

Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

Catawba Nuclear Station, Unit 1	Reactor Trip due to Faulted Reactor Coolant Pump Cable and an Error in Protective Relay Actuation Causes a Subsequent Loss of Offsite Power	
Event Date: 04/04/2012	LER: 413/12-001 IR: 50-413/12-09 and 50-413/12-10	CCDP = 9×10^{-6}

EVENT SUMMARY

Event Description. At 8:03 pm on April 4, 2012, Catawba Unit 1 experienced a complete loss of offsite power (LOOP) for about five hours and 30 minutes. This condition resulted from a trip of Reactor Coolant Pump (RCP) 1D which caused a reactor trip and turbine trip. Shortly after the Unit 1 generator power circuit breakers opened, the Zone G Protective Relaying System unexpectedly actuated on an instantaneous under-frequency condition as a result of an error in the relay logic and opened the switchyard breakers thereby isolating Unit 1 from the grid and resulting in a LOOP.

Both emergency diesel generators (EDGs) automatically started and powered their respective essential busses as designed. Approximately five hours and 30 minutes after the event initiated and after confirming that the sources of the fault were cleared, offsite power was restored to Essential Bus 1ETA. Additional information is provided in References 1–3.

Sequence of Key Events. The following table provides a sequence of key events. Additional information is provided in Reference 2.

April 4, 2012

20:03	With Unit 1 at 100% power, RCP 1D Phase “Y” cable faults to ground causing trip of RCP 1D; automatic reactor trip on Reactor Coolant Loop 1D low flow; automatic turbine trip on reactor trip with power greater than P-8; Feeder Breaker 1ATD supply to Essential Bus 1ETB trips, de-energizing the bus.
20:03:10	Generator Output Breakers 1A and 1B open; EDG 1B automatically starts and repowers Essential Bus 1ETB.
20:03:25	Generator frequency decrease below 57.9 Hz causing instantaneous under-frequency protective relay to isolate Unit 1 offsite power causing Unit 1 LOOP and loss of power to Unit 2.
20:03:35	EDGs 1A, 2A, and 2B start and repower their essential buses; over-current alarm on EDG 2A which was out-of-service for a short period of time, but would not affect the analysis results.
20:06	RHR Pump 2A started to restore decay heat removal.
20:12	Notice of Unusual Event (NOUE) declared.
20:30	Spent Fuel Pool Cooling Pump 2B started.
21:22	Technical Support Center activated.

22:32 Emergency Operations Facility activated.

April 5, 2012

- 01:29 Offsite power restored to Essential Bus 1ETA.
- 01:37 Offsite power restored to Essential Bus 2ETB; NOUE terminated.
- 01:38 EDG 1A shutdown.
- 01:43 EDG 2B shutdown.
- 02:36 Offsite power restored to Essential Bus 2ETA.
- 02:45 EDG 2A shutdown.
- 05:37 Offsite power restored to Essential Bus 1ETB.
- 05:41 EDG 1B shutdown.

Simplified Electrical Drawing. Figure 1 provides a simplified drawing of the electrical distribution systems for Catawba Nuclear Station.

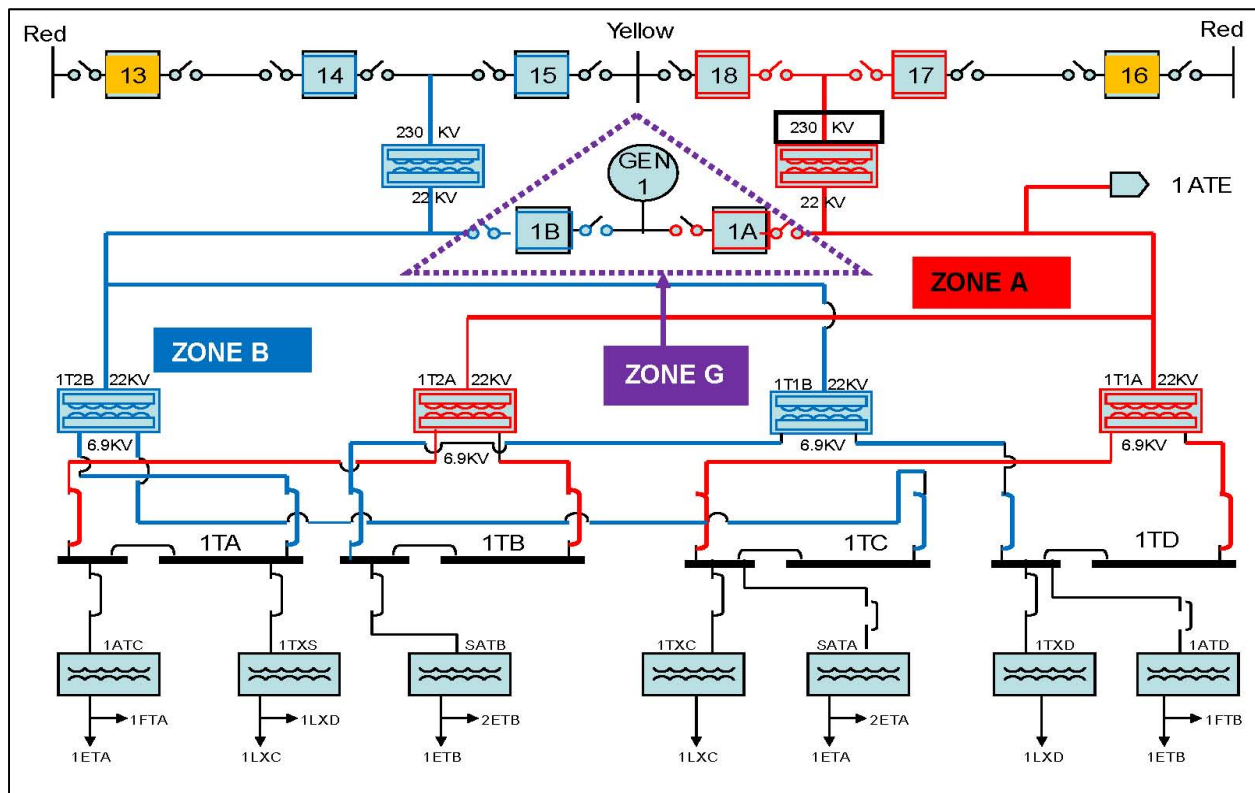


Figure 1. Simplified Electrical Distribution System for Catawba Nuclear Station.

MODELING ASSUMPTIONS

Analysis Type. The Catawba Unit 1 SPAR model, created in May 2012, was used for this event analysis. This event was modeled as a LOOP initiating event.

Analysis Rules. The ASP program uses Significance Determination Process results for degraded conditions when available. However, the ASP Program performs independent analysis for initiating events.

Key Modeling Assumptions. The following modeling assumptions were determined to be significant to the modeling of this event analysis:

- A reactor trip with a subsequent LOOP to both essential buses occurred.
- Offsite power (via the Unit 2 crosstie) was restored to Essential Bus 1ETA in five hours and 26 minutes after the LOOP occurred. However, power from Unit 2 was available throughout the event and operators could have restored power to a Unit 1 essential bus earlier, if needed (i.e., during a postulated station blackout). See the section on Recovery Analysis for further details.

Basic Event Probability Changes. The following initiating event frequencies and basic event probabilities were modified for this event analysis:

- This analysis models the April 4, 2012 reactor trip at Catawba Unit 1 as a LOOP initiating event.
 - The probability of IE-LOOP (*Loss of Offsite Power*) was set to 1.0; all other initiating event probabilities were set to zero.
 - Basic Event OEP-VCF-LP-SITEAV (*Site Loop [Weighted Average]*) was set to FALSE and OEP-VCF-LP-SINGLAV (*Single Unit Loop [Weighted Average]*) was set to TRUE.
- Basic event EPS-XHE-XM-XTIE (Failure to Crosstie Power from Unit 2 during Single Unit LOOP) was set to TRUE because credit for power recovery from Unit 2 was credited in this analysis using the sequence-specific power recovery events. See the section on Recovery Analysis for further details.
- The offsite power (via the Unit 2 crosstie) was recovered to the first Unit 1 essential bus in five hours and 26 minutes and both Unit 1 essential buses approximately nine hours and 34 minutes after the reactor trip and LOOP occurred; therefore, the default EDG and turbine-driven auxiliary feedwater (AFW) pump mission times were changed to reflect the actual time offsite power was restored to the essential buses. Since the overall fail-to-run is made up of two separate factors, the mission times for these factors were set to the following: ZT-DGN-FR-E = 1 hour and ZT-TDP-FR-E = 1 hour (base case values) and ZT-DGN-FR-L = 4.5 hours and ZT-TDP-FR-L = 8.5 hours.

Recovery Analysis. The time required to restore offsite power to plant emergency equipment is a significant factor in modeling the CCDP given a LOOP. The LOOP/Station Blackout (SBO) modeling within the SPAR models include various sequence-specific power recovery factors that are based on the time available to recover offsite power to prevent core damage. For a sequence involving failure of all of the cooling sources (e.g., postulated SBO with a failure of turbine-driven AFW pump), approximately 1 hour would be available to recover offsite power to help avoid core damage. On the other hand, sequences involving successful early inventory control and decay heat removal, but failure of long-term decay heat removal, would accommodate several hours to recover offsite power prior to core damage.

In this analysis, offsite power recovery probabilities are based on:

- Known information about when power was available from the Unit 2 crosstie and when power was restored to the first Unit 1 essential bus,
- A determination on whether offsite power could have been restored sooner given a postulated SBO, and
- Estimated probabilities of failing to realign power from the Unit 2 crosstie to a Unit 1 essential bus given offsite power was available from Unit 2.

During the event, operators restored power to Unit 1 Essential Bus 1ETA via the Unit 2 crosstie in five hours and 26 minutes after the LOOP occurred.¹ To restore offsite power to Unit 1 Essential Bus 1ETA from Unit 2 (if needed because EDGs fail to supply the loads), operators would need to:

- Determine that LOOP and subsequent (postulated) SBO occurred (with potential failures of the turbine-driven AFW pump). In addition, the operators would need to determine that offsite power was still available to Unit 2 via the Train A switchyard breakers to the 6.9 kV buses. The correct determination will lead operators to enter AP/1/A/5500/007, "Loss of Normal Power."
- Standby Transformers SATA would need to be aligned to Unit 2 by racking-out the Unit 1 supply breakers from Bus 1TC and racking-in the Unit 2 supply breakers from Bus 2TC. In parallel, the normal supply breakers for Essential Bus 1ETA would be racked-out and the alternate supply breakers from SATA would be racked-in. Operators would need to develop a plan using OP/2/a/6350/005, "Alternate AC Power Sources" to rack-out/rack-in the applicable breakers.
- Operators would need to shed loads on Essential Bus 1ETA per Enclosure 8 of AP/1/A/5500/007.
- Operators would then use Enclosure 5 of AP/1/A/5500/007 to align alternate power to 1ETA.

Power could have been restored within one hour from Unit 2 during a postulated station blackout (SBO).² The SPAR-H Human Reliability Analysis Method (References 4 and 5) was used to estimate non-recovery probabilities as a function of time following restoration of offsite power to the switchyard.³ Tables 1 and 2 provide the key qualitative information for these recovery HFEs and the performance shaping factor (PSFs) adjustments required for the quantification of the HEPs using SPAR-H.

¹ Operators only have to restore offsite power to a single Unit 1 essential bus for successful recovery in this analysis. Since Essential Bus 1ETB was the train with the fault on it (RCP 1D and reports of faults on Main Transformer 1B); it is assumed that operators would concentrate on restoring power to Essential Bus 1ETA during a postulated Unit 1 SBO.

² The 45-minute estimate for required time to perform the action component of the recovery of offsite power to all four essential buses for Units 1 and 2 was provided by the licensee. The staff review of this estimate determined that the basis for this estimate was reasonable. Since the 45-minute estimate assumed restoring power to the essential buses for both Units, this analysis uses 30 minutes as the approximate action time to complete power recovery to Essential Bus 1ETA (since fewer breaker manipulations are needed).

³ The operators failing to properly diagnose the event and perform the required procedural steps to recover offsite power to Essential Bus 1ETA are assumed to be the dominant failure contributor for recovery in this analysis. Hardware failures are assumed to be negligible (due to their much lower failure probabilities) in this recovery analysis.

Table 1. Qualitative Evaluation of HFEs for Recovery of Power to a Unit 1 Essential Bus.

Definition	The definition for these recovery HFEs is the operators failing to restore offsite power to a Unit 1 essential bus via the Unit 2 crosstie within 1 to 24 hours (depending on the sequence) given a postulated SBO.
Description and Event Context	Depending on postulated failures of the RCP seals (due to unavailability of seal injection/cooling), the availability of the turbine-driven AFW pump, and the time until the station batteries are depleted, operators would have between 1–24 hours to restore power via the Unit 2 crosstie to a Unit 1 essential bus prior to core uncover.
Operator Action Success Criteria	For successful recovery, operators would have to align power from Unit 2 to an essential bus prior to core uncover. The time available for operators to perform this action would be a minimum of 1 hour (given the failure of the EDGs and turbine-driven AFW pump).
Nominal Cues	<ul style="list-style-type: none"> • Essential Bus 1ETA de-energized • Essential Bus 1ETB de-energized • Loss of normally operating components supplied from affected bus • Affected EDG - OFF • Affected EDG breaker - OPEN • Affected sequencer not loading essential loads • 1AD-11, F/4 "ZONE G LOCKOUT TRIP" - LIT
Procedural Guidance	AP/1/A/5500/007, "Loss of Normal Power" and OP/2/a/6350/005, "Alternate AC Power Sources."
Diagnosis/Action	These recovery HFEs contain sufficient diagnosis and action components.

Table 2. SPAR-H Evaluation of HEPs for Recovery of Power to a Unit 1 Essential Bus.

PSF	Diagnosis / Action Multiplier	Notes
Time Available	1 or 0.01 / 1	<p>The operators would need approximately 30 minutes to perform the action component of time to restore power via the Unit 2 crosstie to a Unit 1 essential bus. Therefore, the minimum time for diagnosis is approximately 30 minutes.</p> <p>Therefore, available time for the diagnosis component for one-hour recovery is assigned as <i>Nominal Time</i> (i.e., ×1). Available time for the diagnosis component for recoveries with at least two hours is assigned as <i>Expansive Time</i> (i.e., ×0.01; time available is >2 times nominal and >30 minutes).</p> <p>Since sufficient time was available to for the action component of the recovery, the available time for the action component for the all recovery times is evaluated as <i>Nominal</i> (i.e., ×1). See Reference 5 for guidance on apportioning time between the diagnosis and action components of an HFE.</p>

PSF	Diagnosis / Action Multiplier	Notes
Stress	2 / 1	The PSF for diagnosis stress is assigned a value of <i>High Stress</i> (i.e., ×2) due to the postulated SBO. The PSF for action stress was not determined to be a performance driver for these HFEs; and therefore, was assigned a value of <i>Nominal</i> (i.e., ×1).
Complexity	2 / 1	The PSF for diagnosis complexity is assigned a value of <i>Moderately Complex</i> (i.e., ×2) because operators would have to deal with multiple equipment unavailabilities and the concurrent actions/multiple procedures during a postulated SBO. The PSF for action complexity was not determined to be a performance driver for these HFEs; and therefore, was assigned a value of <i>Nominal</i> (i.e., ×1).
Procedures	1 / 1	There are three procedures (AP/1/A/5500/007, OP/1/A/6350/005, and OP/1/A/6350/002) necessary to align power to Unit 2 to restore offsite power to Unit 1.
Procedures Experience/Training Ergonomics/HMI Fitness for Duty Work Processes	1 / 1	No event information is available to warrant a change in these PSFs (for diagnosis and action) from <i>Nominal</i> for these HFEs.

HEPs evaluated using SPAR-H are calculated using the following formula:

$$\text{Calculated HEP} = (\text{Product of Diagnosis PSFs} \times 0.01) + (\text{Product of Action PSFs} \times 0.001)$$

Basic event OEP-XHE-XL-NR01H (*Operator Fails to Recover Offsite Power in 1 Hour*) was set to 4×10^{-2} .

Basic events OEP-XHE-XL-NR02H (*Operator Fails to Recover Offsite Power in 2 Hours*), OEP-XHE-XL-NR03H (*Operator Fails to Recover Offsite Power in 3 Hours*), OEP-XHE-XL-NR04H (*Operator Fails to Recover Offsite Power in 4 Hours*), OEP-XHE-XL-NR06H (*Operator Fails to Recover Offsite Power in 6 Hours*), and OEP-XHE-XL-NR24H (*Operator Fails to Recover Offsite Power in 24 Hours*) were set to 1×10^{-3} .

ANALYSIS RESULTS

Conditional Core Damage Probabilities. The point estimate conditional core damage probability (CCDP) for this event is 9×10^{-6} .

The Accident Sequence Precursor Program acceptance threshold is a CCDP of 1×10^{-6} or the CCDP equivalent of an uncomplicated reactor trip with a non-recoverable loss of secondary plant systems (e.g., feed water and condensate), whichever is greater. This CCDP equivalent for Catawba is 2×10^{-6} .

Dominant Sequence. The dominant accident sequence is LOOP Sequence 19-77 (CCDP = 2.3×10^{-6}) which contributes 26% of the total internal events CCDP for Unit 1. Additional sequences that contribute greater than 1% of the total internal events CCDP 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 LOOP Sequence 19-77 are:

- LOOP occurs,
- Reactor scram succeeds,
- Emergency power fails,
- Turbine-driven AFW fails,
- Operators fail to restore offsite power within 1 hour,
- Operators fail to recover an EDG within 1 hour,

REFERENCES

1. Catawba Nuclear Station Unit 1, "LER 413/12-001– Unit 1 Automatic Reactor Trip Due to Faulted Reactor Coolant Pump Motor Cable Resulted in Zone G Relay Lockout and Subsequent Loss of Offsite Power and Emergency Diesel Generator Automatic Start for Both Units" dated June 4, 2012. (ML12157A322)
2. U.S. Nuclear Regulatory Commission, "Catawba Nuclear Station NRC Special Inspection Report 05000413/2012009," dated July 25, 2012. (ML12207A614)
3. U.S. Nuclear Regulatory Commission, "Catawba Nuclear Station NRC Special Inspection Report 05000413/2012010," dated October 11, 2012. (ML12285A100)
4. Idaho National Laboratory, NUREG/CR-6883, "The SPAR-H Human Reliability Analysis Method," August 2005 (ML051950061).
5. Idaho National Laboratory, "INL/EXT-10-18533, SPAR-H Step-by-Step Guidance," May 2011 (ML112060305).

Appendix A: Analysis Results

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
EPS-XHE-XM-XTIE	FAILURE TO X-TIE POWER FROM UNIT 2 DURING SINGLE UNIT LOOP	TRUE	1.00E-1
IE-LOOP	LOSS OF OFFSITE POWER	1.00E+0	2.84E-2
OEP-VCF-LP-SITEAV	SITE LOOP (WEIGHTED AVERAGE)	False	5.79E-1
OEP-VCF-LP-SNGLAV	SINGLE UNIT LOOP (WEIGHTED-AVERAGE)	True	7.41E-1
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	4.00E-2	5.46E-1
OEP-XHE-XL-NR02H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2 HOURS	1.00E-3	3.39E-1
OEP-XHE-XL-NR03H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS	1.00E-3	2.34E-1
OEP-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS	1.00E-3	1.73E-1
OEP-XHE-XL-NR06H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 6 HOURS	1.00E-3	1.10E-1
OEP-XHE-XL-NR24H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 24 HOURS	1.00E-3	2.31E-2
ZT-DGN-FR-L	DIESEL GENERATOR FAILS TO RUN	4.88E-3	2.47E-2
ZT-TDP-FR-L	TURBINE DRIVEN PUMP FAILS TO RUN	1.32E-2	3.52E-2

Dominant Sequence Results

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

Event Tree	Sequence	CCDP	% Contribution	Description
LOOP	19-77	2.30E-6	26.1%	/RPS, EPS, AFW-B, OPR-01H, DGR-01H
LOOP	17	1.52E-6	17.2%	/RPS, /EPS, AFW-L, FAB-L, /OPR-02H, HPR
LOOP	19-75-04	1.18E-6	13.4%	/RPS, EPS, AFW-B, /OPR-01H, /BP2, FAB
LOOP	19-02	1.05E-6	12.0%	/RPS, EPS, /AFW-B, /PORV-B, /SSF-SBO, /SSF-LT, OPR-24H
LOOP	02-02-09	8.46E-7	9.6%	/RPS, /EPS, /AFW-L, /PORV-L, LOSC-L, /RSD-L, /BP1, BP2, /OPR-02H, /FW, HPI-L, /SSC1, LPI
LOOP	19-75-03	6.27E-7	7.1%	/RPS, EPS, AFW-B, /OPR-01H, /BP2, /FAB, HPR
LOOP	19-75-10	2.89E-7	3.3%	/RPS, EPS, AFW-B, /OPR-01H, BP2, FAB
LOOP	19-15-2	2.49E-7	2.8%	/RPS, EPS, /AFW-B, /PORV-B, SSF-SBO, /RSD-B, /BP1, BP2, /DC-SHED, /OPR-02H, /HPI, /SSC, LPR
LOOP	19-75-09	1.52E-7	1.7%	/RPS, EPS, AFW-B, /OPR-01H, BP2, /FAB, HPR
Total		8.80E-6	100.0%	

Referenced Fault Trees

Fault Tree	Description
AFW-B	AUXILIARY FEEDWATER
AFW-L	NO OR INSUFFICIENT AFW FLOW USING LOOP-FTF
BP2	RCP SEAL STAGE 2 INTEGRITY
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
EPS	EMERGENCY POWER FAILS
FAB	FEED AND BLEED

Fault Tree	Description
FAB-L	FEED AND BLEED COOLING USING LOOP-FTF FAULT TREE FLAGS
HPI-L	HIGH PRESSURE INJECTION
HPR	HIGH PRESURE RECIRC
LOSC-L	RCP SEALS FAIL FROM LACK OF COOLING USING LOOP- FTF
LPI	LOW PRESSURE INJECTION
LPR	LOW PRESSURE RECIRC
OPR-01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR
OPR-24H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 24 HOURS
SSF-SBO	STANDBY SHUTDOWN FACILITY SEAL COOLING

Cutset Report - LOOP 19-77

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

#	CCDP	Total%	Cutset
	2.30E-6	100	Displaying 1527 of 1527 Cut Sets.
1	8.11E-8	3.52	IE-LOOP,AFW-XHE-XM-CR,EPS-FAN-CF-FRU1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
2	4.75E-8	2.06	IE-LOOP,AFW-TDP-FR-TDP,EPS-FAN-CF-FRU1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
3	4.34E-8	1.89	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FS-1A,EPS-DGN-TM-1B,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
4	4.34E-8	1.89	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FS-1B,EPS-DGN-TM-1A,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
5	3.88E-8	1.69	IE-LOOP,EPS-FAN-CF-FRU1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H,SSF-DGN-TM-DGN
6	3.78E-8	1.64	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FSU1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
7	3.52E-8	1.53	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FR-1A,EPS-DGN-TM-1B,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H,OEP-XHE-XX-NR01H1
8	3.52E-8	1.53	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FR-1B,EPS-DGN-TM-1A,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H,OEP-XHE-XX-NR01H1
9	3.33E-8	1.45	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FRU1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H,OEP-XHE-XX-NR01H0
10	3.17E-8	1.38	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B2,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
11	3.17E-8	1.38	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
12	3.17E-8	1.38	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A2,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
13	3.17E-8	1.38	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
14	2.54E-8	1.1	IE-LOOP,AFW-TDP-FR-TDP,EPS-DGN-FS-1A,EPS-DGN-TM-1B,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
15	2.54E-8	1.1	IE-LOOP,AFW-TDP-FR-TDP,EPS-DGN-FS-1B,EPS-DGN-TM-1A,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H
16	2.33E-8	1.01	IE-LOOP,EPS-FAN-CF-FRU1,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01H,SSF-DGN-FR-DGN

Cutset Report - LOOP 17

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

#	CCDP	Total%	Cutset
	1.52E-6	100	Displaying 1392 of 1392 Cut Sets.
1	2.59E-7	17.1	IE-LOOP,AFW-XHE-XM-CR,CCW-MDP-CF-FSALL,CCW-MDP-RUNA1A2,/OEP-XHE-XL-NR02H
2	2.59E-7	17.1	IE-LOOP,AFW-XHE-XM-CR,CCW-MDP-CF-FSALL,CCW-MDP-RUNB1B2,/OEP-XHE-XL-NR02H
3	1.52E-7	10	IE-LOOP,AFW-TDP-FR-TDP,CCW-MDP-CF-FSALL,CCW-MDP-RUNA1A2,/OEP-XHE-XL-NR02H
4	1.52E-7	10	IE-LOOP,AFW-TDP-FR-TDP,CCW-MDP-CF-FSALL,CCW-MDP-RUNB1B2,/OEP-XHE-XL-NR02H
5	5.62E-8	3.7	IE-LOOP,AFW-TDP-FS-TDP,CCW-MDP-CF-FSALL,CCW-MDP-RUNA1A2,/OEP-XHE-XL-NR02H
6	5.62E-8	3.7	IE-LOOP,AFW-TDP-FS-TDP,CCW-MDP-CF-FSALL,CCW-MDP-RUNB1B2,/OEP-XHE-XL-NR02H
7	4.67E-8	3.07	IE-LOOP,AFW-TDP-TM-TDP,CCW-MDP-CF-FSALL,CCW-MDP-RUNA1A2,/OEP-XHE-XL-NR02H
8	4.67E-8	3.07	IE-LOOP,AFW-TDP-TM-TDP,CCW-MDP-CF-FSALL,CCW-MDP-RUNB1B2,/OEP-XHE-XL-NR02H
9	2.36E-8	1.56	IE-LOOP,AFW-XHE-XM-CR,CCW-MDP-CF-FRALL,CCW-MDP-RUNA1A2,/OEP-XHE-XL-NR02H
10	2.36E-8	1.56	IE-LOOP,AFW-XHE-XM-CR,CCW-MDP-CF-FRALL,CCW-MDP-RUNB1B2,/OEP-XHE-XL-NR02H
11	2.10E-8	1.38	IE-LOOP,ACP-BAC-LP-1ETA,AFW-XHE-XM-CR,CCW-TRN-TM-TRAINB,/OEP-XHE-XL-NR02H

Cutset Report - LOOP 19-75-04

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

#	CCDP	Total%	Cutset
	1.18E-6	100	Displaying 2265 of 2265 Cut Sets.
1	6.50E-8	5.53	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
2	3.81E-8	3.24	IE-LOOP,AFW-TDP-FR-TDP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
3	3.57E-8	3.04	IE-LOOP,AFW-XHE-XM-CR,EPS-FAN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
4	3.11E-8	2.64	IE-LOOP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
5	2.09E-8	1.78	IE-LOOP,AFW-TDP-FR-TDP,EPS-FAN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
6	1.91E-8	1.63	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FS-1B,EPS-DGN-TM-1A,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
7	1.91E-8	1.63	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FS-1A,EPS-DGN-TM-1B,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
8	1.87E-8	1.59	IE-LOOP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-FR-DGN
9	1.71E-8	1.45	IE-LOOP,EPS-FAN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
10	1.67E-8	1.42	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FSU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
11	1.41E-8	1.2	IE-LOOP,AFW-TDP-FS-TDP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-

#	CCDP	Total%	Cutset
			NR01H,/RCS-MDP-LK-BP2
12	1.40E-8	1.19	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A2,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
13	1.40E-8	1.19	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
14	1.40E-8	1.19	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
15	1.40E-8	1.19	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B2,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2

Cutset Report - LOOP 19-02

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

#	CCDP	Total%	Cutset
	1.05E-6	100	Displaying 156 of 156 Cut Sets.
1	1.18E-7	11.2	IE-LOOP,EPS-DGN-FR-1B,EPS-DGN-TM-1A,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
2	1.18E-7	11.2	IE-LOOP,EPS-DGN-FR-1A,EPS-DGN-TM-1B,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
3	1.12E-7	10.6	IE-LOOP,EPS-DGN-CF-FRU1,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H0,/SSF-SBO,/SSF-XHE-XM-SYSLT
4	8.53E-8	8.11	IE-LOOP,EPS-DGN-FR-1A,EPS-DGN-FR-1B,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H2,/SSF-SBO,/SSF-XHE-XM-SYSLT
5	6.14E-8	5.84	IE-LOOP,EPS-FAN-CF-FRU1,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
6	3.29E-8	3.12	IE-LOOP,EPS-DGN-FS-1B,EPS-DGN-TM-1A,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
7	3.29E-8	3.12	IE-LOOP,EPS-DGN-FS-1A,EPS-DGN-TM-1B,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
8	2.86E-8	2.72	IE-LOOP,EPS-DGN-CF-FSU1,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
9	2.40E-8	2.28	IE-LOOP,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B2,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
10	2.40E-8	2.28	IE-LOOP,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A2,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
11	2.40E-8	2.28	IE-LOOP,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B1,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
12	2.40E-8	2.28	IE-LOOP,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A1,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-SYSLT
13	2.38E-8	2.26	IE-LOOP,EPS-DGN-FR-1B,EPS-DGN-FS-1A,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
14	2.38E-8	2.26	IE-LOOP,EPS-DGN-FR-1A,EPS-DGN-FS-1B,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
15	1.74E-8	1.65	IE-LOOP,EPS-DGN-FR-1B,EPS-FAN-FR-EX1A1,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
16	1.74E-8	1.65	IE-LOOP,EPS-DGN-FR-1B,EPS-FAN-FR-EX1A2,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
17	1.74E-8	1.65	IE-LOOP,EPS-DGN-FR-1A,EPS-FAN-FR-EX1B2,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
18	1.74E-8	1.65	IE-LOOP,EPS-DGN-FR-1A,EPS-FAN-FR-EX1B1,OEP-XHE-XL-NR24H,OEP-XHE-XX-NR24H1,/SSF-SBO,/SSF-XHE-XM-SYSLT
19	1.67E-8	1.58	IE-LOOP,EPS-FAN-CF-FSU1,OEP-XHE-XL-NR24H,/SSF-SBO,/SSF-XHE-XM-

#	CCDP	Total%	Cutset
			SYSLT
20	1.63E-8	1.55	IE-LOOP, EPS-DGN-CF-FRU12, OEP-XHE-XL-NR24H, OEP-XHE-XX-NR24H0, /SSF-SBO, /SSF-XHE-XM-SYSLT
21	1.47E-8	1.4	IE-LOOP, EPS-MOV-CF-1RNMOVS, OEP-XHE-XL-NR24H, /SSF-SBO, /SSF-XHE-XM-SYSLT
22	1.09E-8	1.04	IE-LOOP, EPS-DGN-TM-1B, EPS-MOV-CC-1RN232A, OEP-XHE-XL-NR24H, /SSF-SBO, /SSF-XHE-XM-SYSLT
23	1.09E-8	1.04	IE-LOOP, EPS-DGN-TM-1A, EPS-MOV-CC-1RN292B, OEP-XHE-XL-NR24H, /SSF-SBO, /SSF-XHE-XM-SYSLT

Cutset Report - LOOP 02-02-09

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

#	CCDP	Total%	Cutset
	8.46E-7	100	Displaying 600 of 600 Cut Sets.
1	1.73E-7	20.5	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNA1A2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-XHE-XM-SYSL
2	1.73E-7	20.5	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNB1B2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-XHE-XM-SYSL
3	8.39E-8	9.91	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNA1A2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-PDP-FR-SYS
4	8.39E-8	9.91	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNB1B2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-PDP-FR-SYS
5	2.48E-8	2.93	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNB1B2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-DGN-TM-DGN
6	2.48E-8	2.93	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNA1A2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-DGN-TM-DGN
7	1.58E-8	1.86	IE-LOOP, CCW-MDP-CF-FRALL, CCW-MDP-RUNA1A2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-XHE-XM-SYSL
8	1.58E-8	1.86	IE-LOOP, CCW-MDP-CF-FRALL, CCW-MDP-RUNB1B2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-XHE-XM-SYSL
9	1.49E-8	1.77	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNB1B2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-DGN-FR-DGN
10	1.49E-8	1.77	IE-LOOP, CCW-MDP-CF-FSALL, CCW-MDP-RUNA1A2, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-DGN-FR-DGN
11	1.40E-8	1.65	IE-LOOP, ACP-BAC-LP-1ETA, CCW-TRN-TM-TRAINB, /OEP-XHE-XL-NR02H, RCS-MDP-LK-BP2, SSF-XHE-XM-SYSL

Cutset Report - LOOP 19-75-03

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

#	CCDP	Total%	Cutset
	6.27E-7	100	Displaying 1765 of 1765 Cut Sets.
1	1.35E-8	2.15	IE-LOOP, AFW-XHE-XM-CR, NSR-MDP-RUN1A, NSR-MDP-RUN1B, NSR-MOV-CF-RN2838, /OEP-XHE-XL-NR01H, /RCS-MDP-LK-BP2
2	1.35E-8	2.15	IE-LOOP, AFW-XHE-XM-CR, NSR-MDP-RUN1B, NSR-MDP-RUN2A, NSR-MOV-CF-RN2838, /OEP-XHE-XL-NR01H, /RCS-MDP-LK-BP2
3	1.35E-8	2.15	IE-LOOP, AFW-XHE-XM-CR, NSR-MDP-RUN2A, NSR-MDP-RUN2B, NSR-MOV-CF-RN2838, /OEP-XHE-XL-NR01H, /RCS-MDP-LK-BP2
4	1.35E-8	2.15	IE-LOOP, AFW-XHE-XM-CR, NSR-MDP-RUN1A, NSR-MDP-RUN2B, NSR-MOV-CF-RN2838, /OEP-XHE-XL-NR01H, /RCS-MDP-LK-BP2
5	1.12E-8	1.79	IE-LOOP, AFW-XHE-XM-CR, NSR-MDP-CF-FSALL, NSR-MDP-RUN1A, NSR-MDP-RUN1B, /OEP-XHE-XL-NR01H, /RCS-MDP-LK-BP2

#	CCDP	Total%	Cutset
6	1.12E-8	1.79	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN1B,NSR-MDP-RUN2A,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
7	1.12E-8	1.79	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
8	1.12E-8	1.79	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN2A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
9	7.88E-9	1.26	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
10	7.88E-9	1.26	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
11	7.88E-9	1.26	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
12	7.88E-9	1.26	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
13	6.86E-9	1.09	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FR-1B,EPS-DGN-TM-1A,HPI-XHE-XM-RECIRC,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
14	6.86E-9	1.09	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FR-1A,EPS-DGN-TM-1B,HPI-XHE-XM-RECIRC,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
15	6.57E-9	1.05	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN1B,NSR-MDP-RUN2A,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
16	6.57E-9	1.05	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
17	6.57E-9	1.05	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN2A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
18	6.57E-9	1.05	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN1B,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
19	6.50E-9	1.04	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FRU1,HPI-XHE-XM-RECIRC,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2
20	6.44E-9	1.03	IE-LOOP,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
21	6.44E-9	1.03	IE-LOOP,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
22	6.44E-9	1.03	IE-LOOP,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
23	6.44E-9	1.03	IE-LOOP,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,/RCS-MDP-LK-BP2,SSF-DGN-TM-DGN

Cutset Report - LOOP 19-75-10

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

#	CCDP	Total%	Cutset
	2.89E-7	100	Displaying 1236 of 1236 Cut Sets.
1	1.63E-8	5.63	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
2	9.52E-9	3.3	IE-LOOP,AFW-TDP-FR-TDP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
3	8.93E-9	3.09	IE-LOOP,AFW-XHE-XM-CR,EPS-FAN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
4	7.78E-9	2.69	IE-LOOP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
5	5.23E-9	1.81	IE-LOOP,AFW-TDP-FR-TDP,EPS-FAN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2

#	CCDP	Total%	Cutset
6	4.78E-9	1.65	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FS-1B,EPS-DGN-TM-1A,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
7	4.78E-9	1.65	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FS-1A,EPS-DGN-TM-1B,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
8	4.68E-9	1.62	IE-LOOP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-FR-DGN
9	4.27E-9	1.48	IE-LOOP,EPS-FAN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
10	4.16E-9	1.44	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FSU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
11	3.52E-9	1.22	IE-LOOP,AFW-TDP-FS-TDP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
12	3.49E-9	1.21	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A2,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
13	3.49E-9	1.21	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
14	3.49E-9	1.21	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1B,EPS-FAN-FR-EX1A1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
15	3.49E-9	1.21	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-TM-1A,EPS-FAN-FR-EX1B2,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
16	2.92E-9	1.01	IE-LOOP,AFW-TDP-TM-TDP,EPS-DGN-CF-FRU1,HPI-XHE-XM-FB,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2

Cutset Report - LOOP 19-15-12

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

#	CCDP	Total%	Cutset
	2.49E-7	100	Displaying 687 of 687 Cut Sets.
1	1.05E-8	4.22	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
2	1.05E-8	4.22	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
3	1.05E-8	4.22	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
4	1.05E-8	4.22	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
5	8.76E-9	3.51	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN1B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
6	8.76E-9	3.51	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
7	8.76E-9	3.51	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN2A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
8	8.76E-9	3.51	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN1B,NSR-MDP-RUN2A,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
9	5.36E-9	2.15	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-DGN-FR-1B,EPS-DGN-TM-1A,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-XHE-XM-SYSL
10	5.36E-9	2.15	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-DGN-FR-1A,EPS-DGN-TM-1B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-XHE-XM-SYSL
11	5.10E-9	2.04	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
12	5.10E-9	2.04	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS

#	CCDP	Total%	Cutset
13	5.10E-9	2.04	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
14	5.10E-9	2.04	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
15	5.08E-9	2.04	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-DGN-CF-FRU1,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-XHE-XM-SYSL
16	4.25E-9	1.7	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN1B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
17	4.25E-9	1.7	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
18	4.25E-9	1.7	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN2A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
19	4.25E-9	1.7	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-CF-FSALL,NSR-MDP-RUN1B,NSR-MDP-RUN2A,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-PDP-FR-SYS
20	3.87E-9	1.55	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-DGN-FR-1A,EPS-DGN-FR-1B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-XHE-XM-SYSL
21	3.68E-9	1.47	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1A,NSR-MOV-CF-RN1A2A,NSR-TRN-TM-TRAINB,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
22	3.68E-9	1.47	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN2A,NSR-MOV-CF-RN1A2A,NSR-TRN-TM-TRAINB,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
23	3.57E-9	1.43	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-FS-1A,NSR-MDP-RUN1A,NSR-MDP-TM-2A,NSR-TRN-TM-TRAINB,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL
24	2.79E-9	1.12	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-FAN-CF-FRU1,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-XHE-XM-SYSL
25	2.60E-9	1.04	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-DGN-FR-1B,EPS-DGN-TM-1A,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-PDP-FR-SYS
26	2.60E-9	1.04	IE-LOOP,/DCP-XHE-XM-DCSHED,EPS-DGN-FR-1A,EPS-DGN-TM-1B,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,RHR-XHE-XM-RECIRC,SSF-PDP-FR-SYS
27	2.52E-9	1.01	IE-LOOP,/DCP-XHE-XM-DCSHED,NSR-MDP-RUN1A,NSR-MDP-TM-2A,NSR-MOV-CC-1RN28A,NSR-TRN-TM-TRAINB,/OEP-XHE-XL-NR02H,RCS-MDP-LK-BP2,SSF-XHE-XM-SYSL

Cutset Report - LOOP 19-75-09

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

#	CCDP	Total%	Cutset
	1.52E-7	100	Displaying 850 of 850 Cut Sets.
1	3.37E-9	2.21	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
2	3.37E-9	2.21	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
3	3.37E-9	2.21	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
4	3.37E-9	2.21	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
5	2.81E-9	1.84	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN1B,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
6	2.81E-9	1.84	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN1B,NSR-MDP-RUN2A,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2

#	CCDP	Total%	Cutset
7	2.81E-9	1.84	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
8	2.81E-9	1.84	IE-LOOP,AFW-XHE-XM-CR,NSR-MDP-CF-FSALL,NSR-MDP-RUN2A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
9	1.97E-9	1.29	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
10	1.97E-9	1.29	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
11	1.97E-9	1.29	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
12	1.97E-9	1.29	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
13	1.72E-9	1.13	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FR-1B,EPS-DGN-TM-1A,HPI-XHE-XM-RECIRC,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
14	1.72E-9	1.13	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-FR-1A,EPS-DGN-TM-1B,HPI-XHE-XM-RECIRC,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
15	1.64E-9	1.08	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN1B,NSR-MDP-RUN2A,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
16	1.64E-9	1.08	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
17	1.64E-9	1.08	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN2A,NSR-MDP-RUN2B,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
18	1.64E-9	1.08	IE-LOOP,AFW-TDP-FR-TDP,NSR-MDP-CF-FSALL,NSR-MDP-RUN1A,NSR-MDP-RUN1B,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
19	1.63E-9	1.07	IE-LOOP,AFW-XHE-XM-CR,EPS-DGN-CF-FRU1,HPI-XHE-XM-RECIRC,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2
20	1.61E-9	1.06	IE-LOOP,NSR-MDP-RUN2A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
21	1.61E-9	1.06	IE-LOOP,NSR-MDP-RUN1A,NSR-MDP-RUN1B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
22	1.61E-9	1.06	IE-LOOP,NSR-MDP-RUN1A,NSR-MDP-RUN2B,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-TM-DGN
23	1.61E-9	1.06	IE-LOOP,NSR-MDP-RUN1B,NSR-MDP-RUN2A,NSR-MOV-CF-RN2838,/OEP-XHE-XL-NR01H,RCS-MDP-LK-BP2,SSF-DGN-TM-DGN

Referenced Events

Event	Description	Probability
ACP-BAC-LP-1ETA	DIVISION 1A AC POWER 4160V BUS 1ETA FAILS	3.33E-5
AFW-TDP-FR-TDP	AFW TURBINE DRIVEN PUMP FAILS TO RUN (INCLUDING RECOVERY)	1.76E-2
AFW-TDP-FS-TDP	AFW TURBINE DRIVEN PUMP FAILS TO START (INCLUDING RECOVERY)	6.49E-3
AFW-TDP-TM-TDP	AFW TDP UNAVAILABLE DUE TO T/M	5.39E-3
AFW-XHE-XM-CR	OPERATOR FAILS TO THROTTLE AND CONTROL AFW FLOW FROM CONTROL ROOM	3.00E-2
CCW-MDP-CF-FRALL	CCF OF ALL CCWS TO RUN	1.58E-6
CCW-MDP-CF-FSALL	CCF OF ALL CCWS TO START	1.73E-5
CCW-MDP-RUNA1A2	FRACTION OF TIME 1A1 AND 1A2 ARE RUNNING	5.00E-1
CCW-MDP-RUNB1B2	FRACTION OF TIME 1B1 AND 1B2 ARE RUNNING	5.00E-1
CCW-TRN-TM-TRAINB	CCW TRAIN B UNAVAILABLE DUE TO T/M (PSA)	2.10E-2

Event	Description	Probability
EPS-DGN-CF-FRU1	CCF OF UNIT 1 DIESEL GENERATORS TO RUN	1.41E-4
EPS-DGN-CF-FRU12	CCF OF UNIT 1 & 2 DIESEL GENERATORS TO RUN	2.06E-5
EPS-DGN-CF-FSU1	CCF OF UNIT 1 DIESEL GENERATORS TO START	3.61E-5
EPS-DGN-FR-1A	DIESEL GENERATOR 1A FAILS TO RUN	1.04E-2
EPS-DGN-FR-1B	DIESEL GENERATOR 1B FAILS TO RUN	1.04E-2
EPS-DGN-FS-1A	DIESEL GENERATOR 1A FAILS TO START	2.89E-3
EPS-DGN-FS-1B	DIESEL GENERATOR 1B FAILS TO START	2.89E-3
EPS-DGN-TM-1A	DIESEL GENERATOR 1A UNAVAILABLE DUE TO T/M	1.43E-2
EPS-DGN-TM-1B	DIESEL GENERATOR 1B UNAVAILABLE DUE TO T/M	1.43E-2
EPS-FAN-CF-FRU1	CCF OF UNIT DIESEL GENERATOR EXHAUST FANS TO RUN (1A1/1B1)	7.76E-5
EPS-FAN-CF-FSU1	CCF OF UNIT 1 DIESEL GENERATOR EXHAUST FANS TO START (1A1/1B1)	2.11E-5
EPS-FAN-FR-EX1A1	FAILURE OF DIESEL GENERATOR 1A FAN 1A1 TO RUN	2.11E-3
EPS-FAN-FR-EX1A2	FAILURE OF DIESEL GENERATOR 1A FAN 1A2 TO RUN	2.11E-3
EPS-FAN-FR-EX1B1	FAILURE OF DIESEL GENERATOR 1B FAN 1B1 TO RUN	2.11E-3
EPS-FAN-FR-EX1B2	FAILURE OF DIESEL GENERATOR 1B FAN 1B2 TO RUN	2.11E-3
EPS-MOV-CC-1RN232A	FAILURE OF NSR/EPS MOV RN232A TO OPEN	9.63E-4
EPS-MOV-CC-1RN292B	FAILURE OF NSR/EPS MOV 1RN292B TO OPEN	9.63E-4
EPS-MOV-CF-1RNMOVS	CCF OF NSR/EPS MOVS RN232A AND 292B TO OPEN	1.86E-5
EPS-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR	8.71E-1
HPI-XHE-XM-FB	OPERATOR FAILS TO INITIATE FEED AND BLEED COOLING	2.00E-2
HPI-XHE-XM-RECIRC	OPERATOR FAILS TO START HIGH PRESSURE RECIRC	2.00E-3
IE-LOOP	LOSS OF OFFSITE POWER	1.00E+0
NSR-MDP-CF-FSALL	CCF OF ALL NSR MDPS TO START	1.95E-6
NSR-MDP-FS-1A	NSR MDP-1A FAILS TO START	1.36E-3
NSR-MDP-RUN1A	FRACTION OF TIME NSR MDP-1A IS RUNNING	5.00E-1
NSR-MDP-RUN1B	FRACTION OF TIME NSR MDP-1B IS RUNNING	5.00E-1
NSR-MDP-RUN2A	FRACTION OF TIME NSR MDP-2A IS RUNNING	5.00E-1
NSR-MDP-RUN2B	FRACTION OF TIME NSR MDP-2B IS RUNNING	5.00E-1
NSR-MDP-TM-2A	NSR MDP-2A UNAVAILABLE DUE TO T & M	1.32E-2
NSR-MOV-CC-1RN28A	FAILURE OF NSR MDP-1A DISCHARGE MOV RN28A TO OPEN	9.63E-4
NSR-MOV-CF-RN1A2A	CCF OF TRAIN A DISCHARGE MOVS 1RN28A & 2RN28A	1.86E-5
NSR-MOV-CF-RN2838	FAILURE OF NSR MDP DISCHARGE MOVS TO OPEN	2.34E-6
NSR-TRN-TM-TRAINB	NSR TRAIN B UNAVAILABLE DUE TO T & M (PSA)	2.20E-2
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	4.00E-2
OEP-XHE-XL-NR24H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 24 HOURS	1.00E-3
OEP-XHE-XX-NR01H0	CONVOLUTION FACTOR FOR CCF-OPR (1HR AVAIL)	2.26E-1
OEP-XHE-XX-NR01H1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR AVAIL)	2.26E-1
OEP-XHE-XX-NR24H0	CONVOLUTION FACTOR FOR CCF-OPR (24HR AVAIL)	1.00E+0
OEP-XHE-XX-NR24H1	CONVOLUTION FACTOR FOR 1FTR-OPR (24HR AVAIL)	1.00E+0
OEP-XHE-XX-NR24H2	CONVOLUTION FACTOR FOR 2FTR-OPR (24HR AVAIL)	1.00E+0
RCS-MDP-LK-BP2	RCP SEAL STAGE 2 INTEGRITY (BINDING/POPPING OPEN) FAILS	2.00E-1

Event	Description	Probability
RHR-XHE-XM-RECIRC	OPERATOR FAILS TO INITIATE LOW PRESSURE RECIRC	2.00E-3
SSF-DGN-FR-DGN	FAILURE OF SSF DIESEL GENERATOR TO RUN	8.63E-3
SSF-DGN-TM-DGN	SSF DIESEL GENERATOR UNAVAILABLE DUE TO T/M	1.43E-2
SSF-PDP-FR-SYS	FAILURE OF SSF MAKE-UP PDP TRAIN TO RUN	4.85E-2
SSF-XHE-XM-SYSL	OPERATOR FAILS TO START AND ALIGN SSF DURING LOOP	1.00E-1

Appendix B: Key Event Trees

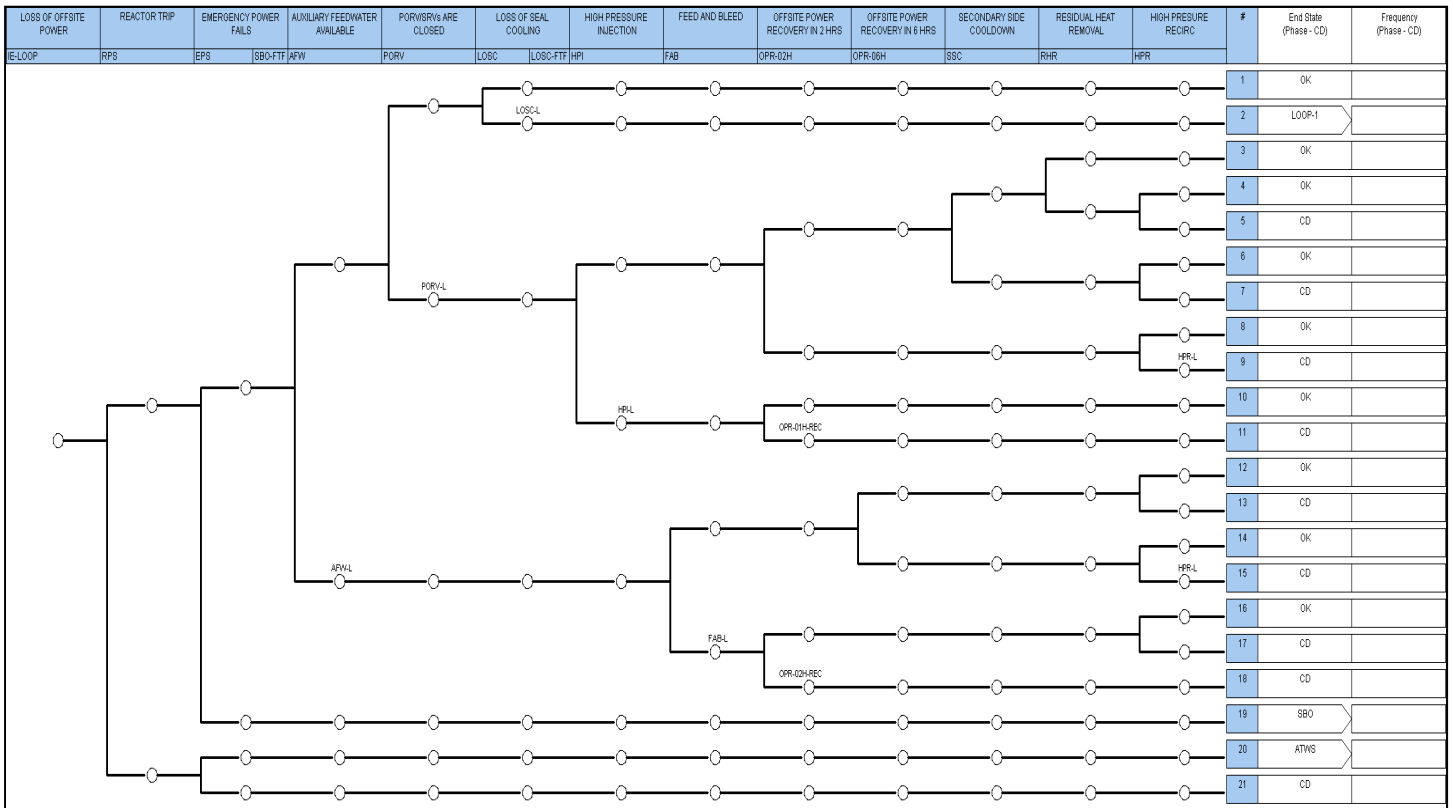


Figure B-1. Catawba Nuclear Station, Unit 1 LOOP event tree.

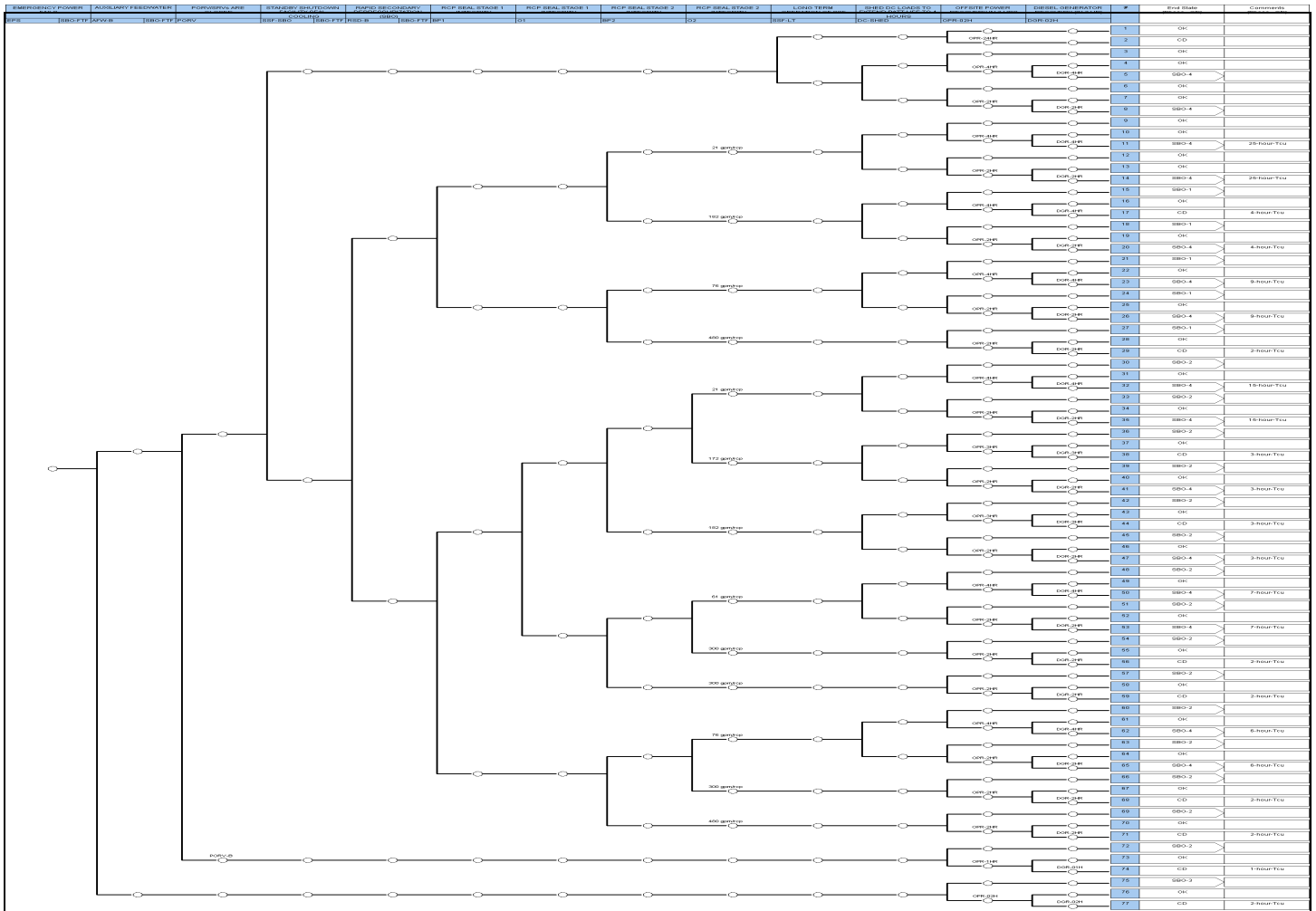


Figure B-2. Catawba Nuclear Station, Unit 1 SBO event tree.