

Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

H. B. Robinson	Concurrent Unavailabilities– EDG B Inoperable due to Failed Output Breaker and EDG A Unavailable due to Testing and Maintenance	
Event Date: 02/22/2010	LER: 261/10-001 IR: 50-261/10-05	ΔCDP = 3×10^{-6}

EVENT SUMMARY

Brief Event Description. At 0455 on February 22, 2010, with H. B. Robinson Steam Electric Plant, Unit 2, operating at approximately 99% power, Emergency Diesel Generator (EDG) B was removed from service for scheduled maintenance. Technical Specifications (TS) Limiting Condition for Operation 3.8.1 Condition B, was entered due one EDG inoperable. During the post-maintenance testing, EDG B Output Breaker 52/27B failed to close. The investigation for the inoperability of Breaker 52/27B determined that the shunt trip attachment (STA) had internal binding that prevented the STA from releasing the trip bar, resulting in the trip bar remaining in the "trip condition" and preventing the breaker from closing. EDG B was inoperable from January 28, 2010 to February 24, 2010, approximately 27 days. In addition, EDG A was declared inoperable on February 8, 2010 for approximately 6 hours and 53 minutes for scheduled maintenance. Additional details are provided in References 1 and 2.

Key Event Details. The following event details are significant to the modeling of this event analysis:

- There were approximately 27 days that the EDG B was unavailable due to the breaker failure. During this period, EDG A was unavailable due to surveillance testing for 7 hours. Therefore, the total duration of EDG B was unavailable by itself is 27 days minus 7 hours, (i.e. 27 days \times 24 hours/day – 7 hours = 641 hours).
- The duration that both the EDG B was unavailable due to the failed breaker and EDG A was undergoing scheduled maintenance was approximately 7 hours.

ANALYSIS RESULTS

Importance. The importance or increase in core damage probability (Δ CDP) for this event is 3.4×10^{-6} ; therefore, this event is a precursor (i.e., Δ CDP greater than or equal to 10^{-6}).

Dominant Sequence. The dominant accident sequence, Loss of Offsite Power [Grid-Related] (LOOPGR) 16-46 (Δ CDP of this sequence from the results of Calculations 1 and 2 combined is 1.6×10^{-6}) contributes 47% of the total internal events Δ CDP. Additional sequences that contribute greater than 1% of the total internal events Δ CDP are provided in Appendix A.

The dominant sequence is shown graphically in Figures B-1 and B-2 in Appendix B. The events and important component failures in LOOPGR Sequence 16-46 are:

- Loss of offsite power (LOOP) transient occurs,
- Reactor trip succeeds,
- Emergency power system fails,
- Auxiliary feedwater (AFW) fails,
- Operators fail to recover offsite power within 1 hour, and
- Operators fail to recover an EDG within 1 hour.

SAPHIRE 8 Report. The SAPHIRE 8 Worksheets (Appendix A) provide the following:

- Summary of conditional event changes, including base and change case probabilities/frequencies.
- Event tree dominant results
- Dominant sequences (including Δ CDPs).
- Sequence logic for all dominant sequences.
- Referenced fault trees (including definitions).
- Cutset report for each dominant sequence.
- Referenced events (including definitions and probabilities for key basic events)

MODELING ASSUMPTIONS

Analysis Type. The Revision 8.16 of the H. B. Robinson SPAR model was used for the analysis of this degraded condition. This analysis was completed using two SAPHIRE calculations: (1) one calculation of the Δ CDP of the unavailability of EDG B by itself for 641 hours, and (2) a second calculation of the Δ CDP with both the EDGs unavailable for 7 hours.

Analysis Rules. The ASP program uses Significance Determination Process results for degraded conditions when available. However, the ASP Program performs independent analyses for unavailabilities of safety equipment that were determined to not be caused by a licensee performance deficiency. In addition, ASP analyses are performed when multiple degraded conditions exist during the same time window.

Key Modeling Assumptions. The following modeling assumptions and associated basic event modifications were required for this event analysis:

Calculation 1– EDG B Unavailable for 641 Hours

- The basic event EPS-DGN-FS-2B (*Diesel Generator 2B fails to start*) was set to TRUE because EDG B failed to start and was unavailable for 641 hours.
- To ensure that the common cause failure probabilities were calculated within SAPHIRE the following basic events were modified as the following:
 - The basic event EPS-DGN-FR-2B (*Diesel Generator 2B fails to run*) was set to 1.0.
 - The basic event EPS-DGN-TM-2B (*Diesel Generator 2B unavailable due to test and maintenance*) was set to TRUE.
 - The basic event EPS-DGN-CF-2ABFR (*Common-cause failure of EDGs 2A and 2B to run*) was set to FALSE.

- The licensee concluded (Reference 1) that several response actions to recover EDG B, such as the discovery of the manually manipulating the trip bar or replacing the affected breaker with a spare could be accomplished in an estimated time frame which ranged from one to four hours. However, during a postulated LOOP with additional EDG failures leading to a station blackout and AFW system failures, this analysis assumes that recovery of EDG B within one hour is not possible. Recovery of EDG B within 4 hours (the other key recovery time for H.B. Robinson) is credited in this analysis.
 - The basic event EPS-XHE-XL-NR04H (*Operators fail to recover an EDG in 4 Hours*) was set to 5.0×10^{-3} . This value was calculated using the SPAR-H Method (Reference 3).
 - This EDG recovery action contains both diagnosis and action activities. Since operators would have enough time to perform the action, the nominal action human error probability (HEP) of 1×10^{-3} was applied.
 - The following performance shaping factors (PSF) were adjusted. All other PSFs were determined to be nominal (i.e., $\times 1$).

PSF for Diagnosis	Multiplier	Notes
Time Available	0.1	Operators would have at least 3 hours to diagnose the problem; therefore, <i>Extra Time</i> (i.e., $\times 0.1$) was selected.
Stress	2	The PSF for diagnosis stress is assigned a value of <i>High Stress</i> (i.e., $\times 2$) because the failure to recover the EDG would lead directly to core damage.
Complexity	2	The PSF for diagnosis complexity is assigned a value of <i>Moderately Complex</i> (i.e., $\times 2$) because the recovery of the EDG required a technician to determine the failure mechanism of the breaker and develop a solution to close the breaker.
Diagnosis HEP	4E-3	
Action HEP	1E-3	
Adjusted Total HEP	5E-3	

Calculation 2– EDGs A and B Unavailable for 7 Hours

- The basic event EPS-DGN-FS-2B was set to TRUE because EDG B failed to start and was unavailable for this 7 hours period.
- The basic event EPS-DGN-TM-2A (*Diesel Generator 2A unavailable due to test and maintenance*) was set to TRUE to because EDG A was undergoing scheduled maintenance for this 7 hour period.
- To ensure that the common cause failure probabilities were calculated within SAPHIRE the following basic events were modified as the following:
 - The basic event EPS-DGN-FR-2B was set to 1.0.
 - The basic event EPS-DGN-TM-2B was set to TRUE.
 - The basic event EPS-DGN-FS-2A (*Diesel Generator 2A fails to start*) was set to 1.0.
 - The basic event EPS-DGN-FR-2A (*Diesel Generator 2A fails to run*) was set to 1.0.
- The basic event EPS-XHE-XL-NR04H was set to 5.0×10^{-3} to credit the potential recovery of EDG B within 4 hours (same as Calculation 1).

REFERENCES

1. Progress Energy, "LER 261/10-001– Emergency Diesel Generator Inoperable in Excess of Technical Specifications Allowed Completion Time," dated June 10, 2010.
2. U.S. Nuclear Regulatory Commission, "H. B. Robinson Steam Electric Plant– NRC Integrated Inspection Report 05000261/2010005", dated January 28, 2011.
3. Idaho National Laboratory, "NUREG/CR-6883: The SPAR-H Human Reliability Analysis Method," dated August 2005.

Appendix A: SAPHIRE 8 Worksheets

Calculation 1– EDG B Unavailable (Failed to Start) for 641 hours

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
EPS-DGN-CF-2ABFR	COMMON CAUSE FAILURE OF DIESEL GENERATORS 2A & 2B TO RUN	False	3.282E-4
EPS-DGN-FR-2B	DIESEL GENERATOR 2B FAILS TO RUN	1.000E+0	2.118E-2
EPS-DGN-FS-2B	DIESEL GENERATOR 2B FAILS TO START	True	5.000E-3
EPS-DGN-TM-2B	DIESEL GENERATOR 2B UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.200E-2
EPS-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR	True	7.857E-1
EPS-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS	5.000E-3	5.568E-1
EPS-DGN-CF-2ABFS	COMMON CAUSE FAILURE OF DIESEL GENERATORS 2A & 2B TO START	1.150E-2	5.750E-5
EPS-DGN-CF-2ABDSFR	CCF OF DIESEL GENERATORS 2A, 2B & DS TO RUN	6.665E-4	1.214E-4
EPS-DGN-CF-2ABDSFS	CCF OF DIESEL GENERATORS 2A, 2B & DS TO START	3.722E-3	1.861E-5

Dominant Sequence Results

Only items contributing at least 1.0% to the total CCDP are displayed.

EVENT TREE	SEQUENCE	CCDP	CDP	ΔCDP	DESCRIPTION
LOOPGR	16-46	1.375E-6	3.242E-8	1.343E-6	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPSC	16-46	4.706E-7	1.047E-8	4.601E-7	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPWR	16-46	4.584E-7	1.158E-8	4.468E-7	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPGR	15	2.173E-7	1.270E-8	2.046E-7	/RPS, /EPS, AFW-L, FAB-L
LOOPSC	15	1.212E-7	6.736E-9	1.145E-7	/RPS, /EPS, AFW-L, FAB-L
LOOPPC	16-46	6.782E-8	1.232E-9	6.658E-8	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPWR	15	5.602E-8	2.821E-9	5.320E-8	/RPS, /EPS, AFW-L, FAB-L
Total		3.939E-6	1.028E-6	2.911E-6	

Referenced Fault Trees

Fault Tree	Description
AFW-B	AUXILIARY FEEDWATER
AFW-L	ROBINSON UNIT 2 PWR B AFW USING LOOP-FTF FAULT TREE FLAGS
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
EPS	EMERGENCY POWER
FAB-L	ROBINSON UNIT 2 PWR B FAB USING LOOP-FTF FAULT TREE FLAGS
OPR-01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR

Cutset Report - LOOPGR 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	1.879E-5	100	Displaying 2612 of 2612 Cutsets.
1	2.115E-6	11.26	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HGR
2	9.546E-7	5.08	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-DGN-TM-2A,OEP-XHE-XL-NR01HGR

#	PROB/FREQ	TOTAL%	CUTSET
3	9.149E-7	4.87	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HGR
4	6.535E-7	3.48	IE-LOOPGR,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HGR
5	5.594E-7	2.98	IE-LOOPGR,AFW-TDP-FR-SDP,EPS-DGN-TM-2A,OEP-XHE-XL-NR01HGR
6	5.361E-7	2.85	IE-LOOPGR,AFW-TDP-FR-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HGR
7	4.230E-7	2.25	IE-LOOPGR,EPS-DGN-CF-2ABDSFS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HGR
8	4.015E-7	2.14	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HGR
9	3.978E-7	2.12	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HGR
10	3.847E-7	2.05	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HGR
11	2.961E-7	1.58	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HGR
12	2.948E-7	1.57	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-DGN-FR-2A,OEP-XHE-XL-NR01HGR,OEP-XHE-XX-NR01HGR1
13	2.841E-7	1.51	IE-LOOPGR,AFW-TDP-TM-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HGR
14	2.728E-7	1.45	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HGR
15	2.614E-7	1.39	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HGR
16	2.387E-7	1.27	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-SEQ-FO-DG2A,OEP-XHE-XL-NR01HGR
17	2.387E-7	1.27	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-FAN-FS-HVS6,OEP-XHE-XL-NR01HGR
18	2.387E-7	1.27	IE-LOOPGR,AFW-TDP-FS-SDP,EPS-FAN-FS-HVE18,OEP-XHE-XL-NR01HGR
19	2.331E-7	1.24	IE-LOOPGR,AFW-TDP-FR-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HGR
20	2.115E-7	1.13	IE-LOOPGR,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HGR
21	2.106E-7	1.12	IE-LOOPGR,AFW-TDP-TM-SDP,EPS-DGN-FR-2A,OEP-XHE-XL-NR01HGR,OEP-XHE-XX-NR01HGR1
22	1.989E-7	1.06	IE-LOOPGR,ACP-CRB-CC-52-18B,AFW-TDP-FS-SDP,OEP-XHE-XL-NR01HGR

Cutset Report - LOOPSC 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	6.431E-6	100	Displaying 1963 of 1963 Cutsets.
1	7.314E-7	11.37	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HSC
2	3.302E-7	5.13	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-DGN-TM-2A,OEP-XHE-XL-NR01HSC
3	3.164E-7	4.92	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HSC
4	2.260E-7	3.51	IE-LOOPSC,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HSC
5	1.935E-7	3.01	IE-LOOPSC,AFW-TDP-FR-SDP,EPS-DGN-TM-2A,OEP-XHE-XL-NR01HSC
6	1.854E-7	2.88	IE-LOOPSC,AFW-TDP-FR-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HSC
7	1.463E-7	2.27	IE-LOOPSC,EPS-DGN-CF-2ABDSFS,FWS-EDP-TM-DDP,OEP-XHE-XL-

#	PROB/FREQ	TOTAL%	CUTSET
			NR01HSC
8	1.388E-7	2.16	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-MDP-FR-FUELD,OEPE-XHE-XL-NR01HSC
9	1.376E-7	2.14	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-DGN-FS-2A,OEPE-XHE-XL-NR01HSC
10	1.331E-7	2.07	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS,EPS-MDP-FR-FUELD,OEPE-XHE-XL-NR01HSC
11	1.024E-7	1.59	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABDSFS,OEPE-XHE-XL-NR01HSC
12	9.827E-8	1.53	IE-LOOPSC,AFW-TDP-TM-SDP,EPS-DGN-FS-2A,OEPE-XHE-XL-NR01HSC
13	9.433E-8	1.47	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-XHE-XM-DGDS,OEPE-XHE-XL-NR01HSC
14	9.206E-8	1.43	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-DGN-FR-2A,OEPE-XHE-XL-NR01HSC,OEPE-XHE-XX-NR01HSC1
15	9.040E-8	1.41	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS,EPS-XHE-XM-DGDS,OEPE-XHE-XL-NR01HSC
16	8.254E-8	1.28	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-FAN-FS-HVS6,OEPE-XHE-XL-NR01HSC
17	8.254E-8	1.28	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-FAN-FS-HVE18,OEPE-XHE-XL-NR01HSC
18	8.254E-8	1.28	IE-LOOPSC,AFW-TDP-FS-SDP,EPS-SEQ-FO-DG2A,OEPE-XHE-XL-NR01HSC
19	8.061E-8	1.25	IE-LOOPSC,AFW-TDP-FR-SDP,EPS-DGN-FS-2A,OEPE-XHE-XL-NR01HSC
20	7.314E-8	1.14	IE-LOOPSC,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABDSFS,OEPE-XHE-XL-NR01HSC
21	6.879E-8	1.07	IE-LOOPSC,ACP-CRB-CC-52-18B,AFW-TDP-FS-SDP,OEPE-XHE-XL-NR01HSC
22	6.576E-8	1.02	IE-LOOPSC,AFW-TDP-TM-SDP,EPS-DGN-FR-2A,OEPE-XHE-XL-NR01HSC,OEPE-XHE-XX-NR01HSC1

Cutset Report - LOOPWR 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	6.265E-6	100	Displaying 1954 of 1954 Cutsets.
1	5.892E-7	9.4	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABDSFS,OEPE-XHE-XL-NR01HWR
2	2.660E-7	4.25	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-DGN-TM-2A,OEPE-XHE-XL-NR01HWR
3	2.549E-7	4.07	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABFS,OEPE-XHE-XL-NR01HWR
4	1.915E-7	3.06	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-DGN-FR-2A,OEPE-XHE-XL-NR01HWR,OEPE-XHE-XX-NR01HWR1
5	1.821E-7	2.91	IE-LOOPWR,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABFS,OEPE-XHE-XL-NR01HWR
6	1.558E-7	2.49	IE-LOOPWR,AFW-TDP-FR-SDP,EPS-DGN-TM-2A,OEPE-XHE-XL-NR01HWR
7	1.493E-7	2.38	IE-LOOPWR,AFW-TDP-FR-SDP,EPS-DGN-CF-2ABFS,OEPE-XHE-XL-NR01HWR
8	1.368E-7	2.18	IE-LOOPWR,AFW-TDP-TM-SDP,EPS-DGN-FR-2A,OEPE-XHE-XL-NR01HWR,OEPE-XHE-XX-NR01HWR1
9	1.314E-7	2.1	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-DGN-FR-2A,OEPE-XHE-XL-NR01HWR,OEPE-XHE-XX-NR01HWR2
10	1.178E-7	1.88	IE-LOOPWR,EPS-DGN-CF-2ABDSFS,FWS-EDP-TM-DDP,OEPE-XHE-XL-NR01HWR
11	1.122E-7	1.79	IE-LOOPWR,AFW-TDP-FR-SDP,EPS-DGN-FR-2A,OEPE-XHE-XL-NR01HWR,OEPE-XHE-XX-NR01HWR1

#	PROB/FREQ	TOTAL%	CUTSET
12	1.118E-7	1.79	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HWR
13	1.108E-7	1.77	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HWR
14	1.072E-7	1.71	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HWR
15	9.387E-8	1.5	IE-LOOPWR,AFW-TDP-TM-SDP,EPS-DGN-FR-2A,OEP-XHE-XL-NR01HWR,OEP-XHE-XX-NR01HWR2
16	8.248E-8	1.32	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HWR
17	8.053E-8	1.29	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-FR-2A,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HWR,OEP-XHE-XX-NR01HWR1
18	7.915E-8	1.26	IE-LOOPWR,AFW-TDP-TM-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HWR
19	7.700E-8	1.23	IE-LOOPWR,AFW-TDP-FR-SDP,EPS-DGN-FR-2A,OEP-XHE-XL-NR01HWR,OEP-XHE-XX-NR01HWR2
20	7.599E-8	1.21	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HWR
21	7.282E-8	1.16	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HWR
22	6.649E-8	1.06	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-FAN-FS-HVS6,OEP-XHE-XL-NR01HWR
23	6.649E-8	1.06	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-FAN-FS-HVE18,OEP-XHE-XL-NR01HWR
24	6.649E-8	1.06	IE-LOOPWR,AFW-TDP-FS-SDP,EPS-SEQ-FO-DG2A,OEP-XHE-XL-NR01HWR
25	6.493E-8	1.04	IE-LOOPWR,AFW-TDP-FR-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HWR

Cutset Report - LOOPGR 15

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	2.970E-6	100	Displaying 2054 of 2054 Cutsets.
1	2.650E-7	8.92	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
2	2.232E-7	7.52	IE-LOOPGR,AFW-MDP-TM-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
3	1.674E-7	5.64	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
4	8.370E-8	2.82	IE-LOOPGR,AFW-MDP-FS-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
5	8.038E-8	2.71	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-536
6	8.038E-8	2.71	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-535
7	6.770E-8	2.28	IE-LOOPGR,AFW-MDP-TM-A,AFW-TDP-FS-SDP,PPR-MOV-FC-535
8	6.770E-8	2.28	IE-LOOPGR,AFW-MDP-TM-A,AFW-TDP-FS-SDP,PPR-MOV-FC-536
9	6.696E-8	2.25	IE-LOOPGR,AFW-FCV-CC-1424,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
10	5.741E-8	1.93	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-536
11	5.741E-8	1.93	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-535
12	5.078E-8	1.71	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-536
13	5.078E-8	1.71	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-535
14	4.710E-8	1.59	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-536
15	4.710E-8	1.59	IE-LOOPGR,AFW-FAN-FR-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-535
16	3.967E-8	1.34	IE-LOOPGR,AFW-MDP-TM-A,AFW-TDP-FR-SDP,PPR-MOV-FC-535

#	PROB/FREQ	TOTAL%	CUTSET
17	3.967E-8	1.34	IE-LOOPGR,AFW-MDP-TM-A,AFW-TDP-FR-SDP,PPR-MOV-FC-536
18	3.627E-8	1.22	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-536
19	3.627E-8	1.22	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-535
20	3.001E-8	1.01	IE-LOOPGR,AFW-MDP-FR-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
21	2.975E-8	1	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-536
22	2.975E-8	1	IE-LOOPGR,AFW-FAN-FS-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-535

Cutset Report - LOOPSC 15

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	1.657E-6	100	Displaying 1563 of 1563 Cutsets.
1	1.482E-7	8.94	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
2	1.248E-7	7.53	IE-LOOPSC,AFW-MDP-TM-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
3	9.360E-8	5.65	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
4	4.680E-8	2.82	IE-LOOPSC,AFW-MDP-FS-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
5	4.494E-8	2.71	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-536
6	4.494E-8	2.71	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-535
7	3.786E-8	2.29	IE-LOOPSC,AFW-MDP-TM-A,AFW-TDP-FS-SDP,PPR-MOV-FC-535
8	3.786E-8	2.29	IE-LOOPSC,AFW-MDP-TM-A,AFW-TDP-FS-SDP,PPR-MOV-FC-536
9	3.744E-8	2.26	IE-LOOPSC,AFW-FCV-CC-1424,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
10	3.210E-8	1.94	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-536
11	3.210E-8	1.94	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-535
12	2.839E-8	1.71	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-536
13	2.839E-8	1.71	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-535
14	2.633E-8	1.59	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-536
15	2.633E-8	1.59	IE-LOOPSC,AFW-FAN-FR-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-535
16	2.218E-8	1.34	IE-LOOPSC,AFW-MDP-TM-A,AFW-TDP-FR-SDP,PPR-MOV-FC-535
17	2.218E-8	1.34	IE-LOOPSC,AFW-MDP-TM-A,AFW-TDP-FR-SDP,PPR-MOV-FC-536
18	2.028E-8	1.22	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-536
19	2.028E-8	1.22	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-535
20	1.678E-8	1.01	IE-LOOPSC,AFW-MDP-FR-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
21	1.664E-8	1	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-536
22	1.664E-8	1	IE-LOOPSC,AFW-FAN-FS-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-535

Cutset Report - LOOPPC 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	9.268E-7	100	Displaying 1093 of 1093 Cutsets.
1	1.069E-7	11.53	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HPC
2	4.825E-8	5.21	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-DGN-TM-2A,OEP-XHE-XL-NR01HPC
3	4.624E-8	4.99	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HPC

#	PROB/FREQ	TOTAL%	CUTSET
4	3.303E-8	3.56	IE-LOOPPC,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HPC
5	2.827E-8	3.05	IE-LOOPPC,AFW-TDP-FR-SDP,EPS-DGN-TM-2A,OEP-XHE-XL-NR01HPC
6	2.709E-8	2.92	IE-LOOPPC,AFW-TDP-FR-SDP,EPS-DGN-CF-2ABFS,OEP-XHE-XL-NR01HPC
7	2.138E-8	2.31	IE-LOOPPC,EPS-DGN-CF-2ABDSFS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HPC
8	2.029E-8	2.19	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A,EPS-MDP-FR-FUELD, OEP-XHE-XL-NR01HPC
9	2.010E-8	2.17	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HPC
10	1.945E-8	2.1	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS, EPS-MDP-FR-FUELD, OEP-XHE-XL-NR01HPC
11	1.496E-8	1.61	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HPC
12	1.436E-8	1.55	IE-LOOPPC,AFW-TDP-TM-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HPC
13	1.379E-8	1.49	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-DGN-TM-2A, EPS-XHE-XM-DGDS, OEP-XHE-XL-NR01HPC
14	1.321E-8	1.43	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFS, EPS-XHE-XM-DGDS, OEP-XHE-XL-NR01HPC
15	1.218E-8	1.31	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-DGN-FR-2A,OEP-XHE-XL-NR01HPC,OEP-XHE-XX-NR01HPC1
16	1.206E-8	1.3	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-FAN-FS-HVE18,OEP-XHE-XL-NR01HPC
17	1.206E-8	1.3	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-FAN-FS-HVS6,OEP-XHE-XL-NR01HPC
18	1.206E-8	1.3	IE-LOOPPC,AFW-TDP-FS-SDP,EPS-SEQ-FO-DG2A,OEP-XHE-XL-NR01HPC
19	1.178E-8	1.27	IE-LOOPPC,AFW-TDP-FR-SDP,EPS-DGN-FS-2A,OEP-XHE-XL-NR01HPC
20	1.069E-8	1.15	IE-LOOPPC,AFW-TDP-TM-SDP,EPS-DGN-CF-2ABDSFS,OEP-XHE-XL-NR01HPC
21	1.005E-8	1.08	IE-LOOPPC,ACP-CRB-CC-52-18B,AFW-TDP-FS-SDP,OEP-XHE-XL-NR01HPC

Cutset Report - LOOPWR 15

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	7.656E-7	100	Displaying 1078 of 1078 Cutsets.
1	6.881E-8	8.99	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
2	5.796E-8	7.57	IE-LOOPWR,AFW-MDP-TM-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
3	4.347E-8	5.68	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
4	2.174E-8	2.84	IE-LOOPWR,AFW-MDP-FS-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
5	2.087E-8	2.73	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-536
6	2.087E-8	2.73	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-535
7	1.758E-8	2.3	IE-LOOPWR,AFW-MDP-TM-A,AFW-TDP-FS-SDP,PPR-MOV-FC-535
8	1.758E-8	2.3	IE-LOOPWR,AFW-MDP-TM-A,AFW-TDP-FS-SDP,PPR-MOV-FC-536
9	1.739E-8	2.27	IE-LOOPWR,AFW-FCV-CC-1424,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
10	1.491E-8	1.95	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-536

#	PROB/FREQ	TOTAL%	CUTSET
11	1.491E-8	1.95	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-535
12	1.319E-8	1.72	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-536
13	1.319E-8	1.72	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-TDP-FS-SDP,PPR-MOV-FC-535
14	1.223E-8	1.6	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-536
15	1.223E-8	1.6	IE-LOOPWR,AFW-FAN-FR-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-535
16	1.030E-8	1.35	IE-LOOPWR,AFW-MDP-TM-A,AFW-TDP-FR-SDP,PPR-MOV-FC-535
17	1.030E-8	1.35	IE-LOOPWR,AFW-MDP-TM-A,AFW-TDP-FR-SDP,PPR-MOV-FC-536
18	9.418E-9	1.23	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-536
19	9.418E-9	1.23	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-TDP-TM-SDP,PPR-MOV-FC-535
20	7.794E-9	1.02	IE-LOOPWR,AFW-MDP-FR-A,AFW-XHE-XM-CNTRL,DCP-BAT-LP-BATB1HR,DCP-XHE-XM-BC1
21	7.726E-9	1.01	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-536
22	7.726E-9	1.01	IE-LOOPWR,AFW-FAN-FS-HV7B,AFW-TDP-FR-SDP,PPR-MOV-FC-535

Referenced Events

Event	Description	Probability
ACP-CRB-CC-52-18B	CIRCUIT BREAKER 52/18B FAILS TO OPEN	2.500E-3
AFW-FAN-FR-HV7B	AFW MDP-2A HVAC HVH-7B FAILS TO RUN	4.749E-3
AFW-FAN-FS-HV7B	CCF OF AFW HVAC HVH-7A&B TO START	3.000E-3
AFW-FCV-CC-1424	FAILURE OF AFW MDP-A DISCHARGE PATH HYDRAULIC VALVE 1424	1.200E-3
AFW-MDP-FR-A	AFW MOTOR-DRIVEN PUMP A FAILS TO RUN	5.379E-4
AFW-MDP-FS-A	AFW MOTOR-DRIVEN PUMP A FAILS TO START	1.500E-3
AFW-MDP-TM-A	AFW MOTOR-DRIVEN A UNAVAILABLE DUE TO T & M	4.000E-3
AFW-TDP-FR-SDP	AFW TURBINE DRIVEN PUMP FAILS TO RUN	4.102E-3
AFW-TDP-FS-SDP	AFW TURBINE DRIVEN PUMP FAILS TO START	7.000E-3
AFW-TDP-TM-SDP	AFW TDP UNAVAILABLE DUE TO TEST AND MAINTENANCE	5.000E-3
AFW-XHE-XM-CNTRL	OPERATOR FAILS TO CONTROL AFW TDP	3.000E-1
AFW-XHE-XM-EPP1	OPERATOR FAILS TO ALIGN SDP DURING SBO	5.000E-2
DCP-BAT-LP-BATB1HR	DIVISION 2B BATTERY 1-B FAILS IN 1 HR	1.000E+0
DCP-XHE-XM-BC1	OPERATOR FAILS TO CLOSE BATT CHARGER BKRS ON E1/E2 UV-LOOP	1.000E-2
EPS-DGN-CF-2ABDSFS	CCF OF DIESEL GENERATORS 2A, 2B & DS TO START	3.722E-3
EPS-DGN-CF-2ABFS	COMMON CAUSE FAILURE OF DIESEL GENERATORS 2A & 2B TO START	1.150E-2
EPS-DGN-FR-2A	DIESEL GENERATOR 2A FAILS TO RUN	2.118E-2
EPS-DGN-FS-2A	DIESEL GENERATOR 2A FAILS TO START	5.000E-3
EPS-DGN-TM-2A	DIESEL GENERATOR 2A UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.200E-2
EPS-FAN-FS-HVE18	DG-A EXHAUST FAN HVE-18 FAILS TO START	3.000E-3
EPS-FAN-FS-HVS6	DG-A SUPPLY FAN HVS-6 FAILS TO START	3.000E-3
EPS-MDP-FR-FUELDS	DIESEL GENERATOR B FUEL TRANSFER PUMP DS FAILS TO RUN	5.887E-2
EPS-SEQ-FO-DG2A	LOAD SEQUENCER FOR DG-2A FAILS TO OPERATE	3.000E-3
EPS-XHE-XM-DGDS	OPERATOR FAILS TO START AND ALIGN DG-DS TO BUS DS	4.000E-2
FWS-EDP-TM-DDP	FWP DDP UNAVAILABLE DUE TO T & M	1.000E-2
IE-LOOPGR	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	1.860E-2
IE-LOPPC	LOSS OF OFFSITE POWER INITIATOR (PLANT-CENTERED)	2.070E-3

Event	Description	Probability
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-RELATE D)	1.040E-2
IE-LOOPWR	LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED)	4.830E-3
OEP-XHE-XL-NR01HGR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (GRID-RELATED)	6.110E-1
OEP-XHE-XL-NR01HPC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (PLANT-CENTERED)	2.775E-1
OEP-XHE-XL-NR01HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (SWITCHYARD)	3.779E-1
OEP-XHE-XL-NR01HWR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (WEATHER-RELATED)	6.555E-1
OEP-XHE-XX-NR01HGR1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-GR AVAIL)	1.750E-1
OEP-XHE-XX-NR01HPC1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-PC AVAIL)	1.430E-1
OEP-XHE-XX-NR01HSC1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-SC AVAIL)	1.580E-1
OEP-XHE-XX-NR01HWR1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-WR AVAIL)	4.080E-1
OEP-XHE-XX-NR01HWR2	CONVOLUTION FACTOR FOR 2FTR-OPR (1HR-WR AVAIL)	2.800E-1
PPR-MOV-FC-535	BLOCK VALVE RC-535 FOR PORV PCV-456 CLOSED DURING POWER (PSA)	1.300E-1
PPR-MOV-FC-536	BLOCK VALVE RC-536 FOR PORV PCV-455C CLOSED DURING POWER (PSA)	1.300E-1

Calculation 2– EDG A in TM and EDG B Unavailable (Failed to Start) for 7 hours

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
EPS-DGN-FR-2A	DIESEL GENERATOR 2A FAILS TO RUN	1.000E+0	2.118E-2
EPS-DGN-FR-2B	DIESEL GENERATOR 2B FAILS TO RUN	1.000E+0	2.118E-2
EPS-DGN-FS-2A	DIESEL GENERATOR 2A FAILS TO START	1.000E+0	5.000E-3
EPS-DGN-FS-2B	DIESEL GENERATOR 2B FAILS TO START	True	5.000E-3
EPS-DGN-TM-2A	DIESEL GENERATOR 2A UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.200E-2
EPS-DGN-TM-2B	DIESEL GENERATOR 2B UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.200E-2
EPS-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR	True	7.857E-1
EPS-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS	5.000E-3	5.568E-1
EPS-DGN-CF-2ABFR	COMMON CAUSE FAILURE OF DIESEL GENERATORS 2A & 2B TO RUN	1.000E+0	3.282E-4
EPS-DGN-CF-2ABFS	COMMON CAUSE FAILURE OF DIESEL GENERATORS 2A & 2B TO START	1.000E+0	5.750E-5
EPS-DGN-CF-2ABDSFR	CCF OF DIESEL GENERATORS 2A, 2B & DS TO RUN	2.118E-2	1.214E-4
EPS-DGN-CF-2ABDSFS	CCF OF DIESEL GENERATORS 2A, 2B & DS TO START	3.746E-3	1.861E-5

Dominant Sequence Results

Only items contributing at least 1.0% to the total CCDP are displayed.

EVENT TREE	SEQUENCE	CCDP	CDP	ΔCCDP	DESCRIPTION
LOOPGR	16-46	2.638E-7	3.540E-10	2.634E-7	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPSC	16-46	9.126E-8	1.143E-10	9.114E-8	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPWR	16-46	7.700E-8	1.265E-10	7.687E-8	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPPC	16-46	1.331E-8	1.346E-11	1.330E-8	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOPGR	16-43	6.016E-9	7.475E-12	6.009E-9	/RPS, EPS, /AFW-B, PORV-B, OPR-01H, DGR-01H
Total		4.895E-7	1.123E-8	4.783E-7	

Referenced Fault Trees

Fault Tree	Description
AFW-B	AUXILIARY FEEDWATER
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
EPS	EMERGENCY POWER
OPR-01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR
PORV-B	ROBINSON UNIT 2 PWR B PORVS/SRVS CHALLENGED DURING SBO

Cutset Report - LOOPGR 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	3.301E-4	100	Displaying 383 of 383 Cutsets.

#	PROB/FREQ	TOTAL%	CUTSET
1	7.955E-5	24.1	IE-LOOPGR,AFW-TDP-FS-SDP,OEP-XHE-XL-NR01HGR
2	5.682E-5	17.21	IE-LOOPGR,AFW-TDP-TM-SDP,OEP-XHE-XL-NR01HGR
3	4.661E-5	14.12	IE-LOOPGR,AFW-TDP-FR-SDP,OEP-XHE-XL-NR01HGR
4	3.345E-5	10.13	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HGR
5	2.273E-5	6.89	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HGR
6	1.364E-5	4.13	IE-LOOPGR,AFW-FCV-CC-6416,OEP-XHE-XL-NR01HGR
7	1.136E-5	3.44	IE-LOOPGR,ACP-XHE-XM-MCC5,AFW-XHE-XM-EPP1,OEP-XHE-XL-NR01HGR
8	6.819E-6	2.07	IE-LOOPGR,AFW-XHE-XM-EPP1,EPS-DGN-TM-DS,OEP-XHE-XL-NR01HGR
9	6.691E-6	2.03	IE-LOOPGR,EPS-MDP-FR-FUELDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HGR
10	4.546E-6	1.38	IE-LOOPGR,EPS-XHE-XM-DGDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HGR

Cutset Report - LOOPSC 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	1.142E-4	100	Displaying 329 of 329 Cutsets.
1	2.751E-5	24.1	IE-LOOPSC,AFW-TDP-FS-SDP,OEP-XHE-XL-NR01HSC
2	1.965E-5	17.21	IE-LOOPSC,AFW-TDP-TM-SDP,OEP-XHE-XL-NR01HSC
3	1.612E-5	14.12	IE-LOOPSC,AFW-TDP-FR-SDP,OEP-XHE-XL-NR01HSC
4	1.157E-5	10.13	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HSC
5	7.861E-6	6.88	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HSC
6	4.717E-6	4.13	IE-LOOPSC,AFW-FCV-CC-6416,OEP-XHE-XL-NR01HSC
7	3.931E-6	3.44	IE-LOOPSC,ACP-XHE-XM-MCC5,AFW-XHE-XM-EPP1,OEP-XHE-XL-NR01HSC
8	2.358E-6	2.07	IE-LOOPSC,AFW-XHE-XM-EPP1,EPS-DGN-TM-DS,OEP-XHE-XL-NR01HSC
9	2.314E-6	2.03	IE-LOOPSC,EPS-MDP-FR-FUELDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HSC
10	1.572E-6	1.38	IE-LOOPSC,EPS-XHE-XM-DGDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HSC

Cutset Report - LOOPWR 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	9.636E-5	100	Displaying 324 of 324 Cutsets.
1	2.216E-5	23	IE-LOOPWR,AFW-TDP-FS-SDP,OEP-XHE-XL-NR01HWR
2	1.583E-5	16.43	IE-LOOPWR,AFW-TDP-TM-SDP,OEP-XHE-XL-NR01HWR
3	1.299E-5	13.48	IE-LOOPWR,AFW-TDP-FR-SDP,OEP-XHE-XL-NR01HWR
4	9.320E-6	9.67	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HWR
5	6.332E-6	6.57	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HWR
6	3.799E-6	3.94	IE-LOOPWR,AFW-FCV-CC-6416,OEP-XHE-XL-NR01HWR
7	3.166E-6	3.29	IE-LOOPWR,ACP-XHE-XM-MCC5,AFW-XHE-XM-EPP1,OEP-XHE-XL-NR01HWR

#	PROB/FREQ	TOTAL%	CUTSET
8	1.900E-6	1.97	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-TM-DS,OEP-XHE-XL-NR01HWR
9	1.864E-6	1.93	IE-LOOPWR,EPS-MDP-FR-FUELDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HWR
10	1.368E-6	1.42	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABDSFR,OEP-XHE-XL-NR01HWR,OEP-XHE-XX-NR01HWR0
11	1.368E-6	1.42	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-CF-2ABFR,EPS-DGN-FR-DS,OEP-XHE-XL-NR01HWR,OEP-XHE-XX-NR01HWR0
12	1.368E-6	1.42	IE-LOOPWR,AFW-XHE-XM-EPP1,EPS-DGN-FR-DS,OEP-XHE-XL-NR01HWR,OEP-XHE-XX-NR01HWR1
13	1.266E-6	1.31	IE-LOOPWR,EPS-XHE-XM-DGDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HWR

Cutset Report - LOOPPC 16-46

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	1.666E-5	100	Displaying 250 of 250 Cutsets.
1	4.021E-6	24.13	IE-LOOPPC,AFW-TDP-FS-SDP,OEP-XHE-XL-NR01HPC
2	2.872E-6	17.24	IE-LOOPPC,AFW-TDP-TM-SDP,OEP-XHE-XL-NR01HPC
3	2.356E-6	14.14	IE-LOOPPC,AFW-TDP-FR-SDP,OEP-XHE-XL-NR01HPC
4	1.691E-6	10.15	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-MDP-FR-FUELDS,OEP-XHE-XL-NR01HPC
5	1.149E-6	6.89	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-XHE-XM-DGDS,OEP-XHE-XL-NR01HPC
6	6.893E-7	4.14	IE-LOOPPC,AFW-FCV-CC-6416,OEP-XHE-XL-NR01HPC
7	5.744E-7	3.45	IE-LOOPPC,ACP-XHE-XM-MCC5,AFW-XHE-XM-EPP1,OEP-XHE-XL-NR01HPC
8	3.447E-7	2.07	IE-LOOPPC,AFW-XHE-XM-EPP1,EPS-DGN-TM-DS,OEP-XHE-XL-NR01HPC
9	3.382E-7	2.03	IE-LOOPPC,EPS-MDP-FR-FUELDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HPC
10	2.298E-7	1.38	IE-LOOPPC,EPS-XHE-XM-DGDS,FWS-EDP-TM-DDP,OEP-XHE-XL-NR01HPC

Cutset Report - LOOPGR 16-43

Only items contributing at least 1% to the total are displayed.

#	PROB/FREQ	TOTAL%	CUTSET
	7.529E-6	100	Displaying 5 of 5 Cutsets.
1	3.658E-6	48.59	IE-LOOPGR,OEP-XHE-XL-NR01HGR,/PPR-MOV-FC-536,PPR-SRV-CO-SBO,PPR-SRV-OO-455C
2	3.658E-6	48.59	IE-LOOPGR,OEP-XHE-XL-NR01HGR,/PPR-MOV-FC-535,PPR-SRV-CO-SBO,PPR-SRV-OO-456

Referenced Events

Event	Description	Probability
ACP-XHE-XM-MCC5	OPERATOR FAILS TO CONNECT BUS DS TO MCC-5	2.000E-2
AFW-FCV-CC-6416	FAILURE OF AFW SDP DISCHARGE PATH HYDRAULIC VALVE 6416	1.200E-3
AFW-TDP-FR-SDP	AFW TURBINE DRIVEN PUMP FAILS TO RUN	4.102E-3
AFW-TDP-FS-SDP	AFW TURBINE DRIVEN PUMP FAILS TO START	7.000E-3
AFW-TDP-TM-SDP	AFW TDP UNAVAILABLE DUE TO TEST AND MAINTENANCE	5.000E-3
AFW-XHE-XM-EPP1	OPERATOR FAILS TO ALIGN SDP DURING SBO	5.000E-2

Event	Description	Probability
EPS-DGN-CF-2ABDSFR	CCF OF DIESEL GENERATORS 2A, 2B & DS TO RUN	2.118E-2
EPS-DGN-CF-2ABFR	COMMON CAUSE FAILURE OF DIESEL GENERATORS 2A & 2B TO RUN	1.000E+0
EPS-DGN-FR-DS	DEDICATED DIESEL GENERATOR FAILS TO RUN	2.118E-2
EPS-DGN-TM-DS	DEDICATED DIESEL GENERATOR UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.200E-2
EPS-MDP-FR-FUELDS	DIESEL GENERATOR B FUEL TRANSFER PUMP DS FAILS TO RUN	5.887E-2
EPS-XHE-XM-DGDS	OPERATOR FAILS TO START AND ALIGN DG-DS TO BUS DS	4.000E-2
FWS-EDP-TM-DDP	FWP DDP UNAVAILABLE DUE TO T & M	1.000E-2
IE-LOOPGR	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	1.860E-2
IE-LOOPPC	LOSS OF OFFSITE POWER INITIATOR (PLANT-CENTERED)	2.070E-3
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-RELATE D)	1.040E-2
IE-LOOPWR	LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED)	4.830E-3
OEP-XHE-XL-NR01HGR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (GRID-RELATED)	6.110E-1
OEP-XHE-XL-NR01HPC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (PLANT-CENTERED)	2.775E-1
OEP-XHE-XL-NR01HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (SWITCHYARD)	3.779E-1
OEP-XHE-XL-NR01HWR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (WEATHER-RELATED)	6.555E-1
OEP-XHE-XX-NR01HWR0	CONVOLUTION FACTOR FOR CCF-OPR (1HR-WR Avail)	4.080E-1
OEP-XHE-XX-NR01HWR1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-WR AVAIL)	4.080E-1
PPR-SRV-CO-SBO	PORVs/SRVs OPEN DURING SBO	3.700E-1
PPR-SRV-OO-455C	PORV PCV-455C FAILS TO RECLOSE AFTER OPENING	1.000E-3
PPR-SRV-OO-456	PORV PCV-456 FAILS TO RECLOSE AFTER OPENING	1.000E-3

Appendix B: Key Event Trees

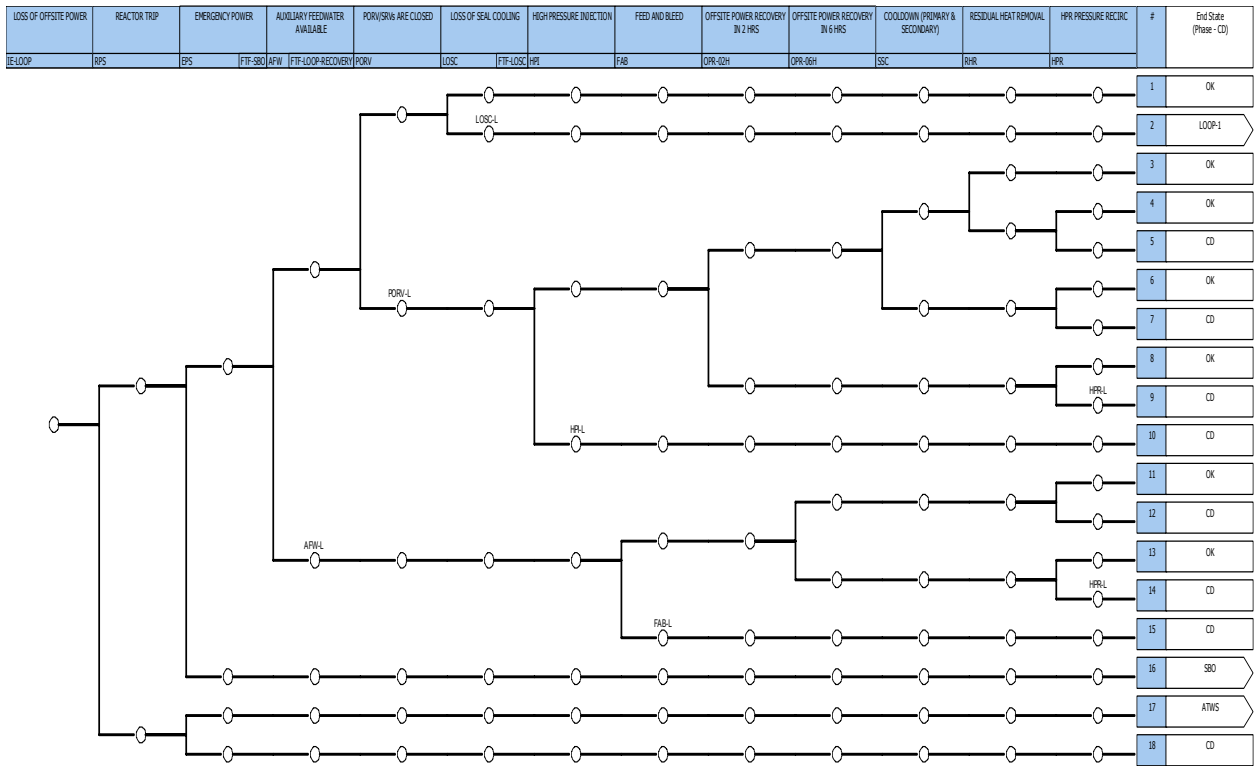


Figure B-1. H. B. Robinson LOOP event tree.

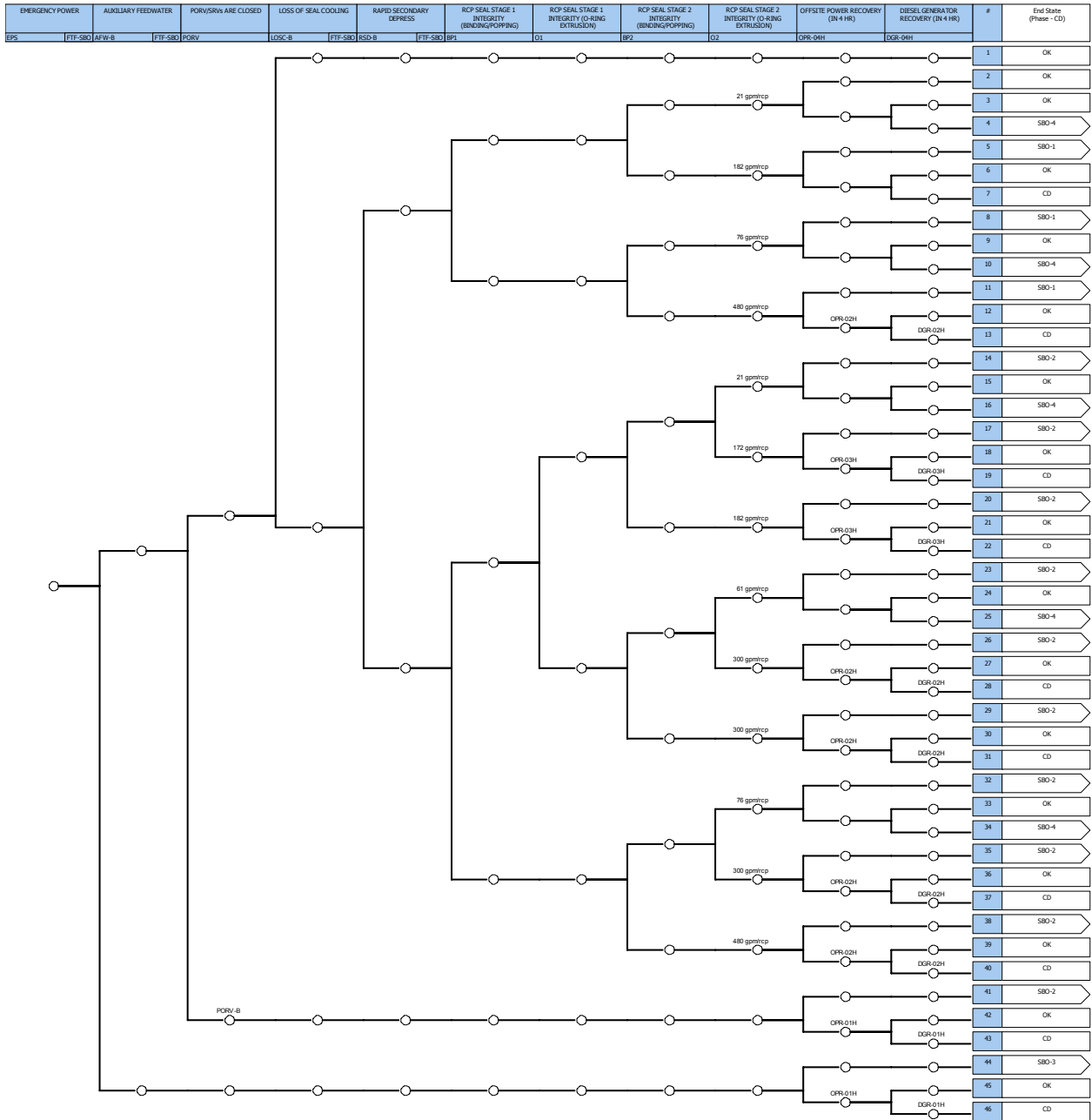


Figure B-2. H. B. Robinson station blackout event tree.