Final Precursor Analysis

Accident Sequence Precursor Program --Office of Nuclear Regulatory Research

Palisades	Loss of shutdown cooling and emergency diesel generator start	
Event Date: March 25, 2003	**LER:** 255/03-003	**CCDP**[1] **=** $3\text{x}10^{-6}$

Event Summary

On March 25, 2003, plant maintenance workers were installing signposts in the parking lot to designate parking spaces. One of the signposts was driven into a conduit and damaged a cable which contained protective relay circuitry for all sources of offsite power. An Alert was declared due to the loss of offsite power combined with the loss of shutdown cooling.

The reported event, loss of offsite power, occurred during a refueling outage, when the reactor vessel head was open, and the cavity was flooded. The decay heat was being removed by DHR system. The event caused temporary disconnection of the AC power from the grid (switchyard power disconnect event) which stopped the running DHR train and auto-started emergency diesel generators. Shutdown cooling was restored after about 1 hour.

Cause. Workers were installing signposts in the parking lot. One of the signposts was driven into a conduit and damaged a cable which contained protective relay circuitry for all sources of offsite power.

Other conditions, failures, and unavailable equipment. No other significant conditions, failures, or unavailable equipment occurred during the event.

Recovery opportunities.

Multiple recovery opportunities exist and are credited in the event tree.

Analysis Results

- **Conditional core damage probability (CCDP)**

This event is modeled as a loss of AC power event leading to loss of RHR cooling during refueling conditions, with a 24-hour mission time. The conditional core damage probability of this event is 3E-06 (mean value). The acceptance threshold for the Accident Sequence Precursor Program is a CCDP of $\geq 1\text{x}10^{-6}$, therefore this condition is a precursor.

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[1] For the initiating event assessment, the parameter of interest is the measure of the conditional core damage probability (CCDP). This is the value obtained when calculating the probability of core damage for an initiating event with subsequent failure of one or more components following the initiating event.

	5%	**Mean**	95%
CCDP	2.6E-07	**2.7E-06**	8.2E-06

- **Dominant sequences**

The dominant sequence that contributes to event importance:

Sequence #5 of the event tree with a probability of 2.7E-06:

Emergency AC Power system is successful
No or insufficient DHR flow
Forced feed RCS Inventory makeup fails
Gravity feed RCS inventory makeup fails
Forced feed by firewater fails
Core damage occurs.

- **Results tables**

  - The conditional probabilities of the sequences with the highest CCDPs are shown in Table 1.
  - The event tree sequence logic for the sequences with the highest CCDPs are provided in Tables 2a and 2b.
  - The conditional cut sets for the sequences with the highest CCDPs are provided in Table 3.
  - Definitions and probabilities for modified or dominant basic events are provided in Table 4.

Modeling Assumptions

- **Assessment summary**

This event is modeled as a loss of AC power event leading to loss of RHR cooling during refueling conditions.

An event tree which contains top events for AC power recovery, restart of DHR, and the three recovery processes (see key modeling assumptions for the recovery processes) is used. The event tree is provided in Attachment C.

- **Modeling assumptions**

Key modeling assumptions. The key modeling assumptions are listed below and discussed in detail in the following sections. These assumptions are important contributors to the overall results.

1. AC power to the plant can be readily restored by means of operator action per EOP Supplement 29.

If the EDGs were not available, closure of breaker 152-401 in the safeguards bus house would have restored AC power to the plant and the DHR system and its support systems. Then, the DHR and its support systems need to be restarted by operator actions. EOP Supplement 29, Section 1.0 would have directed the operator to close safeguards supply breaker 152-401 and then close the 2400V AC incoming breakers, successfully restoring power to the unit.

2. Although not formally proceduralized, the following redundant and diverse methods to make up the water inventory in the containment sump, covering the core, exist if DHR recovery fails. These recoveries are credited with screening values to provide a reasonable upper-bound quantitative estimate of the risk incurred by this event:

   Forced-feed containment sump inventory makeup by using the CSR system (F-FEED).

   Gravity-feed inventory makeup form the SIRWT, with possible refilling of the SIRWT (G-FEED).

   Forced-feed from fire water system, or from a fire truck (FW-FEED)

   This assumption is needed for a reasonable estimation of event risk, since it provides the defense in depth and diversity to the already redundant DHR system. If these additional methods are not credited, the event risk estimate would solely rely on the reliability of the DHR system and its support systems. In that case, an elaborate repair model needs to be introduced to remove the conservatism.

   Tthe water inventory in the accumulators can be dumped into the RCS to extend the time to uncovery. This buys a longer time window for repairs and implementation of operator actions. This is not credited in the current analysis.

3. The time to boiling was estimated by the licensee as 2.5 hours; the time to core uncovery is also estimated, as 14 hours (Reference 2). This provides ample time for the plant personnel to restore original core cooling conditions, and additional cooling methods, if the original redundant DHR cooling fails by common cause.

- **Modifications to fault tree models**

The following modified or new fault tree models are used in the analysis:

AC Availability (EPS-R). EPS-R fault tree is made by using the EPS fault tree from the Palisades SPAR model for at-power events. Two recovery actions are AND-gated at the top of the FT with the EDG failures. These recovery actions are:

EP-XHE-AC-REC Operators restore AC power from the grid using EOP Supplement 29.

EP-DG-REC-SD Recovery of at least 1 EDG.

The fault tree is given by Figure C-2. The top cutsets of this fault tree are given in Table C-1.

DHR Restart (DHR-RESTART). The DHR-RESTART fault tree is made from the Palisades SPAR model for at-power events. The cutsets of this model are examined. The top four single-element cutsets corresponding to valves not opening are deemed not be applicable. The FT sections corresponding to these valves are removed. More cutsets further down may also be removed, but this is not pursued since it does not affect the results.

The fault tree is given by Figure C-3. The top cutsets of this fault tree are given in Table C-2.

RCS makeup by forced feed (F-FEED). A fault tree is made for this recovery by using screening values for operator action and hardware failures. The fault tree is shown in Figure C-4

RCS makeup by gravity feed (F-FEED). A fault tree is made for this recovery by using screening values for operator action and hardware failures. The fault tree is shown in Figure C-5

RCS makeup by fire water (FW-FEED). A fault tree is made for this recovery by using screening values for operator action and hardware failures. The fault tree is shown in Figure C-6

- **Basic event probability changes**

The following new data is introduced:

Probability of failure to recover at least one DG (EP-DG-REC-SD). The value of this basic event failure probability is taken from the SPAR EDG recovery curve at 13 hours as 8.8E-02 (Reference 3).

Probability of failure to connect to offsite power (EP-XHE-AC-REC). This operator action discussed and its failure probability is calculated in Attachment A.

The next three basic events represent failure of operator actions to implement the corresponding recovery action for RCS inventory makeup, when DHR fails.

Probability of failure to implement forced feed (F-FEED-XHE). This operator action discussed and its failure probability is calculated in Attachment A.

Probability of failure to implement gravity feed (F-FEED-XHE). This operator action discussed and its failure probability is calculated in Attachment A.

Probability of failure to implement fire water feed (F-FEED-XHE). This operator action discussed and its failure probability is calculated in Attachment A.

These basic events are used under the event tree tops F-FEED, G-FEED, and FW-FEED which are for un-proceduralized operator actions, coupled with equipment failures, during

a time window of 13 hours. Since these actions are not proceduralized, a screening value of 0.1 is assigned to operator actions associated with implementing each of the methods.

The product of three such failures gives a credit of 1 E-03 for sequence 5.

Also, a screening failure probability of 0.01 is assigned to hardware failures of the equipment used for each method. This assumes a single train reliability, which is typically at the order of 0.01. The hardware failure basic events are:

Probability of hardware failure in forced feed (F-FEED-HARDWARE). This includes at least one pump train. Redundant trains may be available.

Probability of hardware failure in gravity feed (G-FEED-HARDWARE). This includes at least one valve train. Redundant trains may be available.

Probability of hardware failure in fire water feed (FW-FEED-HARDWARE). This includes at least one pump train, and/or fire truck.

Summary of new data

Basic Event	Failure Probability
EP-DG-REC-SD	8.8E-02
EP-XHE-AC-REC	2.0E-05
F-FEED-XHE	1.0E-01
G-FEED-XHE	1.0E-01
FW-FEED-XHE	1.0E-01
F-FEED-HARDWARE	1.0E-02
FW-FEED-HARDWARE	1.0E-02
G-FEED-HARDWARE	1.0E-02

The following existing basic event failure probability is modified:

Probability of failure of operator action to start DHR (DHR-XHE-XM-SD). The probability of operator failing to restart DHR, given power recovery is calculated in Appendix A, as 1E-05.

- **Sensitivity analyses**

Sensitivity analyses are made to examine the importance of modeling assumptions. These sensitivity analyses are documented in Attachment B, and are summarized below.

LOOP occurs during power operation.

A sensitivity analysis is made, considering that the post digging is independent of the plant operating state, and this event could have occurred during power operation, which is an order of magnitude more likely than a shutdown state during a calendar year. This sensitivity analysis shows that the event importance could have been as high as 4 E-05, even when credit is given for easy AC power recovery operator action in this particular case.

No credit for recovery.

The recovery actions F-FEED, G-FEED, and FW-FEED are not proceduralized, but highly credible to be implemented during the 14 hours period, they were credited in the model for a realistic estimate of this event importance. A sensitivity analysis is made, assuming that these recovery actions are not available. The event importance is calculated to be 9.9E-04.

This sensitivity shows that the event importance would be highly conservatively modeled if credible recovery actions are not included in the base case.

Dependence between operator actions.

If DHR restart fails, recovery actions provide a total of 0.001 factor of reduction for the dominant sequence through screening operator actions. If it is assumed that one of the recovery actions is totally dependent on the other two, then this credit is reduced by an order of magnitude. In that case, the event importance becomes 2.7E-05. As expected, the modeling of recovery actions is important to get a realistic estimate of event importance.

SPAR model updates

Palisades SPAR model PALI_302 (zip file dated 05/07/2004 3:45pm) is used. No updates are performed on the model. The model is run with SAPHIRE/GEM version 6.8.

References

1. LP/SD SPAR Model Template for PWRs, Rev. 1/3i, August 2002

2. E-mail from J. Stang to S. Sancaktar containing utility responses to technical questions on the event. 8/16/2004.

3. Emergency DG Recovery Curve used in SPAR Models, Revision 3.

4. SERP Worksheet EA-03-180 dated 9/25/2003 (ML0327207361)

Table 1. Conditional core damage probabilities associated with the highest probability sequences.

Event	Sequence	Importance	Percent
IE-LOOP-SD	5	2.7E-06	100%
IE-LOOP-SD	8	9.4E-11	0%
Sum =		2.7E-06	100%

Table 2a. Event tree sequence logic for top sequences.

Event Tree	Sequence	Importance	%	Sequence Logic
IE-LOOP-SD	5	2.7E-06	100%	/EPS-R DHR-RESTART
				F-FEED G-FEED FW-FEED
IE-LOOP-SD	8	9.4E-11	0%	EPS-R G-FEED FW-FEED

Table 2b. Definitions of top events listed in Table 2a.

Fault Tree Name	Description
DHR-RESTART	No or Insufficient DHR Flow
EPS-R	Emergency AC Power System Failures
F-FEED	Forced Feed RCS Inventory Makeup
FW-FEED	Forced Feed by Firewater Fails
G-FEED	Gravity Feed RCS Inventory Makeup

Table 3. Conditional cut sets for dominant sequences.

SEQUENCE CUT SETS

Event Tree: IE-LOOP-SD
Sequence: 5
CCDP: 2.7E-06

CCDP	% Cut Set	Cut Set Events	
1.0E-006	37.8	RHR-AOV-OO-BYP	G-FEED-XHE
		F-FEED-XHE	FW-FEED-XHE
2.2E-007	8.2	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	LPI-MDP-CF-ALL
1.4E-007	5.2	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	CCW-HTX-PG-E54A
1.4E-007	5.2	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	CCW-HTX-PG-E54B
1.0E-007	3.8	DHR-MOV-CF-PSUC	G-FEED-XHE
		F-FEED-XHE	FW-FEED-XHE
1.0E-007	3.8	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	HPR-MOV-CF-SIRWT
1.0E-007	3.8	RHR-AOV-OO-BYP	G-FEED-XHE
		F-FEED-XHE	FW-FEED-HARDWARE
1.0E-007	3.8	RHR-AOV-OO-BYP	G-FEED-XHE
		F-FEED-HARDWARE	FW-FEED-XHE
1.0E-007	3.8	RHR-AOV-OO-BYP	G-FEED-HARDWARE
		F-FEED-XHE	FW-FEED-XHE
3.4E-008	1.3	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	SDC-HTX-CF-ALL

Event Tree: IE-LOOP-SD
Sequence: 8
CCDP: 9.4E-11

CCDP	% Cut Set	Cut Set Events	
1.3E-011	14.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	G-FEED-XHE
		FW-FEED-XHE	
1.0E-011	10.9	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
		G-FEED-XHE	FW-FEED-XHE
1.0E-011	10.9	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
		G-FEED-XHE	FW-FEED-XHE
6.6E-012	7.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTS	G-FEED-XHE
		FW-FEED-XHE	
6.6E-012	7.0	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-12	EPS-DGN-TM-11
		G-FEED-XHE	FW-FEED-XHE
6.6E-012	7.0	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-TM-12
		G-FEED-XHE	FW-FEED-XHE
6.1E-012	6.5	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-FR-12
		G-FEED-XHE	FW-FEED-XHE
3.9E-012	4.2	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-FR-12
		G-FEED-XHE	FW-FEED-XHE
3.9E-012	4.2	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-12	EPS-DGN-FR-11
		G-FEED-XHE	FW-FEED-XHE
2.5E-012	2.7	EP-DG-REC-SD	EP-XHE-AC-REC

		EPS-DGN-FS-11	EPS-DGN-FS-12
		G-FEED-XHE	FW-FEED-XHE
2.0E-012	2.2	EP-DG-REC-SD	EP-XHE-AC-REC
		G-FEED-XHE	FW-FEED-XHE
		SWS-MDP-CF-STRT	
1.6E-012	1.7	ACP-BAC-LP-1D	EP-DG-REC-SD
		EP-XHE-AC-REC	G-FEED-XHE
		FW-FEED-XHE	
1.6E-012	1.7	EP-DG-REC-SD	EP-XHE-AC-REC
		G-FEED-XHE	FW-FEED-XHE
		DCP-BDC-LP-21	
1.3E-012	1.4	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	G-FEED-XHE
		FW-FEED-HARDWARE	
1.3E-012	1.4	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	G-FEED-HARDWARE
		FW-FEED-XHE	
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
		G-FEED-HARDWARE	FW-FEED-XHE
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
		G-FEED-XHE	FW-FEED-HARDWARE
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
		G-FEED-HARDWARE	FW-FEED-XHE
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
		G-FEED-XHE	FW-FEED-HARDWARE

Table 4. Definitions and probabilities for modified or dominant basic events.

Event Name	Description	Prob	
ACP-BAC-LP-1D	DIVISION 1D AC POWER 4160V BUS A12 FAILS	9.0E-005	
CCW-HTX-PG-E54A	FAILURE OF CCW HEAT EXCHANGER E-54A	1.4E-004	
CCW-HTX-PG-E54B	FAILURE OF CCW HEAT EXCHANGER E-54B	1.4E-004	
DCP-BDC-LP-21	FAILURE OF DC POWER BUS 21D	9.0E-005	
DHR-MOV-CF-PSUC	CCF OF LPI/DHR PUMP SUCTION MOVS	1.0E-004	
EP-DG-REC-SD	EDG RECOVERY DURING SHUTDOWN	8.8E-002	New
EP-XHE-AC-REC	AC RECOVERY DURING SHUTDOWN	2.0E-005	New
EPS-DGN-CF-FTR	COMMON CAUSE FAILURE OF DGNS TO RUN	7.5E-004	
EPS-DGN-CF-FTS	COMMON CAUSE FAILURE OF DGNS TO START	3.8E-004	
EPS-DGN-FR-11	DIESEL GENERATOR 11 FAILS TO RUN	1.9E-002	
EPS-DGN-FR-12	DIESEL GENERATOR 12 FAILS TO RUN	1.9E-002	
EPS-DGN-FS-11	DIESEL GENERATOR 11 FAILS TO START	1.2E-002	
EPS-DGN-FS-12	DIESEL GENERATOR 12 FAILS TO START	1.2E-002	
EPS-DGN-TM-11	DIESEL GENERATOR 11 UNAVAILABLE DUE TO T&M	3.1E-002	
EPS-DGN-TM-12	DIESEL GENERATOR 12 UNAVAILABLE DUE TO T&M	3.1E-002	
F-FEED-HARDWARE	HARDWARE FAILURES OF FORCED FEED	1.0E-002	New
F-FEED-XHE	OPERATOR ACTION TO IMPLEMENT FORCED FEED FAIL	1.0E-001	New
FW-FEED-HARDWARE	HARDWARE FAILURES OF FORCED FEED BY FIRE WATE	1.0E-002	New
FW-FEED-XHE	OPERATOR ACTION TO IMPLEMENT FORCED FEED BY F	1.0E-001	New
G-FEED-HARDWARE	HARDWARE FAILURES OF GRAVITY FEED	1.0E-002	New
G-FEED-XHE	OPERATOR ACTION TO IMPLEMENT GRAVITY FEED FAILS	1.0E-001	New
HPR-MOV-CF-SIRWT	RWST ISOLATION MOVS FAIL TO CLOSE	1.0E-004	
LPI-MDP-CF-ALL	COMMON CAUSE FAILURE OF LPI MDPS	2.2E-004	
RHR-AOV-OO-BYP	LPI ISOL DISCHARGE AOV FAILURES	1.0E-003	
SDC-HTX-CF-ALL	COMMON CAUSE FAILURE OF SDC HEAT EXCHANGERS	3.4E-005	
SWS-MDP-CF-STRT	CCF OF SWS MDPS TO START	1.2E-004	

Note: Events marked as “New” were added to the model for this analysis, and are explained in the text.

Attachment A Calculation of Human Error Probabilities (HEPs)

SPAR HRA worksheets for LP/SD and at Power are used in this section to quantify the HEPs.

A-1 Operator Actions at Shutdown

The following new human error basic events are introduced in the model:

EP-XHE-AC-REC
DHR-XHE-XM-SD
F-FEED-XHE
FW-FEED-XHE
G-FEED-XHE

In this attachment, the HEPs for these human errors are calculated.

Calculation of HEP for EP-XHE-AC-REC. If the EDGs were not available, closure of breaker 152-401 in the safeguards bus house would have restored AC power to the plant and the DHR system and its support systems. Then, the DHR and its support systems need to be restarted by operator actions. EOP Supplement 29, Section 1.0 would have directed the operator to close safeguards supply breaker 152-401 and then close the 2400V AC incoming breakers, successfully restoring power to the unit (EP-XHE-AC-REC). This action can be performed within minutes and up to 14 hours with multiple shifts is available to perform this task. The diagnosis failure is insignificant, since power loss and failure of AC power on emergency buses is immediately apparent in the control room, and locally. Performance shaping factors for high stress due to the event, and time available is greater than 50x are used to get a PSF factor of 0.02. The HEP is calculated to be 2E-05.

Calculation of HEP for DHR-XHE-XM-SD. This basic event represents the operator action to restart DHR, given that AC power is established, either from EDGs or from the grid. This is a well proceduralized and important operator action that is a focal point of the plant operation at this phase of the shutdown state. The diagnosis failure is insignificant since both the control room and the other plant personnel can identify lack of DHR cooling (leading to eventual boiling in the containment where plant crews are operating in this shutdown state). This action can be performed within minutes and up to 14 hours with multiple shifts is available to perform this task. Performance shaping factors for high stress due to the event, time available is greater than 50x, and experience/training high are used to get a PSF factor of 0.01. The HEP is calculated to be 1E-05.

Calculation of HEPs for F-FEED-XHE, G-FEED-XHE, FW-FEED-XHE. Screening values for these operator actions are used. A HEP of 0.1 is assigned to each operator action. These actions have available time windows of many hours, but are not proceduralized. The actions are simple and are aimed to adding water to the flooded containment.

In the base case, no dependence is postulated for these there actions. The maximum credit one can get from these actions in a single accident sequence is 0.001 (0.01 if power is not available). Since these HEPs are action driven, but not diagnosis driven, apply to different “systems”, and can happen at different times in a long time window, no dependence is postulated. As a sensitivity analysis, the dependence is considered.

A-2 Operator Actions at Power (for the sensitivity analysis)

Three AC power recovery actions are calculated in this section these are:

In the first sensitivity case, the power recovery HEPS for the basic events modeled in SPAR are too conservative for this situation, since the grid is not lost, and the power can be rapidly restored by a simple operator action, as discussed above in EP-XHE-AC-REC. The three power recovery basic events affected are:

ACP-XHE-NOREC-ST (base SPAR value 0.53; delta T = 0.5 hours)
OEP-XHE-NOREC-SL (base SPAR value 0.324; delta T = 2.5 hours)
ACP-XHE-NOREC-BD (base SPAR value 0.022; delta T = 6.0 hours)

These three failure probabilities are recalculated for the specific event being assessed:

Probability of operator fail to restore AC power - short term (ACP-XHE-NOREC-ST). This is a proceduralized event with nominal time available under extreme stress. It's failure is dominated by diagnosis (identify the fault and choose the applicable procedure). The PSF multiplier is 5. The HEP is 0.05.

Probability of operator fail to restore AC power - seal LOCA(ACP-XHE-NOREC-SL). This is a proceduralized event with expansive time available under extreme stress. For diagnosis the time is expansive (up to 2+ hours to restore AC); for action, the time is nominal (since most of the time window is already credited for the diagnosis phase). The PSF multiplier for diagnosis is 0.05 and for action is 5. The HEP is calculated to be 0.0005 + 0.005 = 0.0055.

Probability of operator fail to restore AC power - before battery depletion (ACP-XHE-NOREC-BD). This is a proceduralized event with nominal time available under extreme stress. It's failure is dominated by action (long time window up to 6 hours). The PSF multiplier is 5 for extreme stress, 0.1 for time available >5x. The HEP is 0.0005.

Attachment B. Sensitivity Analyses

B-1 LOOP occurs during power operation

The digging activity that lead to the failure is independent of the plant operation mode; it could have as well occurred during power operation and lead to a reactor trip and LOOP. In fact, during a calendar year, the plant normally spends more time in power operation mode than in shutdown. The base conditional core damage probability of this plant given LOOP is 2.5E-04 and is dominated by SBO sequences. However, the power recovery in this event is highly likely since the power is available at the grid, and procedures exist for reestablishing power by simple operator action of breaker closure. In that case, the failure probabilities for power recovery in SBO sequences are improved. These failure probabilities are calculated in Appendix B as

Probability of operator fail to restore AC power - short term (ACP-XHE-NOREC-ST). The HEP is 0.05.

Probability of operator fail to restore AC power - seal LOCA(ACP-XHE-NOREC-SL). The HEP is 0.0055.

Probability of operator fail to restore AC power - before battery depletion (ACP-XHE-NOREC-BD). The HEP is 0.0005.

A sensitivity case is run with setting LOOP frequency to 1.0 and replacing the base AC recovery probabilities with the above values. The event importance, given LOOP, is calculated as 4.3 E-05.

The GEM run documenting the sensitivity case is given as Attachment D.

Note that this event importance is higher than that calculated in the SDP analysis (reference 4) since the SDP assumes that the LOOP initiating event frequency will increase randomly by 0.0311/yr, assuming one consequential digging in 32.1 years of plant operation.

B-2 No credit for recovery.

The recovery actions F-FEED, G-FEED, and FW-FEED are not proceduralized, but highly credible to be implemented during the 14 hours period, they were credited in the model for a realistic estimate of this event importance. A sensitivity analysis is made, assuming that these recovery actions are not available. For this purpose the three operator action probabilities are set to failure:

F-FEED-XHE
FW-FEED-XHE
G-FEED-XHE

GEM code is run with these new values. The resulting cutsets show that the basic event

RHR-AOV-OO-BYP : LPI ISOL DISCHARGE AOV FAILURE TO CLOSE

dominates the results. This valve has been already closed since the DHR system was operating successfully moments before the event. To make the results more realistic, the probability of this basic event is set to success. A GEM run is made and the event importance is calculated to be 9.9E-04. The GEM output is given as Attachment E. The first dominant cutset is common cause failure of motor driven pumps.

This sensitivity shows that the event importance would be highly conservatively modeled if credible recovery actions are not included in the base case.

B-3 Dependence between operator actions.

The recovery actions provide a total of 0.001 factor of reduction for the dominant sequence through screening operator actions. If it is assumed that one of the recovery actions is totally dependent on the other two, then this credit is reduced by an order of magnitude. In that case, the event importance becomes 2.7E-05. As expected, the modeling of recovery actions is important to get a realistic estimate of event importance.

Attachment C. Event Tree and Fault Tree Models

Process

The LP/SD SPAR Model template for PWRs (Reference 1) is examined and applicable logic is extracted to make an event tree for this case. This event tree is named “LOOP Occurs During Refueling Operation”. Applicable fault tree models for failure of EPS and DHR are taken and are modified to reflect the event-specific characteristics. Then, the event tree is quantified using the SAPPHIRE code, with the initiating event frequency set equal to 1.0. The resulting CCDP is reported.

Initiating Events

The initiating event is defined as the loss of power during refueling operations (IE-LOOP-SD). The plant is in shutdown conditions for the last 245 hours. The reactor vessel head is open, and the containment cavity is already flooded. The initiating event frequency is set equal to 1.0

Event Tree Model

An event tree model is generated, referring to the LOOP event tree in Reference 1. The event tree model is given in Figure C-1. It contains 6 top events, and defines two core damage sequences (sequences 5 and 8). The open RCS configuration prevents taking credit for RCS cooling by the secondary cooling system, via SGs. In the nomenclature of Reference 1, this event corresponds to POS Group 3 and Time Window TW3. The fact that the containment sump is flooded helps increase the time to core uncovery and buys ample time for proceduralized and non-proceduralized methods to keep the core covered.

The diagnosis of the event is immediate (loss of power to running DHR train and its support systems; momentary loss of lights in the MCR, etc.) Thus, failure to diagnose the event is not further pursued in the modeling.

The success criteria is taken from SPAR models whenever available. Changes are discussed below.

Given a LOOP event while in refueling mode with the reactor vessel head is open, and the containment cavity is flooded, the event could be successfully mitigated if;

– Power is restored to emergency busses that support the safety related equipment;

– DHR and its support systems are manually started (heat being removed by CCW heat exchangers);

If DHR or one of its support systems fails, three methods to make up containment sump inventory may be credited (each of these three methods is non proceduralized but each is technically and

time-window-wise feasible. Success of any one of these three methods avoids core uncovery during the mission time.

Forced-feed containment sump inventory makeup by using the CSR system.

Gravity-feed inventory makeup form the SIRWT, with possible refilling of the SIRWT.

Forced-feed from fire water system, or from a fire truck.

The failure of the above-defined success path leads to core damage sequence #5 in the event tree.

If power restoration fails, then either one of the following two methods of containment sump inventory makeup would constitute success (heat being removed by boiling):

– Gravity feeding from SIRWT

– Force feed from a fire truck

If this success criteria fails, sequence #8 occurs.

Five event tree top events are modeled by fault trees. These fault trees are:

EPS-R Failure to establish onsite emergency AC power by EDGs, automatically; AND failure to restore AC power from the grid (operator action following EOP); AND failure to restore at least 1 EDG (recovery/repair action).

DHR-RESTART Failure of DHR to remove decay heat via sump water recirculation through CCW heat exchangers.

F-FEED Failure of forced feed RCS inventory makeup

G-FEED Failure of gravity feed RCS inventory makeup

FW-FEED Failure of forced feed by fire water

The mission time is 24 hours.

Fault Tree Models:

The new or modified fault tree models are shown in Figure C-2 through C-6.

Human Error Probability Calculations

Human error probability calculations are given in Attachment A.

Event Importance Calculations

Event importance for one base case and three sensitivity cases are calculated. The gem output for base case is given as Attachment D. The sensitivity cases are discussed in Attachment B.

Uncertainty Analysis

The uncertainty bounds for 5 and 95 % confidences are calculated by GEM code. The summary is displayed on Figure C-7.

Figure C-1 IE-LOOP-SD Event Tree

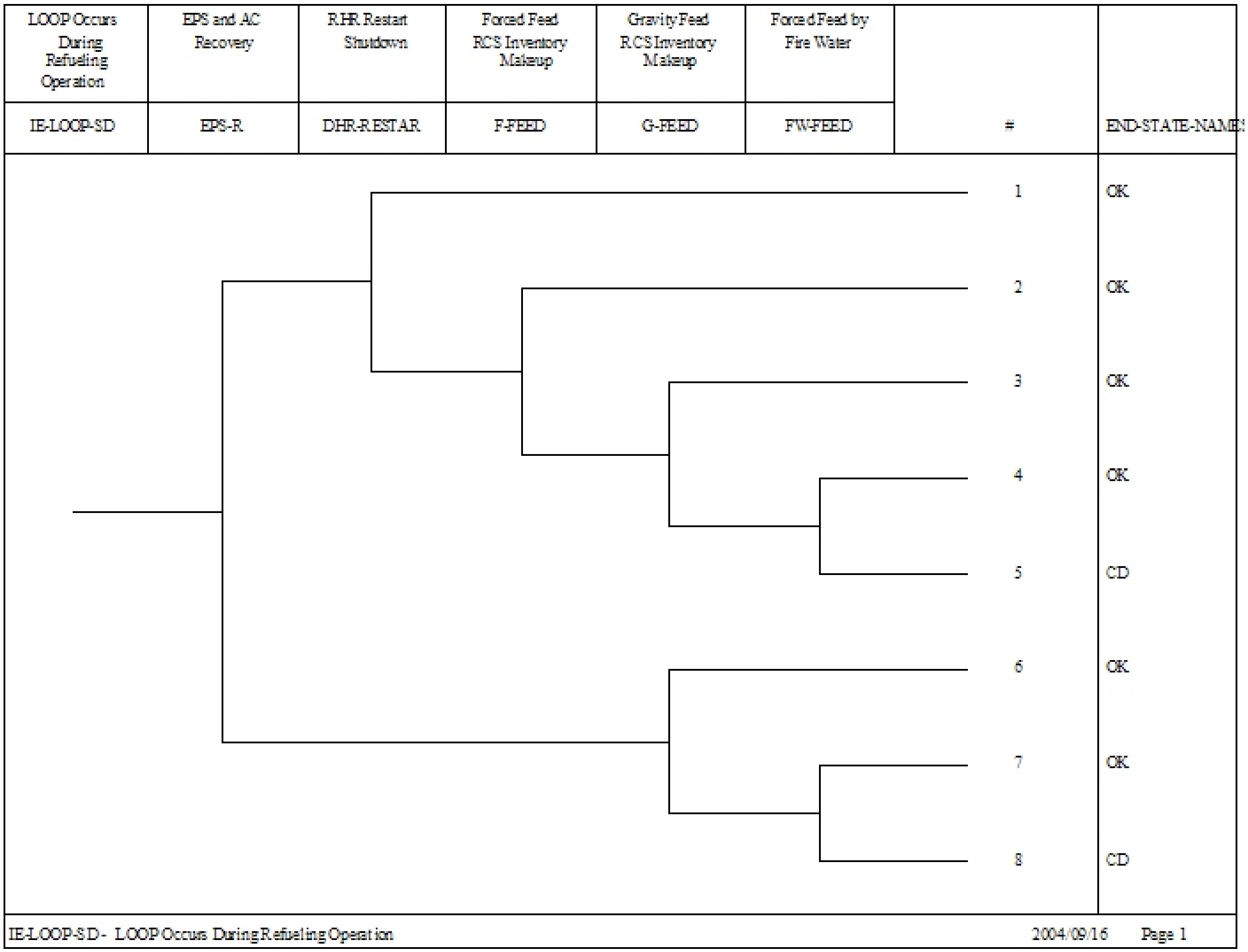


Figure C-2 EPS-R Fault Tree

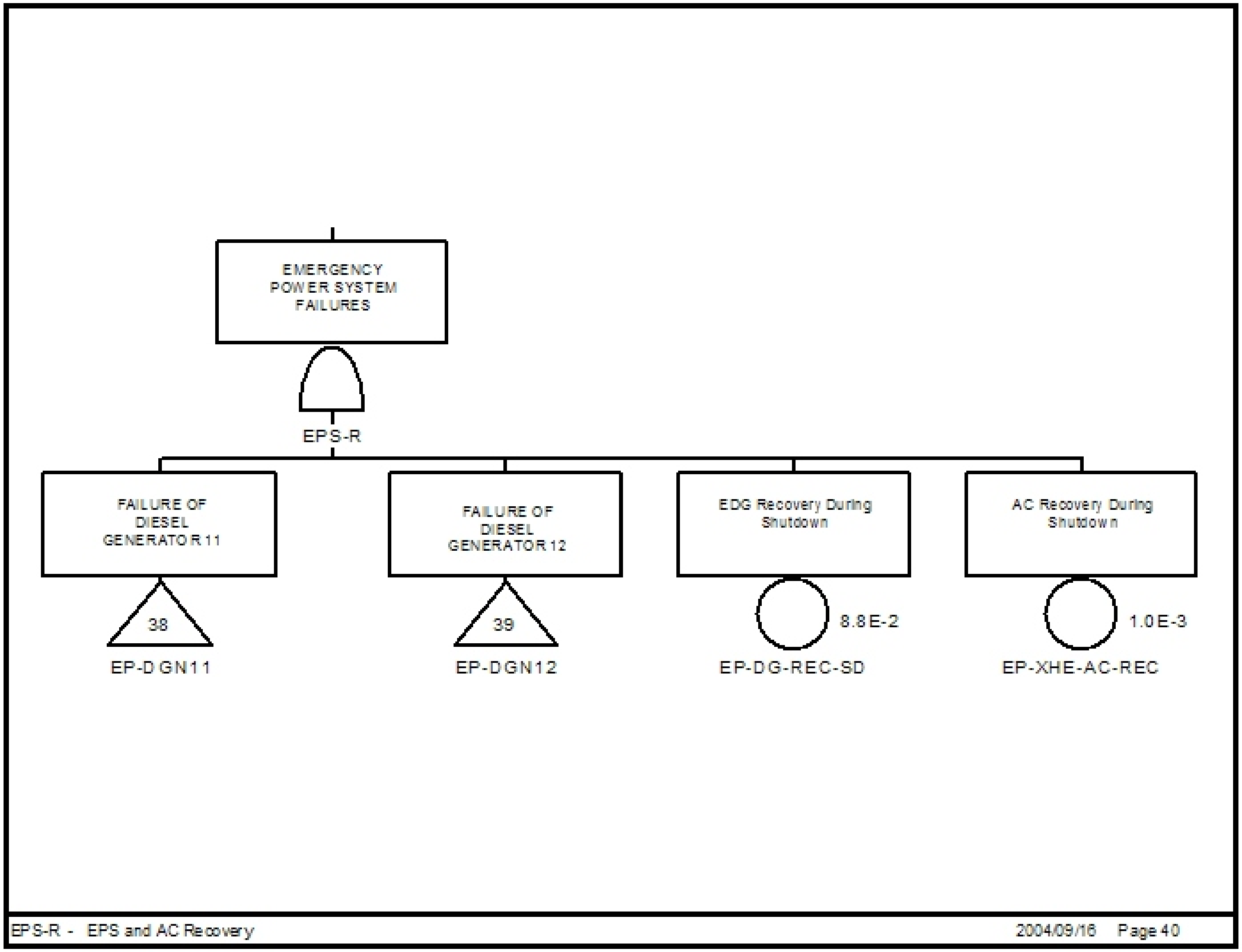


Figure C-3 RHR-R-SD Fault Tree

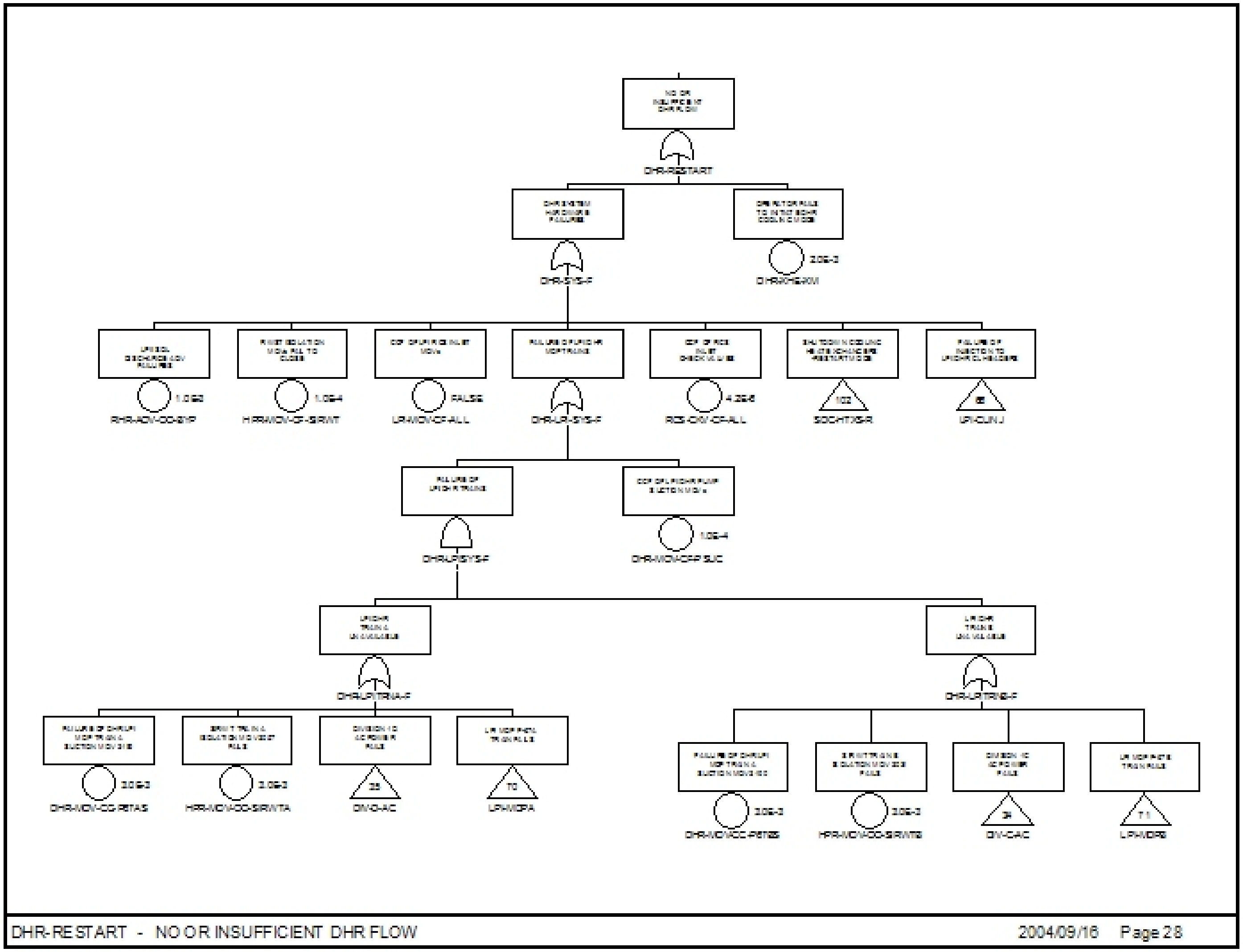


Figure C-4 F-FEED Fault Tree

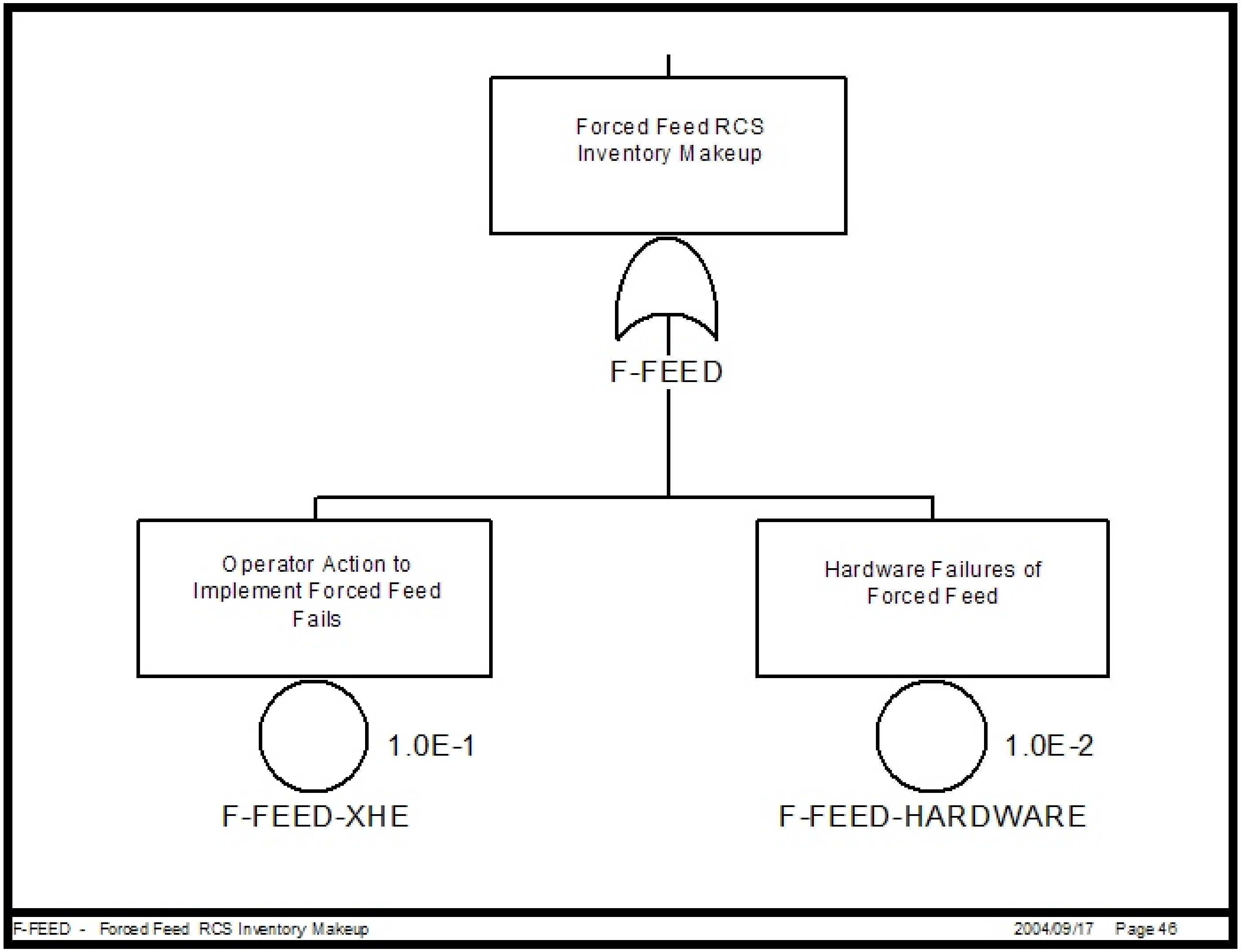


Figure C-5 FW-FEED Fault Tree

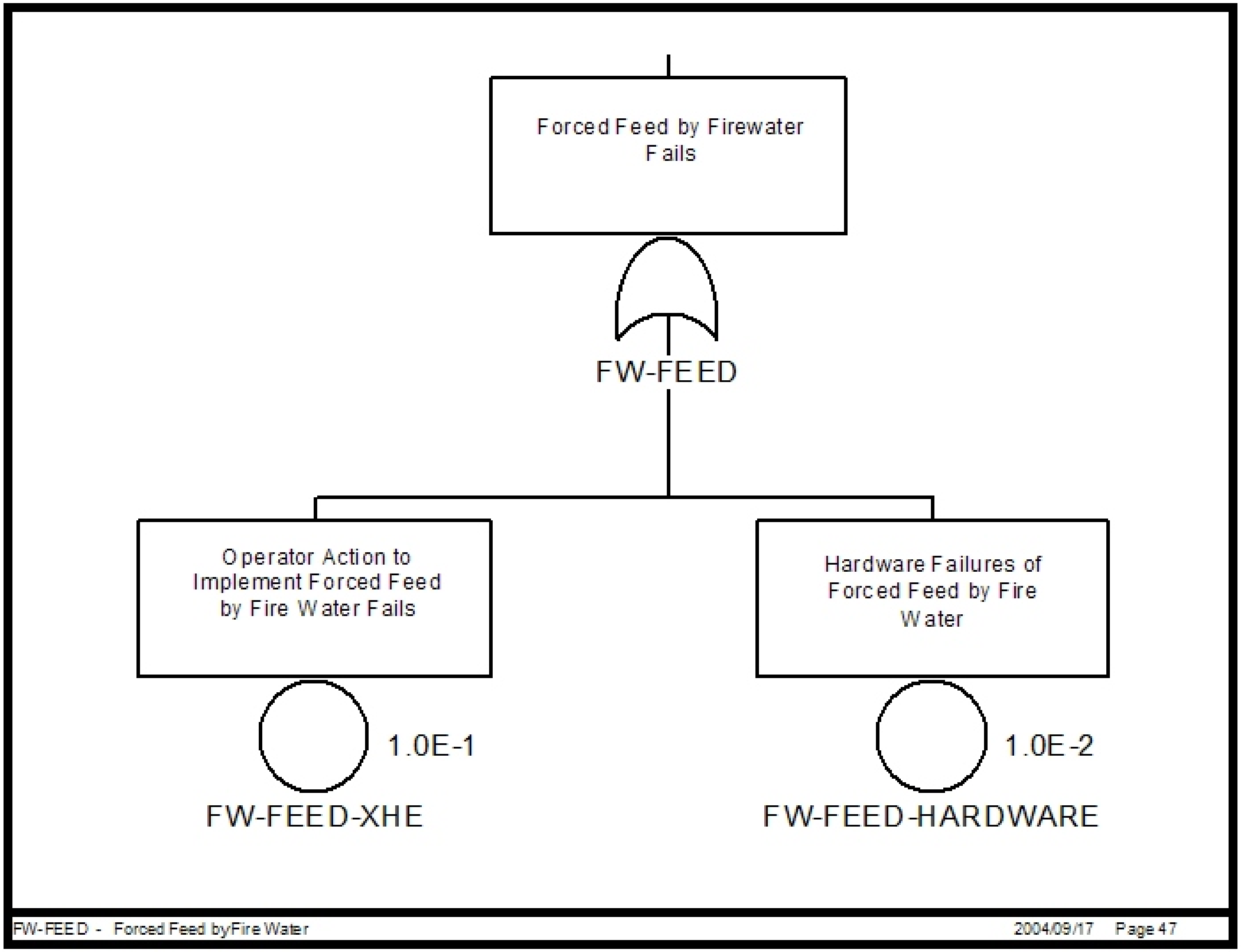


Figure C-6 G-FEED Fault Tree

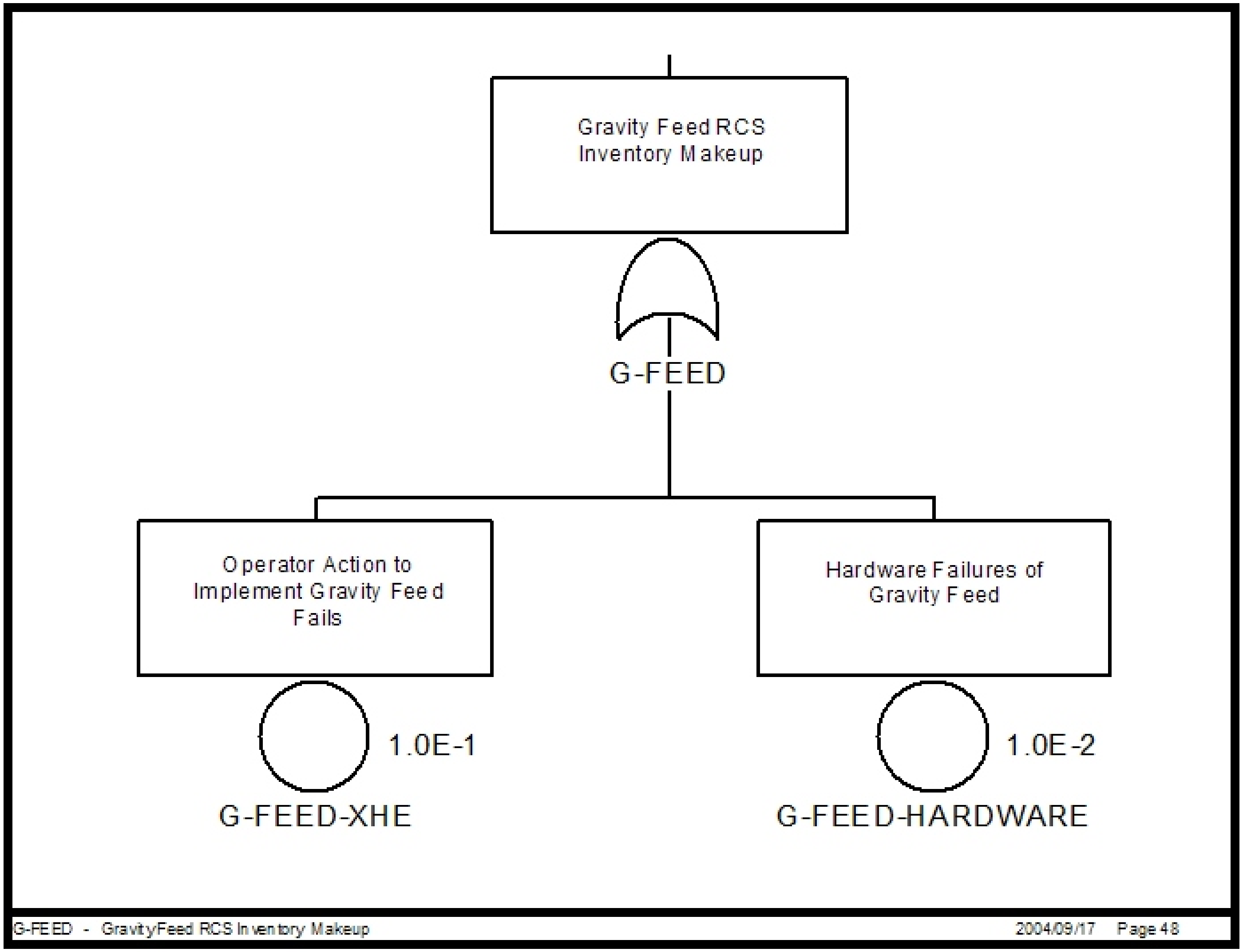
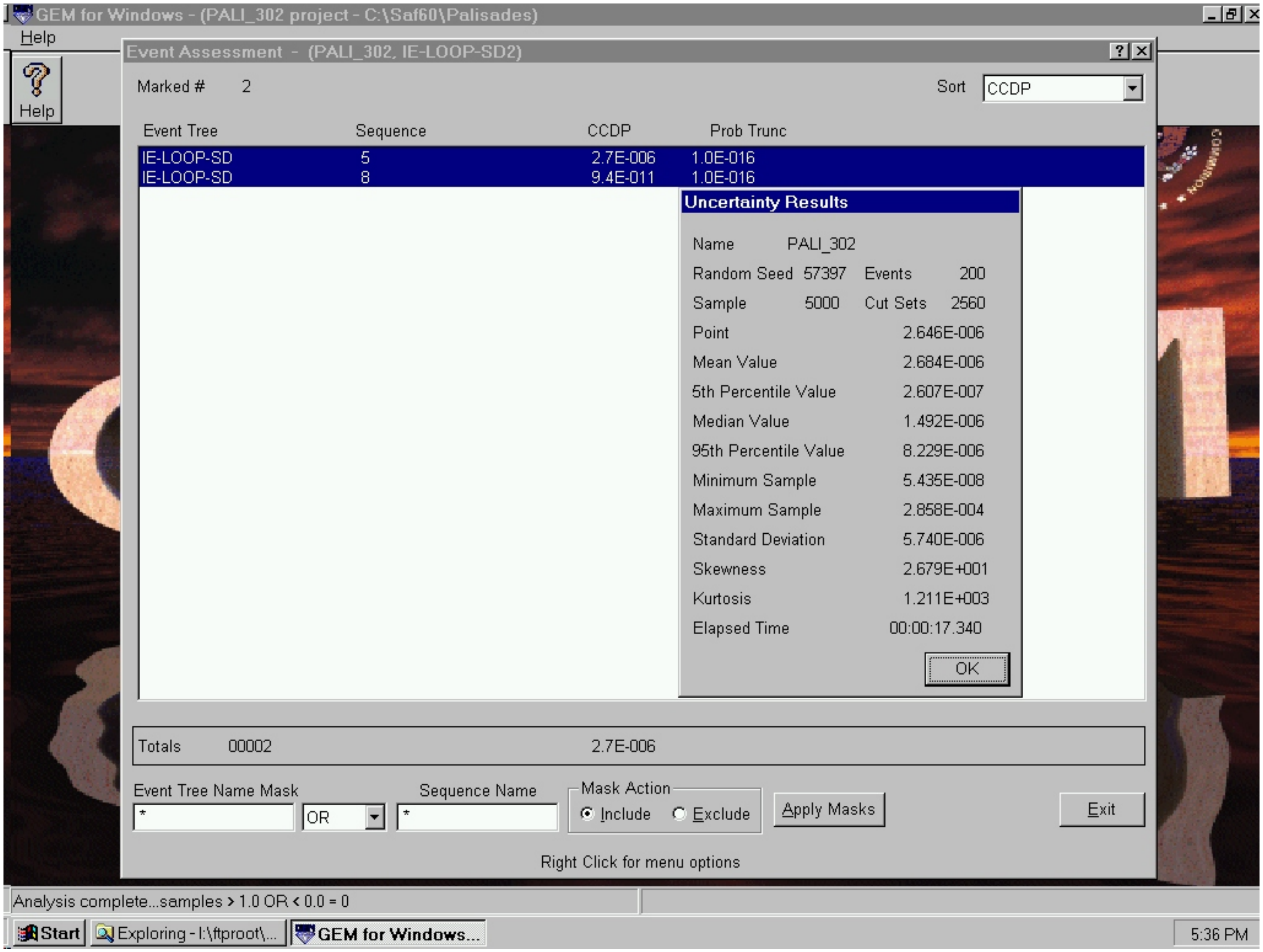


Figure C-7 Uncertainty Results



Output for the Base Case

I N I T I A T I N G   E V E N T   A S S E S S M E N T

```
                                            Code  Ver : 6:80
Fam  : PALI_302                             Model Ver : 1998/02/17
User : EG&G IDAHO, INC.  (INEL)             Init Event: IE-LOOP-SD
Ev ID: IE-LOOP-SD2                          Total CCDP:  2.7E-006
Desc : Initiating Event Assessment
```

BASIC EVENT CHANGES

Event Name	Description	Base Prob	Curr Prob	Type
IE-DHR-SUC-V	DECAY HEAT REMOVAL SUCTION I	1.0E-007	+0.0E+000	
IE-HPI1-DIS-V	HPI TRAIN 1 DISCHARGE ISLOCA	4.6E-004	+0.0E+000	
IE-HPI2-DIS-V	HPI TRAIN 2 DISCHARGE ISLOCA	4.6E-004	+0.0E+000	
IE-LLOCA	LARGE LOSS OF COOLANT ACCIDE	5.7E-010	+0.0E+000	
IE-LOCCW	LOSS OF COMPONENT COOLING WA	1.1E-007	+0.0E+000	
IE-LODC21	LOSS OF DC POWER BUS INITIAT	2.4E-007	+0.0E+000	
IE-LOOP	LOSS OF OFFSITE POWER INITIA	5.2E-006	+0.0E+000	
IE-LOOP-SD	LOOP Occurs During Refueling	1.0E+000	1.0E+000	
IE-LOSW	LOSS OF SERVICE WATER INITIA	1.1E-007	+0.0E+000	
IE-LPI-DIS-V	LPI DISCHARGE ISLOCA IE (BAS	4.6E-004	+0.0E+000	
IE-MLOCA	MEDIUM LOSS OF COOLANT ACCID	4.6E-009	+0.0E+000	
IE-SGTR	STEAM GENERATOR TUBE RUPTURE	8.0E-007	+0.0E+000	
IE-SLOCA	SMALL LOSS OF COOLANT ACCIDE	5.7E-008	+0.0E+000	
IE-TRANS	TRANSIENTS INITIATING EVENT	1.4E-004	+0.0E+000	

SEQUENCE PROBABILITIES

Truncation : Cummulative : 100.0% Individual :   0.0%

Event Tree Name	Sequence Name	CCDP	%Cont
IE-LOOP-SD	5	2.7E-006	100.0
IE-LOOP-SD	8	9.4E-011	0.0

SEQUENCE LOGIC

Event Tree	Sequence Name	Logic	
IE-LOOP-SD	5	/EPS-R	DHR-RESTART
		F-FEED	G-FEED
		FW-FEED	
IE-LOOP-SD	8	EPS-R	G-FEED
		FW-FEED	

Fault Tree Name	Description
DHR-RESTART	NO OR INSUFFICIENT DHR FLOW

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EPS-R	EMERGENCY POWER SYSTEM FAILURES
F-FEED	Forced Feed RCS Inventory Makeup
FW-FEED	Forced Feed by Firewater Fails
G-FEED	Gravity Feed RCS Inventory Makeup

SEQUENCE CUT SETS

Truncation: Cummulative: 100.0% Individual: 1.0%

Event Tree: IE-LOOP-SD CCDP: 2.7E-006
Sequence: 5

CCDP	% Cut Set	Cut Set Events	
1.0E-006	37.8	RHR-AOV-OO-BYP	G-FEED-XHE
		F-FEED-XHE	FW-FEED-XHE
2.2E-007	8.2	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	LPI-MDP-CF-ALL
1.4E-007	5.2	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	CCW-HTX-PG-E54A
1.4E-007	5.2	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	CCW-HTX-PG-E54B
1.0E-007	3.8	DHR-MOV-CF-PSUC	G-FEED-XHE
		F-FEED-XHE	FW-FEED-XHE
1.0E-007	3.8	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	HPR-MOV-CF-SIRWT
1.0E-007	3.8	RHR-AOV-OO-BYP	G-FEED-XHE
		F-FEED-XHE	FW-FEED-HARDWARE
1.0E-007	3.8	RHR-AOV-OO-BYP	G-FEED-XHE
		F-FEED-HARDWARE	FW-FEED-XHE
1.0E-007	3.8	RHR-AOV-OO-BYP	G-FEED-HARDWARE
		F-FEED-XHE	FW-FEED-XHE
3.4E-008	1.3	G-FEED-XHE	F-FEED-XHE
		FW-FEED-XHE	SDC-HTX-CF-ALL

Event Tree: IE-LOOP-SD CCDP: 9.4E-011
Sequence: 8

CCDP	% Cut Set	Cut Set Events	
1.3E-011	14.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	G-FEED-XHE
		FW-FEED-XHE	
1.0E-011	10.9	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
		G-FEED-XHE	FW-FEED-XHE
1.0E-011	10.9	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
		G-FEED-XHE	FW-FEED-XHE
6.6E-012	7.1	EP-DG-REC-SD	EP-XHE-AC-REC

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		EPS-DGN-CF-FTS	G-FEED-XHE
		FW-FEED-XHE	
6.6E-012	7.0	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-12	EPS-DGN-TM-11
		G-FEED-XHE	FW-FEED-XHE
6.6E-012	7.0	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-TM-12
		G-FEED-XHE	FW-FEED-XHE
6.1E-012	6.5	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-FR-12
		G-FEED-XHE	FW-FEED-XHE
3.9E-012	4.2	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-FR-12
		G-FEED-XHE	FW-FEED-XHE
3.9E-012	4.2	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-12	EPS-DGN-FR-11
		G-FEED-XHE	FW-FEED-XHE
2.5E-012	2.7	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-FS-12
		G-FEED-XHE	FW-FEED-XHE
2.0E-012	2.2	EP-DG-REC-SD	EP-XHE-AC-REC
		G-FEED-XHE	FW-FEED-XHE
		SWS-MDP-CF-STRT	
1.6E-012	1.7	ACP-BAC-LP-1D	EP-DG-REC-SD
		EP-XHE-AC-REC	G-FEED-XHE
		FW-FEED-XHE	
1.6E-012	1.7	EP-DG-REC-SD	EP-XHE-AC-REC
		G-FEED-XHE	FW-FEED-XHE
		DCP-BDC-LP-21	
1.3E-012	1.4	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	G-FEED-XHE
		FW-FEED-HARDWARE	
1.3E-012	1.4	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	G-FEED-HARDWARE
		FW-FEED-XHE	
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
		G-FEED-HARDWARE	FW-FEED-XHE
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
		G-FEED-XHE	FW-FEED-HARDWARE
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
		G-FEED-HARDWARE	FW-FEED-XHE
1.0E-012	1.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
		G-FEED-XHE	FW-FEED-HARDWARE

BASIC EVENTS (Cut Sets Only)

Event Name	Description	Curr Prob
ACP-BAC-LP-1D	DIVISION 1D AC POWER 4160V BUS A12 FAILS	9.0E-005
CCW-HTX-PG-E54A	FAILURE OF CCW HEAT EXCHANGER E-54A	1.4E-004
CCW-HTX-PG-E54B	FAILURE OF CCW HEAT EXCHANGER E-54B	1.4E-004
DCP-BDC-LP-21	FAILURE OF DC POWER BUS 21D	9.0E-005
DHR-MOV-CF-PSUC	CCF OF LPI/DHR PUMP SUCTION MOVS	1.0E-004
EP-DG-REC-SD	EDG RECOVERY DURING SHUTDOWN	8.8E-002
EP-XHE-AC-REC	AC RECOVERY DURING SHUTDOWN	2.0E-005
EPS-DGN-CF-FTR	COMMON CAUSE FAILURE OF DGNS TO RUN	7.5E-004
EPS-DGN-CF-FTS	COMMON CAUSE FAILURE OF DGNS TO START	3.8E-004
EPS-DGN-FR-11	DIESEL GENERATOR 11 FAILS TO RUN	1.9E-002
EPS-DGN-FR-12	DIESEL GENERATOR 12 FAILS TO RUN	1.9E-002
EPS-DGN-FS-11	DIESEL GENERATOR 11 FAILS TO START	1.2E-002
EPS-DGN-FS-12	DIESEL GENERATOR 12 FAILS TO START	1.2E-002
EPS-DGN-TM-11	DIESEL GENERATOR 11 UNAVAILABLE DUE TO T&M	3.1E-002
EPS-DGN-TM-12	DIESEL GENERATOR 12 UNAVAILABLE DUE TO T&M	3.1E-002
F-FEED-HARDWARE	HARDWARE FAILURES OF FORCED FEED	1.0E-002
F-FEED-XHE	OPERATOR ACTION TO IMPLEMENT FORCED FEED FAIL	1.0E-001
FW-FEED-HARDWARE	HARDWARE FAILURES OF FORCED FEED BY FIRE WATE	1.0E-002
FW-FEED-XHE	OPERATOR ACTION TO IMPLEMENT FORCED FEED BY F	1.0E-001
G-FEED-HARDWARE	HARDWARE FAILURES OF GRAVITY FEED	1.0E-002
G-FEED-XHE	OPERATOR ACTION TO IMPLEMENT GRAVITY FEED FAI	1.0E-001
HPR-MOV-CF-SIRWT	RWST ISOLATION MOVS FAIL TO CLOSE	1.0E-004
LPI-MDP-CF-ALL	COMMON CAUSE FAILURE OF LPI MDPS	2.2E-004
RHR-AOV-OO-BYP	LPI ISOL DISCHARGE AOV FAILURES	1.0E-003
SDC-HTX-CF-ALL	COMMON CAUSE FAILURE OF SDC HEAT EXCHANGERS	3.4E-005
SWS-MDP-CF-STRT	CCF OF SWS MDPS TO START	1.2E-004

Attachment E Gem Output for Sensitivity case 1: LOOP at Power

I N I T I A T I N G   E V E N T   A S S E S S M E N T

```
                                            Code  Ver : 6:80
Fam  : PALI_302                             Model Ver : 1998/02/17
User : EG&G IDAHO, INC.  (INEL)             Init Event: IE-LOOP
Ev ID: LOOP-SS                              Total CCDP:  4.3E-005
Desc : Initiating Event Assessment
```

BASIC EVENT CHANGES

Event Name	Description	Base Prob	Curr Prob	Type
ACP-XHE-NOREC-BD	OPERATOR FAILS TO RECOVER OF	2.2E-002	5.0E-004	
ACP-XHE-NOREC-ST	OPERATOR FAILS TO RECOVER OF	5.3E-001	5.0E-002	
IE-DHR-SUC-V	DECAY HEAT REMOVAL SUCTION I	1.0E-007	+0.0E+000	
IE-HPI1-DIS-V	HPI TRAIN 1 DISCHARGE ISLOCA	4.6E-004	+0.0E+000	
IE-HPI2-DIS-V	HPI TRAIN 2 DISCHARGE ISLOCA	4.6E-004	+0.0E+000	
IE-LLOCA	LARGE LOSS OF COOLANT ACCIDE	5.7E-010	+0.0E+000	
IE-LOCCW	LOSS OF COMPONENT COOLING WA	1.1E-007	+0.0E+000	
IE-LODC21	LOSS OF DC POWER BUS INITIAT	2.4E-007	+0.0E+000	
IE-LOOP	LOSS OF OFFSITE POWER INITIA	5.2E-006	1.0E+000	
IE-LOSW	LOSS OF SERVICE WATER INITIA	1.1E-007	+0.0E+000	
IE-LPI-DIS-V	LPI DISCHARGE ISLOCA IE (BAS	4.6E-004	+0.0E+000	
IE-MLOCA	MEDIUM LOSS OF COOLANT ACCID	4.6E-009	+0.0E+000	
IE-SGTR	STEAM GENERATOR TUBE RUPTURE	8.0E-007	+0.0E+000	
IE-SLOCA	SMALL LOSS OF COOLANT ACCIDE	5.7E-008	+0.0E+000	
IE-TRANS	TRANSIENTS INITIATING EVENT	1.4E-004	+0.0E+000	
OEP-XHE-NOREC-SL	OPERATOR FAILS TO RECOVER OF	3.2E-001	5.5E-003	

SEQUENCE PROBABILITIES

Truncation : Cummulative : 100.0% Individual :   0.0%

Event Tree Name	Sequence Name	CCDP	%Cont
LOOP	23	1.8E-005	41.9
LOOP	24-26	8.7E-006	20.2
LOOP	13	5.5E-006	12.8
LOOP	12	3.7E-006	8.6
LOOP	24-02	1.4E-006	3.3
LOOP	08	1.3E-006	3.0
LOOP	24-24	1.3E-006	3.0
LOOP	25	1.2E-006	2.8
LOOP	24-13	8.1E-007	1.9
LOOP	11	5.3E-007	1.2

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LOOP	24-10	2.4E-008	0.1
LOOP	24-08	2.2E-008	0.1
LOOP	22	1.6E-008	0.0
LOOP	24-21	1.4E-008	0.0
LOOP	24-19	1.3E-008	0.0
LOOP	20	9.2E-010	0.0
LOOP	09	8.6E-011	0.0
LOOP	17	1.1E-012	0.0
LOOP	21	1.5E-014	0.0

SEQUENCE LOGIC

Event Tree	Sequence Name	Logic	
LOOP	23	/RT-L AFW	/EP BLEED
LOOP	24-26	/RT-L AFW	EP ACP-ST
LOOP	13	/RT-L /AFW PORV-RES	/EP PORV-L HPI-L
LOOP	12	/RT-L /AFW PORV-RES OP-2H	/EP PORV-L /HPI-L CSR-L
LOOP	24-02	/RT-L /AFW /SEALLOCA	EP /PORV-SBO ACP-BD
LOOP	08	/RT-L /AFW PORV-RES /OP-2H /CSR	/EP PORV-L /HPI-L COOLDOWN HPR
LOOP	24-24	/RT-L /AFW PORV-RES	EP PORV-SBO ACP-ST
LOOP	25	RT-L	
LOOP	24-13	/RT-L /AFW /PORV-RES ACP-BD	EP PORV-SBO /SEALLOCA
LOOP	11	/RT-L /AFW PORV-RES	/EP PORV-L /HPI-L

		OP-2H	/CSR-L
		HPR-L	
LOOP	24-11	/RT-L	EP
		/AFW	/PORV-SBO
		SEALLOCA	OP-SL
LOOP	24-09	/RT-L	EP
		/AFW	/PORV-SBO
		SEALLOCA	/OP-SL
		/HPI	COOLDOWN
		CSR	
LOOP	24-22	/RT-L	EP
		/AFW	PORV-SBO
		/PORV-RES	SEALLOCA
		OP-SL	
LOOP	24-20	/RT-L	EP
		/AFW	PORV-SBO
		/PORV-RES	SEALLOCA
		/OP-SL	/HPI
		COOLDOWN	CSR
LOOP	16	/RT-L	/EP
		AFW	/BLEED
		/HPI-L	/OP-6H
		SGCOOL	/CSR
		HPR	
LOOP	24-10	/RT-L	EP
		/AFW	/PORV-SBO
		SEALLOCA	/OP-SL
		HPI	
LOOP	24-08	/RT-L	EP
		/AFW	/PORV-SBO
		SEALLOCA	/OP-SL
		/HPI	COOLDOWN
		/CSR	HPR
LOOP	22	/RT-L	/EP
		AFW	/BLEED
		HPI-L	
LOOP	24-21	/RT-L	EP
		/AFW	PORV-SBO
		/PORV-RES	SEALLOCA
		/OP-SL	HPI
LOOP	24-19	/RT-L	EP
		/AFW	PORV-SBO

		/PORV-RES /OP-SL COOLDOWN HPR	SEALLOCA /HPI /CSR
LOOP	20	/RT-L AFW /HPI-L SGCOOL-L HPR-L	/EP /BLEED OP-6H /CSR-L
LOOP	09	/RT-L /AFW PORV-RES /OP-2H CSR	/EP PORV-L /HPI-L COOLDOWN
LOOP	17	/RT-L AFW /HPI-L SGCOOL	/EP /BLEED /OP-6H CSR
LOOP	21	/RT-L AFW /HPI-L SGCOOL-L	/EP /BLEED OP-6H CSR-L

Fault Tree Name	Description
ACP-BD	OPERATOR FAILS TO RECOVER OFFSITE POWER BEFORE BATTER
ACP-ST	OFFSITE POWER RECOVERY IN SHORT TERM
AFW	NO OR INSUFFICIENT AFW FLOW
BLEED	FAILURE TO PROVIDE BLEED PORTION OF FEED & BLEED COOL
COOLDOWN	RCS COOLDOWN TO SDC PRESSURE USING TBVs, ETC.
CSR	NO OR INSUFFICIENT CSR FLOW
CSR-L	NO OR INSUFFICIENT CSR FLOW DURING LOOP
EP	EMERGENCY POWER SYSTEM FAILURES
HPI	NO OR INSUFFICIENT HPI FLOW
HPI-L	NO OR INSUFFICIENT HPI FLOW DURING LOOP
HPR	NO OR INSUFFICIENT HPR FLOW
HPR-L	NO OR INSUFFICIENT HPR FLOW DURING LOOP
OP-2H	OPERATOR FAILS TO RECOVER OFFSITE POWER WITHIN 2 HRS
OP-6H	OPERATOR FAILS TO RECOVER OFFSITE POWER WITHIN 6 HRS
OP-SL	OPERATOR FAILS TO RECOVER OFFSITE POWER (SEAL LOCA)
PORV-L	PORVs/SRVs OPEN DURING LOOP
PORV-RES	SRVs/PORVs AND BLOCK VALVES FAIL TO RESEAT
PORV-SBO	PORVs/SRVs OPEN DURING SBO
RT-L	REACTOR FAILS TO TRIP DURING LOOP
SEALLOCA	RCP SEALS FAIL DURING LOOP
SGCOOL	FAILURE OF SECONDARY COOLING
SGCOOL-L	FAILURE OF SECONDARY COOLING NO OFFSITE POWER

SEQUENCE CUT SETS

Truncation: Cummulative: 100.0% Individual: 1.0%

Event Tree: LOOP CCDP: 1.8E-005
Sequence: 23

CCDP	% Cut Set	Cut Set Events	
9.6E-007	5.4	EPS-DGN-TM-12	AFW-MDP-TM-8A
		AFW-TDP-FR-8B	
7.5E-007	4.2	AFW-AOV-CF-SGS	EPS-DGN-TM-11
7.5E-007	4.2	AFW-AOV-CF-SGS	EPS-DGN-TM-12
6.1E-007	3.4	EPS-DGN-TM-12	AFW-MDP-FS-8A
		AFW-XHE-XL-MDPFS	AFW-TDP-FR-8B
6.1E-007	3.4	EPS-DGN-TM-11	AFW-XHE-XL-MDPFS
		AFW-MDP-FS-8C	AFW-TDP-FR-8B
5.8E-007	3.3	EPS-DGN-FR-12	AFW-MDP-TM-8A
		AFW-TDP-FR-8B	
5.8E-007	3.3	EPS-DGN-FR-11	AFW-MDP-TM-8C
		AFW-TDP-FR-8B	
5.0E-007	2.8	EPS-DGN-TM-12	AFW-MDP-FR-8A
		AFW-XHE-XL-MDPFR	AFW-TDP-FR-8B
5.0E-007	2.8	EPS-DGN-TM-11	AFW-XHE-XL-MDPFR
		AFW-MDP-FR-8C	AFW-TDP-FR-8B
4.8E-007	2.7	HPI-XHE-XM-FB	AFW-AOV-CF-SGS
4.5E-007	2.5	AFW-AOV-CF-SGS	EPS-DGN-FR-12
4.5E-007	2.5	AFW-AOV-CF-SGS	EPS-DGN-FR-11
3.7E-007	2.1	EPS-DGN-FS-12	AFW-MDP-TM-8A
		AFW-TDP-FR-8B	
3.7E-007	2.1	EPS-DGN-FS-11	AFW-MDP-TM-8C
		AFW-TDP-FR-8B	
3.6E-007	2.1	EPS-DGN-FR-12	AFW-MDP-FS-8A
		AFW-XHE-XL-MDPFS	AFW-TDP-FR-8B
3.6E-007	2.1	EPS-DGN-FR-11	AFW-XHE-XL-MDPFS
		AFW-MDP-FS-8C	AFW-TDP-FR-8B
3.0E-007	1.7	EPS-DGN-FR-12	AFW-MDP-FR-8A
		AFW-XHE-XL-MDPFR	AFW-TDP-FR-8B
3.0E-007	1.7	EPS-DGN-FR-11	AFW-XHE-XL-MDPFR
		AFW-MDP-FR-8C	AFW-TDP-FR-8B
2.9E-007	1.6	AFW-AOV-CF-SGS	EPS-DGN-FS-11
2.9E-007	1.6	AFW-AOV-CF-SGS	EPS-DGN-FS-12
2.3E-007	1.3	EPS-DGN-FS-12	AFW-MDP-FS-8A
		AFW-XHE-XL-MDPFS	AFW-TDP-FR-8B
2.3E-007	1.3	EPS-DGN-FS-11	AFW-XHE-XL-MDPFS
		AFW-MDP-FS-8C	AFW-TDP-FR-8B
2.3E-007	1.3	EPS-DGN-TM-12	AFW-MDP-TM-8A
		AFW-TDP-FS-8B	
1.9E-007	1.1	EPS-DGN-FS-12	AFW-MDP-FR-8A

		AFW-XHE-XL-MDPFR	AFW-TDP-FR-8B
1.9E-007	1.1	EPS-DGN-FS-11	AFW-XHE-XL-MDPFR
		AFW-MDP-FR-8C	AFW-TDP-FR-8B
1.8E-007	1.0	AFW-CKV-CF-PMPS	EPS-DGN-TM-11
1.8E-007	1.0	AFW-CKV-CF-PMPS	EPS-DGN-TM-12

Event Tree: LOOP CCDP: 8.7E-006
Sequence: 24-26

CCDP	% Cut Set	Cut Set Events	
1.1E-006	12.1	ACP-XHE-NOREC-ST	EPS-DGN-CF-FTR
		AFW-TDP-FR-8B	
8.1E-007	9.3	ACP-XHE-NOREC-ST	EPS-DGN-FR-12
		EPS-DGN-TM-11	AFW-TDP-FR-8B
8.1E-007	9.3	ACP-XHE-NOREC-ST	EPS-DGN-FR-11
		EPS-DGN-TM-12	AFW-TDP-FR-8B
5.3E-007	6.1	ACP-XHE-NOREC-ST	EPS-DGN-CF-FTS
		AFW-TDP-FR-8B	
5.2E-007	6.0	ACP-XHE-NOREC-ST	EPS-DGN-FS-11
		EPS-DGN-TM-12	AFW-TDP-FR-8B
5.2E-007	6.0	ACP-XHE-NOREC-ST	EPS-DGN-FS-12
		EPS-DGN-TM-11	AFW-TDP-FR-8B
4.9E-007	5.6	ACP-XHE-NOREC-ST	EPS-DGN-FR-11
		EPS-DGN-FR-12	AFW-TDP-FR-8B
3.2E-007	3.6	ACP-XHE-NOREC-ST	EPS-DGN-FS-11
		EPS-DGN-FR-12	AFW-TDP-FR-8B
3.2E-007	3.6	ACP-XHE-NOREC-ST	EPS-DGN-FS-12
		EPS-DGN-FR-11	AFW-TDP-FR-8B
2.9E-007	3.4	ACP-XHE-NOREC-ST	EPS-DGN-CF-FTR
		AFW-TDP-TM-8B	
2.6E-007	2.9	ACP-XHE-NOREC-ST	EPS-DGN-CF-FTR
		AFW-TDP-FS-8B	
2.0E-007	2.3	ACP-XHE-NOREC-ST	EPS-DGN-FS-11
		EPS-DGN-FS-12	AFW-TDP-FR-8B
2.0E-007	2.3	ACP-XHE-NOREC-ST	EPS-DGN-FR-12
		EPS-DGN-TM-11	AFW-TDP-FS-8B
2.0E-007	2.3	ACP-XHE-NOREC-ST	EPS-DGN-FR-11
		EPS-DGN-TM-12	AFW-TDP-FS-8B
1.6E-007	1.9	ACP-XHE-NOREC-ST	SWS-MDP-CF-STRT
		AFW-TDP-FR-8B	
1.5E-007	1.7	ACP-XHE-NOREC-ST	EPS-DGN-CF-FTS
		AFW-TDP-TM-8B	
1.4E-007	1.6	ACP-XHE-NOREC-ST	EPS-DGN-FR-11
		EPS-DGN-FR-12	AFW-TDP-TM-8B
1.3E-007	1.5	ACP-XHE-NOREC-ST	EPS-DGN-CF-FTS
		AFW-TDP-FS-8B	
1.3E-007	1.5	ACP-XHE-NOREC-ST	EPS-DGN-FS-12
		EPS-DGN-TM-11	AFW-TDP-FS-8B
1.3E-007	1.5	ACP-XHE-NOREC-ST	EPS-DGN-FS-11
		EPS-DGN-TM-12	AFW-TDP-FS-8B
1.3E-007	1.5	ACP-XHE-NOREC-ST	DCP-BDC-LP-21

		AFW-TDP-FR-8B	
1.3E-007	1.5	ACP-BAC-LP-1D	ACP-XHE-NOREC-ST
		AFW-TDP-FR-8B	
1.2E-007	1.4	ACP-XHE-NOREC-ST	EPS-DGN-FR-11
		EPS-DGN-FR-12	AFW-TDP-FS-8B
8.7E-008	1.0	ACP-XHE-NOREC-ST	EPS-DGN-FS-11
		EPS-DGN-FR-12	AFW-TDP-TM-8B
8.7E-008	1.0	ACP-XHE-NOREC-ST	EPS-DGN-FS-12
		EPS-DGN-FR-11	AFW-TDP-TM-8B

Event Tree: LOOP CCDP: 5.5E-006
Sequence: 13

CCDP	% Cut Set	Cut Set Events	
7.5E-007	13.5	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-12	HPI-MDP-TM-P66B
7.5E-007	13.5	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-11	HPI-MDP-TM-P66A
5.6E-007	10.0	HPI-MDP-CF-ALL	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	
4.5E-007	8.1	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FR-11	HPI-MDP-TM-P66A
4.5E-007	8.1	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FR-12	HPI-MDP-TM-P66B
2.9E-007	5.2	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FS-12	HPI-MDP-TM-P66B
2.9E-007	5.2	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FS-11	HPI-MDP-TM-P66A
2.4E-007	4.3	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-11	HPI-MDP-FS-P66A
2.4E-007	4.3	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-12	HPI-MDP-FS-P66B
1.4E-007	2.6	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FR-12	HPI-MDP-FS-P66B
1.4E-007	2.6	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FR-11	HPI-MDP-FS-P66A
9.2E-008	1.7	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FS-11	HPI-MDP-FS-P66A
9.2E-008	1.7	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-FS-12	HPI-MDP-FS-P66B
7.9E-008	1.4	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-12	HPI-XHE-XR-P66B
7.9E-008	1.4	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-11	HPI-XHE-XR-P66A
7.3E-008	1.3	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		HPI-MDP-FS-P66A	HPI-MDP-TM-P66B
7.3E-008	1.3	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		HPI-MDP-TM-P66A	HPI-MDP-FS-P66B
5.7E-008	1.0	PPR-SRV-CO-L	PPR-SRV-OO-SR1
		EPS-DGN-TM-11	HPI-MDP-FR-P66A
5.7E-008	1.0	PPR-SRV-CO-L	PPR-SRV-OO-SR1

		EPS-DGN-TM-12	HPI-MDP-FR-P66B

Event Tree: LOOP
Sequence: 12

CCDP: 3.7E-006

CCDP	% Cut Set	Cut Set Events	
4.6E-007	12.5	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	FPS-DDP-FC-41
		EPS-DGN-TM-12	
4.6E-007	12.5	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-TM-12
		FPS-DDP-FC-9B	
3.8E-007	10.3	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-TM-12
		SWS-XHE-XA-FIRESYS	
2.8E-007	7.5	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	FPS-DDP-FC-41
		EPS-DGN-FR-12	
2.8E-007	7.5	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FR-12
		FPS-DDP-FC-9B	
2.3E-007	6.2	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FR-12
		SWS-XHE-XA-FIRESYS	
1.8E-007	4.9	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	FPS-DDP-FC-41
		EPS-DGN-FS-12	
1.8E-007	4.9	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FS-12
		FPS-DDP-FC-9B	
1.7E-007	4.7	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-TM-12
		FPS-MDP-TM-9A	
1.5E-007	4.0	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FS-12
		SWS-XHE-XA-FIRESYS	
1.4E-007	3.8	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	FPS-DDP-TM-41
		EPS-DGN-TM-12	
1.4E-007	3.8	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-TM-12
		FPS-DDP-TM-9B	
1.0E-007	2.8	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FR-12
		FPS-MDP-TM-9A	
8.5E-008	2.3	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FR-12
		FPS-DDP-TM-9B	
8.5E-008	2.3	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	FPS-DDP-TM-41
		EPS-DGN-FR-12	

6.6E-008	1.8	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 FPS-MDP-TM-9A	PPR-SRV-CO-L EPS-DGN-FS-12
5.5E-008	1.5	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FS-12	PPR-SRV-CO-L FPS-DDP-TM-41
5.5E-008	1.5	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 FPS-DDP-TM-9B	PPR-SRV-CO-L EPS-DGN-FS-12

Event Tree: LOOP CCDP: 1.4E-006
Sequence: 24-02

CCDP	% Cut Set	Cut Set Events	
2.3E-007	17.1	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO	/RCS-MDP-LK-SEALS EPS-DGN-CF-FTR
1.8E-007	13.2	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-TM-11	/RCS-MDP-LK-SEALS EPS-DGN-FR-12
1.8E-007	13.2	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-TM-12	/RCS-MDP-LK-SEALS EPS-DGN-FR-11
1.2E-007	8.6	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO	/RCS-MDP-LK-SEALS EPS-DGN-CF-FTS
1.2E-007	8.5	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-TM-12	/RCS-MDP-LK-SEALS EPS-DGN-FS-11
1.2E-007	8.5	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-TM-11	/RCS-MDP-LK-SEALS EPS-DGN-FS-12
1.1E-007	7.9	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-FR-12	/RCS-MDP-LK-SEALS EPS-DGN-FR-11
7.0E-008	5.1	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-FR-12	/RCS-MDP-LK-SEALS EPS-DGN-FS-11
7.0E-008	5.1	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-FR-11	/RCS-MDP-LK-SEALS EPS-DGN-FS-12
4.5E-008	3.3	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO EPS-DGN-FS-12	/RCS-MDP-LK-SEALS EPS-DGN-FS-11
3.6E-008	2.6	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO	/RCS-MDP-LK-SEALS SWS-MDP-CF-STRT
2.8E-008	2.1	ACP-BAC-LP-1D /RCS-MDP-LK-SEALS	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO
2.8E-008	2.1	ACP-XHE-NOREC-BD /PPR-SRV-CO-SBO	/RCS-MDP-LK-SEALS DCP-BDC-LP-21

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Event Tree: LOOP CCDP: 1.3E-006
Sequence: 08

CCDP	% Cut Set	Cut Set Events	
2.3E-007	17.1	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CF-MNFLW
2.3E-007	17.1	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CF-SUMP
2.3E-007	17.1	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CF-SIRWT
1.1E-007	8.6	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-SMP-FC-SUMP
6.4E-008	4.8	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPA
		HPI-MDP-TM-P66B	
6.4E-008	4.8	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTB
		HPI-MDP-TM-P66A	
6.4E-008	4.8	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTA
		HPI-MDP-TM-P66B	
6.4E-008	4.8	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPB
		HPI-MDP-TM-P66A	
2.3E-008	1.8	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-CKV-CF-SUMP
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPA
		HPR-MOV-OO-SIRWTB	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPB
		HPR-MOV-OO-SIRWTA	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTB
		HPI-MDP-FS-P66A	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTA
		HPI-MDP-FS-P66B	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTB
		HPR-MOV-OO-SIRWTA	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPA
		HPI-MDP-FS-P66B	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPB
		HPI-MDP-FS-P66A	
2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPB
		HPR-MOV-CC-SMPA	

2.0E-008	1.5	/OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-MFLWA
		HPR-MOV-OO-MFLWB	

Event Tree: LOOP CCDP: 1.3E-006
Sequence: 24-24

CCDP	% Cut Set	Cut Set Events	
2.2E-007	17.1	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-CF-FTR
1.7E-007	13.2	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FR-12
		EPS-DGN-TM-11	
1.7E-007	13.2	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FR-11
		EPS-DGN-TM-12	
1.1E-007	8.6	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-CF-FTS
1.1E-007	8.5	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-TM-12	
1.1E-007	8.5	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FS-12
		EPS-DGN-TM-11	
1.0E-007	7.9	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FR-11
		EPS-DGN-FR-12	
6.6E-008	5.1	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-FR-12	
6.6E-008	5.1	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FS-12
		EPS-DGN-FR-11	
4.3E-008	3.3	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-FS-12	
3.4E-008	2.6	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	SWS-MDP-CF-STRT
2.7E-008	2.1	ACP-BAC-LP-1D	ACP-XHE-NOREC-ST
		PPR-SRV-OO-SR1	PPR-SRV-CO-SBO
2.7E-008	2.1	ACP-XHE-NOREC-ST	PPR-SRV-OO-SR1
		PPR-SRV-CO-SBO	DCP-BDC-LP-21

Event Tree: LOOP CCDP: 1.2E-006
Sequence: 25

CCDP	% Cut Set	Cut Set Events
1.2E-006	100.0	RPS-VCF-FO-MECH

Event Tree: LOOP CCDP: 8.1E-007
Sequence: 24-13

CCDP	% Cut Set	Cut Set Events	
1.4E-007	17.1	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-CF-FTR
1.1E-007	13.2	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FR-12
		EPS-DGN-TM-11	
1.1E-007	13.2	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FR-11
		EPS-DGN-TM-12	
6.9E-008	8.6	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-CF-FTS
6.8E-008	8.5	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-TM-12	
6.8E-008	8.5	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FS-12
		EPS-DGN-TM-11	
6.4E-008	7.9	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FR-11
		EPS-DGN-FR-12	
4.1E-008	5.1	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-FR-12	
4.1E-008	5.1	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FS-12
		EPS-DGN-FR-11	
2.6E-008	3.3	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-FS-12	
2.1E-008	2.6	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	SWS-MDP-CF-STRT
1.7E-008	2.1	ACP-BAC-LP-1D	ACP-XHE-NOREC-BD
		/RCS-MDP-LK-SEALS	PPR-SRV-CO-SBO
1.7E-008	2.1	ACP-XHE-NOREC-BD	/RCS-MDP-LK-SEALS
		PPR-SRV-CO-SBO	DCP-BDC-LP-21

Event Tree: LOOP CCDP: 5.3E-007
Sequence: 11

CCDP	% Cut Set	Cut Set Events	
3.1E-008	5.9	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CF-SIRWT
3.1E-008	5.9	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CF-MNFLW
3.1E-008	5.9	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CF-SUMP

2.9E-008	5.4	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-TM-11	PPR-SRV-CO-L HPR-MOV-OO-MFLWB
2.9E-008	5.4	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-TM-12	PPR-SRV-CO-L HPR-MOV-OO-MFLWA
2.9E-008	5.4	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 HPR-MOV-OO-SIRWTA	PPR-SRV-CO-L EPS-DGN-TM-11
2.9E-008	5.4	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-TM-12	PPR-SRV-CO-L HPR-MOV-CC-SMPB
2.9E-008	5.4	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 HPR-MOV-OO-SIRWTB	PPR-SRV-CO-L EPS-DGN-TM-12
2.9E-008	5.4	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-TM-11	PPR-SRV-CO-L HPR-MOV-CC-SMPA
1.7E-008	3.3	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FR-12	PPR-SRV-CO-L HPR-MOV-CC-SMPB
1.7E-008	3.3	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 HPR-MOV-OO-SIRWTA	PPR-SRV-CO-L EPS-DGN-FR-11
1.7E-008	3.3	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 HPR-MOV-OO-SIRWTB	PPR-SRV-CO-L EPS-DGN-FR-12
1.7E-008	3.3	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FR-11	PPR-SRV-CO-L HPR-MOV-CC-SMPA
1.7E-008	3.3	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FR-12	PPR-SRV-CO-L HPR-MOV-OO-MFLWA
1.7E-008	3.3	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FR-11	PPR-SRV-CO-L HPR-MOV-OO-MFLWB
1.5E-008	2.9	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1	PPR-SRV-CO-L HPR-SMP-FC-SUMP
1.1E-008	2.1	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FS-12	PPR-SRV-CO-L HPR-MOV-OO-MFLWA
1.1E-008	2.1	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FS-11	PPR-SRV-CO-L HPR-MOV-OO-MFLWB
1.1E-008	2.1	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FS-11	PPR-SRV-CO-L HPR-MOV-CC-SMPA
1.1E-008	2.1	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1 EPS-DGN-FS-12	PPR-SRV-CO-L HPR-MOV-CC-SMPB
1.1E-008	2.1	OEP-XHE-NOREC-2H PPR-SRV-OO-SR1	PPR-SRV-CO-L EPS-DGN-FS-11

		HPR-MOV-OO-SIRWTA	
1.1E-008	2.1	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	EPS-DGN-FS-12
		HPR-MOV-OO-SIRWTB	
8.7E-009	1.7	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTA
		HPI-MDP-TM-P66B	
8.7E-009	1.7	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-OO-SIRWTB
		HPI-MDP-TM-P66A	
8.7E-009	1.7	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPB
		HPI-MDP-TM-P66A	
8.7E-009	1.7	OEP-XHE-NOREC-2H	PPR-SRV-CO-L
		PPR-SRV-OO-SR1	HPR-MOV-CC-SMPA
		HPI-MDP-TM-P66B	

Event Tree: LOOP CCDP: 1.4E-007
Sequence: 24-11

CCDP	% Cut Set	Cut Set Events	
2.3E-008	17.1	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-CF-FTR
1.8E-008	13.2	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FR-12
		EPS-DGN-TM-11	
1.8E-008	13.2	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FR-11
		EPS-DGN-TM-12	
1.2E-008	8.6	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-CF-FTS
1.2E-008	8.5	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-TM-12	
1.2E-008	8.5	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FS-12
		EPS-DGN-TM-11	
1.1E-008	7.9	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FR-11
		EPS-DGN-FR-12	
6.9E-009	5.1	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-FR-12	
6.9E-009	5.1	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FS-12
		EPS-DGN-FR-11	
4.4E-009	3.3	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	EPS-DGN-FS-11
		EPS-DGN-FS-12	
3.6E-009	2.6	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	SWS-MDP-CF-STRT

2.8E-009	2.1	ACP-BAC-LP-1D	OEP-XHE-NOREC-SL
		RCS-MDP-LK-SEALS	/PPR-SRV-CO-SBO
2.8E-009	2.1	OEP-XHE-NOREC-SL	RCS-MDP-LK-SEALS
		/PPR-SRV-CO-SBO	DCP-BDC-LP-21

BASIC EVENTS (Cut Sets Only)

Event Name	Description	Curr Prob
ACP-BAC-LP-1C	DIVISION 1C AC POWER 4160V BUS A11 FAILS	9.0E-005
ACP-BAC-LP-1D	DIVISION 1D AC POWER 4160V BUS A12 FAILS	9.0E-005
ACP-XHE-NOREC-BD	OPERATOR FAILS TO RECOVER OFFSITE POWER BEFOR	5.0E-004
ACP-XHE-NOREC-ST	OPERATOR FAILS TO RECOVER OFFSITE POWER IN SH	5.0E-002
AFW-AOV-CF-SGS	CCF OF STEAM GENERATOR DISCHARGE AOVS	2.4E-005
AFW-CKV-CF-PMPS	CCF OF AFW PUMP DISCHARGE CHECK VALVES	5.8E-006
AFW-CKV-CF-SGS	CCF OF STEAM GENERATOR INLET CHECK VALVES	4.2E-006
AFW-MDP-CF-START	COMMON CAUSE FAILURE OF AFW MDP TO START	9.2E-005
AFW-MDP-FR-8A	AFW MDP 8A FAILS TO RUN	7.6E-004
AFW-MDP-FR-8C	AFW MDP 8C FAILS TO RUN	7.6E-004
AFW-MDP-FS-8A	AFW MDP 8A FAILS TO START	3.3E-003
AFW-MDP-FS-8C	AFW MDP 8C FAILS TO START	3.3E-003
AFW-MDP-TM-8A	AFW MDP 8A UNAVAILABLE DUE TO T&M	1.1E-003
AFW-MDP-TM-8C	AFW MDP 8C UNAVAILABLE DUE TO T&M	1.1E-003

Event Name	Description	Curr Prob
AFW-PMP-CF-ALL	COMMON CAUSE FAILURE OF AFW PUMPS	1.4E-006
AFW-TDP-FR-8B	AFW TDP 8B FAILS TO RUN	2.8E-002
AFW-TDP-FS-8B	AFW MDP 8B FAILS TO START	6.8E-003
AFW-TDP-TM-8B	AFW TDP 8B UNAVAILABLE DUE TO T&M	7.8E-003
AFW-TNK-FC-CST	AFW CONDENSATE STORAGE TANK FAILURES	1.3E-006
AFW-TNK-FC-MKUP	MAKUP TANK 939 UNAVAILABLE	1.3E-006
AFW-XHE-XL-MDPFR	OPERATOR FAILS TO RECOVER AFW MDP (FAILS TO R	7.5E-001
AFW-XHE-XL-MDPFS	OPERATOR FAILS TO RECOVER AFW MDP (FAILS TO S	2.1E-001
CAC-AOV-CC-VHX4S	CAC VHX-4 SERVICE WATER INLET AOV 0869 FAILS	1.0E-003
CAC-CKV-CF-SWDIS	CCF OF SWS DISCHARGE CHECK VALVES	4.2E-006
CAC-FAN-CF-RUN	CCF OF CAC FANS TO RUN	3.1E-006
CAC-FAN-CF-START	CCF OF CAC FANS TO START	7.2E-006
CAC-XHE-XA-CAC4	OPERATOR FAILS TO ALIGN CAC VHX-4	1.0E-003
CCW-HTX-PG-E54A	FAILURE OF CCW HEAT EXCHANGER E-54A	1.4E-004
CCW-HTX-PG-E54B	FAILURE OF CCW HEAT EXCHANGER E-54B	1.4E-004
CCW-MDP-TM-P52B	CCW MDP P-52B UNAVAILABLE DUE TO T&M	1.1E-002
CSR-XHE-XM	OPERATOR FAILS TO INITIATE THE CSR SYSTEM FOR	1.0E-003
CSS-MDP-CF-ALL	COMMON CAUSE FAILURE OF CSS MDPS	1.3E-004
CSS-MDP-TM-54A	CONTAINMENT SPRAY MDP 54A UNAVAILABLE DUE TO	6.2E-003
DCP-BDC-LP-21	FAILURE OF DC POWER BUS 21D	9.0E-005
EPS-DGN-CF-FTR	COMMON CAUSE FAILURE OF DGNS TO RUN	7.5E-004
EPS-DGN-CF-FTS	COMMON CAUSE FAILURE OF DGNS TO START	3.8E-004
EPS-DGN-FR-11	DIESEL GENERATOR 11 FAILS TO RUN	1.9E-002
EPS-DGN-FR-12	DIESEL GENERATOR 12 FAILS TO RUN	1.9E-002
EPS-DGN-FS-11	DIESEL GENERATOR 11 FAILS TO START	1.2E-002
EPS-DGN-FS-12	DIESEL GENERATOR 12 FAILS TO START	1.2E-002
EPS-DGN-TM-11	DIESEL GENERATOR 11 UNAVAILABLE DUE TO T&M	3.1E-002
EPS-DGN-TM-12	DIESEL GENERATOR 12 UNAVAILABLE DUE TO T&M	3.1E-002
FPS-DDP-FC-41	FIRE PROTECTION SYSTEM PUMP 41 FAILS TO FUNCT	4.8E-002
FPS-DDP-FC-9B	FIRE PROTECTION SYSTEM PUMP 9B FAILS TO FUNCT	4.8E-002
FPS-DDP-TM-41	FPS PUMP 41 UNAVAILABLE DUE TO T&M	1.5E-002
FPS-DDP-TM-9B	FPS PUMP 9B UNAVAILABLE DUE TO T&M	1.5E-002
FPS-MDP-FC-9A	FIRE PROTECTION SYSTEM PUMP 9A FAILS TO FUNCT	3.7E-003
FPS-MDP-TM-9A	FPS PUMP 9A UNAVAILABLE DUE TO T&M	1.8E-002
HPI-CKV-CF-MDPDIS	COMMON CAUSE FAILURE OF HPI DISCHARGE CKVS	1.0E-005
HPI-CKV-CF-SUCT	CCF OF HPI SUCTION CHECK VALVES	1.0E-005
HPI-MDP-CF-ALL	COMMON CAUSE FAILURE OF HPI MDPS	2.2E-004
HPI-MDP-FR-P66A	LPI MDP P-66A FAILS TO RUN	7.2E-004
HPI-MDP-FR-P66B	HPI MDP P-66B FAILS TO RUN	7.2E-004
HPI-MDP-FS-P66A	HPI MDP P-66A FAILS TO START	3.0E-003
HPI-MDP-FS-P66B	HPI MDP P-66B FAILS TO START	3.0E-003
HPI-MDP-TM-P66A	HPI MDP P-66A UNAVAILABLE DUE TO T&M	9.4E-003
HPI-MDP-TM-P66B	HPI MDP P-66B UNAVAILABLE DUE TO T&M	9.4E-003
HPI-XHE-XM-FB	OPERATOR FAILS TO INITIATE FEED AND BLEED COO	2.0E-002
HPI-XHE-XR-P66A	OPERATOR FAILS TO RESTORE HPI MDP P-66A AFTER	1.0E-003
HPI-XHE-XR-P66B	OPERATOR FAILS TO RESTORE HPI MDP P-66B AFTER	1.0E-003
HPR-CKV-CF-SUMP	CCF OF SUMP ISOLATION CHECK VALVES	1.0E-005
HPR-MOV-CC-SMPA	TRAIN A SUMP MOV FAILS	3.0E-003
HPR-MOV-CC-SMPB	TRAIN B SUMP MOV FAILS	3.0E-003
HPR-MOV-CF-MNFLW	CCF OF RWST MINFLOW MOVS	1.0E-004

Event Name	Description	Curr Prob
HPR-MOV-CF-SIRWT	CCF OF SIRWT ISOLATION MOVS TO CLOSE	1.0E-004
HPR-MOV-CF-SUMP	CCF OF SUMP ISOLATION MOVS	1.0E-004
HPR-MOV-OO-MFLWA	FAILURE OF MINFLOW MOV A	3.0E-003
HPR-MOV-OO-MFLWB	FAILURE OF MINFLOW MOV B	3.0E-003
HPR-MOV-OO-SIRWTA	SIRWT TRAIN A ISOLATION MOV 3057 FAILS TO CLO	3.0E-003
HPR-MOV-OO-SIRWTB	SIRWT TRAIN B ISOLATION MOV 3031 FAILS TO CLO	3.0E-003
HPR-SMP-FC-SUMP	CONTAINMENT RECIRCULATION SUMP FAILS	5.0E-005
OEP-XHE-NOREC-2H	OPERATOR FAILS TO RECOVER OFFSITE POWER WITHI	1.2E-001
OEP-XHE-NOREC-6H	OPERATOR FAILS TO RECOVER OFFSITE POWER WITHI	3.6E-002
OEP-XHE-NOREC-SL	OPERATOR FAILS TO RECOVER OFFSITE POWER (SEAL	5.5E-003
PPR-SRV-CO-L	PORVS/SRVS OPEN DURING LOOP	1.6E-001
PPR-SRV-CO-SBO	PORVS/SRVS OPEN DURING SBO	3.7E-001
PPR-SRV-OO-SR1	FAILURE OF SRVS RECLOSE	1.6E-002
RCS-MDP-LK-SEALS	RCP SEALS FAIL W/O COOLING AND INJECTION	8.9E-003
RPS-VCF-FO-MECH	CONTROL ROD ASSEMBLIES FAIL TO INSERT	1.2E-006
SWS-CKV-CF-DISCH	CCF OF CCW MDPS DISCHARGE CHECK VALVES	5.8E-006
SWS-MDP-CF-RUN	COMMON CAUSE FAILURE OF SWS MDPS TO RUN	1.3E-005
SWS-MDP-CF-STRT	CCF OF SWS MDPS TO START	1.2E-004
SWS-XHE-XA-FIRESYS	OPERATOR FAILS TO ALIGN FIRE PROTECTION SYSTE	4.0E-002

Attachment F. Gem Output for sensitivity Case 2 - No Credit for Recovery

I N I T I A T I N G   E V E N T   A S S E S S M E N T

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                                             Code  Ver : 6:80
Fam  : PALI_302                              Model Ver : 1998/02/17
User : EG&G IDAHO, INC.  (INEL)              Init Event: IE-LOOP-SD
Ev ID: IE-LOOP-SD-CASE 2                     Total CCDP:  9.9E-004
Desc : Initiating Event Assessment
```

BASIC EVENT CHANGES

Event Name	Description	Base Prob	Curr Prob	Type
F-FEED-XHE	Operator Action to Implement	1.0E-001	1.0E+000	TRUE
FW-FEED-XHE	Operator Action to Implement	1.0E-001	1.0E+000	TRUE
G-FEED-XHE	Operator Action to Implement	1.0E-001	1.0E+000	TRUE
IE-DHR-SUC-V	DECAY HEAT REMOVAL SUCTION I	1.0E-007	+0.0E+000	
IE-HPI1-DIS-V	HPI TRAIN 1 DISCHARGE ISLOCA	4.6E-004	+0.0E+000	
IE-HPI2-DIS-V	HPI TRAIN 2 DISCHARGE ISLOCA	4.6E-004	+0.0E+000	
IE-LLOCA	LARGE LOSS OF COOLANT ACCIDE	5.7E-010	+0.0E+000	
IE-LOCCW	LOSS OF COMPONENT COOLING WA	1.1E-007	+0.0E+000	
IE-LODC21	LOSS OF DC POWER BUS INITIAT	2.4E-007	+0.0E+000	
IE-LOOP	LOSS OF OFFSITE POWER INITIA	5.2E-006	+0.0E+000	
IE-LOOP-SD	LOOP Occurs During Refueling	1.0E+000	1.0E+000	
IE-LOSW	LOSS OF SERVICE WATER INITIA	1.1E-007	+0.0E+000	
IE-LPI-DIS-V	LPI DISCHARGE ISLOCA IE (BAS	4.6E-004	+0.0E+000	
IE-MLOCA	MEDIUM LOSS OF COOLANT ACCID	4.6E-009	+0.0E+000	
IE-SGTR	STEAM GENERATOR TUBE RUPTURE	8.0E-007	+0.0E+000	
IE-SLOCA	SMALL LOSS OF COOLANT ACCIDE	5.7E-008	+0.0E+000	
IE-TRANS	TRANSIENTS INITIATING EVENT	1.4E-004	+0.0E+000	
RHR-AOV-OO-BYP	LPI ISOL DISCHARGE AOV FAILU	1.0E-003	+0.0E+000	FALSE

SEQUENCE PROBABILITIES

Truncation : Cummulative : 100.0% Individual :   0.0%

Event Tree Name	Sequence Name	CCDP	%Cont
IE-LOOP-SD	5	9.9E-004	100.0
IE-LOOP-SD	8	7.7E-009	0.0

SEQUENCE LOGIC

Event Tree	Sequence Name	Logic	
IE-LOOP-SD	5	/EPS-R F-FEED FW-FEED	DHR-RESTART G-FEED
IE-LOOP-SD	8	EPS-R FW-FEED	G-FEED

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Fault Tree Name	Description
DHR-RESTART	NO OR INSUFFICIENT DHR FLOW
EPS-R	EMERGENCY POWER SYSTEM FAILURES
F-FEED	Forced Feed RCS Inventory Makeup
FW-FEED	Forced Feed by Firewater Fails
G-FEED	Gravity Feed RCS Inventory Makeup

SEQUENCE CUT SETS

Truncation: Cummulative: 100.0% Individual: 1.0%

Event Tree: IE-LOOP-SD CCDP: 9.9E-004
Sequence: 5

CCDP	% Cut Set	Cut Set Events
2.2E-004	22.0	LPI-MDP-CF-ALL
1.4E-004	13.9	CCW-HTX-PG-E54A
1.4E-004	13.9	CCW-HTX-PG-E54B
1.0E-004	10.2	HPR-MOV-CF-SIRWT
1.0E-004	10.2	DHR-MOV-CF-PSUC
3.4E-005	3.4	SDC-HTX-CF-ALL
1.3E-005	1.3	CCW-MDP-CF-RUN
1.0E-005	1.1	LPI-CKV-CF-MDPDIS
1.0E-005	1.0	DHR-XHE-XM-SD

Event Tree: IE-LOOP-SD CCDP: 7.7E-009
Sequence: 8

CCDP	% Cut Set	Cut Set Events	
1.3E-009	17.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTR	
1.0E-009	13.2	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-12	EPS-DGN-TM-11
1.0E-009	13.2	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-TM-12
6.6E-010	8.6	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-CF-FTS	
6.6E-010	8.5	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-TM-12
6.6E-010	8.5	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-12	EPS-DGN-TM-11
6.1E-010	7.9	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FR-11	EPS-DGN-FR-12
3.9E-010	5.1	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-FR-12
3.9E-010	5.1	EP-DG-REC-SD	EP-XHE-AC-REC

		EPS-DGN-FS-12	EPS-DGN-FR-11
2.5E-010	3.3	EP-DG-REC-SD	EP-XHE-AC-REC
		EPS-DGN-FS-11	EPS-DGN-FS-12
2.0E-010	2.6	EP-DG-REC-SD	EP-XHE-AC-REC
		SWS-MDP-CF-STRT	
1.6E-010	2.1	ACP-BAC-LP-1D	EP-DG-REC-SD
		EP-XHE-AC-REC	
1.6E-010	2.1	EP-DG-REC-SD	EP-XHE-AC-REC
		DCP-BDC-LP-21	

BASIC EVENTS (Cut Sets Only)

Event Name	Description	Curr Prob
ACP-BAC-LP-1D	DIVISION 1D AC POWER 4160V BUS A12 FAILS	9.0E-005
CCW-HTX-PG-E54A	FAILURE OF CCW HEAT EXCHANGER E-54A	1.4E-004
CCW-HTX-PG-E54B	FAILURE OF CCW HEAT EXCHANGER E-54B	1.4E-004
CCW-MDP-CF-RUN	COMMON CAUSE FAILURE OF CCW MDPS TO RUN	1.3E-005
DCP-BDC-LP-21	FAILURE OF DC POWER BUS 21D	9.0E-005
DHR-MOV-CF-PSUC	CCF OF LPI/DHR PUMP SUCTION MOVS	1.0E-004
DHR-XHE-XM-SD	OPERATOR FAILS TO RESTART DHR DURING REFUELIN	1.0E-005
EP-DG-REC-SD	EDG RECOVERY DURING SHUTDOWN	8.8E-002
EP-XHE-AC-REC	AC RECOVERY DURING SHUTDOWN	2.0E-005
EPS-DGN-CF-FTR	COMMON CAUSE FAILURE OF DGNS TO RUN	7.5E-004
EPS-DGN-CF-FTS	COMMON CAUSE FAILURE OF DGNS TO START	3.8E-004
EPS-DGN-FR-11	DIESEL GENERATOR 11 FAILS TO RUN	1.9E-002
EPS-DGN-FR-12	DIESEL GENERATOR 12 FAILS TO RUN	1.9E-002
EPS-DGN-FS-11	DIESEL GENERATOR 11 FAILS TO START	1.2E-002
EPS-DGN-FS-12	DIESEL GENERATOR 12 FAILS TO START	1.2E-002
EPS-DGN-TM-11	DIESEL GENERATOR 11 UNAVAILABLE DUE TO T&M	3.1E-002
EPS-DGN-TM-12	DIESEL GENERATOR 12 UNAVAILABLE DUE TO T&M	3.1E-002
HPR-MOV-CF-SIRWT	RWST ISOLATION MOVS FAIL TO CLOSE	1.0E-004
LPI-CKV-CF-MDPDIS	COMMON CAUSE FAILURE OF LPI DISCHARGE CKVS	1.0E-005
LPI-MDP-CF-ALL	COMMON CAUSE FAILURE OF LPI MDPS	2.2E-004
SDC-HTX-CF-ALL	COMMON CAUSE FAILURE OF SDC HEAT EXCHANGERS	3.4E-005
SWS-MDP-CF-STRT	CCF OF SWS MDPS TO START	1.2E-004