

Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

| | | | |
|--|---|----------------------|--------------------|
| Browns Ferry Nuclear Plant, Units 1, 2, & 3 | Loss of Normal Offsite Power Due to Switchyard Damage Caused by a Tornado | | |
| Event Date: 04/27/2011 | LERs: 259/11-001, -002-01, -003-01, -005, and 259/12-006-01 | Unit 1 CCDP = | 1×10 ⁻⁵ |
| | IRs: 50-259/11-03 and -04 | Unit 2 CCDP = | 1×10 ⁻⁵ |
| | | Unit 3 CCDP = | 1×10 ⁻⁵ |

EVENT SUMMARY

At-Power Event Description. On April 27, 2011, at 16:36, severe weather in the Tennessee Valley Service Area caused grid instability and loss of all 500kV offsite power sources that resulted in automatic scrams of all three units. All three units were in Mode 1 at the time of the event. All scram systems were actuated, and all required systems started and functioned successfully with the exception of an indeterminate position indication for the Unit 3 inboard Main Steam Isolation Valve (MSIV) B. All onsite safe shutdown equipment was available with the exception of the Emergency Diesel Generator (EDG) 3B, which was unavailable due to planned maintenance. All three units immediately entered Mode 3 (Hot Shutdown) with their respective 4kV shutdown boards supplied by seven out of eight of the onsite EDGs. On May 2, at approximate 20:50, the Notice of Unusual Event was terminated following restoration of qualified offsite power sources to all eight 4kV shutdown boards.

In addition to the loss of offsite power event on April 27th, two loss of shutdown cooling (SDC) events occurred on April 28th (Units 1 and 2) and May 2nd (Unit 1). Additional details of these events are provided in Appendix C and References 1–5.

Sequence of Key Events. The following table provides a sequence of key events:

| Date | Time | Event Description |
|----------------|-------|--|
| April 27, 2011 | 14:01 | Operations personnel were notified that BFN was under a Tornado Warning. The actions of Procedure 0-A01-107, "Severe Weather," were addressed. |
| | 16:36 | Loss of all 500kV offsite power sources. All Units automatically scram and 7 of 8 EDGs started and loaded to their respective 4kV shutdown boards. EDG 3B was unavailable due to planned maintenance. The 161kV offsite power (Athens) source remained available, but was not used until May 2 nd . |
| | 17:01 | BFN declared a Notification of Unusual Event, due to the loss of normal and alternate supply voltage to all unit-specific 4-kV shutdown boards. |
| April 28, 2011 | 02:43 | Unit 3 entered Mode 4 (Cold Shutdown). |
| | 05:45 | Unit 2 entered Mode 4 (Cold Shutdown). |
| | 13:37 | Unit 1 entered Mode 4 (Cold Shutdown). |
| | 23:30 | EDG C governor hydraulic oil piping leak observed by operations personnel. Maintenance personnel notified to prepare to add oil. Operations personnel prepared to switch from RHR pumps. |

| Date | Time | Event Description |
|----------------|-------|---|
| | 23:38 | Operations personnel performed emergency shutdown of EDG C due to hydraulic oil piping leak on governor. SDC lost to Unit 1 and Unit 2. Unit 1 SDC was lost due to the loss of power to 4kV Shutdown Board C (which was being powered by the EDG C) de-energized and resulted in a loss of power to the RPS Train B causing a PCIS actuation. Unit 2 SDC was lost because the running RHR Pump 2B lost power. |
| | 23:42 | Unit 2 SDC was restored by starting RHR Pump 2D. |
| April 29, 2011 | 00:25 | Unit 1 SDC was restored by resetting PCIS signal and establishing SDC. |
| April 30, 2011 | 10:47 | EDG C was declared operable after replacement of failed hydraulic oil piping fitting and successful post maintenance testing. |
| May 2, 2011 | 06:26 | The output breaker of the EDG A tripped and power was lost to 4kV Shutdown Board A, causing a loss of Unit 1 SDC. Received half-scam (due to loss of RPS A) and PCIS Group 2, 3, 6, and 8 signals. |
| | 06:43 | Power was restored to 4kV Shutdown Board A from the 161kV offsite power source. |
| | 06:52 | Half-scam and PCIS signals were reset. |
| | 07:23 | Unit 1 SDC restored. |
| | 20:10 | All shutdown boards were powered from two qualified 161kV offsite power sources, and all EDGs were secured and in standby readiness. |

Additional Event Information. The following event details are provided as additional information about the event. This additional information was not factored in the modeling of this analysis due to the negligible risk impact.

- On April 27, 2011, at 2120 hours, the Unit 1 reactor water level system generated a low reactor water level scram due to a distracted operations crew allowing reactor water level to lower below +2 inches (Level 3). At the time of this event, the reactor core isolation cooling (RCIC) and control rod drive (CRD) pumps were injecting to the vessel and the reactor level band specified was +2 to +51 inches. A valid containment isolation signal was received and Groups 2, 3, 6, and 8 isolated as expected. Water level was immediately restored to the specified band using RCIC and the CRD System. See Reference 6 for further details.
- On April 19, 2012, the Unit 1, high-pressure coolant injection (HPCI) system was declared inoperable for the performance of surveillance procedure when technicians attempted to trip the HPCI turbine using the manual trip pushbutton, the HPCI turbine failed to trip. The manual trip pushbutton was pressed four times with no results. The turbine stop valve was disassembled and it was determined that the valve disc was bound to valve cover guide. The valve disc was determined to be damaged by repeated contact with the upper lip of the valve cover guide (the valve is not designed for this contact). The cause of the contact was determined to be due to incorrect adjustment of the gaps between the actuator stem valve stem. Damage to the valve was occurring since the adjustment was made in December 2008; therefore, the valve was degraded during the LOOP event on April 27, 2011. The licensee performed an operability evaluation on the valve and determined that the valve was successfully stroked 82 times after the May 30, 2011, when the valve took 45 seconds to close during testing. Therefore, it was determined that if RCIC had failed during the LOOP and plant depressurization was not available (either through operator error or hardware

failure), the turbine stop valve would have properly cycled to control reactor water level for the entire 24-hour mission time.

ANALYSIS RESULTS

Conditional Core Damage Probabilities. The point estimate conditional core damage probabilities (CCDP) for this event analysis for Units 1, 2, and 3 are 1.1×10^{-5} , 1.1×10^{-5} , and 1.3×10^{-5} , respectively.

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. These CCDP equivalents for Browns Ferry are 4×10^{-6} (Unit 1), 3×10^{-6} (Unit 2), and 9×10^{-7} (Unit 3).

Dominant Sequences for the At-Power Analysis. The dominant accident sequence is LOOPWR (*Loss of Offsite Power—Weather-related*) Sequence 28-18 for all Units 1, 2 and 3. It contributes 44% (6.4×10^{-6}) of the Unit 1 total internal events CCDP; 43% (4.6×10^{-6}) of the Unit 2 total internal events CCDP; 36% (4.6×10^{-6}) of the Unit 3 total internal events CCDP. 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 LOOPWR Sequence 28-18 are:

- Weather-related LOOP occurs,
- Reactor scram succeeds,
- Emergency power fails,
- Closure of safety relief valves succeeds,
- Recirculation pump seal integrity is preserved,
- RCIC succeeds,¹
- Extended operation of emergency core cooling system fails,
- Manual depressurization fails,
- Recovery offsite power in 4 hours fails, and
- Recovery of an EDG in 4 hours fails.

Result Tables. Appendix A provides tables that include the following:

- Modified basic events and initiating event frequencies, including base and change case probabilities/frequencies.
- Dominant sequences (including CCDPs).
- Sequence logic for all dominant sequences.
- Fault tree definitions.
- Sequence cutsets.
- Definitions and probabilities for key basic events.

¹ In the dominant LOOPWR Sequence 28-18, RCIC initially succeeds, but the pump is assumed to fail if the batteries deplete due to the operators failing to recover either offsite power or an EDG to a safety bus.

MODELING ASSUMPTIONS

Analysis Type. The individual SPAR models for Browns Ferry Unit 1 (Revision 8.22), Unit 2 (Revision 8.22), and Unit 3 (Revision 8.18) were used for this event analysis. This event was modeled as a weather-related LOOP initiating event at all three units.

The losses of SDC on April 28th (Units 1 and 2) and May 2nd (Unit 1) were determined to have relatively insignificant risk impact when compared to the CCDPs of the at-power LOOP initiating event (i.e., the first 24 hours of the event). Therefore, a sensitivity analysis showing the results of a Unit 1 loss of SDC (a representative case for both losses of SDC) is provided in Appendix C.

Modeling Assumptions. The following modeling assumptions were determined to be vital to this event analysis:

- This analysis models the April 27, 2011 multi-unit reactor trip at Browns Ferry, Units 1, 2, and 3 as weather-related LOOP initiating events.
- The 161kV offsite power source was available to supply power to the site's eight 4kV shutdown boards throughout the event.

Basic Event Probability Changes. The following initiating event frequencies and basic event probabilities were modified for the at-power analysis (i.e., the first 24 hours of the LOOP) for all Units 1, 2 and 3 in this event analysis:

- The weather-related LOOP initiating event probability (*IE-LOOPWR*) was set to 1.0. All other initiating events' probabilities were set to zero.
- The house event, HE-LOOP-WR (Loss of Offsite Power IE Has Occurred—Weather-Related), was set to TRUE for this weather related LOOP event.
- The basic event OEP-VCF-LP-SITEWR (*Weather-Related Site LOOP*) was set to TRUE, since the LOOP affected all three units.
- EDG 3B was not available during the event due to planned maintenance. Therefore, basic event EDG-DGN-TM-DG3B (*EDG 3B is Unavailable Due to Test or Maintenance*) was set to TRUE.
- Power recovery to the site's eight 4kV shutdown boards was available from the 161kV offsite power source throughout the event. Therefore, the non-recovery probabilities for the basic events OEP-XHE-XL-NR30MWR (*Operator Fail to Recover Offsite Power in 30 minutes—Weather-related*), OEP-XHE-XL-NR01HWR (*Operator Fail to Recover Offsite Power in 1 hour—Weather-related*), OEP-XHE-XL-NR04HWR (*Operator Fail to Recover Offsite Power in 4 hours—Weather-related*), OEP-XHE-XL-NR10HWR (*Operator Fail to Recover Offsite Power in 10 hours—Weather-related*), and OEP-XHE-XL-NR12HWR (*Operator Fail to Recover Offsite Power in 12 hours—Weather-related*) were adjusted based on the SPAR-H guidance (References 7 and 8).
 - *Description and Event Context*– Recovery of offsite power to the site's eight 4kV shutdown boards was possible almost immediately after the event occurred. Operators

could restore offsite power to the 4kV Shutdown Boards A, B, C, and D for Units 1 and 2; 3EA and 3EB for Unit 3 through the Athens 161kV offsite power source.

- *Operator Action Success Criteria*– The restoration of electrical power from the 161kV switchyard system to the 4kV shutdown boards is performed manually by the main control room (MCR) operators.
- *Cues*– The availability of the offsite power is communicated to the MCR operators via the load dispatcher. The operators have voltage and load indications of the offsite power sources in the MCR.
- *Procedural Guidance*– Abnormal Operating Instruction (AOI)-57 provides guidance on loss of offsite power and its restoration.
- *Diagnosis/Action*– These human failure events (HFEs) contain sufficient diagnosis activities. The nominal action component of the human error probabilities (HEPs) is 0.001. No event information is available to warrant a change in the action performance shaping factors (PSFs) for these HEPs. The table below shows the PSFs that were adjusted; all other PSFs were determined to be *Nominal* (i.e., ×1).
- Based on the adjusted PSFs, the following HEPs were recalculated:
 - Basic event OEP-XHE-XL-NR30MWR was set to 4.1×10^{-2} .
 - Basic event OEP-XHE-XL-NR01HWR was set to 5.0×10^{-3} .
 - Basic events OEP-XHE-XL-NR04HWR, OEP-XHE-XL-NR10HWR, and OEP-XHE-XL-NR12HWR were set to 1.4×10^{-3} .

| PSF | Multiplier | Notes |
|----------------|----------------|---|
| Time Available | 1 / 0.1 / 0.01 | The recovery of offsite power was possible almost immediately after the LOOP occurred; therefore, a minimum of 30 minutes was available for operators to recover power to a safety bus during a postulated SBO. Since the action time required to recover power to a safety bus is minimal (<5 minutes), the minimum time for diagnosis is approximately 25 minutes. Therefore, available time for OEP-XHE-XL-NR30MWR is assigned as <i>Nominal</i> (i.e., ×1). Available time for OEP-XHE-XL-NR01HWR is assigned as <i>Extra Time</i> (i.e., ×0.1; time available is 1 to 2 times nominal and > 30 minutes). Available time for OEP-XHE-XL-NR04HWR, OEP-XHE-XL-NR10HWR, and OEP-XHE-XL-NR12HWR were assigned as <i>Expansive Time</i> (i.e., ×0.01; time available >2 times nominal and >30 minutes). |
| Stress | 2 | The PSF for diagnosis stress is assigned a value of <i>High Stress</i> (i.e., ×2) for all offsite power recovery actions due to the postulated SBO. |
| Complexity | 2 | The PSF for diagnosis complexity is assigned a value of <i>Moderately Complex</i> (i.e., ×2) for all offsite power recovery actions because operators would have to deal with multiple equipment unavailabilities and concurrent actions with multiple procedures. |

REFERENCES

1. Browns Ferry Nuclear Plant Unit 1, "LER 259/11-001, Three-Unit Scram Caused by Loss of All 500-kV Offsite Power Sources", dated June 27, 2011 (ML11180A056).
2. Browns Ferry Nuclear Plant Unit 1, "LER 259/11-002-01, Loss of Safety Function (SDC) Resulting from Loss of Power from C EDG Due to Oil Leak," dated March 21, 2012 (ML12083A194).
3. Browns Ferry Nuclear Plant Unit 1, "LER 259/11-003-01, Loss of Safety Function (SDC) Resulting from Emergency Diesel Generator Output Breaker Trip," dated December 21, 2011 (ML11363A057).
4. U.S. Nuclear Regulatory Commission, "Browns Ferry Nuclear Plant - NRC Integrated Inspection Report 05000259/2011003, 05000260/2011003, and 05000296/2011003," dated August 8, 2011 (ML112210368).
5. U.S. Nuclear Regulatory Commission, "Browns Ferry Nuclear Plant - NRC Integrated Inspection Report 05000259/2011004, 05000260/2011004, and 05000296/2011004," dated November 14, 2011 (ML113180503).
6. Browns Ferry Nuclear Plant Unit 1, "LER 259/11-005, Reactor Water Level Scram due to Distracted Operations Crew," dated June 27, 2011 (ML11180A007).
7. Browns Ferry Nuclear Plant Unit 1, "LER 259/12-006-01, High Pressure Coolant Injection System Turbine Failed to Trip Using the Manual Trip Pushbutton," dated July 18, 2012 (ML12202A001).
8. Idaho National Laboratory, "NUREG/CR-6883, SPAR-H Human Reliability Analysis Method," August 2005 (ML051950061).
9. Idaho National Laboratory, "INL/EXT-10-18533, SPAR-H Step-by-Step Guidance," May 2011 (ML112060305).

Appendix A: Analysis Results

Unit 1

Summary of Conditional Event Changes

| Event | Description | Cond. Value | Nominal Value |
|------------------------|---|-------------|---------------|
| EPS-DGN-TM-DG3B | DG B IS UNAVAILABLE BECAUSE OF MAINTENANCE | TRUE | 1.43E-2 |
| HE-LOOPWR | HOUSE EVENT - LOSS OF OFFSITE POWER IE HAS OCCURRED (WEATHER-RELATED) | TRUE | FALSE |
| IE-LOOPWR ^a | LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED) | 1.00E+0 | 3.91E-3 |
| OEP-VCF-LP-SITEWR | SITE LOOP (WEATHER-RELATED) | TRUE | 6.92E-1 |
| OEP-XHE-XL-NR01HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (WEATHER-RELATED) | 5.00E-3 | 6.87E-1 |
| OEP-XHE-XL-NR04HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (WEATHER-RELATED) | 1.40E-3 | 4.24E-1 |
| OEP-XHE-XL-NR10HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 10 HOURS (WEATHER-RELATED) | 1.40E-3 | 2.62E-1 |
| OEP-XHE-XL-NR12HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 12 HOURS (WEATHER-RELATED) | 1.40E-3 | 2.33E-1 |
| OEP-XHE-XL-NR30MWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 30 MINUTES (WEATHER-RELATED) | 4.10E-2 | 7.96E-1 |

a. All other initiating event probabilities were set to zero.

Implied Event Changes as per RASP Guidance

| Event | Description | Cond. Value | Nominal Value |
|-------------------|--|-------------|---------------|
| EPS-DGN-FR-DG3B | DIESEL GENERATOR 3B FAILS TO RUN | 1.00E+0 | 2.85E-2 |
| EPS-DGN-FS-DG3B | DIESEL GENERATOR 3B FAILS TO START | 1.00E+0 | 2.89E-3 |
| EPS-DGN-CF-3RUN | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 1.22E-4 | 5.93E-5 |
| EPS-DGN-CF-3START | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO START | 8.01E-6 | 4.75E-6 |

Dominant Sequence Results

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

| Event Tree | Sequence | CCDP | % Contribution | Description |
|--------------|----------|----------------|----------------|--|
| LOOPWR | 28-18 | 4.60E-6 | 43.9% | /RPS, EPS, /SRV, /RPSL, /RCI01, EXT, DEP01, OPR-04H, DGR-04H |
| LOOPWR | 25 | 2.80E-6 | 26.8% | /RPS, /EPS, /SRV, HPI, DEP |
| LOOPWR | 06 | 8.93E-7 | 8.5% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, CVS, LI |
| LOOPWR | 04 | 7.12E-7 | 6.8% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, /CVS, LI01 |
| LOOPWR | 28-34-3 | 4.59E-7 | 4.4% | /RPS, EPS, /SRV, RPSL, /RCI01, OPR-04H, DGR-04H |
| LOOPWR | 13 | 3.32E-7 | 3.2% | /RPS, /EPS, /SRV, /HPI, SPC, DEP |
| LOOPWR | 28-30 | 2.76E-7 | 2.6% | /RPS, EPS, /SRV, /RPSL, RCI01, /HCI01, DEP01, OPR-04H, DGR-04H |
| Total | | 1.05E-5 | 100% | |

Referenced Fault Trees

| Fault Tree | Description |
|------------|------------------------|
| CVS | CONTAINMENT VENTING |
| DEP | MANUAL REACTOR DEPRESS |

| Fault Tree | Description |
|------------|---|
| DEP01 | MANUAL REACTOR DEPRESS |
| DGR-04H | OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS |
| EPS | EMERGENCY POWER |
| EXT | ACTIONS TO EXTEND ECCS OPERATION |
| HPI | HIGH PRESSURE INJECTION (RCIC or HPCI) |
| LI | LATE INJECTION |
| LI01 | BROWNS FERRY 1 LATE INJECTION |
| OPR-04H | OFFSITE POWER RECOVERY IN 4 HRS |
| RCI01 | RCIC |
| RHR | LOSS OF RESIDUAL HEAT REMOVAL SYSTEM |
| RPSL | RECIRC PUMP SEAL INTEGRITY |
| SPC | SUPPRESSION POOL COOLING |

Cutset Report - LOOPWR 28-18

| # | CCDP | Total % | Cutset |
|---|---------|---------|--------------------------------|
| | 4.60E-6 | 100 | Displaying 186 of 186 Cutsets. |
| 1 | 4.57E-6 | 99.4 | IE-LOOPWR,RSW-STR-CF-ALL |

Cutset Report - LOOPWR 25

| # | CCDP | Total % | Cutset |
|----|---------|---------|--|
| | 2.81E-6 | 100 | Displaying 194 of 194 Cutsets. |
| 1 | 7.86E-7 | 28 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |
| 2 | 3.57E-7 | 12.7 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-TRAIN |
| 3 | 2.25E-7 | 8.01 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-TDP-FR-TRAIN |
| 4 | 2.17E-7 | 7.74 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-TM-TRAIN |
| 5 | 1.43E-7 | 5.11 | IE-LOOPWR,ADS-XHE-XM-MDEPR1,HPI-XHE-XL-LVL8,HPI-XHE-XO-ERROR |
| 6 | 1.29E-7 | 4.59 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-FS-TRAIN |
| 7 | 1.29E-7 | 4.59 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-TDP-FR-TRAIN |
| 8 | 9.86E-8 | 3.51 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-TM-TRAIN |
| 9 | 5.95E-8 | 2.12 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT |
| 10 | 5.84E-8 | 2.08 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FS-TRAIN |
| 11 | 3.95E-8 | 1.41 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER |
| 12 | 3.68E-8 | 1.31 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-TDP-FS-TRAIN |
| 13 | 3.55E-8 | 1.27 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-TDP-TM-TRAIN |

Cutset Report - LOOPWR 06

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 8.93E-7 | 100 | Displaying 979 of 979 Cutsets. |
| 1 | 5.00E-7 | 56 | IE-LOOPWR,CVS-XHE-XM-VENT,RHR-XHE-XM-ERROR |
| 2 | 1.08E-7 | 12 | IE-LOOPWR,DCP-BDC-TM-RMOV1B,RHR-XHE-XM-ERROR |
| 3 | 1.08E-7 | 12 | IE-LOOPWR,DCP-BDC-TM-RMOV1A,RHR-XHE-XM-ERROR |
| 4 | 1.42E-8 | 1.59 | IE-LOOPWR,DCP-XHE-XM-1ABC,EPS-DGN-FR-DG3A,RHR-XHE-XM-ERROR |

Cutset Report - LOOPWR 04

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 7.12E-7 | 100 | Displaying 1512 of 1512 Cutsets. |
| 1 | 5.00E-7 | 70.3 | IE-LOOPWR,OPR-XHE-XM-LI01,RHR-XHE-XM-ERROR |

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| 2 | 1.84E-8 | 2.58 | IE-LOOPWR,CRD-MDP-TM-TRNB,CRD-SYS-FC-ARUN,RSW-MDP-CF-RUN |
| 3 | 1.40E-8 | 1.96 | IE-LOOPWR,CRD-MDP-TM-TRNB,CRD-SYS-FC-ARUN,RSW-MDP-CF-START |

Cutset Report - LOOPWR 28-34-3

| # | CCDP | Total % | Cutset |
|---|---------|---------|---|
| | 4.59E-7 | 100 | Displaying 26 of 26 Cutsets. |
| 1 | 4.57E-7 | 99.5 | IE-LOOPWR,RRS-MDP-LK-SEALS,RSW-STR-CF-ALL |

Cutset Report - LOOPWR 13

| # | CCDP | Total % | Cutset |
|---|---------|---------|---|
| | 3.32E-7 | 100 | Displaying 292 of 292 Cutsets. |
| 1 | 2.50E-7 | 75.4 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-XHE-XM-ERROR |
| 2 | 1.53E-8 | 4.61 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-MOV-CF-INJECT |
| 3 | 4.93E-9 | 1.49 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-ACT-XR-SRIB,RHR-ACT-XR-SRIIB |
| 4 | 4.19E-9 | 1.26 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-ACT-XR-SRIB,RHR-ACT-XR-SRIIA |
| 5 | 4.19E-9 | 1.26 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-ACT-XR-SRIA,RHR-ACT-XR-SRIIB |
| 6 | 3.56E-9 | 1.07 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-ACT-XR-SRIA,RHR-ACT-XR-SRIIA |

Cutset Report - LOOPWR 28-30

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 2.76E-7 | 100 | Displaying 14 of 14 Cutsets. |
| 1 | 1.81E-7 | 65.7 | IE-LOOPWR,RCI-TDP-FR-TRAIN,RSW-STR-CF-ALL |
| 2 | 5.00E-8 | 18.1 | IE-LOOPWR,RCI-TDP-TM-TRAIN,RSW-STR-CF-ALL |
| 3 | 2.97E-8 | 10.8 | IE-LOOPWR,RCI-TDP-FS-TRAIN,RSW-STR-CF-ALL |
| 4 | 1.37E-8 | 4.97 | IE-LOOPWR,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT,RSW-STR-CF-ALL |

Referenced Events

| Event | Description | Probability |
|---------------------|---|-------------|
| ADS-XHE-XM-MDEPR | OPERATOR FAILS TO DEPRESSURIZE THE REACTOR | 5.00E-4 |
| ADS-XHE-XM-MDEPR1 | OPERATOR FAILS TO DEPRESSURIZE THE REACTOR | 1.43E-1 |
| CRD-MDP-TM-TRNB | CRD TRAIN B IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| CRD-SYS-FC-ARUN | CRD PUMP A IS RUNNING PUMP B IS IN STANDBY | 5.00E-1 |
| CVS-XHE-XM-VENT | OPERATOR FAILS TO VENT CONTAINMENT | 1.00E-3 |
| DCP-BDC-TM-RMOV1A | 250 VDC RMOV BOARD 1A IS UNAVAILABLE DUE TO TM | 2.15E-4 |
| DCP-BDC-TM-RMOV1B | 250 VDC RMOV BOARD 1B IS UNAVAILABLE | 2.15E-4 |
| DCP-XHE-XM-1ABC | OPERATOR FAILS TO ALIGN BACKUP POWER TO DC-MOV1A B C | 1.00E-3 |
| EPS-DGN-FR-DG3A | DIESEL GENERATOR 3A FAILS TO RUN | 2.85E-2 |
| HCI-MOV-CC-IVFRO | HPCI INJECTION VALVE 44 FAILS TO REOPEN | 1.50E-1 |
| HCI-MULTIPLE-INJECT | MULTIPLE HPCI INJECTIONS REQUIRED | 1.50E-1 |
| HCI-TDP-FR-TRAIN | HPCI PUMP TRAIN FAILS TO RUN GIVEN IT STARTED | 3.97E-2 |
| HCI-TDP-FS-TRAIN | HPCI PUMP FAILS TO START | 6.49E-3 |
| HCI-TDP-TM-TRAIN | HPCI TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.13E-2 |
| HCI-XHE-XL-INJECT | OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN | 8.00E-1 |
| HPI-XHE-XL-LVL8 | OPERATOR FAILS TO RECOVER HPCI/RCIC AFTER LEVEL 8 | 1.00E-3 |
| HPI-XHE-XO-ERROR | OPERATOR FAILS TO START/CONTROL RCIC/HPCI INJECTION | 1.00E-3 |
| IE-LOOPWR | LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED) | 1.00E+0 |
| OPR-XHE-XM-LI01 | OPERATOR FAILS TO START/CONTROL LATE INJECTION | 1.00E-3 |
| RCI-MOV-FC-XFER | RCIC FAILS TO TRANSFER DURING RECIRCULATION | 7.97E-3 |
| RCI-RESTART | RESTART OF RCIC IS REQUIRED | 1.50E-1 |

| Event | Description | Probability |
|-------------------|---|-------------|
| RCI-TDP-FR-TRAIN | RCIC PUMP FAILS TO RUN GIVEN THAT IT STARTED | 3.97E-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 | 1.10E-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 |
| RHR-ACT-XR-SRIA | UNDETECTED HUMAN ERROR AFTER SR-3 3 5 1 6 (CHANNEL A LOOP I) | 2.67E-3 |
| RHR-ACT-XR-SRIB | UNDETECTED HUMAN ERROR AFTER SR-3 3 5 1 6 (CHANNEL B LOOP I) | 3.14E-3 |
| RHR-ACT-XR-SRIIA | UNDETECTED HUMAN ERROR AFTER SR-3 3 5 1 6 (CHANNEL A LOOP II) | 2.67E-3 |
| RHR-ACT-XR-SRIIB | UNDETECTED HUMAN ERROR AFTER SR-3 3 5 1 6 (CHANNEL B LOOP II) | 3.14E-3 |
| RHR-MOV-CF-INJECT | SPC INJECTION VALVES FAIL FROM COMMON CAUSE | 3.06E-5 |
| RHR-XHE-XM-ERROR | OPERATOR FAILS TO START/CONTROL RHR | 5.00E-4 |
| RRS-MDP-LK-SEALS | RECIRCULATION PUMP SEALS FAIL | 1.00E-1 |
| RSW-MDP-CF-RUN | RHR SW PUMPS FAIL FROM COMMON CAUSE TO RUN | 2.58E-6 |
| RSW-MDP-CF-START | RHR SW PUMPS FAIL FROM COMMON CAUSE TO START | 1.96E-6 |
| RSW-STR-CF-ALL | RHR SW STRAINERS FAIL FROM COMMON CAUSE | 4.57E-6 |

Unit 2

Summary of Conditional Event Changes

| Event | Description | Cond. Value | Nominal Value |
|------------------------|---|-------------|---------------|
| EPS-DGN-TM-DG3B | DG B IS UNAVAILABLE BECAUSE OF MAINTENANCE | TRUE | 1.43E-2 |
| HE-LOOPWR | HOUSE EVENT - LOSS OF OFFSITE POWER IE HAS OCCURRED (WEATHER-RELATED) | TRUE | FALSE |
| IE-LOOPWR ^a | LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED) | 1.00E+0 | 3.91E-3 |
| OEP-VCF-LP-SITEWR | SITE LOOP (WEATHER-RELATED) | TRUE | 6.92E-1 |
| OEP-XHE-XL-NR01HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (WEATHER-RELATED) | 5.00E-3 | 6.87E-1 |
| OEP-XHE-XL-NR04HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (WEATHER-RELATED) | 1.40E-3 | 4.24E-1 |
| OEP-XHE-XL-NR10HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 10 HOURS (WEATHER-RELATED) | 1.40E-3 | 2.62E-1 |
| OEP-XHE-XL-NR12HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 12 HOURS (WEATHER-RELATED) | 1.40E-3 | 2.33E-1 |
| OEP-XHE-XL-NR30MWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 30 MINUTES (WEATHER-RELATED) | 4.10E-2 | 7.96E-1 |

a. All other initiating event probabilities were set to zero.

Implied Event Changes as per RASP Guidance

| Event | Description | Cond. Value | Nominal Value |
|-------------------|--|-------------|---------------|
| EPS-DGN-FR-DG3B | DIESEL GENERATOR 3B FAILS TO RUN | 1.00E+0 | 2.85E-2 |
| EPS-DGN-FS-DG3B | DIESEL GENERATOR 3B FAILS TO START | 1.00E+0 | 2.89E-3 |
| EPS-DGN-CF-3RUN | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 1.22E-4 | 5.93E-5 |
| EPS-DGN-CF-3START | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO START | 8.01E-6 | 4.75E-6 |

Dominant Sequence Results

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

| Event Tree | Sequence | CCDP | % Contribution | Description |
|--------------|----------|----------------|----------------|--|
| LOOPWR | 28-18 | 4.60E-6 | 43.1% | /RPS, EPS, /SRV, /RPSL, /RCI01, EXT, DEP01, OPR-04H, DGR-04H |
| LOOPWR | 25 | 2.93E-6 | 27.5% | /RPS, /EPS, /SRV, HPI, DEP |
| LOOPWR | 04 | 6.86E-7 | 6.4% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, /CVS, LI01 |
| LOOPWR | 06 | 5.29E-7 | 5.0% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, CVS, LI |
| LOOPWR | 13 | 4.75E-7 | 4.5% | /RPS, /EPS, /SRV, /HPI, SPC, DEP |
| LOOPWR | 28-34-3 | 4.59E-7 | 4.3% | /RPS, EPS, /SRV, RPSL, /RCI01, OPR-04H, DGR-04H |
| LOOPWR | 24 | 2.91E-7 | 2.7% | /RPS, /EPS, /SRV, HPI, /DEP, LPI, VA |
| LOOPWR | 28-30 | 2.76E-7 | 2.6% | /RPS, EPS, /SRV, /RPSL, RCI01, /HCI01, DEP01, OPR-04H, DGR-04H |
| LOOPWR | 12 | 2.31E-7 | 2.2% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, LPI, VA |
| Total | | 1.07E-5 | 100% | |

Referenced Fault Trees

| Fault Tree | Description |
|------------|------------------------|
| CVS | CONTAINMENT VENTING |
| DEP | MANUAL REACTOR DEPRESS |

| Fault Tree | Description |
|------------|--|
| DEP01 | MANUAL REACTOR DEPRESS |
| DGR-04H | DIESEL GENERATOR RECOVERY IN 4 HRS |
| EPS | TRANSFER BRANCH SBO |
| EXT | ACTIONS TO EXTEND ECCS OPERATION |
| HPI | HIGH PRESSURE INJECTION (RCIC or HPCI) |
| LI | LATE INJECTION |
| LI01 | BROWNS FERRY 2 LATE INJECTION FAULT TREE |
| LPI | LOW PRESSURE INJECTION (CS or LPCI) |
| OPR-04H | OFFSITE POWER RECOVERY IN 4 HRS |
| RCI01 | RCIC |
| RHR | LOSS OF RESIDUAL HEAT REMOVAL SYSTEM |
| RPSL | RECIRC PUMP SEAL INTEGRITY |
| SPC | SUPPRESSION POOL COOLING (LATE) |
| VA | ALTERNATE LOW PRESS INJECTION |

Cutset Report - LOOPWR 28-18

| # | CCDP | Total % | Cutset |
|---|---------|---------|--------------------------------|
| | 4.60E-6 | 100 | Displaying 192 of 192 Cutsets. |
| 1 | 4.57E-6 | 99.4 | IE-LOOPWR,RSW-STR-CF-ALL |

Cutset Report - LOOPWR 25

| # | CCDP | Total % | Cutset |
|----|---------|---------|--|
| | 2.93E-6 | 100 | Displaying 184 of 184 Cutsets. |
| 1 | 7.86E-7 | 26.9 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |
| 2 | 3.57E-7 | 12.2 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-TRAIN |
| 3 | 2.25E-7 | 7.67 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-TDP-FR-TRAIN |
| 4 | 2.17E-7 | 7.41 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-TM-TRAIN |
| 5 | 1.57E-7 | 5.37 | IE-LOOPWR,DEP-XHE-CRD-ADS,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |
| 6 | 1.29E-7 | 4.4 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-TDP-FR-TRAIN |
| 7 | 1.29E-7 | 4.4 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-FS-TRAIN |
| 8 | 9.86E-8 | 3.36 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-TM-TRAIN |
| 9 | 7.14E-8 | 2.44 | IE-LOOPWR,DEP-XHE-CRD-ADS,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-TRAIN |
| 10 | 5.95E-8 | 2.03 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT |
| 11 | 5.84E-8 | 2 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FS-TRAIN |
| 12 | 4.49E-8 | 1.53 | IE-LOOPWR,DEP-XHE-CRD-ADS,HCI-TDP-TM-TRAIN,RCI-TDP-FR-TRAIN |
| 13 | 4.34E-8 | 1.48 | IE-LOOPWR,DEP-XHE-CRD-ADS,HCI-TDP-FR-TRAIN,RCI-TDP-TM-TRAIN |
| 14 | 3.95E-8 | 1.35 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER |
| 15 | 3.68E-8 | 1.26 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-TDP-FS-TRAIN |
| 16 | 3.55E-8 | 1.21 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-TDP-TM-TRAIN |

Cutset Report - LOOPWR 04

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 6.86E-7 | 100 | Displaying 1185 of 1185 Cutsets. |
| 1 | 5.00E-7 | 72.9 | IE-LOOPWR,OPR-XHE-XM-LI01,RHR-XHE-XM-ERROR |
| 2 | 1.84E-8 | 2.68 | IE-LOOPWR,CRD-MDP-TM-TRNB,CRD-SYS-FC-ARUN,RSW-MDP-CF-RUN |
| 3 | 1.40E-8 | 2.04 | IE-LOOPWR,CRD-MDP-TM-TRNB,CRD-SYS-FC-ARUN,RSW-MDP-CF-START |

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| 4 | 7.06E-9 | 1.03 | IE-LOOPWR,DCP-BDC-TM-TURB,RSW-MDP-CF-RUN |

Cutset Report - LOOPWR 06

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 5.29E-7 | 100 | Displaying 86 of 86 Cutsets. |
| 1 | 5.00E-7 | 94.4 | IE-LOOPWR,CVS-XHE-XM-VENT,RHR-XHE-XM-ERROR |

Cutset Report - LOOPWR 13

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 4.75E-7 | 100 | Displaying 82 of 82 Cutsets. |
| 1 | 2.50E-7 | 52.6 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-XHE-XM-ERROR |
| 2 | 1.00E-7 | 21 | IE-LOOPWR,ACP-BAC-TM-RMOV2D,ADS-XHE-XM-MDEPR |
| 3 | 5.00E-8 | 10.5 | IE-LOOPWR,DEP-XHE-CRD-ADS,RHR-XHE-XM-ERROR |
| 4 | 2.00E-8 | 4.21 | IE-LOOPWR,ACP-BAC-TM-RMOV2D,DEP-XHE-CRD-ADS |
| 5 | 1.67E-8 | 3.51 | IE-LOOPWR,ACP-BAC-LP-RMOV2D,ADS-XHE-XM-MDEPR |
| 6 | 1.53E-8 | 3.22 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-MOV-CF-SPCINJEC |
| 7 | 5.00E-9 | 1.05 | IE-LOOPWR,ADS-XHE-XM-MDEPR,RHR-STR-CF-NLOCA |

Cutset Report - LOOPWR 28-34-3

| # | CCDP | Total % | Cutset |
|---|---------|---------|---|
| | 4.59E-7 | 100 | Displaying 26 of 26 Cutsets. |
| 1 | 4.57E-7 | 99.5 | IE-LOOPWR,RRS-MDP-LK-SEALS,RSW-STR-CF-ALL |

Cutset Report - LOOPWR 24

| # | CCDP | Total % | Cutset |
|----|---------|---------|--|
| | 2.91E-7 | 100 | Displaying 558 of 558 Cutsets. |
| 1 | 3.21E-8 | 11 | IE-LOOPWR,EPS-DGN-FR-DGB,EPS-DGN-FR-DGD,HCI-TDP-FR-TRAIN,HVC-XHE-XM-DOOR |
| 2 | 1.62E-8 | 5.56 | IE-LOOPWR,EPS-DGN-FR-DGD,EPS-DGN-TM-DGB,HCI-TDP-FR-TRAIN,HVC-XHE-XM-DOOR |
| 3 | 1.62E-8 | 5.56 | IE-LOOPWR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGD,HCI-TDP-FR-TRAIN,HVC-XHE-XM-DOOR |
| 4 | 1.46E-8 | 5.01 | IE-LOOPWR,EPS-DGN-FR-DGB,EPS-DGN-FR-DGD,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,HVC-XHE-XM-DOOR |
| 5 | 1.13E-8 | 3.88 | IE-LOOPWR,EPS-DGN-FR-DGD,HCI-TDP-FR-TRAIN,HVC-CHL-CFG-1ASTANDBY,HVC-CHL-TM-1A,HVC-XHE-XM-DOOR |
| 6 | 1.13E-8 | 3.88 | IE-LOOPWR,EPS-DGN-FR-DGB,HCI-TDP-FR-TRAIN,/HVC-CHL-CFG-1ASTANDBY,HVC-CHL-TM-1B,HVC-XHE-XM-DOOR |
| 7 | 9.18E-9 | 3.15 | IE-LOOPWR,EPS-DGN-FR-DGB,EPS-DGN-FR-DGD,HCI-TDP-TM-TRAIN,HVC-XHE-XM-DOOR |
| 8 | 7.35E-9 | 2.53 | IE-LOOPWR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGD,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,HVC-XHE-XM-DOOR |
| 9 | 7.35E-9 | 2.53 | IE-LOOPWR,EPS-DGN-FR-DGD,EPS-DGN-TM-DGB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,HVC-XHE-XM-DOOR |
| 10 | 5.69E-9 | 1.95 | IE-LOOPWR,EPS-DGN-TM-DGB,HCI-TDP-FR-TRAIN,/HVC-CHL-CFG-1ASTANDBY,HVC-CHL-TM-1B,HVC-XHE-XM-DOOR |
| 11 | 5.69E-9 | 1.95 | IE-LOOPWR,EPS-DGN-TM-DGD,HCI-TDP-FR-TRAIN,HVC-CHL-CFG-1ASTANDBY,HVC-CHL-TM-1A,HVC-XHE-XM-DOOR |
| 12 | 5.26E-9 | 1.81 | IE-LOOPWR,EPS-DGN-FR-DGB,EPS-DGN-FR-DGD,HCI-TDP-FS-TRAIN,HVC-XHE-XM-DOOR |
| 13 | 5.12E-9 | 1.76 | IE-LOOPWR,EPS-DGN-FR-DGD,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,HVC-CHL-CFG-1ASTANDBY,HVC-CHL-TM-1A,HVC-XHE-XM-DOOR |
| 14 | 5.12E-9 | 1.76 | IE-LOOPWR,EPS-DGN-FR-DGB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,/HVC-CHL-CFG-1ASTANDBY,HVC-CHL-TM-1B,HVC-XHE-XM-DOOR |

| # | CCDP | Total % | Cutset |
|----|---------|---------|---|
| 15 | 4.63E-9 | 1.59 | IE-LOOPWR, EPS-DGN-FR-DGD, EPS-DGN-TM-DGB, HCI-TDP-TM-TRAIN, HVC-XHE-XM-DOOR |
| 16 | 4.63E-9 | 1.59 | IE-LOOPWR, EPS-DGN-FR-DGB, EPS-DGN-TM-DGD, HCI-TDP-TM-TRAIN, HVC-XHE-XM-DOOR |
| 17 | 3.26E-9 | 1.12 | IE-LOOPWR, EPS-DGN-FR-DGB, EPS-DGN-FS-DGD, HCI-TDP-FR-TRAIN, HVC-XHE-XM-DOOR |
| 18 | 3.26E-9 | 1.12 | IE-LOOPWR, EPS-DGN-FR-DGD, EPS-DGN-FS-DGB, HCI-TDP-FR-TRAIN, HVC-XHE-XM-DOOR |
| 19 | 3.22E-9 | 1.11 | IE-LOOPWR, EPS-DGN-FR-DGD, HCI-TDP-TM-TRAIN, HVC-CHL-CFG-1ASTANDBY, HVC-CHL-TM-1A, HVC-XHE-XM-DOOR |
| 20 | 3.22E-9 | 1.11 | IE-LOOPWR, EPS-DGN-FR-DGB, HCI-TDP-TM-TRAIN, /HVC-CHL-CFG-1ASTANDBY, HVC-CHL-TM-1B, HVC-XHE-XM-DOOR |

Cutset Report - LOOPWR 28-30

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 2.76E-7 | 100 | Displaying 14 of 14 Cutsets. |
| 1 | 1.81E-7 | 65.7 | IE-LOOPWR, RCI-TDP-FR-TRAIN, RSW-STR-CF-ALL |
| 2 | 5.00E-8 | 18.1 | IE-LOOPWR, RCI-TDP-TM-TRAIN, RSW-STR-CF-ALL |
| 3 | 2.97E-8 | 10.8 | IE-LOOPWR, RCI-TDP-FS-TRAIN, RSW-STR-CF-ALL |
| 4 | 1.37E-8 | 4.97 | IE-LOOPWR, RCI-RESTART, RCI-TDP-FS-RSTRT, RCI-XHE-XL-RSTRT, RSW-STR-CF-ALL |

Cutset Report - LOOPWR 12

| # | CCDP | Total % | Cutset |
|----|---------|---------|--|
| | 2.31E-7 | 100 | Displaying 274 of 274 Cutsets. |
| 1 | 4.00E-8 | 17.3 | IE-LOOPWR, ACP-BAC-TM-SB2A, ACP-BAC-TM-SB2B |
| 2 | 2.39E-8 | 10.3 | IE-LOOPWR, ACP-CRB-CC-1616, /HVC-CHL-CFG-1ASTANDBY, HVC-CHL-TM-1B, HVC-XHE-XM-DOOR |
| 3 | 2.39E-8 | 10.3 | IE-LOOPWR, ACP-CRB-CC-1724, HVC-CHL-CFG-1ASTANDBY, HVC-CHL-TM-1A, HVC-XHE-XM-DOOR |
| 4 | 1.37E-8 | 5.91 | IE-LOOPWR, ACP-CRB-CC-1616, ACP-CRB-CC-1718, ACP-CRB-CC-1724 |
| 5 | 1.00E-8 | 4.32 | IE-LOOPWR, OPR-XHE-XM-ALPI, RHR-STR-CF-NLOCA |
| 6 | 9.63E-9 | 4.16 | IE-LOOPWR, LCI-MOV-CC-F067, RHR-STR-CF-NLOCA |
| 7 | 9.63E-9 | 4.16 | IE-LOOPWR, RHR-MOV-CC-F101, RHR-STR-CF-NLOCA |
| 8 | 9.63E-9 | 4.16 | IE-LOOPWR, RHR-STR-CF-NLOCA, RSW-MOV-CC-F057 |
| 9 | 7.32E-9 | 3.16 | IE-LOOPWR, /HVC-CHL-CFG-1ASTANDBY, HVC-CHL-FR-1A, HVC-CHL-TM-1B, HVC-XHE-XM-DOOR |
| 10 | 7.32E-9 | 3.16 | IE-LOOPWR, HVC-CHL-CFG-1ASTANDBY, HVC-CHL-FR-1B, HVC-CHL-TM-1A, HVC-XHE-XM-DOOR |
| 11 | 6.66E-9 | 2.88 | IE-LOOPWR, ACP-BAC-LP-SB2B, ACP-BAC-TM-SB2A |
| 12 | 6.66E-9 | 2.88 | IE-LOOPWR, ACP-BAC-LP-SB2A, ACP-BAC-TM-SB2B |
| 13 | 5.72E-9 | 2.47 | IE-LOOPWR, ACP-CRB-CC-1616, ACP-CRB-CC-1724, HVC-XHE-XM-DOOR |
| 14 | 5.26E-9 | 2.27 | IE-LOOPWR, ACP-BAC-TM-SB2A, ACP-CRB-CC-1724, ACP-XHE-XM-SB2B |
| 15 | 5.26E-9 | 2.27 | IE-LOOPWR, ACP-BAC-TM-SB2B, ACP-CRB-CC-1616, ACP-XHE-XM-SB2A |
| 16 | 4.94E-9 | 2.14 | IE-LOOPWR, HVC-ACX-CF-1AR, HVC-XHE-XM-DOOR |
| 17 | 2.39E-9 | 1.03 | IE-LOOPWR, ACP-CRB-CC-1616, /HVC-CHL-CFG-1ASTANDBY, HVC-CHL-FS-1B, HVC-XHE-XM-DOOR |
| 18 | 2.39E-9 | 1.03 | IE-LOOPWR, ACP-CRB-CC-1724, HVC-CHL-CFG-1ASTANDBY, HVC-CHL-FS-1A, HVC-XHE-XM-DOOR |

Referenced Events

| Event | Description | Probability |
|-------------------|--|-------------|
| ACP-BAC-LP-RMOV2D | BROWNS FERRY 1 480V RMOV BOARD 2D BUS IS UNAVAILABLE | 3.33E-5 |
| ACP-BAC-LP-SB2A | SHUTDOWN BOARD 2A IS UNAVAILABLE | 3.33E-5 |
| ACP-BAC-LP-SB2B | SHUTDOWN BOARD 2B IS UNAVAILABLE | 3.33E-5 |

| Event | Description | Probability |
|-----------------------|---|-------------|
| ACP-BAC-TM-RMOV2D | BROWNS FERRY 2 480V RMOV BOARD 2D BUS IS UNAVAILABLE - TM | 2.00E-4 |
| ACP-BAC-TM-SB2A | 480 VAC SHUTDOWN BOARD 2A BUS IS UNAVAILABLE - TM | 2.00E-4 |
| ACP-BAC-TM-SB2B | 480 VAC SHUTDOWN BOARD 2B BUS IS UNAVAILABLE - TM | 2.00E-4 |
| ACP-CRB-CC-1616 | SD BOARD B OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ACP-CRB-CC-1718 | SD BOARD C OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ACP-CRB-CC-1724 | SD BOARD D OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ACP-XHE-XM-SB2A | OPERATOR FAILS TO ALIGN ALTERNATE POWER TO SB 2A | 1.10E-2 |
| ACP-XHE-XM-SB2B | OPERATOR FAILS TO ALIGN ALTERNATE POWER TO SB 2B | 1.10E-2 |
| ADS-XHE-XM-MDEPR | OPERATOR FAILS TO DEPRESSURIZE THE REACTOR | 5.00E-4 |
| CRD-MDP-TM-TRNB | CRD TRAIN B IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| CRD-SYS-FC-ARUN | CRD PUMP A IS RUNNING, PUMP B IS IN STANDBY | 5.00E-1 |
| CVS-XHE-XM-VENT | OPERATOR FAILS TO VENT CONTAINMENT | 1.00E-3 |
| DCP-BDC-TM-TURB | 250 VDC BATTERY BOARD TO 4KV UNIT BOARD (2B) BUS- TM | 2.74E-3 |
| DEP-XHE-CRD-ADS | DEPENDENCY ADJUSTMENT FOR CRD-XHE-XM-ERROR AND ADS-XHE-XM-MDEPR | 1.00E-4 |
| EPS-DGN-FR-DGB | DIESEL GENERATOR B FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DGD | DIESEL GENERATOR D FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FS-DGB | DIESEL GENERATOR B FAILS TO START | 2.89E-3 |
| EPS-DGN-FS-DGD | DIESEL GENERATOR D FAILS TO START | 2.89E-3 |
| EPS-DGN-TM-DGB | DG B IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| EPS-DGN-TM-DGD | DG D IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| HCI-MOV-CC-IVFRO | HPCI INJECTION VALVE FAILS TO REOPEN | 1.50E-1 |
| HCI-MULTIPLE-INJECT | MULTIPLE HPCI INJECTIONS REQUIRED | 1.50E-1 |
| HCI-TDP-FR-TRAIN | HPCI PUMP TRAIN FAILS TO RUN GIVEN IT STARTED | 3.97E-2 |
| HCI-TDP-FS-TRAIN | HPCI PUMP FAILS TO START | 6.49E-3 |
| HCI-TDP-TM-TRAIN | HPCI TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.13E-2 |
| HCI-XHE-XL-INJECT | OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN | 8.00E-1 |
| HVC-ACX-CF-1AR | AHU-31-88 (1A) & AHU-31-89 (1B) FAILS TO RUN DUE TO CCF | 4.94E-6 |
| HVC-CHL-CFG-1ASTANDBY | WATER CHILLER 1A IN STANDBY | 5.00E-1 |
| HVC-CHL-FR-1A | WATER CHILLER 1A FAILS TO RUN | 7.32E-4 |
| HVC-CHL-FR-1B | WATER CHILLER 1B FAILS TO RUN | 7.32E-4 |
| HVC-CHL-FS-1A | WATER CHILLER 1A FAILS TO START | 2.00E-3 |
| HVC-CHL-FS-1B | WATER CHILLER 1B FAILS TO START | 2.00E-3 |
| HVC-CHL-TM-1A | WATER CHILLER 1A IN T&M | 2.00E-2 |
| HVC-CHL-TM-1B | WATER CHILLER 1B IN T&M | 2.00E-2 |
| HVC-XHE-XM-DOOR | FAILURE TO OPEN DOORS/INSTALL FANS AFTER HVAC FAILURE | 1.00E-3 |
| IE-LOOPWR | LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED) | 1.00E+0 |
| LCI-MOV-CC-F067 | LPCI LOOP B INJECTION VALVE 74-67 FAILS TO OPEN | 9.63E-4 |
| OPR-XHE-XM-ALPI | OPERATOR FAILS TO START/CONTROL ALTERNATE LOW PRES INJECTION | 1.00E-3 |
| OPR-XHE-XM-LI01 | OPERATOR FAILS TO START/CONTROL LATE INJECTION | 1.00E-3 |
| 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 | 3.97E-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 |

| Event | Description | Probability |
|---------------------|--|-------------|
| RCI-TDP-TM-TRAIN | RCIC PUMP TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.10E-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 |
| RHR-MOV-CC-F101 | RHR CROSS TIE MOV 74-101 FAILS TO OPEN | 9.63E-4 |
| RHR-MOV-CF-SPCINJEC | SPC INJECTION VALVES FAIL FROM COMMON CAUSE | 3.06E-5 |
| RHR-STR-CF-NLOCA | SUPPRESSION POOL STRAINERS FAIL FROM COMMON CAUSE (NON-LOCA) | 1.00E-5 |
| RHR-XHE-XM-ERROR | OPERATOR FAILS TO START/CONTROL RHR | 5.00E-4 |
| RRS-MDP-LK-SEALS | RECIRCULATION PUMP SEALS FAIL | 1.00E-1 |
| RSW-MDP-CF-RUN | RHR SW PUMPS FAIL FROM COMMON CAUSE TO RUN | 2.58E-6 |
| RSW-MDP-CF-START | RHR SW PUMPS FAIL FROM COMMON CAUSE TO START | 1.96E-6 |
| RSW-MOV-CC-F057 | RHR SW/RHR CROSS TIE MOV 23-57 FAILS TO OPEN | 9.63E-4 |
| RSW-STR-CF-ALL | RHR SW STRAINERS FAIL FROM COMMON CAUSE | 4.57E-6 |

Unit 3

Summary of Conditional Event Changes

| Event | Description | Cond. Value | Nominal Value |
|------------------------|---|-------------|---------------|
| EPS-DGN-TM-DG3B | DG B IS UNAVAILABLE BECAUSE OF MAINTENANCE | TRUE | 1.43E-2 |
| HE-LOOPWR | HOUSE EVENT - LOSS OF OFFSITE POWER IE HAS OCCURRED (WEATHER-RELATED) | TRUE | FALSE |
| IE-LOOPWR ^a | LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED) | 1.00E+0 | 3.91E-3 |
| OEP-VCF-LP-SITEWR | SITE LOOP (WEATHER-RELATED) | TRUE | 6.92E-1 |
| OEP-XHE-XL-NR01HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (WEATHER-RELATED) | 5.00E-3 | 1.00E+0 |
| OEP-XHE-XL-NR04HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (WEATHER-RELATED) | 1.40E-3 | 1.00E+0 |
| OEP-XHE-XL-NR10HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 10 HOURS (WEATHER-RELATED) | 1.40E-3 | 1.00E+0 |
| OEP-XHE-XL-NR12HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 12 HOURS (WEATHER-RELATED) | 1.40E-3 | 1.00E+0 |
| OEP-XHE-XL-NR30MWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 30 MINUTES (WEATHER-RELATED) | 4.10E-2 | 1.00E+0 |

a. All other initiating event probabilities were set to zero.

Implied Event Changes as per RASP Guidance

| Event | Description | Cond. Value | Nominal Value |
|-------------------|--|-------------|---------------|
| EPS-DGN-FR-DG3B | DIESEL GENERATOR 3B FAILS TO RUN | 1.00E+0 | 2.85E-2 |
| EPS-DGN-FS-DG3B | DIESEL GENERATOR 3B FAILS TO START | 1.00E+0 | 2.89E-3 |
| EPS-DGN-CF-3START | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO START | 8.01E-6 | 4.75E-6 |
| EPS-DGN-CF-3RUN | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 1.22E-4 | 5.93E-5 |

Dominant Sequence Results

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

| Event Tree | Sequence | CCDP | % Contribution | Description |
|--------------|----------|----------------|----------------|--|
| LOOPWR | 28-18 | 4.62E-6 | 35.0% | /RPS, EPS, /SRV, /RPSL, /RCI01, EXT, DEP01, OPR-04H, DGR-04H |
| LOOPWR | 25 | 3.29E-6 | 24.9% | /RPS, /EPS, /SRV, HPI, DEP |
| LOOPWR | 24 | 2.52E-6 | 19.0% | /RPS, /EPS, /SRV, HPI, /DEP, LPI, VA |
| LOOPWR | 04 | 6.83E-7 | 5.2% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, /CVS, LI01 |
| LOOPWR | 06 | 5.43E-7 | 4.1% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, CVS, LI |
| LOOPWR | 28-34-3 | 4.61E-7 | 3.5% | /RPS, EPS, /SRV, RPSL, /RCI01, OPR-04H, DGR-04H |
| LOOPWR | 12 | 4.54E-7 | 3.4% | /RPS, /EPS, /SRV, /HPI, SPC, /DEP, LPI, VA |
| LOOPWR | 13 | 2.79E-7 | 2.1% | /RPS, /EPS, /SRV, /HPI, SPC, DEP |
| LOOPWR | 28-30 | 2.76E-7 | 2.1% | /RPS, EPS, /SRV, /RPSL, RCI01, /HCI01, DEP01, OPR-04H, DGR-04H |
| Total | | 1.32E-5 | 100% | |

Referenced Fault Trees

| Fault Tree | Description |
|------------|------------------------|
| CVS | CONTAINMENT VENTING |
| DEP | MANUAL REACTOR DEPRESS |
| DEP01 | MANUAL REACTOR DEPRESS |

| Fault Tree | Description |
|------------|--|
| DGR-04H | DIESEL GENERATOR RECOVERY IN 4 HRS |
| EPS | TRANSFER BRANCH SBO |
| EXT | ACTIONS TO EXTEND ECCS OPERATION |
| HPI | HIGH PRESSURE INJECTION (RCIC or HPCI) |
| LI | LATE INJECTION |
| LI01 | BROWNS FERRY 3 LATE INJECTION FAULT TREE |
| LPI | LOW PRESSURE INJECTION (CS or LPCI) |
| OPR-04H | OFFSITE POWER RECOVERY IN 4 HRS |
| RCI01 | RCIC |
| RHR | LOSS OF RESIDUAL HEAT REMOVAL SYSTEMS |
| RPSL | RECIRC PUMP SEAL INTEGRITY |
| SPC | SUPPRESSION POOL COOLING |
| VA | ALTERNATE LOW PRESS INJECTION |

Cutset Report - LOOPWR 28-18

| # | CCDP | Total % | Cutset |
|---|---------|---------|--------------------------------|
| | 4.62E-6 | 100 | Displaying 729 of 729 Cutsets. |
| 1 | 4.57E-6 | 98.8 | IE-LOOPWR,RSW-STR-CF-ALL |

Cutset Report - LOOPWR 25

| # | CCDP | Total % | Cutset |
|----|---------|---------|---|
| | 3.29E-6 | 100 | Displaying 166 of 166 Cutsets. |
| 1 | 7.86E-7 | 23.9 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |
| 2 | 3.77E-7 | 11.4 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-XHE-XE-MISCAL |
| 3 | 3.57E-7 | 10.9 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-TRAIN |
| 4 | 2.25E-7 | 6.83 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-TDP-FR-TRAIN |
| 5 | 2.17E-7 | 6.6 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-TM-TRAIN |
| 6 | 1.71E-7 | 5.2 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-XHE-XE-MISCAL |
| 7 | 1.29E-7 | 3.91 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-TDP-FR-TRAIN |
| 8 | 1.29E-7 | 3.91 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-TDP-FS-TRAIN |
| 9 | 1.08E-7 | 3.27 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-XHE-XE-MISCAL |
| 10 | 9.86E-8 | 3 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-TM-TRAIN |
| 11 | 6.17E-8 | 1.87 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-XHE-XE-MISCAL |
| 12 | 5.95E-8 | 1.81 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-RESTART,RCI-TDP-FS-RSTRT,RCI-XHE-XL-RSTRT |
| 13 | 5.84E-8 | 1.78 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FS-TRAIN |
| 14 | 3.95E-8 | 1.2 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-TRAIN,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER |
| 15 | 3.68E-8 | 1.12 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-TRAIN,RCI-TDP-FS-TRAIN |
| 16 | 3.55E-8 | 1.08 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-TRAIN,RCI-TDP-TM-TRAIN |
| 17 | 3.37E-8 | 1.02 | IE-LOOPWR,ADS-XHE-XM-MDEPR,HCI-XHE-XE-MISCAL,RCI-TDP-FR-TRAIN |

Cutset Report - LOOPWR 24

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 2.52E-6 | 100 | Displaying 11858 of 11858 Cutsets. |
| 1 | 1.07E-7 | 4.26 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FR-DG3A,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |
| 2 | 5.40E-8 | 2.15 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-TM-DG3A,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| 3 | 5.13E-8 | 2.04 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FR-DG3A,HCI-TDP-FR-TRAIN,RCI-XHE-XE-MISCAL |
| 4 | 4.86E-8 | 1.93 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FR-DG3A,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-TRAIN |
| 5 | 3.63E-8 | 1.44 | IE-LOOPWR,EPS-DGN-FR-DG3A,EPS-DGN-FR-DG3C,EPS-DGN-FR-DGC,HCI-TDP-FR-TRAIN,RCI-TDP-FR-TRAIN |
| 6 | 3.06E-8 | 1.22 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FR-DG3A,HCI-TDP-TM-TRAIN,RCI-TDP-FR-TRAIN |
| 7 | 2.97E-8 | 1.18 | IE-LOOPWR,ACP-CRB-CC-SB3EC,DCP-XHE-XM-BB3,EPS-DGN-FR-DG3A,RCI-TDP-FR-TRAIN |
| 8 | 2.96E-8 | 1.18 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FR-DG3A,HCI-TDP-FR-TRAIN,RCI-TDP-TM-TRAIN |
| 9 | 2.59E-8 | 1.03 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-TM-DG3A,HCI-TDP-FR-TRAIN,RCI-XHE-XE-MISCAL |

Cutset Report - LOOPWR 04

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 6.83E-7 | 100 | Displaying 705 of 705 Cutsets. |
| 1 | 5.00E-7 | 73.2 | IE-LOOPWR,OPR-XHE-XM-LI01,RHR-XHE-XM-ERROR |
| 2 | 3.67E-8 | 5.38 | IE-LOOPWR,CRD-MDP-TM-TRN3B,RSW-MDP-CF-RUN |
| 3 | 2.80E-8 | 4.09 | IE-LOOPWR,CRD-MDP-TM-TRN3B,RSW-MDP-CF-START |
| 4 | 7.12E-9 | 1.04 | IE-LOOPWR,CRD-MDP-TM-TRN3B,RHR-XHE-XM-ERROR,RS1-XHE-XM-ERROR |
| 5 | 6.86E-9 | 1.01 | IE-LOOPWR,CRD-MDP-TM-TRN3B,RHR-MOV-CC-F067,RHR-XHE-XM-ERROR |
| 6 | 6.86E-9 | 1.01 | IE-LOOPWR,CRD-MDP-TM-TRN3B,RHR-MOV-CC-F100,RHR-XHE-XM-ERROR |
| 7 | 6.86E-9 | 1.01 | IE-LOOPWR,CRD-MDP-TM-TRN3B,RHR-XHE-XM-ERROR,RSW-MOV-CC-F057 |

Cutset Report - LOOPWR 06

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 5.43E-7 | 100 | Displaying 222 of 222 Cutsets. |
| 1 | 5.00E-7 | 92.1 | IE-LOOPWR,CVS-XHE-XM-VENT,RHR-XHE-XM-ERROR |
| 2 | 7.00E-9 | 1.29 | IE-LOOPWR,OEP-XHE-XL-NR10HWR,PCA-TNK-FC-N2TKA,RHR-XHE-XM-ERROR |

Cutset Report - LOOPWR 28-34-3

| # | CCDP | Total % | Cutset |
|---|---------|---------|---|
| | 4.61E-7 | 100 | Displaying 88 of 88 Cutsets. |
| 1 | 4.57E-7 | 99.2 | IE-LOOPWR,RRS-MDP-LK-SEALS,RSW-STR-CF-ALL |

Cutset Report - LOOPWR 12

| # | CCDP | Total % | Cutset |
|----|---------|---------|---|
| | 4.54E-7 | 100 | Displaying 885 of 885 Cutsets. |
| 1 | 9.53E-8 | 21 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FR-DG3A,OEP-XHE-XL-NR04HWR |
| 2 | 4.81E-8 | 10.6 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-TM-DG3A,OEP-XHE-XL-NR04HWR |
| 3 | 1.41E-8 | 3.11 | IE-LOOPWR,EPS-DGN-FR-DG3A,EPS-DGN-FR-DG3C,EPS-DGN-FR-DGC,OEP-XHE-XL-NR04HWR,OEP-XHE-XX-NR04HWR2 |
| 4 | 1.37E-8 | 3.02 | IE-LOOPWR,ACP-CRB-CC-SB3EA,ACP-CRB-CC-SB3EB,ACP-CRB-CC-SB3EC |
| 5 | 1.27E-8 | 2.8 | IE-LOOPWR,EPS-DGN-FR-DG3A,EPS-DGN-FR-DG3C,EPS-DGN-FR-DGC,OEP-XHE-XL-NR04HWR,OEP-XHE-XX-NR04HWR3 |
| 6 | 1.00E-8 | 2.2 | IE-LOOPWR,OPR-XHE-XM-ALPI,RHR-STR-CF-NLOCA |
| 7 | 9.68E-9 | 2.13 | IE-LOOPWR,ACP-CRB-CC-SB3EC,EPS-DGN-FS-DG3A,OEP-XHE-XL-NR04HWR |
| 8 | 9.63E-9 | 2.12 | IE-LOOPWR,RHR-MOV-CC-F100,RHR-STR-CF-NLOCA |
| 9 | 9.63E-9 | 2.12 | IE-LOOPWR,RHR-MOV-CC-F067,RHR-STR-CF-NLOCA |
| 10 | 9.63E-9 | 2.12 | IE-LOOPWR,RHR-STR-CF-NLOCA,RSW-MOV-CC-F057 |
| 11 | 9.01E-9 | 1.99 | IE-LOOPWR,EPS-DGN-FR-DG3C,EPS-DGN-FR-DGC,EPS-DGN-TM-DG3A,OEP-XHE-XL-NR04HWR,OEP-XHE-XX-NR04HWR1 |

| # | CCDP | Total % | Cutset |
|----|---------|---------|--|
| 12 | 9.01E-9 | 1.99 | IE-LOOPWR, EPS-DGN-FR-DG3A, EPS-DGN-FR-DGC, EPS-DGN-TM-DG3C, OEP-XHE-XL-NR04HWR, OEP-XHE-XX-NR04HWR1 |
| 13 | 8.21E-9 | 1.81 | IE-LOOPWR, EPS-DGN-FR-DG3A, EPS-DGN-TM-DG3C, EPS-DGN-TM-DGC, OEP-XHE-XL-NR04HWR |
| 14 | 8.21E-9 | 1.81 | IE-LOOPWR, EPS-DGN-FR-DG3C, EPS-DGN-TM-DG3A, EPS-DGN-TM-DGC, OEP-XHE-XL-NR04HWR |
| 15 | 8.01E-9 | 1.77 | IE-LOOPWR, ACP-CRB-CC-SB3EA, ACP-CRB-CC-SB3EC, OEP-XHE-XL-NR04HWR |
| 16 | 7.12E-9 | 1.57 | IE-LOOPWR, EPS-DGN-FR-DG3C, EPS-DGN-FR-DGC, EPS-DGN-TM-DG3A, OEP-XHE-XL-NR04HWR, OEP-XHE-XX-NR04HWR2 |
| 17 | 7.12E-9 | 1.57 | IE-LOOPWR, EPS-DGN-FR-DG3A, EPS-DGN-FR-DGC, EPS-DGN-TM-DG3C, OEP-XHE-XL-NR04HWR, OEP-XHE-XX-NR04HWR2 |
| 18 | 7.12E-9 | 1.57 | IE-LOOPWR, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, EPS-DGN-TM-DGC, OEP-XHE-XL-NR04HWR, OEP-XHE-XX-NR04HWR2 |
| 19 | 6.66E-9 | 1.47 | IE-LOOPWR, ACP-BAC-LP-SB3B, ACP-BAC-TM-SB3A |
| 20 | 6.40E-9 | 1.41 | IE-LOOPWR, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, EPS-DGN-TM-DGC, OEP-XHE-XL-NR04HWR, OEP-XHE-XX-NR04HWR3 |
| 21 | 5.89E-9 | 1.3 | IE-LOOPWR, ACP-CRB-CC-SB3EC, EPS-SEQ-FO-DG3A, OEP-XHE-XL-NR04HWR |

Cutset Report - LOOPWR 13

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 2.79E-7 | 100 | Displaying 44 of 44 Cutsets. |
| 1 | 2.50E-7 | 89.7 | IE-LOOPWR, ADS-XHE-XM-MDEPR, RHR-XHE-XM-ERROR |
| 2 | 1.53E-8 | 5.49 | IE-LOOPWR, ADS-XHE-XM-MDEPR, RHR-MOV-CF-SPCINJEC |
| 3 | 5.00E-9 | 1.79 | IE-LOOPWR, ADS-XHE-XM-MDEPR, RHR-STR-CF-NLOCA |

Cutset Report - LOOPWR 28-30

| # | CCDP | Total % | Cutset |
|---|---------|---------|--|
| | 2.76E-7 | 100 | Displaying 39 of 39 Cutsets. |
| 1 | 1.81E-7 | 65.6 | IE-LOOPWR, RCI-TDP-FR-TRAIN, RSW-STR-CF-ALL |
| 2 | 5.00E-8 | 18.1 | IE-LOOPWR, RCI-TDP-TM-TRAIN, RSW-STR-CF-ALL |
| 3 | 2.97E-8 | 10.7 | IE-LOOPWR, RCI-TDP-FS-TRAIN, RSW-STR-CF-ALL |
| 4 | 1.37E-8 | 4.96 | IE-LOOPWR, RCI-RESTART, RCI-TDP-FS-RSTRT, RCI-XHE-XL-RSTRT, RSW-STR-CF-ALL |

Referenced Events

| Event | Description | Probability |
|------------------|---|-------------|
| ACP-BAC-LP-SB3B | SHUTDOWN BOARD 3B IS UNAVAILABLE | 3.33E-5 |
| ACP-BAC-TM-SB3A | SHUTDOWN BOARD 3A IS UNAVAILABLE | 2.00E-4 |
| ACP-CRB-CC-SB3EA | SD BOARD 3EA OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ACP-CRB-CC-SB3EB | SD BOARD 3EB OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ACP-CRB-CC-SB3EC | SD BOARD 3EC OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ADS-XHE-XM-MDEPR | OPERATOR FAILS TO DEPRESSURIZE THE REACTOR | 5.00E-4 |
| CRD-MDP-TM-TRN3B | CRD TRAIN B IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| CVS-XHE-XM-VENT | OPERATOR FAILS TO VENT CONTAINMENT | 1.00E-3 |
| DCP-XHE-XM-BB3 | OPERATOR FAILS TO ALIGN BACKUP POWER TO DC-BATBD3 | 1.10E-2 |
| EPS-DGN-FR-DG3A | DIESEL GENERATOR 3A FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DG3C | DIESEL GENERATOR 3C FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DGC | DIESEL GENERATOR C FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FS-DG3A | DIESEL GENERATOR 3A FAILS TO START | 2.89E-3 |
| EPS-DGN-TM-DG3A | DG A IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |

| Event | Description | Probability |
|---------------------|---|-------------|
| EPS-DGN-TM-DG3C | DG C IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| EPS-DGN-TM-DGC | DG C IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| EPS-SEQ-FO-DG3A | DG 3A LOAD SEQUENCER FAILS TO OPERATE | 1.76E-3 |
| HCI-MOV-CC-IVFRO | HPCI INJECTION VALVE FAILS TO REOPEN | 1.50E-1 |
| HCI-MULTIPLE-INJECT | MULTIPLE HPCI INJECTIONS REQUIRED | 1.50E-1 |
| HCI-TDP-FR-TRAIN | HPCI PUMP TRAIN FAILS TO RUN GIVEN IT STARTED | 3.97E-2 |
| HCI-TDP-FS-TRAIN | HPCI PUMP FAILS TO START | 6.49E-3 |
| HCI-TDP-TM-TRAIN | HPCI TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.13E-2 |
| HCI-XHE-XE-MISCAL | MISCALIBRATION OF HPCI EXHAUST PRESSURE INSTRUMENTATION | 1.70E-3 |
| HCI-XHE-XL-INJECT | OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN | 8.00E-1 |
| IE-LOOPWR | LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED) | 1.00E+0 |
| OEP-XHE-XL-NR04HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (WEATHER-RELATED) | 1.40E-3 |
| OEP-XHE-XL-NR10HWR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 10 HOURS (WEATHER-RELATED) | 1.40E-3 |
| OEP-XHE-XX-NR04HWR1 | CONVOLUTION FACTOR FOR 1FTR-OPR (4HR-WR AVAIL) | 5.53E-1 |
| OEP-XHE-XX-NR04HWR2 | CONVOLUTION FACTOR FOR 2FTR-OPR (4HR-WR AVAIL) | 4.37E-1 |
| OEP-XHE-XX-NR04HWR3 | CONVOLUTION FACTOR FOR 3FTR-OPR (4HR-WR AVAIL) | 3.93E-1 |
| OPR-XHE-XM-ALPI | OPERATOR FAILS TO START/CONTROL ALTERNATE LOW PRES INJECTION | 1.00E-3 |
| OPR-XHE-XM-LI01 | OPERATOR FAILS TO START/CONTROL LATE INJECTION | 1.00E-3 |
| PCA-TNK-FC-N2TKA | NITROGEN SUPPLY TANK A IS UNAVAILABLE | 1.00E-2 |
| 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 | 3.97E-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 | 1.10E-2 |
| RCI-XHE-XE-MISCAL | RCIC FAILS FROM MISCALIBRATION OF RUPTURE DISC | 1.90E-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 |
| RHR-MOV-CC-F067 | LPCI LOOP B INJECTION VALVE 74-67 FAILS TO OPEN | 9.63E-4 |
| RHR-MOV-CC-F100 | RHR CROSS TIE MOV 74-100 FAILS TO OPEN | 9.63E-4 |
| RHR-MOV-CF-SPCINJEC | SPC INJECTION VALVES FAIL FROM COMMON CAUSE | 3.06E-5 |
| RHR-STR-CF-NLOCA | SUPPRESSION POOL STRAINERS FAIL FROM COMMON CAUSE (NON-LOCA) | 1.00E-5 |
| RHR-XHE-XM-ERROR | OPERATOR FAILS TO START/CONTROL RHR | 5.00E-4 |
| RRS-MDP-LK-SEALS | RECIRCULATION PUMP SEALS FAIL | 1.00E-1 |
| RS1-XHE-XM-ERROR | OPERATOR FAILS TO ALIGN RHRSW INJECTION | 1.00E-3 |
| RSW-MDP-CF-RUN | RHRSW PUMPS FAIL FROM COMMON CAUSE TO RUN | 2.58E-6 |
| RSW-MDP-CF-START | RHRSW PUMPS FAIL FROM COMMON CAUSE TO START | 1.96E-6 |
| RSW-MOV-CC-F057 | RHRSW/RHR CROSS TIE MOV 23-57 FAILS TO OPEN | 9.63E-4 |
| RSW-STR-CF-ALL | RHRSW STRAINERS FAIL FROM COMMON CAUSE | 4.57E-6 |

Appendix B: Key Event Trees

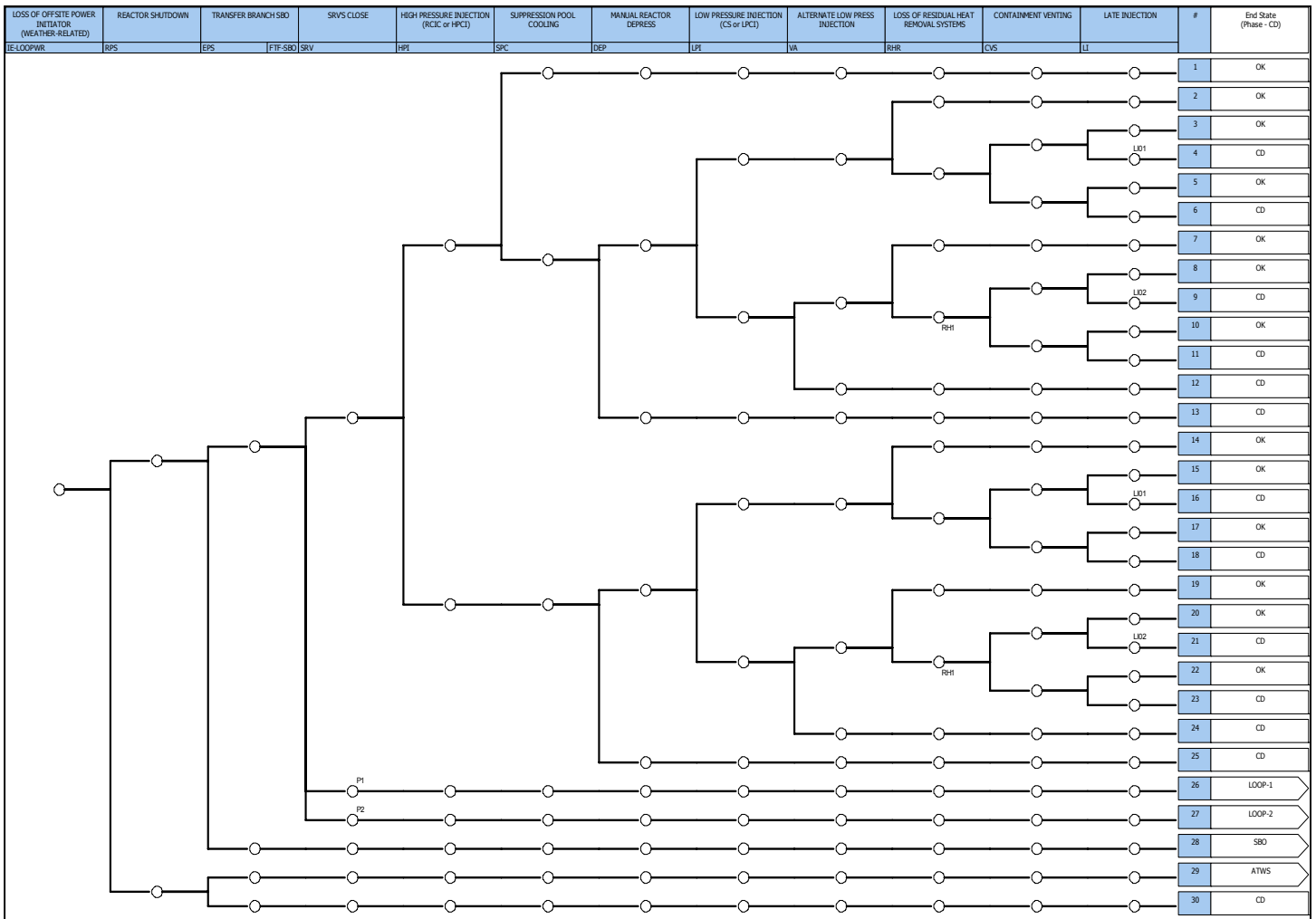


Figure B-1. Browns Ferry LOOP Event Tree (Weather-Related).

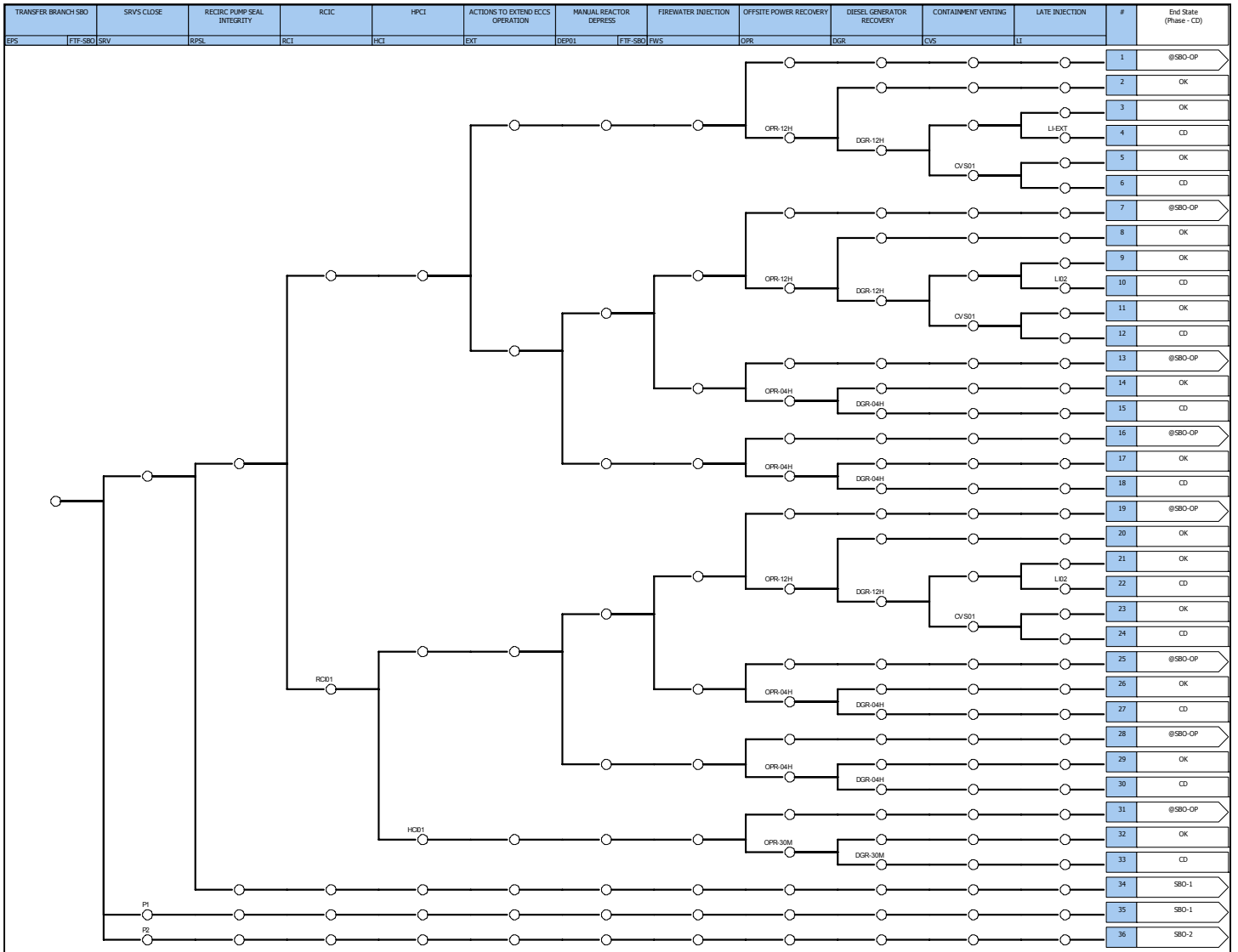


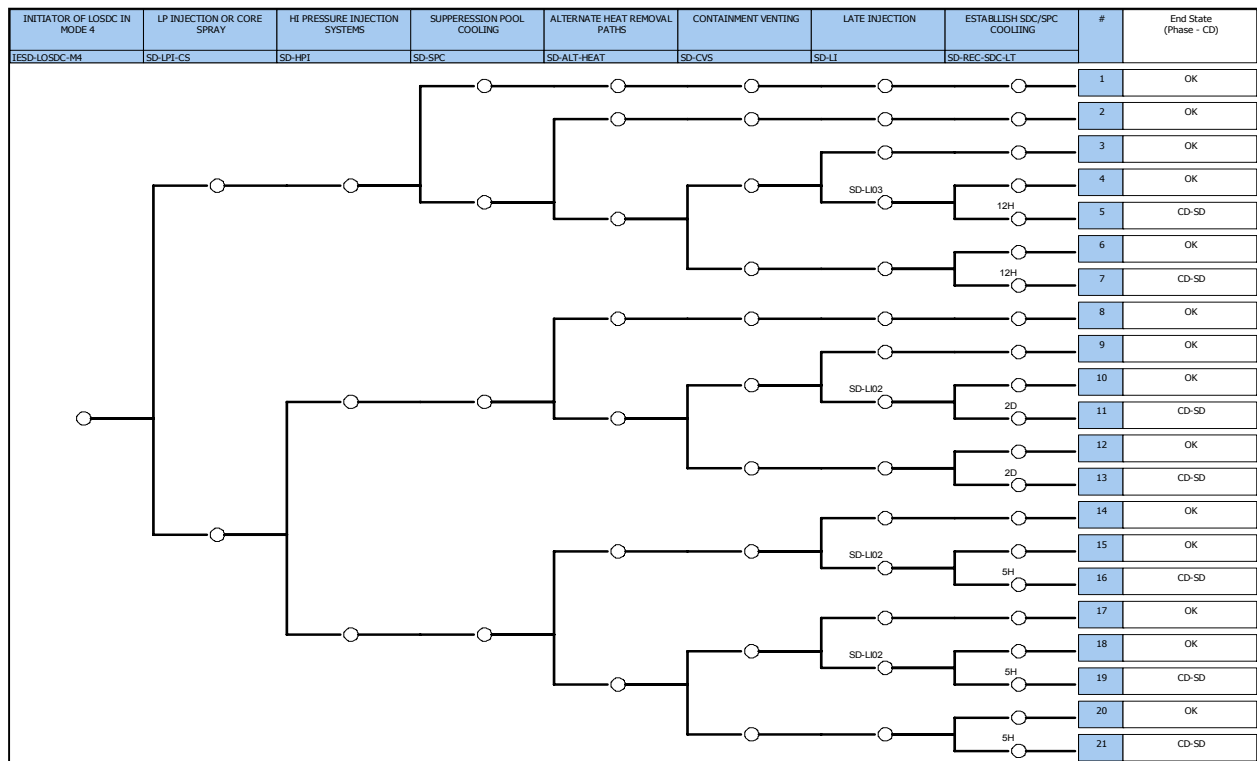
Figure B-2. Browns Ferry SBO Event Tree.

Appendix C: Sensitivity Analysis for Losses of SDC

Shutdown Events Description. On April 28, 2011, at 23:38, with all three units in Mode 4 (Cold Shutdown) and power supplied to the 4kV shutdown boards by onsite EDGs, operators observed a small leak on the governor hydraulic oil system piping for the EDG C. The leak rapidly progressed from one drop per minute to a steady stream/spray. Operators shut down the EDG C, due to worsening voltage and frequency fluctuations. The 4kV Shutdown Board C, which was being powered by the EDG C, de-energized and resulted in a loss of power to the RPS Train B causing a PCIS actuation. The Group 2 PCIS isolation caused the loss of SDC on Unit 1 for 47 minutes. In addition, the loss of power to the 4kV Shutdown Board C also caused the loss of the RHR Pump 2B leading to a momentary suspension of SDC for Unit 2. Shutdown Cooling for Unit 2 was immediately restored using the RHR Pump 2D. Unit 3 was not affected by this event. Additional details are provided in Reference 3.

On May 2, 2011, at approximately 06:26, the EDG A Output Breaker tripped interrupting power to 4kV Shutdown Board A, causing a loss of power to a portion of the Unit 1 RPS leading to PCIS Group 2, 3, 6, and 8 isolations. The Group 2 isolation caused the loss of SDC on Unit 1 for approximately 57 minutes. Power was restored to 4kV Shutdown Board A at 06:43. Units 2 and 3 were not affected by this event. Additional details are provided in Reference 4.

Sensitivity Analysis Assumptions. The two losses of SDC on April 28th (Units 1 and 2) and May 2nd (Unit 1 only) are expected to have similar CCDPs because both events were the result of losses of power to a shutdown board, similar durations of the loss of SDC, and similar operator actions to restore SDC. Therefore, for the purposes of the sensitivity analysis, the loss of SDC on April 28th for Unit 1 was analyzed as a representative case for both losses of SDC. For this analysis, a loss of SDC event tree (*IESD-LOSDC-M4*) for Browns Ferry Unit 1 SPAR model was created and is shown below.



In addition, the following modeling assumptions were made for the analysis of the Unit 1 loss of SDC on April 28th:

- A truncation of 1×10^{-13} was used to ensure the low HEPs in the loss of SDC event tree were preserved in the cutsets.
- The loss of SDC cooling initiating event probability (*IESD-LOSDC-M4*) was set to 1.0. All other shutdown initiating events' probabilities were set to zero.
- The following house events were set to TRUE for this weather related LOOP event.
 - HE-LOOP (*Loss of Offsite Power IE Has Occurred*)
 - HE-LOOP-A (*Loss of Offsite Power to 4kV AC Shutdown Board A*)
 - HE-LOOP-B (*Loss of Offsite Power to 4kV AC Shutdown Board B*)
 - HE-LOOP-C (*Loss of Offsite Power to 4kV AC Shutdown Board C*)
 - HE-LOOP-D (*Loss of Offsite Power to 4kV AC Shutdown Board D*)
 - HE-LOOP-WR (*Loss of Offsite Power IE Has Occurred—Weather-Related*)
- The basic event OEP-VCF-LP-SITEWR (*Weather-Related Site LOOP*) was set to TRUE, since the LOOP affected all three units.
- The basic events SD-XHE-XR-SDC-5H (*Operators Fail to Recover SDC in 5 Hours*), SD-XHE-XR-SDC-12H (*Operators Fail to Recover SDC in 12 Hours*), and SD-XHE-XR-SDC-2D (*Operators Fail to Recover SDC in 2 Days*) were calculated based on References 6 and 7.
 - *Description and Event Context*– Loss SDC due to the PCIS.
 - *Operator Action Success Criteria*– The recovery of SDC requires the resetting of the PCIS and the realignment of the applicable SDC system valves.
 - *Cues*– A loss of SDC caused by an automatic isolation (PCIS Group II or due to high discharge header pressure) would have at least one of the one of the following cues based on AOI-74-1:
 - RHR SYS I/II Discharge or SDC Header Pressure High at 100 psi.
 - 1-FCV-74-47, RHR SDC Suction Outboard Isolation Valve Closed.
 - 1-FCV-74-48, RHR SDC Suction Inboard Isolation Valve Closed.
 - 1-FCV-74-53, RHR System I LPCI Inboard Injection Valve Closed.
 - 1-FCV-74-67, RHR System II LPCI Inboard Injection Valve Closed.
 - *Diagnosis/Action*– These HFEs contain sufficient diagnosis activities. The nominal action component of the HEPs is 0.001. No event information is available to warrant a change in the action PSFs for these HEPs. The table below shows the PSFs that were adjusted; all other PSFs were determined to be *Nominal* (i.e., $\times 1$).
 - Based on the adjusted PSFs, the following HEPs were recalculated:
 - Therefore, basic events SD-REC-SDC-5H, SD-REC-SDC-12H, and SD-REC-SDC-2D were set to 1.4×10^{-3} .

| PSF | Multiplier | Notes |
|----------------|------------|--|
| Time Available | 0.01 | The recovery of SDC is possible by resetting the PCIS isolation signal and restoring the SDC alignment. The time required to perform these actions is estimated to be approximately 40 minutes; therefore, the minimum time for diagnosis is approximately 4 hours. Thus, the available time for these HFEs were assigned as <i>Expansive Time</i> (i.e., $\times 0.01$; time available is >2 times nominal and >30 minutes). |
| Stress | 2 | The PSF for diagnosis stress is assigned a value of <i>High Stress</i> (i.e., $\times 2$) for the recovery of loss of SDC due PCIS. |
| Complexity | 2 | The PSF for diagnosis complexity is assigned a value of <i>Moderately Complex</i> (i.e., $\times 2$) for the multiple actions in and out of the MCR to reset the PCIS and restore the SDC alignment. |

- EDG C was tripped by operators due to a governor hydraulic oil leak. Therefore, basic event EPS-DGN-FR-DGC (*EDG C Fails to Run*) was set to TRUE.
- EDG 3B was not available during the event due to planned maintenance. Therefore, basic event EDG-DGN-TM-DG3B (*EDG 3B is Unavailable Due to Test or Maintenance*) was set to TRUE.

Results. The point estimate CCDP for the Unit 1 loss of SDC on April 28th is 2.4×10^{-7} . The dominant accident sequence, SD-LOSDC-M4 Sequence 11 (CCDP = 2.7×10^{-7}) contributes 49.8% of the total internal events CCDP. The events and important component failures in SD-LOSDC-M4 Sequence 11 are:

- Loss of SDC occurs,
- Low pressure injection or core spray fails,
- High pressure injection succeeds,
- Alternate heat removal fails,
- Containment venting succeeds,
- Residual heat removal service water cooling fails,
- Operators fail to recover SDC in 12 hours.

The tables below provide the following:

- Modified basic events and initiating event frequencies, including base and change case probabilities/frequencies.
- Dominant sequences (including CCDPs).
- Sequence logic for all dominant sequences.
- Fault tree definitions.
- Sequence cutsets.
- Definitions and probabilities for key basic events.

Summary of Conditional Event Changes

| Event | Description | Cond. Value | Nominal Value |
|----------------------------|---|-------------|---------------|
| EPS-DGN-FR-DGC | DIESEL GENERATOR C FAILS TO RUN | TRUE | 2.85E-2 |
| EPS-DGN-TM-DG3B | DG B IS UNAVAILABLE BECAUSE OF MAINTENANCE | TRUE | 1.43E-2 |
| HE-LOOP | HOUSE EVENT - LOSS OF OFFSITE POWER IE HAS OCCURRED | TRUE | FALSE |
| HE-LOOP-A | LOSS OF OFFSITE POWER TO 4KV AC SHUTDOWN BOARD A | TRUE | FALSE |
| HE-LOOP-B | LOSS OF OFFSITE POWER TO 4KV AC SHUTDOWN BOARD B | TRUE | FALSE |
| HE-LOOP-C | LOSS OF OFFSITE POWER TO 4 KVAC SHUTDOWN BOARD C | TRUE | FALSE |
| HE-LOOP-D | LOSS OF OFFSITE POWER TO 4 KVAC SHUTDOWN BOARD D | TRUE | FALSE |
| HE-LOOPWR | HOUSE EVENT - LOSS OF OFFSITE POWER IE HAS OCCURRED (WEATHER-RELATED) | TRUE | FALSE |
| IESD-LOSDC-M4 ^a | INITIATOR OF LOSDC IN MODE 4 | 1.00E+0 | 1.00E+0 |
| OEP-VCF-LP-SITWR | SITE LOOP (WEATHER-RELATED) | TRUE | 6.92E-1 |
| SD-XHE-XR-SDC-12H | FAIL TO RECOVER SDC LATE - 12 HRS | 1.40E-3 | 5.00E-1 |
| SD-XHE-XR-SDC-2D | FAIL TO RECOVER SDC LATE - 2 days | 1.40E-3 | 3.10E-1 |
| SD-XHE-XR-SDC-5H | FAIL TO RECOVER SDC LATE - 5 HRS | 1.40E-3 | 8.00E-1 |

a. All other initiating event probabilities were set to zero.

Implied Event Changes as per RASP Guidance

| Event | Description | Cond. Value | Nominal Value |
|-------------------|--|-------------|---------------|
| EPS-DGN-FR-DG3B | DIESEL GENERATOR 3B FAILS TO RUN | 1.00E+0 | 2.85E-2 |
| EPS-DGN-FS-DG3B | DIESEL GENERATOR 3B FAILS TO START | 1.00E+0 | 2.89E-3 |
| EPS-DGN-FS-DGC | DIESEL GENERATOR C FAILS TO START | FALSE | 2.89E-3 |
| EPS-DGN-TM-DGC | DG C IS UNAVAILABLE BECAUSE OF MAINTENANCE | TRUE | 1.43E-2 |
| EPS-DGN-CF-START | DIESEL GENERATORS FAIL FROM COMMON CAUSE TO START | 4.71E-6 | 4.75E-6 |
| EPS-DGN-CF-RUN | DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 2.08E-3 | 5.93E-5 |
| EPS-DGN-CF-3RUN | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 1.22E-4 | 5.93E-5 |
| EPS-DGN-CF-3START | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO START | 8.01E-6 | 4.75E-6 |

Dominant Sequence Results

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

| Event Tree | Sequence | CCDP | % Contribution | Description |
|--------------|----------|----------------|----------------|--|
| SD-LOSDC-M4 | 11 | 1.90E-7 | 79.5% | SD-LPI-CS, /SD-HPI, SD-ALT-HEAT, /SD-CVS, SD-LI02, SD-REC-SDC-2D |
| SD-LOSDC-M4 | 05 | 3.98E-8 | 16.7% | /SD-LPI-CS, SD-SPC, SD-ALT-HEAT, /SD-CVS, SD-LI, SD-REC-SDC-12H |
| SD-LOSDC-M4 | 07 | 5.26E-9 | 2.2% | /SD-LPI-CS, SD-SPC, SD-ALT-HEAT, SD-CVS, SD-REC-SDC-12H |
| SD-LOSDC-M4 | 13 | 2.94E-9 | 1.2% | SD-LPI-CS, /SD-HPI, SD-ALT-HEAT, SD-CVS, SD-REC-SDC-2D |
| Total | | 2.39E-7 | 100% | |

Referenced Fault Trees

| Fault Tree | Description |
|-------------|------------------------------|
| SD-ALT-HEAT | ALTERNATE HEAT REMOVAL PATHS |
| SD-CVS | CONTAINMENT VENTING |

| Fault Tree | Description |
|----------------|---|
| SD-LI | LATE INJECTION |
| SD-LI02 | RESIDUAL HEAT REMOVAL SERVICE WATER COOLING |
| SD-LPI-CS | LP INJECTION OR CORE SPRAY |
| SD-REC-SDC-12H | ESTABLISH NORMAL SDC LONG TERM |
| SD-REC-SDC-2D | ESTABLISH NORMAL SDC LONG TERM |
| SD-SPC | SUPPERSSION POOL COOLING |

Cutset Report - SD-LOSDC-M4 11

| # | CCDP | Total % | Cutset |
|----|---------|---------|--|
| | 1.90E-7 | 100 | Displaying 7523 of 7523 Cutsets. |
| 1 | 1.40E-8 | 7.38 | IESD-LOSDC-M4, EPS-DGN-CF-ALL, SD-XHE-XR-SDC-2D |
| 2 | 1.37E-8 | 7.23 | IESD-LOSDC-M4, ACP-CRB-CF-OPSD, SD-XHE-XR-SDC-2D |
| 3 | 1.25E-8 | 6.58 | IESD-LOSDC-M4, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, ESW-XHE-XL-NOREC2, SD-XHE-XR-SDC-2D |
| 4 | 6.40E-9 | 3.37 | IESD-LOSDC-M4, RSW-STR-CF-ALL, SD-XHE-XR-SDC-2D |
| 5 | 6.29E-9 | 3.32 | IESD-LOSDC-M4, EPS-DGN-FR-DG3C, EPS-DGN-TM-DG3A, ESW-XHE-XL-NOREC2, SD-XHE-XR-SDC-2D |
| 6 | 6.29E-9 | 3.32 | IESD-LOSDC-M4, EPS-DGN-FR-DG3A, EPS-DGN-TM-DG3C, ESW-XHE-XL-NOREC2, SD-XHE-XR-SDC-2D |
| 7 | 4.87E-9 | 2.57 | IESD-LOSDC-M4, EPS-DGN-CF-3RUN, EPS-DGN-FR-DGB, SD-XHE-XR-SDC-2D |
| 8 | 4.82E-9 | 2.54 | IESD-LOSDC-M4, ACP-XHE-XE-ERRORC, EPS-DGN-FR-DG3A, ESW-XHE-XL-NOREC2, SD-XHE-XR-SDC-2D |
| 9 | 3.17E-9 | 1.67 | IESD-LOSDC-M4, EPS-DGN-TM-DG3A, EPS-DGN-TM-DG3C, ESW-XHE-XL-NOREC2, SD-XHE-XR-SDC-2D |
| 10 | 2.92E-9 | 1.54 | IESD-LOSDC-M4, ACP-XHE-XM-EPST, EPS-DGN-CF-RUN, SD-XHE-XR-SDC-2D |
| 11 | 2.71E-9 | 1.43 | IESD-LOSDC-M4, ACP-CRB-CC-1614, EPS-DGN-FR-DG3C, EPS-DGN-FR-DGB, SD-XHE-XR-SDC-2D |
| 12 | 2.45E-9 | 1.29 | IESD-LOSDC-M4, EPS-DGN-CF-3RUN, EPS-DGN-TM-DGB, SD-XHE-XR-SDC-2D |
| 13 | 2.43E-9 | 1.28 | IESD-LOSDC-M4, ACP-XHE-XE-ERRORC, EPS-DGN-TM-DG3A, ESW-XHE-XL-NOREC2, SD-XHE-XR-SDC-2D |
| 14 | 2.36E-9 | 1.25 | IESD-LOSDC-M4, EPS-DGN-CF-RUN, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, SD-XHE-XR-SDC-2D |
| 15 | 2.36E-9 | 1.25 | IESD-LOSDC-M4, EPS-DGN-CF-RUN, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3D, SD-XHE-XR-SDC-2D |
| 16 | 2.36E-9 | 1.25 | IESD-LOSDC-M4, EPS-DGN-CF-RUN, EPS-DGN-FR-DG3C, EPS-DGN-FR-DG3D, SD-XHE-XR-SDC-2D |
| 17 | 2.26E-9 | 1.19 | IESD-LOSDC-M4, EPS-DGN-CF-3RUN, RSW-MDP-TM-TRNC1, SD-XHE-XR-SDC-2D |

Cutset Report - SD-LOSDC-M4 05

| # | CCDP | Total % | Cutset |
|---|----------|---------|---|
| | 3.98E-8 | 100 | Displaying 14405 of 14405 Cutsets. |
| 1 | 4.59E-10 | 1.15 | IESD-LOSDC-M4, CRD-SYS-FC-ARUN, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, EPS-DGN-FR-DGB, EPS-DGN-FR-DGD, SD-XHE-XR-SDC-12H |
| 2 | 4.59E-10 | 1.15 | IESD-LOSDC-M4, CRD-SYS-FC-BRUN, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, EPS-DGN-FR-DGB, EPS-DGN-FR-DGD, SD-XHE-XR-SDC-12H |

Cutset Report - SD-LOSDC-M4 07

| # | CCDP | Total % | Cutset |
|---|----------|---------|--|
| | 5.26E-9 | 100 | Displaying 2810 of 2810 Cutsets. |
| 1 | 3.23E-10 | 6.14 | IESD-LOSDC-M4, CAD-TNK-FC-N2TKA, EPS-DGN-FR-DG3A, EPS-DGN-FR-DG3C, EPS-DGN-FR-DGB, SD-XHE-XR-SDC-12H |
| 2 | 1.63E-10 | 3.09 | IESD-LOSDC-M4, CAD-TNK-FC-N2TKA, EPS-DGN-FR-DG3A, EPS-DGN-FR-DGB, EPS-DGN-TM-DG3C, SD-XHE-XR-SDC-12H |
| 3 | 1.63E-10 | 3.09 | IESD-LOSDC-M4, CAD-TNK-FC-N2TKA, EPS-DGN-FR-DG3C, EPS-DGN-FR-DGB, EPS-DGN-TM-DG3A, SD-XHE-XR-SDC-12H |

| # | CCDP | Total % | Cutset |
|----|----------|---------|---|
| 4 | 1.63E-10 | 3.09 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,EPS-DGN-FR-DG3C,EPS-DGN-TM-DGB,SD-XHE-XR-SDC-12H |
| 5 | 1.25E-10 | 2.37 | IESD-LOSDC-M4,ACP-XHE-XE-ERRORC,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,EPS-DGN-FR-DGB,SD-XHE-XR-SDC-12H |
| 6 | 8.21E-11 | 1.56 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DGB,EPS-DGN-TM-DG3A,EPS-DGN-TM-DG3C,SD-XHE-XR-SDC-12H |
| 7 | 8.21E-11 | 1.56 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3C,EPS-DGN-TM-DG3A,EPS-DGN-TM-DGB,SD-XHE-XR-SDC-12H |
| 8 | 8.21E-11 | 1.56 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,EPS-DGN-TM-DG3C,EPS-DGN-TM-DGB,SD-XHE-XR-SDC-12H |
| 9 | 6.29E-11 | 1.2 | IESD-LOSDC-M4,ACP-XHE-XE-ERRORC,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,EPS-DGN-TM-DGB,SD-XHE-XR-SDC-12H |
| 10 | 6.29E-11 | 1.2 | IESD-LOSDC-M4,ACP-XHE-XE-ERRORC,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DGB,EPS-DGN-TM-DG3A,SD-XHE-XR-SDC-12H |
| 11 | 5.43E-11 | 1.03 | IESD-LOSDC-M4,DCP-XHE-XM-1ABC,EPS-DGN-FR-DG3A,ESW-MDP-FS-PMPD3,SD-XHE-XR-SDC-12H |
| 12 | 5.43E-11 | 1.03 | IESD-LOSDC-M4,DCP-XHE-XM-1ABC,EPS-DGN-FR-DG3C,ESW-MDP-FS-PMPD3,SD-XHE-XR-SDC-12H |

Cutset Report - SD-LOSDC-M4 13

| # | CCDP | Total % | Cutset |
|----|----------|---------|---|
| | 2.94E-9 | 100 | Displaying 2052 of 2052 Cutsets. |
| 1 | 1.54E-10 | 5.24 | IESD-LOSDC-M4,DCP-BDC-TM-RMOV1B,SD-XHE-XR-SDC-2D,SIS-ACT-CF-LRP |
| 2 | 1.54E-10 | 5.24 | IESD-LOSDC-M4,DCP-BDC-TM-RMOV1A,SD-XHE-XR-SDC-2D,SIS-ACT-CF-LRP |
| 3 | 1.40E-10 | 4.76 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-CF-ALL,SD-XHE-XR-SDC-2D |
| 4 | 1.37E-10 | 4.66 | IESD-LOSDC-M4,ACP-CRB-CF-OPSD,CAD-TNK-FC-N2TKA,SD-XHE-XR-SDC-2D |
| 5 | 1.25E-10 | 4.25 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,EPS-DGN-FR-DG3C,ESW-XHE-XL-NOREC2,SD-XHE-XR-SDC-2D |
| 6 | 6.40E-11 | 2.18 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,RSW-STR-CF-ALL,SD-XHE-XR-SDC-2D |
| 7 | 6.29E-11 | 2.14 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3C,EPS-DGN-TM-DG3A,ESW-XHE-XL-NOREC2,SD-XHE-XR-SDC-2D |
| 8 | 6.29E-11 | 2.14 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,EPS-DGN-TM-DG3C,ESW-XHE-XL-NOREC2,SD-XHE-XR-SDC-2D |
| 9 | 4.87E-11 | 1.66 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-CF-3RUN,EPS-DGN-FR-DGB,SD-XHE-XR-SDC-2D |
| 10 | 4.82E-11 | 1.64 | IESD-LOSDC-M4,ACP-XHE-XE-ERRORC,CAD-TNK-FC-N2TKA,EPS-DGN-FR-DG3A,ESW-XHE-XL-NOREC2,SD-XHE-XR-SDC-2D |
| 11 | 3.17E-11 | 1.08 | IESD-LOSDC-M4,CAD-TNK-FC-N2TKA,EPS-DGN-TM-DG3A,EPS-DGN-TM-DG3C,ESW-XHE-XL-NOREC2,SD-XHE-XR-SDC-2D |

Referenced Events

| Event | Description | Probability |
|-------------------|---|-------------|
| ACP-CRB-CC-1614 | SD BOARD A OFFSITE POWER SUPPLY BREAKER FAILS TO OPEN | 2.39E-3 |
| ACP-CRB-CF-OPSD | COMMON CAUSE FAILURE OF OFFSITE POWER FEED TO SHUTDOWN BOARDS | 9.79E-6 |
| ACP-XHE-XE-ERRORC | OPERATOR FAILS TO ALIGN 3C DIESEL TO SHUTDOWN BOARD C | 1.10E-2 |
| ACP-XHE-XM-EPSXT | OPERATOR FAILS TO CROSSTIE EMERGENCY BUSES | 1.00E-3 |
| CAD-TNK-FC-N2TKA | N2 SUPPLY TANK A IS UNAVAILABLE (CONTAINMENT AIR DILUTION) | 1.00E-2 |
| CRD-SYS-FC-ARUN | CRD PUMP A IS RUNNING PUMP B IS IN STANDBY | 5.00E-1 |
| CRD-SYS-FC-BRUN | CRD PUMP B IS RUNNING PUMP A IS IN STANDBY | 5.00E-1 |
| DCP-BDC-TM-RMOV1A | 250 VDC RMOV BOARD 1A IS UNAVAILABLE DUE TO TM | 2.15E-4 |
| DCP-BDC-TM-RMOV1B | 250 VDC RMOV BOARD 1B IS UNAVAILABLE | 2.15E-4 |
| DCP-XHE-XM-1ABC | OPERATOR FAILS TO ALIGN BACKUP POWER TO DC-MOV1A B C | 1.00E-3 |
| EPS-DGN-CF-3RUN | UNIT 3 DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 1.22E-4 |

| Event | Description | Probability |
|-------------------|---|-------------|
| EPS-DGN-CF-ALL | ALL 8 DIESEL GENERATORS FAIL FROM COMMON CAUSE | 1.00E-5 |
| EPS-DGN-CF-RUN | DIESEL GENERATORS FAIL FROM COMMON CAUSE TO RUN | 2.08E-3 |
| EPS-DGN-FR-DG3A | DIESEL GENERATOR 3A FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DG3C | DIESEL GENERATOR 3C FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DG3D | DIESEL GENERATOR 3D FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DGB | DIESEL GENERATOR B FAILS TO RUN | 2.85E-2 |
| EPS-DGN-FR-DGD | DIESEL GENERATOR D FAILS TO RUN | 2.85E-2 |
| EPS-DGN-TM-DG3A | DG A IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| EPS-DGN-TM-DG3C | DG C IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| EPS-DGN-TM-DGB | DG B IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.43E-2 |
| ESW-MDP-FS-PMPD3 | EECW PUMP D3 FAILS TO START | 1.36E-3 |
| ESW-XHE-XL-NOREC2 | OPERATOR FAILS TO RECOVER EECW WITH SWING PUMP AVAILABLE | 1.10E-2 |
| IESD-LOSDC-M4 | INITIATOR OF LOSDC IN MODE 4 | 1.00E+0 |
| RSW-MDP-TM-TRNC1 | RHRWS PUMP C1 IS UNAVAILABLE BECAUSE OF MAINTENANCE | 1.32E-2 |
| RSW-STR-CF-ALL | RHRWS STRAINERS FAIL FROM COMMON CAUSE | 4.57E-6 |
| SD-XHE-XR-SDC-12H | FAIL TO RECOVER SDC LATE - 12 HOURS | 1.40E-3 |
| SD-XHE-XR-SDC-2D | FAIL TO RECOVER SDC LATE - 2 DAYS | 1.40E-3 |
| SIS-ACT-CF-LRP | DIVISION I, II LOW RX PRESS PERMISSIVE SIGNALS FAIL FROM COMMON CAUSE | 5.12E-4 |