-PG-BD2	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-2 PLUGGED				
972	SGRT-MV-PG-BD21	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-21 PLUGGED				
973	SGRT-MV-PG-BD22	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-22 PLUGGED				
974	SGRT-MV-PG-BD24	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-24 PLUGGED				
975	SGRT-MV-PG-BD4	1	4.000E-005	+0.000E+000	+0.000E+000
	BD-4 PLUGGED				
976	SGRT-MV-PG-RT1	1	4.000E-005	+0.000E+000	+0.000E+000
	RT1 PLUGGED				
977	SGRT-MV-PG-RT13	1	4.000E-005	+0.000E+000	+0.000E+000
	RT13 PLUGGED				
978	SGRT-MV-PG-RT18	1	4.000E-005	+0.000E+000	+0.000E+000
	RT18 PLUGGED				
979	SGRT-MV-PG-RT19	1	4.000E-005	+0.000E+000	+0.000E+000
	RT19 PLUGGED				
980	SGRT-MV-PG-RT2	1	4.000E-005	+0.000E+000	+0.000E+000
	RT2 PLUGGED				
981	SGRT-MV-PG-RT20	1	4.000E-005	+0.000E+000	+0.000E+000
	RT20 PLUGGED				
982	SGRT-MV-PG-RT21	1	4.000E-005	+0.000E+000	+0.000E+000
	RT21 PLUGGED				
983	SGRT-MV-PG-RT25	1	4.000E-005	+0.000E+000	+0.000E+000
	RT25 PLUGGED				
984	SGRT-MV-PG-RT27	1	4.000E-005	+0.000E+000	+0.000E+000
	RT27 PLUGGED				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
985	SGRT-MV-PG-RT32	1	4.000E-005	+0.000E+000	+0.000E+000
	RT32 PLUGGED				
986	SGRT-MV-PG-RT37	1	4.000E-005	+0.000E+000	+0.000E+000
	RT37 PLUGGED				
987	SGRT-MV-PG-RT38	1	4.000E-005	+0.000E+000	+0.000E+000
	RT38 PLUGGED				
988	SGRT-MV-PG-RT39	1	4.000E-005	+0.000E+000	+0.000E+000
	RT39 PLUGGED				
989	SGRT-MV-PG-RT40	1	4.000E-005	+0.000E+000	+0.000E+000
	RT40 PLUGGED				
990	SGRT-MV-PG-RT44	1	4.000E-005	+0.000E+000	+0.000E+000
	RT44 PLUGGED				
991	SGRT-MV-PG-RT46	1	4.000E-005	+0.000E+000	+0.000E+000
	RT46 PLUGGED				
992	SGRT-MV-PG-RT51	1	4.000E-005	+0.000E+000	+0.000E+000
	RT51 PLUGGED				
993	SGRT-MV-PG-RT56	1	4.000E-005	+0.000E+000	+0.000E+000
	RT56 PLUGGED				
994	SGRT-MV-PG-RT57	1	4.000E-005	+0.000E+000	+0.000E+000
	RT57 PLUGGED				
995	SGRT-MV-PG-RT6	1	4.000E-005	+0.000E+000	+0.000E+000
	RT6 PLUGGED				
996	SGRT-MV-PG-RT8	1	4.000E-005	+0.000E+000	+0.000E+000
	RT8 PLUGGED				
997	SGRT-PMP-FR-RT1A	1	7.200E-004	+0.000E+000	+0.000E+000
	SGRT PUMP RT-1A FAILS TO RUN				
998	SGRT-PMP-FR-RT1B	1	7.200E-004	+0.000E+000	+0.000E+000
	SGRT PUMP RT-1B FAILS TO RUN				
999	SGRT-PMP-FR-RT1C	1	7.200E-004	+0.000E+000	+0.000E+000
	SGRT PUMP RT-1C FAILS TO RUN				
1000	SGRT-PMP-FS-RT1A	1	3.000E-003	+0.000E+000	+0.000E+000
	PUMP RT-1A FAILS TO START				
1001	SGRT-PMP-FS-RT1B	1	3.000E-003	+0.000E+000	+0.000E+000
	PUMP RT-1B FAILS TO START				
1002	SGRT-PMP-FS-RT1C	1	3.000E-003	+0.000E+000	+0.000E+000
	PUMP RT-1C FAILS TO START				
1003	SGRT-PMP-MA-RT1A	1	1.000E-003	+0.000E+000	+0.000E+000
	PUMP RT-1A IN MAINTENANCE				
1004	SGRT-PMP-MA-RT1B	1	1.000E-003	+0.000E+000	+0.000E+000
	PUMP RT-1B IN MAINTENANCE				
1005	SGRT-PMP-MA-RT1C	1	1.000E-003	+0.000E+000	+0.000E+000
	PUMP RT-1C IN MAINTENANCE				
1006	SGRT-SGA	F	+0.000E+000	+0.000E+000	+0.000E+000
	SGRT A INOPERATIONAL				
1007	SGRT-SGB	F	+0.000E+000	+0.000E+000	+0.000E+000
	SGRT B INOPERATIONAL				
1008	SGRT-SGC	F	+0.000E+000	+0.000E+000	+0.000E+000
	SGRT C INOPERATIONAL				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
1009	SGRT-XHE-FS-100	F	+0.000E+000	+0.000E+000	+0.000E+000
	OPERATOR FAILS TO ALIGN SGRT SYSTEM				
1010	SGS-DRAINED-CSD	1	1.000E-003	+0.000E+000	+0.000E+000
	Secondary Side of SGs Drained in POSS 6 of Drained Mainten				
1011	SGS-DRAINED-R	1	8.300E-003	+0.000E+000	+0.000E+000
	Secondary Side of SGs Drained in POSS 6 or 10 or Refueling				
1012	SIS-ACT-FA-SISA	1	+0.000E+000	+0.000E+000	+0.000E+000
	NO SIGNAL FROM SIS TRAIN A				
1013	SIS-ACT-FA-SISB	1	+0.000E+000	+0.000E+000	+0.000E+000
	NO SIGNAL FROM SIS TRAIN B				
1014	SLOCA-NRACSL-LT	1	9.200E-002	+0.000E+000	+0.000E+000
	SEAL LOCA W/ NON REC AC POWER AND SEC DEPRESS				
1015	SLOCA-NRACSL-ST	1	9.900E-002	+0.000E+000	+0.000E+000
	SEAL LOCA W/ NON REC AC POWER AND NO DEPRESS				
1016	SP-SI-CLSI-HE	F	+0.000E+000	+0.000E+000	+0.000E+000
	SPURIOUS SI/CLSI SIGNAL				
1017	SSHR-AOV-XHE-105	1	1.300E-002	+0.000E+000	+0.000E+000
	Operator Failure to Use Steam Dump to Condenser				
1018	SUMPPLUG	1	1.000E+000	+0.000E+000	+0.000E+000
	Containment Sump Plugged				
1019	SW-AOV-FT-SW263	1	1.000E+000	+0.000E+000	+0.000E+000
	1-SW-263 FAILS CLOSED ON LOSS OF OFFSITE POWER				
1020	SW-AOV-SC-SW263	1	7.500E-007	+0.000E+000	+0.000E+000
	SOLENOID OPERATED VALVE 1-SW-263 SPURIOUSLY CLOSES				
1021	SW-CCF-AIRINJ	1	3.200E-004	+0.000E+000	+0.000E+000
	AIR INJECTION TO CC HXRS CCF				
1022	SW-CCF-SC-MOV102	1	2.500E-004	+0.000E+000	+0.000E+000
	MOVs 1-SW-MOV-102A & 102B SPURIOUS CLOSE				
1023	SW-CKV-PG6-SW333	1	6.000E-007	1.000E-007	6.000E+000
	4C CHILLER SW 1-SW-333 PLUGS DURING 6 HOUR LCO				
1024	SW-PIPE-MA-2PS3	1	1.200E-005	+0.000E+000	+0.000E+000
	UNSCHEDULED MAINT ON UNIT 2 SERVICE WATER SUPPLY PIPING (PS3				
1025	SW-PIPE-MA-PS4	1	1.200E-005	+0.000E+000	+0.000E+000
	UNSCHEDULED MAINT ON UNIT 1 SERVICE WATER SUPPLY PIPING (PS4				
1026	SW-STR-PL-TS15CA	4	7.200E-004	3.000E-005	2.400E+001
	STRAINER TS-15C FOR TRAIN A PLUGGED DURING MISSION				
1027	SW-STR-PL-TS15CC	4	7.200E-004	3.000E-005	2.400E+001
	STRAINER TS-15C FOR TRAIN C PLUGGED DURING MISSION				
1028	SW-TBFLOWDIVER	4	2.664E-006	1.110E-007	2.400E+001
	FLOW DIVERSION TO TURBINE BLDG - SW SUBSYSTEM				
1029	SWS-AOV-SC-100A	1	1.200E-005	5.000E-007	2.400E+001
	1-SW-PCV-100A SPURIOUS CLOSED DURING MISSION				
1030	SWS-AOV-SC-100C	1	1.200E-005	5.000E-007	2.400E+001
	1-SW-PCV-100C SPURIOUS CLOSED DURING MISSION				
1031	SWS-CCF-FT-3ABCD	1	6.300E-004	+0.000E+000	+0.000E+000
	COMMON CAUSE FAILURE OF SWS ISOL MOVs 103ABCD				
1032	SWS-CCF-PG-TS15C	1	1.900E-004	+0.000E+000	+0.000E+000
	CCF 3/3 PG TS-15C STRAINERS PLUG				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
1033	SWS-CKV-FT-SW323	1	1.000E-004	+0.000E+000	+0.000E+000
	CHECK VALVE 1-SW-323 FAILS TO OPEN				
1034	SWS-CKV-PG-SW313	4	2.400E-006	1.000E-007	2.400E+001
	CHECK VALVE 1-SW-313 PLUGS DURING MISSION				
1035	SWS-CKV-PG-SW333	4	2.400E-006	1.000E-007	2.400E+001
	CHECK VALVE 2-SW-333 PLUGS DURING MISSION				
1036	SWS-MOV-FT-103A	1	3.000E-003	+0.000E+000	+0.000E+000
	SWS MOTOR OP VLV 103A FAILS TO OPEN				
1037	SWS-MOV-FT-103B	1	3.000E-003	+0.000E+000	+0.000E+000
	SWS MOTOR OP VLV 103B FAILS TO OPEN				
1038	SWS-MOV-FT-103C	1	3.000E-003	+0.000E+000	+0.000E+000
	SWS MOTOR OP VLV 103C FAILS TO OPEN				
1039	SWS-MOV-FT-103D	1	3.000E-003	+0.000E+000	+0.000E+000
	SWS MOTOR OP VLV 103D FAILS TO OPEN				
1040	SWS-MOV-MA-103A	1	2.000E-004	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE SWS MOV 103A				
1041	SWS-MOV-MA-103B	1	2.000E-004	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE SWS MOV 103B				
1042	SWS-MOV-MA-103C	1	2.000E-004	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE SWS MOV 103C				
1043	SWS-MOV-MA-103D	1	2.000E-004	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON SWS MOV103D				
1044	SWS-MOV-MA-104D	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON SWS MOV 104D - STATE 6				
1045	SWS-MOV-MA0103A	1	2.000E-004	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE SWS MOV 103A				
1046	SWS-MOV-MA0104D	1	+0.000E+000	+0.000E+000	+0.000E+000
	TEST AND MAINTENANCE ON SWS MOV 104D - STATE 10				
1047	SWS-MOV-OP-RSFP	1	1.440E-003	+0.000E+000	+0.000E+000
	OPERS DON'T OPEN SW MOV5				
1048	SWS-MOV-OP-RSS	1	1.440E-003	+0.000E+000	+0.000E+000
	OPER DON'T OPEN MOV5				
1049	SWS-MOV-PG-104A	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 104A PLUGGED				
1050	SWS-MOV-PG-104B	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 104B PLUGGED				
1051	SWS-MOV-PG-104C	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 104C PLUGGED				
1052	SWS-MOV-PG-104D	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 104D PLUGGED				
1053	SWS-MOV-PG-105A	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 105A PLUGGED				
1054	SWS-MOV-PG-105B	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 105B PLUGGED				
1055	SWS-MOV-PG-105C	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 105C PLUGGED				
1056	SWS-MOV-PG-105D	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 105D PLUGGED				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
1057	SWS-MOV-PG-106A	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 106A PLUGGED				
1058	SWS-MOV-PG-106B	1	6.500E-004	1.000E-007	1.300E+004
	SWS MOTOR OPER VALVE 106B PLUGGED				
1059	SWS-PCV-FT-100B	1	1.000E-003	+0.000E+000	+0.000E+000
	PRES CONTROL VALVE 1-SW-PCV-100B FAILS TO OPEN DURING STANDBY				
1060	SWS-STR-PG-TS15C	6	1.080E-002	3.000E-005	7.200E+002
	STRAINER TS-15C PLUGGED DURING STANDBY				
1061	SWS-XHE-AP12	1	1.000E+000	+0.000E+000	+0.000E+000
1062	SWS-XVM-PG-37U2	1	4.000E-005	1.000E-007	7.200E+002
	MANUAL VALVE XV37 AT UNIT 2 PLUGGED				
1063	SWS-XVM-PG-39U2	1	4.000E-005	1.000E-007	7.200E+002
	MANUAL VALVE XV39 AT UNIT 2 PLUGGED				
1064	SWS-XVM-PG-SW321	1	4.000E-005	1.000E-007	7.200E+002
	GATE VALVE 1-SW-321 PLUGGED DURING STANDBY				
1065	SWS-XVM-PG-SW324	1	4.000E-005	1.000E-007	7.200E+002
	GATE VALVE 1-SW-324 PLUGGED DURING STANDBY				
1066	SWS-XVM-PG-XV33	1	4.000E-005	1.000E-007	7.200E+002
	MANUAL VALVE XV33 PLUGGED				
1067	SWS-XVM-PG-XV35	1	4.000E-005	1.000E-007	7.200E+002
	MANUAL VALVE XV35 PLUGGED				
1068	SWS-XVM-PG-XV37	1	4.000E-005	1.000E-007	7.200E+002
	MANUAL VALVE XV37 PLUGGED				
1069	SWS-XVM-PG-XV39	1	4.000E-005	1.000E-007	7.200E+002
	MANUAL VALVE XV39 PLUGGED				
1070	T-TOP	1	6.600E+000	+0.000E+000	+0.000E+000
	TURBINE TRIP SUBSEQUENT TO ATWS				
1071	TB-FREQ-VSFM06	1	2.200E-002	+0.000E+000	+0.000E+000
	FREQ OF MAINT TO OPER U1 AHU FAN MOTOR 1VSFM06A IN 1 YEAR				
1072	UNIT2-LOW-POWER	1	3.500E-001	+0.000E+000	+0.000E+000
	UNIT 2 LOW POWER INSUF STM FOR AFW TDP				
1073	VS-AHU-FX-VSAC6	6	7.621E-003	1.740E-006	8.760E+003
	FREQ OF 1-VS-AC-6 LOSS OF FUNCTION IN 1 YEAR INTERVAL				
1074	VS-AHU-LF-VSAC6	4	3.432E-005	1.430E-006	2.400E+001
	LOSS OF FUNCTION IN AIR HANDLING UNIT 1-VS-AC-6				
1075	VS-AHU-LF-VSAC7	4	3.432E-005	1.430E-006	2.400E+001
	LOSS OF FUNCTION IN AIR HANDLING UNIT 1-VS-AC-7				
1076	VS-AHU-LF7-VSAC7	6	1.201E-004	1.430E-006	1.680E+002
	U1 AHU 1-VS-AC-7 LOSS OF FUNCTION DURING 7 DAY LCO				
1077	VS-AHU-MA-VSAC6	F	+0.000E+000	+0.000E+000	+0.000E+000
	AIR HANDLING UNIT 1-VS-AC-6 UNSCHEDULED MAINTENANCE				
1078	VS-AHU-MA-VSAC7	1	3.750E-003	+0.000E+000	+0.000E+000
	FAN MOTOR 1-VS-FMO-7 FOR 1-VS-AC-7 UNAVAIL DUE TO MAIN				
1079	VS-BCFLOWDIVER	4	2.664E-006	1.110E-007	2.400E+001
	CHILLED WATER DIVERSION TO BEARING COOLING SYSTEM				
1080	VS-CCF-FT-PABC	1	1.080E-004	+0.000E+000	+0.000E+000
	CCF 3/3 FR 24 HR 1-VS-P-1A B C FAIL (AIR LOW SUCTION)				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
1081	VS-CHL-FR-VSE3A	4	3.600E-003	1.500E-004	2.400E+001
	CHILLER 1-VS-E-3A FAILS TO RUN 24 HR				
1082	VS-CHL-FR-VSE3B	4	3.600E-003	1.500E-004	2.400E+001
	CHILLER 1-VS-E-3B FAILS TO RUN 24 HR				
1083	VS-CHL-FR-VSE4A	4	3.600E-003	1.500E-004	2.400E+001
	CHILLER 1-VS-E-4A FAILS TO RUN FOR 24 HR MISSION				
1084	VS-CHL-FR-VSE4B	4	3.600E-003	1.500E-004	2.400E+001
	CHILLER 1-VS-E-4B FAILS TO RUN FOR 24 HR MISSION				
1085	VS-CHL-FR-VSE4C	4	3.600E-003	1.500E-004	2.400E+001
	1-VS-E-4C FAILS TO RUN FOR 6 HOUR LCO				
1086	VS-CHL-FR6-VSE4C	4	9.000E-004	1.500E-004	6.000E+000
	1-VS-E-4C CHILLER FAILS TO RUN FOR 6 HOUR LCO				
1087	VS-CHL-FR7-VSE4B	6	5.400E-002	1.500E-004	7.200E+002
	1-VS-E-4B CHILLER FAILS TO RUN FOR 7 DAY LCO				
1088	VS-CHL-FS-VSE4B	1	3.900E-003	+0.000E+000	+0.000E+000
	CHILLER 1-VS-E-4B FAILS TO START				
1089	VS-CHL-MA-VSE4B	F	+0.000E+000	+0.000E+000	+0.000E+000
	MAINTENANCE OF CHILLER 1-VS-E-4B - STATE 6				
1090	VS-CHL-MA0VSE4B	F	+0.000E+000	+0.000E+000	+0.000E+000
	MAINTENANCE OF CHILLER 1-VS-E-4B - STATE 6				
1091	VS-CKV-FT-VS292	1	1.000E-004	+0.000E+000	+0.000E+000
	CHECK VALVE 1-VS-292 FAILS CLOSED DURING STANDBY				
1092	VS-CKV-PG-VS271	4	2.400E-006	1.000E-007	2.400E+001
	CHILLER 1-VS-E-3B CHECK VALVE 1-VS-271 DURING 24 HR				
1093	VS-CKV-PG-VS276	4	2.400E-006	1.000E-007	2.400E+001
	CHILLER 1-VS-E-3A CHECK VALVE 1-VS-276 PLUGS DURING 24 HR				
1094	VS-CKV-PG-VS288	4	2.400E-006	1.000E-007	2.400E+001
	CHECK VALVE 1-VS-288 PLUGS DURING MISSION				
1095	VS-CKV-PG-VS296	4	2.400E-006	1.000E-007	2.400E+001
	CHECK VALVE 1-VS-296 PLUGS DURING MISSION				
1096	VS-CKV-PG6-VS296	1	6.000E-007	1.000E-007	6.000E+000
	4C CHILLER CHILLED WATER 1-VS-296 PLUGS DURING 6 HOUR LCO				
1097	VS-EVC-FR-VSE1A	4	3.600E-003	1.500E-004	2.400E+001
	EVAPORATIVE CON- DENSER 1-VS-E-1A FAILS TO RUN 24 HR				
1098	VS-EVC-FR-VSE1B	4	3.600E-003	1.500E-004	2.400E+001
	EVAPORATIVE CON- DENSER 1-VS-E-1B FAILS TO RUN 24 HR				
1099	VS-FMO-FR-FMO6	4	9.864E-005	4.110E-006	2.400E+001
	1-VS-AC-6 FAN MOTOR FAILS TO RUN FOR MISSION 1-VS-FMO-6				
1100	VS-FMO-FR-FMO7	4	9.864E-005	4.110E-006	2.400E+001
	1-VS-AC-7 FAN MOTOR FAILS TO RUN FOR MISSION 1-VS-FMO-7				
1101	VS-FMO-FR7-FMO7	6	3.452E-004	4.110E-006	1.680E+002
	FAN MOTOR 1-VS-FMO-7 FOR 1-VS-AC-7 FAILS TO RUN 7 DAY LCO				
1102	VS-FMO-FS-FMO6	1	3.900E-003	+0.000E+000	+0.000E+000
	1-VS-AC-6 FAN MOTOR FAILS TO START 1-VS-FMO-6				
1103	VS-FMO-FS-FMO7	1	3.900E-003	+0.000E+000	+0.000E+000
	FAN MOTOR 1-VS-FMO-7 FOR 1-VS-AC-7 FAILS TO START				
1104	VS-FRQ-MA-VSE4A	1	3.410E+000	+0.000E+000	+0.000E+000
	FREQ OF MAINTENANCE TO 1ST CHILLER TRAIN IN 1 YEAR INTERVAL				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
1105	VS-MDF-FR-VSP1B	4	7.200E-004	3.000E-005	2.400E+001
	MOTOR DRIVEN PUMP 1-VS-P-1B FAILS TO RUN DURING MISSION				
1106	VS-MDF-FR-VSP1C	4	7.200E-004	3.000E-005	2.400E+001
	MOTOR DRIVEN PUMP 1-VS-P-1C FAILS TO RUN				
1107	VS-MDP-FR-VSP1A	4	7.200E-004	3.000E-005	2.400E+001
	MOTOR DRIVEN PUMP 1-VS-P-1A FAILS TO RUN				
1108	VS-MDP-FR-VSP2A	4	7.200E-004	3.000E-005	2.400E+001
	MOTOR DRIVEN PUMP 1-VS-P-2A FAILS TO RUN DURING MISSION				
1109	VS-MDP-FR-VSP2B	4	7.200E-004	3.000E-005	2.400E+001
	MOTOR DRIVEN PUMP 1-VS-P-2B FAILS TO RUN DURING MISSION				
1110	VS-MDP-FR-VSP2C	4	7.200E-004	3.000E-005	2.400E+001
	MOTOR DRIVEN PUMP 1-VS-P-2C FAILS TO RUN DURING MISSION				
1111	VS-MDP-FR-VSP3A	4	7.512E-004	3.130E-005	2.400E+001
	CHILLER 1-VS-E-3A PUMP 1-VS-P-3A FAILS TO RUN 24 HR				
1112	VS-MDP-FR-VSP3B	4	7.512E-004	3.130E-005	2.400E+001
	CHILLER 1-VS-E-3B PUMPS 1-VS-P-3B FAILS TO RUN 24 HR				
1113	VS-MDP-FR6-VSP1C	4	1.800E-004	3.000E-005	6.000E+000
	4C CHILLER SW PUMP 1-VS-P-1C FAILS TO RUN FOR 6 HOUR LCO				
1114	VS-MDP-FR6-VSP2C	4	1.800E-004	3.000E-005	6.000E+000
	4C CHILLER CHILLED WATER 1-VS-P-2C PUMP FAILS TO RUN FOR 6 H				
1115	VS-MDP-FR7-VSP1B	1	1.080E-002	3.000E-005	7.200E+002
	STANDBY 4B CHILLER 1-VS-P-1B PUMP FAILS TO RUN FOR 7 DAY LCO				
1116	VS-MDP-FR7-VSP2B	1	1.080E-002	3.000E-005	7.200E+002
	STANDBY 4B CHILLER 1-VS-P-2B PUMP FAILS TO RUN FOR 7 DAY LCO				
1117	VS-MDP-FS-VSP1B	1	3.000E-003	+0.000E+000	+0.000E+000
	MOTOR DRIVEN PUMP 1-VS-P-1B FAILS TO START FROM STANDBY				
1118	VS-MDP-FS-VSP2B	1	3.000E-003	+0.000E+000	+0.000E+000
	MOTOR DRIVEN PUMP 1-VS-P-2B FAILS TO START FROM STANDBY				
1119	VS-MOV-FT-PG107B	1	3.000E-003	+0.000E+000	+0.000E+000
	MOTOR OPERATED VALVE 1-PG-MOV-107B FAILS TO OPEN				
1120	VS-MOV-SC-P107A	1	1.200E-005	5.000E-007	2.400E+001
	MOV 1-PG-MOV-107A SPURIOUS CLOSES DURING MISSION				
1121	VS-MOV-SC-P107C	1	1.200E-005	5.000E-007	2.400E+001
	MOV 1-PG-MOV-107C SPURIOUS CLOSES DURING MISSION				
1122	VS-MSW-NO-TRAN1	1	2.660E-005	+0.000E+000	+0.000E+000
	MANUAL SWITCH FAILS OPEN TRANSFER SW 1 FOR 1-VS-E-4B				
1123	VS-SW-CO-ACGR1B	1	2.660E-005	+0.000E+000	+0.000E+000
	MANUAL SELECTOR SWITCH FAILS OPEN A/C GROUP 1B				
1124	VS-XHE-FO-EO18	1	1.000E+000	+0.000E+000	+0.000E+000
	1-E-O RX TRIP OR SI STEP 18 VERIFY VENTILATION ALIGNMENT				
1125	VS-XHE-FO-FCA10	1	1.000E+000	+0.000E+000	+0.000E+000
	FCA-1.00 SAFE SHUTDOWN AREA FIRE ATTACHMENT 10 VENT (OPEN CR				
1126	VS-XVM-FT-VS247	6	3.600E-005	1.000E-007	7.200E+002
	GATE VALVE 1-VS-247 FAILS TO OPEN OR PLUGS (DURING SHUTDOWN				
1127	VS-XVM-FT-VS251	6	3.600E-005	1.000E-007	7.200E+002
	GATE VALVE 1-VS-251 FAILS TO OPEN OR PLUGS (DURING SHUTDOWN)				
1128	VS-XVM-PG-VS291	6	3.600E-005	1.000E-007	7.200E+002
	GATE VALVE 1-VS-291 PLUGS DURING STANDBY				

BASIC EVENTS PROBABILITY REPORT

Family: FLOOD/WINDOW

Case: ALTERNATE

Event Number	Primary Name	Calculation Type	Mean Probability	Lamda	Tau
1129	VS-XVM-PG-VS294	6	3.600E-005	1.000E-007	7.200E+002
	GATE VALVE 1-VS-294 PLUGS DURING STANDBY				
1130	Z	1	1.400E-002	+0.000E+000	+0.000E+000
	UNFAVORABLE MODERATOR TEMP COEFFICIENT				
1131	Z1	1	5.000E-001	+0.000E+000	+0.000E+000
	VERY LOW MODERATOR TEMP COEFFICIENT				

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