

# ASP Program Analysis - Reject

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research			
<b>Peach Bottom Atomic Power Station, Unit 3</b>		HPCI system inoperable for 17 hours due to flow controller failure	
<b>Event Date:</b> 12/31/2015	<b>LER:</b> 278-2015-001 <b>IR:</b> 05000278/2016001	<b>CCDP</b> = $4 \times 10^{-8}$	
<b>Plant Type:</b> General Electric BWR/4 with a Mark I Containment			
<b>Plant Operating Mode (Reactor Power Level):</b> Mode 1 (100% Reactor Power)			
<b>Analyst:</b> Erulappa Chelliah	<b>Reviewer:</b> David Aird	<b>Contributors:</b> N/A	<b>BC Approved Date:</b> 8/23/2016

## EVENT DETAILS

**Event Description.** On December 31, 2015, at approximately 6:30 a.m., during shift turnover panel walk-downs, an operator identified that flow-controller output indication of the high pressure coolant injection (HPCI) system was showing zero percent. The controller was in automatic mode with the set-point at 5000-gallons per minute, which would typically result in a controller output value of 100%. This discovered condition would have prevented the HPCI system from performing its design safety function in the event of an accident. The operators declared the HPCI system to be inoperable per Technical Specifications (TS) and entered the appropriate action statements of the TS.

The operators observed the controller at 100% at 4:00 a.m. on December 31. It was during the 6:30 a.m. walk-down when the controller was observed showing zero percent. After 2.5 hours of undetected inoperability of the HPCI flow controller, troubleshooting of the HPCI system by the operators determined that a signal converter in the HPCI control circuitry had failed, resulting in the HPCI system not being capable of providing a sufficient flow rate if it had been demanded to mitigate a design basis event.

Then, the licensee took a period of next 14.5 hours at power to replace the failed signal converter of the HPCI flow controller. After a successful replacement of the flow controller, the operators satisfactorily tested the HPCI system and returned the HPCI system to an operable status at approximately 9:10 p.m. The elapsed time from discovery to the time when the system was returned to service was approximately 14 hours and 40 minutes. The maximum period of inoperability is 17 hours and 10 minutes if the controller failed immediately after the 4:00 a.m. walk down.

In summary, the operators were operating the Peach Bottom Unit 3 at power with an inoperable HPCI system for a condition period of approximately 17 hours.

The licensee reported this condition to the USNRC, on December 31, at approximately 1:15 p.m., pursuant to the requirements of 10CFR 50.72(b)(3)(v)(D). The licensee also reported this inoperable condition of the HPCI system, in a licensee event report (LER), in accordance with 10 CFR Part 50.73(a)(2)(v)(D), as an event or condition that could have prevented the fulfillment of the safety function of a system at power to mitigate a design basis hazard event (Reference-1).

**Cause.** The operators found the inoperability cause of the HPCI system to be a prior failure of a signal converter in the HPCI control circuitry. Based on a failure analysis of the failed flow-controller, the operators determined that a transistor inside the signal converter failed. The failure of the signal converter was determined to be a latent manufacturing issue resulting in an infant mortality of the converter.

## MODELING

**Basis for ASP Analysis/SDP Results.** The ASP Program uses Significance Determination Process (SDP) results for degraded conditions when available and applicable. The ASP Program performs independent analyses for initiating events. ASP analyses of initiating events account for all failures/degraded conditions and unavailabilities (e.g., equipment out for test/maintenance) that occurred during the event, regardless of licensee performance.<sup>1</sup> Region I inspectors reviewed the LER and other related information and determined no findings or violations of NRC requirements existed. Region I closed the LER in Inspection Report (IR) 05000278/2016001 (Reference-2).

An independent ASP analysis is required because no SDP analysis was performed for the event. Given that it was a failure/unavailability of a safety system, the risk impact (if any) should be analyzed and documented.

**Analysis Type.** A condition analysis was performed using the Peach Bottom Unit 3 Standardized Plant Analysis Risk (SPAR) model Revision 8.21, created in May 2014.

Using the SAPHIRE8 code, the analyst conducted a condition risk analysis case (see Appendix A) to estimate the increase in core damage probability ( $\Delta$ CDP) due to an as-found inoperability of the HPCI system.

**SPAR Model Modifications.** None

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

- A condition assessment was performed with a duration of 17 hours.
- The probability of basic event HCI-TDP-FS-TRAIN (*HPCI Pump Fails to Start*) was set to 1.0. Setting this basic event to TRUE would have an impact on the common cause probability of other turbine driven pumps in the SPAR model. The analyst determined that other controllers were not susceptible to this failure mode.
- There were no other structures, systems, or components out of service that contributed to this event.

## ANALYSIS RESULTS

**$\Delta$ CDP/Rejection Basis.** The point estimate  $\Delta$ CDP for this event is  $4.4 \times 10^{-8}$ . The ASP Program threshold is a  $\Delta$ CDP of greater than  $1 \times 10^{-6}$ . Therefore, this event is not a precursor and is screened out of the ASP Program.

<sup>1</sup> ASP analyses also account for any degraded condition(s) that were identified after the initiating event occurred if the failure/degradation exposure period(s) overlapped the initiating event date.

**Dominant Sequence.** The dominant accident sequence is LOACB E13 Sequence 62 ( $\Delta\text{CDP} = 9 \times 10^{-9}$ ) that contributes approximately 20% of the total internal events  $\Delta\text{CDP}$ . The cut sets/sequences that contribute to the top 95% and/or at least 1% of the total internal events  $\Delta\text{CDP}$  are provided in Appendix A.

The events and important component/system failures in LOACB E13 Sequence 62 are:

- Loss of 4160V AC Bus E13 occurs (initiating event), and
- Operators fail to perform a manual action associated with depressurizing the reactor.

## REFERENCES

1. Peach Bottom Atomic Power Station Unit 3, "Loss of High Pressure Coolant Injection System Function as a Result of Failed Flow Controller Signal Converter," LER 278-2015-001-00, dated February 26, 2016 (ML16057A011).
2. U. S. Nuclear Regulatory Commission, "Peach Bottom Atomic Power Station, Unit 3 – NRC Integrated Inspection Report 05000278/2016001," dated May 4, 2016 (ML16125A073).

## Appendix A: SAPHIRE 8 Worksheet

### Condition Assessment Summary

Duration	17 hours
CCDP	5.05E-8
CDP	6.55E-9
<b>Δ CDP</b>	<b>4.39E-8</b>

### Summary of Conditional Event Changes

Event	Description	Cond Type	Cond Value	Nominal Type	Nominal Value
HCI-TDP-FS-TRAIN	HPCI PUMP FAILS TO START	1	1.00E+0	1	6.49E-3

### Implied Event Changes as per RASP Guidance

Event	Description	Cond Value	Nominal Value
HCI-TDP-FR-TRAIN	HPCI PUMP TRAIN FAILS TO RUN GIVEN IT STARTED	1.00E+0	3.95E-2
HCI-TDP-TM-TRAIN	HPCI PUMP TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE	True	1.13E-2

### Event Tree Dominant Results

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

<u>EVENT TREE</u>	<u>CCDP</u>	<u>CDP</u>	<u>Δ CDP</u>	<u>DESCRIPTION</u>
LOCHS	1.75E-8	1.58E-9	1.59E-8	PEACH BOTTOM LOSS OF CONDENSER HEAT SINK
LOACB-E13	1.30E-8	1.08E-9	1.19E-8	PEACH BOTTOM LOSS OF AC BUS E13
LOMFW	8.65E-9	7.55E-10	7.90E-9	PEACH BOTTOM LOSS OF MAIN FEEDWATER
LOOPGR	2.31E-9	5.35E-10	1.78E-9	PEACH BOTTOM LOSS OF OFFSITE POWER (GRID-RELATED)
LOIAS	1.92E-9	1.96E-10	1.72E-9	PEACH BOTTOM LOSS INSTRUMENT AIR
LOOPSC	1.84E-9	3.32E-10	1.51E-9	PEACH BOTTOM LOSS OF OFFSITE POWER (SWITCHYARD-CENTERED)
MANSD	1.23E-9	1.60E-10	1.07E-9	PEACH BOTTOM MANUAL SHUTDOWN
TRANS	9.20E-10	2.92E-10	6.28E-10	PEACH BOTTOM GENERAL TRANSIENT
LOOPWR	8.02E-10	2.29E-10	5.73E-10	PEACH BOTTOM LOSS OF OFFSITE POWER (WEATHER-RELATED)
<b>Total</b>	<b>5.05E-8</b>	<b>6.55E-9</b>	<b>4.39E-8</b>	

### Dominant Sequence Results

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

<u>EVENT TREE</u>	<u>SEQUENCE</u>	<u>CCDP</u>	<u>CDP</u>	<u>Δ CDP</u>	<u>DESCRIPTION</u>
LOACB-E13	62	9.72E-9	7.57E-10	8.96E-9	/RPS, /SRV, PCS, HPI, DEP
LOCHS	53	8.71E-9	7.40E-10	7.97E-9	/RPS, /SRV, HPI, DEP
LOCHS	52	8.70E-9	7.38E-10	7.97E-9	/RPS, /SRV, HPI, /DEP, CDS, LPI, VA
LOMFW	59	4.31E-9	3.66E-10	3.95E-9	/RPS, /SRV, HPI, /DEP, CDS, LPI, VA
LOMFW	60	4.31E-9	3.66E-10	3.95E-9	/RPS, /SRV, HPI, DEP

<u>EVENT TREE</u>	<u>SEQUENCE</u>	<u>CCDP</u>	<u>CDP</u>	<u>Δ CDP</u>	<u>DESCRIPTION</u>
LOACB-E13	61	3.24E-9	2.52E-10	2.99E-9	/RPS, /SRV, PCS, HPI, /DEP, CDS, LPI, VA
LOIAS	65	1.41E-9	1.16E-10	1.29E-9	/RPS, /SRV, HPI, DEP
LOOPGR	34	1.14E-9	4.32E-10	7.09E-10	/RPS, /EPS, /SRV, HPI, /DEP, LPI, VA
LOOPGR	35	7.68E-10	6.32E-11	7.05E-10	/RPS, /EPS, /SRV, HPI, DEP
LOOPSC	34	8.49E-10	2.47E-10	6.02E-10	/RPS, /EPS, /SRV, HPI, /DEP, LPI, VA
LOOPSC	35	6.55E-10	5.38E-11	6.01E-10	/RPS, /EPS, /SRV, HPI, DEP
MANS D	62	5.93E-10	5.68E-11	5.36E-10	/RPS, PCS, HPI, DEP
MANS D	61	5.86E-10	5.14E-11	5.35E-10	/RPS, PCS, HPI, /DEP, CDS, LPI, VA
<b>Total</b>		<b>5.05E-8</b>	<b>6.55E-9</b>	<b>4.39E-8</b>	

### Referenced Fault Trees

<u>Fault Tree</u>	<u>Description</u>
CDS	CONDENSATE
DEP	MANUAL REACTOR DEPRESS
HPI	HIGH PRESSURE INJECTION
LPI	LOW PRESSURE INJECTION
PCS	POWER CONVERSION SYSTEM
VA	ALTERNATE LOW PRESS INJECTION

### Cut Set Report - LOACB-E13 62

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

<u>#</u>	<u>PROB/FREQ</u>	<u>TOTAL%</u>	<u>CUT SET</u>
Total	5.01E-6	100	Displaying 2 Cut Sets. (2 Original)
1	3.34E-6	66.69	IE-LOACB-E13,ADS-XHE-XM-ADSBT
2	1.67E-6	33.34	IE-LOACB-E13,ADS-XHE-XM-MDEPR

### Cut Set Report - LOCHS 53

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

<u>#</u>	<u>PROB/FREQ</u>	<u>TOTAL%</u>	<u>CUT SET</u>
	4.49E-6	100	Displaying 32 Cut Sets. (32 Original)
1	2.75E-6	61.15	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-TDP-FR-TRAIN
2	7.61E-7	16.95	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-TDP-TM-TRAIN
3	4.51E-7	10.05	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-TDP-FS-TRAIN
4	2.09E-7	4.64	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
5	1.38E-7	3.08	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
6	6.95E-8	1.55	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-XHE-XO-ERROR
7	6.69E-8	1.49	IE-LOCHS,ADS-XHE-XM-MDEPR,RCI-MOV-CC-INJEC

### Cut Set Report - LOCHS 52

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

<u>#</u>	<u>PROB/FREQ</u>	<u>TOTAL%</u>	<u>CUT SET</u>
	4.48E-6	100	Displaying 23 Cut Sets. (23 Original)
1	2.75E-6	61.22	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-TDP-FR-TRAIN

#	PROB/FREQ	TOTAL%	CUT SET
2	7.61E-7	16.97	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-TDP-TM-TRAIN
3	4.51E-7	10.06	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-TDP-FS-TRAIN
4	2.09E-7	4.65	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
5	1.38E-7	3.09	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
6	6.95E-8	1.55	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-XHE-XO-ERROR
7	6.69E-8	1.49	IE-LOCHS,LPI-XHE-XM-ERROR,RCI-MOV-CC-INJEC

### Cut Set Report - LOMFW 59

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

#	PROB/FREQ	TOTAL%	CUT SET
	2.22E-6	100	Displaying 23 Cut Sets. (23 Original)
1	1.36E-6	61.22	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-TDP-FR-TRAIN
2	3.77E-7	16.97	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-TDP-TM-TRAIN
3	2.24E-7	10.06	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-TDP-FS-TRAIN
4	1.03E-7	4.65	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
5	6.86E-8	3.09	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
6	3.45E-8	1.55	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-XHE-XO-ERROR
7	3.32E-8	1.49	IE-LOMFW,LPI-XHE-XM-ERROR,RCI-MOV-CC-INJEC

### Cut Set Report - LOMFW 60

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

#	PROB/FREQ	TOTAL%	CUT SET
	2.22E-6	100	Displaying 26 Cut Sets. (26 Original)
1	1.36E-6	61.22	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-TDP-FR-TRAIN
2	3.77E-7	16.97	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-TDP-TM-TRAIN
3	2.24E-7	10.06	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-TDP-FS-TRAIN
4	1.03E-7	4.65	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
5	6.86E-8	3.09	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
6	3.45E-8	1.55	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-XHE-XO-ERROR
7	3.32E-8	1.49	IE-LOMFW,ADS-XHE-XM-MDEPR,RCI-MOV-CC-INJEC

### Cut Set Report - LOACB-E13 61

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

#	PROB/FREQ	TOTAL%	CUT SET
Total	1.67E-6	100	Displaying 1 Cut Sets. (1 Original)
1	1.67E-6	100.00	IE-LOACB-E13,LPI-XHE-XM-ERROR

### Cut Set Report - LOIAS 65

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

#	PROB/FREQ	TOTAL%	CUT SET
	7.25E-7	100	Displaying 32 Cut Sets. (32 Original)
1	2.96E-7	40.82	IE-LOIAS,ADS-XHE-XM-ADSBT,RCI-TDP-FR-TRAIN
2	1.48E-7	20.41	IE-LOIAS,ADS-XHE-XM-MDEPR,RCI-TDP-FR-TRAIN

#	PROB/FREQ	TOTAL%	CUT SET
3	8.20E-8	11.31	IE-LOIAS,ADS-XHE-XM-ADSBT,RCI-TDP-TM-TRAIN
4	4.86E-8	6.71	IE-LOIAS,ADS-XHE-XM-ADSBT,RCI-TDP-FS-TRAIN
5	4.10E-8	5.66	IE-LOIAS,ADS-XHE-XM-MDEPR,RCI-TDP-TM-TRAIN
6	2.43E-8	3.35	IE-LOIAS,ADS-XHE-XM-MDEPR,RCI-TDP-FS-TRAIN
7	2.25E-8	3.10	IE-LOIAS,ADS-XHE-XM-ADSBT,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
8	1.49E-8	2.06	IE-LOIAS,ADS-XHE-XM-ADSBT,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
9	1.12E-8	1.55	IE-LOIAS,ADS-XHE-XM-MDEPR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
10	7.49E-9	1.03	IE-LOIAS,ADS-XHE-XM-ADSBT,RCI-XHE-XO-ERROR
11	7.46E-9	1.03	IE-LOIAS,ADS-XHE-XM-MDEPR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER

### Cut Set Report - LOOPGR 34

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

#	PROB/FREQ	TOTAL%	CUT SET
	5.88E-7	100	Displaying 70 Cut Sets. (70 Original)
1	2.41E-7	40.99	IE-LOOPGR,LPI-XHE-XM-ERROR,RCI-TDP-FR-TRAIN
2	1.40E-7	23.82	IE-LOOPGR,CWG-XHE-XL-NR01H,EPS-XHE-XL-NR01H,EPS-XHE-XM-RCOOL,OEP-XHE-XL-NR01HGR
3	6.68E-8	11.36	IE-LOOPGR,LPI-XHE-XM-ERROR,RCI-TDP-TM-TRAIN
4	3.96E-8	6.74	IE-LOOPGR,LPI-XHE-XM-ERROR,RCI-TDP-FS-TRAIN
5	1.83E-8	3.11	IE-LOOPGR,LPI-XHE-XM-ERROR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
6	1.22E-8	2.07	IE-LOOPGR,LPI-XHE-XM-ERROR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
7	1.02E-8	1.73	IE-LOOPGR,CWG-XHE-XL-NR01H,EPS-DGN-FR-DGC,EPS-DGN-TM-DGD,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01HGR,OEP-XHE-XX-NR01HGR1
8	1.02E-8	1.73	IE-LOOPGR,CWG-XHE-XL-NR01H,EPS-DGN-FR-DGD,EPS-DGN-TM-DGC,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01HGR,OEP-XHE-XX-NR01HGR1
9	6.18E-9	1.05	IE-LOOPGR,CWG-XHE-XL-NR01H,EPS-DGN-FR-DGC,EPS-DGN-FR-DGD,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01HGR,OEP-XHE-XX-NR01HGR2
10	6.10E-9	1.04	IE-LOOPGR,LPI-XHE-XM-ERROR,RCI-XHE-XO-ERROR

### Cut Set Report - LOOPGR 35

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

#	PROB/FREQ	TOTAL%	CUT SET
	3.96E-7	100	Displaying 43 Cut Sets. (43 Original)
1	2.41E-7	60.85	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-TDP-FR-TRAIN
2	6.68E-8	16.87	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-TDP-TM-TRAIN
3	3.96E-8	10.00	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-TDP-FS-TRAIN
4	1.83E-8	4.62	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
5	1.22E-8	3.07	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
6	6.10E-9	1.54	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-XHE-XO-ERROR

#	PROB/FREQ	TOTAL%	CUT SET
7	5.87E-9	1.48	IE-LOOPGR,ADS-XHE-XM-MDEPR,RCI-MOV-CC-INJEC

### Cut Set Report - LOOPSC 34

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

#	PROB/FREQ	TOTAL%	CUT SET
	4.38E-7	100	Displaying 64 Cut Sets. (64 Original)
1	2.05E-7	46.94	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-TDP-FR-TRAIN
2	7.28E-8	16.62	IE-LOOPSC,CWG-XHE-XL-NR01H,EPS-XHE-XL-NR01H,EPS-XHE-XM-RCOOL,OEP-XHE-XL-NR01HSC
3	5.69E-8	13.01	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-TDP-TM-TRAIN
4	3.38E-8	7.72	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-TDP-FS-TRAIN
5	1.56E-8	3.56	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
6	1.04E-8	2.37	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
7	5.41E-9	1.24	IE-LOOPSC,CWG-XHE-XL-NR01H,EPS-DGN-FR-DGC,EPS-DGN-TM-DGD,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01HSC,OEP-XHE-XX-NR01HSC1
8	5.41E-9	1.24	IE-LOOPSC,CWG-XHE-XL-NR01H,EPS-DGN-FR-DGD,EPS-DGN-TM-DGC,EPS-XHE-XL-NR01H,OEP-XHE-XL-NR01HSC,OEP-XHE-XX-NR01HSC1
9	5.20E-9	1.19	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-XHE-XO-ERROR
10	5.01E-9	1.14	IE-LOOPSC,LPI-XHE-XM-ERROR,RCI-MOV-CC-INJEC

### Cut Set Report - LOOPSC 35

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

#	PROB/FREQ	TOTAL%	CUT SET
	3.37E-7	100	Displaying 39 Cut Sets. (39 Original)
1	2.05E-7	60.89	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-TDP-FR-TRAIN
2	5.69E-8	16.88	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-TDP-TM-TRAIN
3	3.38E-8	10.01	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-TDP-FS-TRAIN
4	1.56E-8	4.62	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
5	1.04E-8	3.07	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
6	5.20E-9	1.54	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-XHE-XO-ERROR
7	5.01E-9	1.48	IE-LOOPSC,ADS-XHE-XM-MDEPR,RCI-MOV-CC-INJEC

### Cut Set Report - MANSD 62

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

#	PROB/FREQ	TOTAL%	CUT SET
	3.06E-7	100	Displaying 112 Cut Sets. (112 Original)
1	1.08E-7	35.30	IE-MANSD,ADS-XHE-XM-MDEPR,MSS-TBV-CC-BYPAS,RCI-TDP-FR-TRAIN
2	2.99E-8	9.78	IE-MANSD,ADS-XHE-XM-MDEPR,MSS-TBV-CC-BYPAS,RCI-TDP-TM-TRAIN
3	2.57E-8	8.40	IE-MANSD,ADS-XHE-XM-MDEPR,PCS-XHE-XO-ERROR,RCI-TDP-FR-TRAIN
4	2.44E-8	7.99	IE-MANSD,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP1,RCI-TDP-FR-TRAIN



#	PROB/FREQ	TOTAL%	CUT SET
5	2.44E-8	7.99	IE-MANSD,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP2,RCI-TDP-FR-TRAIN
6	1.77E-8	5.80	IE-MANSD,ADS-XHE-XM-MDEPR,MSS-TBV-CC-BYPAS,RCI-TDP-FS-TRAIN
7	8.19E-9	2.68	IE-MANSD,ADS-XHE-XM-MDEPR,MSS-TBV-CC-BYPAS,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
8	7.12E-9	2.33	IE-MANSD,ADS-XHE-XM-MDEPR,PCS-XHE-XO-ERROR,RCI-TDP-TM-TRAIN
9	6.77E-9	2.22	IE-MANSD,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP2,RCI-TDP-TM-TRAIN
10	6.77E-9	2.22	IE-MANSD,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP1,RCI-TDP-TM-TRAIN
11	5.44E-9	1.78	IE-MANSD,ADS-XHE-XM-MDEPR,MSS-TBV-CC-BYPAS,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
12	4.22E-9	1.38	IE-MANSD,ADS-XHE-XM-MDEPR,PCS-XHE-XO-ERROR,RCI-TDP-FS-TRAIN
13	4.01E-9	1.31	IE-MANSD,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP1,RCI-TDP-FS-TRAIN
14	4.01E-9	1.31	IE-MANSD,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP2,RCI-TDP-FS-TRAIN

### Cut Set Report - MANSD 61

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

#	PROB/FREQ	TOTAL%	CUT SET
	3.02E-7	100	Displaying 88 Cut Sets. (88 Original)
1	1.08E-7	35.70	IE-MANSD,LPI-XHE-XM-ERROR,MSS-TBV-CC-BYPAS,RCI-TDP-FR-TRAIN
2	2.99E-8	9.90	IE-MANSD,LPI-XHE-XM-ERROR,MSS-TBV-CC-BYPAS,RCI-TDP-TM-TRAIN
3	2.57E-8	8.50	IE-MANSD,LPI-XHE-XM-ERROR,PCS-XHE-XO-ERROR,RCI-TDP-FR-TRAIN
4	2.44E-8	8.08	IE-MANSD,CDS-AOV-CC-MKUP2,LPI-XHE-XM-ERROR,RCI-TDP-FR-TRAIN
5	2.44E-8	8.08	IE-MANSD,CDS-AOV-CC-MKUP1,LPI-XHE-XM-ERROR,RCI-TDP-FR-TRAIN
6	1.77E-8	5.87	IE-MANSD,LPI-XHE-XM-ERROR,MSS-TBV-CC-BYPAS,RCI-TDP-FS-TRAIN
7	8.19E-9	2.71	IE-MANSD,LPI-XHE-XM-ERROR,MSS-TBV-CC-BYPAS,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT
8	7.12E-9	2.36	IE-MANSD,LPI-XHE-XM-ERROR,PCS-XHE-XO-ERROR,RCI-TDP-TM-TRAIN
9	6.77E-9	2.24	IE-MANSD,CDS-AOV-CC-MKUP2,LPI-XHE-XM-ERROR,RCI-TDP-TM-TRAIN
10	6.77E-9	2.24	IE-MANSD,CDS-AOV-CC-MKUP1,LPI-XHE-XM-ERROR,RCI-TDP-TM-TRAIN
11	5.44E-9	1.80	IE-MANSD,LPI-XHE-XM-ERROR,MSS-TBV-CC-BYPAS,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
12	4.22E-9	1.40	IE-MANSD,LPI-XHE-XM-ERROR,PCS-XHE-XO-ERROR,RCI-TDP-FS-TRAIN
13	4.01E-9	1.33	IE-MANSD,CDS-AOV-CC-MKUP2,LPI-XHE-XM-ERROR,RCI-TDP-FS-TRAIN

#	PROB/FREQ	TOTAL%	CUT SET
14	4.01E-9	1.33	IE-MANSD,CDS-AOV-CC-MKUP1,LPI-XHE-XM-ERROR,RCI-TDP-FS-TRAIN

### Referenced Events

Event	Description	Probability
ADS-XHE-XM-ADSBT	OPERATOR FAILS TO VALVE IN ADS NITROGEN BOTTLE BANK	1.00E-3
ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR	5.00E-4
CDS-AOV-CC-MKUP1	MAKEUP PATH 1 FAILS	9.51E-4
CDS-AOV-CC-MKUP2	MAKEUP PATH 2 FAILS	9.51E-4
CWG-XHE-XL-NR01H	OPERATOR FAILS TO ESTABLISH CONOWINGO TIE LINE SETUP IN 1 HOUR	2.00E-2
EPS-DGN-FR-DGC	DIESEL GENERATOR C FAILS TO RUN	3.01E-2
EPS-DGN-FR-DGD	DIESEL GENERATOR D FAILS TO RUN	3.01E-2
EPS-DGN-TM-DGC	DG C IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.43E-2
EPS-DGN-TM-DGD	DG D IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.43E-2
EPS-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HR	8.71E-1
EPS-XHE-XM-RCOOL	OPERATOR FAILS TO ESTABLISH ROOM COOLING W/OUT EHV	1.00E-3
IE-LOACB-E13	LOSS OF 4160 VAC BUS E13 (30A15)	3.34E-3
IE-LOCHS	LOSS OF CONDENSER HEAT SINK	1.39E-1
IE-LOIAS	LOSS OF INSTRUMENT AIR	7.49E-3
IE-LOMFW	LOSS OF FEEDWATER	6.89E-2
IE-LOOPGR	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	1.22E-2
IE-LOOPSC	LOOP INITIATOR (SWITCHYARD-CENTERED)	1.04E-2
IE-MANSD	MANUAL SHUTDOWN	1.30E+0
LPI-XHE-XM-ERROR	OPERATOR FAILS TO CONTROL LOW PRESSURE INJECTION	5.00E-4
MSS-TBV-CC-BYPAS	TURBINE BYPASS VALVES FAIL TO OPEN	4.20E-3
OEP-XHE-XL-NR01HGR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (GRID-RELATED)	6.59E-1
OEP-XHE-XL-NR01HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (SWITCHYARD)	4.01E-1
OEP-XHE-XX-NR01HGR1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-GR AVAIL)	1.68E-1
OEP-XHE-XX-NR01HGR2	CONVOLUTION FACTOR FOR 2FTR-OPR (1HR-GR AVAIL)	4.88E-2
OEP-XHE-XX-NR01HSC1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR-SC AVAIL)	1.72E-1
PCS-XHE-XO-ERROR	OPERATOR FAILS TO MAINTAIN FEEDWATER INJECTION	1.00E-3
RCI-MOV-CC-INJEC	RCIC INJECTION VALVE CAUSES FAILURE TO START	9.63E-4
RCI-MOV-FC-XFER	RCIC FAILS TO TRANSFER DURING RECIRCULATION	7.97E-3
RCI-RESTART	RESTART OF RCIC IS REQUIRED	1.50E-1
RCI-TDP-FR-TRAIN	RCIC PUMP FAILS TO RUN GIVEN THAT IT STARTED	3.95E-2
RCI-TDP-FS-RSTRT	RCIC FAILS TO RESTART GIVEN START AND SHORT-TERM RUN	8.00E-2
RCI-TDP-FS-TRAIN	RCIC PUMP FAILS TO START	6.49E-3
RCI-TDP-TM-TRAIN	RCIC PUMP TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.09E-2
RCI-XHE-XL-RSTRT	OPERATOR FAILS TO RECOVER RCIC FAILURE TO RESTART	2.50E-1
RCI-XHE-XL-XFER	OPERATOR FAILS TO RECOVER SUCTN XFER FAILURE	2.50E-1
RCI-XHE-XO-ERROR	OPERATOR FAILS TO START/CONTROL RCIC INJECTION	1.00E-3