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Technical Report

ABWR Shutdown Risk Evaluation

Approved by M.Ino
Nov 8, 2010

Safety & Dynamics Engineering Group

Toshiba Corporation
System Design & Engineering Department

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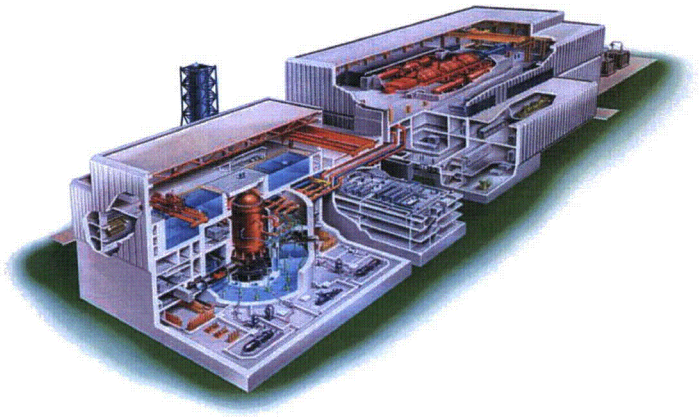

Toshiba America Nuclear Energy ABWR
Shutdown Probabilistic Risk Assessment

Revision 0

August 2010

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Table of Contents

Section Page

1 PURPOSE 7

2 INTRODUCTION 7

3 METHODOLOGY 9

3.1 Definition of Plant Operating State Characteristics 10

3.2 Shutdown Initiating Events Identification and Analysis 12

3.2.1 Identification of Initiating Events 12

3.2.2 Initiating Event Quantification 15

3.2.3 Impact of Initiating Events on Systems 17

3.2.4 Assessment of Intersystem Drainage Paths as Initiating Events 19

3.2.4.1 Methodology for Pathway Screening from Detailed Assessment 19

3.2.4.2 Review of Flow Diversion Pathways 19

3.2.4.3 Flow Diversion Fault Tree Model Guidelines 21

3.3. Accident Sequences and Event Tree Analysis 22

3.3.1 Accident Sequence Success Criteria 22

3.3.2 Event Trees 23

3.4 Systems Analysis 25

3.4.1 Modeling Discrepancies from SSAR Analysis 25

3.4.2 Fault Tree Model Additions 25

3.5 Data Analysis 27

3.5.1 Component Data Analysis 27

3.5.2 Human Reliability Analysis 27

3.6 Quantification 32

3.6.1 Unavailability Event Settings 32

3.6.2 Initiating Event Settings 37

3.6.3 Recovery Assessment 38

3.6.3.1 System and Component Recovery 38

3.6.3.2 Offsite Power Recovery 40

3.6.3.3 Recovery Rules 42

4 RESULTS ANALYSIS 42

4.1 Case 1. CCDP Results 43

4.2 Case 2. CDF – Limiting Unavailability Case Results 49

4.3 Case 3. CDF – Realistic Unavailability Case Results 55

4.4 Case 3a. CDF Sensitivity Case Results 62

4.5 Minimum Sets of Systems Analysis 64

4.6 Reliability Goals (Input to RAP) 68

5 REFERENCES 70

APPENDIX A – EVENT TREES A-1

APPENDIX B – QUANTIFICATION SUPPORT FILES B-1

APPENDIX C - CASE 1. CCDP - TOP 50 CUTSETS C-1

APPENDIX D - CASE 2 - CDF LIMITING UNAVAILABILITY CASE - TOP 50 CUTSETS D-1

APPENDIX E - CASE 3 - CDF REALISTIC UNAVAILABILITY CASE - TOP 50 CUTSETS E-1

APPENDIX F FAULT TREE BASIC EVENT LISTING F-1

APPENDIX G FAULT TREE LISTINGS (Attached PDF) G-1

List of Tables

Table Page

Table 1 POS versus Time to TAF 11

Table 2 POS Split Fractions 12

Table 3 Assessment and Disposition of Initiating Event Categories 13

Table 4 Shutdown Initiating Events Included in Fault Tree Model 16

Table 5 Impact of Initiating Events on Front Line Systems 17

Table 6 Flow Diversion Pathway Screening Results 20

Table 7 Success Criteria for Loss of Decay Heat Removal 23

Table 8 Probability of Failure to Diagnose (Ref. 3) 28

Table 9 Summary of Diagnostic Operator Actions 28

Table 10 Probability of Failure to Start a Specified "Minimum-Set" System (Ref. 3) 30

Table 11 Summary of Operator Actions to Actuate Components 30

Table 12 Unavailability Event Settings for Quantification Analyses 33

Table 13 Initiating Event Settings for Quantification Analyses 37

Table 14 Probabilities of Non-recovery for ECCS Equipment and EDG by POS 39

Table 15 Application of Equipment Recovery Events 40

Table 16 Calculation of the Composite LOSP Non-Recovery for Shutdown 41

Table 17 Summary of LOSP Non-Recovery Probabilities 42

Table 18 Summary of CCDP/ CDF Results for Analysis Cases 43

Table 19 Initiating Event Contributions to CCDP 44

Table 20 POS Contributions to CCDP 44

Table 21 Operator Action Contributions to CCDP 45

Table 22 Recovery Event Contributions to CCDP 46

Table 23 Summary Component Failure Event Contributions to CCDP 47

Table 24 Initiating Event Contributions to CDF 49

Table 25 POS Contributions to CDF 50

Table 26 Operator Action Contributions to CDF 52

Table 27 Recovery Event Contributions to CDF 52

Table 28 Summary Component Failure Event Contributions to CDF 53

Table 29 Initiating Event Contributions to CDF 56

Table 30 POS Contributions to CDF 56

Table 31 Operator Action Contributions to CDF 58

Table 32 Recovery Event Contributions to CDF 58

Table 33 Summary Component Failure Event Contributions to CDF 59

Table 34 Initiating Event Contributions to CDF 62

Table 35 POS Contributions to CDF 63

Table 36 Minimum Sets of Systems Evaluated for Modes 3 and 4 65

Table 37 Minimum Sets of Systems Evaluated for Modes 5 (unflooded) 66

Table 39 Summary of Minimum Sets Analysis CCDPs 68

Table 40 Reliability Goals for Input to RAP 69

List of Figures

Figure — Page

Figure 1. Breakdown of Initiating Event Contribution by POS to CCDP 44

Figure 2. Breakdown of Initiating Event Contribution by POS to CDF 51

Figure 3. Breakdown of Initiating Event Contribution by POS to CDF 57

Figure 4. Breakdown of Initiating Event Contribution by POS to CDF 64

Figure A-1. Loss of One RHR Event Tree – Mode 3, Starting at 4 Hours A-2

Figure A-2. Loss of One RHR Event Tree - Mode 4, 6 Hours to 2 Days A-3

Figure A-3. Loss of One RHR Event Tree - Mode 5, 2 to 3 Days A-4

Figure A-4. Loss of One RHR Event Tree - Mode 5, 3 to 8 Days A-5

Figure A-5. Loss of One RHR Event Tree - Mode 5, 8 to 10 Days A-6

Figure A-6. Loss of One RHR Event Tree - Mode 5 – Greater than 10 Days A-7

Figure A-7. Loss of Div A SWS Event Tree - Mode 3 Starting at 4 Hours A-8

Figure A-8. Loss of Div A SWS Event Tree - Mode 4, 6 Hours to 2 Days A-9

Figure A-9. Loss of Div A SYS Event Tree - Mode 5, 2 to 3 Days A-10

Figure A-10. Loss of Div A SWS Event Tree - Mode 5, 3 to 33 Days A-11

Figure A-11. Loss of Div C SWS Event Tree - Mode 3, Starting at 4 Hours A-12

Figure A-12. Loss of Div C SWS Event Tree - Mode 4, 6 Hours to 2 Days A-13

Figure A-13. Loss of Div C SWS Event Tree - Mode 5, 2 to 3 Days A-14

Figure A-14. Loss of Div C SWS Event Tree - Mode 5, 3 to 8 Days A-15

Figure A-15. Loss of Div C SWS Event Tree - Mode 5, 8 to 10 Days A-16

Figure A-16. Loss of Div C SWS Event Tree - Greater Than 10 Days A-17

Figure A-17. Loss of Offsite Power Event Tree - Mode 3, Starting at 4 Hours A-18

Figure A-18. Loss of Offsite Power Event Tree - Mode 4, 6 Hours to 2 Days A-19

Figure A-19. Loss of Offsite Power Event Tree - Mode 5, 2 to 33 Days A-20

Figure A-20. Small LOCA Event Tree - Mode 3 or 4 ..... A-21

Figure A-21. Medium or Large LOCA Event Tree - Mode 3 or 4 ..... A-22

Figure A-22. LOCA Event Tree, Mode 5 ..... A-23

Figure G-1. Main Condenser System G-2

Figure G-2. Feedwater System (SDC) G-10

Figure G-3. Feedwater or Condensate Pump (SDC) G-16

Figure G-4. Fuel Pool Cooling (SDC) G-17

Figure G-5. One CRD (SDC) G-24

Figure G-6. One Condensate Pump G-28

Figure G-7. Cleanup Water System (SDC) G-36

Figure G-8. Clean-up Water or Fuel Pool (SDC) G-43

Figure G-9. RHR in Shutdown Cooling Mode G-44

Figure G-10. Service Water System G-85

Figure G-11. RHR Core Flooding Mode G-127

Figure G-12. RHR-A and RHR-B Core Flooding (SDC) G-170

Figure G-13. RHR-B and RHR-C Core Flooding (SDC) G-171

Figure G-14. High Pressure Core Flooding System G-172

Figure G-15. Reactor Depressurization System G-207

Figure G-16. Diesel Generators G-234

Figure G-17. Gas Turbine Generator G-235

Figure G-18. HVAC Emergency Cooling Water System G-236

Figure G-19. Instrumentation System G-256

Figure G-20. Electric Power System G-319

Figure G-21. AC Independent Water Addition G-405

Figure G-22. RHR LOCA Isolation G-408

Figure G-23. Loss of RHR A Initiating Event G-412

Figure G-24. Loss of SWS A Initiating Event G-459

Figure G-25. Loss of SWS C Initiating Event G-466

Figure G-26. Loss of Offsite Power Initiating Event G-474

Figure G-27. LOCA Initiating Event G-477

Figure G-28. Mutually Exclusive Logic G-488

Figure G-29. Shutdown Top Logic and Sequence Logic G-496

1 PURPOSE

Revision 4 of the ABWR Design Control Document (DCDR4) includes evaluation of plant response to severe accidents in Tier 2 Chapter 19. Chapter 19 also contains the results of the original PRA studies performed by GE at the time of the DCDR4 submittal. As part of the DCDRA project, Toshiba is making improvements to the ABWR design. These improvements change some assumptions and inputs used by GE in the DCDR4 PRA evaluation. Also, PRA methodology has changed substantially since the issuance of DCDR4 in 1997. The Toshiba ABWR DCD Renewal Amendment (DCDRA) project has performed a limited update of the original PRA studies to incorporate Toshiba ABWR design features and to verify that a more modern PRA treatment would not change the PRA conclusions and insights.

This purpose of this analysis is to develop a low power shutdown PRA to support the approved Toshiba ABWR design control document renewal amendment (DCDRA). The PRA shall incorporate improvements and additional considerations over prior studies, including revised reliability data, quantitative analysis of LOCA contributors and core damage frequency analysis through the linked fault tree approach. This document provides supplemental information for the ABWR DCDRA sections 19Q, 19QA and 19QB.

The shutdown analysis addresses ABWR design elements, procedures, and plant features. Modes of operation that are evaluated include Modes 3 (hot shutdown), Mode 4 (cold shutdown) and Mode 5 (refueling). Only the time in Mode 3 after the entry into RHR cooling is addressed. The beginning time period of Mode 3 is addressed in the full power PSA as a response to a manual shutdown and is included in the mission time. The analysis ends with Mode 5 operation near the point of start up. Startup operations are not evaluated in this study, but are considered to demonstrate lower risk contribution due to very low decay heat levels late in an shutdown.

There are four risk categories addressed by this shutdown analysis.

- Decay heat removal,
- Inventory control,
- Reactivity control,
- Electrical power (as a subset of inventory control and decay heat removal)

This is a Level 1 PRA analysis; therefore, containment integrity is not specifically addressed in this report.

2 INTRODUCTION

The shutdown PRA model is based on an assumption that the final as-built plant will be designed and operated in accordance with the established policies and procedures associated with the Toshiba Design Control Document (DCD) Renewal and Amendment. The methods used in the shutdown PRA are consistent with state of the art methods at the time. Therefore, it is similar to the DCD in scope and treatment for both event trees and system modeling. As with the DCD model, it addresses cooldown from Mode 3, Mode 4, and Mode 5. It does not address startup testing after refueling in Modes 4 and 3.

The Shutdown PRA includes plant structures, systems and components that are necessary to maintain plant parameters within a safe-stable state during maintenance and refueling outages. This involves the following systems:

- Residual heat removal system
- Main condenser and condensate system
- Feedwater system
- Fuel pool cooling system
- Control rod drive system
- Cleanup water system
- Service water system
- Reactor closed cooling water system
- High pressure core flood system
- Reactor depressurization system
- Gas turbine generator
- Firewater (AC independent water addition)

In addition, other supporting systems are necessary to ensure that these frontline systems properly function. These systems address the requirement for ac and dc electrical power, HVAC emergency cooling water, and the instrumentation system for successful operation.

The system modeling for the shutdown PRA uses detailed fault tree models for the systems called out in the event tree top logic for shutdown operations. These fault trees, in turn, call on support systems, such as power and cooling systems that are required for their operation. These support systems are also analyzed with detailed fault trees. The fault trees include component failures, maintenance unavailability, and potential human errors. Direct dependencies are modeled explicitly; indirect dependencies are modeled through extensive consideration of potential common cause failures. This model is similar to the DCD model in scope and treatment with a few differences.

Differences from the original DCD analysis include quantitative evaluation of LOCA events and evaluation for core damage frequency (CDF) versus conditional core damage probability (CCDP). Further, the core damage sequences are evaluated using a linked fault tree approach versus evaluating individual event tree branch probabilities to derive the sequence frequencies.

DCD analysis elements such as HRA values, event timing and common cause failure data are retained unless otherwise identified in this report.

Updated component independent failure data is taken from Reference 4.

Offsite power and diesel recoveries values are updated from Reference 5.

3 METHODOLOGY

The starting point for this analysis was to review the existing documentation and develop a working copy of the shutdown event trees and fault trees based on References 1, 2, and 3. This gives a starting point for the review and upgrade process. The development of a shutdown model includes the following steps.

1. Definition of Plant Operating State Characteristics

    - Define plant operating states based on plant configuration and success criteria.
    - Define the outage duration and duration of each plant operating state.
    - Determine the available recovery time based on thermal hydraulic analysis for each plant state.

2. Shutdown Initiating Events Identification and Analysis

    - Develop a list of potential initiating events based on the above references and on other PRAs.
    - Develop screening criteria and screen low risk flow diversion paths for LOCA initiating events.
    - Develop final list of initiating events and calculate point estimate frequencies.
    - Identify initiating event impacts on systems

3. Accident Sequences and Event Tree Analysis

    - Review success criteria for each initiating event category.
    - Review existing event trees for adequacy and reproduce event trees.
    - Modify existing event trees as necessary to address linked fault tree modeling approach
    - Develop new event trees for LOCA initiating events
    - Create top logic and sequence logic fault trees and merge all system models together into one model

4. Systems Model Analysis

    - Develop shutdown system models based on existing documentation.
    - Merge system models and top logic into one top model

- Develop additional models to support event trees where point estimates were used before. This includes initiating events trees, LOCA isolation model, ACIWA model
- Insert initiating event impacts into system models
- Perform other system model updates to address linked fault tree approach

5. Data Analysis
    - Update reliability data with newer generic data.
    - Update systems models as necessary for data differences
    - Develop/update data for human reliability analysis
    - Review and update component unavailability as necessary
6. Quantification
    - Develop/update data for non-recovery of offsite power
    - Develop data for non-recovery of failed components
    - Develop quantification recovery rules
    - Develop quantification cases and required quantification flag files.
    - Quantify fault tree model
7. Results Analysis
    - Review cutset solutions
    - Analyze cutsets for various importance measures
    - Document results

These steps are documented throughout the next section.

3.1 DEFINITION OF PLANT OPERATING STATE CHARACTERISTICS

The DCD was reviewed and the shutdown plant operating states (POS) were identified based on time after reactor shutdown that a specific configuration occurred, mode changed, or success criteria changed. The POS are labeled using the plant mode and a suffix if multiple states occurred in a given mode. Time to boil and time to top of active fuel (TAF) are taken from Reference 3, Tables 19QB-1 & 2 to be used in recovery assessment and human reliability assessments (HRA). This decay heat and timing information was interpolated for missing data points. Table 1 summarizes the plant modes and plant operating states used in the analysis along with their critical timing considerations.

Table 1
POS versus Time to TAF

Mode/ POS	Time after SD	DH (MW)	Water Mass(Kg)	Time to Boil	Time to TAF	Description	Comment
2						Hot Standby - Low power operation and RX shutdown	Addressed in Full Power PRA
3						Hot Shutdown - Cooldown from operating pressure to initiating of RHR/SDC	Addressed in Full Power PRA as mission time response.
3	4h-6h	41.9	4.4E5	1.3h	6.4h	Hot Shutdown - Cooldown with RHR/SDC to approximately 200°F (93.3°C)	Start of RHR
4	6h-2d	~36	4.4E5	~1.5h	~7.5h	Cold shutdown (T< 93.3oC) (vessel intact – containment can be open)	End with head detentioned (off). Decay heat is an estimate based on curve fit of DCD values
5a	2d-3d	20	5.0E5	1.2h	13h	Refueling with water level raised to steam lines (remove head, raise level to remove internals, refueling well dry or filling)	Head Off , Unflooded
5a	3d-3d+	17	5.0E5	1.3h	15h	Filling Refueling Cavity	Noted for lower decay heat values in DCD
5b	3d+ to 8d	17	5.4E6	15h	7.8d	Cavity Full, FP Connected (fuel movement- may have restrictions on secondary containment)	Alternate success path from Firewater
5c	8d - 10d	~12	5.4E6	~21h	~11d	Same as above, but lower decay heat	Alternate success path from CUW or Firewater
5d	10d-33d	9.4	5.4E6	27h	14.5d	Same, but lower decay heat (Decay heat is based on 14d as an average)	Alternate success path from CUW, Firewater, or FPC

Although, time to boil may be an important consideration for onsite risk, this analysis assumes that boiling is an acceptable heat removal method and that time to top of active fuel (TAF) is the appropriate measure for assessing the available time to perform recovery actions that prevent fuel damage.

In order to calculate the relative contribution of initiating events to each of the POS, Shutdown POS split fraction events are used to condition the fault tree initiating event frequencies to account for the amount of time spent in each shutdown POS. Based on a 33 day outage the split fractions are developed as follows:

Table 2
POS Split Fractions

Basic Event	Description	Duration	Fraction of 33 days
X_POS3	Fraction of POS 3 - 4hours to 6 hours	2 hours	0.003
X_POS4	Fraction of POS 4 - 6hours to 2 days	42 hours	0.053
X_POS5a	Fraction of POS 5a - 2 days to 3 days	24 hours	0.030
X_POS5b	Fraction of POS 5b – 3 days to 8 days	5 days	0.152
X_POS5c	Fraction of POS 5c - 8 days to 10 days	2 days	0.061
X_POS5d	Fraction of POS 5d - 10 days to 33 days	23 days	0.697

3.2 SHUTDOWN INITIATING EVENTS IDENTIFICATION AND ANALYSIS

3.2.1 Identification of Initiating Events

The ABWR DCD and other PRAs were reviewed to determine a complete set of initiating events (IEs) that should be addressed by the shutdown model. Events addressing reactivity control and refueling accidents are addressed qualitatively with no additional analysis added to that which is already provided in the DCD.

Initiating event categories include:

- Loss of reactivity control
- Loss of inventory
    - RPV drainage
    - LOCA (isolable and unisolable)
    - Fuel pool drainage
    - Drainage through interfacing systems

- Loss of decay heat removal
    - Loss of RHR
    - Loss of RHR support: Loss of AC, Loss of RBC, Loss of SWS, Loss of offsite power (LOSP)
- Other refueling events.

Each of these IE categories are discussed in more detail in the Table 3.

Table 3
Assessment and Disposition of Initiating Event Categories

Initiator Category	Comments	Disposition
Loss of Reactivity Control		
Control Rod Drop, Rod Ejection, Mis-Load, Rod Withdrawal	Qualitatively addressed in DCD 19L.5	No change to DCD qualitative evaluation.
ATWS	Low power operation outside Scope. Analysis starts with reactor already shutdown.	No change to DCD qualitative evaluation.
Loss of Inventory due to LOCA or RPV Drainage		
RPV Drainage		
Large non-isolable maintenance Induced LOCA		
FMCRD Replacement	DCD 19L.6.1 qualitatively addressed	No change to DCD qualitative evaluation.
RIP replacements	DCD 19.L.6.2 qualitatively addressed	No change to DCD qualitative evaluation.
LOCA (Pipe break)		
Large or Medium break	Not addressed in DCD. Success is same for Large and Medium with breaks above TAF. Includes connected piping in RHR and CUW systems.	Evaluate - The difference between isolable and non-isolable are addressed with a split fraction.
Small break	Not addressed in DCD. Success is different than above cases only because during Mode 3 and 4, the RPV may need to be depressurized by the SRVs to allow for LP Injection. Includes interconnected piping in RHR, CUW, and CRD.	Evaluate - The difference between isolable and non-isolable are addressed with a split fraction.

Table 3
Assessment and Disposition of Initiating Event Categories (continued)

Initiator Category	Comments	Disposition
Non-isolable small break below TAF	The CUW drain line is a 3.5" line connected to the bottom RPV head. Makeup must meet both drainage and decay heat requirements.	Evaluate
Fuel Pool Drainage	Addressed in DCD 19.L.9	No action
Interfacing Systems Drainage (Maintenance related or Valve Failure)		
CRD system	DCD 19.L.6.3 and Table 19L-6 qualitatively states that multiple valve failures must occur for each path resulting in a very low probability and low flow (Three Paths)	Qualitative or quantitative screening used to exclude paths from evaluation.
CUW system	DCD 19L.6.4 and Table 19L-7 discusses 7 paths. There is no quantitative analysis. Based on design features, qualitatively assumes low risk significance.	5 of 7 paths screened out using qualitative or quantitative criteria
RHR System LOCA in connected system (RHR)	DCD 19L.6.5 and Table 19L-8 discusses 9 paths. There is no quantitative analysis. Based on design features, qualitatively assumes low risk significance.	2 of 9 paths screened out using qualitative or quantitative criteria
Over drain of refuel well event	Beyond ending time period of analysis. LOCA isolation already addressed in DCD section 19L.	No change to DCD
Loss of Decay Heat Removal		
Loss of cooling water (SWS, RBCCW)	Use Internal Events – with maintenance adjustments (SWS already discussed in DCD)	Evaluate
Loss of offsite power	Include	Evaluate
Loss of AC Power Bus	Include - Use Internal Events -	Evaluate
Loss of DC Power Bus	Include - Use Internal Events	Evaluate
Loss of one SDC/RHR loop	Include	Evaluate
Isolation of one SDC/RHR loop	Combine with Loss of RHR	Evaluate
Isolation of CUW as DHR	Analysis assumes RHR is operating system and CUW is only a backup.	No change to DCD

Table 3
Assessment and Disposition of Initiating Event Categories (continued)

Initiator Category	Comments	Disposition
Other		
Cold overpressurization	Not in DCD, This is largely a PWR concern.	No change to DCD
Loss of fuel pool cooling	Addressed in DCD 19.L.9	No change to DCD
Heavy load drop pipe or vessel failure	Dropped Fuel or Fuel cask addressed in DCD 19.L.9	No change to DCD
Transient with PCS available (low power only)	Outside scope	No change to DCD
Inadvertent open relief valve after shutdown	Not Addressed in DCD. No consequence during Modes 3 and 4 since provides decay heat path. During Mode 5, steam lines are typically plugged.	No change to DCD

3.2.2 Initiating Event Quantification

Initiating event frequencies are based on an assumed 33 day refueling outage that is entered once per 2 years (24 month fuel cycle). There are two types of initiating events that are calculated: 1. time dependent failures that are based on 33 days/2 years (16.5), and 2. demand based failures that are based on the demand for starting shutdown cooling. The initiating event frequencies are calculated as follows:

- For fault tree based IEs, a mission time of 24 hours is used in the system tree. This mission time failure probability is multiplied by the IE designator with value 16.5 (33 days / 2 years) to estimate the shutdown annual frequency. This allows the same running failures to be used in the IE tree as in the mitigating system tree and does not require IE designator events to be populated through the fault tree to fail a system due to an associated initiating event.

- Point estimate IEs are calculated starting with a frequency based on either reactor critical years (e.g., LOCA, given no better source) or in terms of shutdown years (e.g., shutdown LOSP). This frequency is multiplied by 16.5d/365d to calculate an annual shutdown frequency in terms of reactor years (i.e., /year). The conversion factor is 16.5d/365d = 0.045. Likewise the initiating event demand failures are the same as those in the mitigating tree.

- Component demands related to initial start of RHR system are calculated based on 1 demand per 2 year fuel cycle.

- Demands for a Type B operator action (errors of commission) are calculated on 1 demand per 2 year cycle.

- For the time dependent initiating events, the contribution of the initiator to a specific POS is calculated by multiplying the frequency by the POS split fraction.

The final list of initiating events is provided in Table 4 below. These initiators are applicable to all POSs with the exception of "SD_LORHRAS", which is used only during Mode 3 and represents demand faults to place RHR train A into operation.

Table 4
Shutdown Initiating Events Included in Fault Tree Model

IE	Description	Event Trees	Data Source	Formula	Frequency (/year)
SD_S01	Large or Medium LOCA	MLOCA and LOCA	Ref. 4	FPIEF/10 * 0.045 (Note 1)	4.99E-7
SD_S2	Small LOCA	Small LOCA and LOCA	Ref. 4	FPIEF/10 * 0.9 * 0.045 (Note 1, 2)	2.03E-6
SD_S3	Non-Isolable Small LOCA below TAF in CUW suction	MLOCA and LOCA	Ref. 4	FPIEF/10 * 0.1 * 0.045 (Note 1,2)	2.25E-7
SD_CUW	Flow diversion in CUW system	MLOCA and LOCA	Ref. 4	Fault Tree	1.40E-8
SD_RHR0	Pipe Break in Train A RHR system	MLOCA and LOCA	Ref. 3	1.72E-7/hr*24hr*16.5d	6.81E-5 (Note 3)
SD_RHR1	Flow diversion in RHR system	MLOCA and LOCA	Ref. 2	Fault Tree(Note 4)	2.48E-4
SD_LOSWA	Loss of SWS Train A	LORHR/LOSWA	Ref. 4	Fault Tree	5.58E-4
SD_LOSWC	Loss of SWS Train C	LOSWC	Ref. 4	Fault Tree	5.58E-4
SD_RBCA	Loss of RBC Train A	LORHR	Ref. 4	Fault Tree	5.68E-3
SD_TE	Loss of Offsite Power	LORHR/SBO	Ref. 5	1.96E-1 * 0.045	8.82E-3
SD_LOAC1	Loss of Div I AC Bus	LORHR	Ref. 4	Fault Tree	6.96E-4
SD_LORHRA	Loss of RHR Train A	LORHR	Ref. 4	Fault Tree	5.08E-2
SD_LODC1	Loss of Div I DC Bus	LORHR	Ref. 4	Fault Tree	8.83E-5
SD_LORHRAS	Failure of RHR Train A Initiation	LORHR	Ref. 4	Fault Tree (Notes 5)	6.44E-2

Notes:
1. The full power initiating event frequency (FPIEF) for LOCAs is divided by 10 to estimate a more realistic low pressure LOCA frequency.
2. The piping associated with the CUW suction line is estimated to be 10% of the small LOCA frequency.

3. Pipe break frequency of 1.72E-7/hr is based on Reference 2.
4. Time based fault trees use 24 hours mission time and fault tree is multiplied (AND gate) by 16.5 to calculate the annual frequency.
5. Demand based fault tree use failure on demand event and tree is multiplied (AND gate) by 0.5 to calculate the annual frequency.

The Loss of SWS C initiating event and event trees were included in Reference 3. Under the assumption that RHR train A is in operation, a failure of SWS C would not fail RHR train A. However, it would impact other systems such as CUW that provide alternate decay heat removal options. Subsequent failure of RHR is analyzed on a 24 hour mission time. Therefore, the initiator and event trees are included in the evaluation for completeness.

3.2.3 Impact of Initiating Events on Systems

Initiating events have various impacts on plant systems availability. The impacts were reviewed in order to identify where initiating events would fault systems and require special modeling. The impacts of initiating events on systems are summarized in Table 5.

Table 5
Impact of Initiating Events on Front Line Systems

IE	Description	Front Line Makeup Systems							Front Line Heat Removal Systems			
		HPCF (UH)	Feedwater + Condensate (Q)	CRD (C)	ADS (X)	RHR LPCF (V1)	Condensate Pump (CDS)	Firewater Pump (FW)	RHR (SDC)	CUW (W2)	Main Condenser (V2)	Fuel Pool Cooling (FPC)
SD_S01	Medium or Large LOCA	A	A, LR		NC	A	A, LR		LR	LR	LR	F[1]
SD_S2	Small LOCA	A	A, LR			A	A, LR		LR	LR	LR	F[1]
SD_S3	Non-Isolable Small LOCA below TAF in CUW suction		LR	F			LR		LR	F	LR	F[1]
SD_CUW	Flow diversion in CUW system		LR				LR		LR	F	LR	F[1]
SD_RHR0	Pipe Break Train A RHR system		LR			P	LR		P, LR	L	LR	F[1]
SD_RHR1	Flow diversion in RHR system		LR			P	LR		P, LR	L	LR	F1

Table 5
Impact of Initiating Events on Front Line Systems (continued)

IE	Description	Front Line Makeup Systems							Front Line Heat Removal Systems			
		HPCF (UH)	Feedwater + Condensate (Q)	CRD (C)	ADS (X)	RHR LPCF (V1)	Condensate Pump (CDS)	Firewater Pump (FW)	RHR (SDC)	CUW (W2)	Main Condenser (V2)	Fuel Pool Cooling (FPC)
SD_LOSWA	Loss of SWS Train A		P	P		P	P		P	P	P	P
SD_LOSWC	Loss of SWS Train C					P			P			
SD_RBCA	Loss of RBC Train A			P		P			P	P		P
SD_TE	Loss of Offsite Power		R				R	R[2]			R	
SD_LORHRAS	Failure of RHR Train A Initiation					P			P			
SD_LORHRA	Loss of RHR Train A					P			P			
SD_LOAC1	Loss of Div I AC Bus		P	P		P	P		P	P	P	
SD_LODC1	Loss of Div I DC Bus		P	P	P	P	P		P	P	P	

Notes:
NC – Not credited in any plant operating state
A – The potential for a break location to occur between the RPV and isolation valve is not considered a loss of function of the affected train given diverted flow will prevent inventory loss through the break assuming a non-guillotine break.
F – System failed by event
L – System isolates on a Level 3 isolation signal and not credited
LR – System isolates on Level 3 isolation signal and some trains credited as recoverable
P – One or more trains partially failed by event
R – Recoverable using CBT
1. Fuel pool cooling only failed if fuel pool level cannot be maintained at skimmer height.
2. Motor driven fire pumps affected, not diesel driven fire pump. Only the alternative coolant injection source (diesel fire pump) is credited.

Events labeled as "L" or "F" are addressed by inserting logic in the fault tree. For impacts labeled with a "LR", there is typically an operator action in the model to place the system in service and there are events to model the failure of isolation valves to open. Therefore, no model additions are required. For impacts labeled with a "P", the system dependency logic typically addresses this impact and no other modeling is required.

3.2.4 Assessment of Intersystem Drainage Paths as Initiating Events

Flow diversion paths in the RHR, CUW and CRD systems are identified in Reference 2. Flow diversions through these paths can drain the RPV and are evaluated for inclusion in the fault tree model as potentially important initiating events.

3.2.4.1 Methodology for Pathway Screening from Detailed Assessment

A screening approach was used to separate potentially higher risk flow diversion paths from those paths of negligible risk significance. The following screening criteria are used to identify pathways of negligible risk:

Criteria 1: Diversion path is less than 2 Inches. If the flow path is less than 2 inches in diameter, it is assumed that CRD will be able to make up the flow, preventing a disturbance in shutdown cooling operation.

Criteria 2: Diversion path has at least one locked valve. If at least one manual valve or MOV is locked closed, then the risk of inadvertent valve opening or risk of operator misaligning is negligible. Typically there is a periodic walk down to verify locked valve position.

Criteria 3: Diversion path ends at a pipe cap. Drain lines typically have one or two normally closed isolation valves. If the line is also capped, the discharge is sealed and the consequence of valve failure or operator error is insignificant.

Criteria 4: Diversion path is through three or more closed isolation valves. If a diversion path requires failure or inadvertent opening of three or more valves, the frequency of such an event is considered to be insignificant.

3.2.4.2 Review of Flow Diversion Pathways

Flow diversion paths were reviewed using P&IDs and Reference 2. For each flow diversion pathway, the screening criteria that apply are indicated in the following table.

Table 6
Flow Diversion Pathway Screening Results

Path	Line Size	Locked	Capped	Valve Arrangement	Valve Tags	Screening Criteria
CRD System						
1	32A	No	No	AOV + CV	F126*, F115*	1
2	32A	No	Yes	Manual +Cap	F141*	1, 3
3	32A	No	No	CV	F138*	1
RWCU System						
1	50A	Yes	No	Manual + Manual	F500, F501	1, 2
2	50A	Yes	No	Manual	F055A	1, 2
3	50A	Yes	No	Manual	F055B	1, 2
4	150A	No	No	AOV + MOV + MOV	F022, F024, F025	4
5	150A	No	No	AOV + MOV	F022, F023	None
6	50A	No	No	Manual	F056	1
7	150A	No	No	AOV + MOV	F022, F024	None
RHR System						
1	50A	No	No	Manual	F026	1
2	150A	No	No	MOV + MOV	F029A(B,C), F030A(B,C)	None
3	250A	No	No	MOV	F008A(B,C)	None
4**	300A	No	No	MOV + MOV	F014B(C), F015B(C)	None
5**	250A	No	No	MOV + MOV	F017B(C), F018B(C)	None
6**	100A	No	No	MOV	F019B(C)	None

Table 6
Flow Diversion Pathway Screening Results (continued)

Path	Line Size	Locked	Capped	Number of Valves	Valve Tags	Screening Criteria
7**	300A	Yes	No	Manual	F016B(C)	2
8	450A	No	No	MOV	F001A(B,C)	None
9	100A	No	No	MOV	F021A(B,C)	None

* indicates typical for each CRD control unit.
** indicates not in Loop A (only in Loops B & C)

Nine paths are identified that did not screen by the adopted approach. These paths are included in the fault tree model as potential initiating events. Because RHR train A is assumed to be in operation, only RHR train A paths are modeled except for paths 4, 5, 6, and 7 where path B is modeled to mimic the potential for RHR train B or C as the normally operating train. Should RHR train A contain any or all of these paths in the future, the current modeling of paths 4 through 7 for trains B and C bounds the case for train A.

Isolation of the RHR suction valves F010 and F011 is modeled in the event trees. Only automatic isolation of the flow diversion is modeled. Manual isolation is not credited for conservatism. Early isolation would provide additional time to re-establish shutdown cooling. All LOCAs are assumed to fail one train of RHR, in this case train A, the operating train. LOCAs in the reactor cleanup water system are assumed to fail the reactor cleanup water system.

3.2.4.3 Flow Diversion Fault Tree Model Guidelines

The following guidelines were used to develop the fault tree models for intersystem flow diversions:

- Component data is the same for the mitigating model, and wherever possible, the same event names are used.
- For MOV and AOV transfers open failures, the power must be normally connected during the outage for the failure mode to be considered. If the power is off, then the rate for manual valve leakage is used.
- Valve interlocks are assumed to prevent and operator from inadvertently opening an isolation valve. However, the effectiveness of the interlock is not considered when modeling a spurious operation of a MOV to the open position. The spurious failure mode assumes that the interlock is failed.
- The initiating event frequency (valve mission time) is based on 16.5 days. This is accomplished by using a 24 hours mission time event and a 16.5 day outage length.
- If there are 2 valves in series, the second valve uses the standby failure rate based on a 2 year exposure unless other exposure is identified in other failure events.

- Type A human errors (pre-initiator latent unavailability) are modeled as follows. For two valves in series, the latent unavailability for failure to restore the component after maintenance shall use a human error probability (HEP) of 1E-3 unless the valve is locked closed and verified. If control room indication shows valve position, then no error is assessed based on shift walkdown of control board.

- Type B human errors (errors of commission) are modeled as follows: The following values are used for inadvertently opening valves in a line. If there is an interlock, no type B HFE is applied.

Configuration	HEP
Manual valve with visible flow discharge	1E-6
Two manual valves in series with visible flow discharge	1E-7
Manual valve with no indication of flow	1E-4
Two manual valves in series with no indication of flow	1E-5
MOV with control room indication	1E-6
Two MOVs in series with control room indication	1E-7

A Type B human error event can occur in a line with an already failed valve. This failure may be due to a standby mechanical type failure or if the valve was left open due to a Type A human error. Type B events are modeled as initiating events and are multiplied by the 16.5 day factor, providing a final value that is conservative. The Type A and Type B probabilities above are screening values developed using engineering judgment.

3.3. ACCIDENT SEQUENCES AND EVENT TREE ANALYSIS

3.3.1 Accident Sequence Success Criteria

In order to prevent core damage given an initiating event, sufficient systems must be available to ensure that the core decay heat is removed and the fuel remains covered by water. No fuel damage will occur as long as the fuel remains covered by water. There are three ways to achieve success:

(1) Remove decay heat directly from the coolant in the RPV

(2) Remove decay heat indirectly by condensing the steam produced, and provide makeup water to the RPV

(3) Allow the coolant to boil in the RPV and provide makeup water to the RPV to keep the core covered

Table 7 summarizes the success criteria for loss of decay heat removal initiating events.

Table 7
Success Criteria for Loss of Decay Heat Removal

System	Applicable POS	Comment
1 RHR (SDC) or	All	All times when available
Main Condenser or	3, 4	Open MSIVs and establish condensate return path with 1 Feedwater and 1 Condensate pump
CUW or	3,4, 5c, 5d	If temp 386 K (>234□F) or after 8 days (using 2 pumps and using 2 nonregenerative heat exchangers and with regenerative heat exchanger bypassed)
FPC or	5d	Mode 5 only after 10 days. Both pumps and heat exchangers in each train required.
1 Feedwater + Condensate or	3, 4	High pressure injection
1 HPCF or	All	High pressure injection
1 CRD or	All	High pressure injection
1 Condensate or	All	Low pressure injection (requires ADS in Modes 3 and 4 unless large or medium flow diversion or LOCA)
1 LPFL or	All	Low pressure injection (requires ADS in Modes 3 and 4 unless large or medium flow diversion or LOCA)
1 ACIWA (Firewater)	All	Low pressure injection (requires ADS in Modes 3 and 4 unless large or medium flow diversion or LOCA)

In addition, if a LOCA occurs, continuous makeup may be required unless the break can be isolated. The design of the RPV with piping penetrations above the TAF allows for many makeup sources to be used but direct decay removal methods may be unavailable. If a break or flow diversion pathway remains unisolated, then the normal suction of RHR and CUW may become uncovered and fail the suction path. Therefore, following failed isolation, RHR (SDC) and CUW are not credited.

If a break occurs in the CUW suction line to the bottom vessel head, only HPCF or LPCF is credited.

3.3.2 Event Trees

The event trees are structured to follow the developed success criteria with considerations for operator errors and component recovery. The ABWR SSAR documentation (Reference 3) provided shutdown event trees which were used for re-creation of shutdown event tree files using CAFTA. These event trees were Loss of RHR, Loss of SW and Loss of Offsite Power. In

addition to these three event tree types, LOCA event trees were developed to address the pipe break and flow diversion initiating events. The resulting shutdown event trees fall into these four categories:

- Loss of One RHR (Figures A.1 through A.6)
- Loss of a Division of the SW system (Figures A.7 through A.16)
- Loss of Offsite Power (Figures A.17 through A.19)
- LOCA (Figures A.20 through A.22).

The LOCA event trees were simplified to address Modes 3 and 4 as one set of trees and one generalized LOCA tree for Mode 5. The specific differences between success criteria based on time after shutdown, as identified by the POS, are addressed in the system functional top logic.

The Loss of One RHR Event Trees (figures A.1 through A.6) were modified to credit low pressure core flood (LPCF) from RHR train A. The original version of the trees assumed that if RHRA was the initiating event, LPCF from RHR train A would be unavailable. Cutset reviews indicated that a vast majority of RHR faults occurred at startup of the system due to valves in the suction line to the RPV failing to open. This particular failure would not prevent operation of LPCF from RHR train A.

There are two specific deviations from the DCD with regard to the event tree analysis. First, the DCD evaluated CCDP, so the initiating events were assumed to have a value of 1.0. For this analysis, the initiating event uses the calculated annual frequencies, in the form of point estimates or fault trees, and the CDF is calculated for the event tree sequences. A CCDP analysis is performed by setting the initiating event trees or events to true.

Second, any initiator that could cause a loss of the operating train of RHR (A) is included as an input to the loss of RHR initiating event. These include any of the events listed in Table 4 as inputs to the LORHR event trees. This allows for dependent faults from support system initiators to properly propagate to multiple systems. The DCD approach was to exclude specific trains of systems from being credited based on the knowledge of dependencies. In the updated model, loss of SW train A and LOSP are inputs to both the Loss or RHR event trees and their specific loss of SW or LOSP event trees. In the case of LOSP events, this allows partial loss of onsite power events after LOSP to occur with front line system failures in the cut set solution. The LOSP event tree is limited to station blackout cutset results that contain only power failures and not combinations of front line and power failures that may be important.

From the developed shutdown event trees the functional logic was generated in CAFTA. This functional logic represents the shutdown top logic structure.

The plant systems required for a safe-stable shutdown mode are listed in the introduction of this report. The ABWR design has been evaluated for risks associated with shutdown conditions (i.e., Modes 3, 4, and 5). The success criterion for each shutdown event tree was derived from Reference 3 and an analysis of accident sequences postulated for each shutdown event tree.

The event trees are provided in Appendix A.

3.4 SYSTEMS ANALYSIS

Fault tree information was gathered from Reference 3, which includes descriptions of the fault tree systems by function. The fault tree information from the SSAR was input into CAFTA to reproduce fault tree models for each system. Appendix G provides figures of the system fault trees that are necessary to support the shutdown event trees.

3.4.1 Modeling Discrepancies from SSAR Analysis

Although every effort was made to duplicate the fault trees as they were presented in the SSAR documentation, some discrepancies within the SSAR documentation were identified that needed to be resolved. These discrepancies are discussed below.

3.4.1.1 Basic Event Discrepancies

Although the same basic event names were used for some of the basic events in the shutdown model as in the on-line model, some of the failure rates, unavailabilities, and descriptions assigned to the basic events were inconsistent. For this reason, a new basic event database was developed for the shutdown model. The Shutdown model unavailabilities are shutdown specific values and where different from the on-line model. The suffix "_SD" was added to the BE name for event names that were the same as the power model. The shutdown model as represented in Reference 3 had a mission time of 20 hours typically on basic events, which appeared to be a divergence from the DCD documentation. This time was changed to 24 hours for consistency with the documentation and to facilitate the approach used for quantifying the initiator frequencies. The failure rates were updated in the shutdown model to be consistent with the revised at power model, making the two databases more consistent.

3.4.1.2 Gate Naming Discrepancies

Although the same gate names were used for some of the gates in the shutdown model as in the on-line model, some of the descriptions used were inconsistent. For this reason, the gate database that was used for the on-line model could not be used for the shutdown model, and a new gate database was developed for the shutdown model. In the Shutdown model gate database, the descriptions shown in the SSAR Appendix Q were used regardless of the descriptions associated with the same basic events used in the on-line model.

3.4.1.3 Instrumentation Model Discrepancies

Figure 19QA-19al of the SSAR is a representation of Page 38 of the Electrical Power System fault tree, but should be a representation of Page 38 of the Instrumentation System. The wrong page appears to have inadvertently been scanned into the middle of the Instrumentation System Fault Tree in the SSAR. The updated fault tree used in this analysis is the corrected instrument power fault tree for the DCD.

3.4.2 Fault Tree Model Additions

The DCD fault tree consisted of many individual fault trees that were individually quantified to provide branch values to the event tree. The updated model links all the system models to sequence logic. This logic forms the top logic and is in turn connected to a mutually exclusive tree. This forms the structure of a one top model.

The mutually exclusive logic is a simple tree that forms combinations that are deleted if they appear in cutsets. The tree includes inputs that preclude in individual cutsets the coincident occurrence of POS events, flow diversions to the fuel pool when the dam is removed, and certain combinations of unavailability that would be disallowed.

Another addition to the DCD logic is the initiating event tree logic. The system trees were reviewed and copied to new trees. The support system transfers were cut so that the initiating event flag event would identify the system at fault. For RHR, a running tree was used to address time when the pump is running and a demand tree was developed for the initial transition to RHR operating during Mode 3. Table 4 lists the systems that have IE fault tree models.

Many valve failure events are based on testing exposure time throughout the RHR A model. In order for these valve failures to address the operation of the system, a new version of the basic events with suffix "_IE" were created that used a mission time. These new events were incorporated into the loss of RHR train A initiating event tree. In order for these events to propagate failure to the mitigating trees, the events were added beside the exposure time based events but conditioned with the initiating event flag.

System impacts from initiators or POSs were addressed by logic inserted into the system models. Tables 1 and 7 describe limitations of when fuel pool cooling and CUW can be used for decay heat removal during Mode 5. Although most event trees account for this, the LOCA event trees were developed so that these limitations were added to the system models. By adding a POS identifier event to the system model as an input, this prevents credit for that system during that POS. Likewise by adding an initiating event to system logic, the initiating event fails that logic. System faults were added according to Table 5.

The DCD discussed assumed unavailability of Division 3 for the minimum sets analysis. The impact of this assumed limiting unavailability was added using POS events. This addition is discussed further in the Component Data Analysis Section that follows.

The logic for Firewater addition was not included in the DCD documentation. The logic was developed in Reference 6 and reproduced in this analysis.

With addition of LOCA event trees, logic for failure of LOCA isolation was added. There are three types of inputs to this logic.

First, there is a LOCA in the CUW suction line that cannot be isolated. A break in the line is assumed to fail CUW and because the pipe connection is below active fuel, this break is assumed to be beyond the makeup capacity of CRD.

The next input addresses small medium and large LOCAs that occur between the vessel and the isolation valves. A fraction of 0.5 was conservatively assumed to address those LOCAs that would not be isolable.

The last input addresses isolation of LOCAs that occur downstream of RHR valves F010 and F011. A fault tree was developed that includes mechanical, electrical, and signal failures of these valves. No information specific to the valve signal logic was found except that the valves close on RPV Level 2 isolation signal. Therefore, the RHR actuation logic at level 2 was reused for the valves as a conservative surrogate. It is likely that pump actuation and LOCA isolation use a majority of the same level logic, but this has not been verified. It is conservative to use

the same logic because if it fails the train isolation, it also fails the auto actuation of LPCF function used to mitigate the failed isolation. The valves in series have redundant power supplies. For the RHR A train, F010A is powered by Division 1 and F011A is powered by Division 2. Therefore, the natural assumption is that the associated logic for the valve isolation would be diverse as well. Manual isolation of the suction valves is not credited.

The fault tree did not address potential unavailability of the emergency diesels with specific basic events. Basic events EDGCMAINT, EDGDMAINT, and EDGEMAINT were added to the fault tree. The unavailability values are discussed in the following data section.

The fault tree listings are included in Appendix G.

3.5 DATA ANALYSIS

3.5.1 Component Data Analysis

The component failure rates and initiating events frequencies were updated using Reference 4. As a result of the data update, many standby components failure to run faults were split into two events, failure to run during the first hour of operation and failure to run after the first hour of operation.

Component unavailabilities were maintained from the SSAR documentation, with a few exceptions:

- RHR train A unavailability was changed from 1.1 to 0.1. This is appears to be a typographical error in the SSAR documentation.
- Standby SW and RBC pump unavailabilities were changed from 9.22E-5 to 0.1. The original value is not representative of maintenance unavailability during an outage. A more realistic value was chosen.

No EDG unavailability is included in the Reference 3 documentation. This is likely due to the minimum sets approach selected for the DCD. Based on typical outage plans, EDGs typically undergo some form of maintenance during outages. Diesel unavailability events were added to the model to address this possibility. A probability of 0.25 was assumed as a conservative estimate of each diesel's unavailability during shutdown. Coincident unavailability of EDGs was disallowed as mutually exclusive combinations.

3.5.2 Human Reliability Analysis

The human reliability assessment for operator actions to recover core cooling after a loss of shutdown cooling event is taken directly from Table 19QB-3 of Reference 3. In general there are two types of actions modeled, diagnostic and implementation. The diagnostic events are modeled as an event in the event trees and the implementation event are modeled at the system level. There is only one diagnostic event for each event tree. A failure of this event prevents mitigation from all systems except those ECCS systems that are automatically initiated.

There are two types of diagnostic actions addressed, Case A, based on the time to boil (TTB) during Mode 5, and Case B, based on the time to core damage (TTCD) during all modes. In

general for this evaluation, Case B is used. Table 8 provides analysis results for the probability of failure to diagnose as presented in Reference 3.

Table 8
Probability of Failure to Diagnose (Ref. 3)

Case	Mode	Time After Shutdown	Prob. (Fail to Diagnose)	
			Calculated	Used in PRA
A	5	2-3 days	1.0E-4	1.0E-4
A	5	Greater than 3 days	<<1.0E-5	1.0E-5
B	3,4 and 5 (prior to flooding reactor cavity)	Any time after shutdown	<<1.0E-5	1.0E-4
B	5 (afer flooding reactor cavity)	Any time	<<1.0E-5	Negligible[1]

1. For negligible values a value of 1.0E-6 is used.

The application of these events to specific events for the diagnostic human errors is described in Table 9 for the different plant states and initiators. For LOCA cases, the diagnostic values are conservatively increased by two orders of magnitude to account for shortened time associated with the lost inventory.

Table 9
Summary of Diagnostic Operator Actions

Misdiagnoses Event	Mode/POS	Time after SD	Probability of Misdiagnoses of Loss of RHR	
			Case A (TTB)	Case B (TTCD)
Loss of one RHR, one SWS, or Offsite Power				
OPERATOR	3	4h-6h	N/a	1.0E-04
OPERATOR	4	6h-2d	N/a	1.0E-04
OPERATOR	5a	2d-3d	1.0E-04	1.0E-04
		3d-3d+ [2]	1.0E-05	1.0E-04
OPERM5	5b	3d+ to 8d	1.0E-05	Negligible[1]
OPERM5	5c	8d - 10d	1.0E-05	Negligible
OPERM5	5d	10d-33d	1.0E-05	Negligible

Table 9
Summary of Diagnostic Operator Actions (continued)

Misdiagnoses Event	Mode/POS	Time after SD	Probability of Misdiagnoses of Loss of RHR	
			Case A (TTB)	Case B (TTCD)
Large or Medium LOCAs				
OPERL	3	4h-6h	N/a	1.0E-02
OPERL	4	6h-2d	N/a	1.0E-02
OPERL	5a	2d-3d	1.0E-02	1.0E-02
		3d-3d+	1.0E-03	1.0E-02
Small LOCAs				
OPERS	3	4h-6h	N/a	1.0E-03
OPERS	4	6h-2d	N/a	1.0E-03
OPERS	5a	2d-3d	1.0E-03	1.0E-03
		3d-3d+	1.0E-04	1.0E-03
All LOCAs				
OPERLM5	5b	3d+ to 8d	1.0E-03	1.0E-04
OPERLM5	5c	8d - 10d	1.0E-03	1.0E-04
OPERLM5	5d	10d-33d	1.0E-03	1.0E-04

1. For negligible values a value of 1.0E-6 is used.
2. "3d+" represents the time in the third day that the refueling cavity is being filled

Each system includes operator actions for failure to start standby systems. One event is typically used for all trains of the system so that complete dependence is assessed between trains. According to Reference 3, for systems that are part of a minimum set analysis, the operator action to start additional trains is analyzed with a separate event to account for dependence. Reference 3 provides a discussion on the human error analysis to fail to start the standby systems. Table 10 provides analysis results for the probability of failure to start a specified minimum sets systems as presented in Reference 3

Table 10
Probability of Failure to Start a Specified "Minimum-Set" System (Ref. 3)

Case	Mode	Prob. (Fail to Diagnose)	
		Calculated	Used in PRA
A	All	4.0E-3	2.0E-2*
B	All	4.0E-3	2.0E-2*

* Failure to start a second division of the same system is 0.1 due to common mode failure considerations.

As a rule, a value of 2E-2 is provided for the human error probability with exceptions found in Reference 3. The justification of these exceptions is not documented, and these values are retained for consistency with Reference 3. In addition, the Reference 3 states that to assess dependency between starting multiple trains of a minimum sets system, an HEP of 0.1 is used for failure to start a second pump, given failure to start the first. This is only found in the RHR system model. The modeling of this approach assumes that given a loss of RHRA, that RHRB is the first pump that the operator attempts to start (RHRSDIEA, 0.02) and RHR C is the second (RHRSDERC, 0.1). A limitation to this approach is that if pump B fails due to mechanical faults, then there should be no dependence between operator actions to start the second pump, but only the dependent failure probability of 0.1 is credited. This is recognized as conservatism and is not changed in the model. For the Loss of SW C initiator the assumed first standby pump that is started is RHRA. As a result there is a second set of operator actions for starting pump A initially (RHRSDERA, 0.02) and then to start RHR B (RHRSDIEC, 0.1). Because there are two events in the RHR B tree, this results in overestimating the contribution to starting for all initiators. Therefore, the logic was modified to enable these human error events only following a loss of SWS C initiating event. For the operator actions that follow a Loss of RHR A, they were made mutually exclusive with the Loss SW C initiator. This is a minor model change to preclude double counting the failure events. Table 11 lists the operator actions to actuate components.

Table 11
Summary of Operator Actions to Actuate Components

Name	Description	Prob.
ADSMAN	OPERATOR FAILS TO OPEN NON-ADS SRV'S	2.00E-03
CONOP	OPERATOR FAILURE TO INITIATE CONDENSATE FLOW MANUALLY	2.00E-02
CRDOP	OPERATOR FAILURE TO INITIATE STANDBY CRD MANUALLY	2.00E-02
CRFLOP	OPERATOR FAILURE TO INCREASE CRD FLOW RATE	2.00E-02
CTGMAN	MANUAL INITIATION	2.00E-02
EDGMAN	MANUAL INITIATION FAILURE	2.00E-02

Table 11
Summary of Operator Actions to Actuate Components (continued)

Name	Description	Prob.
EHU69C	OPERATOR FAILS TO TRANSFER POWER	1.00E-03
EHUS1AD	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 1	1.00E-03
EHUS1BD	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 2	1.00E-03
EHUS1CD	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 3	1.00E-03
EHUS1DD	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 4	1.00E-03
FPOP	OPERATOR FAILURE TO INITIATE STANDBY FP COOLING MANUALLY	2.00E-02
FWOP	OPERATOR FAILURE TO INITIATE FEEDWATER MANUALLY	2.00E-02
HOOBOPHL	OPERATOR FAILS TO ATTEMPT MANUAL INITIATION OF HPCF AFTER 30 MIN.	1.00E-01
HUEROR5	OPER FAILS TO ATTEMPT MANUAL TRANSFER FROM CST TO SUPP POOL	1.00E-02
MCOP	OPERATOR FAILS TO INITIATE MAIN CONDENSER COOLING MANUALLY	2.00E-02
OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM	2.00E-02
RHRSDERA	FAILURE TO MANUALLY INITIATE RHR A – Used for Loss or SWC initiator	2.00E-02
RHRSDERC	FAILURE TO MANUALLY INITIATE RHR C – Used for loss of RHRA initiators	1.00E-01
RHRSDIEA	FAILURE TO MANUALLY INITIATE RHR B – Used for loss of RHRA initiators	2.00E-02
RHRSDIEC	FAILURE TO MANUALLY INITIATE RHR B – *Used for Loss or SWC initiator*	1.00E-01
RWCUOP	OPERATOR FAILURE TO INITIATE RWCU MANUALLY	2.00E-02
VOPERRF	OPERATOR FAILS TO START STANDBY CHILLED WATER PUMP	1.00E-03
WOPERR	OPERATOR FAILS TO PERFORM INDICATED ACTION TO START STANDBY SWS TRAINS	1.00E-03

3.6 QUANTIFICATION

Quantification of the fault tree model is broken down into three analyses that provide three different types of results. This is done to address various safety thresholds. The first analysis calculates conditional core damage probability (CCDP) using a limiting set of systems available. In this analysis, Division 1 and 2 systems are assumed to be available with the exception of operational faults, and human errors, and Division 3 equipment is unavailable. This configuration of unavailability addresses Technical Specification limits. For this analysis, the initiators of interest are those contributing to loss of shutdown cooling and not the LOCA events.

The second analysis is similar to the first, except that core damage frequency is calculated using the same limited configuration of available equipment.

The third analysis addresses a more realistic core damage frequency through the use of nominal component unavailability values versus the use assumed unavailabilities.

3.6.1 Unavailability Event Settings

Because the quantification is done using a linked fault tree, flag files are used during quantification to turn equipment unavailability on and off. For systems without unavailability events, a reliability event is used as a surrogate. Table 12 addresses the unavailability event settings for each of the analyses. The values in the "CDF Realistic" column are the unavailability probabilities used in the fault tree model.

For the realistic CDF analysis, unavailabilities of ECCS front line equipment are disallowed from occurring concurrently through use of mutually exclusive combinations. Other unavailability of system trains is allowed to occur at random in the cutsets solution. ECCS front line equipment is defined as EDGs, RHR, and HPCF. Random occurrence of RBC and SWS standby train unavailability are allowed to occur together in a single cutset.

Table 12
Unavailability Event Settings for Quantification Analyses

Plant Systems	Existing Unavailability Event	Quantification Case Settings			Assumed State	Surrogate UA Event	Comments
		CCDP	CDF Limiting	CDF Realistic			
RCIC					UA[1]		Unavailable throughout outage
ADS					S		ADS not credited in plant mode 5
RHRA(SDC)	WDAMAINT_SD	F[1]	F	0.1	O[1]		
RHRB(SDC)	WDBMAINT_SD	F	F	0.1	S[1]		
RHRC(SDC)	WDCMAINT_SD	T[1]	T	0.1	S		
HPCF(B)	HPBMAINT_SD	F	F	0.1	S		
HPCF(C)	HPCMAINT_SD	T	T	0.1	S		
Main Condenser	MCMAINT			0.1	S		Random unavailability allowed
Feedwater	FWMAINT	F	F	0.1	S		System UA event set to false allows individual trains to be set
FW(A)					S		
FW(B)		T	T		S	FWBR	
FW(C)		T	T		S	FWCR	
CRD(A)					O		

Table 12
Unavailability Event Settings for Quantification Analyses (continued)

Plant Systems	Existing Unavailability Event	Quantification Case Settings			Assumed State	Surrogate UA Event	Comments
		CCDP	CDF Limiting	CDF Realistic			
CRD(B)	CR001BM	F	F	0.1	S		Train B is on Div II power
LPFL(A)	WDAMAINT_SD	F	F	0.1	S		Same event as for RHR
LPFL(B)	WDBMAINT_SD	F	F	0.1	S		Same event as for RHR
LPFL(C)	WDCMAINT_SD	T	T	0.1	S		Same event as for RHR
CUW System	RWMAINT	F	F	0.1	S		Set system unavailability to false for CCDP and Limiting case
CUW(A)					S		Division I component
CUW(B)					S		Division 2 component
Condensate	CMAINT	F	F	0.1	S		System UA event set to false allows individual trains to be set
Cond Pump(A)					S		Division 1
Cond Pomp(B)					S		Division 2
Cond Pump(C)		T	T	0.1	S	COCR	Division 3
Cond Pump(D)		T	T	0.1	S	CODR	Division 3
DG(C) *Div 1*	EDGCMAINT	F	F	0.25	S		New maintenance event for EDG with realistic value
DG(D) *Div 2*	EDGDMAINT	F	F	0.25	S		New maintenance event for EDG with realistic value

Table 12
Unavailability Event Settings for Quantification Analyses (continued)

Plant Systems	Existing Unavailability Event	Quantification Case Settings			Assumed State	Surrogate UA Event	Comments
		CCDP	CDF Limiting	CDF Realistic			
DG(E) *Div 3*	EDGEMAINT	T	T	0.25	S		New maintenance event for EDG with realistic value
CTG					S		
ACIWA(Firewater)					S		
SWS(A)					O		Only one modeled as operating
SWS(B)					O/S[1]		
SWS(C)					O/S		Must assume pump is running for LOSWC initiator
SWS(D)	WPMSC1DM_SD	F	F	0.1	S		Revised to more realistic value
SWS(E)	WPMSC1EM_SD	F	F	0.1	S		Revised to more realistic value
SWS(F)	WPMSC1FM_SD	T	T	0.1	S		Revised to more realistic value
RBC(A)					O		Only one modeled as operating
RBC(B)					O/S		
RBC(C)					O/S		Must assume pump is running for LOSWC initiator
RBC(D)	WPMRC1DM_SD	F	F	0.1	S		Revised to more realistic value
RBC(E)	WPMRC1EM_SD	F	F	0.1	S		Revised to more realistic value

Table 12
Unavailability Event Settings for Quantification Analyses (continued)

Plant Systems	Existing Unavailability Event	Quantification Case Settings			Assumed State	Surrogate UA Event	Comments
		CCDP	CDF Limiting	CDF Realistic			
RBC(F)	WPMRC1FM_SD	T	T	0.1	S		Revised to more realistic value
RBCHX(G)	WHEB1GM_SD			5.42E-05	S		
RBCHX(H)	WHEB1HM_SD			5.42E-05	S		
RBCHX(J)	WHEB1JM_SD			5.42E-05	S		
FPC(A)					O		
FPC(B)	FP001BM	F	F	0.1	S		
FPCHX(B)	FP001BHM	F	F	0.1	S		
AC Power Div 3		T[2]	T[2]		O	EAC69EH	
DC Power Div 3		T[2]	T[2]		O	EDP103H	
Standby Refrig-erator Water Pump (Div3)	WPMMNTF	T	T	9.22E-05	S		
Standby Refrig-erator (Div 3)	WRFMNTF	T	T	5.88E-05	S		

1. T – Set True for quantification, F – Set False for quantification, S – assumed standby train, O – assumed operating train, UA – unavailable, O/S – likely operating, but assume in standby.
2. Division 3 power has impact on LOOP B RHR suction valves so a logic gate P3-F011B is added to gate C001BMV that uses a flag event to disable the power failure as is described in the DCD.

3.6.2 Initiating Event Settings

In order to quantify the CCDP a number of changes to the initiating events are set during quantification. Because the CCDP study addresses only the loss of RHR initiators (i.e., loss of one RHR, loss of one SW, loss of offsite power), the LOCA initiating events are set to false for quantification. Also, the support system initiators for RHR train A are set to false as their contribution would be redundant to the loss of RHR train A. The initiating events are set to 1 given the enabling system logic is set to true by a flag event. This results in an initiating event frequency of 1.0 to calculate the CCDP. For the CCDP calculation, the POS split fractions are set to 1.0 so that each POS is equally weighted with regard to duration. This is in contrast to the CDF quantification, for which each event tree has an initiating event frequency related to the fraction of the outage length. Table 13 summarizes the initiating event settings for quantification.

Table 13
Initiating Event Settings for Quantification Analyses

IE Name	Factor	Description	Quantification Case		
			CCDP	CDF Limiting	CDF Realistic
SD_CUW	16.5	Flow Diversion In The CUW System	F[1]	NC[1]	NC
SD_LOAC1	16.5	Loss of Div I AC Bus	F	NC	NC
SD_LODC1	16.5	Loss of Div I DC Bus	F	NC	NC
SD_LORHRA	16.5	Shutdown Loss of RHR Train A Initiator	1[2,3]	NC	NC
SD_LORHRAS	0.5	Failure of RHR Train A Initiation For Shutdown Cooling	F[4]	NC	NC
SD_LOSWA	16.5	Loss of SWS Train A	1[2]	NC	NC
SD_LOSWC	16.5	Loss of SWS Train C	1[2]	NC	NC
SD_RBCA	16.5	Loss of RBC Train A	F	NC	NC
SD_RHR0	6.81E-05	Pipe Break In Train A RHR System	F	NC	NC
SD_RHR1	16.5	Flow Diversion In The RHR System	F	NC	NC
SD_S01	4.99E-07	Large or Medium LOCA	F	NC	NC
SD_S2	2.03E-06	Small LOCA	F	NC	NC
SD_S3	2.25E-07	Non-Isolable Small LOCA Below TAF in CUW Suction	F	NC	NC
SD_TE	8.82E-03	Loss of Offsite Power	1	NC	NC

Table 13
Initiating Event Settings for Quantification Analyses (continued)

IE Name	Factor	Description	Quantification Case		
			CCDP	CDF Limiting	CDF Realistic
X_POS3	0.003	Fraction of POS 3 – 4 hours to 6 hours	1	NC	NC
X_POS4	0.053	Fraction of POS 4 – 6 hours to 2 days	1	NC	NC
X_POS5A	0.030	Fraction of POS 5a - 2 days to 3 days	1	NC	NC
X_POS5B	0.152	Fraction of POS 5b – 3 days to 8 days	1	NC	NC
X_POS5C	0.061	Fraction of POS 5c - 8 days to 10 days	1	NC	NC
X_POS5D	0.697	Fraction of POS 5d - 10 days to 33 days	1	NC	NC

1. F – set to false during quantification, NC - No change
2. The initiator is ANDed with fault tree logic that is set to true with flag event X_CCDP
3. The LPCF train A logic is set to true using logic SD_LORHRA * X_CCDP assuming the initiator fails the RHR A pump train.
4. The Loss of RHR train A to start initiator during Mode 3 is redundant for CCDP calculation.

Quantification flag files are included in Appendix B.

3.6.3 Recovery Assessment

The quantification process produces raw cutsets. Within these are two types of events evaluated for recovery. The first is a system recovery flag, typically of the form REC*. The second is the loss of offsite power initiator, SD_TE. The following section describes the analysis for recovery.

3.6.3.1 System and Component Recovery

System recovery probabilities are generally calculated using the exponential recovery formula:

P_f= Exponential (-T/MTTR) Equ. 1

where:

P_f= Probability of failure to recover

T = Available repair time

MTTR = Mean time to repair

A mean time to repair of 19 hours, based on the WASH-1400 data, is assumed throughout the DCD for the repair of most system components as long as the core and the RPV are intact. For events involving loss of offsite power or station blackout, the MTTR is based on recovery of onsite or offsite power.

For systems involving (multiple) redundant divisions of equipment, there is a potential for recovery of each of the failed divisions. However, for this analysis and in consideration of shutdown configurations and common mode failures, only one train is recovered.

The recovery of onsite power is addressed by use of the CTG or by repairing an EDG. This discussion addresses recovery of an EDG. The probability of failure to repair an EDG in the allotted time comes from Reference 5. This reference provides a Weibull distribution with parameters $\alpha = 0.745$ and $\beta = 6.14h$ used to develop the probability of exceedance curve for EDG repair times. The equation for a Weibull distribution is used to calculate the failure probabilities for available repair time according to each plant operating state. The non-recovery probability is calculated as follows:

$$P_{nr} = 1 - f_{Weibull}(x, \alpha, \beta) \qquad \text{Equ. 2}$$

where:

$f_{Weibull}(x, \alpha, \beta)$ is the Weibull cumulative distribution function with equation:

$$f_{Weibull}(x, \alpha, \beta) = 1 - e^{-(x/\beta)^{\alpha}} \qquad \text{Equ. 3}$$

x = the available recovery time, and

α and β are the Weibull distribution parameters.

A function, WEIBULL, is available to perform the calculation in the Excel spreadsheet. Table 14 summarizes the non-recovery probabilities of ECCS trains and EDGs for each plant operating state.

Table 14
Probabilities of Non-recovery for ECCS Equipment and EDG by POS

Mode/ POS	Time after SD	Time to Boil	Time to CD	Non-Recovery Pf			
				ECCS (MTTR =19h)		EDG (Ref. 2 Data)	
				Boil	CD	Boil	CD
3	4h-6h	1.3h	6.4h	0.934	0.714	0.730	0.357
4	6h-2d	1.5h	7.5h	0.462	0.674	0.705	0.313
5a	2d-3d	1.2h	13h	0.469	0.504	0.744	0.174
5a	3d-3d+	1.3h	15h	0.467	0.454	0.730	0.143
5b	3d+ to 8d	15h	7.8d	0.227	5.26E-05	0.143	2.89E-06
5c	8d - 10d	21h	11d	0.166	9.24E-07	0.082	6.98E-08
5d	10d-33d	27h	14.5d	0.121	1.11E-08	0.049	1.62E-09

The non-recovery probabilities that are used in the cutset recovery are based on the time to core damage versus time to boiling. Calculations presented in DCD section 19QB show that the boiling release rates, assuming no core damage, are well below allowable limits for normal plant operations. Also, most equipment in the reactor building is qualified to operate in a steam environment, except CRD, however, due to hardy construction CRD is expected to operate. Therefore, the time between the onset of boiling and core uncover is included as available equipment recovery time. Several events are modeled for recovery of equipment. These events overlap between several plant states and event trees. The resultant recovery values are applied to the cutset solution according to the following conditions in Table 15.

Table 15
Application of Equipment Recovery Events

Recovered BE	POS 3	POS 4	POS 5A	POS 5B	POS 5C	POS 5D
Failure of ECCS Train – Added Component Recovery Events						
	RECECCS3	RECECCS4	RECECCS5A	RECECCS5B	RECECCS5C	RECECCS5D
REC90	0.714	0.674	0.504			
REC45				5.26E-05	9.24E-07	
REC50			0.504	5.26E-05	9.24E-07	1.11E-08
REC20						1.11E-08
Failure of an EDG – Added Component Recovery Events						
	RECEDG3	RECEDG4	RECEDG5A	RECEDG5B	RECEDG5C	RECEDG5D
REC90	0.357	0.313				
REC50			0.174	2.89E-06	6.98E-08	1.62E-09

3.6.3.2 Offsite Power Recovery

The recovery of offsite power is addressed using a simplified approach assuming that all diesel generator failures are start failures so that the time to recover offsite power assumes that onsite power is lost at the occurrence of the initiator. Reference 5 provides Wiebull distribution parameters for offsite power non-recovery versus time for each of the four LOSP types. The report provides a composite curve of a weighted average or each of the LOSP types for at-power operation and states that the curve is weighted based on the LOSP type frequency. Therefore, for the shutdown composite recovery curve, the same exercise was performed except the shutdown LOSP frequencies were used to weight each of the four recovery distributions. Using equation 2, the time specific non-recovery probabilities were calculated, and then averaged by weighting each probability by its LOSP frequency and then dividing by the average SD loop frequency. Tables 16 and 17 summarize the analysis.

Table 16
Calculation of the Composite LOSP Non-Recovery for Shutdown

Table ES-3 LOOP Probability of Exceedance Versus Duration Curve Fits and Summary Statistics (Reference 5)					
LOOP relation	Plant	Switch	Grid	Weather	Average
SD Loop frequencies	5.09E-02	1.00E-01	9.13E-03	3.52E-02	4.88E-02
Mu (μ)	-0.76	-0.391	0.3	0.793	
Sigma (σ)	1.287	1.256	1.064	1.982	
LOOP	Calculated Non-Recovery Curves for Each LOSP Type				Shutdown Weighted Composite [1]
Duration (Hours)	Plant	Switchyard	Grid	Weather	
0	1	1	1	1	1.00E+00
0.25	6.87E-01	7.86E-01	9.44E-01	8.64E-01	7.82E-01
0.5	4.79E-01	5.95E-01	8.25E-01	7.73E-01	6.08E-01
1	2.77E-01	3.78E-01	6.11E-01	6.55E-01	4.13E-01
1.2	2.32E-01	3.24E-01	5.44E-01	6.21E-01	3.64E-01
1.3	2.13E-01	3.01E-01	5.14E-01	6.06E-01	3.43E-01
1.5	1.83E-01	2.63E-01	4.61E-01	5.78E-01	3.08E-01
6.4	2.10E-02	3.68E-02	7.18E-02	2.96E-01	8.10E-02
7.5	1.55E-02	2.77E-02	5.35E-02	2.69E-01	6.92E-02
13	4.89E-03	9.30E-03	1.66E-02	1.86E-01	4.03E-02
15	3.52E-03	6.80E-03	1.18E-02	1.67E-01	3.51E-02
21	1.56E-03	3.12E-03	4.95E-03	1.28E-01	2.53E-02
27	8.12E-04	1.67E-03	2.43E-03	1.03E-01	1.98E-02
187.2 (7.8d)	1.61E-06	3.78E-06	1.78E-06	1.26E-02	2.27E-03
264 (11d)	4.26E-07	1.01E-06	3.55E-07	7.91E-03	1.43E-03
348 (14.5d)	1.39E-07	3.34E-07	9.03E-08	5.35E-03	9.64E-04

The composite probability of non-recovery can be calculated using the following formula:

$$P_{nr\ (composite)} = (F_p{*}P_p+F_s{*}P_s+F_g{*}P_g+F_w{*}P_w)/(F_p+F_s+F_g+F_w) \qquad \text{Equ. 3}$$

where:

F is the frequency of LOSP event as identified by the subscripts, and

P is the probability of non-recovery of LOSP events as identified by the subscripts

Table 17
Summary of LOSP Non-Recovery Probabilities

Mode/ POS	Time after SD	Time to Boil	Time to TAF	LOSP Probability of Non-Recovery	
				TTB	TTTAF
3	4h-6h	1.3h	6.4h	3.43E-01	8.10E-02
4	6h-2d	1.5h	7.5h	3.08E-01	6.92E-02
5a	2d-3d	1.2h	13h	3.64E-01	4.03E-02
5a	3d-3d+	1.3h	15h	3.43E-01	3.51E-02
5b	3d+ to 8d	15h	7.8d	3.51E-02	2.27E-03
5c	8d - 10d	21h	11d	2.53E-02	1.43E-03
5d	10d-33d	27h	14.5d	1.98E-02	9.64E-04

3.6.3.3 Recovery Rules

Recovery rules used during quantification are included in Appendix B.

4 RESULTS ANALYSIS

Three quantifications were performed for the shutdown model: Case 1 - CCDP with Division 3 unavailable (limiting), Case 2 - CDF with Division 3 unavailable (limiting), and Case 3 - CDF with more realistic nominal unavailability. As a separate sensitivity study, Case 3 was modified by disallowing unavailability of frontline ECCS (EDG, RHR, LPCF) prior to Mode 5 with refueling cavity flooded. Table 18 summarizes the results of each analysis.

Table 18
Summary of CCDP/ CDF Results for Analysis Cases

Case:	Description	Truncation	CCDP/ CDF
Case 1. CCDP	CCDP - given loss of shutdown cooling initiators, RHR, SWA, SWC, and LOSP - limiting unavailability (All division 3)	1E-10	1.48E-06
Case 2. CDF limiting	CDF for all SD initiating events with limiting unavailability (All Division 3)	1E-13	1.77E-09/yr
Case 3. CDF realistic	CDF for all SD initiating events with nominal unavailabilities	1E-14	4.21E-10/yr
Case 3a. CDF sensitivity	CDF for all SD initiating events with nominal unavailabilities (sensitivity to no frontline ECCS unavailability during POS 3, 4, 5a)	1E-14	6.92E-11/yr

The results of each case were reviewed and determined to be predictable given the constraints of each case.

In addition to these risk analysis cases, a minimum sets analysis was performed to validate the assessment performed in the DCD (Reference 3) Tables 19Q-3, 4, and 5.

The results of each analysis are discussed in the following sections.

4.1 CASE 1. CCDP RESULTS

The conditional core damage frequency was calculated for Loss of RHRA, Loss of SWA, Loss of SWC and LOSP using assumptions of train A RHR and supports in operating, train B in standby, and Division 3 systems unavailable to address technical specification limits. The resultant cumulative CCDP is 1.48E-6 using a truncation of 1E-10, over four orders of magnitude below the CCDP. This CCDP is somewhat conservative in that each initiator is given a value of 1 for each event tree that is evaluated, so the combined initiating event frequency of the 4 initiating event type trees and 6 plant states results in 24 evaluated initiating events per outage.

The top 50 cutsets for Case 1 are listed in Appendix C.

The importance of each initiating event was reviewed. The AC power system proves very important when one division is unavailable and LOSP frequency set to 1.0. The contribution to CCDP by initiator is listed in Table 19.

Table 19
Initiating Event Contributions to CCDP

Initiator	Description	% Cont
SD_TE	LOSS OF OFFSITE POWER	45%
SD_LOSWA	LOSS OF SWS TRAIN A	27%
SD_LORHRA	SHUTDOWN LOSS OF RHR TRAIN A INITIATOR	27%
SD_LOSWC	LOSS OF SWS TRAIN C	1%

The results of CCDP contributions by plant operating state is an indicator largely of how much time there is to recover offsite power or onsite power. The results are dominated by those POS that have the highest decay heat and the lowest water inventory. Once the vessel is open as in POS 5a, the RPV cannot be re-pressurized, so the water cannot hold as much heat resulting in lower recovery time than in POS 4. The contribution to CCDP by plant operating state is listed in Table 20.

Table 20
POS Contributions to CCDP

Plant State	Description	% Cont
POS3	POS 3 - 4HOURS TO 6 HOURS	37.1%
POS4	POS 4 - 6HOURS TO 2 DAYS	32.7%
POS5A	POS 5A - 2 DAYS TO 3 DAYS	29.6%
POS5B	POS 5B - 3 DAYS TO 8 DAYS	0.1%
POS5C	POS 5C - 8 DAYS TO 10 DAYS	0.1%
POS5D	POS 5D - 10 DAYS TO 33 DAYS	0.5%

Figure 1 combines these results to illustrate the contribution of each initiating event by the plant operating state.

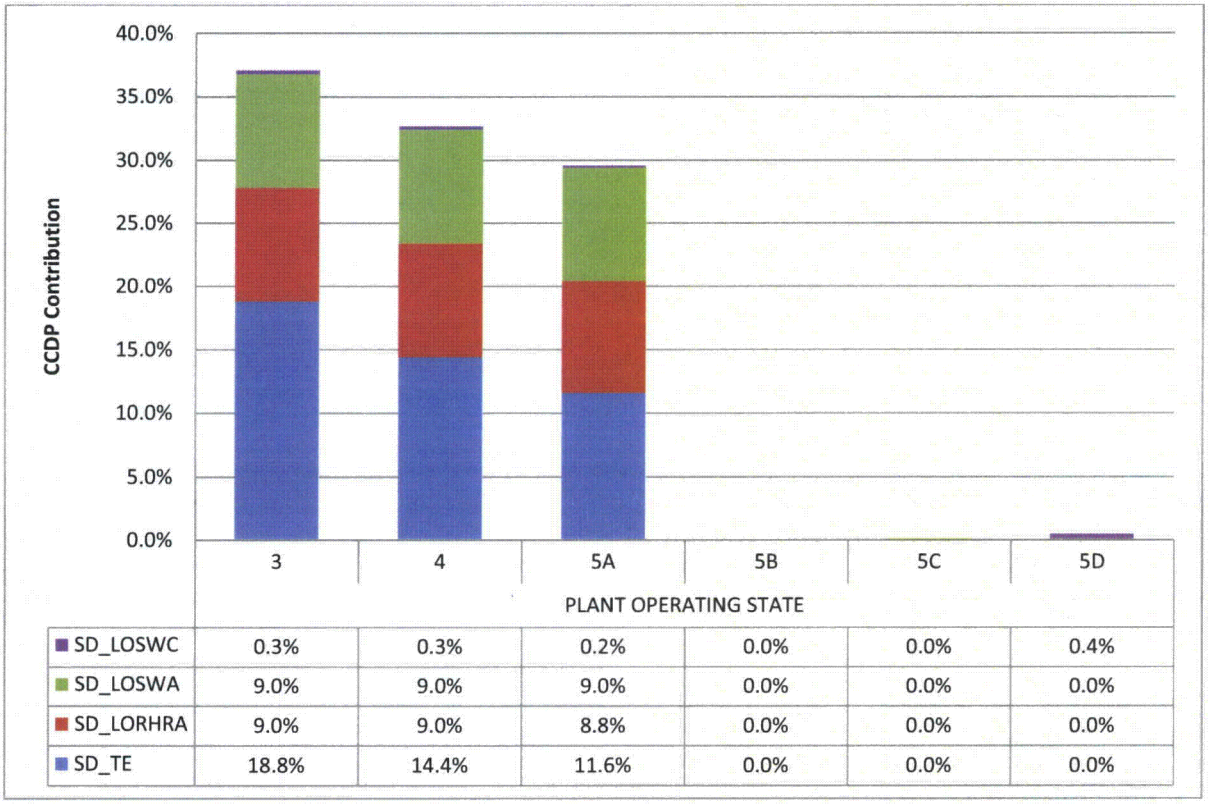


Figure 1. Breakdown of Initiating Event Contribution by POS to CCDP

The most important operator actions were reviewed. The importance is proportional to the shorter response times available during the early POSs of the outage and to the importance of AC power. The contribution of the top 8 operator actions is listed in Table 21.

Table 21
Operator Action Contributions to CCDP

Operator Action	Description	% Cont
OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC	57.8%
OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM	41.5%
CTGMAN	MANUAL INITIATION	11.5%
EDGMAN	MANUAL INITIATION FAILURE	4.5%
HOOBOPHL	OPERATOR FAILS TO ATTEMPT MANUAL INITIATION OF HPCF AFTER 30 MIN.	0.8%

Table 21
Operator Action Contributions to CCDP (continued)

Operator Action	Description	% Cont
CRFLOP	OPERATOR FAILURE TO INCREASE CRD FLOW RATE	0.3%
OPERM5	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC MODE 5	0.2%
RHRSDIEC	FAILURE TO MANUALLY INITIATE RHRB	0.001%

The component recovery actions are similar to the operator action importances and are ranked by the importance of AC power and the time available during each POS. The top recovery actions are listed in Table 22.

Table 22
Recovery Event Contributions to CCDP

Recovery	Description	%Cont
RECOSP3	FAILURE TO RECOVER OSP DURING POS 3	16.3%
RECEDG3	FAILURE TO RECOVER EDG DURING POS 3	16.4%
RECOSP4	FAILURE TO RECOVER OSP DURING POS 4	12.4%
RECEDG4	FAILURE TO RECOVER EDG DURING POS 4	12.1%
RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A	9.6%
RECECCS5A	FAILURE TO RECOVER ECCS DURING POS 5A	9.4%
RECECCS4	FAILURE TO RECOVER ECCS DURING POS 4	1.3%
RECEDG5A	FAILURE TO RECOVER EDG DURING POS 5A	0.9%
RECOSP5C	FAILURE TO RECOVER OSP DURING POS 5C	0.02%

Components important to the CCDP results were reviewed. The top component importances are related to AC power reliability. Given that Division 3 is assumed unavailable, its supported components are not listed below. The Fussell-Vesely importances of the top 50 component failures are listed in Table 23.

Table 23
Summary Component Failure Event Contributions to CCDP

Equip.Failure	Failure Description	Prob.	RAW	F/V
GTURBINEFS	CTG FAILS TO START AND LOAD	2.43E-02	8.26	1.81E-01
EDGCD	2 D.G.'S CCF	1.94E-03	88.67	1.70E-01
GTURBINEFR	CTG FAILS TO RUN	1.93E-02	8.20	1.42E-01
EDGD	DG D FAILS TO RUN	2.48E-02	5.40	1.12E-01
EDGC	DG C FAILS TO RUN	2.48E-02	5.28	1.09E-01
EDGFSDD	DG FAILS TO START	2.21E-02	5.36	9.86E-02
EDGFSCD	DG FAILS TO START	2.21E-02	5.24	9.58E-02
HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)	1.00E-02	8.58	7.66E-02
WDBSTRN	STRAINER E11-D001B PLUGGED	6.46E-03	9.79	5.71E-02
ECA023H	CABLE 23 FAILURE	1.16E-04	409.63	4.75E-02
ECA024H	CABLE 24 FAILURE	1.16E-04	409.63	4.75E-02
ECA041H	CABLE 41 FAILURE	1.16E-04	409.63	4.75E-02
ECAXX2H	CABLE FAILURE	1.16E-04	409.63	4.75E-02
ECAXX5H	CABLE FAILURE	1.16E-04	409.63	4.75E-02
ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER	1.00E-03	32.58	3.16E-02
ETR6D1H	TRANSFORMER T6D1 FAILS	6.54E-05	405.60	2.65E-02
ETR6D2H	TRANSFORMER T6D2 FAILURE	6.54E-05	405.60	2.65E-02
EDGE	DG E FAILS TO RUN	2.48E-02	1.78	1.99E-02
WDBRAC	RHR-B PUMP ROOM A.C. UNIT FAILS	2.25E-03	9.76	1.98E-02
CTGMANSW	CTG MANUAL DISCONNECT SWITCH OPEN	3.00E-03	7.25	1.88E-02
VPVF012B	PCV P25-F012B FAILS FULL OPEN (NOFO)	4.56E-05	405.61	1.85E-02
F005BMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005B (NCFC)	2.08E-03	9.76	1.82E-02

Table 23
Summary Component Failure Event Contributions to CCDP (continued)

Equip Failure	Failure Description	Prob	RAW	F/V
F021BFO	MINIMUM FLOW VALVE E11-F021B FAILS OPEN (NOFO)	2.08E-03	9.76	1.82E-02
W013BFC	FAILURE OF HX INLET VALVE P21-F013B (NCFC)	2.08E-03	9.76	1.82E-02
EDGFSED	DG FAILS TO START	2.21E-02	1.78	1.77E-02
EDGCDE	3 D.G.'S CCF	3.81E-04	43.34	1.61E-02
HPBRAC	PUMP B ROOM A.C. UNIT FAILS	2.25E-03	8.11	1.61E-02
HMV10BHO	VALVE E22-F010B FAILS TO CLOSE	2.08E-03	8.11	1.48E-02
HMV10BHW	VALVE E22-F010B FAILS TO OPEN	2.08E-03	8.11	1.48E-02
HMV14BHW	VALVE E22-F003B FAILS CLOSED (NCFC-VALVE BODY STUCK)	2.08E-03	8.11	1.48E-02
EDGCDEN	3 D.G.'S CCF	3.81E-04	39.43	1.46E-02
C001BMF	RHR PUMP B FAILS TO START	1.56E-03	9.76	1.37E-02
HSS000HW	SPARGERS PLUGGED	1.64E-03	8.12	1.17E-02
GTURBINEFLR	CTG FAILS TO LOAD AND RUN FOR FIRST HOUR	1.87E-03	6.93	1.11E-02
HPM01BDW	HPCF PUMP B FAILS TO START	1.56E-03	8.12	1.11E-02
EDGC1	DG C FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	4.53	1.03E-02
EDGD1	DG D FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	4.53	1.03E-02
C001BCB	RHR CIRCUIT BREAKER FAILS TO CLOSE	1.10E-03	9.77	9.66E-03
EBY1CCFN	BATTERY CCF	5.28E-06	1,680.00	8.89E-03
EDGDE	2 D.G.'S CCF	1.94E-03	3.72	5.28E-03
EDGCE	2 D.G.'S CCF	1.94E-03	3.26	4.40E-03
DLSPMPRUN	FAILURE OF DIESEL FIRE PUMP TO RUN AFTER 1 HOUR	1.28E-02	1.30	3.93E-03
ECB905H	DG BKR 905 FAILS TO CLOSE	1.10E-03	3.85	3.14E-03

Table 23
Summary Component Failure Event Contributions to CCDP (continued)

Equip Failure	Failure Description	Prob.	RAW	F/V
ECB925H	DG BKR 925 FAILS TO CLOSE	1.10E-03	3.85	3.14E-03
PMPTRUCKRUN	FAILURE OF DIESEL PUMPER TRUCK TO RUN	2.40E-02	1.11	2.77E-03
ELOOP1	LOSS OF OFF-SITE LINE 1 (1, 1) POWER	1.00E-02	1.26	2.61E-03
DIV2MUX	DIVISION 2 TRANSMISSION NETWORK FAILURE (EMS)	6.31E-05	41.47	2.55E-03
IRMU12	1ST ESF REMOTE MULTIPLEXING UNIT DIV 2 FAILS	6.31E-05	41.47	2.55E-03
IRMU22	2ND ESF REMOTE MULTIPLEXING UNIT DIV 2 FAILS	6.31E-05	41.47	2.55E-03
VPR007B	DIFF PRESSURE TRANSMITTER P25-DPT-007B FAILS	6.28E-06	405.63	2.54E-03

4.2 CASE 2. CDF – LIMITING UNAVAILABILITY CASE RESULTS

The core damage frequency was calculated for all shutdown initiators including LOCA using assumptions of RHR train A and supports in operation, train B in standby, and Division 3 systems unavailable to address technical specification limits. The resultant CDF is 1.77E-09/year using a truncation of 1E-13, over four orders of magnitude below the CDF.

The top 50 cut sets for Case 2 are included in Appendix D.

The importance of each initiating event was reviewed. Given the LOSP frequency is adjusted to the nominal value, the AC power system is not as important as for the Case 1 CCDP results. The most important initiator is related to faults with starting RHR A during Mode 3 with only one other division available. RHR train A failure during operation is the next most important initiator followed by flow diversions in the RHR system. The overall risk from any of these initiators is very small. The contribution to CDF by initiator is listed in Table 24.

Table 24
Initiating Event Contributions to CDF

Initiator	Description	% Cont
SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	37.8%
SD_LORHRA	SHUTDOWN LOSS OF RHR TRAIN A INITIATOR	31.0%
SD_RHR1	FLOW DIVERSION IN THE RHR SYSTEM	14.4%

Table 24
Initiating Event Contributions to CDF (continued)

Initiator	Description	% Cont
SD_TE	LOSS OF OFFSITE POWER	8.3%
SD_RHR0	PIPE BREAK IN TRAIN A RHR SYSTEM	4.1%
SD_RBCA	LOSS OF RBC TRAIN A	3.1%
SD_LOSWC	LOSS OF SWS TRAIN C	1.2%
SD_LOAC1	LOSS OF DIV I AC BUS	0.1%
SD_LODC1	LOSS OF DIV I DC BUS	0.015%
SD_LOSWA	LOSS OF SWS TRAIN A	ξ
SD_CUW	FLOW DIVERSION IN THE CUW SYSTEM	ξ
SD_S01	LARGE OR MEDIUM LOCA	ξ
SD_S2	SMALL LOCA	ξ
SD_S3	NON-ISOLABLE SMALL LOCA BELOW TAF IN CUW SUCTION	ξ

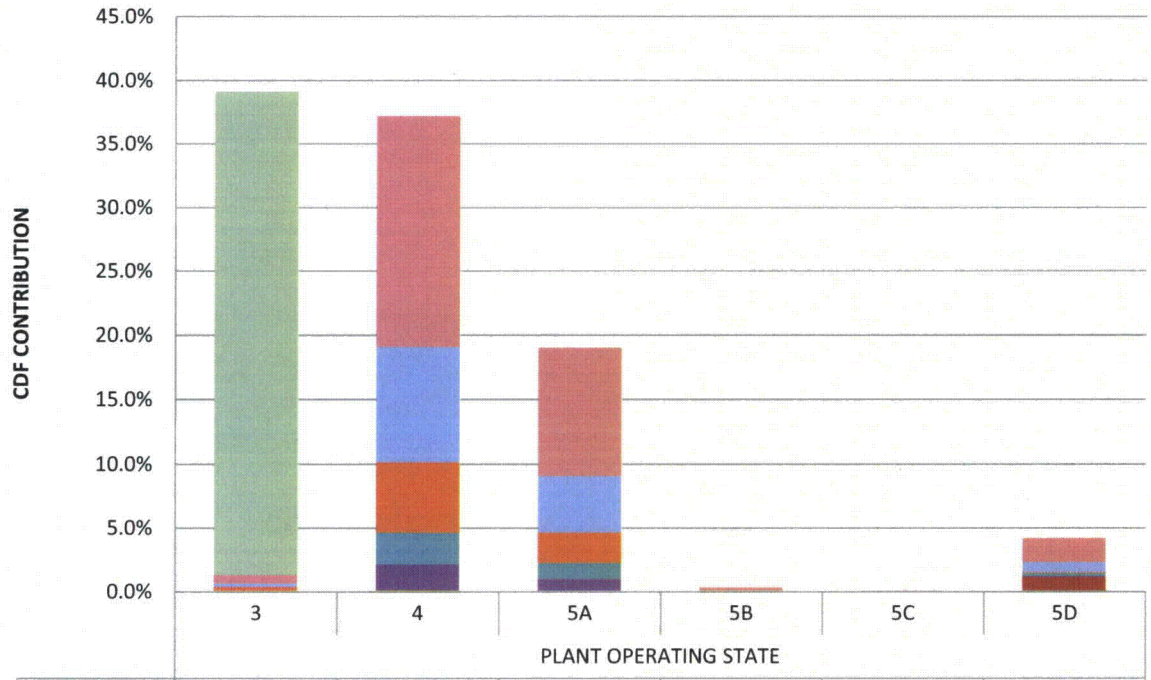
ξ - Falls below truncation

The results of CDF contributions by plant operating state are an indicator that the largest risk is associated with placing the RHR systems in service. The actual duration of POS3 is rather short so that once operating, there is little likelihood of failures occurring in 2 hours. POS4 and 5A importance appear to be related to the duration of the POS given the time to core damage is similar for both POS. Depressurization may be required in POS4, also adding to the importance of that time period. The contribution to CDF by plant operating state is listed in Table 25.

Table 25
POS Contributions to CDF

Plant State	Description	% Cont
POS3 - INITIATION	POS – INITATION OF RHR AT 4 HOURS	37.8%
POS3	POS 3 – 4 HOURS TO 6 HOURS	1.3%
POS4	POS 4 – 6 HOURS TO 2 DAYS	37.2%
POS5A	POS 5A - 2 DAYS TO 3 DAYS	19.0%
POS5B	POS 5B - 3 DAYS TO 8 DAYS	0.3%
POS5C	POS 5C - 8 DAYS TO 10 DAYS	0.1%
POS5D	POS 5D - 10 DAYS TO 33 DAYS	4.2%

Figure 2 combines these results to illustrate the contribution of each initiating event by the plant operating state.



	3	4	5A	5B	5C	5D
SD_LORHRAS	37.8%					
SD_LORHRA	0.6%	18.1%	9.9%	0.3%	0.1%	1.9%
SD_RHR1	0.3%	8.9%	4.4%	0.0%	0.0%	0.8%
SD_TE	0.3%	5.5%	2.4%	0.0%	0.0%	0.0%
SD_RHR0	0.1%	2.5%	1.3%	0.0%	0.0%	0.2%
SD_RBCA	0.0%	2.1%	1.0%	0.0%	0.0%	0.1%
SD_LOAC1	0.0%	0.11%	0.04%	0.0%	0.0%	0.0%
SD_LOSWC	0.0%	0.00%	0.00%	0.0%	0.0%	1.2%
SD_LODC1	0.0%	0.01%	0.00%	0.0%	0.0%	0.0%

Figure 2. Breakdown of Initiating Event Contribution by POS to CDF

The most important operator actions were reviewed. The top importances are proportionally related to the shorter response times available during the early POSs of the outage and to the importance of AC power. The contribution of the top 9 operator actions is listed in Table 26.

Table 26
Operator Action Contributions to CDF

Operator Action	Description	% Cont
OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC	65.2%
OPERL	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER MLOCA PRE-CAVITY FLOOD (POS 3, 4, 5A)	17.4%
OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM	13.8%
CTGMAN	MANUAL INITIATION	4.1%
OPERM5	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC MODE 5	2.4%
OPERLM5	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOCA MODE 5	1.1%
HOOBOPHL	OPERATOR FAILS TO ATTEMPT MANUAL INITIATION OF HPCF AFTER 30 MIN.	1.1%
EDGMAN	MANUAL INITIATION FAILURE	1.0%
CRFLOP	OPERATOR FAILURE TO INCREASE CRD FLOW RATE	0.3%

The component recovery actions are not as important as they were for the Case 1 CCDP analysis, largely because the results are dominated by operator error. The top recovery actions are listed in Table 27.

Table 27
Recovery Event Contributions to CDF

Recovery	Description	%Cont
RECOSP4	FAILURE TO RECOVER OSP DURING POS 4	4.8%
RECEDG4	FAILURE TO RECOVER EDG DURING POS 4	4.7%
RECECCS5A	FAILURE TO RECOVER ECCS DURING POS 5A	2%
RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A	2.0%
RECECCS4	FAILURE TO RECOVER ECCS DURING POS 4	1%
RECOSP3	FAILURE TO RECOVER OSP DURING POS 3	0.3%
RECEDG3	FAILURE TO RECOVER EDG DURING POS 3	0.3%
RECEDG5A	FAILURE TO RECOVER EDG DURING POS 5A	0.2%

Components important to the CDF results were reviewed. The top component importances are related to starting RHR train A and its flow paths. Given that Division 3 is assumed unavailable, its supported components are not listed in below. The Fussell-Vesely importances of the top 50 component failures are listed in Table 28.

Table 28
Summary Component Failure Event Contributions to CDF

Equip Failure	Failure Description	Prob.	RAW	F/V
WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS	2.25E-03	116.0	2.60E-01
HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)	1.00E-02	14.4	1.35E-01
WDBSTRN	STRAINER E11-D001B PLUGGED	6.46E-03	15.1	9.14E-02
ECA023H	CABLE 23 FAILURE	1.16E-04	701.4	8.14E-02
ECA024H	CABLE 24 FAILURE	1.16E-04	701.4	8.14E-02
ECA041H	CABLE 41 FAILURE	1.16E-04	701.4	8.14E-02
ECAXX2H	CABLE FAILURE	1.16E-04	701.4	8.14E-02
ECAXX5H	CABLE FAILURE	1.16E-04	701.4	8.14E-02
F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)	2.08E-03	38.7	7.85E-02
F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)	2.08E-03	38.7	7.85E-02
W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)	2.08E-03	38.7	7.85E-02
ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER	1.00E-03	67.4	6.65E-02
C001AMF	RHR PUMP A FAILS TO START	1.56E-03	38.4	5.84E-02
GTURBINEFS	CTG FAILS TO START AND LOAD	2.43E-02	3.3	5.71E-02
EDGCD	2 D.G.'S CCF	1.94E-03	29.2	5.49E-02
ETR6D1H	TRANSFORMER T6D1 FAILS	6.54E-05	693.2	4.53E-02
ETR6D2H	TRANSFORMER T6D2 FAILURE	6.54E-05	693.2	4.53E-02
GTURBINEFR	CTG FAILS TO RUN	1.93E-02	3.3	4.47E-02
EDGD	DG D FAILS TO RUN	2.48E-02	2.6	3.99E-02

Table 28
Summary Component Failure Event Contributions to CDF (continued)

Equip Failure	Failure Description	Prob.	RAW	F/V
EDGFSDD	DG FAILS TO START	2.21E-02	2.6	3.49E-02
CALN002A	MISCALIBRATION OF FLOW TRANSMITTERS FT008A B C	5.00E-05	656.5	3.28E-02
RHRF001TO	MOV F001 TRANSFERS OPEN (INITIATOR)	3.36E-06	9,530.0	3.20E-02
RHRF008TO	MOV F008 TRANSFERS OPEN (INITIATOR)	3.36E-06	9,530.0	3.20E-02
RHRF019TO	MOV F019 TRANSFERS OPEN (INITIATOR)	3.36E-06	9,530.0	3.20E-02
RHRF021TO	MOV F021 TRANSFERS OPEN (INITIATOR)	3.36E-06	9,530.0	3.20E-02
EDGC	DG C FAILS TO RUN	2.48E-02	2.3	3.20E-02
VPVF012B	PCV P25-F012B FAILS FULL OPEN (NOFO)	4.56E-05	684.8	3.12E-02
EDGFSCD	DG FAILS TO START	2.21E-02	2.3	2.84E-02
WDBRAC	RHR-B PUMP ROOM A.C. UNIT FAILS	2.25E-03	13.2	2.76E-02
F005BMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005B (NCFC)	2.08E-03	13.1	2.51E-02
F021BFO	MINIMUM FLOW VALVE E11-F021B FAILS OPEN (NOFO)	2.08E-03	13.1	2.51E-02
W013BFC	FAILURE OF HX INLET VALVE P21-F013B (NCFC)	2.08E-03	13.1	2.51E-02
HPBRAC	PUMP B ROOM A.C. UNIT FAILS	2.25E-03	11.8	2.44E-02
HMV10BHO	VALVE E22-F010B FAILS TO CLOSE	2.08E-03	11.7	2.22E-02
HMV10BHW	VALVE E22-F010B FAILS TO OPEN	2.08E-03	11.7	2.22E-02
HMV14BHW	VALVE E22-F003B FAILS CLOSED (NCFC-VALVE BODY STUCK)	2.08E-03	11.7	2.22E-02
C001BMF	RHR PUMP B FAILS TO START	1.56E-03	12.1	1.73E-02
HSS000HW	SPARGERS PLUGGED	1.64E-03	11.3	1.69E-02
HPM01BDW	HPCF PUMP B FAILS TO START	1.56E-03	10.9	1.54E-02
WDALUB	RHR PUMP A FAILS TO RUN AFTER FIRST HOUR	1.62E-04	83.2	1.33E-02
ECA022H	CABLE 22 FAILURE	1.16E-04	108.7	1.25E-02

Table 28
Summary Component Failure Event Contributions to CDF (continued)

Equip Failure	Failure Description	Prob.	RAW	F/V
ECAXX1H	CABLE FAILURE	1.16E-04	108.7	1.25E-02
C001BCB	RHR CIRCUIT BREAKER FAILS TO CLOSE	1.10E-03	11.4	1.15E-02
DLS001A	VALVE E11-F001A LIMIT SWITCH FAILS	6.67E-03	2.4	9.41E-03
DLS008A	VALVE E11-F008A LIMIT SWITCH FAILS	6.67E-03	2.4	9.41E-03
WDAMBC	PUMP A MOTOR BEARING COOLER FAILS	1.14E-04	79.9	9.00E-03
WDAMSC	PUMP A MECH. SEALER COOLER FAILS	1.14E-04	79.9	9.00E-03
HFE_RP6	TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 6	1.00E-06	7,740.0	7.74E-03
HFE_RP9	TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 9	1.00E-06	7,740.0	7.74E-03
EDGCDE	3 D.G.'S CCF	3.81E-04	18.7	6.73E-03

4.3 CASE 3. CDF – REALISTIC UNAVAILABILITY CASE RESULTS

The core damage frequency was calculated for all shutdown initiators including LOCA for a more realistic CDF calculation, using assumptions of train A RHR and supports in operation, train B and C in standby with nominal unavailabilities. Unavailability is not restricted to any particular plant operating state for this case. The resultant CDF is 4.21E-10/year using a truncation of 1E-14, over four orders of magnitude below the CDF.

A review of the cutsets indicates that there is a large contribution (>50%) from LOSP during the mission time. The estimates of the LOSP probability during the mission time appear to be related to the reliability assurance program (RAP) reliability goal presented in Table 40. With regard to actual experiential reliability, this number appears to be conservative. Even with this conservatism the overall CDF indicates very low risk during shutdown. These values are not adjusted from the original documentation, and the rest of this discussion assumes that these values are accurate. The top 50 cutsets for Case 3 are included in Appendix E.

The importance of each initiating event was reviewed. Like Case 2, the most important initiator is related to faults with starting RHR A during Mode 3 except that the contributions are lower than Case 3 due to availability of Division 3. Loss of offsite power is the next important initiator. Its importance is directly tied to POS4 duration, available recovery time and need for RPV pressure control. With all onsite power failed, a delay in depressurization precludes the use of ACIWA. Loss of RHR train A during operation is the next most important initiator followed by loss of RBC train A. Like the LOSP event, their importance is tied to POS4 duration, available recovery time and need for RPV pressure control. The overall risk from any of these initiators is very small. The contribution to CDF by initiator is listed in Table 29.

Table 29
Initiating Event Contributions to CDF

Initiator	Description	% Cont
SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	50.6%
SD_TE	LOSS OF OFFSITE POWER	35.1%
SD_LORHRA	SHUTDOWN LOSS OF RHR TRAIN A INITIATOR	5.3%
SD_LOSWC	LOSS OF SWS TRAIN C	5.2%
SD_RBCA	LOSS OF RBC TRAIN A	2.8%
SD_RHR1	FLOW DIVERSION IN THE RHR SYSTEM	0.8%
SD_RHR0	PIPE BREAK IN TRAIN A RHR SYSTEM	0.2%
SD_LOSWA	LOSS OF SWS TRAIN A	0.2%
SD_LOAC1	LOSS OF DIV I AC BUS	ξ
SD_LODC1	LOSS OF DIV I DC BUS	ξ
SD_CUW	FLOW DIVERSION IN THE CUW SYSTEM	ξ
SD_S01	LARGE OR MEDIUM LOCA	ξ
SD_S2	SMALL LOCA	ξ
SD_S3	NON-ISOLABLE SMALL LOCA BELOW TAF IN CUW SUCTION	ξ

ξ - Falls below truncation

The results of CDF contributions by plant operating state are an indicator that the largest risk is associated with placing the RHR systems in service. The actual duration of POS3 is rather short so that once operating, there is little likelihood of failures occurring in 2 hours. The potential need for pressure control in POS4, adds to the importance of that time period. POS4 and 5A importance is also related to the duration of the POS given the time to core damage is similar for both POSs. The contribution to CDF by POS is listed in Table 30.

Table 30
POS Contributions to CDF

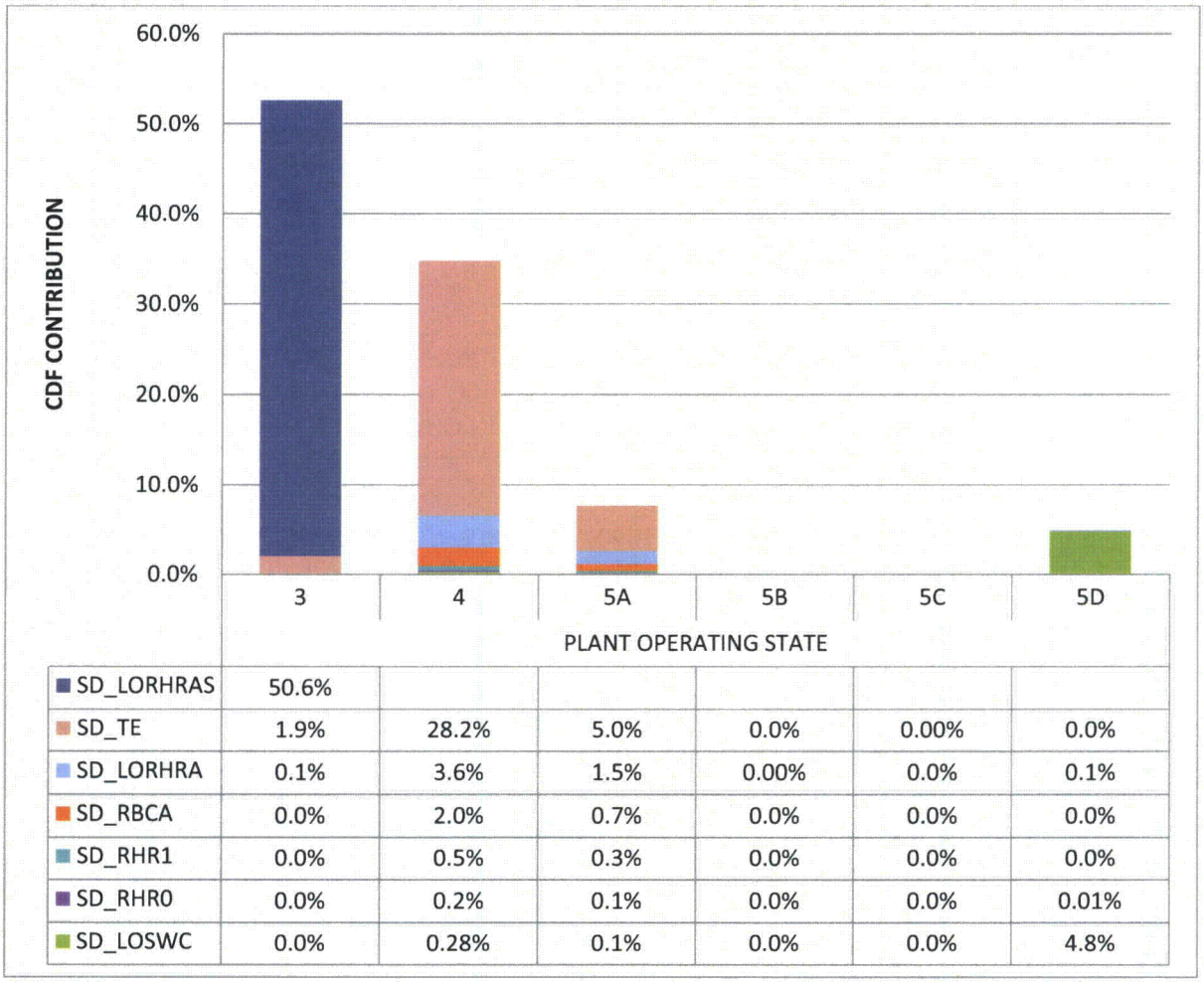
Plant State	Description	% Cont
POS3 - INITIATION	POS – INITATION OF RHR AT 4 HOURS	50.6%
POS3	POS 3 – 4 HOURS TO 6 HOURS	2.0%
POS4	POS 4 – 6 HOURS TO 2 DAYS	34.8%

Table 30
POS Contributions to CDF (continued)

Plant State	Description	% Cont
POS5A	POS 5A - 2 DAYS TO 3 DAYS	7.7%
POS5B	POS 5B - 3 DAYS TO 8 DAYS	ξ
POS5C	POS 5C - 8 DAYS TO 10 DAYS	ξ
POS5D	POS 5D - 10 DAYS TO 33 DAYS	4.9%

ξ - Falls below truncation

Figure 3 combines these results to illustrate the contribution of each initiating event by the plant operating state.



	3	4	5A	5B	5C	5D
SD_LORHRAS	50.6%					
SD_TE	1.9%	28.2%	5.0%	0.0%	0.00%	0.0%
SD_LORHRA	0.1%	3.6%	1.5%	0.00%	0.0%	0.1%
SD_RBCA	0.0%	2.0%	0.7%	0.0%	0.0%	0.0%
SD_RHR1	0.0%	0.5%	0.3%	0.0%	0.0%	0.0%
SD_RHR0	0.0%	0.2%	0.1%	0.0%	0.0%	0.01%
SD_LOSWC	0.0%	0.28%	0.1%	0.0%	0.0%	4.8%

Figure 3. Breakdown of Initiating Event Contribution by POS to CDF

The most important operator actions were reviewed. The top importance is related to loss of offsite power events, both as and initiator and during the mission time, resulting in a greater need for AC independent water addition. The total contribution of LOSP as an initiator and during the mission exceeds 76% of the CDF contribution. The contribution of the top 10 operator actions is listed in Table 31.

Table 31
Operator Action Contributions to CDF

Operator Action	Description	% Cont
OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM	87.1%
EDGMAN	MANUAL INITIATION FAILURE	21.1%
CTGMAN	MANUAL INITIATION	15.9%
OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC	9.8%
CRFLOP	OPERATOR FAILURE TO INCREASE CRD FLOW RATE	2.0%
OPERL	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER MLOCA PRE-CAVITY FLOOD (POS 3 4 5A)	1.0%
HOOBOPHL	OPERATOR FAILS TO ATTEMPT MANUAL INITIATION OF HPCF AFTER 30 MIN.	0.70%
WOPERR	OPERATOR FAILS TO PERFORM INDICATED ACTION TO START STANDBY SWS TRAINS	0.26%
EHU69C	OPERATOR FAILS TO TRANSFER POWER	0.16%
OPERM5	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC MODE 5	0.11%

The component recovery actions are similar to the operator action importances and are ranked by the importance of AC power and the time available during each POS. The top recovery actions are listed in Table 32.

Table 32
Recovery Event Contributions to CDF

Recovery	Description	%Cont
RECOSP4	FAILURE TO RECOVER OSP DURING POS 4	28.1%
RECEDG4	FAILURE TO RECOVER EDG DURING POS 4	27.6%
RECECCS5A	FAILURE TO RECOVER ECCS DURING POS 5A	1.8%

Table 32
Recovery Event Contributions to CDF (continued)

Recovery	Description	%Cont
RECECCS4	FAILURE TO RECOVER ECCS DURING POS 4	5.0%
RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A	5.0%
RECEDG5A	FAILURE TO RECOVER EDG DURING POS 5A	4.8%
RECOSP3	FAILURE TO RECOVER OSP DURING POS 3	1.9%
RECEDG3	FAILURE TO RECOVER EDG DURING POS 3	1.9%

Components important to the CDF results were reviewed. The top components importances are related to AC power reliability. The unavailability of the A RHR train is directly related to the failure to placing RHR train A in service and directly impacts LPCF A. The combination of event OPERATOR and WDAMAINT_SD may be somewhat conservative, given the operators would know that the train is unavailable prior to condenser cooling mode. Regardless, the overall calculated CDF is very low and no adjustment is made. The Fussell-Vesely importances of the top 50 component failures are listed in Table 33.

Table 33
Summary Component Failure Event Contributions to CDF

Equip Failure	Failure Description	Prob.	RAW	F/V
ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER	1.00E-03	497.4	4.97E-01
GTURBINEFS	CTG FAILS TO START AND LOAD	2.43E-02	15.4	3.58E-01
WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE	1.00E-01	3.7	3.04E-01
GTURBINEFR	CTG FAILS TO RUN	1.93E-02	15.3	2.81E-01
EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE	2.50E-01	1.8	2.62E-01
EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE	2.50E-01	1.8	2.51E-01
EDGE	DG E FAILS TO RUN	2.48E-02	6.5	1.40E-01
EDGDE	2 D.G.'S CCF	1.94E-03	72.3	1.39E-01
EDGD	DG D FAILS TO RUN	2.48E-02	6.4	1.36E-01
EDGFSED	DG FAILS TO START	2.21E-02	6.5	1.24E-01

Table 33
Summary Component Failure Event Contributions to CDF (continued)

Equip Failure	Failure Description	Prob	RAW	F/V
EDGDMAINT	EDG D UNAVAILABLE DUE TO MAINTENANCE	2.50E-01	1.4	1.22E-01
EDGFSDD	DG FAILS TO START	2.21E-02	6.3	1.20E-01
EDGCDE	3 D.G.'S CCF	3.81E-04	212.5	8.06E-02
EDGC	DG C FAILS TO RUN	2.48E-02	3.9	7.24E-02
EDGFSCD	DG FAILS TO START	2.21E-02	3.8	6.41E-02
EDGCD	2 D.G.'S CCF	1.94E-03	32.6	6.13E-02
EDGCE	2 D.G.'S CCF	1.94E-03	31.4	5.90E-02
HPBMAINT_SD	HPCF-B UNAVAIL DUE TO MAINT	1.00E-01	1.5	5.14E-02
WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS	2.25E-03	23.5	5.08E-02
WPMSC1FM_SD	STANDBY PUMP IN MAINTENANCE	1.00E-01	1.5	4.94E-02
HPCMAINT_SD	HPCF-C UNAVAIL DUE TO MAINT	1.00E-01	1.4	4.05E-02
ELOOP1	LOSS OF OFF-SITE LINE 1 (1, 1) POWER	1.00E-02	4.9	3.94E-02
CTGMANSW	CTG MANUAL DISCONNECT SWITCH OPEN	3.00E-03	13.2	3.68E-02
WDBMAINT_SD	RHR LOOP B UNAVAILABLE DUE TO MAINTENANCE	1.00E-01	1.3	3.67E-02
ELOOP2	LOSS OF OFF-SITE LINE 2 (2, 2)	1.00E-02	4.6	3.63E-02
DLS001A	VALVE E11-F001A LIMIT SWITCH FAILS	6.67E-03	6.1	3.45E-02
DLS008A	VALVE E11-F008A LIMIT SWITCH FAILS	6.67E-03	6.1	3.45E-02
CALN002A	MISCALIBRATION OF FLOW TRANSMITTERS FT008A B C	5.00E-05	612.9	3.06E-02
WDCMAINT_SD	RHR LOOP C UNAVAILABLE DUE TO MAINTENANCE	1.00E-01	1.3	2.74E-02
WPMSC1CH	PUMP FAILS	1.50E-04	178.7	2.67E-02
WFLD1CH	STRAINER P41-D001C PLUGS	1.42E-04	177.5	2.51E-02
GTURBINEFLR	CTG FAILS TO LOAD AND RUN FOR FIRST HOUR	1.87E-03	12.7	2.19E-02

Table 33
Summary Component Failure Event Contributions to CDF (continued)

Equip Failure	Failure Description	Prob	RAW	F/V
F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)	2.08E-03	9.5	1.78E-02
F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)	2.08E-03	9.5	1.78E-02
W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)	2.08E-03	9.5	1.78E-02
HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)	1.00E-02	2.4	1.37E-02
ECA022H	CABLE 22 FAILURE	1.16E-04	115.1	1.32E-02
ECAXX1H	CABLE FAILURE	1.16E-04	115.1	1.32E-02
HCMAER1	TEST VALVE E22-F005C MISPOSITIONED (CLOSED)	1.00E-02	2.3	1.29E-02
C001AMF	RHR PUMP A FAILS TO START	1.56E-03	9.0	1.25E-02
EDGE1	DG E FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	5.1	1.19E-02
EBY101HN	BATTERY FAILURE	5.28E-04	23.5	1.19E-02
EDGCDEN	3 D.G.'S CCF	3.81E-04	31.9	1.18E-02
DLSPMPRUN	FAILURE OF DIESEL FIRE PUMP TO RUN AFTER 1 HOUR	1.28E-02	1.9	1.14E-02
EDGD1	DG D FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	4.8	1.10E-02
CCFTLU	CCF SYSTEM LOGIC UNIT FAILS	3.72E-06	2,680.0	9.96E-03
CMAINT	CONDENSATE UNAVAILABLE DUE TO MAINTENANCE	1.00E-01	1.1	9.63E-03
F001AFO	PUMP SUCTION VALVE E11-F001A FAILS OPEN (NOFO)	2.08E-03	5.5	9.33E-03
F010AFC	VALVE E11-F010A FAILS CLOSED (NCFC)	2.08E-03	5.5	9.33E-03
F011AFC	VALVE E11-F011A FAILS CLOSED (NCFC)	2.08E-03	5.5	9.33E-03

4.4 CASE 3A. CDF SENSITIVITY CASE RESULTS

As a sensitivity study, the core damage frequency was calculated for all shutdown initiators including LOCA for the realistic CDF calculation, using assumptions of train A RHR and supports in operation, train B and C in standby with nominal unavailabilities. Unavailability of ECCS equipment in the RHR, HPCF and EDG systems is restricted to not occur before refueling cavity flooding. This is more typical of traditional plant shutdown operations. All other unavailability events are not restricted to occur in any particular plant operating state for this case. The resultant CDF is 6.92E-11/year using a truncation of 1E-14, near four orders of magnitude below the CDF. This CDF is an 83% reduction over the Case 3 realistic analysis with random frontline ECCS unavailability allowed before cavity flooding.

By restricting the ECCS maintenance away from the most important POS identified in Case 3, the contribution of mission time LOSP is greatly reduced. The resultant largest contributor to CDF is LOSP with onsite power failures and operator failure to initiate ACIWA during Modes 3 and 4. The increase of the Loss of SWS train C initiator is related to loss of offsite power during the mission time with failures or unavailability of emergency power. The loss of SWC is dominated by POS 5D, the longest period, resulting in the highest frequency. The importance of each initiating event was reviewed. The contribution to CDF by initiator is listed in Table 34.

Table 34
Initiating Event Contributions to CDF

Initiator	Description	% Cont
SD_TE	LOSS OF OFFSITE POWER	47.2%
SD_LOSWC	LOSS OF SWS TRAIN C	29.2%
SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	17.8%
SD_LORHRA	SHUTDOWN LOSS OF RHR TRAIN A INITIATOR	3.6%
SD_RBCA	LOSS OF RBC TRAIN A	2.0%
SD_RHR1	FLOW DIVERSION IN THE RHR SYSTEM	0.1%
SD_RHR0	PIPE BREAK IN TRAIN A RHR SYSTEM	0.07%
SD_LOSWA	LOSS OF SWS TRAIN A	ξ
SD_LOAC1	LOSS OF DIV I AC BUS	ξ
SD_LODC1	LOSS OF DIV I DC BUS	ξ
SD_CUW	FLOW DIVERSION IN THE CUW SYSTEM	ξ
SD_S01	LARGE OR MEDIUM LOCA	ξ
SD_S2	SMALL LOCA	ξ
SD_S3	NON-ISOLABLE SMALL LOCA BELOW TAF IN CUW SUCTION	ξ

ξ - Falls below truncation

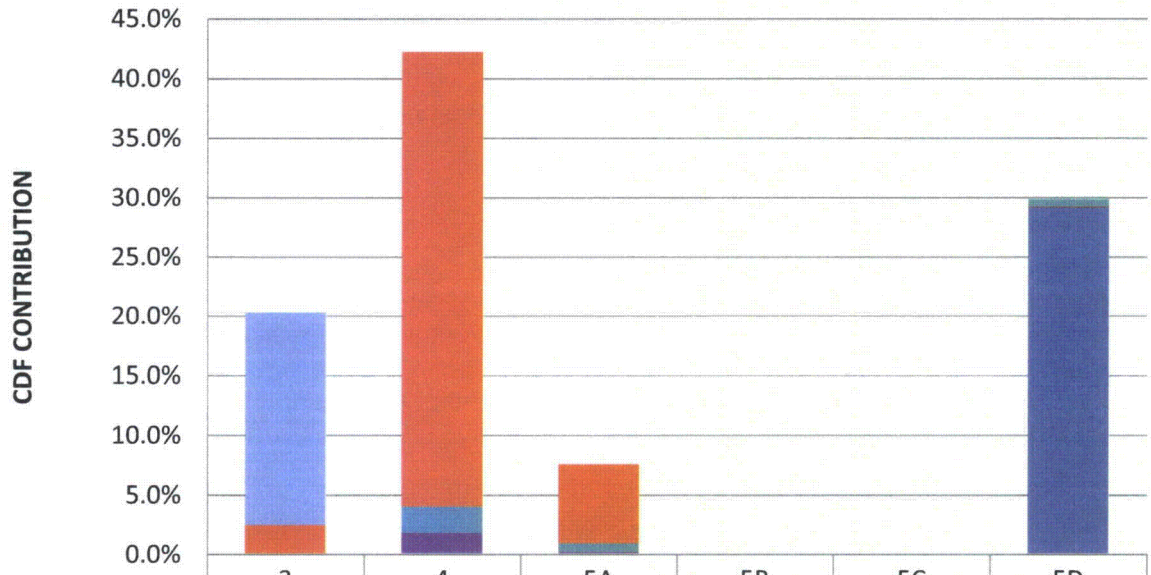
The results of CDF contributions by plant operating state are an indicator that the duration of POS 4, the higher decay heat levels with lower water inventory, and the need for pressure control dominate the overall outage risk, even with front line ECCS systems available during mode 4. Because the overall risk contribution in Modes 3 and 4 is lower (as compared to Case 3) the percent contribution from POS 5D is a higher contribution of the overall risk, but the CDF is not larger. The risk contribution during POS 5D is generally due to the initiating event frequency being directly proportional to the length of the state. The contribution to CDF by plant operating state is listed in Table 35.

Table 35
POS Contributions to CDF

Plant State	Description	% Cont
POS3 - INITIATION	POS – INITATION OF RHR AT 4 HOURS	17.8%
POS3	POS 3 – 4 HOURS TO 6 HOURS	2.5%
POS4	POS 4 – 6 HOURS TO 2 DAYS	42.2%
POS5A	POS 5A - 2 DAYS TO 3 DAYS	7.6%
POS5B	POS 5B - 3 DAYS TO 8 DAYS	ξ
POS5C	POS 5C - 8 DAYS TO 10 DAYS	ξ
POS5D	POS 5D - 10 DAYS TO 33 DAYS	29.8%

ξ - Falls below truncation

Figure 4 combines these results to illustrate the contribution of each initiating event by the plant operating state.



	3	4	5A	5B	5C	5D
SD_LORHRAS	17.8%					
SD_TE	2.5%	38.2%	6.6%	0.0%	0.0%	0.0%
SD_LORHRA	0.1%	2.2%	0.7%	0.0%	0.0%	0.6%
SD_RBCA	0.0%	1.8%	0.3%	0.0%	0.0%	0.0%
SD_RHR1	0.0%	0.06%	0.00%	0.00%	0.00%	0.00%
SD_RHR0	0.0%	0.02%	0.00%	0.00%	0.00%	0.05%
SD_LOSWC	0.0%	0.00%	0.00%	0.00%	0.00%	29.20%

Figure 4. Breakdown of Initiating Event Contribution by POS to CDF

4.5 MINIMUM SETS OF SYSTEMS ANALYSIS

A separate study of Minimum Sets was performed in order to validate the DCD conclusions in sections 19Q.7 and Tables 19Q-3, 4, and 5. The purpose of the minimum sets analysis is to demonstrate that the core damage criteria can be maintained with many systems unavailable and that the level of redundancy results in low risk at shutdown.

The assumptions of the minimum sets analysis is as follows:

- Division 3 equipment is unavailable
- The initiating events are for loss of RHR (Loss or RHRA, Loss of SWA, Loss of SWC, and LOSP) and are conditional events (value of 1.0) for the calculation of CCDP,

- Systems or trains that are not part of a selected minimum set are those that are not credited and are given unavailability of 1.0.
- Systems or trains that are part of a minimum set assume a maintenance unavailability of zero and only unreliability is quantified

The analysis was performed by using the model settings used in the Case 1 analysis of the CCDP of the linked fault tree as documented in Tables 12 and 13 for "CCDP". The minimum sets analysis included the following changes in order to use the linked fault tree model

- Maintenance event, MCMAINT, was set to false rather than using the nominal value to comply with the rules of setting systems availability. If the main condenser was to be failed, another event was used as a surrogate.
- Only the sequences that include all the system faults were quantified. This was done by setting operator action basic events, OPERATOR and OPERM5 to false because they result in only one minimum set of HPCFB and LPCF B for the assumptions.
- For the Loss of SW train C initiating event, the A train of RHR is not failed. To meet the minimum set parameters, basic event WDALUB is set to true to fail RHR train A.

The cases that were evaluated are listed in Tables 36, 37, and 38.

Table 36
Minimum Sets of Systems Evaluated for Modes 3 and 4

Run	RHRB	Main Condenser	CUW	HPCFB	CRD	ADS	RHRB (CF)	Condensate	Fire Water
MinSet34_1	*	.T.	.T.	.T.	*	*	*	.T.	*
MinSet34_2 (Note 1)	*	.T.	*	.T.	.T.	*	*	.T.	*
MinSet34_3	*	.T.	.T.	.T.	.T.	*	*	*	*
MinSet34_4	*	*	.T.	.T.	.T.	*	*	.T.	*
MinSet34_5	*	.T.	.T.	*	*	*	.T.	*	.T.

1. A loss of SW train A in conjunction with this minimum set does not meet the conditional core damage criteria of 1E-4 because the initiator fails the minimum set system of CUW.

"*" indicates evaluated as a minimum set.
".T." indicates that a non-minimum set system is set to unavailable (true)

Table 37
Minimum Sets of Systems Evaluated for Modes 5 (unflooded)

Run	RHRB	HPCFB	CRD	RHRB(CF)	Condensate	Fire Water
MinSet5a_1	*	.T.	*	*	*	*
MinSet5a_2	*	.T.	.T.	.T.	*	*
MinSet5a_3	*	*	*	.T.	*	.T.

"*" indicates evaluated as a minimum set.
".T." indicates that a non-minimum set system is set to unavailable (true)

Table 38
Minimum Sets of Systems Evaluated for Modes 5 (flooded)

Run	RHRB	FPC	CUW	HPCFB	CRD	RHRB(CF)	Condensate	Fire Water
MinSet5BCD_1	*	.T.	.T.	.T.	.T.	.T.	*	*
MinSet5BCD_2	*	.T.	.T.	.T.	*	*	.T.	.T.
MinSet5BCD_3	*	.T.	.T.	*	*	.T.	*	.T.
MinSet5BCD_4	*	.T.	.T.	.T.	.T.	*	*	*
MinSet5BCD_5‡	.T.	.T.	*	.T.	*	.T.	*	*
MinSet5BCD_6‡	.T.	.T.	*	.T.	.T.	.T.	*	*
MinSet5BCD_7‡	.T.	*	.T.	.T.	*	.T.	*	.T.
MinSet5BCD_8†	.T.	*	.T.	.T.	.T.	.T.	*	*
MinSet5BCD_9†	.T.	*	.T.	.T.	*	.T.	.T.	*

"*" indicates evaluated as a minimum set.
".T." indicates that a non-minimum set system is set to unavailable (true)
‡ After 8 days CUW can be credited
† After 10 days FP cooling can be credited

In order to fail the non-minimum set systems/trains the following surrogate events were used in quantification flag files and set to true:

System	Surrogate Failure Event
Condensate	CONOP
CRD	CRDCST
CUW	RWCUOP
Fire Water	OP-ACIWA
FPC	FP001A
HPCFB	HPM01BDW
Main Condenser	MCOP
RHRB	F009BFC
RHRB (CF)	F001BFC

All of the minimum sets that were evaluated resulted in CCDPs lower than the target goal of 1E-4 with the exception of analysis MinSet34_2 from Table 36. For the case of MinSet34_2, the conditional Loss of SW A initiating event (probability of 1.0) also fails CUW due the requirement of two cooling trains (A and B) for CUW success. Therefore this is not a valid minimum set under the assumption that the conditional loss of SWS train A requires that both the running and standby pump fail. However, in the DCD discussion for this initiator, the analysis credits the standby pump so that RHR train A would remain available, and the minimum set would be valid. Table 39 summarizes the Minimum Sets analysis results. It should be noted that these results are not additive from top to bottom as they represent overlapping configurations.

Table 39
Summary of Minimum Sets Analysis CCDPs

Run	Individual Initiating Events CCDP				Initiators
	LORHRA	LOSWA	LOSWC	LOSP	Total
MinSet34_1	1.96E-07	1.96E-07	2.05E-07	4.33E-07	1.03E-06
MinSet34_2	2.09E-05	*4.15E-04*	2.14E-05	4.68E-07	4.27E-05 ‡
MinSet34_3	8.65E-06	8.65E-06	9.17E-06	4.68E-07	2.69E-05
MinSet34_4	1.07E-05	1.07E-05	1.13E-05	5.17E-07	3.32E-05
MinSet34_5	7.75E-07	7.75E-07	8.01E-07	2.20E-05	2.43E-05
MinSet5a_1	6.88E-08	7.15E-08	7.13E-08	1.42E-07	3.54E-07
MinSet5a_2	1.45E-05	1.48E-05	3.13E-05	2.34E-07	6.09E-05
MinSet5a_3	2.78E-07	4.68E-07	2.87E-07	7.34E-06	8.38E-06
MinSet5BCD_1	9.82E-10	9.82E-10	6.22E-05	ξ	6.22E-05
MinSet5BCD_2	ξ	ξ	8.17E-06	ξ	8.17E-06
MinSet5BCD_3	ξ	ξ	5.88E-07	ξ	5.88E-07
MinSet5BCD_4	ξ	ξ	6.17E-06	ξ	6.17E-06
MinSet5BCD_5	ξ	ξ	1.47E-06	ξ	1.47E-06
MinSet5BCD_6	ξ	3.70E-10	1.22E-05	ξ	1.22E-05
MinSet5BCD_7	ξ	ξ	4.65E-06	ξ	4.65E-06
MinSet5BCD_8	ξ	ξ	1.11E-05	ξ	1.11E-05
MinSet5BCD_9	ξ	ξ	1.44E-06	ξ	1.44E-06

ξ - Falls below truncation of 1E-10
‡ - Loss of SWA case precludes this case as being a valid Minimum Set with both SWS pumps assumed failed. If the conditional loss of SWS A involves only the running pump, as described in the DCD, then this is a valid minimum set.

4.6 RELIABILITY GOALS (INPUT TO RAP)

Reliability goals were set in the DCD as input for the RAP. These values are based on quantification of the system train functional tops. The following assumed system unavailabilities were validated against the updated model by system quantifications. The original SSAR values were validated as appropriate indicators and are retained as important in minimizing shutdown

risk to be included in the ABWR Reliability Assurance Program. Table 40 summarizes the reliability goals to support input to RAP.

Table 40
Reliability Goals for Input to RAP

System	Unavailability (Per Demand)	Notes
RHR (SDC)	7E-2 per division	Evaluated system train tops RHRSDB; failure probability of 6.58E-2 supports goal.
RHR (LPFL)	4E-2 per division	Evaluated system train tops WDCSB; failure probability of 1.91E-2 supports goal.
HPCF	5E-2	Evaluated system train tops HPCFB; failure probability of 2.23E-2 supports goal.
CRD	5E-4 per system	Evaluated system functional top CRDU; failure probability of 4.46E-4 supports goal.
CTG	5E-2 per system	Evaluated system top CTGF; failure probability of 4.96E-2 supports goal.
EDG	4E-3 of all EDGs	Evaluated SBO top gate DG3FAIL; resultant failure probability of 2.43E-3 supports goal.
Offsite Power	1E-3 of both offsite feeds	The unavailability represents a mission time loss of power. This failure is modeled by event ELOOP12 with value 1E-3 and supports the goal.
ADS	6E-6 per system	Evaluated functional top RXDEPRES; failure probability of 4.34E-5 is dominated by a common cause failure event. This event includes conservatisms such that the goal is assumed to be realistic.
DC Power	7E-6 per division	Evaluated system train top EDC11; failure probability of 6.78E-6 supports goal.

In the above table, system maintenance is not included and support system failures are excluded in the system reliability evaluation.

5 REFERENCES

1. ABWR Standard Safety Analysis Report, Chapter 19D, Probabilistic Evaluations, Amendment 31, Rev. 5, General Electric Company, 23A6100.

2. ABWR Standard Safety Analysis Report, Chapter 19L, ABWR Shutdown Risk Evaluation, Amendment 31, Rev. 5, General Electric Company, 23A6100.

3. ABWR Standard Safety Analysis Report, Chapter 19Q, ABWR Shutdown Risk Assessment - Amendment 31, Rev. 1, General Electric Company, 23A6100.

4. RSC-CALKNX-2010-0501, Update of the Toshiba DCD PRA MOR Component and Initiating Event Data to Support the Toshiba DCDRA, July 2010

5. Eide, S.A., et al., Reevaluation of Station Blackout Risk at Nuclear Power Plants Analysis of Loss of Offsite Power Events: 1986-2004, USNRC, NUREG/CR-6890, December 2005

6. RSC-CALKNX-2009-0606, Impact on Core Damage Risk During Shutdown of Sharing a Single ACIWA System Between Units 3 and 4, STP 3 & 4, June 2009

7. ABWR Updated Shutdown Model Event Tree Files:

Files	Date	
Loss_1_RHR_Mode_3_Start_4_Hours.eta	7/17/2010	12:04 AM
Loss_1_RHR_Mode_4_6_Hours.eta	6/2/2010	2:44 PM
Loss_1_RHR_Mode_5_2_TO_3_DAYS.eta	7/17/2010	12:01 AM
Loss_1_RHR_Mode_5_3_TO_8_DAYS.eta	7/17/2010	12:00 AM
Loss_1_RHR_Mode_5_8_TO_10_DAYS.eta	7/16/2010	11:59 PM
Loss_1_RHR_Mode_5_GREATER_10_DAYS.eta	7/16/2010	11:58 PM
Loss_DIV_A_SWS_MODE_3_START_4_HOURS.eta	12/11/2008	11:09 AM
Loss_DIV_A_SWS_MODE_4_6_HOURS_2_DAYS.eta	12/11/2008	11:09 AM
Loss_DIV_A_SWS_MODE_5_2_TO_3_DAYS.eta	12/11/2008	11:09 AM
Loss_DIV_A_SWS_MODE_5_3_TO_33_DAYS.eta	12/11/2008	11:10 AM
Loss_DIV_C_SWS_MODE_3_START_4_HOURS.eta	12/11/2008	11:10 AM
Loss_DIV_C_SWS_MODE_4_6_HOURS_2_DAYS.eta	12/11/2008	11:10 AM
Loss_DIV_C_SWS_MODE_5_2_TO_3_DAYS.eta	12/11/2008	11:11 AM
Loss_DIV_C_SWS_MODE_5_3_TO_8_DAYS.eta	12/11/2008	11:11 AM
Loss_DIV_C_SWS_MODE_5_8_TO_10_DAYS.eta	12/11/2008	11:11 AM
Loss_DIV_C_SWS_Mode_5_GREATER_10_DAYS.eta	12/11/2008	11:12 AM
Loss_OFFSITE_POWER_Mode_3_Start_4_Hours.eta	12/11/2008	11:12 AM
Loss_OFFSITE_POWER_Mode_4_6_Hours_TO_2_DAYS.eta	12/11/2008	11:12 AM
Loss_OFFSITE_POWER_Mode_5_2_to_33_days.eta	12/11/2008	11:12 AM
MLOCA_Mode_3 or 4.eta	7/9/2010	6:04 PM
SLOCA_Mode_3 or 4.eta	7/9/2010	6:05 PM
LOCA_Mode_5.eta	7/9/2010	6:06 PM

8. ABWR Updated Shutdown Analysis - Model and Results Files:

Files	Date
Model Files:	
ABWR_SD.caf	08/02/2010 08:31 PM
ABWR_SD.RR	07/24/2010 01:00 AM
Quantification Files:	
ABWRSD.qnt	08/02/2010 10:10 AM
ABWR_SD_CCDP.FLG	07/18/2010 01:23 AM
ABWR_SD_LIMITING.FLG	07/17/2010 11:29 PM
SEN.FLG	07/20/2010 11:05 PM
ABWR_SD.RECV	07/21/2010 09:13 AM
INIT-POS-TAG.RECV	07/16/2010 05:43 PM
Results Files from Quantification:	
CCDP.CUT	07/23/2010 12:44 PM
CDFLIMITING.CUT	07/24/2010 01:01 AM
CDFREALIST.CUT	08/10/2010 10:10 AM
CDFSENS.CUT	08/10/2010 10:10 AM

9. ABWR Updated Shutdown Analysis - Quantification and Results Files for Minimum Sets Analysis:

Files	Date
PRAQuant Files:	
Minset losp.qnt	07/23/2010 1:29 PM
Minset rhr.qnt	07/23/2010 1:29 PM
Minset swa.qnt	07/23/2010 1:27 PM
Minset swc.qnt	07/23/2010 1:26 PM
Master Flag Files:	
MinSet_CCDP_lorhr.FLG	07/20/2010 10:27 PM
MinSet_CCDP_losp.FLG	07/20/2010 10:41 PM
MinSet_CCDP_loswa.FLG	07/20/2010 10:28 PM
MinSet_CCDP_loswc.FLG	07/21/2010 13:28 PM
Sequence Flag Files:	
MinSet34_1.flg	07/20/2010 04:15 PM
MinSet34_2.flg	07/20/2010 04:17 PM
MinSet34_3.flg	07/20/2010 04:18 PM
MinSet34_4.flg	07/20/2010 04:18 PM
MinSet34_5.flg	07/20/2010 04:19 PM
MinSet5A_1.flg	07/20/2010 05:50 PM
MinSet5A_2.flg	07/20/2010 05:50 PM
MinSet5A_3.flg	07/20/2010 05:50 PM
MinSet5BCD_1.flg	07/20/2010 05:49 PM
MinSet5BCD_2.flg	07/20/2010 05:49 PM
MinSet5BCD_3.flg	07/20/2010 05:49 PM
MinSet5BCD_4.flg	07/20/2010 05:49 PM

MinSet5BCD_5.flg	07/20/2010	10:18 PM
MinSet5BCD_6.flg	07/20/2010	10:19 PM
MinSet5BCD_7.flg	07/20/2010	10:18 PM
MinSet5BCD_8.flg	07/20/2010	10:18 PM
MinSet5BCD_9.flg	07/20/2010	10:18 PM

Multi- Module Cutsets Files: (preferred access is through PRAQUANT table)

Minset_LOSP.cut	07/23/2010	1:29 PM
Minset_RHR.cut	07/23/2010	1:28 PM
Minset_SWA.cut	07/23/2010	1:26 PM
Minset_SWC.cut	07/23/2010	1:26 PM

10. ABWR Updated Shutdown Analysis - Other Analysis Files:

Files	Date	
ABWR Shutdown Analysis Inputs and Results.xlsx	8/03/2010	9:25 AM

Review and Quality Page

Reviewer Directions:

Provide detailed technical or global editorial comments here. Individual editorial or illustrative comments may be electronically provided (tracking) or attached to this review sheet.

Resolution Process:

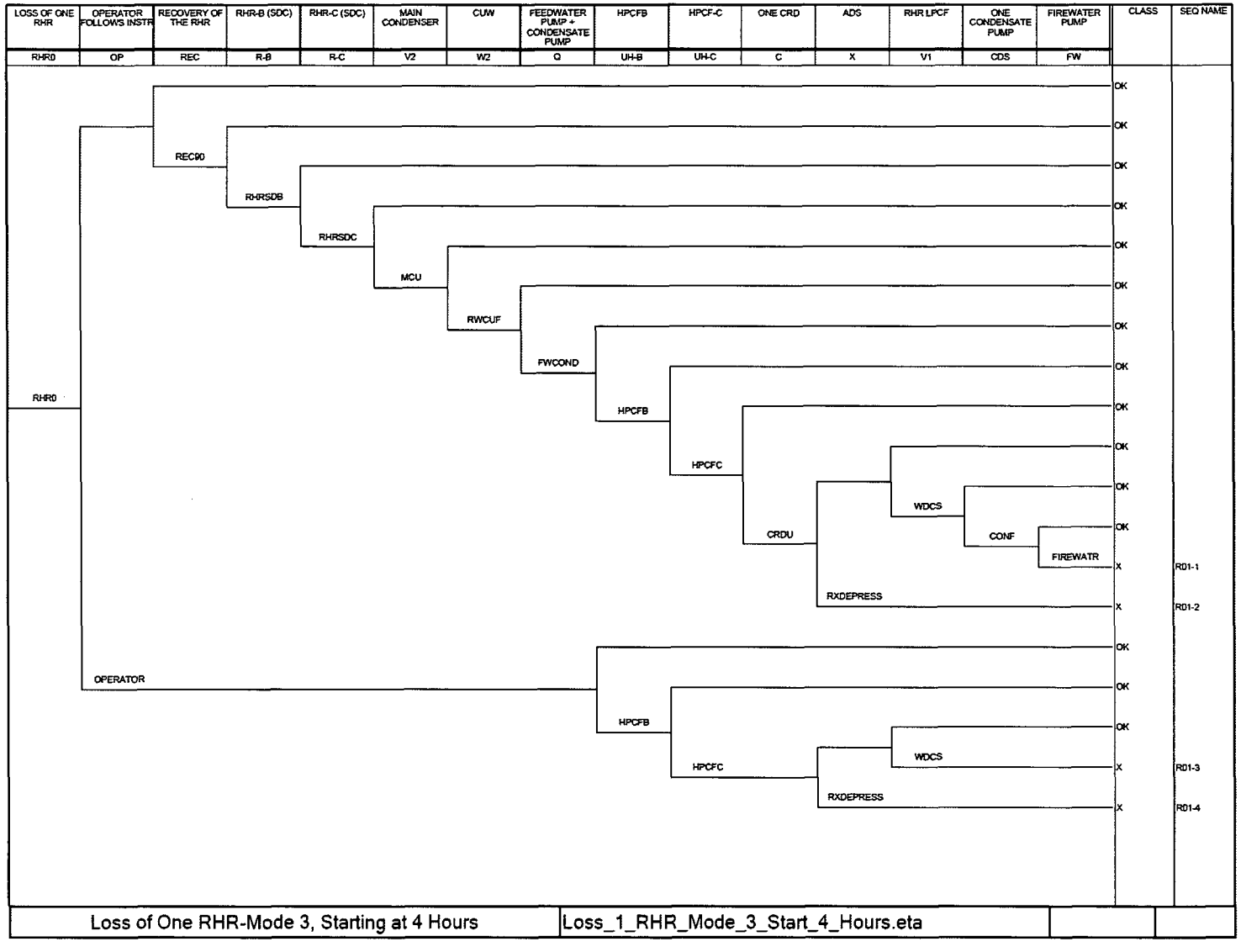
Originator must provide resolutions for all comments.

Reviewer is to approve all proposed resolutions prior to completing the review process. No review is complete until this step is accomplished.

Reviewer Comment	Originator Resolution of Comment	Reviewer Approval
1. Figure 1 does not match table before it.	Numbers reversed in table.	PDS
2. Define RAP	Done	PDS
3. Sensitivity case truncation is not greater than four orders of magnitude below CDF as stated.	Corrected wording from "over" to "near" since it is a sensitivity	PDS
4. Missing data source reference for SD_CUW in Table 4	Added	PDS

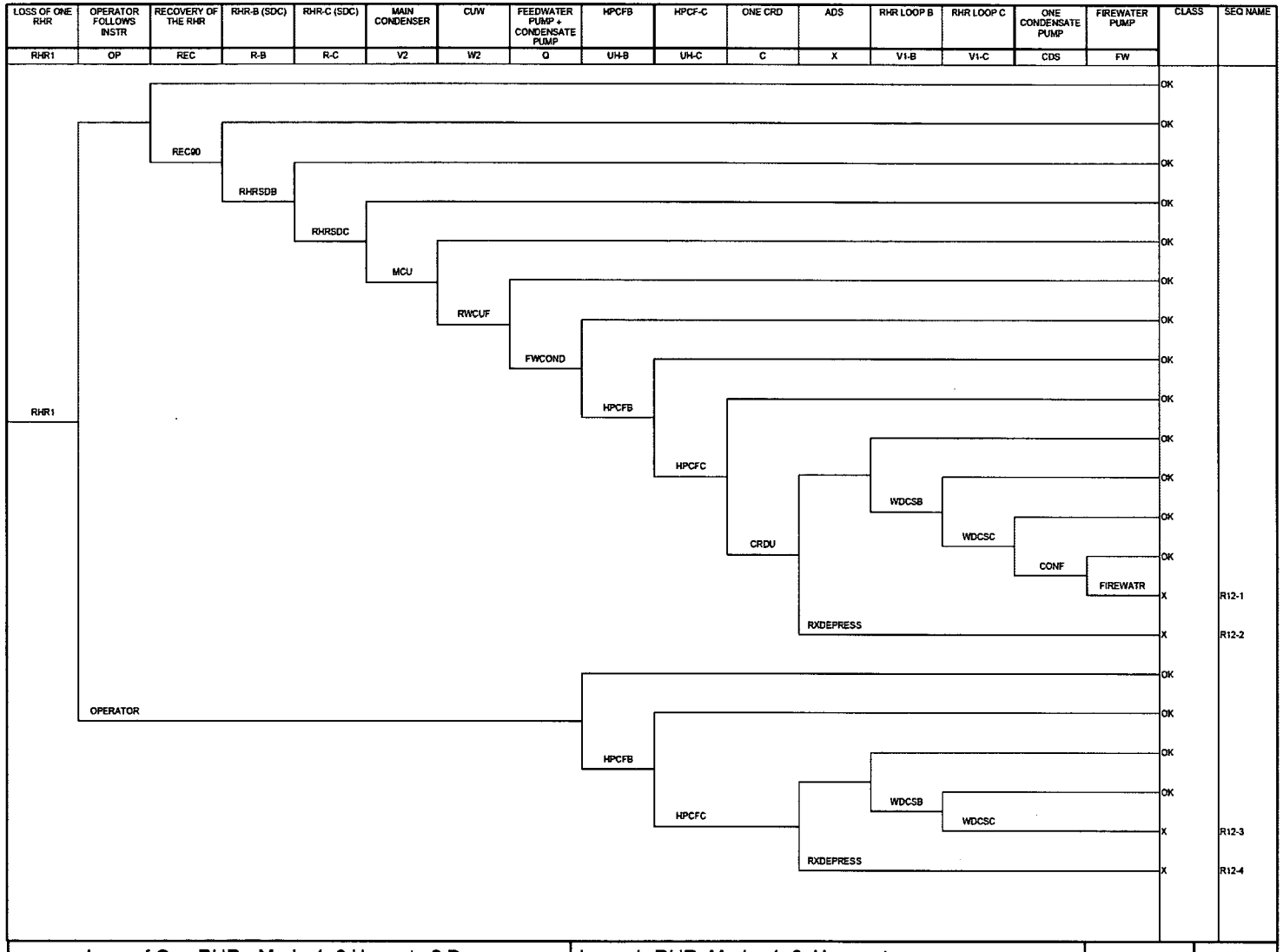
APPENDIX A – EVENT TREES

Figures A-1 through A-22 replace the referenced Figures 19Q-1 through 19Q-22 as cited in the DCDRA.



Loss of One RHR-Mode 3, Starting at 4 Hours | Loss_1_RHR_Mode_3_Start_4_Hours.eta

Figure A-1. Loss of One RHR Event Tree – Mode 3, Starting at 4 Hours



Loss of One RHR - Mode 4, 6 Hours to 2 Days | Loss_1_RHR_Mode_4_6_Hours.eta

Figure A-2. Loss of One RHR Event Tree - Mode 4, 6 Hours to 2 Days

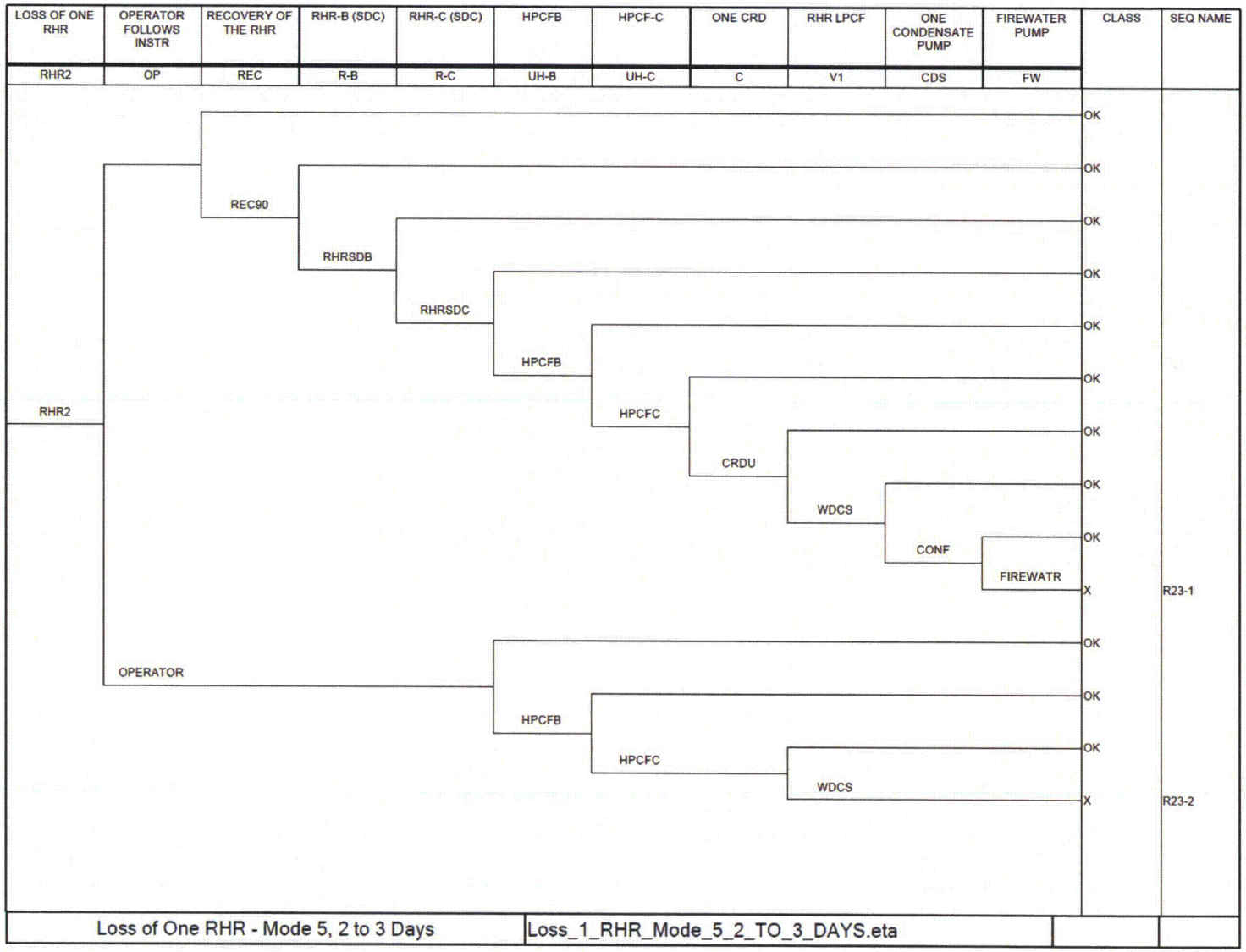


Figure A-3. Loss of One RHR Event Tree - Mode 5, 2 to 3 Days

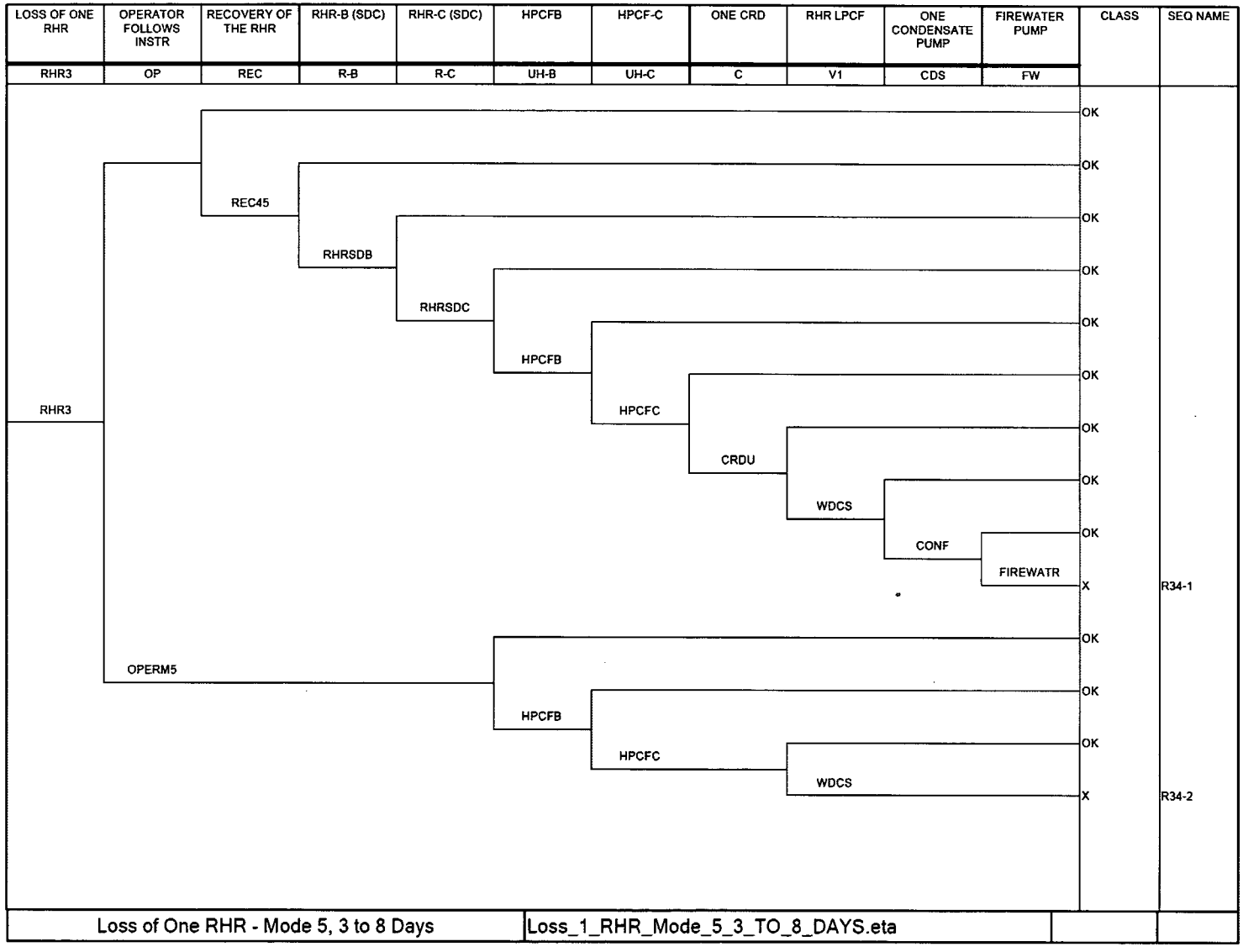


Figure A-4. Loss of One RHR Event Tree - Mode 5, 3 to 8 Days

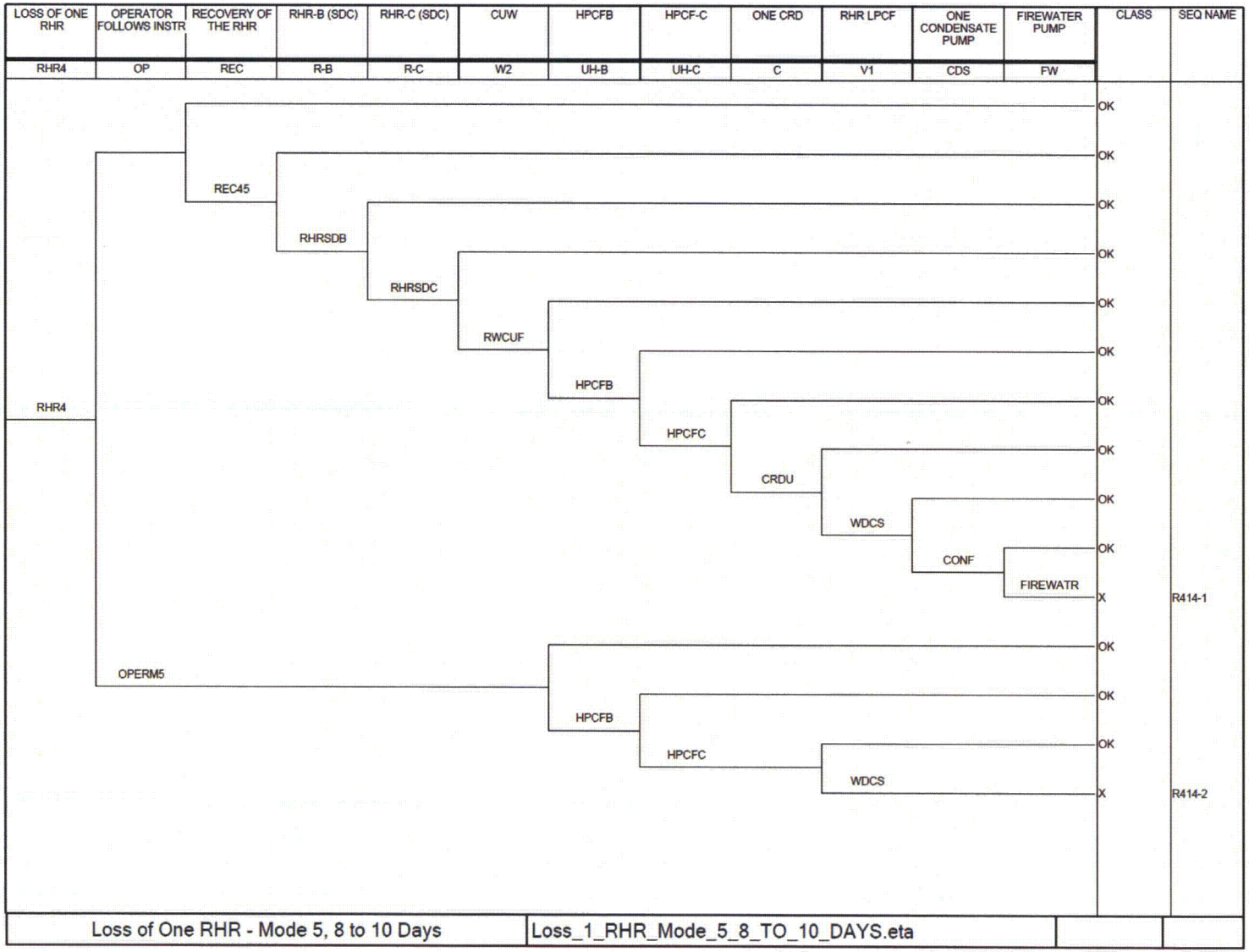


Figure A-5. Loss of One RHR Event Tree - Mode 5, 8 to 10 Days

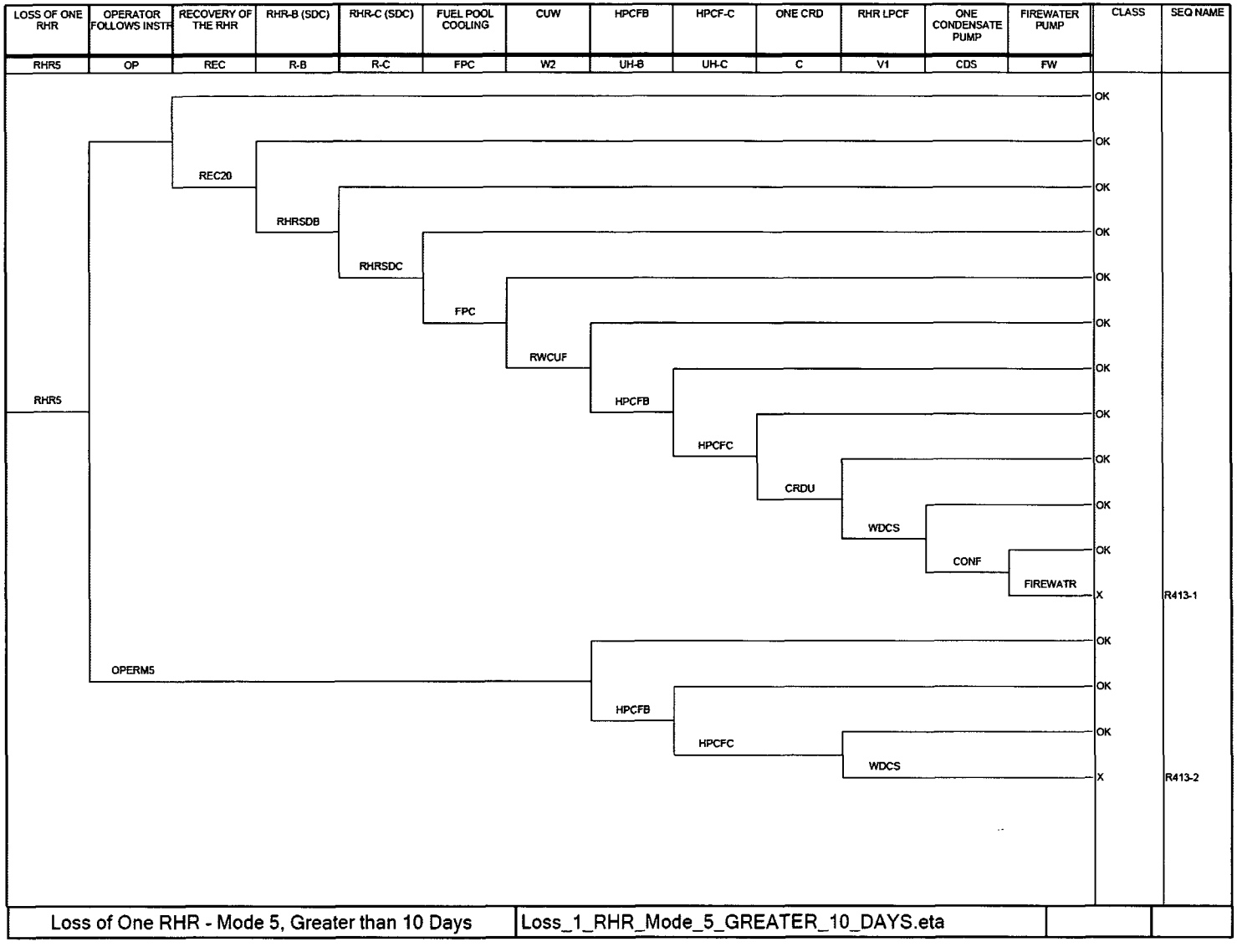


Figure A-6. Loss of One RHR Event Tree - Mode 5 – Greater than 10 Days

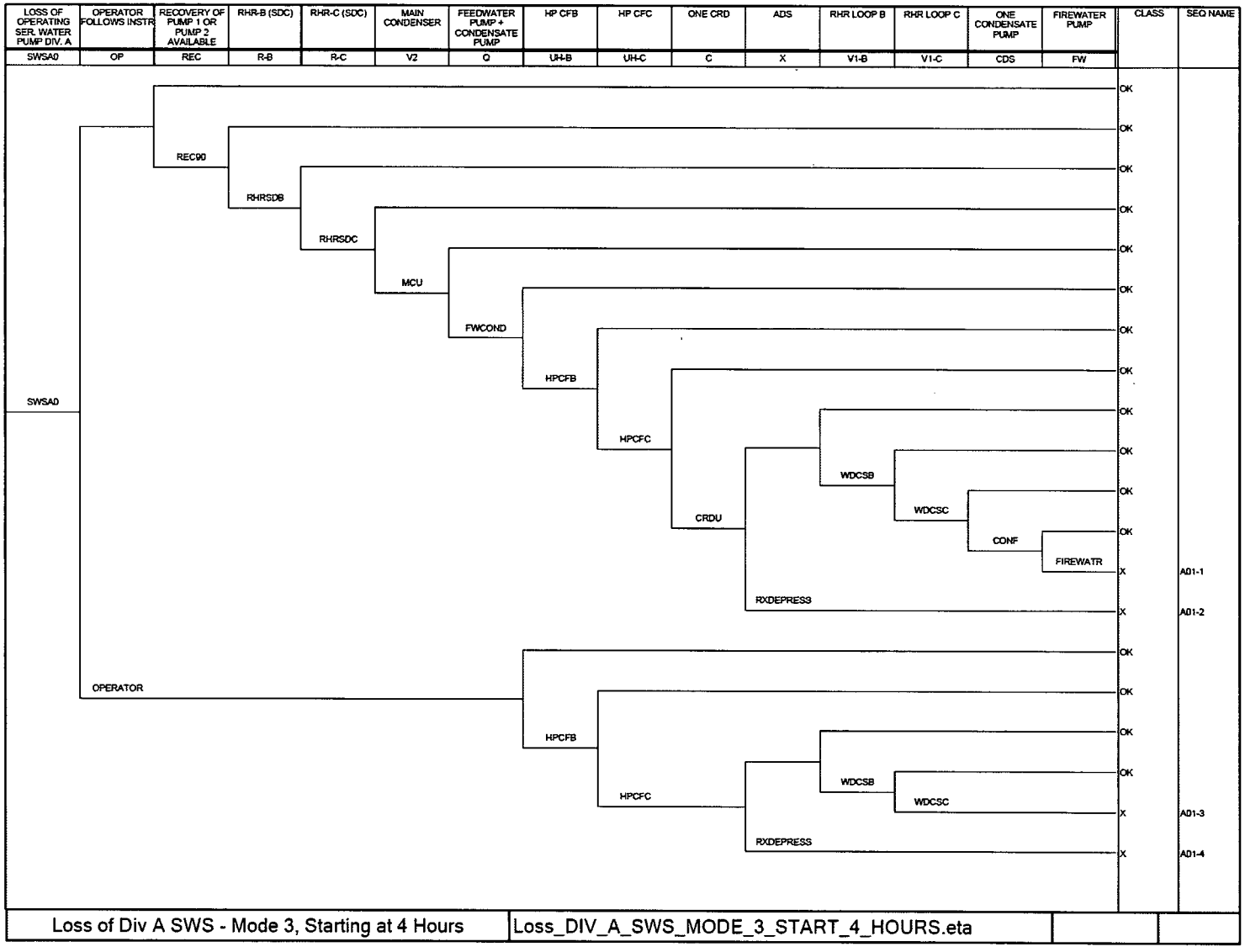
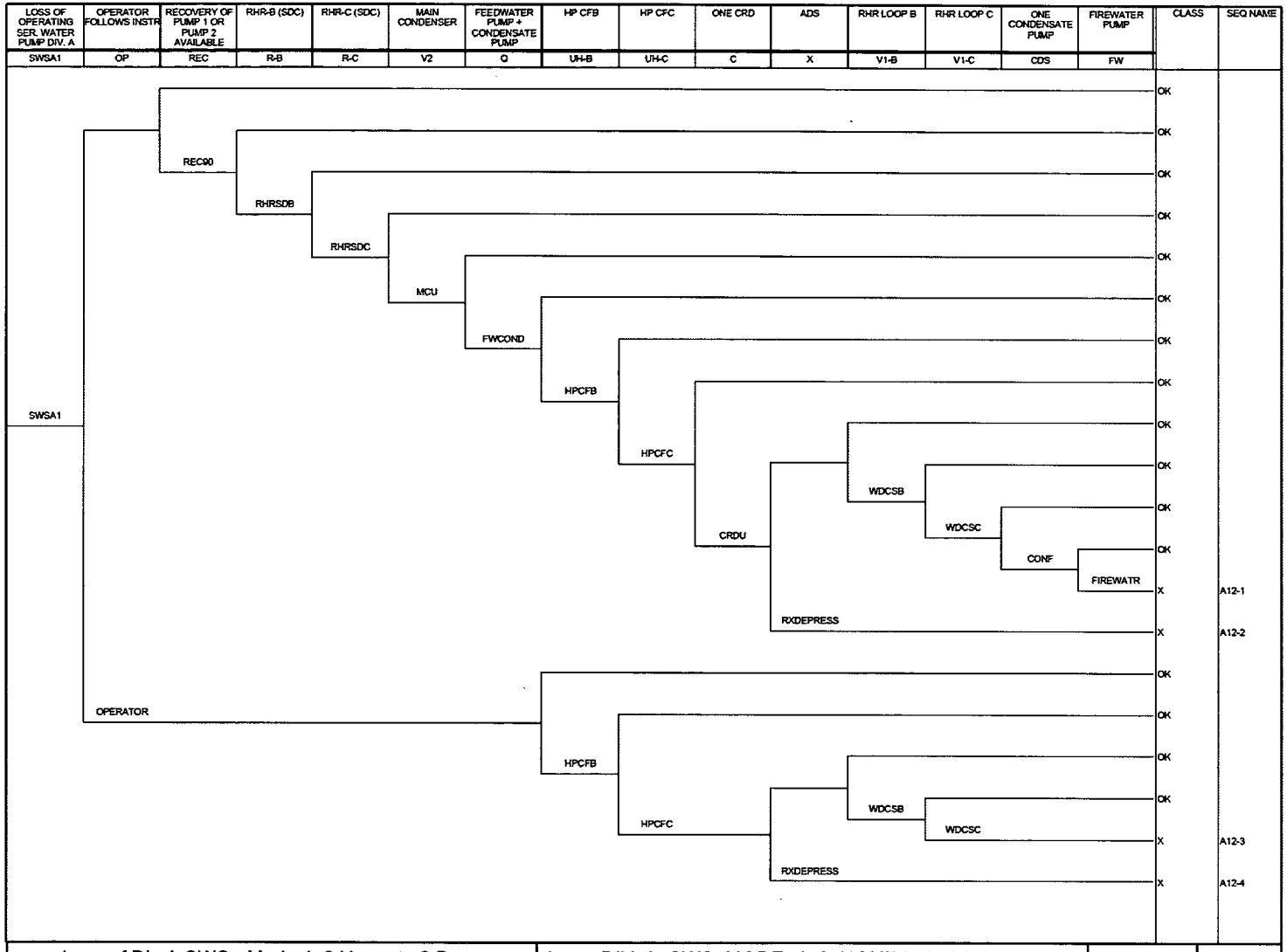
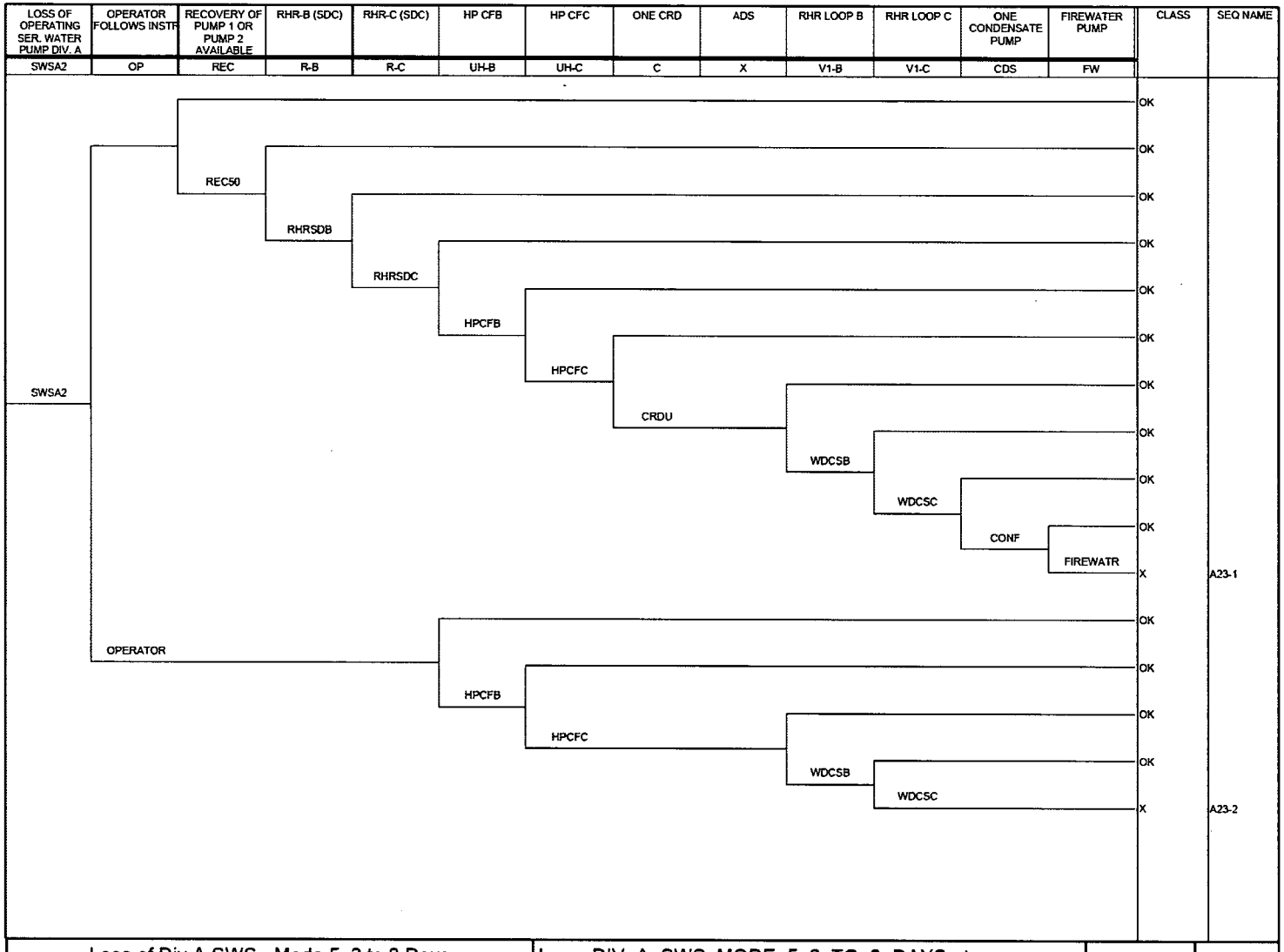


Figure A-7. Loss of Div A SWS Event Tree - Mode 3 Starting at 4 Hours



Loss of Div A SWS - Mode 4, 6 Hours to 2 Days	Loss_DIV_A_SWS_MODE_4_6_HOURS_2_DAYS.eta		

Figure A-8. Loss of Div A SWS Event Tree - Mode 4, 6 Hours to 2 Days



Loss of Div A SWS - Mode 5, 2 to 3 Days | Loss_DIV_A_SWS_MODE_5_2_TO_3_DAYS.eta

Figure A-9. Loss of Div A SYS Event Tree - Mode 5, 2 to 3 Days

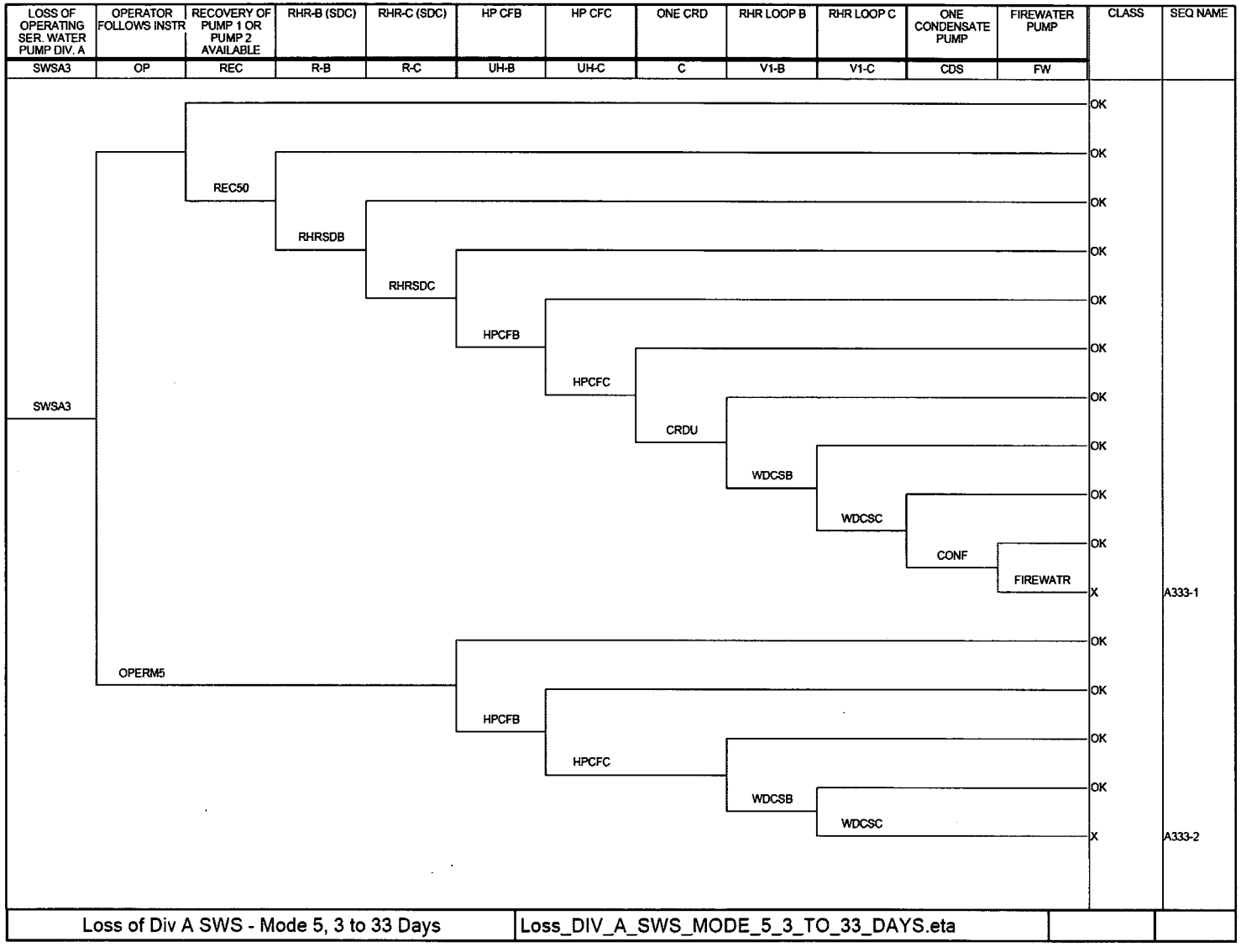
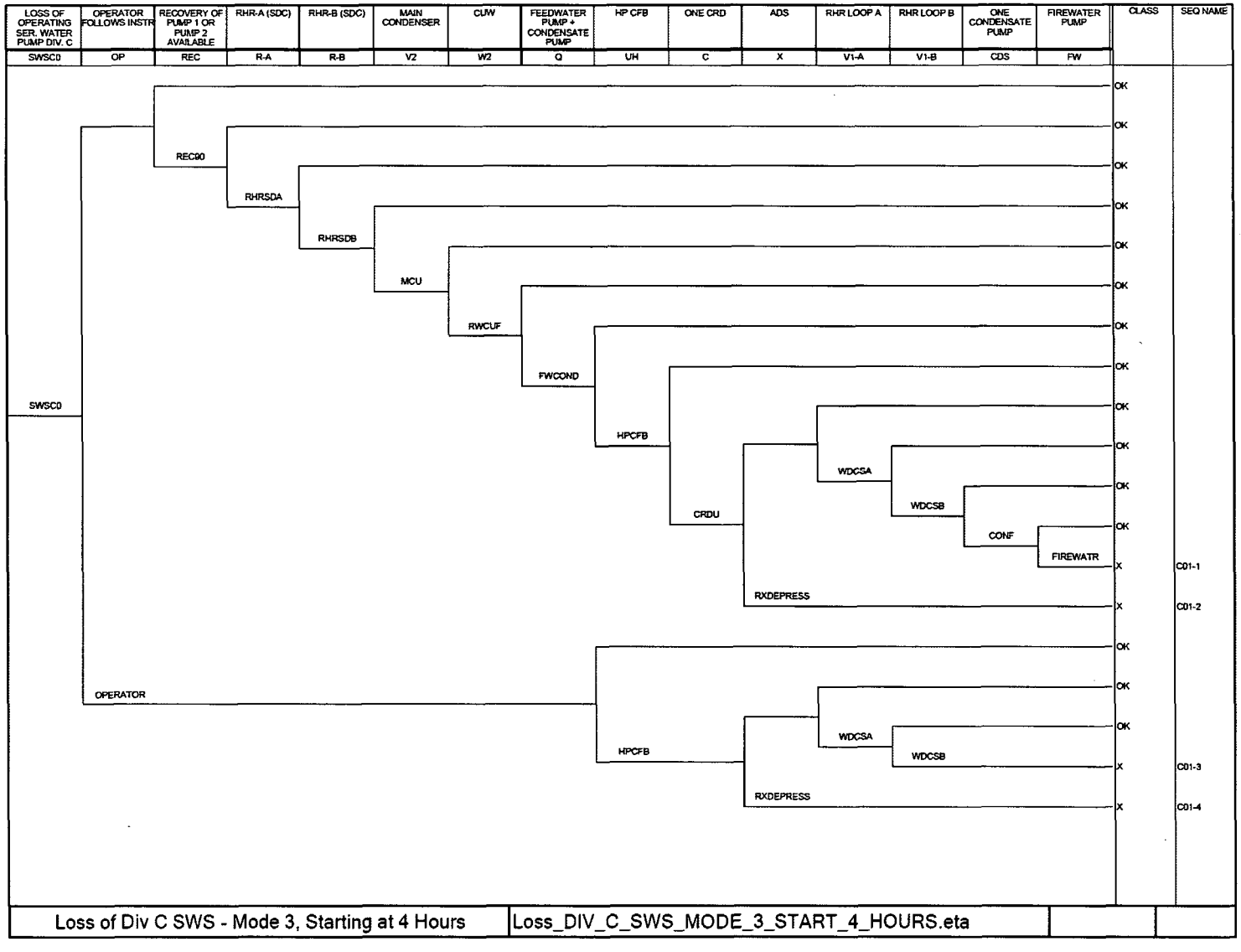
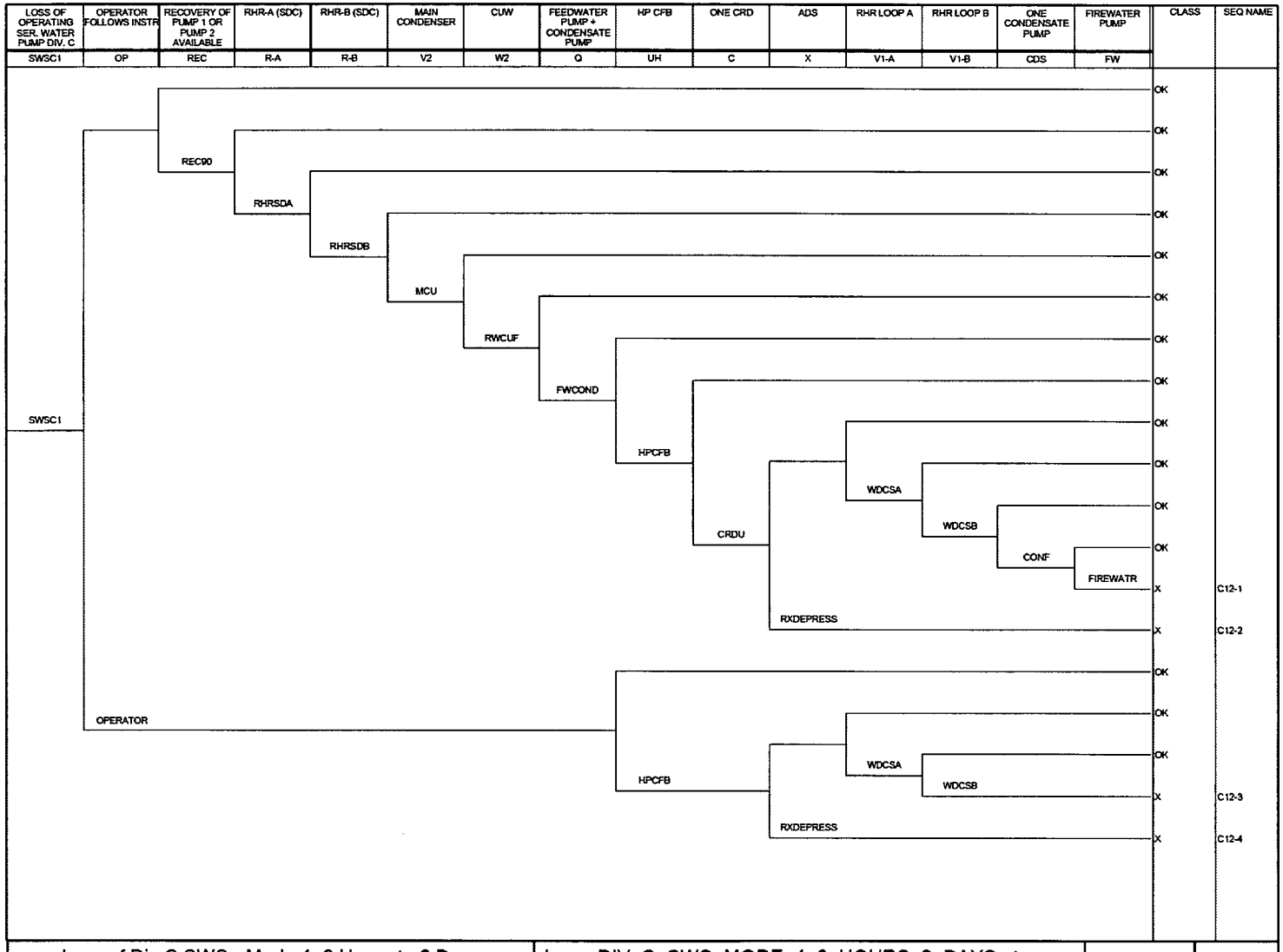


Figure A-10. Loss of Div A SWS Event Tree - Mode 5, 3 to 33 Days



Loss of Div C SWS - Mode 3, Starting at 4 Hours	Loss_DIV_C_SWS_MODE_3_START_4_HOURS.eta		

Figure A-11. Loss of Div C SWS Event Tree - Mode 3, Starting at 4 Hours



Loss of Div C SWS - Mode 4, 6 Hours to 2 Days | Loss_DIV_C_SWS_MODE_4_6_HOURS_2_DAYS.eta

Figure A-12. Loss of Div C SWS Event Tree - Mode 4, 6 Hours to 2 Days

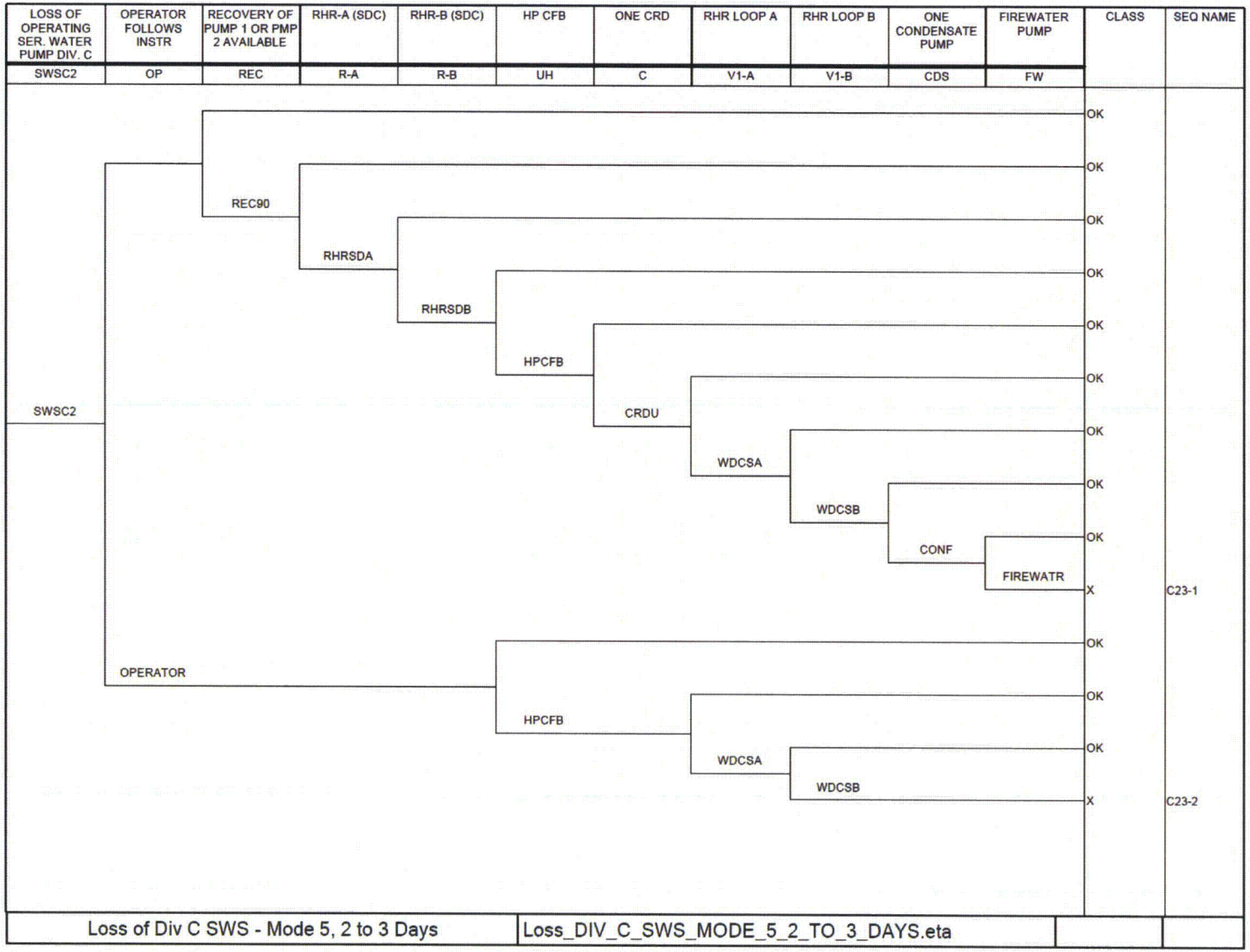


Figure A-13. Loss of Div C SWS Event Tree - Mode 5, 2 to 3 Days

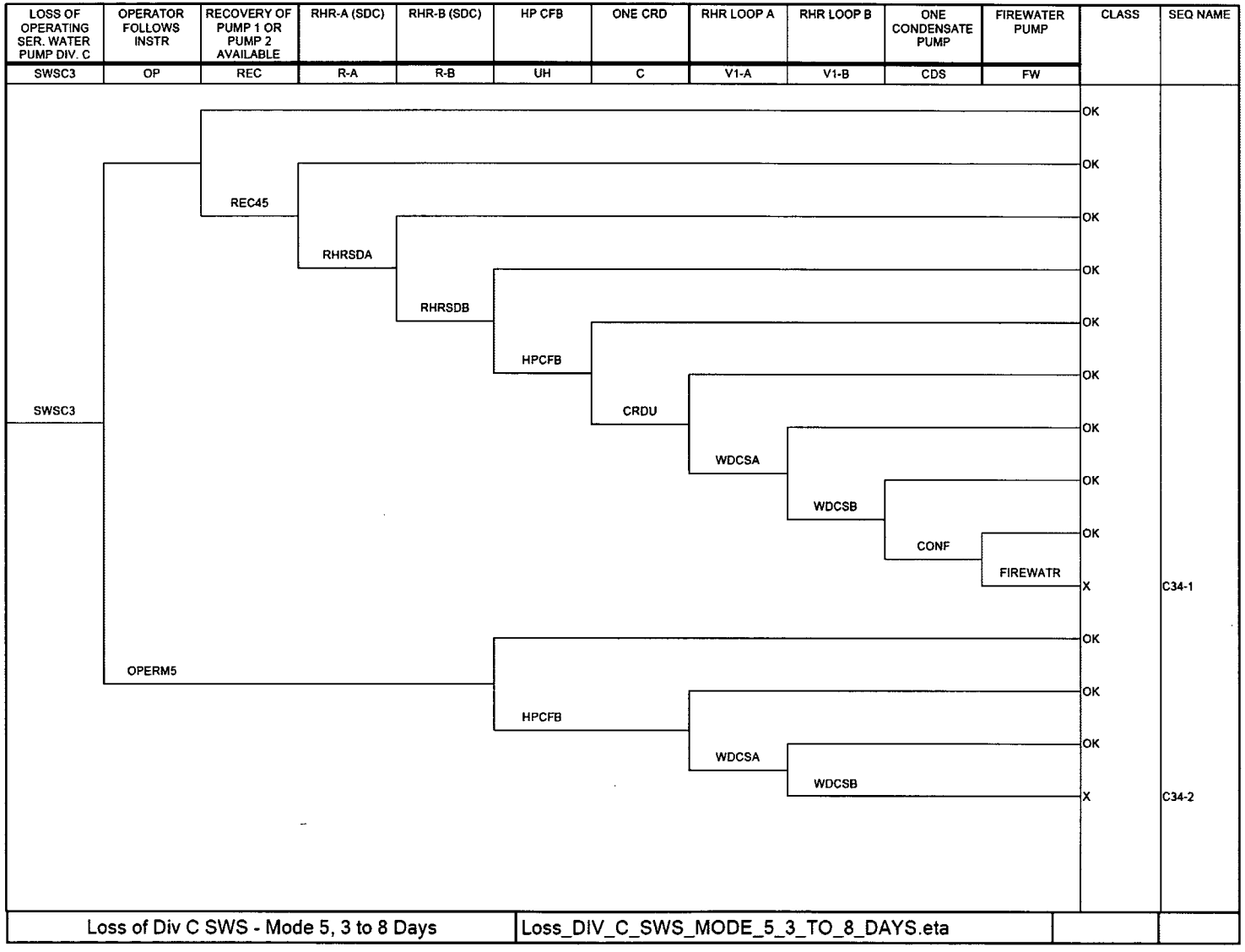
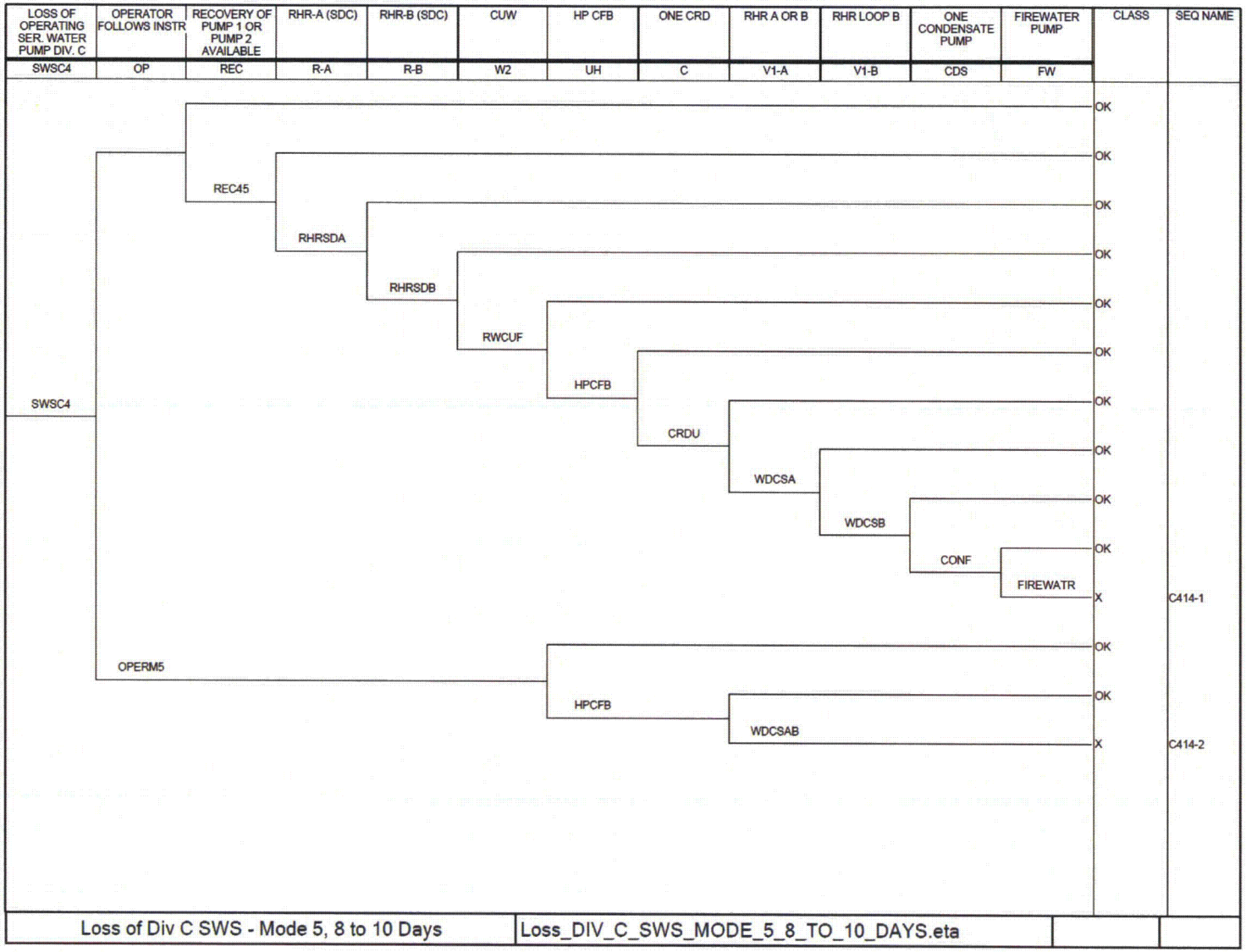
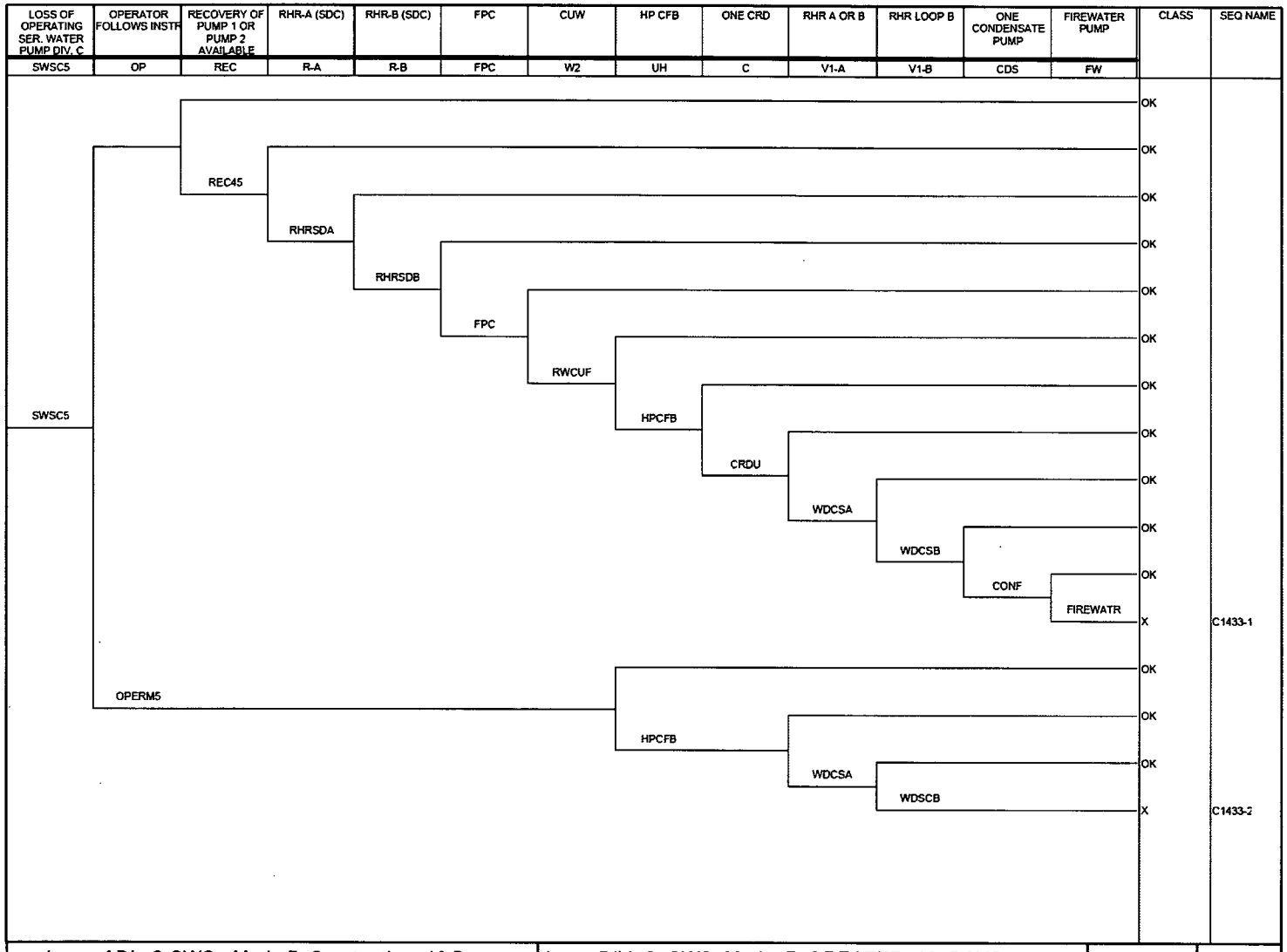


Figure A-14. Loss of Div C SWS Event Tree - Mode 5, 3 to 8 Days



Loss of Div C SWS - Mode 5, 8 to 10 Days | Loss_DIV_C_SWS_MODE_5_8_TO_10_DAYS.eta

Figure A-15. Loss of Div C SWS Event Tree - Mode 5, 8 to 10 Days



Loss of Div C SWS - Mode 5, Greater than 10 Days | Loss_DIV_C_SWS_Mode_5_GREATER_10_DAYS.eta

Figure A-16. Loss of Div C SWS Event Tree - Greater Than 10 Days

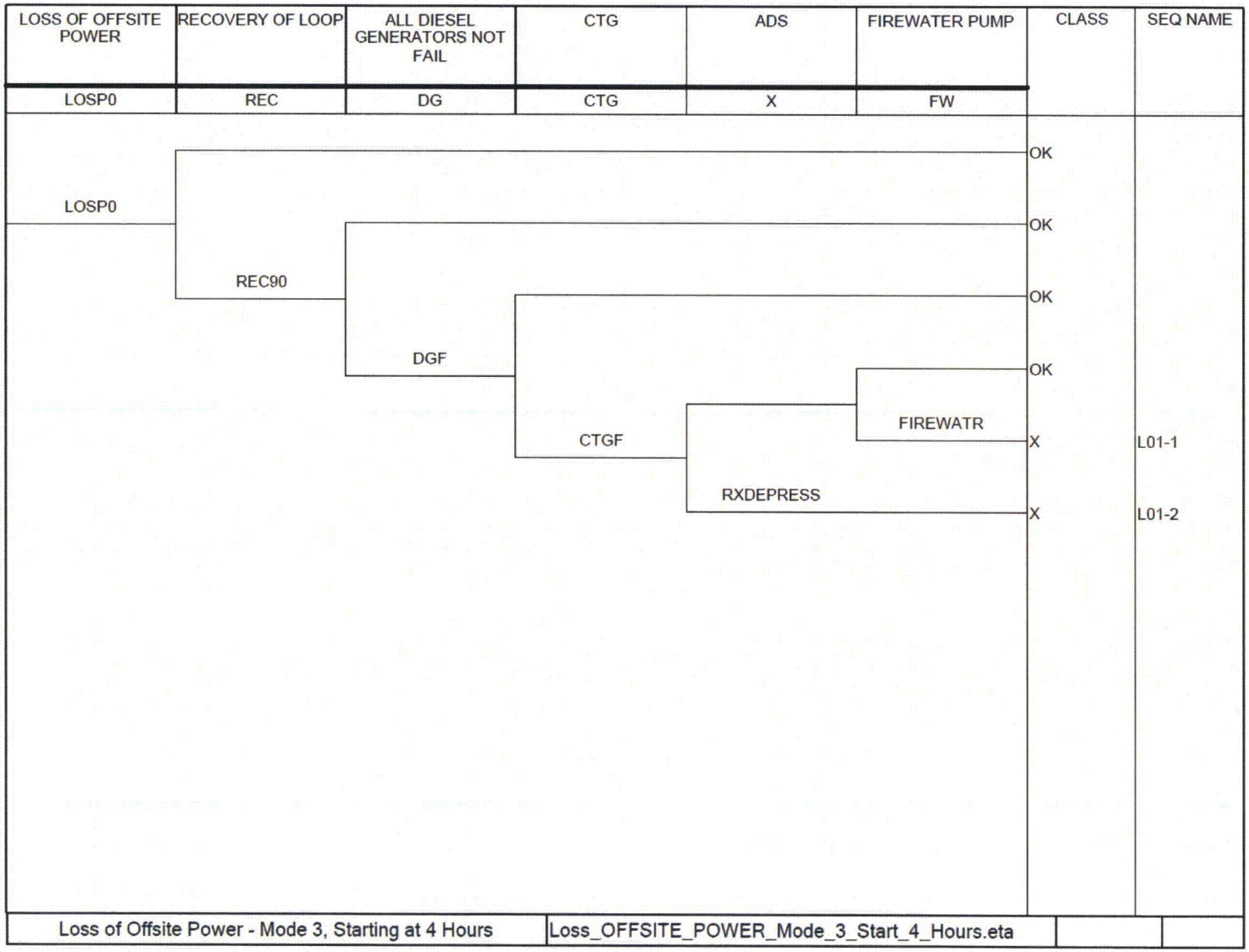


Figure A-17. Loss of Offsite Power Event Tree - Mode 3, Starting at 4 Hours

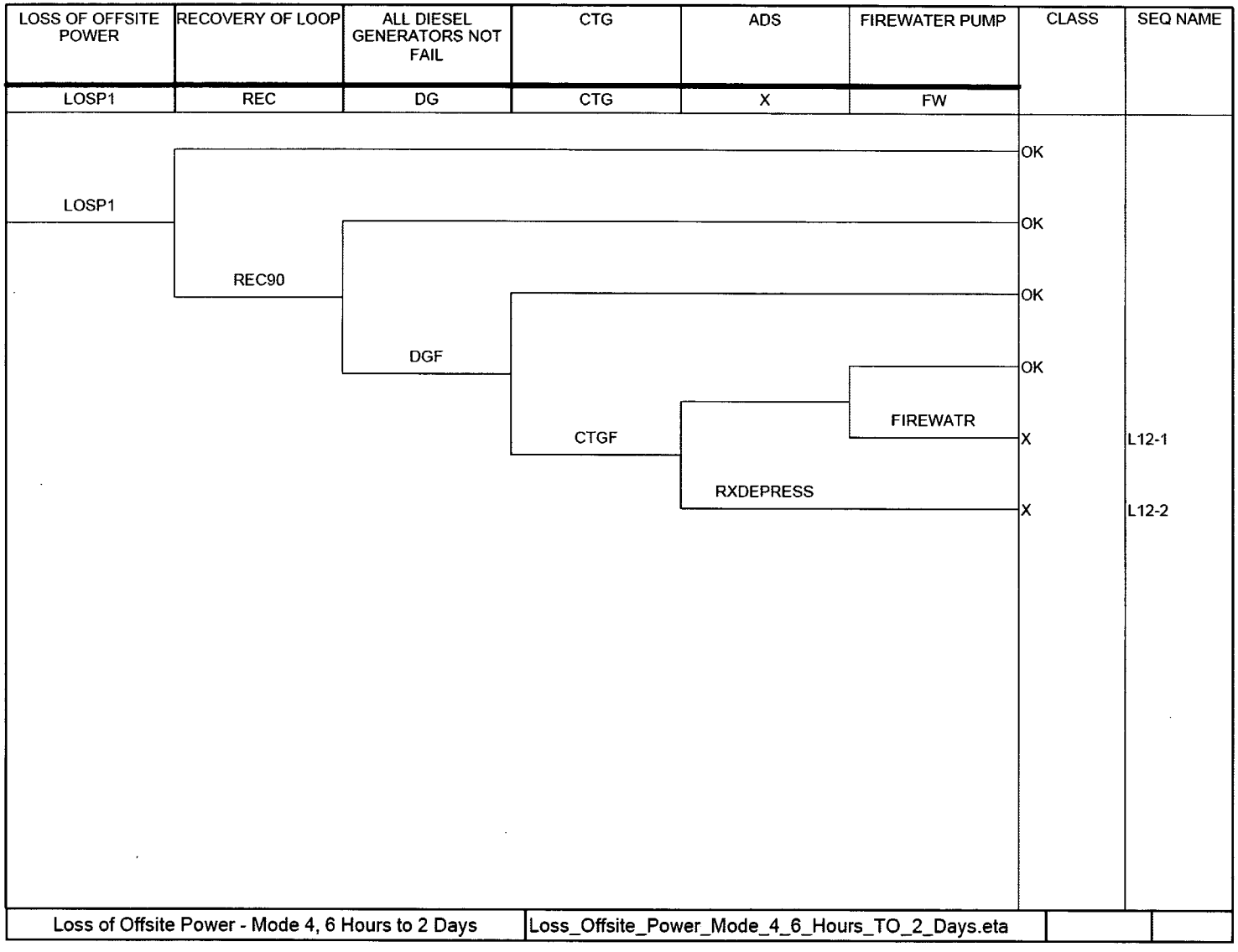


Figure A-18. Loss of Offsite Power Event Tree - Mode 4, 6 Hours to 2 Days

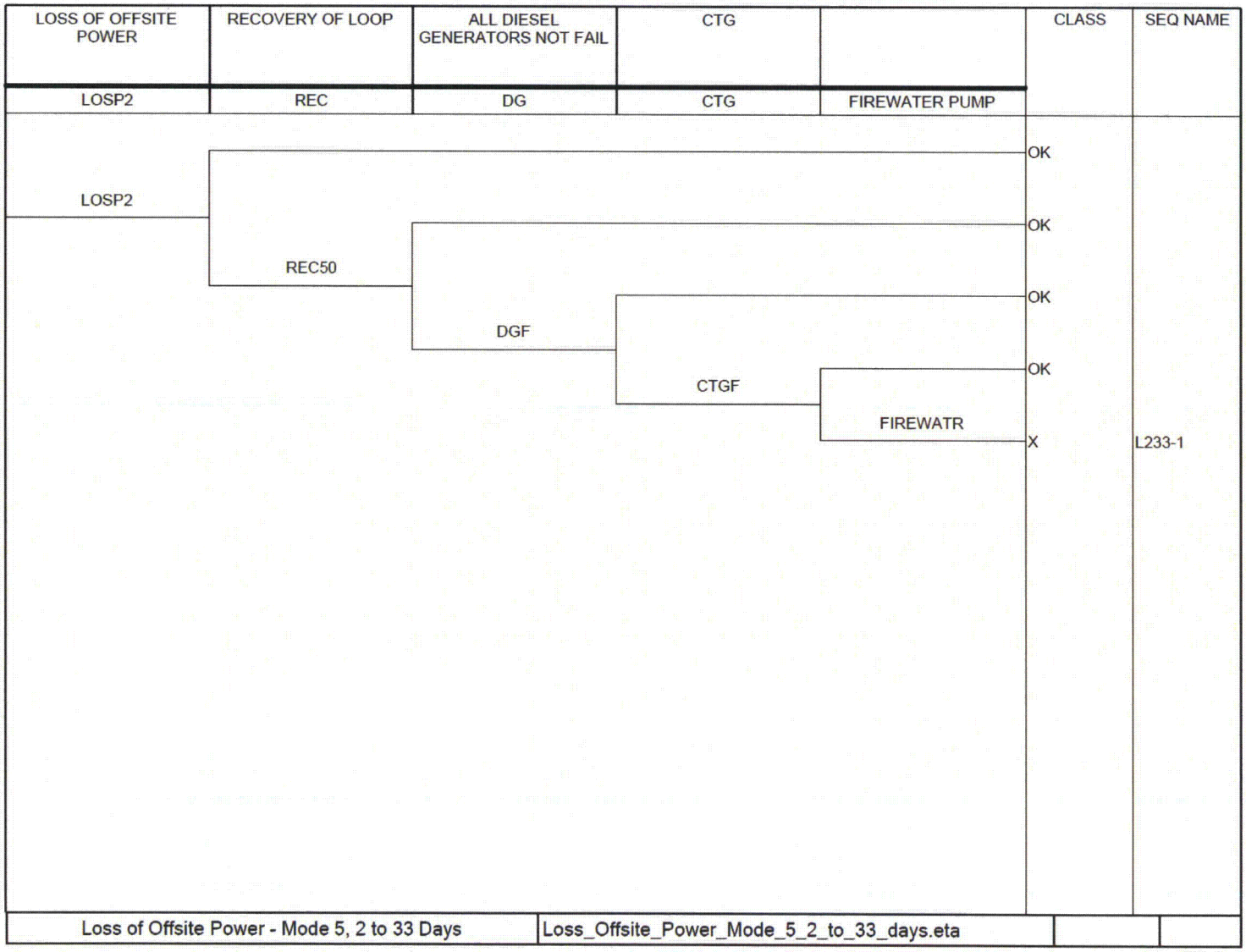


Figure A-19. Loss of Offsite Power Event Tree - Mode 5, 2 to 33 Days

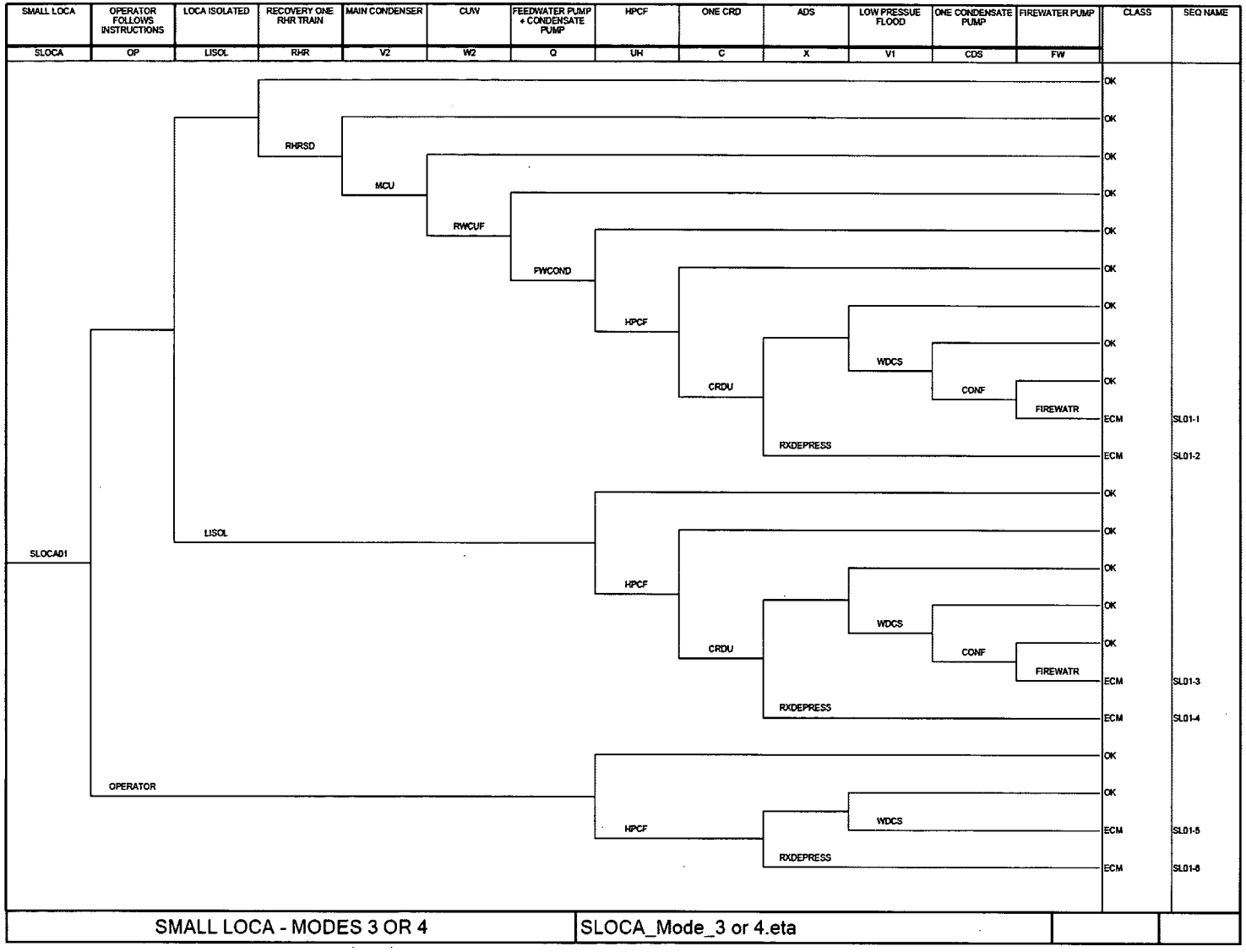


Figure A-20. Small LOCA Event Tree - Mode 3 or 4

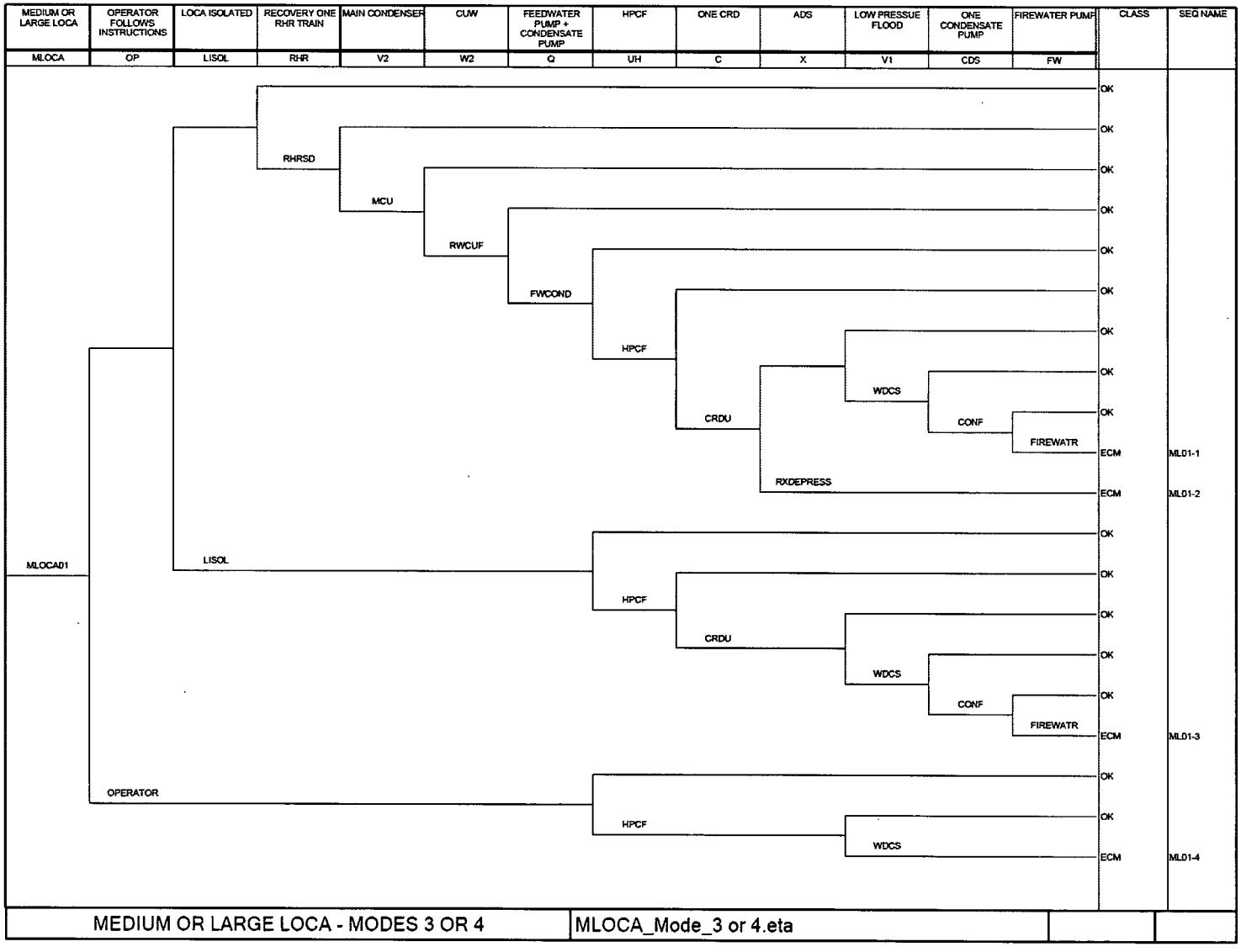


Figure A-21. Medium or Large LOCA Event Tree - Mode 3 or 4

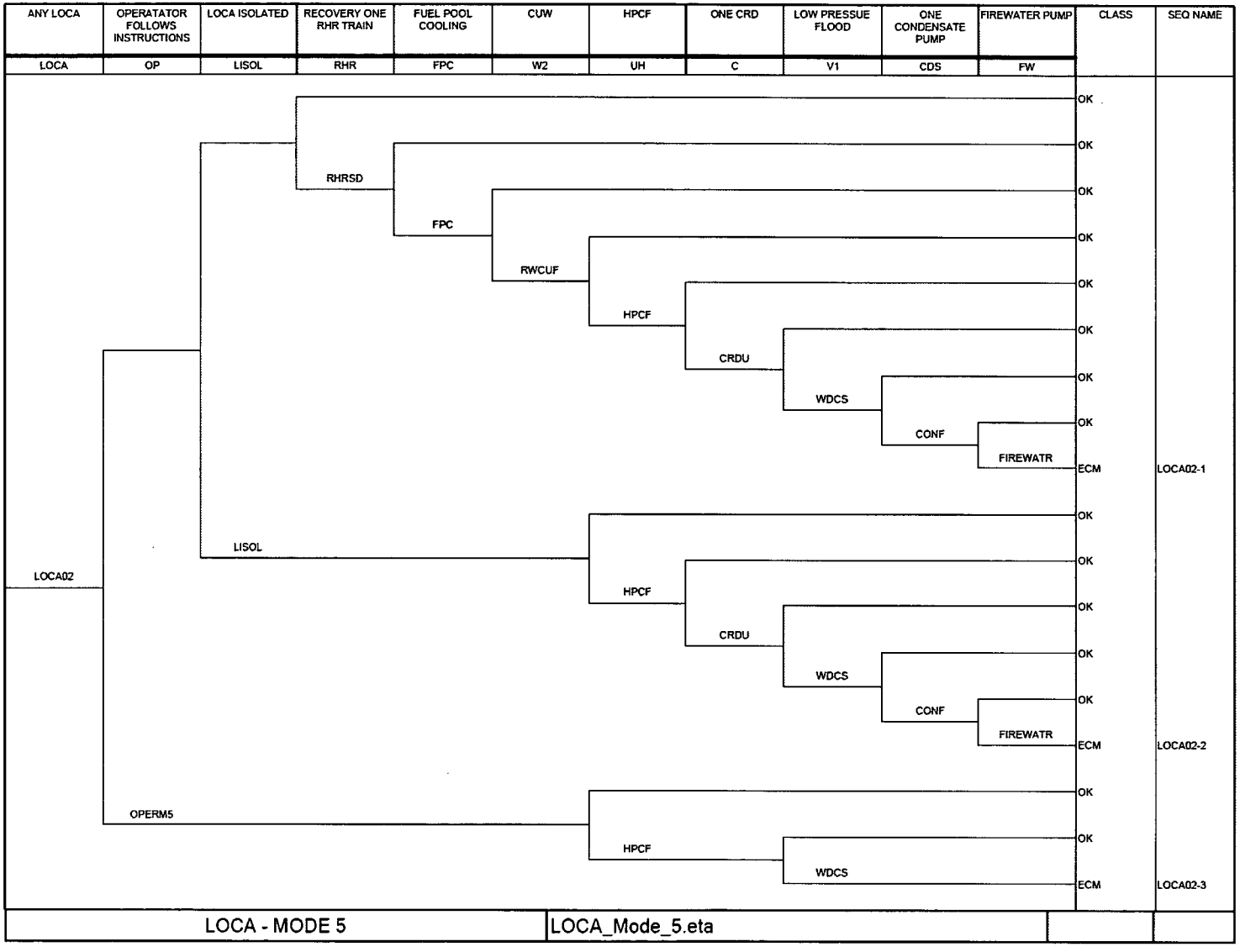


Figure A-22. LOCA Event Tree, Mode 5

APPENDIX B – QUANTIFICATION SUPPORT FILES

Flag Files:

ABWR_SD_CCDP.FLG

```
;-----------------------------------------------------------------------
;  Set Division 1,2,3 unavailabilities to T, T, F
;-----------------------------------------------------------------------
WDAMAINT_SD EQU .F.
WDBMAINT_SD EQU .F.
WDCMAINT_SD EQU .T.
HPBMAINT_SD EQU .F.
HPCMAINT_SD EQU .T.
CR001BM     EQU .F.
RWMAINT     EQU .F.
EDGCMAINT   EQU .F.
EDGDMAINT   EQU .F.
EDGEMAINT   EQU .T.
WPMSC1DM_SD EQU .F.
WPMSC1EM_SD EQU .F.
WPMSC1FM_SD EQU .T.
WPMRC1DM_SD EQU .F.
WPMRC1EM_SD EQU .F.
WPMRC1FM_SD EQU .T.
FP001BM     EQU .F.
FP001BHM    EQU .F.
WPMMNTF     EQU .T.
WRFMNTF     EQU .T.
;-----------------------------------------------------------------------
; Set main feedwater and condensate system unavailability events to false
; and set individual run failures to true to simulate unavailability
;-----------------------------------------------------------------------
FWMAINT     EQU .F.
FWBR        EQU .T.
FWCR        EQU .T.
CMAINT      EQU .F.
COCR        EQU .T.
CODR        EQU .T.
;-----------------------------------------------------------------------
; Uncomment following lines to run with Division 3
; power unavailable
;-----------------------------------------------------------------------
EAC69EH     EQU .T.
EDP103H     EQU .T.
X_P3-F011B  EQU .F.
;-----------------------------------------------------------------------
; The following lines are for CCDP analysis
;-----------------------------------------------------------------------
; Set redundant IE events to false
;-----------------------------------------------------------------------
SD_LOAC1    EQU .F.
SD_LODC1    EQU .F.
SD_LORHRAS  EQU .F.
SD_RBCA     EQU .F.
```

```
;-----------------------------------------------------------------------
; Set LOCA IE events to false
;-----------------------------------------------------------------------
SD_RHR0      EQU .F.
SD_RHR1      EQU .F.
SD_S01       EQU .F.
SD_S2        EQU .F.
SD_S3        EQU .F.
;-----------------------------------------------------------------------
; Set Initiators to 1 and trees to true to CCDP analysis
; The following lines permanently change the BE probability
; Be sure to set PRAQUANT to make a temporary copy of BE file.
;-----------------------------------------------------------------------
X_CCDP            EQU .T.
SD_LORHRA    PROB 1
SD_LOSWA     PROB 1
SD_LOSWC     PROB 1
SD_TE        PROB 1
X_POS3       PROB 1
X_POS4       PROB 1
X_POS5A      PROB 1
X_POS5B      PROB 1
X_POS5C      PROB 1
X_POS5D      PROB 1
```

ABWR_SD_LIMITING.FLG

```
;-----------------------------------------------------------------------
;  Set Division 1,2,3 unavailabilities to T, T, F
;-----------------------------------------------------------------------
WDAMAINT_SD      EQU .F.
WDBMAINT_SD      EQU .F.
WDCMAINT_SD      EQU .T.
HPBMAINT_SD      EQU .F.
HPCMAINT_SD      EQU .T.
CR001BM          EQU .F.
RWMAINT          EQU .F.
EDGCMAINT        EQU .F.
EDGDMAINT        EQU .F.
EDGEMAINT        EQU .T.
WPMSC1DM_SD      EQU .F.
WPMSC1EM_SD      EQU .F.
WPMSC1FM_SD      EQU .T.
WPMRC1DM_SD      EQU .F.
WPMRC1EM_SD      EQU .F.
WPMRC1FM_SD      EQU .T.
FP001BM          EQU .F.
FP001BHM         EQU .F.
WPMMNTF          EQU .T.
WRFMNTF          EQU .T.
;-----------------------------------------------------------------------
; Set main feedwater and condensate system unavailability events to false
; and set individual run failures to true to simulate unavailability
;-----------------------------------------------------------------------
FWMAINT          EQU .F.
```

```
FWBR            EQU .T.
FWCR            EQU .T.
CMAINT          EQU .F.
COCR            EQU .T.
CODR            EQU .T.
;-----------------------------------------------------------------------
; Uncomment following lines to run with Division 3
; power unavailable
;-----------------------------------------------------------------------
EAC69EH     EQU .T.
EDP103H     EQU .T.
X_P3-F011B  EQU .F.
```

Recovery Rules:

ABWR_SD.RECV

```
**RECOVERY RULES**
**MAX RECOVERIES**  1
;----------------------------------------
;   Recovery of EDG failures
;----------------------------------------
**RECOVERY** RECEDG3  0.357
 SD_TE X_POS3 REC90 EDG*

**RECOVERY** RECEDG4  0.313
 SD_TE X_POS4 REC90 EDG*

**RECOVERY** RECEDG5A  0.174
 SD_TE X_POS5A REC50 EDG*

**RECOVERY** RECEDG5B  2.89E-06
  SD_TE X_POS5B REC50 EDG*

**RECOVERY** RECEDG5C  6.98E-08
 SD_TE X_POS5C REC50 EDG*

**RECOVERY** RECEDG5D  1.62E-09
 SD_TE X_POS5D REC50 EDG*
;----------------------------------------
;  Recovery of ECCS component failures
;  If EDG already recovered, no recovery added.
;----------------------------------------
**RECOVERY** RECECCS3  0.714
X_POS3 REC90
SD_LORHRAS REC90

**RECOVERY** RECECCS4  0.674
X_POS4 REC90

**RECOVERY** RECECCS5A  0.504
X_POS5A REC90
X_POS5A REC50

**RECOVERY** RECECCS5B  5.26E-05
```

```
X_POS5B REC45
X_POS5B REC50

**RECOVERY** RECECCS5C  9.24E-07
X_POS5C REC45
X_POS5C REC50

**RECOVERY** RECECCS5D  1.11E-08
X_POS5D  REC50
X_POS5D REC20

;----------------------------------------
;  Reset Recoveries Flags to limit 1
;  LOSP recovery per cutset
;----------------------------------------

**CLEAR RECOVERY FLAGS**

;----------------------------------------
; RECOVER OFFSITE POWER
;----------------------------------------

**RECOVERY** RECOSP3     8.10E-02
SD_TE X_POS3 REC*

**RECOVERY** RECOSP4     6.92E-02
 SD_TE X_POS4 REC*

**RECOVERY** RECOSP5A    4.03E-02
 SD_TE X_POS5A REC*

**RECOVERY** RECOSP5B    2.27E-03
 SD_TE X_POS5B REC*

**RECOVERY** RECOSP5C    1.43E-03
 SD_TE X_POS5C REC*

**RECOVERY** RECOSP5D    9.64E-04
 SD_TE X_POS5D REC*
```

APPENDIX C - CASE 1. CCDP - TOP 50 CUTSETS

The top 50 cutsets are listed below for the CCDP analysis of loss of shutdown cooling events. All cutsets include an extra event without description that begins with "XSD" and is used to create Figure 1. The top 50 cutsets have representative cutsets form all the important initiating events.

#	Event	Description	Cutset Prob	Event Prob
1	SD_TE	LOSS OF OFFSITE POWER	2.73E-08	1.00E+00
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
2	SD_TE	LOSS OF OFFSITE POWER	2.24E-08	1.00E+00
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCD	2 D.G.'S CCF		1.94E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
3	SD_TE	LOSS OF OFFSITE POWER	2.17E-08	1.00E+00
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
4	SD_TE	LOSS OF OFFSITE POWER	2.04E-08	1.00E+00
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_TE_4			1.00E+00
5	SD_TE	LOSS OF OFFSITE POWER	1.92E-08	1.00E+00
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02

#	Event	Description	Cutset Prob	Event Prob
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS5A	FAILURE TO RECOVER ECCS DURING POS 5A		5.04E-01
	RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A		4.03E-02
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_TE_5A			1.00E+00
6	SD_TE	LOSS OF OFFSITE POWER	1.68E-08	1.00E+00
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCD	2 D.G.'S CCF		1.94E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_TE_4			1.00E+00
7	SD_TE	LOSS OF OFFSITE POWER	1.62E-08	1.00E+00
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_TE_4			1.00E+00
8	SD_TE	LOSS OF OFFSITE POWER	1.58E-08	1.00E+00
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCD	2 D.G.'S CCF		1.94E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS5A	FAILURE TO RECOVER ECCS DURING POS 5A		5.04E-01
	RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A		4.03E-02
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_TE_5A			1.00E+00
9	SD_TE	LOSS OF OFFSITE POWER	1.52E-08	1.00E+00
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS5A	FAILURE TO RECOVER ECCS DURING POS 5A		5.04E-01
	RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A		4.03E-02
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_TE_5A			1.00E+00
10	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00
11	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LORHRA_4			1.00E+00

#	Event	Description	Cutset Prob	Event Prob
12	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LORHRA_5A			1.00E+00
13	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00
14	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LORHRA_4			1.00E+00
15	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LORHRA_5A			1.00E+00
16	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00
17	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LORHRA_4			1.00E+00
18	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LORHRA_5A			1.00E+00
19	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00
20	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LORHRA_4			1.00E+00
21	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LORHRA_5A			1.00E+00
22	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00

#	Event	Description	Cutset Prob	Event Prob
23	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LORHRA_4			1.00E+00
24	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.16E-08	1.00E+00
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LORHRA_5A			1.00E+00
25	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LOSWA_3			1.00E+00
26	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LOSWA_4			1.00E+00
27	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LOSWA_5A			1.00E+00
28	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LOSWA_3			1.00E+00
29	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LOSWA_4			1.00E+00
30	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LOSWA_5A			1.00E+00
31	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LOSWA_3			1.00E+00
32	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LOSWA_4			1.00E+00
33	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LOSWA_5A			1.00E+00

#	Event	Description	Cutset Prob	Event Prob
34	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LOSWA_3			1.00E+00
35	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LOSWA_4			1.00E+00
36	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LOSWA_5A			1.00E+00
37	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LOSWA_3			1.00E+00
38	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LOSWA_4			1.00E+00
39	SD_LOSWA	LOSS OF SWS TRAIN A	1.16E-08	1.00E+00
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LOSWA_5A			1.00E+00
40	SD_TE	LOSS OF OFFSITE POWER	8.61E-09	1.00E+00
	EDGC	DG C FAILS TO RUN		2.48E-02
	EDGD	DG D FAILS TO RUN		2.48E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
41	SD_TE	LOSS OF OFFSITE POWER	7.69E-09	1.00E+00
	EDGC	DG C FAILS TO RUN		2.48E-02
	EDGFSDD	DG FAILS TO START		2.21E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
42	SD_TE	LOSS OF OFFSITE POWER	7.69E-09	1.00E+00
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGFSCD	DG FAILS TO START		2.21E-02

#	Event	Description	Cutset Prob	Event Prob
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
43	SD_TE	LOSS OF OFFSITE POWER	7.09E-09	1.00E+00
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGC	DG C FAILS TO RUN		2.48E-02
	EDGD	DG D FAILS TO RUN		2.48E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
44	SD_TE	LOSS OF OFFSITE POWER	6.96E-09	1.00E+00
	EDGE	DG E FAILS TO RUN		2.48E-02
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
45	SD_TE	LOSS OF OFFSITE POWER	6.86E-09	1.00E+00
	EDGFSCD	DG FAILS TO START		2.21E-02
	EDGFSDD	DG FAILS TO START		2.21E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
46	SD_TE	LOSS OF OFFSITE POWER	6.85E-09	1.00E+00
	EDGC	DG C FAILS TO RUN		2.48E-02
	EDGD	DG D FAILS TO RUN		2.48E-02
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_TE_3			1.00E+00
47	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	6.54E-09	1.00E+00
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04

#	Event	Description	Cutset Prob	Event Prob
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00
48	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	6.54E-09	1.00E+00
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		1.00E+00
	XSD_LORHRA_4			1.00E+00
49	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	6.54E-09	1.00E+00
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		1.00E+00
	XSD_LORHRA_5A			1.00E+00
50	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	6.54E-09	1.00E+00
	ETR6D2H	TRANSFORMER T6D2 FAILURE		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		1.00E+00
	XSD_LORHRA_3			1.00E+00

APPENDIX D - CASE 2 - CDF LIMITING UNAVAILABILITY CASE - TOP 50 CUTSETS

The top 50 cutsets are listed below for the CDF limiting analysis of all shutdown initiating events. All cutsets include an extra event without description that begins with "XSD" and is used to create Figure 2.

#	Event	Description	Cutset Prob	Event Prob
1	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.50E-11	5.00E-01
	CALN002A	MISCALIBRATION OF FLOW TRANSMITTERS FT008A,B,C		5.00E-05
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
2	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	2.29E-11	1.65E+01
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
3	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	2.29E-11	1.65E+01
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
4	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	2.29E-11	1.65E+01
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
5	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	2.29E-11	1.65E+01
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
6	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	2.29E-11	1.65E+01
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
7	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.30E-11	1.65E+01
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
8	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.30E-11	1.65E+01
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02

#	Event	Description	Cutset Prob	Event Prob
	XSD_LORHRA_5A			1.00E+00
9	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.30E-11	1.65E+01
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
10	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.30E-11	1.65E+01
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
11	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.30E-11	1.65E+01
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
12	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.29E-11	1.65E+01
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
13	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.29E-11	1.65E+01
	ETR6D2H	TRANSFORMER T6D2 FAILURE		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
14	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	1.27E-11	1.65E+01
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	WDBSTRN	STRAINER E11-D001B PLUGGED		6.46E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
15	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA023H	CABLE 23 FAILURE		1.16E-04
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
16	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA023H	CABLE 23 FAILURE		1.16E-04
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
17	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
18	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01

#	Event	Description	Cutset Prob	Event Prob
	ECA024H	CABLE 24 FAILURE		1.16E-04
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
19	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA024H	CABLE 24 FAILURE		1.16E-04
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
20	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
21	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA041H	CABLE 41 FAILURE		1.16E-04
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
22	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA041H	CABLE 41 FAILURE		1.16E-04
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
23	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
24	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECAXX2H	CABLE FAILURE		1.16E-04
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
25	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECAXX2H	CABLE FAILURE		1.16E-04
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
26	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
27	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECAXX5H	CABLE FAILURE		1.16E-04
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
28	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECAXX5H	CABLE FAILURE		1.16E-04
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00

#	Event	Description	Cutset Prob	Event Prob
29	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.21E-11	5.00E-01
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
30	SD_TE	LOSS OF OFFSITE POWER	9.55E-12	8.82E-03
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
31	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	9.06E-12	5.00E-01
	C001AMF	RHR PUMP A FAILS TO START		1.56E-03
	ECA023H	CABLE 23 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
32	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	9.06E-12	5.00E-01
	C001AMF	RHR PUMP A FAILS TO START		1.56E-03
	ECA024H	CABLE 24 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
33	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	9.06E-12	5.00E-01
	C001AMF	RHR PUMP A FAILS TO START		1.56E-03
	ECA041H	CABLE 41 FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
34	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	9.06E-12	5.00E-01
	C001AMF	RHR PUMP A FAILS TO START		1.56E-03
	ECAXX2H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
35	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	9.06E-12	5.00E-01
	C001AMF	RHR PUMP A FAILS TO START		1.56E-03
	ECAXX5H	CABLE FAILURE		1.16E-04
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
36	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	8.99E-12	1.65E+01
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	VPVF012B	PCV P25-F012B FAILS FULL OPEN (NOFO)		4.56E-05
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_LORHRA_4			1.00E+00
37	SD_TE	LOSS OF OFFSITE POWER	7.86E-12	8.82E-03
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCD	2 D.G.'S CCF		1.94E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02

#	Event	Description	Cutset Prob	Event Prob
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
38	SD_TE	LOSS OF OFFSITE POWER	7.59E-12	8.82E-03
	EDGCD	2 D.G.'S CCF		1.94E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
39	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	7.29E-12	1.65E+01
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
40	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	7.29E-12	1.65E+01
	ETR6D2H	TRANSFORMER T6D2 FAILURE		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
41	SD_LORHRA	OTHER E11 VALVES FAIL AS INTIATING EVENT	7.21E-12	1.65E+01
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDARAC	RHR-A PUMP ROOM A.C. UNIT FAILS		2.25E-03
	WDBSTRN	STRAINER E11-D001B PLUGGED		6.46E-03
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_LORHRA_5A			1.00E+00
42	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.80E-12	5.00E-01
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
43	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.80E-12	5.00E-01
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
44	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.80E-12	5.00E-01
	ETR6D1H	TRANSFORMER T6D1 FAILS		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
45	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.80E-12	5.00E-01
	ETR6D2H	TRANSFORMER T6D2 FAILURE		6.54E-05
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
46	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.80E-12	5.00E-01
	ETR6D2H	TRANSFORMER T6D2 FAILURE		6.54E-05
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03

#	Event	Description	Cutset Prob	Event Prob
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
47	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.80E-12	5.00E-01
	ETR6D2H	TRANSFORMER T6D2 FAILURE		6.54E-05
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	XSD_LORHRAS_3			1.00E+00
48	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.71E-12	5.00E-01
	F005AMF	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)		2.08E-03
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDBSTRN	STRAINER E11-D001B PLUGGED		6.46E-03
	XSD_LORHRAS_3			1.00E+00
49	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.71E-12	5.00E-01
	F021AFO	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)		2.08E-03
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDBSTRN	STRAINER E11-D001B PLUGGED		6.46E-03
	XSD_LORHRAS_3			1.00E+00
50	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.71E-12	5.00E-01
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	W013AFC	FAILURE OF HX INLET VALVE P21-F013A (NCFC)		2.08E-03
	WDBSTRN	STRAINER E11-D001B PLUGGED		6.46E-03
	XSD_LORHRAS_3			1.00E+00

APPENDIX E - CASE 3 - CDF REALISTIC UNAVAILABILITY CASE - TOP 50 CUTSETS

The top 50 cutsets are listed below for the realistic CDF analysis of all shutdown initiating events. All cutsets include an extra event without description that begins with "XSD" and is used to create Figure 3.

#	Event	Description	Cutset Prob	Event Prob
1	SD_TE	LOSS OF OFFSITE POWER	2.46E-11	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
2	SD_TE	LOSS OF OFFSITE POWER	1.96E-11	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
3	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	8.41E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGDE	2 D.G.'S CCF		1.94E-03
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
4	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.93E-12	5.00E-01
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGDE	2 D.G.'S CCF		1.94E-03
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
5	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.69E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01

#	Event	Description	Cutset Prob	Event Prob
	EDGDE	2 D.G.'S CCF		1.94E-03
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
6	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	6.61E-12	5.00E-01
	EDGCDE	3 D.G.'S CCF		3.81E-04
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
7	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	5.44E-12	5.00E-01
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCDE	3 D.G.'S CCF		3.81E-04
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
8	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	5.25E-12	5.00E-01
	EDGCDE	3 D.G.'S CCF		3.81E-04
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
9	SD_TE	LOSS OF OFFSITE POWER	4.51E-12	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC50	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG5A	FAILURE TO RECOVER EDG DURING POS 5A		1.74E-01
	RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A		4.03E-02
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_TE_5A			1.00E+00
10	SD_TE	LOSS OF OFFSITE POWER	3.58E-12	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02

#	Event	Description	Cutset Prob	Event Prob
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC50	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG5A	FAILURE TO RECOVER EDG DURING POS 5A		1.74E-01
	RECOSP5A	FAILURE TO RECOVER OSP DURING POS 5A		4.03E-02
	X_POS5A	FRACTION OF POS 5A - 2 DAYS TO 3 DAYS		3.00E-02
	XSD_TE_5A			1.00E+00
11	SD_TE	LOSS OF OFFSITE POWER	3.04E-12	8.82E-03
	CTGMANSW	CTG MANUAL DISCONNECT SWITCH OPEN		3.00E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
12	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.66E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGE	DG E FAILS TO RUN		2.48E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
13	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.50E-12	5.00E-01
	CALN002A	MISCALIBRATION OF FLOW TRANSMITTERS FT008A,B,C		5.00E-05
	HBMAER1	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)		1.00E-02
	HPCMAINT_SD	HPCF-C UNAVAIL DUE TO MAINT		1.00E-01
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
14	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.50E-12	5.00E-01
	CALN002A	MISCALIBRATION OF FLOW TRANSMITTERS FT008A,B,C		5.00E-05
	HCMAER1	TEST VALVE E22-F005C MISPOSITIONED (CLOSED)		1.00E-02
	HPBMAINT_SD	HPCF-B UNAVAIL DUE TO MAINT		1.00E-01
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	XSD_LORHRAS_3			1.00E+00
15	SD_TE	LOSS OF OFFSITE POWER	2.44E-12	8.82E-03
	EDGE	DG E FAILS TO RUN		2.48E-02
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
16	SD_TE	LOSS OF OFFSITE POWER	2.39E-12	8.82E-03

#	Event	Description	Cutset Prob	Event Prob
	EDGCD	2 D.G.'S CCF		1.94E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
17	SD_TE	LOSS OF OFFSITE POWER	2.39E-12	8.82E-03
	EDGCE	2 D.G.'S CCF		1.94E-03
	EDGDMAINT	EDG D UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
18	SD_TE	LOSS OF OFFSITE POWER	2.39E-12	8.82E-03
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGDE	2 D.G.'S CCF		1.94E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
19	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.37E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGFSED	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
20	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.37E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGE	DG E FAILS TO RUN		2.48E-02
	EDGFSDD	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01

#	Event	Description	Cutset Prob	Event Prob
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
21	SD_TE	LOSS OF OFFSITE POWER	2.30E-12	8.82E-03
	EBY1CCFN	BATTERY CCF		5.28E-06
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS4	FAILURE TO RECOVER ECCS DURING POS 4		6.74E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
22	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.19E-12	5.00E-01
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGE	DG E FAILS TO RUN		2.48E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
23	SD_TE	LOSS OF OFFSITE POWER	2.17E-12	8.82E-03
	EDGFSED	DG FAILS TO START		2.21E-02
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
24	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.12E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGFSDD	DG FAILS TO START		2.21E-02
	EDGFSED	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
25	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	2.11E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGE	DG E FAILS TO RUN		2.48E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02

#	Event	Description	Cutset Prob	Event Prob
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
26	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.95E-12	5.00E-01
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGFSED	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
27	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.95E-12	5.00E-01
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGE	DG E FAILS TO RUN		2.48E-02
	EDGFSDD	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
28	SD_TE	LOSS OF OFFSITE POWER	1.94E-12	8.82E-03
	EDGE	DG E FAILS TO RUN		2.48E-02
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
29	SD_TE	LOSS OF OFFSITE POWER	1.90E-12	8.82E-03
	EDGCD	2 D.G.'S CCF		1.94E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
30	SD_TE	LOSS OF OFFSITE POWER	1.90E-12	8.82E-03
	EDGCE	2 D.G.'S CCF		1.94E-03
	EDGDMAINT	EDG D UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02

#	Event	Description	Cutset Prob	Event Prob
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
31	SD_TE	LOSS OF OFFSITE POWER	1.90E-12	8.82E-03
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGDE	2 D.G.'S CCF		1.94E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
32	SD_TE	LOSS OF OFFSITE POWER	1.89E-12	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFLR	CTG FAILS TO LOAD AND RUN FOR FIRST HOUR		1.87E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
33	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.89E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGD	DG D FAILS TO RUN		2.48E-02
	EDGFSED	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
34	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.89E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGE	DG E FAILS TO RUN		2.48E-02
	EDGFSDD	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
35	SD_TE	LOSS OF OFFSITE POWER	1.87E-12	8.82E-03

#	Event	Description	Cutset Prob	Event Prob
	EDGCDE	3 D.G.'S CCF		3.81E-04
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
36	SD_TE	LOSS OF OFFSITE POWER	1.87E-12	8.82E-03
	EDGCDEN	3 D.G.'S CCF		3.81E-04
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
37	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.86E-12	5.00E-01
	CCFTLU	CCF SYSTEM LOGIC UNIT FAILS		3.72E-06
	HOOBOPHL	OPERATOR FAILS TO ATTEMPT MANUAL INITIATION OF HPCF AFTER 30 MIN.		1.00E-01
	OPERATOR	OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC		1.00E-04
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
38	SD_TE	LOSS OF OFFSITE POWER	1.86E-12	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		3.00E-03
	XSD_TE_3			1.00E+00
39	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.74E-12	5.00E-01
	CTGMAN	MANUAL INITIATION		2.00E-02
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGFSDD	DG FAILS TO START		2.21E-02
	EDGFSED	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
40	SD_TE	LOSS OF OFFSITE POWER	1.73E-12	8.82E-03
	EDGFSED	DG FAILS TO START		2.21E-02
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER		2.00E-02

#	Event	Description	Cutset Prob	Event Prob
		ADDITION SYSTEM		
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
41	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.68E-12	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGFSDD	DG FAILS TO START		2.21E-02
	EDGFSED	DG FAILS TO START		2.21E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
42	SD_TE	LOSS OF OFFSITE POWER	1.49E-12	8.82E-03
	EDGCDE	3 D.G.'S CCF		3.81E-04
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
43	SD_TE	LOSS OF OFFSITE POWER	1.49E-12	8.82E-03
	EDGCDEN	3 D.G.'S CCF		3.81E-04
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
44	SD_TE	LOSS OF OFFSITE POWER	1.48E-12	8.82E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	GTURBINEFR	CTG FAILS TO RUN		1.93E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG3	FAILURE TO RECOVER EDG DURING POS 3		3.57E-01
	RECOSP3	FAILURE TO RECOVER OSP DURING POS 3		8.10E-02
	X_POS3	FRACTION OF POS 3 - 4HOURS TO 6 HOURS		3.00E-03
	XSD_TE_3			1.00E+00
45	SD_TE	LOSS OF OFFSITE POWER	1.11E-12	8.82E-03
	ECBCTG1	CTG DIV 1 BREAKER FAILS TO CLOSE		1.10E-03
	EDGEMAINT	EDG E UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGMAN	MANUAL INITIATION FAILURE		2.00E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER		2.00E-02

#	Event	Description	Cutset Prob	Event Prob
		ADDITION SYSTEM		
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECEDG4	FAILURE TO RECOVER EDG DURING POS 4		3.13E-01
	RECOSP4	FAILURE TO RECOVER OSP DURING POS 4		6.92E-02
	X_POS4	FRACTION OF POS 4 - 6HOURS TO 2 DAYS		5.30E-02
	XSD_TE_4			1.00E+00
46	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	1.04E-12	5.00E-01
	CTGMANSW	CTG MANUAL DISCONNECT SWITCH OPEN		3.00E-03
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGDE	2 D.G.'S CCF		1.94E-03
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
47	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	8.41E-13	5.00E-01
	EDGCMAINT	EDG C UNAVAILABLE DUE TO MAINTENANCE		2.50E-01
	EDGDE	2 D.G.'S CCF		1.94E-03
	ELOOP1	LOSS OF OFF-SITE LINE 1 (1,1) POWER		1.00E-02
	ELOOP2	LOSS OF OFF-SITE LINE 2 (2,2)		1.00E-02
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
48	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	8.33E-13	5.00E-01
	EDGC	DG C FAILS TO RUN		2.48E-02
	EDGDE	2 D.G.'S CCF		1.94E-03
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
49	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	8.33E-13	5.00E-01
	EDGCD	2 D.G.'S CCF		1.94E-03
	EDGE	DG E FAILS TO RUN		2.48E-02
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00
50	SD_LORHRAS	FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING	8.33E-13	5.00E-01
	EDGCE	2 D.G.'S CCF		1.94E-03
	EDGD	DG D FAILS TO RUN		2.48E-02

#	Event	Description	Cutset Prob	Event Prob
	ELOOP12	COMMON MODE LOSS OF BOTH OFFSITE POWER		1.00E-03
	GTURBINEFS	CTG FAILS TO START AND LOAD		2.43E-02
	OP-ACIWA	OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM		2.00E-02
	REC90	NON-RECOVERY OF FAILED EQUIPMENT		1.00E+00
	RECECCS3	FAILURE TO RECOVER ECCS DURING POS 3		7.14E-01
	WDAMAINT_SD	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE		1.00E-01
	XSD_LORHRAS_3			1.00E+00

APPENDIX F FAULT TREE BASIC EVENT LISTING

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ADSMAN	1	1	N	OPERATOR FAILS TO OPEN NON-ADS SRV'S	2.00E-03	N	2.00E-03
ANTMD1VL	3	360	H	INTERNAL TIMER FAILS TO TRIP VALVE	1.50E-06	H	5.40E-04
ANTMD2VL	3	360	H	INTERNAL TIMER FAILS TO TRIP VALVE	1.50E-06	H	5.40E-04
ARVCCFD	1	1	N	COMMON CAUSE FAILURE OF SRV'S	4.34E-05	N	4.34E-05
BF003AFC	3	1095	H	TESTABLE CHECK VALVE B21-F003A FAILS TO OPEN	5.87E-08	H	6.43E-05
BF004AFC	1	1	N	CHECK VALVE B21-F004A FAILS TO OPEN	6.07E-05	N	6.07E-05
BF005AFC	3	1095	H	MANUAL VALVE B21-F005A FAILS CLOSED (NOFC)	1.76E-08	H	1.93E-05
BF005AFC_IE	3	24	H	MANUAL VALVE B21-F005A FAILS CLOSED (NOFC)	1.76E-08	H	4.22E-07
C001ACB	1	1	N	RHR CIRCUIT BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
C001AMF	1	1	N	RHR PUMP A FAILS TO START	1.56E-03	N	1.56E-03
C001AMOV	1	1	N	MANUAL OVERRIDE FAILS INITIATION SIGNAL	1.80E-04	N	1.80E-04
C001BCB	1	1	N	RHR CIRCUIT BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
C001BMF	1	1	N	RHR PUMP B FAILS TO START	1.56E-03	N	1.56E-03
C001BMOV	1	1	N	MANUAL OVERRIDE FAILS INITIATION SIGNAL	1.80E-04	N	1.80E-04
C001CCB	1	1	N	RHR CIRCUIT BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
C001CMF	1	1	N	RHR PUMP C FAILS TO START	1.56E-03	N	1.56E-03
C001CMOV	1	1	N	MANUAL OVERRIDE FAILS INITIATION SIGNAL	1.80E-04	N	1.80E-04
CALN002A	1	1	N	MISCALIBRATION OF FLOW TRANSMITTERS FT008A,B,C	5.00E-05	N	5.00E-05
CCFBYP		2.45E-06		CCF SLU BYPASS UNIT			2.45E-06
CCFDTM		6.31E-08		CCF OF DIGITAL TRIP UNITS			6.31E-08
CCFMUX *		6.31E-08		CCF OF TRANSMISSION NETWORK (EMS)			6.31E-08
CCFS3A		1.26E-06		RPV PRESSURE SENSORS CCF			1.26E-06
CCFTLU *		3.72E-06		CCF SYSTEM LOGIC UNIT FAILS			3.72E-06
CHWLI		6.60E-06		THE CONDENSER HOTWELL LEVEL INSUFFICIENT			6.60E-06
CMAINT		0.1		CONDENSATE UNAVAILABLE DUE TO MAINTENANCE			1.00E-01
COAD	1	1	n	PUMP A FAILS TO START	1.66E-03	n	1.66E-03
COAR	3	24	H	PUMP A FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04
COBD	1	1	n	PUMP B FAILS TO START	1.66E-03	n	1.66E-03
COBR	3	24	H	PUMP B FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
COCD	1	1	n	PUMP C FAILS TO START	1.66E-03	n	1.66E-03
COCR	3	24	H	PUMP C FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04
CODD	1	1	n	PUMP D FAILS TO START	1.66E-03	n	1.66E-03
CODR	3	24	H	PUMP D FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04
CONOP		2.00E-02		OPERATOR FAILURE TO INITIATE CONDENSATE FLOW MANUALLY			2.00E-02
COVLVA	1	1	n	PUMP A LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
COVLVB	1	1	n	PUMP B LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
COVLVC	1	1	n	PUMP C LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
COVLVD	1	1	n	PUMP D LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
CR001AR	3	24	H	ACTIVE PUMP C001A FAILS TO RUN	6.27E-06	H	1.50E-04
CR001BD	1	1	n	STANDBY PUMP C001B FAILS TO START	1.56E-03	n	1.56E-03
CR001BM		0.1		STANDBY PUMP C001B IN MAINTENANCE			1.00E-01
CR001BR	3	23	H	STANDBY PUMP C001B FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
CR001BR1	3	1	H	STANDBY PUMP C001B FAILS TO RUN FOR FIRST HOUR	9.69E-06	H	9.69E-06
CR002AP	3	24	H	DRIVE WATER FILTER D002A PLUGS	1.22E-07	H	2.93E-06
CR002BP	3	24	H	DRIVE WATER FILTER D002B PLUGS	1.22E-07	H	2.93E-06
CR005B	1	1	n	PUMP DISCHARGE CHECK VALVE F005B FAILS TO OPEN	6.07E-05	n	6.07E-05
CRDCST		6.60E-06		CST WATER LEVEL INSUFFICIENT			6.60E-06
CRDOP		2.00E-02		OPERATOR FAILURE TO INITIATE STANDBY CRD MANUALLY			2.00E-02
CRFLOP		2.00E-02		OPERATOR FAILURE TO INCREASE CRD FLOW RATE			2.00E-02
CTGMAN		0.02		MANUAL INITIATION			2.00E-02
CTGMANSW	1	1	N	CTG MANUAL DISCONNECT SWITCH OPEN	3.00E-03	N	3.00E-03
DIV1MUX	3	59	H	DIVISION 1 TRANSMISSION NETWORK FAILURE (EMS)	1.07E-06	H	6.31E-05
DIV2MUX	3	59	H	DIVISION 2 TRANSMISSION NETWORK FAILURE (EMS)	1.07E-06	H	6.31E-05
DIV3MUX	3	59	H	DIVISION 3 TRANSMISSION NETWORK FAILURE (EMS)	1.07E-06	H	6.31E-05
DIV4MUX	3	59	H	DIVISION 4 TRANSMISSION NETWORK FAILURE (EMS)	1.07E-06	H	6.31E-05
DLS001A	3	1095	H	VALVE E11-F001A LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS001B	3	1095	H	VALVE E11-F001B LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS001C	3	1095	H	VALVE E11-F001C LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS008A	3	1095	H	VALVE E11-F008A LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS008B	3	1095	H	VALVE E11-F008B LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS008C	3	1095	H	VALVE E11-F008C LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
DLS018B	3	1095	H	VALVE E11-F018B LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS018C	3	1095	H	VALVE E11-F018C LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS019B	3	1095	H	VALVE E11-F019B LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLS019C	3	1095	H	VALVE E11-F019C LIMIT SWITCH FAILS	6.11E-06	H	6.67E-03
DLSPMPRUN	3	23	H	FAILURE OF DIESEL FIRE PUMP TO RUN AFTER 1 HOUR	5.59E-04	H	1.28E-02
DLSPMPRUN1	3	1	H	FAILURE OF DIESEL FIRE PUMP TO RUN DURING FIRST HOUR	4.79E-03	H	4.78E-03
DSLPMPSTART	1	2.46E-04	N	FAILURE OF DIESEL FIRE PUMP TO START	1.25E-02	N	3.08E-06
EAC69CH	3	24	H	DIV 1 SWGR FAILURE	2.23E-07	H	5.35E-06
EAC69CHN	3	24	H	DIV 1 SWGR FAILURE	2.23E-07	H	5.35E-06
EAC69DH	3	24	H	DIV 2 SWGR FAILURE	2.23E-07	H	5.35E-06
EAC69DHN	3	24	H	DIV 2 SWGR FAILURE	2.23E-07	H	5.35E-06
EAC69EH	3	24	H	DIV 3 SWGR FAILURE	2.23E-07	H	5.35E-06
EAC69EHN	3	24	H	DIV 3 SWGR FAILURE	2.23E-07	H	5.35E-06
EBC404H	3	7.6	H	480V FEEDER BREAKER 404 OPEN	2.88E-07	H	2.19E-06
EBC406H	3	7.6	H	480V FEEDER BREAKER 406 OPEN	2.88E-07	H	2.19E-06
EBC426H	3	7.6	H	480V FEEDER BREAKER 426 OPEN	2.88E-07	H	2.19E-06
EBC434H	3	7.6	H	480V FEEDER BREAKER 434 OPEN	2.88E-07	H	2.19E-06
EBCN11H	3	55.9	H	CHARGER FAILURE	2.43E-06	H	1.36E-04
EBCN11H_IE	3	24	H	CHARGER FAILURE	2.43E-06	H	5.83E-05
EBCN12H	3	55.9	H	CHARGER FAILURE	2.43E-06	H	1.36E-04
EBCN13H	3	55.9	H	CHARGER FAILURE	2.43E-06	H	1.36E-04
EBCN14H	3	55.9	H	CHARGER FAILURE	2.43E-06	H	1.36E-04
EBCS12H	3	55.9	H	STANDBY CHARGER FAILURE	2.43E-06	H	1.36E-04
EBCS34H	3	55.9	H	STANDBY CHARGER FAILURE	2.43E-06	H	1.36E-04
EBS6C1H	3	24	H	SWITCHGEAR P/C 6C-1 FAILURE	2.23E-07	H	5.35E-06
EBS6C1HN	3	24	H	SWITCHGEAR P/C 6C-1 FAILURE	2.23E-07	H	5.35E-06
EBS6C2H	3	24	H	BUS P/C 6C-2 FAILURE	2.23E-07	H	5.35E-06
EBS6D1H	3	24	H	SWITCHGEAR P/C 6D-1 FAILURE	2.23E-07	H	5.35E-06
EBS6D1HN	3	24	H	SWITCHGEAR P/C 6D-1 FAILURE	2.23E-07	H	5.35E-06
EBS6D2H	3	24	H	BUS P/C 6D-2 FAILURE	2.23E-07	H	5.35E-06
EBS6E1H	3	24	H	SWITCHGEAR P/C 6E-1 FAILURE	2.23E-07	H	5.35E-06
EBS6E2H	3	24	H	BUS P/C 6E-2 FAILURE	2.23E-07	H	5.35E-06

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
EBSE1H	3	24	H	ESF DIV 1 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSE1HN	3	24	H	ESF DIV 1 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSE2H	3	24	H	ESF DIV 2 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSE2HN	3	24	H	ESF DIV 2 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSE3H	3	24	H	ESF DIV 3 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSXX1H	3	24	H	ESF DIV 1 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSXX2H	3	24	H	ESF DIV 2 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSXX3H	3	24	H	ESF DIV 3 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSXX4H	3	24	H	ESF DIV 1 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSXX5H	3	24	H	ESF DIV 2 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBSXX6H	3	24	H	ESF DIV 3 480V MCC BUS FAILURE	2.23E-07	H	5.35E-06
EBY101H	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY101HN	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY102H	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY102HN	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY103H	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY103HN	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY104H	3	284	H	BATTERY FAILURE	1.86E-06	H	5.28E-04
EBY1CCF		5.28E-06		BATTERY CCF			5.28E-06
EBY1CCFN		5.28E-06		BATTERY CCF			5.28E-06
ECA002H	3	24	H	NORMAL PREFERRED CABLE 2,4 OR 10 FAILURE	4.84E-06	H	1.16E-04
ECA011H	3	24	H	CABLE 7,11 OR 12 FAILURE	4.84E-06	H	1.16E-04
ECA021H	3	24	H	CABLE 21 FAILURE	4.84E-06	H	1.16E-04
ECA021HN	3	24	H	CABLE 21 FAILURE	4.84E-06	H	1.16E-04
ECA022H	3	24	H	CABLE 22 FAILURE	4.84E-06	H	1.16E-04
ECA023H	3	24	H	CABLE 23 FAILURE	4.84E-06	H	1.16E-04
ECA023HN	3	24	H	CABLE 23 FAILURE	4.84E-06	H	1.16E-04
ECA024H	3	24	H	CABLE 24 FAILURE	4.84E-06	H	1.16E-04
ECA025H	3	24	H	CABLE 25 FAILURE	4.84E-06	H	1.16E-04
ECA026H	3	24	H	CABLE 26 FAILURE	4.84E-06	H	1.16E-04
ECA040H	3	24	H	CABLE 40 FAILURE	4.84E-06	H	1.16E-04
ECA040HN	3	24	H	CABLE 40 FAILURE	4.84E-06	H	1.16E-04

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ECA041H	3	24	H	CABLE 41 FAILURE	4.84E-06	H	1.16E-04
ECA041HN	3	24	H	CABLE 41 FAILURE	4.84E-06	H	1.16E-04
ECA042H	3	24	H	CABLE 42 FAILURE	4.84E-06	H	1.16E-04
ECA043H	3	24	H	480V INPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECA044H	3	24	H	480V FEEDER CABLE 44 FAILURE	4.84E-06	H	1.16E-04
ECA045H	3	24	H	480V INPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECA046H	3	24	H	480V FEEDER CABLE 46 FAILURE	4.84E-06	H	1.16E-04
ECA047H	3	24	H	480V INPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECA048H	3	24	H	480V FEEDER CABLE 48 FAILURE	4.84E-06	H	1.16E-04
ECA050H	3	24	H	480V INPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECA051H	3	24	H	480V FEEDER CABLE 51 FAILURE	4.84E-06	H	1.16E-04
ECA1B1H	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECA1B1HN	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECA1B2H	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECA1B2HN	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECA1B3H	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECA1B3HN	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECA1B4H	3	24	H	BATTERY CABLE FAILURE	4.84E-06	H	1.16E-04
ECACTGH	3	24	H	CTG CABLE FAILURE	4.84E-06	H	1.16E-04
ECADGCH	3	24	H	DG C CABLE FAILURE	4.84E-06	H	1.16E-04
ECADGDH	3	24	H	DG D CABLE FAILURE	4.84E-06	H	1.16E-04
ECADGEH	3	24	H	DG E CABLE FAILURE	4.84E-06	H	1.16E-04
ECAN11H	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAN12H	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAN13H	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAN14H	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAS1AH	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAS1BH	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAS1CH	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAS1DH	3	24	H	CHARGER OUTPUT CABLE FAILURE	4.84E-06	H	1.16E-04
ECAXX1H	3	24	H	CABLE FAILURE	4.84E-06	H	1.16E-04
ECAXX2H	3	24	H	CABLE FAILURE	4.84E-06	H	1.16E-04

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ECAXX3H	3	24	H	CABLE FAILURE	4.84E-06	H	1.16E-04
ECAXX4H	3	24	H	CABLE FAILURE	4.84E-06	H	1.16E-04
ECAXX5H	3	24	H	CABLE FAILURE	4.84E-06	H	1.16E-04
ECAXX6H	3	24	H	CABLE FAILURE	4.84E-06	H	1.16E-04
ECB1B1H	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1B1HN	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1B2H	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1B2HN	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1B3H	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1B3HN	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1B4H	3	7.6	H	BATTERY OUTPUT BREAKER OPEN	2.88E-07	H	2.19E-06
ECB1DCH	3	7.6	H	DIV 1 DC POWER BKR 1 FAILS OPEN	2.88E-07	H	2.19E-06
ECB2DCH	3	7.6	H	DIV 2 DC POWER BKR 2 FAILS OPEN	2.88E-07	H	2.19E-06
ECB301H	3	7.6	H	P/C 6C-1 INCOMING BKR 301 OPEN	2.88E-07	H	2.19E-06
ECB301HN	3	7.6	H	P/C 6C-1 INCOMING BKR 301 OPEN	2.88E-07	H	2.19E-06
ECB312H	3	7.6	H	SWITCHGEAR P/C 6C-1 FEED BREAKER 312 OPEN	2.88E-07	H	2.19E-06
ECB312HN	3	7.6	H	SWITCHGEAR P/C 6C-1 FEED BREAKER 312 OPEN	2.88E-07	H	2.19E-06
ECB331H	3	7.6	H	P/C 6C-2 INCOMING BREAKER 331 OPEN	2.88E-07	H	2.19E-06
ECB341H	3	7.6	H	P/C 6D-1 INCOMING BKR 341 OPEN	2.88E-07	H	2.19E-06
ECB341HN	3	7.6	H	P/C 6D-1 INCOMING BKR 341 OPEN	2.88E-07	H	2.19E-06
ECB354H	3	7.6	H	SWITCHGEAR P/C 6C-1 FEED BREAKER 354 OPEN	2.88E-07	H	2.19E-06
ECB354HN	3	7.6	H	SWITCHGEAR P/C 6C-1 FEED BREAKER 354 OPEN	2.88E-07	H	2.19E-06
ECB361H	3	7.6	H	P/C 6D-2 INCOMING BREAKER 361 OPEN	2.88E-07	H	2.19E-06
ECB371H	3	7.6	H	P/C 6E-2 INCOMING BKR 371 OPEN	2.88E-07	H	2.19E-06
ECB380H	3	7.6	H	SWITCHGEAR P/C 6E-1 FEED BREAKER 380 OPEN	2.88E-07	H	2.19E-06
ECB391H	3	7.6	H	P/C 6E-2 INCOMING BREAKER 391 OPEN	2.88E-07	H	2.19E-06
ECB3DCH	3	7.6	H	DIV 3 DC POWER BKR 3 FAILS OPEN	2.88E-07	H	2.19E-06
ECB403H	3	7.6	H	480V FEEDER BREAKER 403 OPEN	2.88E-07	H	2.19E-06
ECB405H	3	7.6	H	480V FEEDER BREAKER 405 OPEN	2.88E-07	H	2.19E-06
ECB410H	3	7.6	H	DIV 1 480V MCC INCOMING BREAKER 410 OPEN	2.88E-07	H	2.19E-06
ECB410HN	3	7.6	H	DIV 1 480V MCC INCOMING BREAKER 410 OPEN	2.88E-07	H	2.19E-06
ECB420H	3	7.6	H	DIV 2 480V MCC INCOMING BREAKER 420 OPEN	2.88E-07	H	2.19E-06

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ECB420HN	3	7.6	H	DIV 2 480V MCC INCOMING BREAKER 420 OPEN	2.88E-07	H	2.19E-06
ECB425H	3	7.6	H	480V FEEDER BREAKER 425 OPEN	2.88E-07	H	2.19E-06
ECB430H	3	7.6	H	DIV 3 480V MCC INCOMING BREAKER 430 OPEN	2.88E-07	H	2.19E-06
ECB433H	3	7.6	H	480V FEEDER BREAKER 433 OPEN	2.88E-07	H	2.19E-06
ECB901H	3	7.6	H	INCOMING BKR TO M/C E OPEN	2.88E-07	H	2.19E-06
ECB902H	1	1	N	INCOMING BKR 902 FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECB904H	3	7.6	H	6.9 KV BREAKER 904 OPEN	2.88E-07	H	2.19E-06
ECB905H	1	1	N	DG BKR 905 FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECB911H	3	7.6	H	6.9 KV BREAKER 911 OPEN	2.88E-07	H	2.19E-06
ECB911HN	3	7.6	H	6.9 KV BREAKER 911 OPEN	2.88E-07	H	2.19E-06
ECB921H	3	7.6	H	INCOMING BKR TO M/C F OPEN	2.88E-07	H	2.19E-06
ECB922H	1	1	N	INCOMING BKR 922 FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECB924H	3	7.6	H	6.9 KV BREAKER 924 OPEN	2.88E-07	H	2.19E-06
ECB925H	1	1	N	DG BKR 925 FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECB926H	1	1	n	SAFETY BKR FAILS TO CLOSE	1.10E-03	n	1.10E-03
ECB927H	1	1	n	NON-SAFETY BKR FAILS TO CLOSE	1.10E-03	n	1.10E-03
ECB931H	3	7.6	H	6.9 KV BREAKER 931 OPEN	2.88E-07	H	2.19E-06
ECB931HN	3	7.6	H	6.9 KV BREAKER 931 OPEN	2.88E-07	H	2.19E-06
ECB941H	3	7.6	H	INCOMING BKR TO M/C G OPEN	2.88E-07	H	2.19E-06
ECB942H	1	1	N	INCOMING BKR 942 FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECB944H	3	7.6	H	6.9 KV BREAKER 944 OPEN	2.88E-07	H	2.19E-06
ECB945H	1	1	N	DG BKR 945 FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECB951H	3	7.6	H	6.9 KV BREAKER 951 OPEN	2.88E-07	H	2.19E-06
ECBCTG1	1	1	N	CTG DIV 1 BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBCTG1N	1	1	N	CTG DIV 1 BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBCTG2	1	1	N	CTG DIV 2 BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBCTG2N	1	1	N	CTG DIV 2 BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBCTG3	1	1	N	CTG DIV 3 BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBCTG3N	1	1	N	CTG DIV 3 BREAKER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBD12H	3	7.6	H	125V DC DISTRIBUTION PANEL BKR D12 OPEN	2.88E-07	H	2.19E-06
ECBD22H	3	7.6	H	125V DC DISTRIBUTION PANEL BKR D22 OPEN	2.88E-07	H	2.19E-06
ECBD23H	3	7.6	H	125 V NON-DIVISIONAL DISTRIBUTION PEANEL OPEN	2.88E-07	H	2.19E-06

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ECBD32H	3	7.6	H	125V DC DISTRIBUTION PANEL BKR D32 OPEN	2.88E-07	H	2.19E-06
ECBN01H	1	1	N	OUTPUT TRANSFER BREAKER IN NORMAL CHARGER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBN02H	1	1	N	OUTPUT TRANSFER BREAKER IN NORMAL CHARGER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBN03H	1	1	N	OUTPUT TRANSFER BREAKER IN NORMAL CHARGER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBN04H	1	1	N	OUTPUT TRANSFER BREAKER IN NORMAL CHARGER FAILS TO CLOSE	1.10E-03	N	1.10E-03
ECBX11H	3	7.6	H	DIV 1 480V MCC INCOMING BREAKER OPEN	2.88E-07	H	2.19E-06
ECBX12H	3	7.6	H	DIV 2 480V MCC INCOMING BREAKER OPEN	2.88E-07	H	2.19E-06
ECBX13H	3	7.6	H	DIV 3 480V MCC INCOMING BREAKER OPEN	2.88E-07	H	2.19E-06
ECBX14H	3	7.6	H	DIV 1 480V MCC INCOMING BREAKER OPEN	2.88E-07	H	2.19E-06
ECBX15H	3	7.6	H	DIV 2 480V MCC INCOMING BREAKER OPEN	2.88E-07	H	2.19E-06
ECBX16H	3	7.6	H	DIV 3 480V MCC INCOMING BREAKER OPEN	2.88E-07	H	2.19E-06
ECBXX1H	3	7.6	H	SWITCHGEAR P/C 6C-2 FEED BREAKER OPEN	2.88E-07	H	2.19E-06
ECBXX2H	3	7.6	H	SWITCHGEAR P/C 6D-2 FEED BREAKER OPEN	2.88E-07	H	2.19E-06
ECBXX3H	3	7.6	H	SWITCHGEAR P/C 6E-2 FEED BREAKER OPEN	2.88E-07	H	2.19E-06
ECBXX4H	3	7.6	H	SWGR P/C 6C-1 FEEDER BREAKER OPEN	2.88E-07	H	2.19E-06
ECBXX5H	3	7.6	H	SWGR P/C 6D-1 FEEDER BREAKER OPEN	2.88E-07	H	2.19E-06
ECBXX6H	3	7.6	H	SWGR P/C 6E-1 FEEDER BREAKER OPEN	2.88E-07	H	2.19E-06
ECL902H	3	365	H	BKR CONTROL LOGIC FAILURE	1.07E-06	H	3.90E-04
ECL922H	3	365	H	BKR CONTROL LOGIC FAILURE	1.07E-06	H	3.90E-04
ECL942H	3	365	H	BKR CONTROL LOGIC FAILURE	1.07E-06	H	3.90E-04
EDC11N	3	24	H	FAILURE OF GROUP A 125V DC BUS	2.23E-07	H	5.35E-06
EDC12N	3	24	H	FAILURE OF GROUP B 125 V DC BUS	2.23E-07	H	5.35E-06
EDC13N	3	24	H	FAILURE OF GROUP C 125 V DC BUS	2.23E-07	H	5.35E-06
EDE0A1H		1.43E-06		DIODE SID OPEN			1.43E-06
EDE0A1HN		1.43E-06		DIODE SID OPEN			1.43E-06
EDE0B1H		1.43E-06		DIODE SID OPEN			1.43E-06
EDE0B1HN		1.43E-06		DIODE SID OPEN			1.43E-06
EDE0C1H		1.43E-06		DIODE SID OPEN			1.43E-06
EDE0C1HN		1.43E-06		DIODE SID OPEN			1.43E-06
EDE0D1H		1.43E-06		DIODE SID OPEN			1.43E-06
EDGC	3	23	H	DG C FAILS TO RUN	1.09E-03	H	2.48E-02
EDGC1	1	1	N	DG C FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	N	2.90E-03

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
EDGCD	1	1	N	2 D.G.'S CCF	1.94E-03	N	1.94E-03
EDGCDE	1	1	N	3 D.G.'S CCF	3.81E-04	N	3.81E-04
EDGCDEN	1	1	N	3 D.G.'S CCF	3.81E-04	N	3.81E-04
EDGCE	1	1	N	2 D.G.'S CCF	1.94E-03	N	1.94E-03
EDGCMAINT	0	0.25		EDG C UNAVAILABLE DUE TO MAINTENANCE	2.00E-02	N	2.50E-01
EDGD	3	23	H	DG D FAILS TO RUN	1.09E-03	H	2.48E-02
EDGD1	1	1	N	DG D FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	N	2.90E-03
EDGDE	1	1	N	2 D.G.'S CCF	1.94E-03	N	1.94E-03
EDGDMAINT	0	0.25		EDG D UNAVAILABLE DUE TO MAINTENANCE	2.00E-02	N	2.50E-01
EDGE	3	23	H	DG E FAILS TO RUN	1.09E-03	H	2.48E-02
EDGE1	1	1	N	DG E FAILS TO LOAD AND RUN DURING FIRST HOUR	2.90E-03	N	2.90E-03
EDGEMAINT	0	0.25		EDG E UNAVAILABLE DUE TO MAINTENANCE	2.00E-02	N	2.50E-01
EDGFSCD	1	1	N	DG FAILS TO START	2.21E-02	N	2.21E-02
EDGFSDD	1	1	N	DG FAILS TO START	2.21E-02	N	2.21E-02
EDGFSED	1	1	N	DG FAILS TO START	2.21E-02	N	2.21E-02
EDGMAN		2.00E-02		MANUAL INITIATION FAILURE			2.00E-02
EDP101H	3	24	H	FAILURE OF DIV 1 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EDP101HN	3	24	H	FAILURE OF DIV 1 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EDP102H	3	24	H	FAILURE OF DIV 2 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EDP102HN	3	24	H	FAILURE OF DIV 2 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EDP103H	3	24	H	FAILURE OF DIV 3 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EDP103HN	3	24	H	FAILURE OF DIV 3 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EDP104H	3	24	H	FAILURE OF DIV 4 DISTRIBUTION PANEL	2.23E-07	H	5.35E-06
EHU69C	1	1	N	OPERATOR FAILS TO TRANSFER POWER	1.00E-03	N	1.00E-03
EHUS1AD	1	1	N	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 1	1.00E-03	N	1.00E-03
EHUS1BD	1	1	N	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 2	1.00E-03	N	1.00E-03
EHUS1CD	1	1	N	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 3	1.00E-03	N	1.00E-03
EHUS1DD	1	1	N	OPERATOR FAILS TO TRANSFER STANDBY CHARGER TO DIV 4	1.00E-03	N	1.00E-03
ELCDGCH	3	365	H	DG C CONTROL FAILURE	1.07E-06	H	3.90E-04
ELCDGDH	3	365	H	DG D CONTROL FAILURE	1.07E-06	H	3.90E-04
ELCDGEH	3	365	H	DG E CONTROL FAILURE	1.07E-06	H	3.90E-04
ELOOP1	1	1	N	LOSS OF OFF-SITE LINE 1 (1,1) POWER	1.00E-02	N	1.00E-02

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ELOOP12	1	1	N	COMMON MODE LOSS OF BOTH OFFSITE POWER	1.00E-03	N	1.00E-03
ELOOP2	1	1	N	LOSS OF OFF-SITE LINE 2 (2,2)	1.00E-02	N	1.00E-02
ETR6C1H	3	60	H	TRANSFORMER T6C1 FAILS	1.09E-06	H	6.54E-05
ETR6C1H_IE	3	24	H	TRANSFORMER T6C1 FAILS	1.09E-06	H	2.62E-05
ETR6C1HN	3	60	H	TRANSFORMER T6C1 FAILS	1.09E-06	H	6.54E-05
ETR6C2H	3	60	H	TRANSFORMER T6C2 FAILURE	1.09E-06	H	6.54E-05
ETR6D1H	3	60	H	TRANSFORMER T6D1 FAILS	1.09E-06	H	6.54E-05
ETR6D1HN	3	60	H	TRANSFORMER T6D1 FAILS	1.09E-06	H	6.54E-05
ETR6D2H	3	60	H	TRANSFORMER T6D2 FAILURE	1.09E-06	H	6.54E-05
ETR6E1H	3	60	H	TRANSFORMER T6E1 FAILS	1.09E-06	H	6.54E-05
ETR6E2H	3	60	H	TRANSFORMER T6E2 FAILURE	1.09E-06	H	6.54E-05
ETRSU1H	3	60	H	MAIN POWER TRANSFORMER FAILS	1.09E-06	H	6.54E-05
ETRSU2H	3	60	H	RESERVE AUXILIARY TRANSFORMER FAILURE	1.09E-06	H	6.54E-05
F001AFC	3	1095	H	PUMP SUCTION VALVE E11-F001A FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
F001AFO	3	1095	H	PUMP SUCTION VALVE E11-F001A FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F001AFO_IE	3	24	H	PUMP SUCTION VALVE E11-F001A FAILS OPEN (NOFO)	1.90E-06	H	4.56E-05
F001BFC	3	1095	H	PUMP SUCTION VALVE E11-F001B FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
F001BFO	3	1095	H	PUMP SUCTION VALVE E11-F001B FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F001CFC	3	1095	H	PUMP SUCTION VALVE E11-F001C FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
F001CFO	3	1095	H	PUMP SUCTION VALVE E11-F001C FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F002AFC	1	1	N	PUMP DISCHARGE CHECK VALVE E11-F002A FAILS CLOSED	6.07E-05	N	6.07E-05
F002BFC	1	1	N	PUMP DISCHARGE CHECK VALVE E11-F002B FAILS CLOSED	6.07E-05	N	6.07E-05
F002CFC	1	1	N	PUMP DISCHARGE CHECK VALVE E11-F002C FAILS CLOSED	6.07E-05	N	6.07E-05
F003AFC	3	1095	H	MANUAL VALVE E11-F003A FAILS CLOSED	1.76E-08	H	1.93E-05
F003AFC_IE	3	24	H	MANUAL VALVE E11-F003A FAILS CLOSED	1.76E-08	H	4.22E-07
F003BFC	3	1095	H	MANUAL VALVE E11-F003B FAILS CLOSED	1.76E-08	H	1.93E-05
F003CFC	3	1095	H	MANUAL VALVE E11-F003C FAILS CLOSED	1.76E-08	H	1.93E-05
F004AFC	3	1095	H	VALVE E11-F004A FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
F004AFC_IE	3	24	H	VALVE E11-F004A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
F004BFC	3	1095	H	VALVE E11-F004B FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
F004CFC	3	1095	H	VALVE E11-F004C FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
F005AMF	3	1095	H	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)	1.90E-06	H	2.08E-03

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
F005AMF_IE	3	24	H	MECHANICAL FAILURE OF INJECTION VALVE E11-F005A (NCFC)	1.90E-06	H	4.56E-05
F005BMF	3	1095	H	MECHANICAL FAILURE OF INJECTION VALVE E11-F005B (NCFC)	1.90E-06	H	2.08E-03
F005CMF	3	1095	H	MECHANICAL FAILURE OF INJECTION VALVE E11-F005C (NCFC)	1.90E-06	H	2.08E-03
F006AMF	3	1095	H	MECHANICAL FAILURE OF TESTABLE CHECK VALVE E11-F006A	5.87E-08	H	6.43E-05
F006AMF_IE	3	24	H	MECHANICAL FAILURE OF TESTABLE CHECK VALVE E11-F006A	5.87E-08	H	1.41E-06
F006BMF	3	1095	N	MECHANICAL FAILURE OF TESTABLE CHECK VALVE E11-F006B	5.87E-08	N	6.43E-05
F006CMF	3	1095	N	MECHANICAL FAILURE OF TESTABLE CHECK VALVE E11-F006C	5.87E-08	N	6.43E-05
F008AFC	3	1095	H	VALVE E11-F008A FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F008AFC_IE	3	24	H	VALVE E11-F008A FAILS OPEN (NCFO)	1.40E-07	H	3.36E-06
F008BFC	3	1095	H	VALVE E11-F008B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F008CFC	3	1095	H	VALVE E11-F008C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F009AFC	3	1095	H	MANUAL VALVE E11-F009A FAILS TO REMAIN OPEN	1.76E-08	H	1.93E-05
F009AFC_IE	3	24	H	MANUAL VALVE E11-F009A FAILS TO REMAIN OPEN	1.76E-08	H	4.22E-07
F009BFC	3	1095	H	MANUAL VALVE E11-F009B FAILS TO REMAIN OPEN	1.76E-08	H	1.93E-05
F009CFC	3	1095	H	MANUAL VALVE E11-F009C FAILS TO REMAIN OPEN	1.76E-08	H	1.93E-05
F010AFC	3	1095	H	VALVE E11-F010A FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F010AFC_IE	3	24	H	VALVE E11-F010A FAILS CLOSED (NCFC)	1.90E-06	H	4.56E-05
F010AFO	3	1095	H	VALVE E11-F010A FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F010BFC	3	1095	H	VALVE E11-F010B FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F010CFC	3	1095	H	VALVE E11-F010C FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F011AFC	3	1095	H	VALVE E11-F011A FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F011AFC_IE	3	24	H	VALVE E11-F011A FAILS CLOSED (NCFC)	1.90E-06	H	4.56E-05
F011AFO	3	1095	H	VALVE E11-F011A FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F011BFC	3	1095	H	VALVE E11-F011B FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F011CFC	3	1095	H	VALVE E11-F011C FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F012AFC	3	1095	H	RPV SUCTION LINE ISOLATION VALVE E11-F012A FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F012AFC_IE	3	24	H	RPV SUCTION LINE ISOLATION VALVE E11-F012A FAILS CLOSED (NCFC)	1.90E-06	H	4.56E-05
F012BFC	3	1095	H	RPV SUCTION LINE ISOLATION VALVE E11-F012B FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F012CFC	3	1095	H	RPV SUCTION LINE ISOLATION VALVE E11-F012C FAILS CLOSED (NCFC)	1.90E-06	H	2.08E-03
F013AFO	3	1095	H	HX TUBE SIDE BYPASS VALVE E11-F013A FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F013AFO_IE	3	24	H	HX TUBE SIDE BYPASS VALVE E11-F013A FAILS OPEN (NCFO)	1.40E-07	H	3.36E-06
F013BFO	3	1095	H	HX TUBE SIDE BYPASS VALVE E11-F013B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
F013CFO	3	1095	H	HX TUBE SIDE BYPASS VALVE E11-F013C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F014BFO	3	1095	H	FUEL POOL VALVE E11-F014B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F014CFO	3	1095	H	FUEL POOL VALVE E11-F014C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F015BFO	3	1095	H	FUEL POOL VALVE E11-F015B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F015CFO	3	1095	H	FUEL POOL VALVE E11-F015C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F017BFO	3	1095	H	DW SPRAY VALVE E11-F017B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F017CFO	3	1095	H	DW SPRAY VALVE E11-F017C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F018BFO	3	1095	H	DW SPRAY VALVE E11-F018B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F018CFO	3	1095	H	DW SPRAY VALVE E11-F018C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F019BFO	3	1095	H	WW SPRAY VALVE E11-F019B FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F019CFO	3	1095	H	WW SPRAY VALVE E11-F019C FAILS OPEN (NCFO)	1.40E-07	H	1.53E-04
F021AFO	3	1095	H	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F021AFO_IE	3	24	H	MINIMUM FLOW VALVE E11-F021A FAILS OPEN (NOFO)	1.90E-06	H	4.56E-05
F021BFO	3	1095	H	MINIMUM FLOW VALVE E11-F021B FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F021CFO	3	1095	H	MINIMUM FLOW VALVE E11-F021C FAILS OPEN (NOFO)	1.90E-06	H	2.08E-03
F022TO	1	24	H	AOV F022 TRANSFERS OPEN (INITIATOR)	1.23E-07	H	2.95E-06
F023TO	1	1025	H	MOV F023 TRANSFERS OPEN (STANDBY)	1.40E-07	H	1.44E-04
F025TO	1	1025	H	MOV F025 TRANSFERS OPEN (STANDBY)	1.40E-07	H	1.44E-04
FALSE		0		FALSE EVENT TO TURN OFF MUTUALLY EXCLUSIVE GATE			0.00E+00
FMV021A	3	360	H	MOV F021A FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
FMV021B	3	360	H	MOV F021B FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
FP001A	3	24	H	HEAT EXCHANGER A FAILS DURING OPERATION (LEAK)	2.10E-06	H	5.04E-05
FP001AR	3	24	H	RUNNING PUMP FAILS DURING MISSION	6.27E-06	H	1.50E-04
FP001B	3	24	H	HEAT EXCHANGER B FAILS DURING OPERATION (LEAK)	2.10E-06	H	5.04E-05
FP001BD	1	1	n	PUMP C001B FAILS TO START	1.66E-03	n	1.66E-03
FP001BHM		0.1		HEAT EXCHANGER B IN MAINTENANCE			1.00E-01
FP001BM		0.1		PUMP C001B IN MAINTENANCE			1.00E-01
FP001BR	3	24	H	PUMP C001B FAILS DURING MISSION	6.27E-06	H	1.50E-04
FP003BD	1	1	n	PUMP CHECK VALVE F003B FAILS TO OPEN	6.07E-05	n	6.07E-05
FPD004A	3	24	H	STRAINER D004A PLUGS	5.92E-06	H	1.42E-04
FPD004B	3	24	H	STRAINER D004B PLUGS	5.92E-06	H	1.42E-04
FPOP		2.00E-02		OPERATOR FAILURE TO INITIATE STANDBY FP COOLING MANUALLY			2.00E-02

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
FWAD	1	1	n	PUMP A FAILS TO START	1.66E-03	n	1.66E-03
FWAR	3	24	H	PUMP A FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04
FWBD	1	1	n	PUMP B FAILS TO START	1.66E-03	n	1.66E-03
FWBR	3	24	H	PUMP B FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04
FWCD	1	1	n	PUMP C FAILS TO START	1.66E-03	n	1.66E-03
FWCR	3	24	H	PUMP C FAILS TO RUN AFTER START	6.27E-06	H	1.50E-04
FWMAINT		0.1		FEEDWATER UNAVAILABLE DUE TO MAINTENANCE			1.00E-01
FWOP		2.00E-02		OPERATOR FAILURE TO INITIATE FEEDWATER MANUALLY			2.00E-02
FWVLVA	1	1	n	PUMP A LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
FWVLVB	1	1	n	PUMP B LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
FWVLVC	1	1	n	PUMP C LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
GTURBINEFLR	1	1	N	CTG FAILS TO LOAD AND RUN FOR FIRST HOUR	1.87E-03	N	1.87E-03
GTURBINEFR	3	23	H	CTG FAILS TO RUN	8.48E-04	H	1.93E-02
GTURBINEFS	1	1	N	CTG FAILS TO START AND LOAD	2.43E-02	N	2.43E-02
HBMAER1	1	1	N	TEST VALVE E22-F005B MISPOSITIONED (CLOSED)	1.00E-02	N	1.00E-02
HBMAER2	1	1	N	TEST VALVE INADVERTENTLY LEFT OPEN	1.00E-02	N	1.00E-02
HCMAER1	1	1	N	TEST VALVE E22-F005C MISPOSITIONED (CLOSED)	1.00E-02	N	1.00E-02
HCMAER2	1	1	N	TEST VALVE INADVERTENTLY LEFT OPEN	1.00E-02	N	1.00E-02
HCV02BHP	3	1095	H	CHECK VALVE E22-F002B FAILS CLOSED	5.87E-08	H	6.43E-05
HCV02CHP	3	1095	H	CHECK VALVE E22-F002C FAILS CLOSED	5.87E-08	H	6.43E-05
HCV04BHP	3	1095	H	TESTABLE CHECK VALVE E22-F004B FAILS TO OPEN	5.87E-08	H	6.43E-05
HCV04CHP	3	1095	H	TESTABLE CHECK VALVE E22-F004C FAILS TO OPEN	5.87E-08	H	6.43E-05
HCV07BHP	1	1	N	CHECK VALVE E22-F007B FAILS CLOSED	6.07E-05		6.07E-05
HCV07CHP	1	1	N	CHECK VALVE E22-F007C FAILS CLOSED	6.07E-05		6.07E-05
HCV21BHP	3	1095	H	PUMP DISCHARGE CHECK VALVE E22-F021B FAILS TO OPEN	5.87E-08	H	6.43E-05
HCV21CHP	3	1095	H	PUMP DISCHARGE CHECK VALVE E22-F021C FAILS TO OPEN	5.87E-08	H	6.43E-05
HFE_RP2		1.00E-07		TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 2			1.00E-07
HFE_RP4		1.00E-07		TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 4			1.00E-07
HFE_RP5		1.00E-06		TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 5			1.00E-06

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
HFE_RP6		1.00E-06		TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 6			1.00E-06
HFE_RP9		1.00E-06		TYPE B ERROR OF COMMISSION HUMAN FAILURE EVENT TO OPEN RHR PATH 9			1.00E-06
HFE008BH	3	1095	H	FLOW XMITTER E22-FT008B-2 FAILS LOW	1.38E-07	H	1.51E-04
HFE008CF	1	1	N	MISCALIBRATION OF FLOW TRANSMITTERS (CCF)	5.00E-05	N	5.00E-05
HFE008CH	3	1095	H	FLOW XMITTER E22-FT008C-2 FAILS LOW	1.38E-07	H	1.51E-04
HFELEBHX	1	1	N	CCF OF WATER LEVEL 8 SENSORS MISCALIBRATED (4 DIV)	2.00E-05	N	2.00E-05
HFLSPBHW	3	1095	H	SUCTION STRAINER E22-D003B PLUGGED	5.92E-06	H	6.46E-03
HFLSPCHW	3	1095	H	SUCTION STRAINER E22-D003C PLUGGED	5.92E-06	H	6.46E-03
HLECSTAH	3	4	H	CST LEVEL SENSOR P13-LS-Z601A FAILS	4.25E-07	H	1.70E-06
HLECSTBH	3	4	H	CST LEVEL SENSOR P13-LS-Z601B FAILS	4.25E-07	H	1.70E-06
HLECSTCH	3	4	H	CST LEVEL SENSOR P13-LS-Z601C FAILS	4.25E-07	H	1.70E-06
HLECSTDH	3	4	H	CST LEVEL SENSOR P13-LS-Z601D FAILS	4.25E-07	H	1.70E-06
HLNCSTL1		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
HLNCSTL2		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
HLNCSTL3		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
HLNCSTL4		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
HMO01BDR	3	23	H	HPCF PUMP B FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
HMO01BDR1	3	1	H	HPCF PUMP B FAILS TO RUN FOR FIRST HOUR	9.69E-06	H	9.69E-06
HMO01CDR	3	23	H	HPCF PUMP C FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
HMO01CDR1	3	1	H	HPCF PUMP C FAILS TO RUN FOR FIRST HOUR	9.69E-06	H	9.69E-06
HMV06BHP	3	1095	H	PUMP SUCTION VALVE E22-F006B FAILS CLOSED (NCFC)	1.90E-06		2.08E-03
HMV06CHP	3	1095	H	PUMP SUCTION VALVE E22-F006C FAILS CLOSED (NCFC)	1.90E-06		2.08E-03
HMV08BHI	3	1095	H	TEST VALVE E22-F008B FAILS TO CLOSE	1.90E-06	H	2.08E-03
HMV08BHO	3	1095	H	VALVE E22-F008B FAILS OPEN (NCFO)	1.40E-07		1.53E-04
HMV08CHI	3	1095	H	TEST VALVE E22-F008C FAILS TO CLOSE	1.90E-06	H	2.08E-03
HMV08CHO	3	1095	H	VALVE E22-F008C FAILS OPEN (NCFO)	1.40E-07		1.53E-04
HMV09BHI	3	1095	H	TEST VALVE E22-F009B FAILS TO CLOSE	1.90E-06	H	2.08E-03
HMV09BHO	3	1095	H	VALVE E22-F009B FAILS OPEN (NCFO)	1.40E-07		1.53E-04
HMV09CHI	3	1095	H	TEST VALVE E22-F009C FAILS TO CLOSE	1.90E-06	H	2.08E-03
HMV09CHO	3	1095	H	VALVE E22-F009C FAILS OPEN (NCFO)	1.40E-07		1.53E-04

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
HMV10BHO	3	1095	H	VALVE E22-F010B FAILS TO CLOSE	1.90E-06		2.08E-03
HMV10BHW	3	1095	H	VALVE E22-F010B FAILS TO OPEN	1.90E-06	H	2.08E-03
HMV10CHO	3	1095	H	VALVE E22-F010C FAILS TO CLOSE	1.90E-06		2.08E-03
HMV10CHW	3	1095	H	VALVE E22-F010C FAILS TO OPEN	1.90E-06	H	2.08E-03
HMV14BHW	3	1095	H	VALVE E22-F003B FAILS CLOSED (NCFC-VALVE BODY STUCK)	1.90E-06	H	2.08E-03
HMV14CHW	3	1095	H	VALVE E22-F003C FAILS CLOSED (NCFC-VALVE BODY STUCK)	1.90E-06	H	2.08E-03
HOOBOPHL	1	1	N	OPERATOR FAILS TO ATTEMPT MANUAL INITIATION OF HPCF AFTER 30 MIN.	1.00E-01	N	1.00E-01
HPBMAINT_SD	0	0.1	N	HPCF-B UNAVAIL DUE TO MAINT	2.00E-02	N	1.00E-01
HPBMBC	1	1	N	PUMP B MOTOR BEARING COOLER FAILS	1.14E-04	N	1.14E-04
HPBMSC	1	1	N	PUMP B MECH. SEALER COOLER FAILS	1.14E-04	N	1.14E-04
HPBRAC	3	24	H	PUMP B ROOM A.C. UNIT FAILS	9.40E-05	H	2.25E-03
HPCMAINT_SD	0	0.1	N	HPCF-C UNAVAIL DUE TO MAINT	2.00E-02	N	1.00E-01
HPCMBC	1	1	N	PUMP C MOTOR BEARING COOLER FAILS	1.14E-04	N	1.14E-04
HPCMSC	1	1	N	PUMP C MECH. SEALER COOLER FAILS	1.14E-04	N	1.14E-04
HPCRAC	3	24	H	PUMP C ROOM A.C. UNIT FAILS	9.40E-05	H	2.25E-03
HPCSPARG	3	1095	H	SPARGERS PLUGGED	1.50E-06	H	1.64E-03
HPM01BDW	1	1	N	HPCF PUMP B FAILS TO START	1.56E-03	N	1.56E-03
HPM01CDW	1	1	N	HPCF PUMP C FAILS TO START	1.56E-03	N	1.56E-03
HPR007BH	3	4	H	PRESSURE XMITTER E22-PT007B FAILS LOW	1.57E-06	H	6.28E-06
HPR007CF	1	1	N	MISCALIBRATION OF PRESSURE TRANSMITTERS (CCF)	5.00E-05		5.00E-05
HPR007CH	3	4	H	PRESSURE XMITTER E22-PT007C FAILS LOW	1.57E-06	H	6.28E-06
HSS000HW	3	1095	H	SPARGERS PLUGGED	1.50E-06	H	1.64E-03
HUEROR5	1	1	N	OPER FAILS TO ATTEMPT MANUAL TRANSFER FROM CST TO SUPP POOL	1.00E-02	N	1.00E-02
HXA	3	24	H	HEAT EXCHANGER PLUGS DURING OPERATION	3.60E-06	H	8.64E-05
HXA1	3	24	H	HEAT EXCHANGER LEAKS DURING OPERATION	2.10E-06	H	5.04E-05
HXB	3	24	H	HEAT EXCHANGER PLUGS DURING OPERATION	3.60E-06	H	8.64E-05
HXB1	3	24	H	HEAT EXCHANGER LEAKS DURING OPERATION	2.10E-06	H	5.04E-05
HXC	3	24	H	HEAT EXCHANGER PLUGS DURING OPERATION	3.60E-06	H	8.64E-05
HXC1	3	24	H	HEAT EXCHANGER LEAKS DURING OPERATION	2.10E-06	H	5.04E-05
HXV01BHQ	3	1095	H	VALVE E22-F001B FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
HXV01CHQ	3	1095	H	VALVE E22-F001C FAILS CLOSED (NOFC)	1.40E-07	H	1.53E-04
HXV16BHQ	3	1095	H	VALVE E22-F005B FAILS TO REMAIN OPEN	1.76E-08	H	1.93E-05

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
HXV16CHQ	3	1095	H	VALVE E22-F005C FAILS TO REMAIN OPEN	1.76E-08	H	1.93E-05
IBYP1	3	370	H	BYPASS UNIT DIVISION 1 FAILS	1.07E-06	H	3.96E-04
IBYP2	3	370	H	BYPASS UNIT DIVISION 2 FAILS	1.07E-06	H	3.96E-04
IBYP3	3	370	H	BYPASS UNIT DIVISION 3 FAILS	1.07E-06	H	3.96E-04
IDTM1	3	59	H	DIGITAL TRIP MODULE FAILS DIVISION 1	1.07E-06	H	6.31E-05
IDTM2	3	59	H	DIGITAL TRIP MODULE FAILS DIVISION 2	1.07E-06	H	6.31E-05
IDTM3	3	59	H	DIGITAL TRIP MODULE FAILS DIVISION 3	1.07E-06	H	6.31E-05
IDTM4	3	59	H	DIGITAL TRIP MODULE FAILS DIVISION 4	1.07E-06	H	6.31E-05
IDWPFLG		1		FLAG			1.00E+00
IIN012H	3	59	H	DIV 1 TO 2 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN013H	3	59	H	DIV 1 TO 3 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN021H	3	59	H	DIV 2 TO 1 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN023H	3	59	H	DIV 2 TO 3 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN031H	3	59	H	DIV 3 TO 1 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN032H	3	59	H	DIV 3 TO 2 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN041H	3	59	H	DIV 4 TO 1 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN042H	3	59	H	DIV 4 TO 2 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
IIN043H	3	59	H	DIV 4 TO 3 DTM TO SLU TRANSMISSION FAILS	1.15E-06	H	6.78E-05
ILC001H	3	59	H	DIV 1 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
ILC002H	3	59	H	DIV 2 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
ILC003H	3	59	H	DIV 3 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
ILC004H	3	59	H	DIV 4 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
ILCCCFH *		6.31E-08		CCF REMOTE MULTIPLEXING UNITS			6.31E-08
ILE011H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003A	4.25E-07	H	1.70E-06
ILE012H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003B	4.25E-07	H	1.70E-06
ILE013H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003C	4.25E-07	H	1.70E-06
ILE014H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003D	4.25E-07	H	1.70E-06
ILE021H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003E	4.25E-07	H	1.70E-06
ILE022H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003F	4.25E-07	H	1.70E-06
ILE023H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003H	4.25E-07	H	1.70E-06
ILE024H	3	4	H	RPV LEVEL SENSOR FAILURE B21-LT003G	4.25E-07	H	1.70E-06
ILEPVCH		2.01E-07		RPV LEVEL SENSORS CCF			2.01E-07

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
ILINK11	3	4.25	H	SLU/EMS LINK FOR DIVISION 1 SLU 1 FAILS	1.07E-06	H	4.55E-06
ILINK11H	3	4.25	H	DIV 1 TO 1 DTM TO SLU TRANSMISSION FAILS	1.07E-06	H	4.55E-06
ILINK12	3	4.25	H	SLU/EMS LINK FOR DIVISION 2 SLU 1 FAILS	1.07E-06	H	4.55E-06
ILINK13	3	4.25	H	SLU/EMS LINK FOR DIVISION 3 SLU 1 FAILS	1.07E-06	H	4.55E-06
ILINK21	3	4.25	H	SLU/EMS LINK FOR DIVISION 1 SLU 2 FAILS	1.07E-06	H	4.55E-06
ILINK22	3	4.25	H	SLU/EMS LINK FOR DIVISION 2 SLU 2 FAILS	1.07E-06	H	4.55E-06
ILINK22H	3	4.25	H	DIV 2 TO 2 DTM TO SLU TRANSMISSION FAILS	1.07E-06	H	4.55E-06
ILINK23	3	4.25	H	SLU/EMS LINK FOR DIVISION 3 SLU 2 FAILS	1.07E-06	H	4.55E-06
ILINK33H	3	4.25	H	DIV 3 TO 3 DTM TO SLU TRANSMISSION FAILS	1.07E-06	H	4.55E-06
ILINK41	3	4.25	H	EMS/DTM LINK FOR DIVISION 1 FAILS	1.07E-06	H	4.55E-06
ILINK42	3	4.25	H	EMS/DTM LINK FOR DIVISION 2 FAILS	1.07E-06	H	4.55E-06
ILINK43	3	4.25	H	EMS/DTM LINK FOR DIVISION 3 FAILS	1.07E-06	H	4.55E-06
ILINK44	3	4.25	H	EMS/DTM LINK FOR DIVISION 4 FAILS	1.07E-06	H	4.55E-06
ILN0D1H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0D2H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0D3H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0D4H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0V1H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0V2H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0V3H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
ILN0V4H		2.05E-03		INSTRUMENT LINE BREAK			2.05E-03
IPRDW1H	3	4	H	DW PRESSURE SENSOR FAILURE B21-PT025A	1.57E-06	H	6.28E-06
IPRDW2H	3	4	H	DW PRESSURE SENSOR FAILURE B21-PT025B	1.57E-06	H	6.28E-06
IPRDW3H	3	4	H	DW PRESSURE SENSOR FAILURE B21-PT025C	1.57E-06	H	6.28E-06
IPRDW4H	3	4	H	DW PRESSURE SENSOR FAILURE B21-PT025D	1.57E-06	H	6.28E-06
IPRDWCH		1.26E-06		DW PRESSURE SENSORS CCF			1.26E-06
IRMU11	3	59	H	1ST ESF REMOTE MULTIPLEXING UNIT DIV 1 FAILS	1.07E-06	H	6.31E-05
IRMU12	3	59	H	1ST ESF REMOTE MULTIPLEXING UNIT DIV 2 FAILS	1.07E-06	H	6.31E-05
IRMU13	3	59	H	1ST ESF REMOTE MULTIPLEXING UNIT DIV 3 FAILS	1.07E-06	H	6.31E-05
IRMU21	3	59	H	2ND ESF REMOTE MULTIPLEXING UNIT DIV 1 FAILS	1.07E-06	H	6.31E-05
IRMU22	3	59	H	2ND ESF REMOTE MULTIPLEXING UNIT DIV 2 FAILS	1.07E-06	H	6.31E-05
IRMU23	3	59	H	2ND ESF REMOTE MULTIPLEXING UNIT DIV 3 FAILS	1.07E-06	H	6.31E-05

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
IRMUDWP1	3	59	H	DIV 1 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMUDWP2	3	59	H	DIV 2 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMUDWP3	3	59	H	DIV 3 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMUDWP4	3	59	H	DIV 4 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV11	3	59	H	DIV 1 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV12	3	59	H	DIV 2 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV13	3	59	H	DIV 3 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV14	3	59	H	DIV 4 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV21	3	59	H	DIV 1 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV22	3	59	H	DIV 2 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV23	3	59	H	DIV 3 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
IRMULV24	3	59	H	DIV 4 REMOTE MULTIPLEXING UNIT FAILS	1.07E-06	H	6.31E-05
ISLU11	3	59	H	SLU 1 FAILS DIVISION 1	1.07E-06	H	6.31E-05
ISLU12	3	59	H	SLU 1 FAILS DIVISION 2	1.07E-06	H	6.31E-05
ISLU13	3	59	H	SLU 1 FAILS DIVISION 3	1.07E-06	H	6.31E-05
ISLU21	3	59	H	SLU 2 FAILS DIVISION 1	1.07E-06	H	6.31E-05
ISLU22	3	59	H	SLU 2 FAILS DIVISION 2	1.07E-06	H	6.31E-05
ISLU23	3	59	H	SLU 2 FAILS DIVISION 3	1.07E-06	H	6.31E-05
LCST2	1	1	N	CST WATER LEVEL INSUFFICIENT	6.60E-06	N	6.60E-06
MCAR	3	24	H	PUMP A FAILS TO RUN	6.27E-06	H	1.50E-04
MCBD	1	1	n	PUMP LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
MCBR	3	24	H	PUMP B FAILS TO RUN	6.27E-06	H	1.50E-04
MCBS	1	1	n	PUMP B FAILS TO START	1.66E-03	n	1.66E-03
MCCD	1	1	n	PUMP LEG CHECK VALVE FAILS TO OPEN	6.07E-05	n	6.07E-05
MCCR	3	24	H	PUMP C FAILS TO RUN	6.27E-06	H	1.50E-04
MCCS	1	1	n	PUMP C FAILS TO START	1.66E-03	n	1.66E-03
MCMAINT		1.00E-01		MAIN CONDENSER UNAVAILABLE DUE TO MAINTENANCE			1.00E-01
MCOP		2.00E-02		OPERATOR FAILS TO INITIATE MAIN CONDENSER COOLING MANUALLY			2.00E-02
MCVAC		1.00E-03		LOSS OF MAIN CONDENSER VACUUM			1.00E-03
NISOL-LOCA		0.5		FRACTION OF LOCAS THAT ARE NON-ISOLABLE			5.00E-01
NSDRPVF	1	1	N	RPV WATER LEVEL INADEQUATE	1.00E-06	N	1.00E-06
OP-ACIWA		2.00E-02		OPERATOR FAILS TO INITIATE AC-INDEPENDENT WATER ADDITION SYSTEM			2.00E-02

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
OPERATOR		1.00E-04		OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC			1.00E-04
OPERL		1.00E-02		OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER MLOCA PRE-CAVITY FLOOD (POS 3 4 5A)			1.00E-02
OPERLM5		1.00E-04		OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOCA MODE 5			1.00E-04
OPERM5		1.00E-06		OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER LOSDC MODE 5			1.00E-06
OPERS		1.00E-03		OPERATOR FAILS TO FOLLOW INSTRUCTIONS AFTER SLOCA PRE-CAVITY FLOOD (POS 3 4 5A)			1.00E-03
PMPTRUCKRUN		2.40E-02		FAILURE OF DIESEL PUMPER TRUCK TO RUN			2.40E-02
PMPTRUCKSTART		2.00E-02		FAILURE OF DIESEL PUMPER TRUCK TO START			2.00E-02
PPP101	3	4	H	RPV PRESSURE SENSOR FAILURE B21-PT007A	1.57E-06	H	6.28E-06
PPP102	3	4	H	RPV PRESSURE SENSOR FAILURE B21-PT007B	1.57E-06	H	6.28E-06
PPP103	3	4	H	RPV PRESSURE SENSOR FAILURE B21-PT007C	1.57E-06	H	6.28E-06
PPP104	3	4	H	RPV PRESSURE SENSOR FAILURE B21-PT007D	1.57E-06	H	6.28E-06
REC20		1		NON-RECOVERY OF FAILED EQUIPMENT			1.00E+00
REC45		1		NON-RECOVERY OF FAILED EQUIPMENT			1.00E+00
REC50		1		NON-RECOVERY OF FAILED EQUIPMENT			1.00E+00
REC90		1		NON-RECOVERY OF FAILED EQUIPMENT			1.00E+00
RECECCS3		0.714		FAILURE TO RECOVER ECCS DURING POS 3			7.14E-01
RECECCS4		0.674		FAILURE TO RECOVER ECCS DURING POS 4			6.74E-01
RECECCS5A		0.504		FAILURE TO RECOVER ECCS DURING POS 5A			5.04E-01
RECECCS5B		5.26E-05		FAILURE TO RECOVER ECCS DURING POS 5B			5.26E-05
RECECCS5C		9.24E-07		FAILURE TO RECOVER ECCS DURING POS 5C			9.24E-07
RECECCS5D		1.11E-08		FAILURE TO RECOVER ECCS DURING POS 5D			1.11E-08
RECEDG3		0.357		FAILURE TO RECOVER EDG DURING POS 3			3.57E-01
RECEDG4		0.313		FAILURE TO RECOVER EDG DURING POS 4			3.13E-01
RECEDG5A		0.174		FAILURE TO RECOVER EDG DURING POS 5A			1.74E-01
RECEDG5B		2.89E-06		FAILURE TO RECOVER EDG DURING POS 5B			2.89E-06
RECEDG5C		6.98E-08		FAILURE TO RECOVER EDG DURING POS 5C			6.98E-08
RECEDG5D		1.62E-09		FAILURE TO RECOVER EDG DURING POS 5D			1.62E-09
RECOSP3		8.10E-02		FAILURE TO RECOVER OSP DURING POS 3			8.10E-02
RECOSP4		6.92E-02		FAILURE TO RECOVER OSP DURING POS 4			6.92E-02
RECOSP5A		4.03E-02		FAILURE TO RECOVER OSP DURING POS 5A			4.03E-02

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
RECOSP5B		2.27E-03		FAILURE TO RECOVER OSP DURING POS 5B			2.27E-03
RECOSP5C		1.43E-03		FAILURE TO RECOVER OSP DURING POS 5C			1.43E-03
RECOSP5D		9.64E-04		FAILURE TO RECOVER OSP DURING POS 5D			9.64E-04
RFE635HX	1	1	N	MISCALIBRATION OF CST LEVEL SENSORS	2.00E-05	N	2.00E-05
RHRCFER	1	1	N	FAILURE TO MANUALLY INITIATE	1.00E-01	N	1.00E-01
RHRF001TO	1	24	H	MOV F001 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF008TO	1	24	H	MOV F008 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF014TO	1	24	H	MOV F014 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF015TO	3	1095	H	MOV F015 TRANSFERS OPEN (STANDBY FAILURE)	1.40E-07	H	1.53E-04
RHRF017TO	1	24	H	MOV F017 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF018TO	1	1095	H	MOV F018 TRANSFERS OPEN (STANDBY)	1.40E-07	H	1.53E-04
RHRF019TO	1	24	H	MOV F019 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF021TO	1	24	H	MOV F021 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF029TO	1	24	H	MOV F029 TRANSFERS OPEN (INITIATOR)	1.40E-07	H	3.36E-06
RHRF030TO	3	1095	H	MOV F030 TRANSFERS OPEN (STANDBY FAILURE)	1.40E-07	H	1.53E-04
RHRSDERA		0.02		FAILURE TO MANUALLY INITIATE RHR A			2.00E-02
RHRSDERC		0.1		FAILURE TO MANUALLY INITIATE RHR C			1.00E-01
RHRSDIEA		0.02		FAILURE TO MANUALLY INITIATE RHR B			2.00E-02
RHRSDIEC		0.1		FAILURE TO MANUALLY INITIATE RHR B			1.00E-01
RMV002F	3	24	H	RWCU ISOLATION MOV F002 FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
RMV003F	3	24	H	RWCU ISOLATIONMOV F003 FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
RMV011F	3	360	H	MOV F011 FAILS CLOSED (NOFC)	1.90E-06	H	6.84E-04
RMV015F	3	24	H	MOV F015 FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
RW001AD	1	1	n	PUMP C001A FAILS TO START	1.66E-03	n	1.66E-03
RW001AR	3	24	H	PUMP C001A FAILS DURING MISSION	6.27E-06	H	1.50E-04
RW001BD	1	1	n	PUMP C001B FAILS TO START	1.66E-03	n	1.66E-03
RW001BR	3	24	H	PUMP C001B FAILS DURING MISSION	6.27E-06	H	1.50E-04
RW0021		1.14E-04		HEAT EXCHANGER 1 FAILS DURING OPERATION			1.14E-04
RW0022		1.14E-04		HEAT EXCHANGER 2 FAILS DURING OPERATION			1.14E-04
RW008AD	1	1	n	PUMP DISCHARGE CHECK VALVE F008A FAILS TO OPEN	6.07E-05	n	6.07E-05
RW008BD	1	1	n	PUMP DISCHARGE CHECK VALVE F008B FAILS TO OPEN	6.07E-05	n	6.07E-05
RW014D	1	1	n	CHECK VALVE F014 FAILS CLOSED	6.07E-05	n	6.07E-05

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
RWCUOP		2.00E-02		OPERATOR FAILURE TO INITIATE RWCU MANUALLY			2.00E-02
RWD001A	3	24	H	STRAINER D001A PLUGS	5.92E-06	H	1.42E-04
RWD001B	3	24	H	STRAINER D001B PLUGS	5.92E-06	H	1.42E-04
RWMAINT		0.1		RWCU UNAVAILABLE DUE TO MAINTENANCE			1.00E-01
SD_CUW		16.5		FLOW DIVERSION IN THE CUW SYSTEM			1.65E+01
SD_LOAC1		16.5		LOSS OF DIV I AC BUS			1.65E+01
SD_LODC1		16.5		LOSS OF DIV I DC BUS			1.65E+01
SD_LORHRA		16.5		OTHER E11 VALVES FAIL AS INTIATING EVENT			1.65E+01
SD_LORHRAS		0.5		FAILURE OF RHR TRAIN A INITIATION FOR SHUTDOWN COOLING			5.00E-01
SD_LOSWA		16.5		LOSS OF SWS TRAIN A			1.65E+01
SD_LOSWC		16.5		LOSS OF SWS TRAIN C			1.65E+01
SD_RBCA		16.5		LOSS OF RBC TRAIN A			1.65E+01
SD_RHR0		6.81E-05		PIPE BREAK IN TRAIN A RHR SYSTEM			6.81E-05
SD_RHR1		16.5		FLOW DIVERSION IN THE RHR SYSTEM			1.65E+01
SD_S01		4.99E-07		LARGE OR MEDIUM LOCA			4.99E-07
SD_S2		2.03E-06		SMALL LOCA			2.03E-06
SD_S3		2.25E-07		NON-ISOLABLE SMALL LOCA BELOW TAF IN CUW SUCTION			2.25E-07
SD_TE		8.82E-03		LOSS OF OFFSITE POWER			8.82E-03
TSTINPRB		6.85E-04		TEST IN PROGRESS			6.85E-04
TSTINPRC		6.85E-04		TEST IN PROGRESS			6.85E-04
VF016A	3	24	H	TCV P25-F016A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
VF016B	3	24	H	TCV P25-F016B FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
VF016C	3	24	H	TCV P25-F016C FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
VF022A	3	24	H	TCV P25-F022A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
VF022B	3	24	H	TCV P25-F022B FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
VF022C	3	24	H	TCV P25-F022C FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
VOPERRF		1.00E-03		OPERATOR FAILS TO START STANDBY CHILLED WATER PUMP			1.00E-03
VPR007A	3	4	H	DIFF PRESSURE TRANSMITTER P25-DPT-007A FAILS	1.57E-06	H	6.28E-06
VPR007B	3	4	H	DIFF PRESSURE TRANSMITTER P25-DPT-007B FAILS	1.57E-06	H	6.28E-06
VPR007C	3	4	H	DIFF PRESSURE TRANSMITTER P25-DPT-007C FAILS	1.57E-06	H	6.28E-06
VPRXXXA	3	4	H	DIFF PRESSURE TRANSMITTER A FAILS	1.57E-06	H	6.28E-06
VPRXXXB	3	4	H	DIFF PRESSURE TRANSMITTER B FAILS	1.57E-06	H	6.28E-06

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
VPRXXXC	3	4	H	DIFF PRESSURE TRANSMITTER C FAILS	1.57E-06	H	6.28E-06
VPRXXXE	3	4	H	DIFF PRESSURE TRANSMITTER E FAILS	1.57E-06	H	6.28E-06
VPRXXXF	3	4	H	DIFF PRESSURE TRANSMITTER F FAILS	1.57E-06	H	6.28E-06
VPVF012A	3	24	H	PCV P25-F012A FAILS FULL OPEN (NOFO)	1.90E-06	H	4.56E-05
VPVF012B	3	24	H	PCV P25-F012B FAILS FULL OPEN (NOFO)	1.90E-06	H	4.56E-05
VPVF012C	3	24	H	PCV P25-F012C FAILS FULL OPEN (NOFO)	1.90E-06	H	4.56E-05
VTE005A	3	4	H	TEMP SENSOR P25-TE-005A FAILS	1.17E-06	H	4.68E-06
VTE005B	3	4	H	TEMP SENSOR P25-TE-005B FAILS	1.17E-06	H	4.68E-06
VTE005C	3	4	H	TEMP SENSOR P25-TE-005C FAILS	1.17E-06	H	4.68E-06
W013AFC	3	1095	H	FAILURE OF HX INLET VALVE P21-F013A (NCFC)	1.90E-06	H	2.08E-03
W013AFC_IE	3	24	H	FAILURE OF HX INLET VALVE P21-F013A (NCFC)	1.90E-06	H	4.56E-05
W013BFC	3	1095	H	FAILURE OF HX INLET VALVE P21-F013B (NCFC)	1.90E-06	H	2.08E-03
W013CFC	3	1095	H	FAILURE OF HX INLET VALVE P21-F013C (NCFC)	1.90E-06	H	2.08E-03
WAVR6AH	3	24	H	TEMPERATURE CONTROL VALVE P21-F006A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WAVR6BH	3	24	H	TEMPERATURE CONTROL VALVE P21-F006B FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WAVR6CH	3	24	H	TEMPERATURE CONTROL VALVE P21-F006C FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WCVH1F	1	1	N	STANDBY PUMP LEG CHECK VALVE P25-F001F FAILS TO OPEN	6.07E-05	N	6.07E-05
WCVR1DD	1	1	N	STANDBY PUMP CHECK VALVE P21-F001D FAILS TO OPEN	6.07E-05	N	6.07E-05
WCVR1ED	1	1	N	STANDYBY PUMP CHECK VALVE P21-F001E FAILS TO OPEN	6.07E-05	N	6.07E-05
WCVR1FD	1	1	N	STANDYBY PUMP CHECK VALVE P21-F001F FAILS TO OPEN	6.07E-05	N	6.07E-05
WCVS1DD	1	1	N	STANDBY PUMP LEG CHECK VALVE P41-F001D FAILS TO OPEN	6.07E-05	N	6.07E-05
WCVS1ED	1	1	N	STANDBY PUMP LEG CHECK VALVE P41-F001E FAILS TO OPEN	6.07E-05	N	6.07E-05
WCVS1FD	1	1	N	STANDBY PUMP LEG CHECK VALVE P41-F001F FAILS TO OPEN	6.07E-05	N	6.07E-05
WDALUB	3	23	H	RHR PUMP A FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WDALUB1	3	1	H	RHR PUMP A FAILS TO RUN DURING FIRST HOUR	9.96E-06	H	9.96E-06
WDAMAINT_SD	0	0.1	N	RHR LOOP A UNAVAILABLE DUE TO MAINTENANCE	2.00E-02	N	1.00E-01
WDAMBC	1	1	N	PUMP A MOTOR BEARING COOLER FAILS	1.14E-04	N	1.14E-04
WDAMSC	1	1	N	PUMP A MECH. SEALER COOLER FAILS	1.14E-04	N	1.14E-04
WDAN2LF	3	1095	H	FLOW SIGNAL FROM FT008A FAILS	1.38E-07	H	1.51E-04
WDAN2LF_IE	3	24	H	FLOW SIGNAL FROM FT008A FAILS	1.38E-07	H	3.31E-06
WDARAC	3	24	H	RHR-A PUMP ROOM A.C. UNIT FAILS	9.40E-05	H	2.25E-03
WDASTRN	3	1095	H	STRAINER E11-D001A PLUGGED	5.92E-06	H	6.46E-03

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
WDBLUB	3	23	H	RHR PUMP B FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WDBLUB1	3	1	H	RHR PUMP B FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WDBMAINT_SD	0	0.1	N	RHR LOOP B UNAVAILABLE DUE TO MAINTENANCE	2.00E-02	N	1.00E-01
WDBMBC	1	1	N	PUMP B MOTOR BEARING COOLER FAILS	1.14E-04	N	1.14E-04
WDBMSC	1	1	N	PUMP B MECH. SEALER COOLER FAILS	1.14E-04	N	1.14E-04
WDBN2LF	3	1095	H	FLOW SIGNAL FROM FT008B FAILS	1.38E-07	H	1.51E-04
WDBRAC	3	24	H	RHR-B PUMP ROOM A.C. UNIT FAILS	9.40E-05	H	2.25E-03
WDBSTRN	3	1095	H	STRAINER E11-D001B PLUGGED	5.92E-06	H	6.46E-03
WDCLUB	3	23	H	RHR PUMP C FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WDCLUB1	3	1	H	RHR PUMP C FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WDCMAINT_SD	0	0.1	N	RHR LOOP C UNAVAILABLE DUE TO MAINTENANCE	2.00E-02	N	1.00E-01
WDCMBC	1	1	N	PUMP C MOTOR BEARING COOLER FAILS	1.14E-04	N	1.14E-04
WDCMSC	1	1	N	PUMP C MECH. SEALER COOLER FAILS	1.14E-04	N	1.14E-04
WDCN2LF	3	1095	H	FLOW SIGNAL FROM FT008C FAILS	1.38E-07	H	1.51E-04
WDCRAC	3	24	H	RHR-C PUMP ROOM A.C. UNIT FAILS	9.40E-05	H	2.25E-03
WDCSTRN	3	1095	H	STRAINER E11-D001C PLUGGED	5.92E-06	H	6.46E-03
WDNPSC	1	1	N	REACTOR PRESSURE DROPS CAUSING SUCTION CAVITATION	1.00E-06	N	1.00E-06
WFLD1AH	3	24	H	STRAINER P41-D001A PLUGS	5.92E-06	H	1.42E-04
WFLD1BH	3	24	H	STRAINER P41-D001B PLUGS	5.92E-06	H	1.42E-04
WFLD1CH	3	24	H	STRAINER P41-D001C PLUGS	5.92E-06	H	1.42E-04
WFLD1DH	3	24	H	STRAINER P41-D001D PLUGS	5.92E-06	H	1.42E-04
WFLD1EH	3	24	H	STRAINER P41-D001E PLUGS	5.92E-06	H	1.42E-04
WFLD1FH	3	24	H	STRAINER P41-D001F PLUGS	5.92E-06	H	1.42E-04
WHEB1AH	3	24	H	ACTIVE HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1AH1	3	24	H	ACTIVE HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1BH	3	24	H	ACTIVE HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1BH1	3	24	H	ACTIVE HEAT EXCHANGER FAILURE	2.10E-06	H	5.04E-05
WHEB1CH	3	24	H	ACTIVE HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1CH1	3	24	H	ACTIVE HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1DH	3	24	H	ACTIVE HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1DH1	3	24	H	ACTIVE HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1EH	3	24	H	ACTIVE HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
WHEB1EH1	3	24	H	ACTIVE HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1FH	3	24	H	ACTIVE HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1FH1	3	24	H	ACTIVE HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1GH	3	24	H	STANDBY HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1GH1	3	24	H	STANDBY HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1GM_SD	0	5.42E-05	H	STANDBY HEAT EXCHANGER IN MAINTENANCE	7.62E-03	H	5.42E-05
WHEB1HH	3	24	H	STANDBY HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1HH1	3	24	H	STANDBY HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1HM_SD	0	5.42E-05	H	STANDBY HEAT EXCHANGER IN MAINTENANCE	7.62E-03	H	5.42E-05
WHEB1JH	3	24	H	STANDBY HEAT EXCHANGER PLUGS	3.60E-06	H	8.64E-05
WHEB1JH1	3	24	H	STANDBY HEAT EXCHANGER LEAKS	2.10E-06	H	5.04E-05
WHEB1JM_SD	0	5.42E-05	H	STANDBY HEAT EXCHANGER IN MAINTENANCE	7.62E-03	H	5.42E-05
WHECWAN		1.50E-03		FAILURE OF DIV A HECW TO PROVIDE ECCS COOLING			1.50E-03
WHECWBN		6.69E-04		FAILURE OF DIV B HECW TO PROVIDE ECCS COOLING			6.69E-04
WHECWCN		6.73E-04		FAILURE OF DIV C HECW TO PROVIDE ECCS COOLING			6.73E-04
WMV13AH	3	24	H	VALVE P41-F013A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMV13BH	3	24	H	VALVE P41-F013B FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMV13CH	3	24	H	VALVE P41-F013C FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMV13DH	3	360	H	VALVE P41-F013D FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMV13EH	3	360	H	VALVE P41-F013E FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMV13FH	3	360	H	VALVE P41-F013F FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMVR4AH	3	24	H	SEPARATION VALVE P21-F004A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVR4CH	3	24	H	SEPARATION VALVE P21-F004C FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVR4DH	3	24	H	SEPARATION VALVE P21-F004D FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVR4EH	3	24	H	SEPARATION VALVE P21-F004E FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVR4FH	3	24	H	SEPARATION VALVE P21-F004F FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVR4GH	3	360	H	SEPARATION VALVE P21-F004G FAILS TO OPEN (NCFC)	1.90E-06	H	6.84E-04
WMVR4HH	3	360	H	SEPARATION VALVE P21-F004H FAILS TO OPEN (NCFC)	1.90E-06	H	6.84E-04
WMVR4JH	3	360	H	SEPARATION VALVE P21-F004J FAILS TO OPEN (NCFC)	1.90E-06	H	6.84E-04
WMVS3AH	3	24	H	SEPARATION VALVE P41-F003A FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS3BH	3	24	H	SEPARATION VALVE P41-F003B FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS3CH	3	24	H	SEPARATION VALVE P41-F003C FAILS (NOFC)	1.40E-07	H	3.36E-06

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
WMVS3DH	3	24	H	SEPARATION VALVE P41-F003D FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS3EH	3	24	H	SEPARATION VALVE P41-F003E FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS3FH	3	24	H	SEPARATION VALVE P41-F003F FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS3GH	3	360	H	SEPARATION VALVE F003G FOR THE STANDBY HX FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMVS3HH	3	360	H	SEPARATION VALVE F003H FOR THE STANDBY HX FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMVS3JH	3	360	H	SEPARATION VALVE F003J FOR THE STANDBY HX FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMVS4AH	3	24	H	VALVE P41-F004A FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVS4BH	3	24	H	VALVE P41-F004B FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVS4CH	3	24	H	VALVE P41-F004C FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
WMVS4DH	3	360	H	VALVE P41-F004D FAILS CLOSED (NOFC)	1.40E-07	H	5.04E-05
WMVS4EH	3	360	H	VALVE P41-F004E FAILS CLOSED (NOFC)	1.40E-07	H	5.04E-05
WMVS4FH	3	360	H	VALVE P41-F004F FAILS CLOSED (NOFC)	1.40E-07	H	5.04E-05
WMVS5AH	3	24	H	SEPARATION VALVE P41-F005A FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS5BH	3	24	H	SEPARATION VALVE P41-F005B FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS5CH	3	24	H	SEPARATION VALVE P41-F005C FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS5DH	3	24	H	SEPARATION VALVE P41-F005D FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS5EH	3	24	H	SEPARATION VALVE P41-F005E FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS5FH	3	24	H	SEPARATION VALVE P41-F005F FAILS (NOFC)	1.40E-07	H	3.36E-06
WMVS5GH	3	360	H	SEPARATION VALVE F005G FOR THE STANDBY HX FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMVS5HH	3	360	H	SEPARATION VALVE F005H FOR THE STANDBY HX FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WMVS5JH	3	360	H	SEPARATION VALVE F005J FOR THE STANDBY HX FAILS CLOSED (NCFC)	1.90E-06	H	6.84E-04
WOPERR	1	1	N	OPERATOR FAILS TO PERFORM INDICATED ACTION TO START STANDBY SWS TRAINS	1.00E-02	N	1.00E-02
WPMHC1A	3	24	H	PUMP FAILURE	6.27E-06	H	1.50E-04
WPMHC1B	3	24	H	PUMP FAILURE	6.27E-06	H	1.50E-04
WPMHC1C	3	24	H	PUMP FAILURE	6.27E-06	H	1.50E-04
WPMHC1E	3	24	H	PUMP FAILURE	6.27E-06	H	1.50E-04
WPMHC1F	3	24	H	PUMP FAILURE	6.27E-06	H	1.50E-04
WPMMNTF		9.22E-05		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	9.22E-05
WPMRC1AH	3	24	H	RUNNING PUMP FAILS DURING MISSION	6.27E-06	H	1.50E-04
WPMRC1BH	3	24	H	RUNNING PUMP FAILS DURING MISSION	6.27E-06	H	1.50E-04
WPMRC1CH	3	24	H	RUNNING PUMP FAILS DURING MISSION	6.27E-06	H	1.50E-04

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
WPMRC1DD	1	1	N	STANDBY PUMP FAILS TO START	1.56E-03	N	1.56E-03
WPMRC1DH	3	23	H	STANDBY PUMP FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WPMRC1DH1	3	1	H	STANDBY PUMP FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WPMRC1DM_SD	0	0.1		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	1.00E-01
WPMRC1ED	3	1	N	STANDBY PUMP FAILS TO START	1.56E-03	N	1.56E-03
WPMRC1EH	3	23	H	STANDBY PUMP FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WPMRC1EH1	3	1	H	STANDBY PUMP FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WPMRC1EM_SD	0	0.1		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	1.00E-01
WPMRC1FD	1	1	N	STANDBY PUMP FAILS TO START	1.56E-03	N	1.56E-03
WPMRC1FH	3	23	H	STANDBY PUMP FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WPMRC1FH1	3	1	H	STANDBY PUMP FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WPMRC1FM_SD	0	0.1		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	1.00E-01
WPMSC1AH	3	24	H	PUMP FAILS	6.27E-06	H	1.50E-04
WPMSC1BH	3	24	H	PUMP FAILS	6.27E-06	H	1.50E-04
WPMSC1CH	3	24	H	PUMP FAILS	6.27E-06	H	1.50E-04
WPMSC1DD	1	1	N	STANDBY PUMP FAILS TO START	1.56E-03	N	1.56E-03
WPMSC1DH	3	23	H	STANDBY PUMP FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WPMSC1DH1	3	1	H	STANDBY PUMP FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WPMSC1DM_SD	0	0.1		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	1.00E-01
WPMSC1ED	1	1	N	STANDBY PUMP FAILS TO START	1.56E-03	N	1.56E-03
WPMSC1EH	3	23	H	STANDBY PUMP FAILS TO RUN AFTER FIRST HOUR	7.05E-06	H	1.62E-04
WPMSC1EH1	3	1	H	STANDBY PUMP FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WPMSC1EM_SD	0	0.1		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	1.00E-01
WPMSC1FD	1	1	N	STANDBY PUMP FAILS TO START	1.56E-03	N	1.56E-03
WPMSC1FH	3	23	H	STANDBY PUMP FAILS TO RUN AFTER START	7.05E-06	H	1.62E-04
WPMSC1FH1	3	1	H	STANDBY PUMP FAILS TO RUN DURING FIRST HOUR	9.69E-06	H	9.69E-06
WPMSC1FM_SD	0	0.1		STANDBY PUMP IN MAINTENANCE	9.70E-06	H	1.00E-01
WPMSTRTF	1	1	N	STANDBY PUMP FAILURE TO START	1.56E-03	N	1.56E-03
WPPHEAH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPPHEBH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPPREAH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPPREBH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07

NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
WPPRECH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPPSWSAH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPPSWSBH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPPSWSCH	3	24	H	PIPE RUPTURED	4.93E-09	H	1.18E-07
WPV025A	3	24	H	MO-PCV P21-F025A FAILS CLOSED	1.40E-07	H	3.36E-06
WPV025B	3	24	H	MO-PCV P21-F025B FAILS CLOSED	1.40E-07	H	3.36E-06
WPV025C	3	24	H	MO-PCV P21-F025C FAILS CLOSED	1.40E-07	H	3.36E-06
WPV025E	3	24	H	MO-PCV P21-F025E FAILS CLOSED	1.40E-07	H	3.36E-06
WPV025F	3	24	H	MO-PCV P21-F025F FAILS CLOSED	1.40E-07	H	3.36E-06
WRFD1A	3	24	H	REFRIGERATOR FAILURE	8.46E-05	H	2.03E-03
WRFD1B	3	24	H	REFRIGERATOR FAILURE	8.46E-05	H	2.03E-03
WRFD1C	3	24	H	REFRIGERATOR FAILURE	8.46E-05	H	2.03E-03
WRFD1E	3	24	H	REFRIGERATOR FAILURE	8.46E-05	H	2.03E-03
WRFD1F	3	24	H	REFRIGERATOR FAILURE	8.46E-05	H	2.03E-03
WRFMNTF	3	1.963	H	STANDBY REFRIGERATOR IN MAINTENANCE	3.00E-05	H	5.89E-05
WTE005A	3	4	H	TEMPERATURE ELEMENT P21-TE-005A FAILS LOW	1.17E-06	H	4.68E-06
WTE005B	3	4	H	TEMPERATURE ELEMENT P21-TE-005B FAILS LOW	1.17E-06	H	4.68E-06
WTE005C	3	4	H	TEMPERATURE ELEMENT P21-TE-005C FAILS LOW	1.17E-06	H	4.68E-06
WTE052	3	4	H	TEMP SENSOR U41-TE-052 FAILS	1.17E-06	H	4.68E-06
WTE056	3	4	H	TEMP SENSOR U41-TE-056 FAILS	1.17E-06	H	4.68E-06
WTE060	3	4	H	TEMP SENSOR U41-TE-060 FAILS	1.17E-06	H	4.68E-06
WTE113A	3	4	H	TEMP SENSOR U41-TE-113A FAILS	1.17E-06	H	4.68E-06
WTE113B	3	4	H	TEMP SENSOR U41-TE-113B FAILS	1.17E-06	H	4.68E-06
WTE113C	3	4	H	TEMP SENSOR U41-TE-113C FAILS	1.17E-06	H	4.68E-06
WVMR4BH	3	24	H	SEPARATION VALVE P21-F004B FAILS CLOSED (NOFC)	1.40E-07	H	3.36E-06
X_CCDP		0		FLAG EVENT TO INVOKE CCDP ANALYSIS			0.00E+00
X_P3-F011B	+	TRUE		FLAG TO DISABLE VALVE FAILURE FOR GIVEN DIVISON 3 IS UNAVAILBLE			1.00E+00
X_POS3		0.003		FRACTION OF POS 3 - 4HOURS TO 6 HOURS			3.00E-03
X_POS4		0.053		FRACTION OF POS 4 - 6HOURS TO 2 DAYS			5.30E-02
X_POS5A		0.03		FRACTION OF POS 5A - 2 DAYS TO 3 DAYS			3.00E-02
X_POS5B	0	0.152		FRACTION OF POS 5B - 3 DAYS TO 8 DAYS			1.52E-01
X_POS5C		0.061		FRACTION OF POS 5C - 8 DAYS TO 10 DAYS			6.10E-02

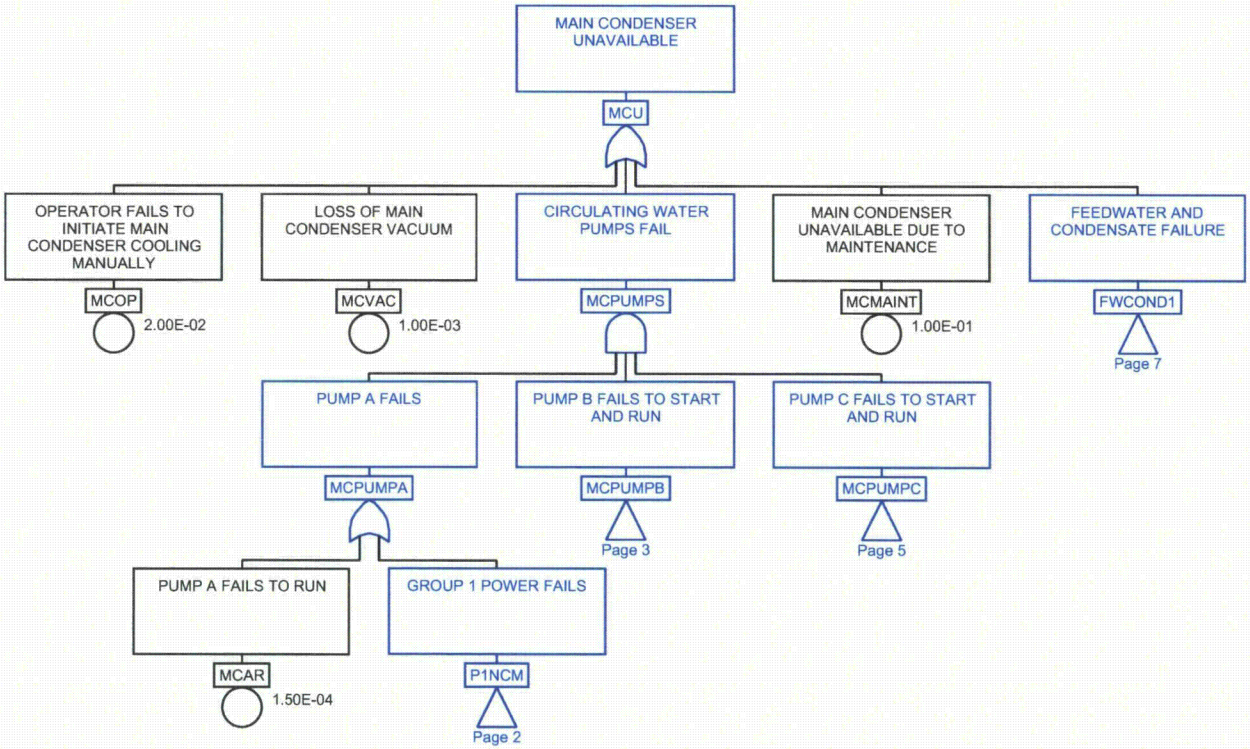
NAME	C	FACTOR	UNITS	DESC	RATE	U	PROB
X_POS5D		0.697		FRACTION OF POS 5D - 10 DAYS TO 33 DAYS			6.97E-01
ZSP100DF	1	1	N	SUPP POOL WATER UNAVAILABLE DUE TO POOL RUPTURE	3.00E-07	N	3.00E-07
ZSP200DW	1	1	N	SP WATER UNAVAILABLE DUE TO HIGH TEMPERATURE	1.00E-06	N	1.00E-06

* Refers to Essential Communications Function equipment

APPENDIX G FAULT TREE LISTINGS (ATTACHED PDF)

Figures G-1 through G-29 replace the referenced Figures 19QA-1 through 19QA-29 as cited in the DCDRA.

Figure G-1. Main Condenser System G-2
Figure G-2. Feedwater System (SDC) G-10
Figure G-3. Feedwater or Condensate Pump (SDC) G-16
Figure G-4. Fuel Pool Cooling (SDC) G-17
Figure G-5. One CRD (SDC) G-24
Figure G-6. One Condensate Pump G-28
Figure G-7. Cleanup Water System (SDC) G-36
Figure G-8. Clean-up Water or Fuel Pool (SDC) G-43
Figure G-9. RHR in Shutdown Cooling Mode G-44
Figure G-10. Service Water System G-85
Figure G-11. RHR Core Flooding Mode G-127
Figure G-12. RHR-A and RHR-B Core Flooding (SDC) G-170
Figure G-13. RHR-B and RHR-C Core Flooding (SDC) G-171
Figure G-14. High Pressure Core Flooding System G-172
Figure G-15. Reactor Depressurization System G-207
Figure G-16. Diesel Generators G-234
Figure G-17. Gas Turbine Generator G-235
Figure G-18. HVAC Emergency Cooling Water System G-236
Figure G-19. Instrumentation System G-256
Figure G-20. Electric Power System G-319
Figure G-21. AC Independent Water Addition G-405
Figure G-22. RHR LOCA Isolation G-408
Figure G-23. Loss of RHR A Initiating Event G-412
Figure G-24. Loss of SWS A Initiating Event G-459
Figure G-25. Loss of SWS C Initiating Event G-466
Figure G-26. Loss of Offsite Power Initiating Event G-474
Figure G-27. LOCA Initiating Event G-477
Figure G-28. Mutually Exclusive Logic G-488
Figure G-29. Shutdown Top Logic and Sequence Logic G-496



1 2 3 4 5

Figure G-1 Main Condenser System

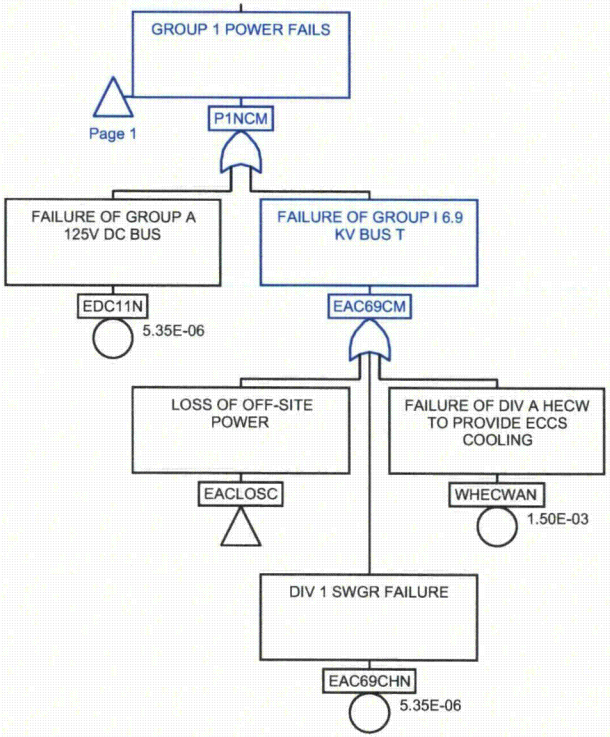
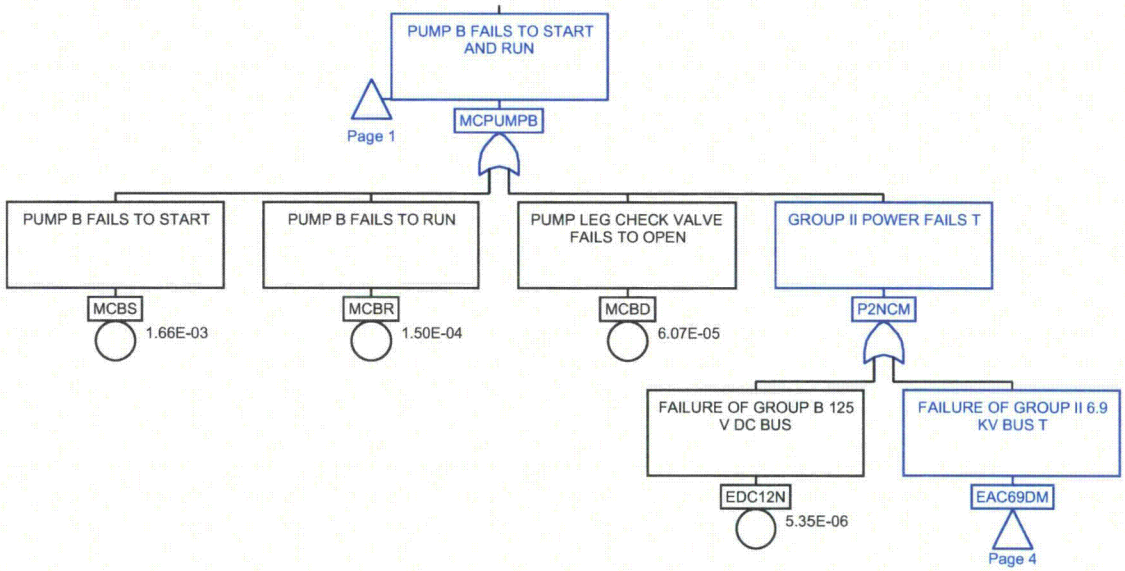
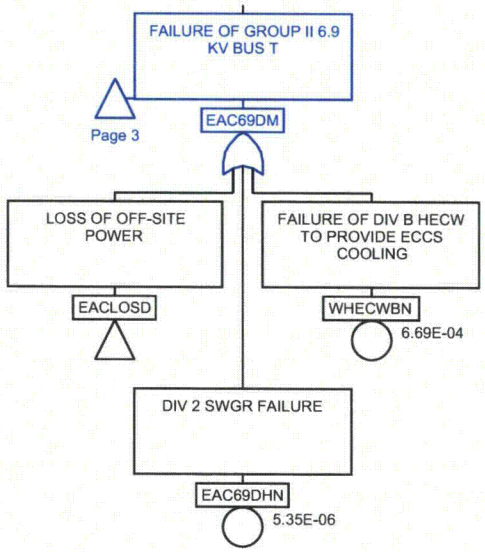


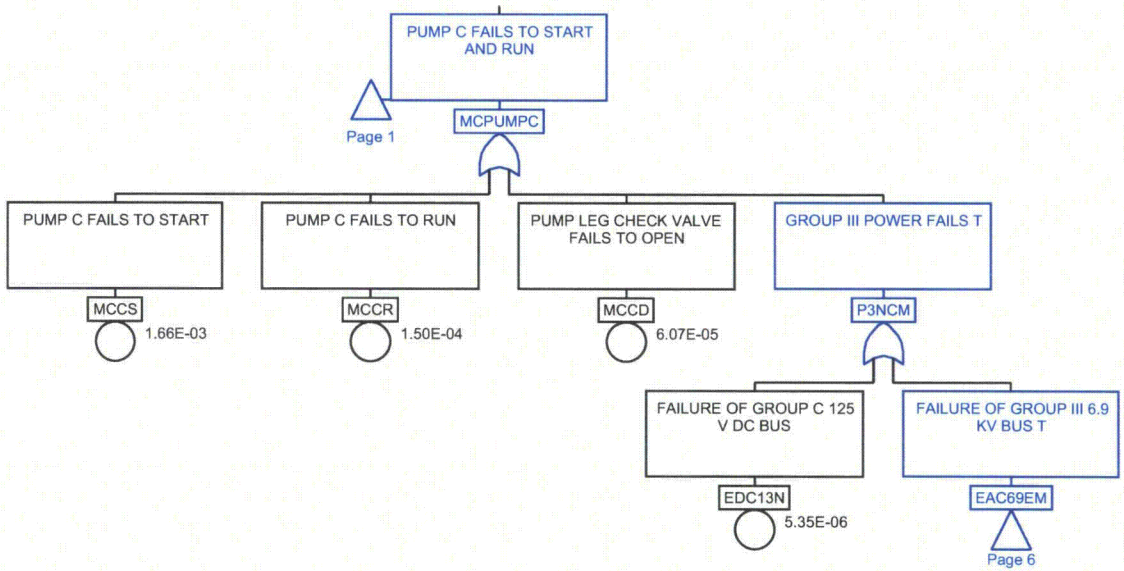
Figure G-1 Main Condenser System



1 2 3 4

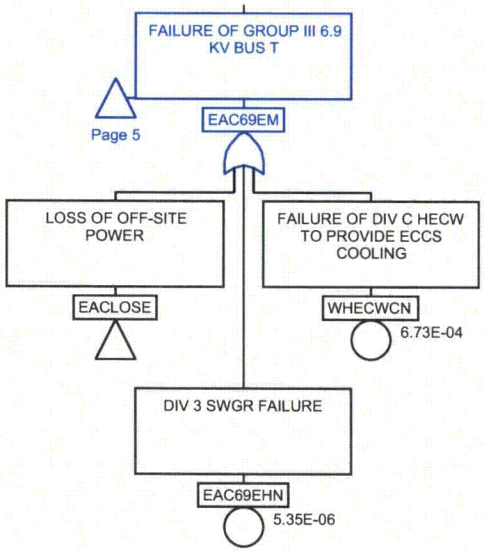
Figure G-1 Main Condenser System

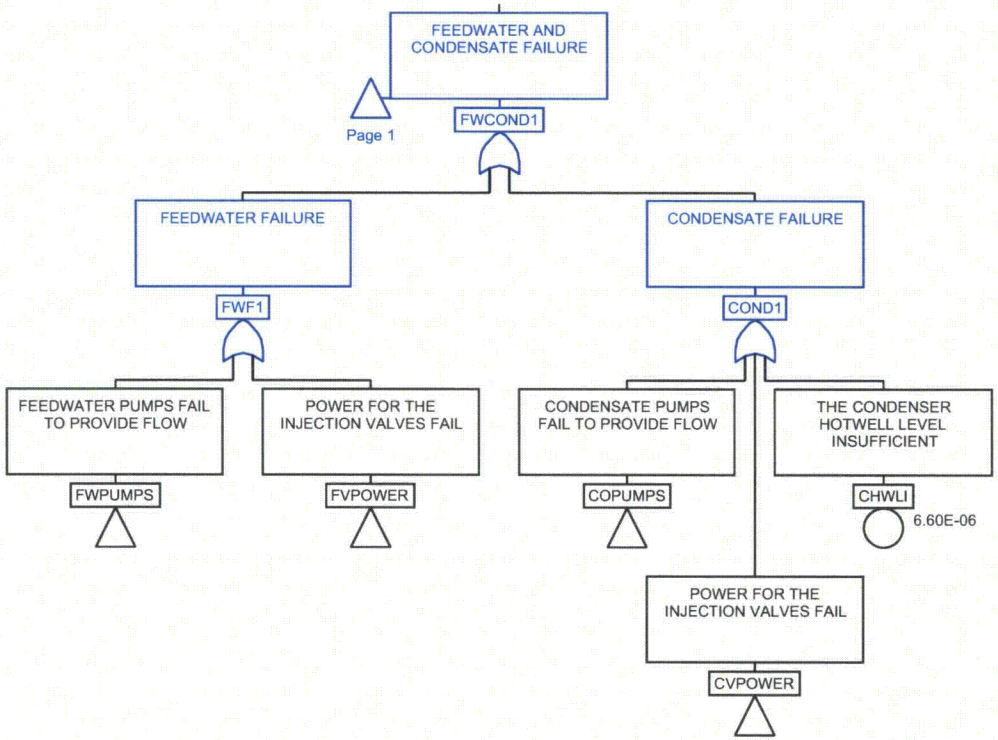

FAILURE OF GROUP II 6.9 KV BUS T
Page 3
EAC69DM
LOSS OF OFF-SITE POWER
FAILURE OF DIV B HECW TO PROVIDE ECCS COOLING
EACLOSD
WHECWBN
6.69E-04
DIV 2 SWGR FAILURE
EAC69DHN
5.35E-06



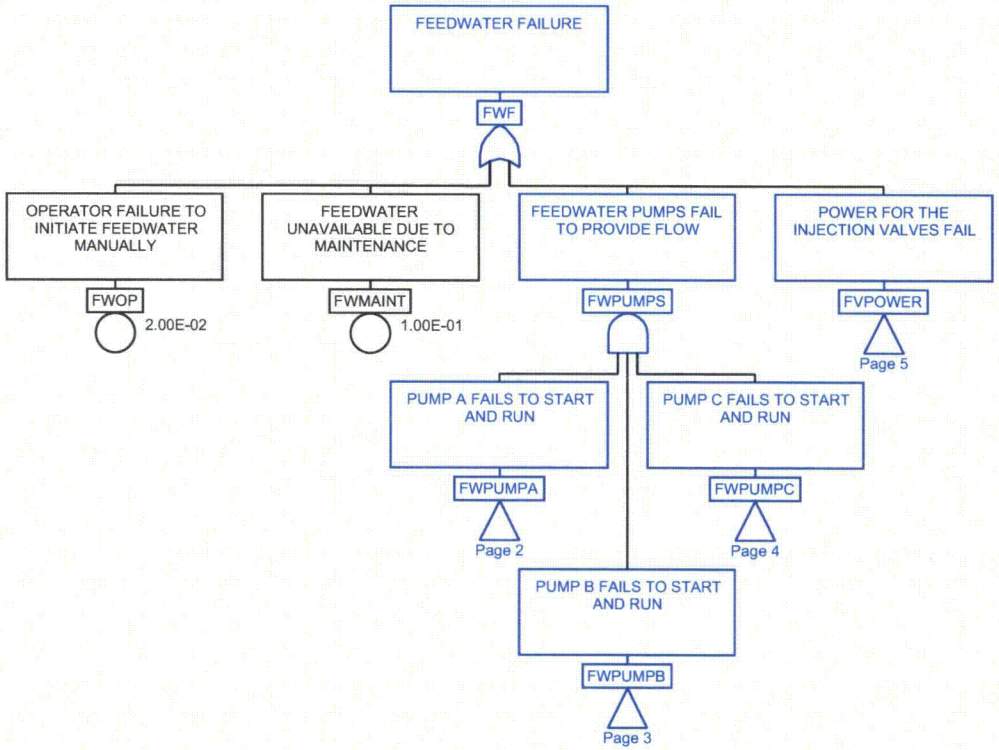
1 2 3 4

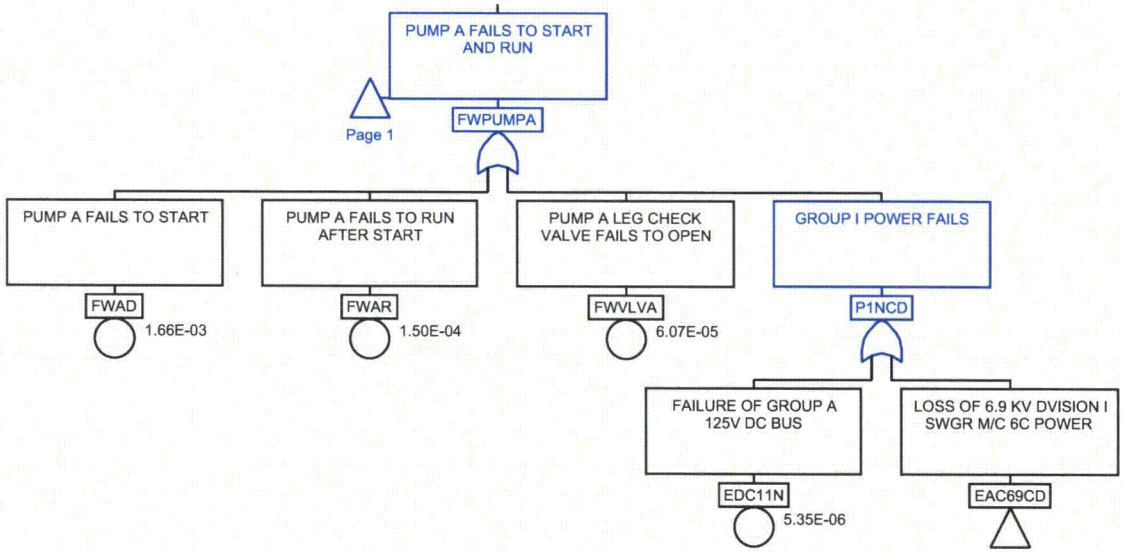
Figure G-1 Main Condenser System

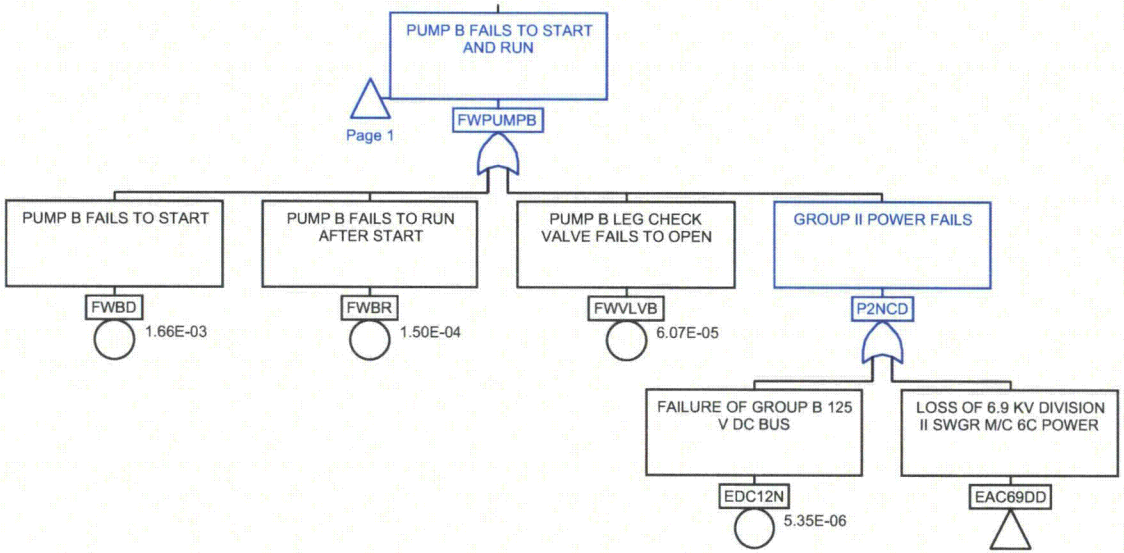

FAILURE OF GROUP III 6.9 KV BUS T
Page 5
EAC69EM
LOSS OF OFF-SITE POWER
FAILURE OF DIV C HECW TO PROVIDE ECCS COOLING
EACLOSE
WHECWCN
6.73E-04
DIV 3 SWGR FAILURE
EAC69EHN
5.35E-06

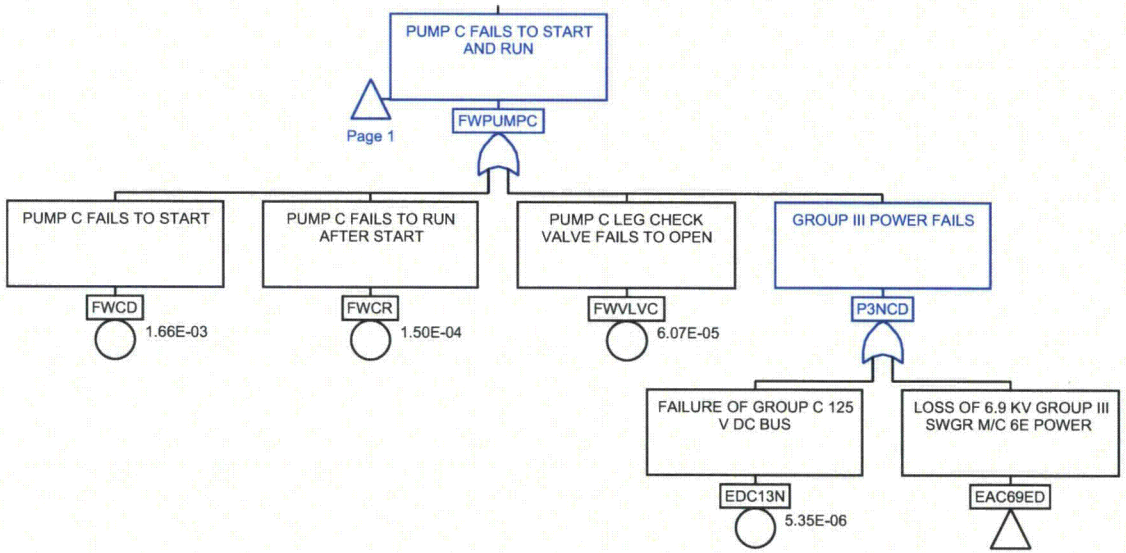

FEEDWATER AND CONDENSATE FAILURE
Page 1
FWCOND1
FEEDWATER FAILURE
CONDENSATE FAILURE
FWF1
COND1
FEEDWATER PUMPS FAIL TO PROVIDE FLOW
POWER FOR THE INJECTION VALVES FAIL
CONDENSATE PUMPS FAIL TO PROVIDE FLOW
THE CONDENSER HOTWELL LEVEL INSUFFICIENT
FWPUMPS
FVPOWER
COPUMPS
CHWLI
6.60E-06
POWER FOR THE INJECTION VALVES FAIL
CVPOWER

Name	Page	Zone	Name	Page	Zone	
CHWLI	7	4	WHECWBN	4	2	Shutdown Probabilistic Risk Assessment
COND1	7	4	WHECWCN	6	2	
COPUMPS	7	3				
CVPOWER	7	4				
EAC69CHN	2	2				
EAC69CM	2	2				
EAC69DHN	4	2				
EAC69DM	3	5				
EAC69DM	4	2				
EAC69EHN	6	2				
EAC69EM	5	5				
EAC69EM	6	2				
EACLOSC	2	2				
EACLOSD	4	1				
EACLOSE	6	1				
EDC11N	2	1				
EDC12N	3	4				
EDC13N	5	4				
FVPOWER	7	2				
FWCOND1	1	5				
FWCOND1	7	3				
FWF1	7	2				
FWPUMPS	7	1				
MCAR	1	2				
MCBD	3	3				
MCBR	3	2				
MCBS	3	1				
MCCD	5	3				
MCCR	5	2				
MCCS	5	1				
MCMAINT	1	4				
MCOP	1	1				
MCPUMPA	1	2				
MCPUMPB	1	3				
MCPUMPB	3	3				
MCPUMPC	1	4				
MCPUMPC	5	3				
MCPUMPS	1	3				
MCU	1	3				
MCVAC	1	2				
P1NCM	1	3				
P1NCM	2	2				
P2NCM	3	4				
P3NCM	5	4				
WHECWAN	2	3				


FEEDWATER FAILURE
FWF
OPERATOR FAILURE TO INITIATE FEEDWATER MANUALLY
FEEDWATER UNAVAILABLE DUE TO MAINTENANCE
FEEDWATER PUMPS FAIL TO PROVIDE FLOW
POWER FOR THE INJECTION VALVES FAIL
FWOP
2.00E-02
FWMAINT
1.00E-01
FWPUMPS
FVPOWER
Page 5
PUMP A FAILS TO START AND RUN
PUMP C FAILS TO START AND RUN
FWPUMPA
Page 2
FWPUMPC
Page 4
PUMP B FAILS TO START AND RUN
FWPUMPB
Page 3

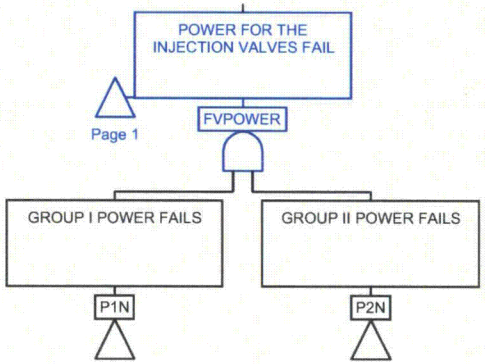

PUMP A FAILS TO START AND RUN
Page 1
FWPUMPA
PUMP A FAILS TO START
PUMP A FAILS TO RUN AFTER START
PUMP A LEG CHECK VALVE FAILS TO OPEN
GROUP I POWER FAILS
FWAD
1.66E-03
FWAR
1.50E-04
FWVLVA
6.07E-05
P1NCD
FAILURE OF GROUP A 125V DC BUS
LOSS OF 6.9 KV DVISION I SWGR M/C 6C POWER
EDC11N
5.35E-06
EAC69CD


PUMP B FAILS TO START AND RUN
Page 1
FWPUMPB
PUMP B FAILS TO START
PUMP B FAILS TO RUN AFTER START
PUMP B LEG CHECK VALVE FAILS TO OPEN
GROUP II POWER FAILS
FWBD
1.66E-03
FWBR
1.50E-04
FWVLVB
6.07E-05
P2NCD
FAILURE OF GROUP B 125 V DC BUS
LOSS OF 6.9 KV DIVISION II SWGR M/C 6C POWER
EDC12N
5.35E-06
EAC69DD

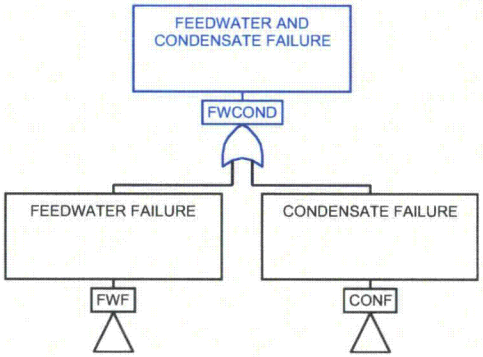


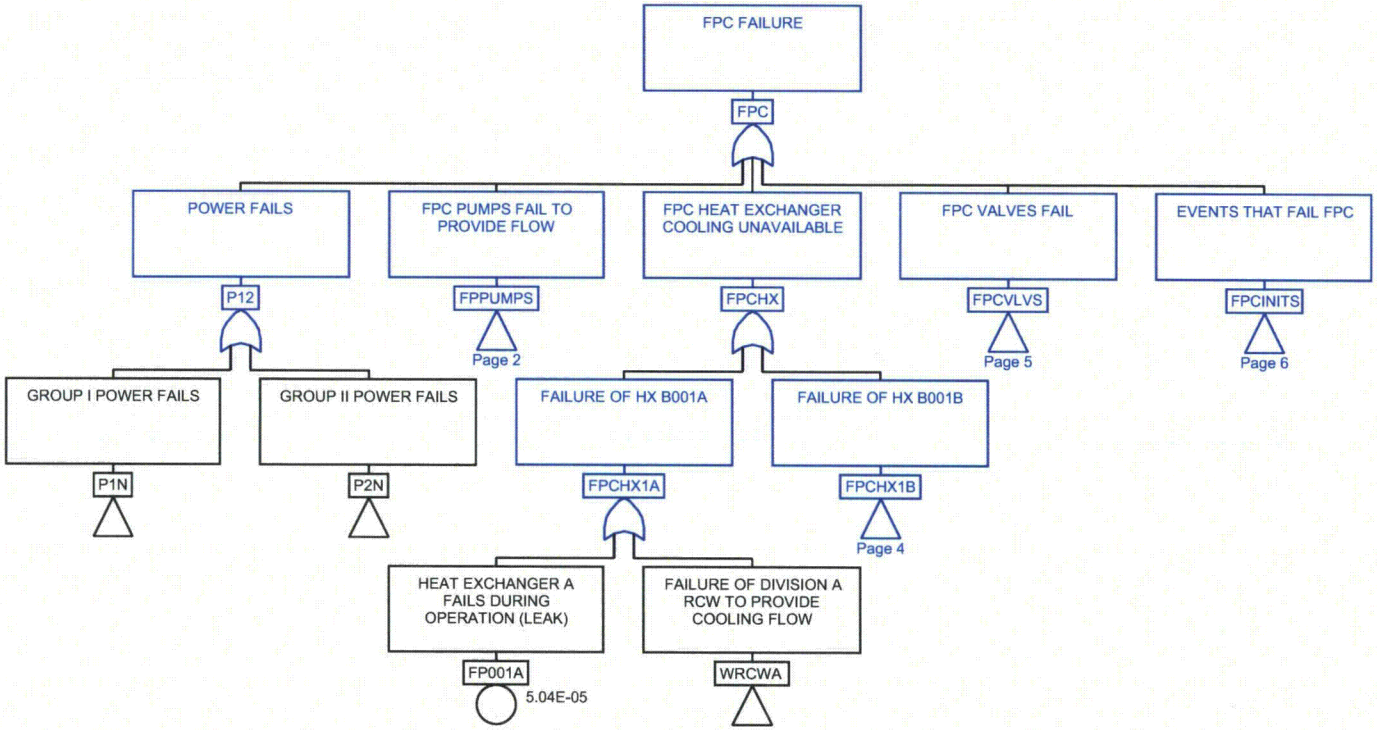
1 2 3 4

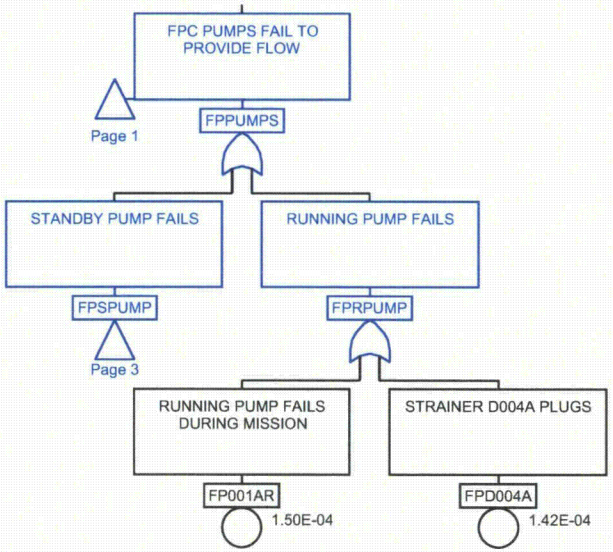
Figure G-2 Feedwater System (SDC)

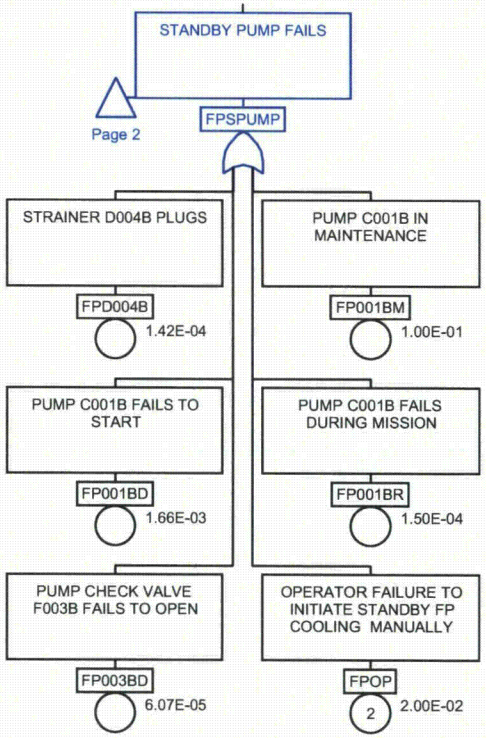

POWER FOR THE
INJECTION VALVES FAIL
Page 1
FVPOWER
GROUP I POWER FAILS
GROUP II POWER FAILS
P1N
P2N

Name	Page	Zone	Name	Page	Zone	
EAC69CD	2	5				Shutdown Probabilistic Risk Assessment
EAC69DD	3	5				
EAC69ED	4	5				
EDC11N	2	4				
EDC12N	3	4				
EDC13N	4	4				
FVPOWER	1	4				
FVPOWER	5	2				
FWAD	2	1				
FWAR	2	2				
FWBD	3	1				
FWBR	3	2				
FWCD	4	1				
FWCR	4	2				
FWF	1	3				
FWMAINT	1	2				
FWOP	1	1				
FWPUMPA	1	3				
FWPUMPA	2	3				
FWPUMPB	1	3				
FWPUMPB	3	3				
FWPUMPC	1	4				
FWPUMPC	4	3				
FWPUMPS	1	3				
FWVLVA	2	3				
FWVLVB	3	3				
FWVLVC	4	3				
P1N	5	1				
P1NCD	2	4				
P2N	5	2				
P2NCD	3	4				
P3NCD	4	4				


FEEDWATER AND
CONDENSATE FAILURE
FWCOND
FEEDWATER FAILURE
CONDENSATE FAILURE
FWF
CONF

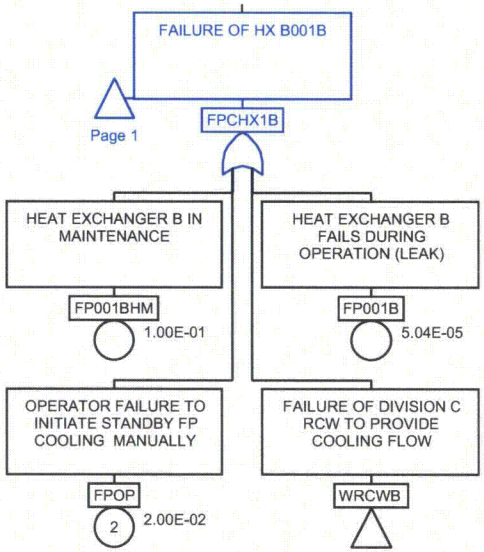

FPC FAILURE
FPC
POWER FAILS
FPC PUMPS FAIL TO PROVIDE FLOW
FPC HEAT EXCHANGER COOLING UNAVAILABLE
FPC VALVES FAIL
EVENTS THAT FAIL FPC
P12
FPPUMPS
Page 2
FPCHX
FPCVLVS
Page 5
FPCINITS
Page 6
GROUP I POWER FAILS
GROUP II POWER FAILS
FAILURE OF HX B001A
FAILURE OF HX B001B
P1N
P2N
FPCHX1A
FPCHX1B
Page 4
HEAT EXCHANGER A FAILS DURING OPERATION (LEAK)
FAILURE OF DIVISION A RCW TO PROVIDE COOLING FLOW
FP001A
5.04E-05
WRCWA


FPC PUMPS FAIL TO PROVIDE FLOW
Page 1
FPPUMPS
STANDBY PUMP FAILS
RUNNING PUMP FAILS
FPSPUMP
FPRPUMP
Page 3
RUNNING PUMP FAILS DURING MISSION
STRAINER D004A PLUGS
FP001AR
1.50E-04
FPD004A
1.42E-04



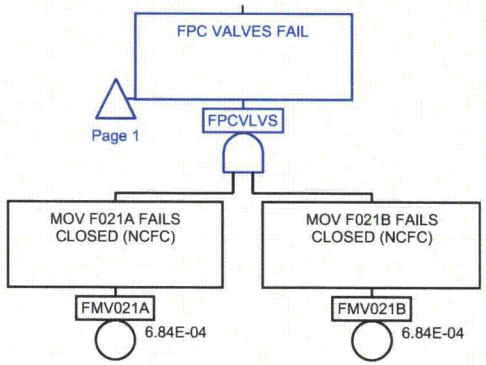
1 2

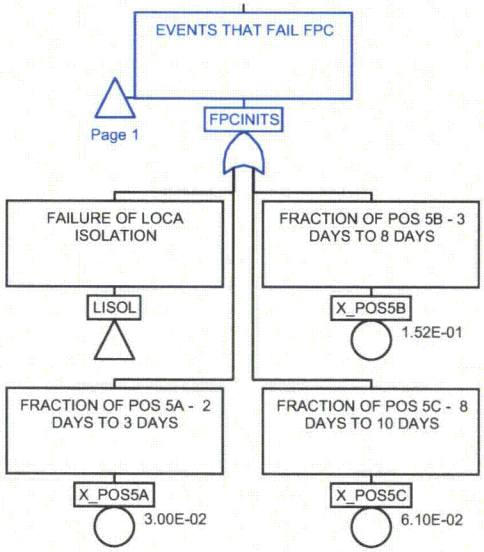
Figure G-4 Fuel Pool Cooling (SDC)



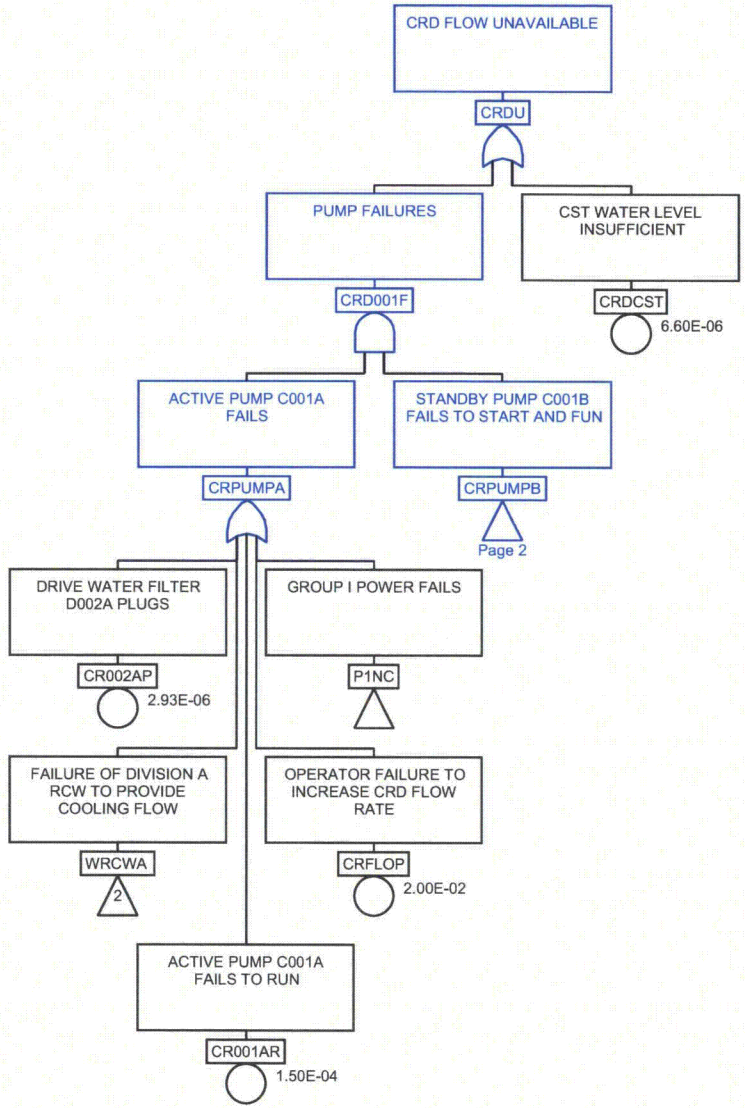
1 2

Figure G-4 Fuel Pool Cooling (SDC)


FPC VALVES FAIL
Page 1
FPCVLVS
MOV F021A FAILS CLOSED (NCFC)
MOV F021B FAILS CLOSED (NCFC)
FMV021A
6.84E-04
FMV021B
6.84E-04

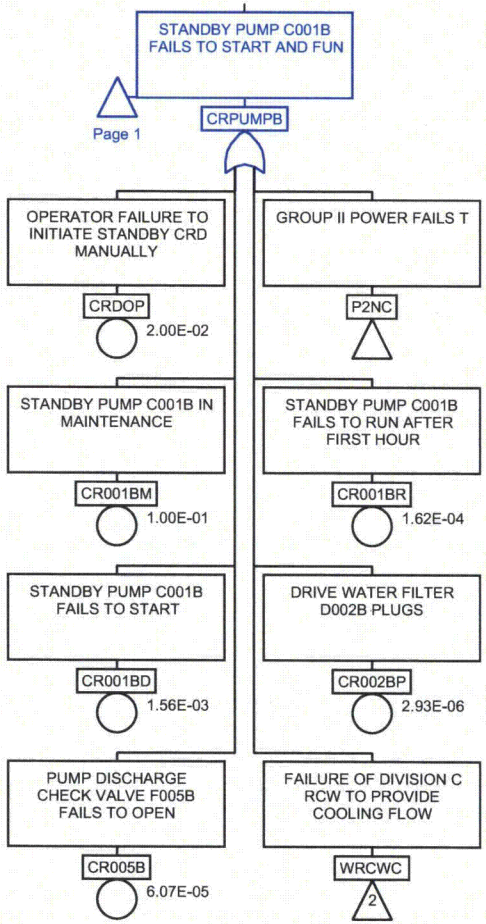

EVENTS THAT FAIL FPC
Page 1
FPCINITS
FAILURE OF LOCA ISOLATION
FRACTION OF POS 5B - 3 DAYS TO 8 DAYS
LISOL
X_POS5B
1.52E-01
FRACTION OF POS 5A - 2 DAYS TO 3 DAYS
FRACTION OF POS 5C - 8 DAYS TO 10 DAYS
X_POS5A
3.00E-02
X_POS5C
6.10E-02

Name	Page	Zone	Name	Page	Zone
FMV021A	5	1			
FMV021B	5	2			
FP001A	1	3			
FP001AR	2	2			
FP001B	4	2			
FP001BD	3	1			
FP001BHM	4	1			
FP001BM	3	2			
FP001BR	3	2			
FP003BD	3	1			
FPC	1	4			
FPCHX	1	4			
FPCHX1A	1	3			
FPCHX1B	1	4			
FPCHX1B	4	2			
FPCINITS	1	6			
FPCINITS	6	2			
FPCVLVS	1	5			
FPCVLVS	5	2			
FPD004A	2	3			
FPD004B	3	1			
FPOP	3	2			
FPOP	4	1			
FPPUMPS	1	3			
FPPUMPS	2	2			
FPRPUMP	2	2			
FPSPUMP	2	1			
FPSPUMP	3	2			
LISOL	6	1			
P12	1	2			
P1N	1	1			
P2N	1	2			
WRCWA	1	4			
WRCWB	4	2			
X_POS5A	6	1			
X_POS5B	6	2			
X_POS5C	6	2			



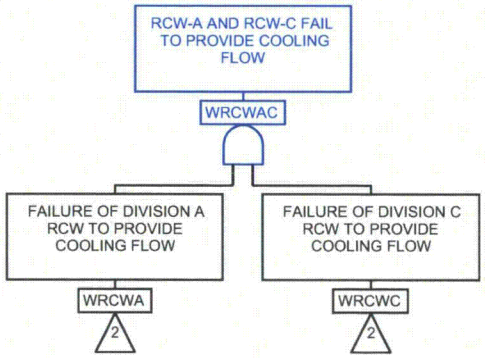
1 2 3

Figure G-5 One CRD (SDC)

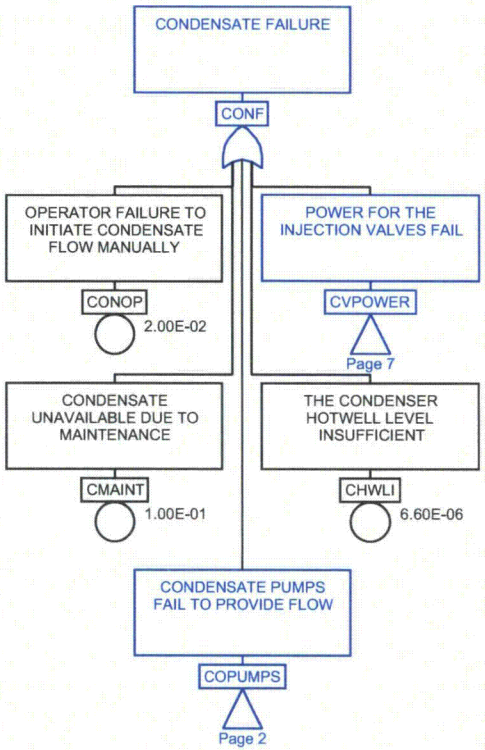


1 2

Figure G-5 One CRD (SDC)


RCW-A AND RCW-C FAIL TO PROVIDE COOLING FLOW
WRCWAC
FAILURE OF DIVISION A RCW TO PROVIDE COOLING FLOW
FAILURE OF DIVISION C RCW TO PROVIDE COOLING FLOW
WRCWA
2
WRCWC
2

Name	Page	Zone	Name	Page	Zone	
CR001AR	1	2				Shutdown Probabilistic Risk Assessment
CR001BD	2	1				
CR001BM	2	1				
CR001BR	2	2				
CR002AP	1	1				
CR002BP	2	2				
CR005B	2	1				
CRD001F	1	2				
CRDCST	1	3				
CRDOP	2	1				
CRDU	1	3				
CRFLOP	1	2				
CRPUMPA	1	2				
CRPUMPB	1	3				
CRPUMPB	2	2				
P1NC	1	2				
P2NC	2	2				
WRCWA	1	1				
WRCWA	3	1				
WRCWAC	3	2				
WRCWC	2	2				
WRCWC	3	2				


CONDENSATE FAILURE
CONF
OPERATOR FAILURE TO INITIATE CONDENSATE FLOW MANUALLY
CONOP
2.00E-02
POWER FOR THE INJECTION VALVES FAIL
CVPOWER
Page 7
CONDENSATE UNAVAILABLE DUE TO MAINTENANCE
CMAINT
1.00E-01
THE CONDENSER HOTWELL LEVEL INSUFFICIENT
CHWLI
6.60E-06
CONDENSATE PUMPS FAIL TO PROVIDE FLOW
COPUMPS
Page 2

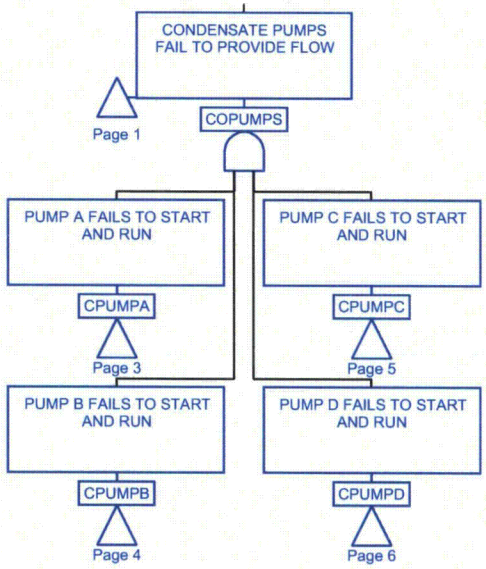
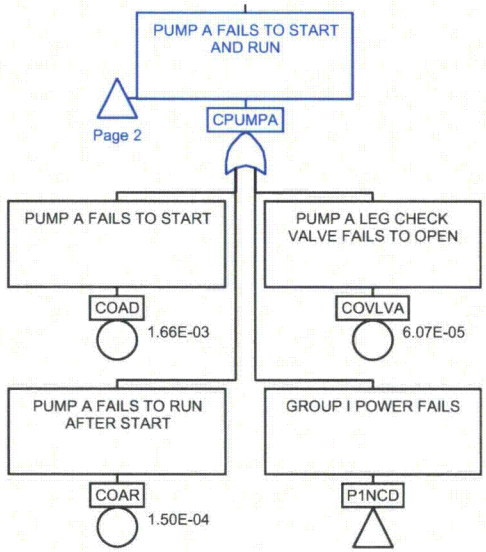
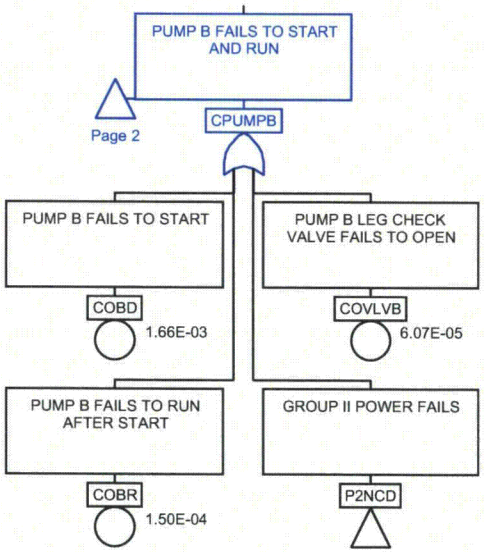


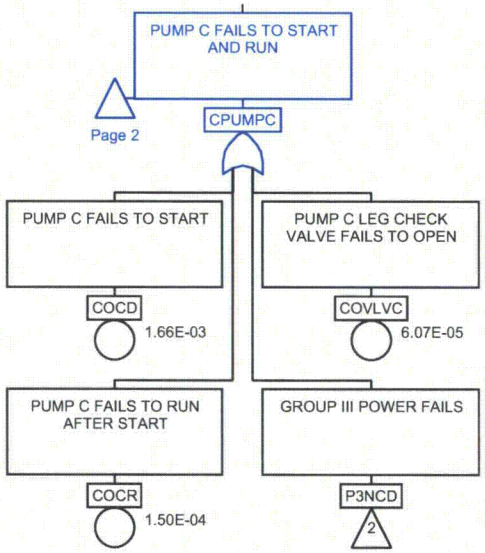
Figure G-6 One Condensate Pump

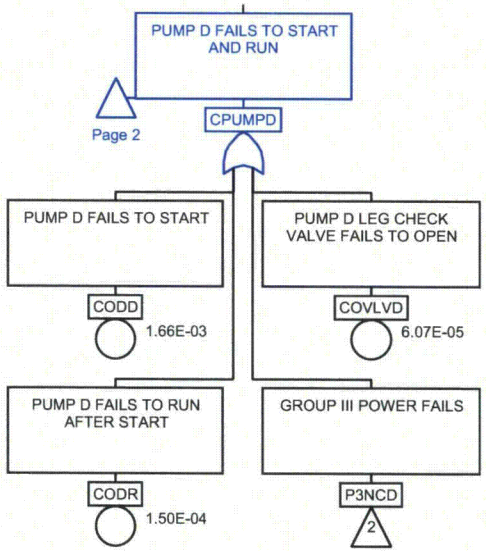

PUMP A FAILS TO START AND RUN
Page 2
CPUMPA
PUMP A FAILS TO START
PUMP A LEG CHECK VALVE FAILS TO OPEN
COAD
1.66E-03
COVLVA
6.07E-05
PUMP A FAILS TO RUN AFTER START
GROUP I POWER FAILS
COAR
1.50E-04
P1NCD



1 2

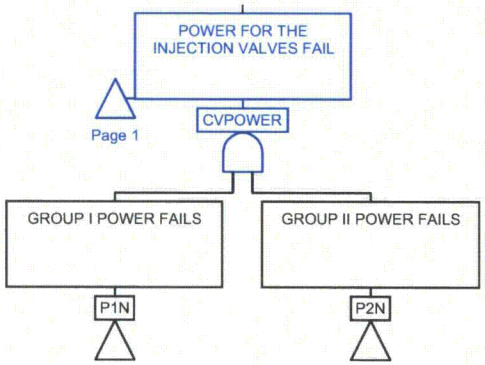
Figure G-6 One Condensate Pump


PUMP C FAILS TO START AND RUN
Page 2
CPUMPC
PUMP C FAILS TO START
PUMP C LEG CHECK VALVE FAILS TO OPEN
COCD
1.66E-03
COVLVC
6.07E-05
PUMP C FAILS TO RUN AFTER START
GROUP III POWER FAILS
COCR
1.50E-04
P3NCD
2

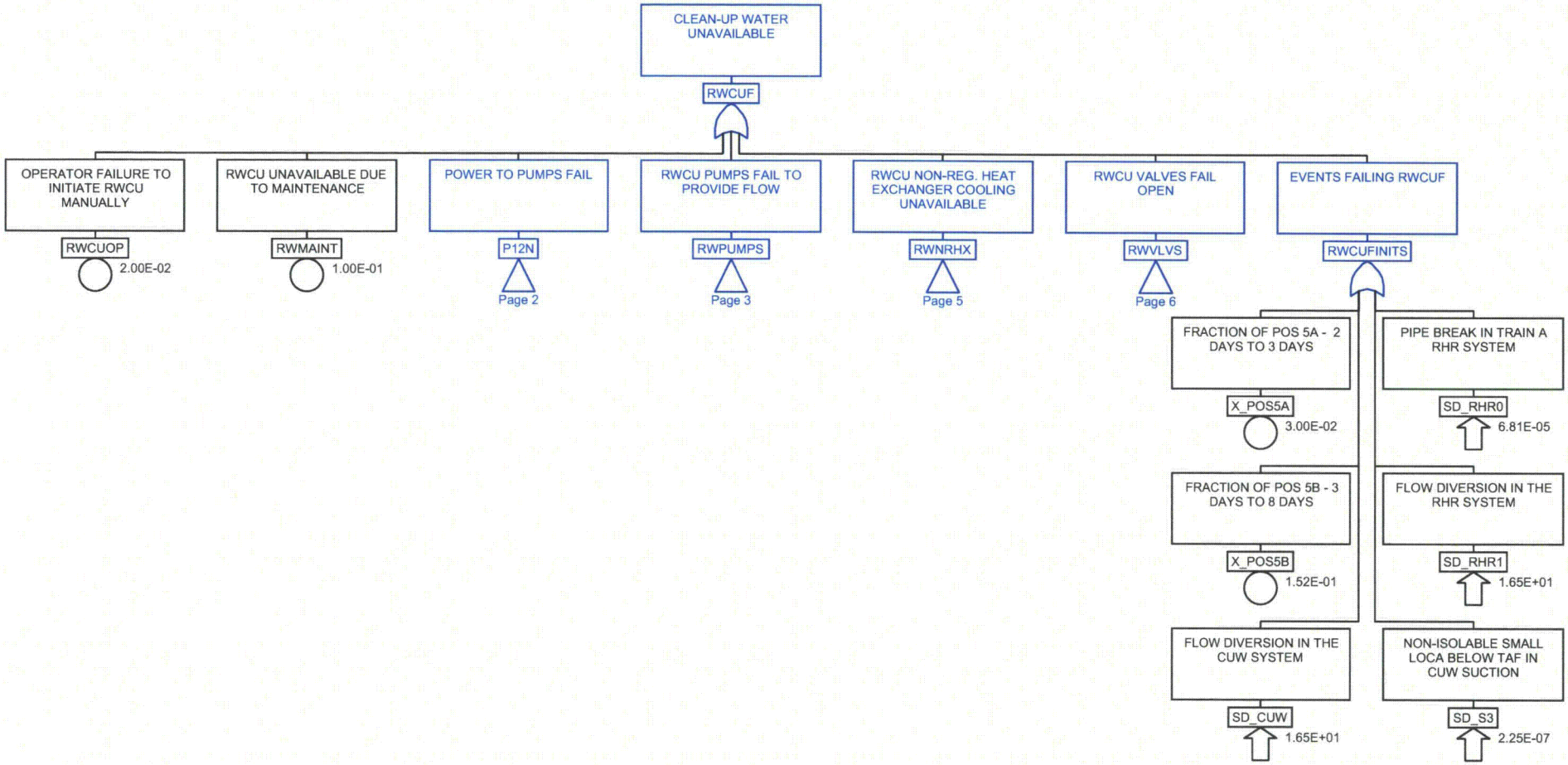


1 2

Figure G-6 One Condensate Pump

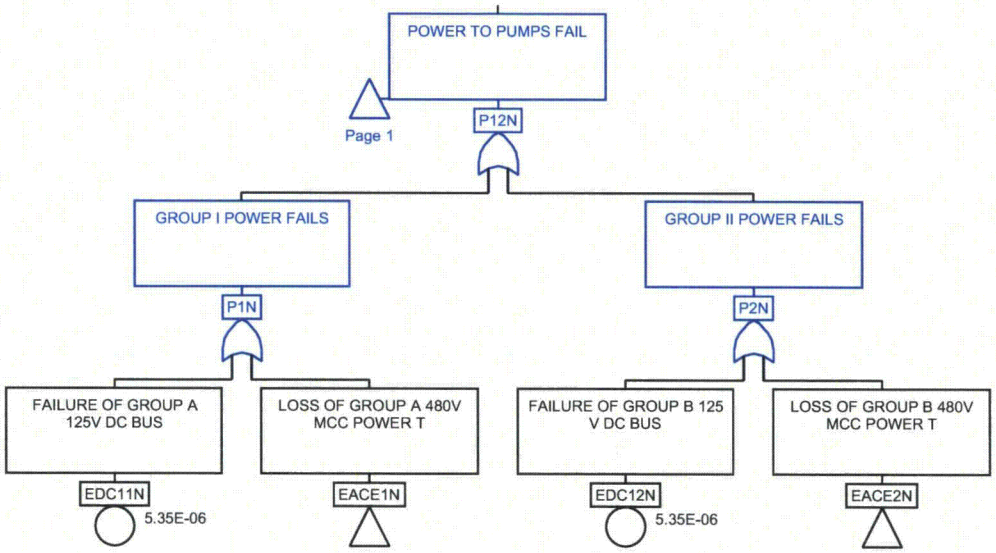

POWER FOR THE
INJECTION VALVES FAIL
Page 1
CVPOWER
GROUP I POWER FAILS
GROUP II POWER FAILS
P1N
P2N

Name	Page	Zone	Name	Page	Zone
CHWLI	1	2			
CMAINT	1	1			
COAD	3	1			
COAR	3	1			
COBD	4	1			
COBR	4	1			
COCD	5	1			
COCR	5	1			
CODD	6	1			
CODR	6	1			
CONF	1	2			
CONOP	1	1			
COPUMPS	1	2			
COPUMPS	2	2			
COVLVA	3	2			
COVLVB	4	2			
COVLVC	5	2			
COVLVD	6	2			
CPUMPA	2	1			
CPUMPA	3	2			
CPUMPB	2	1			
CPUMPB	4	2			
CPUMPC	2	2			
CPUMPC	5	2			
CPUMPD	2	2			
CPUMPD	6	2			
CVPOWER	1	2			
CVPOWER	7	2			
P1N	7	1			
P1NCD	3	2			
P2N	7	2			
P2NCD	4	2			
P3NCD	5	2			
P3NCD	6	2			



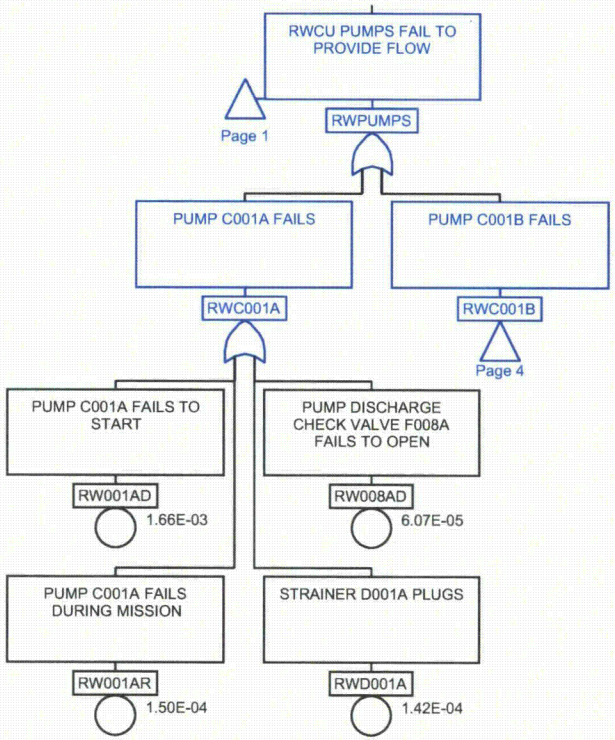
1 2 3 4 5 6 7

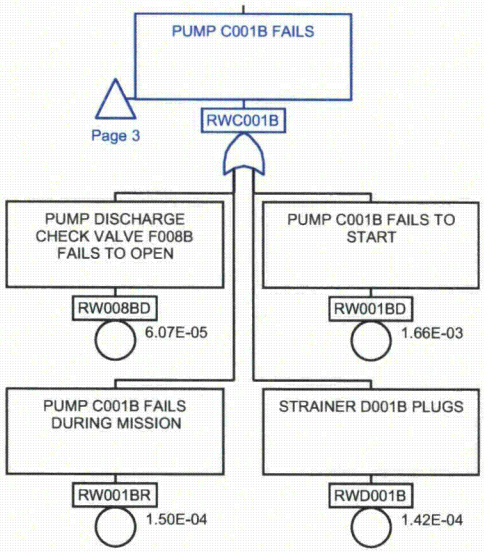
Figure G-7 Clean-Up Water System (SDC)

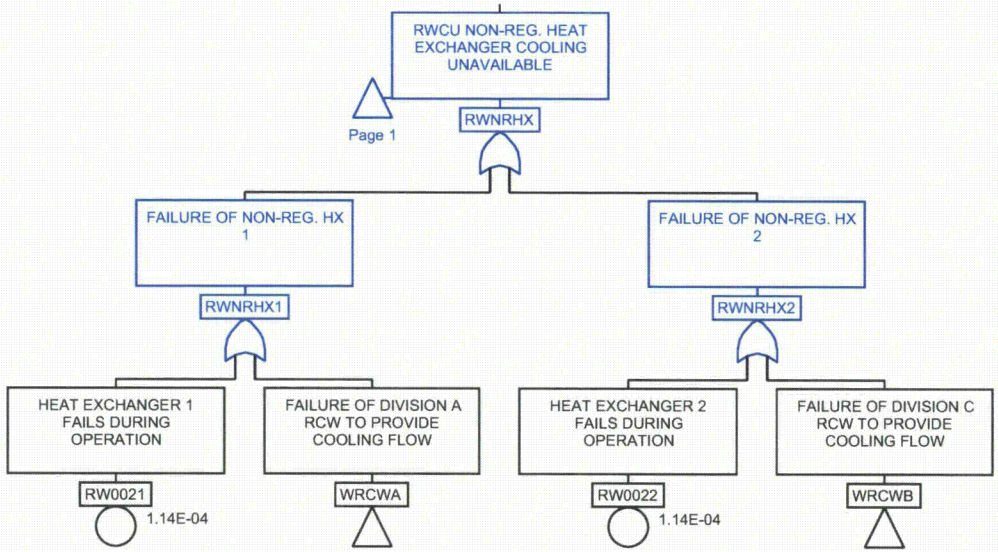


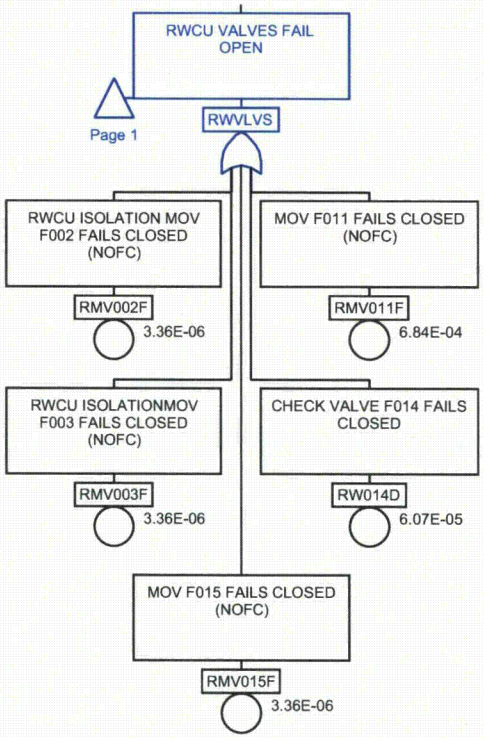
1 2 3 4

Figure G-7 Clean-Up Water System (SDC)

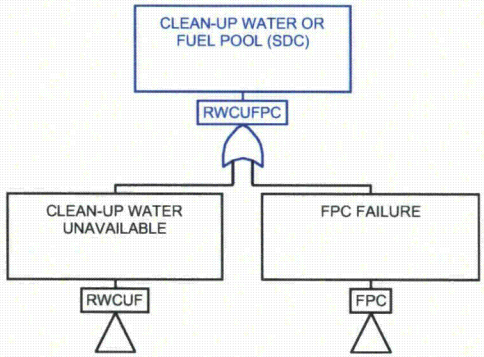

RWCU PUMPS FAIL TO PROVIDE FLOW
Page 1
RWPUMPS
PUMP C001A FAILS
PUMP C001B FAILS
RWC001A
RWC001B
Page 4
PUMP C001A FAILS TO START
PUMP DISCHARGE CHECK VALVE F008A FAILS TO OPEN
RW001AD
1.66E-03
RW008AD
6.07E-05
PUMP C001A FAILS DURING MISSION
STRAINER D001A PLUGS
RW001AR
1.50E-04
RWD001A
1.42E-04


PUMP C001B FAILS
Page 3
RWC001B
PUMP DISCHARGE CHECK VALVE F008B FAILS TO OPEN
RW008BD
6.07E-05
PUMP C001B FAILS TO START
RW001BD
1.66E-03
PUMP C001B FAILS DURING MISSION
RW001BR
1.50E-04
STRAINER D001B PLUGS
RWD001B
1.42E-04


RWCU NON-REG. HEAT EXCHANGER COOLING UNAVAILABLE
RWNRHX
Page 1
FAILURE OF NON-REG. HX 1
RWNRHX1
FAILURE OF NON-REG. HX 2
RWNRHX2
HEAT EXCHANGER 1 FAILS DURING OPERATION
RW0021
1.14E-04
FAILURE OF DIVISION A RCW TO PROVIDE COOLING FLOW
WRCWA
HEAT EXCHANGER 2 FAILS DURING OPERATION
RW0022
1.14E-04
FAILURE OF DIVISION C RCW TO PROVIDE COOLING FLOW
WRCWB


RWCU VALVES FAIL OPEN
Page 1
RWVLVS
RWCU ISOLATION MOV F002 FAILS CLOSED (NOFC)
RMV002F
3.36E-06
MOV F011 FAILS CLOSED (NOFC)
RMV011F
6.84E-04
RWCU ISOLATIONMOV F003 FAILS CLOSED (NOFC)
RMV003F
3.36E-06
CHECK VALVE F014 FAILS CLOSED
RW014D
6.07E-05
MOV F015 FAILS CLOSED (NOFC)
RMV015F
3.36E-06

Name	Page	Zone	Name	Page	Zone	
EACE1N	2	2	X_POS5B	1	7	Shutdown Probabilistic Risk Assessment
EACE2N	2	4				
EDC11N	2	1				
EDC12N	2	3				
P12N	1	3				
P12N	2	3				
P1N	2	2				
P2N	2	4				
RMV002F	6	1				
RMV003F	6	1				
RMV011F	6	2				
RMV015F	6	2				
RW001AD	3	1				
RW001AR	3	1				
RW001BD	4	2				
RW001BR	4	1				
RW0021	5	1				
RW0022	5	3				
RW008AD	3	2				
RW008BD	4	1				
RW014D	6	2				
RWC001A	3	2				
RWC001B	3	3				
RWC001B	4	2				
RWCUF	1	4				
RWCUFINITS	1	7				
RWCUOP	1	1				
RWD001A	3	2				
RWD001B	4	2				
RWMAINT	1	2				
RWNRHX	1	5				
RWNRHX	5	3				
RWNRHX1	5	2				
RWNRHX2	5	4				
RWPUMPS	1	4				
RWPUMPS	3	2				
RWVLVS	1	6				
RWVLVS	6	2				
SD_CUW	1	7				
SD_RHR0	1	8				
SD_RHR1	1	8				
SD_S3	1	8				
WRCWA	5	2				
WRCWB	5	4				
X_POS5A	1	7				



1 2

Figure G-8 Clean-Up Water or Fuel Pool (SDC)