# Final Precursor Analysis

**Accident Sequence Precursor Program – Office of Nuclear Regulatory Research**

| | | |
|---|---|---|
| **Millstone Power Station Units 2 and 3** | Ground Fault during Line Maintenance Causes Loss of Offsite Power to Both Units | |
| **Event Date:** 5/25/2014 | **LER:** 336/14-006<br>**IR:** 50-336/14-11 | **CCDPs =** $1\times10^{-5}$ (Unit 2)<br>$2\times10^{-5}$ (Unit 3) |
| **Plant Type:** Pressurized-Water Reactors (PWRs)<br>Combustion Engineering with a Large Dry Containment (Unit 2)<br>Westinghouse 4-Loop with Sub-Atmospheric Containment (Unit 3) | | |
| **Plant Operating Mode (Reactor Power Level):** Mode 1 (100% Reactor Power, Both Units) | | |
| **Analyst:** Christopher Hunter | **Reviewer:** Song-hua Shen | **Contributors:** N/A |

## EXECUTIVE SUMMARY


At 7:01 a.m. on May 25, 2014, with Millstone Power Station Units 2 and 3 operating at 100% reactor power, a total loss of offsite power (LOOP) occurred. The cause of the LOOP was a ground fault on one of the three offsite power lines with another line out for maintenance. The third line tripped on over-current because it was not capable of supporting the full power output for the site. Both units experienced a turbine trip on power to load imbalance followed by an automatic reactor trip. Both units' safety-related emergency diesel generators (EDGs) automatically started and supplied power to their respective safety busses. As designed, the motor-driven auxiliary feedwater (AFW) pumps automatically started for Unit 2 and all AFW pumps automatically started for Unit 3. Offsite power was restored to at least one safety bus at each unit by approximately 10:30 a.m. and fully restored at 12:56 p.m. on May 25, 2014.

According to the risk analysis modeling assumptions used in this Accident Sequence Precursor (ASP) analysis, the most likely core damage sequence for Unit 2 is a non-recoverable LOOP and subsequent station blackout (SBO) due to postulated failures of all EDGs (including the SBO diesel generator), the failure of the turbine-driven AFW pump, and the failure to restore power to a safety bus within one hour. This accident sequence accounts for approximately 67% of the event conditional core damage probability (CCDP) for Unit 2.

For Unit 3, the most likely core damage sequence is non-recoverable LOOP and subsequent SBO due to postulated failures of both Unit 3 EDGs. Operators successfully aligned the SBO diesel generator to one of the Unit 3's safety buses; however, the operators do not have sufficient time to perform this action to prevent a challenge to the integrity of reactor coolant pump (RCP) seals (due to lack of seal injection/cooling) and subsequent loss-of-coolant accident (LOCA) occurs. AFW and high-pressure injection (HPI) are successful, but failure of high-pressure recirculation leads to core damage. This accident sequence accounts for approximately 23% of the event CCDP for Unit 3.

In general, these results are consistent with at-power LOOP events previously analyzed by the ASP Program at other PWRs.

## EVENT DETAILS

**Event Description.** At 7:01 a.m. on May 25, 2014, with Millstone Power Station Units 2 and 3 operating at 100% reactor power, a total LOOP occurred. Both units experienced a turbine trip on power to load imbalance followed by an automatic reactor trip. Both units' safety-related EDGs automatically started and supplied power to their respective safety busses. As designed, the motor-driven AFW pumps automatically started for Unit 2 and all AFW pumps automatically started for Unit 3.

The Millstone staff declared a Notice of Unusual Event (NOUE) for both units at 7:15 a.m. due to a LOOP for greater than 15 minutes. Offsite power was restored to at least one safety bus at each unit by approximately 10:30 a.m. and fully restored at 12:56 p.m. on May 25, 2014. The NOUE was exited at 2:14 p.m. on May 25, 2014.

Additional information is provided in Reference 1 (licensee event report) and Reference 2 (inspection report).

**Cause.** Prior to the event, the station had one offsite line out-of-service (Line 371) for maintenance. A suspected ground fault on the grid in the Northeast Utilities' Card substation caused the loss of offsite Line 383. Line 310 tripped on instantaneous ground over current, which was unexpected. The final line (Line 348) tripped on over-current when both units attempted to feed the full power output of both Millstone units through the single remaining line (Line 348).

**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.

- Unit 2 experienced a water hammer in the condensate polishing facility during the event. This was entered into licensee's corrective action program. The condensate polishing facility is not risk significant; therefore, the system is not modeled in the Millstone Unit 2 Standardized Plant Analysis Risk (SPAR) Model. In addition, the condenser heat sink including feedwater condensate systems are assumed to be unavailable during a LOOP.

- The Unit 3 reactor trip was affected by a loss of air when the Instrument Air Compressor 13 failed to start. The loss of instrument air affected head vent letdown alignment. After unsuccessful attempts to align the head vent to the volume control tank, letdown was returned to the pressurizer relief tank (PRT) and the PRT rupture disk burst approximately 20 minutes later. Normal charging and letdown was subsequently restored, which resulted in lifting a relief valve in the letdown line. This relief valve discharged to the primary drains transfer tank (PDTT). As a result, a PDTT high level alarm was received and normal charging and letdown was isolated nine minutes later. Instrument air is not safety-related and is not currently modeled in the Millstone Unit 3 SPAR model. However, operators manually cycled the power operated relief valves (PORVs) to control RCS pressure. The demand of the PORVs and their potential failure to reclose after demand is modeled in Unit 3 analysis (see Key Modeling Assumptions for Unit 3).

## MODELING ASSUMPTIONS

**Analysis Type.** The Millstone Unit 2 SPAR Model Revision 8.17 (created in March 2011) and Millstone Unit 3 SPAR Model Revision 8.20 (created in March 2012), were used for the analyses of this event. This event was modeled as a grid-related LOOP initiating event for both units.

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

**Key Modeling Assumptions for Both Units.** The following modeling assumptions were determined to be significant to the modeling of the event analyses for both units:

- The analyses model the May 25, 2014, dual-unit reactor trip at Millstone Power Station as grid-related LOOP initiating events.
  - The probability of grid-related LOOP (*IE-LOOPGR*) was set to 1.0; all other initiating event probabilities were set to zero.
  - Basic Event LOOP-DUAL-UNIT (*Dual Unit LOOP*) was set to TRUE. In addition, Basic Event LOOP-SNGL-UNIT (*Single Unit LOOP*) was set to FALSE.

- To adjust the potential for each unit needing the SBO diesel generator, the combined failure probability of each unit's dedicated EDGs was calculated for a 3-hour mission time. The calculated failure probability of $6.8\times10^{-4}$ was used for Basic Events EPS-DGN-FC-UNIT2 (*SBO Diesel Generator Aligned to Unit 2*) and EPS-DGN-FC-UNIT3 (*SBO Diesel Generator Aligned to Unit 3*).

- *Offsite Power Recovery.* The time required to restore offsite power to plant emergency equipment is a significant factor in modeling the CCDP given a LOOP. The LOOP/SBO modeling within the SPAR models includes various sequence-specific power recovery factors that are based on the time available to recover offsite power to prevent core damage. For a sequence involving failure of all of the cooling sources (e.g., postulated SBO with a failure of turbine-driven AFW pump), approximately one hour would be available to recover offsite power to avoid core damage. Sequences involving successful early inventory control and decay heat removal, but subsequent failure of RCP seals resulting in a LOCA or the failure of long-term decay heat removal, would give operators additional time to recover offsite power prior to core damage.

  The key offsite power recovery times for Millstone Unit 2 that are modeled within the SPAR model are:

  - 1 Hour—A LOOP and subsequent SBO with failure of all turbine-driven AFW pump, failure of a PORV(s) to reclose resulting in a LOCA, or a LOCA resulting from the failure of the RCP seals.
  - 2 Hours—A LOOP with successful emergency ac power and AFW, but with a PORV(s) failing to reclose resulting in a LOCA. Recovery of offsite power must occur with sufficient time to recover condenser vacuum and depressurize the reactor coolant system (RCS) to shutdown cooling initiation conditions (assumed to take 4 hours) before refueling water storage tank (RWST) depletion and recirculation sump switch over at six hours. Failure requires the use of high-pressure recirculation.

– 6 Hours—A LOOP with successful emergency ac power with the failure of AFW and successful once through cooling. Recovery of offsite power must occur with sufficient time to recover secondary side cooling before RWST depletion and recirculation sump switch over at six hours. Failure requires the use of high-pressure recirculation.
– 8 Hours—A LOOP and subsequent SBO with successful running of the turbine-driven AFW pump with no subsequent LOCA (e.g., PORV failing to reclose or RCP seal failure). Operators must restore offsite power prior to the battery depletion time of 8 hours.

The key offsite power recovery times for Millstone Unit 3 that are modeled within the SPAR model are:

– 1 Hour—A LOOP and subsequent SBO with failure of all turbine-driven AFW pump, failure of a PORV(s) to reclose resulting in a LOCA, or a LOCA resulting from the failure of the RCP seals.
– 2 Hours—A LOOP with successful emergency ac power and AFW, but with a PORV(s) failing to reclose resulting in a LOCA. Recovery of offsite power must occur with sufficient time to recover condenser vacuum and depressurize the reactor coolant system (RCS) to shutdown cooling initiation conditions (assumed to take 4 hours) before refueling water storage tank (RWST) depletion and recirculation sump switch over at six hours. Failure requires the use of high-pressure recirculation. In addition, the 2-hour recovery time applies to a LOOP and subsequent SBO with failure of both stages of RCP seals resulting in a 480 gpm/RCP LOCA. Operators must recover offsite power prior to core uncovery.
– 3 Hours— A LOOP and subsequent SBO with operators failing to depressurize the secondary and the failure (binding/popping or o-ring extrusion) of Stage 2 of RCP seals resulting in a 176–182 gpm/RCP LOCA. Operators must recover offsite power prior to core uncovery.
– 4 Hours—A LOOP and subsequent SBO with operators successfully depressurizing the secondary and the failure (binding/popping) of Stage 2 of RCP seals resulting in a 182 gpm/RCP LOCA. Operators must recover offsite power prior to core uncovery.
– 6 Hours—A LOOP with successful emergency ac power with the failure of AFW and successful once through cooling. Recovery of offsite power must occur with sufficient time to recover secondary side cooling before RWST depletion and recirculation sump switch over at six hours. Failure requires the use of high-pressure recirculation. In addition, the 6-hour recovery time applies to a LOOP and subsequent SBO with operators failing to depressurize the secondary and the failure (o-ring extrusion) of Stage 1 of RCP seals resulting in a 61 gpm/RCP LOCA. Operators must recover offsite power prior to core uncovery.
– 8 Hours—A LOOP and subsequent SBO with successful running of the turbine-driven AFW pump with no subsequent LOCA (e.g., PORV failing to reclose or RCP seal failure). Operators must restore offsite power prior to the battery depletion time of 8 hours.

Offsite power was restored to both units' reserve station service transformers (RSSTs) approximately 3 hours after the LOOP occurred. It took an additional 30 minutes (approximately) for operators to restore offsite power to the first safety bus for each unit. However, this could be done more quickly (5–10 minutes) if more immediate power recovery

was needed (e.g., postulated SBO). Based on this information, recovery of offsite power to a safety bus prior to 3 hours is assumed to fail for both units.

– Therefore, the recovery action OEP-XHE-XL-N01H (*Operator Fails to Recover Offsite Power in 1 Hour*), and OEP-XHE-XL-N02H (*Operator Fails to Recover Offsite Power in 2 Hours*) were set to TRUE for Unit 2. For Unit 3, OEP-XHE-XL-N01HGR (*Operator Fails to Recover Offsite Power in 1 Hour (Grid-Related)*), OEP-XHE-XL-N02HGR (*Operator Fails to Recover Offsite Power in 2 Hours (Grid-Related)*), and OEP-XHE-XL-N03HGR (*Operator Fails to Recover Offsite Power in 3 Hours (Grid-Related)*) were set to TRUE.

Credit was given for offsite power recovery for applicable times greater than 3 hours. The SPAR-H Human Reliability Analysis Method (Reference 3 and Reference 4) was used to estimate non-recovery probabilities as a function of time following restoration of offsite power to the switchyard.

Tables 1 and 2 provide the key qualitative information for this recovery and the performance shaping factor (PSFs) adjustments required for the quantification of offsite power recovery events for times greater than 2 hours using SPAR-H.

**Table 1.** Key Qualitative Information for Offsite Power Recovery after 3 Hours.

| | |
|---|---|
| **Definition** | The definition for overall recovery is the operators' failure to align the RSST to re-energize a safety bus in 4 to 8 hours (depending on the sequence). |
| **Description and Event Context** | Depending on postulated failures of the EDGs, RCP seals (due to unavailability of seal injection/cooling), PORV(s) reclosing after demand, the availability of the turbine-driven AFW pump, and the time until the station batteries are depleted, operators would have between 4–8 hours to re-energize prior to core uncovery. |
| **Operator Action Success Criteria** | Once power has been restored to the RSST, operators would need to close one of the RSS supply breakers to energize a safety bus. The time available for operators to perform this action would be a minimum of 1 hour. |
| **Nominal Cues** | Loss of voltage on one or more safety buses |
| **Procedural Guidance** | ***Unit 2***<br>• EOP 2528, "Loss of Offsite Power/Loss of Forced Circulation"<br>• EOP 2530, "Station Blackout"<br>• Appendix 23, "Restoring Electrical Power"<br>***Unit 3***<br>• EOP 35, ECA-0.0, "Loss of All AC Power"<br>• EOP 35, GA-3, "Energizing 4.16V Bus from Offsite Power" |
| **Diagnosis/Action** | This recovery action contains diagnosis and action activities. |

**Table 2.** SPAR-H Evaluation for Offsite Power Recovery after 3 Hours.

| PSF | Multiplier Diagnosis / Action | Notes |
|---|---|---|
| Time Available | 0.01 / 1 | For recovery actions with 4 hours or more available, approximately 1 hour (at a minimum) would be available to perform the actions required to re-energize a safety bus prior to core uncovery. Therefore, the diagnosis PSF for available time is assigned as *Expansive Time* (i.e., ×0.01; time available is >2 times nominal and >30 minutes).<br>Sufficient time exists to perform the action component of the offsite power recovery; therefore, the action PSF for available time is set to *Nominal*. See Reference 4 for guidance on apportioning time between the diagnosis and action components of an HFE. |
| Stress | 2 / 1 | The PSF for diagnosis stress is assigned a value of *High Stress* (i.e., ×2) due to the postulated SBO and that core damage will occur if operators fail to restore power to a safety bus.<br>The PSF for action stress was not determined to be a performance driver for this HFE; and therefore, was assigned a value of *Nominal* (i.e., ×1). |
| Complexity | 2 / 1 | The PSF for diagnosis complexity is assigned a value of *Moderately Complex* (i.e., ×2) because operators would have to deal with multiple equipment unavailabilities and the concurrent actions/multiple procedures during a LOOP and postulated SBO.<br>The PSF for action complexity was not determined to be a performance driver for this HFE; and therefore, was assigned a value of *Nominal* (i.e., ×1). |
| Procedures Experience/Training, Ergonomics/HMI, Fitness for Duty, Work Processes | 1 /1 | No event information is available to warrant a change in these PSFs (diagnosis or action) from *Nominal* for this HFE. |

Offsite power recovery actions with at least three hours of available time are calculated using the following SPAR-H formula:

*Power Recovery HEP = (Product of Diagnosis PSFs * Nominal Diagnosis HEP) + (Product of Action PSFs * Nominal Action HEP)*

$= (0.04 * 0.01) + (1 * 0.001) = 1\times10^{-3}$

Therefore, the following Unit 2 HEPs for offsite power recovery, OEP-XHE-XL-NR06H (*Operator Fails to Recover Offsite Power in 6 Hours*) and OEP-XHE-XL-NR08H (*Operator Fails to Recover Offsite Power in 8 Hours*), are calculated to be $1\times10^{-3}$.

The following Unit 3 HEPs for offsite power recovery, OEP-XHE-XL-NR04HGR (*Operator Fails to Recover Offsite Power in 4 Hours(Grid-Related)*), OEP-XHE-XL-NR06HGR

(*Operator Fails to Recover Offsite Power in 6 Hours(Grid-Related)*), and OEP-XHE-XL-NR08HGR (*Operator Fails to Recover Offsite Power in 8 Hours (Grid-Related)*), are calculated to be $1\times10^{-3}$.

- The offsite power was recovered to at least one safety bus in both units in approximately 3 hours and 30 minutes after the LOOP occurred. Offsite power was restored to all safety buses (for both units) approximately 6 hours after the LOOP occurred. Therefore, the default EDG and turbine-driven AFW pump mission times were changed to reflect the actual time offsite power was restored to the safety buses. Since the overall fail-to-run is made up of two separate factors, the mission times for these factors were set to the following: ZT-DGN-FR-E = 1 hour and ZT-TDP-FR-E = 1 hour (nominal values) and ZT-DGN-FR-L = 2.5 hours and ZT-TDP-FR-L= 5 hours.

**Key Modeling Assumptions for Unit 3.** In addition, to the modeling assumptions above; the following assumptions were made in Unit 3 analysis:

- The Basic Events PPR-SRV-CO-L (*PORVs/SRVs Open during a LOOP*) and PPR-SRV-CO-B (*PORVs/SRVs Open during an SBO*) were set to TRUE because operators used both PORVs to control RCS pressure due to the loss of letdown. There were 11 open/close cycles of both PORVs; PORV 455A was cycled six times and PORV 456 was cycled five times. Therefore, a binomial expansion was used to adjust the failure probabilities for Basic Events PPR-SRV-OO-455A (*PORV 455A Fails to Reclose after Opening*) and PPR-SRV-OO-456 (*PORV 456 Fails to Reclose after Opening*) to account for the increased probability that the valves could stick open. These probabilities were changed to $5.8\times10^{-3}$ and $4.8\times10^{-3}$, respectively.

- The diesel-driven firewater pump was reported to be out of service. The firewater system is not modeled explicitly except two operator actions to align firewater for alternated supply of AFW and alternated cooling water to the charging pumps. Therefore, Basic Events AFW-XHE-XM-FIREW (*Operator Fails to Align Firewater to AFW Suction*) and CCE-XHE-XM-ACOOL (*Operator Fails to Establish Firewater to the Charging Pump Cooling Heat Exchangers*) were set to TRUE. This simplifying modeling assumption has a negligible impact on the Unit 3 CCDP.

## ANALYSIS RESULTS

**CCDPs.** The point estimate CCDPs for this event are $1.2\times10^{-5}$ (Unit 2) and $1.6\times10^{-5}$ (Unit 3). The ASP Program acceptance threshold is a CCDP of $1\times10^{-6}$ or the CCDP equivalent of an uncomplicated reactor trip with a non-recoverable loss of secondary plant systems (e.g., feed water and condensate), whichever is greater. This CCDP equivalent is $1\times10^{-6}$ and $6\times10^{-7}$, for Millstone Units 2 and 3, respectively. Therefore, this event resulted in a precursor for both units.

**Unit 2 Dominant Sequence.** The dominant accident sequence is LOOP/SBO Sequence 22-31 (CCDP = $8.1\times10^{-6}$), which contributes approximately 67% of the total internal events CCDP. The cut sets and sequences that contribute to the top 95% and/or at least 1% of the total internal events CCDP are provided in Appendix A.

The dominant sequence is shown graphically in Figures C-1 and C-2 in Appendix C. The events and important component failures in LOOP/SBO Sequence 22-31 are:

- A non-recoverable grid-related LOOP occurs,
- Reactor scram succeeds,
- Emergency powers fails,
- Safety relief valves reclose (if opened),
- Turbine-driven AFW pump fails, and
- Operators fail to recover ac power (offsite power or EDGs) within 1 hour.

**Unit 3 Dominant Sequence.** The dominant accident sequence is LOOP/SBO Sequence 16-01-04 (CCDP =3.7 $\times 10^{-6}$), which contributes approximately 23% of the total internal events CCDP. The cut sets and sequences that contribute to the top 95% and/or at least 1% of the total internal events CCDP are provided in Appendix B.

The dominant sequence is shown graphically in Figures C-3 and C-4 in Appendix C. The events and important component failures in LOOP/SBO Sequence 16-01-04 are:

- A non-recoverable grid-related LOOP occurs,
- Reactor scram succeeds,
- Normal emergency powers fails resulting in an SBO,
- SBO diesel generator is successful, but not before RCP seals are challenged due to lack of cooling/injection,
- Safety relief valves reclose (if opened),
- AFW is successful,
- Rapid secondary depressurization is successful,
- Stage 2 of the RCP seals fail (binding and popping),
- Operators fail to recover ac power (offsite power or EDGs) within 2 hours,
- High-pressure injection is successful, and
- High-pressure recirculation fails.

## REFERENCES

1. Dominion Nuclear Connecticut, Inc., "LER 336/14-006– Millstone Power Station Dual Unit Reactor Trip on Loss of Offsite Power," dated July 24, 2014 (ML14211A526).

2. U.S. Nuclear Regulatory Commission, "Millstone Power Station Units 2 and 3 – NRC Special Inspection Report 05000336/2014011 AND 05000423/2014011," dated August 28, 2014 (ML14240A006).

3. Idaho National Laboratory, NUREG/CR-6883, "The SPAR-H Human Reliability Analysis Method," August 2005 (ML051950061).

4. Idaho National Laboratory, "INL/EXT-10-18533, SPAR-H Step-by-Step Guidance," May 2011 (ML112060305).

# Appendix A: Unit 2 Analysis Results

### Summary of Conditional Event Changes

| Event | Description | Cond. Value | Nominal Value |
|---|---|---|---|
| EPS-DGN-FC-UNIT3 | BLACKOUT DIESEL IS REQUIRED BY UNIT 3 | 6.80E-4 | 0.00E+0 |
| IE-LOOP[a] | LOSS OF OFFSITE POWER | 1.00E+0 | 2.84E-2 |
| LOOP-DUAL-UNIT | DUAL UNIT LOOP | TRUE | 5.82E-1 |
| LOOP-SNGL-UNIT | SINGLE UNIT LOOP | FALSE | 4.18E-1 |
| OEP-XHE-XL-NR01H | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR | TRUE | 5.46E-1 |
| OEP-XHE-XL-NR02H | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2 HOURS | TRUE | 3.39E-1 |
| OEP-XHE-XL-NR06H | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 6 HOURS | 1.00E-3 | 1.10E-1 |
| OEP-XHE-XL-NR08H | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 8 HOURS | 1.00E-3 | 7.82E-2 |
| ZT-DGN-FR-L | DIESEL GENERATOR FAILS TO RUN | 2.70E-3 | 2.47E-2 |
| ZT-TDP-FR-L | TURBINE DRIVEN PUMP FAILS TO RUN | 7.80E-3 | 3.52E-2 |

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

### Dominant Sequence Results

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

| Event Tree | Sequence | CCDP | % Contribution | Description |
|---|---|---|---|---|
| LOOP | 22-31 | 8.06E-6 | 67.1% | /RPS, EPS, EPS-SBO, AFW-B, OPR-01H, DGR-01H |
| LOOP | 21 | 3.59E-6 | 29.9% | /RPS, /EPS, AFW-L, OTC-L |
| **Total** | | **1.20E-5** | **100.0%** | |

### Referenced Fault Trees

| Fault Tree | Description |
|---|---|
| AFW-B | MILLSTONE 2 AUXILIARY FEEDWATER USING SBO-FTF FLAG SET |
| AFW-L | MILLSTONE 2 AUXILIARY FEEDWATER USING LOOP-FTF FLAG SET |
| DGR-01H | MILLSTONE 2 OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR |
| EPS | EMERGENCY POWER |
| EPS-SBO | STATION BLACKOUT POWER |
| OPR-01H | OFFSITE POWER RECOVERY IN 1 HOUR |
| OTC-L | MILLSTONE 2 ONCE THROUGH COOLING USING LOOP-FTF FAULT TREE FLAGS |

### Cut Set Report - LOOP 22-31

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 8.06E-6 | 100 | Displaying 5766 Cut Sets. (5766 Original) |
| 1 | 6.36E-7 | 7.88 | IE-LOOP,AFW-XHE-XM-TDP,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 2 | 3.88E-7 | 4.82 | IE-LOOP,AFW-TDP-FR-TDP,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 3 | 3.54E-7 | 4.39 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H |
| 4 | 3.54E-7 | 4.39 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR01H |
| 5 | 3.36E-7 | 4.16 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-CF-RUN,EPS-XHE-XL-NR01H |

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| 6 | 2.06E-7 | 2.56 | IE-LOOP,AFW-TDP-FS-TDP,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 7 | 2.03E-7 | 2.51 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR01H |
| 8 | 1.99E-7 | 2.46 | IE-LOOP,AFW-XHE-XM-TDP,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H |
| 9 | 1.71E-7 | 2.13 | IE-LOOP,AFW-TDP-TM-TDP,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 10 | 1.25E-7 | 1.55 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-FS-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H |
| 11 | 1.25E-7 | 1.55 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-FS-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR01H |
| 12 | 1.21E-7 | 1.50 | IE-LOOP,AFW-TDP-FR-TDP,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H |
| 13 | 1.09E-7 | 1.35 | IE-LOOP,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-CF-START,EPS-XHE-XL-NR01H |
| 14 | 1.03E-7 | 1.28 | IE-LOOP,ACP-CRB-CC-24DIT2,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-TM-DGA,EPS-XHE-XL-NR01H |
| 15 | 1.03E-7 | 1.28 | IE-LOOP,ACP-CRB-CC-S324D2,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-TM-DGA,EPS-XHE-XL-NR01H |
| 16 | 1.03E-7 | 1.28 | IE-LOOP,ACP-CRB-CC-24CIT2,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H |
| 17 | 1.03E-7 | 1.28 | IE-LOOP,ACP-CRB-CC-S324C2,ACP-XHE-XM-ALT,AFW-XHE-XM-TDP1,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H |

**Cut Set Report - LOOP 21**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 3.60E-6 | 100 | Displaying 8266 Cut Sets. (8266 Original) |
| 1 | 6.39E-8 | 1.78 | IE-LOOP,AFW-AOV-CF-FW43AB,AFW-XHE-XM-BYPASS,HPI-XHE-XM-FBL |
| 2 | 5.29E-8 | 1.47 | IE-LOOP,AFW-XHE-XM-TDP,DCP-BCH-CF-CHR,DCP-XHE-XM-CH201C |
| 3 | 4.56E-8 | 1.27 | IE-LOOP,AFW-MDP-TM-9B,AFW-XHE-XM-TDP,EPS-DGN-FR-DGA,PPR-MOV-FC-BLK1 |
| 4 | 4.56E-8 | 1.27 | IE-LOOP,AFW-MDP-TM-9A,AFW-XHE-XM-TDP,EPS-DGN-FR-DGB,PPR-MOV-FC-BLK2 |
| 5 | 3.84E-8 | 1.07 | IE-LOOP,AFW-MDP-TM-9A,AFW-XHE-XM-TDP,EPS-DGN-FR-DGB,IAS-MDC-FR-IAF3A |
| 6 | 3.84E-8 | 1.07 | IE-LOOP,AFW-MDP-TM-9B,AFW-XHE-XM-TDP,EPS-DGN-FR-DGA,IAS-MDC-FR-IAF3B |

**Referenced Events**

| Event | Description | Probability |
|---|---|---|
| ACP-CRB-CC-24CIT2 | FAILURE OF OFFSITE LINE CRB 24C-IT-2 FROM BUS 24A TO OPEN | 2.39E-3 |
| ACP-CRB-CC-24DIT2 | FAILURE OF OFFSITE LINE CRB 24D-IT-2 FROM BUS 24B TO OPEN | 2.39E-3 |
| ACP-CRB-CC-S324C2 | FAILURE OF OFFSITE LINE CRB 22S3-24C-2 FROM RSST TO OPEN | 2.39E-3 |
| ACP-CRB-CC-S324D2 | FAILURE OF OFFSITE LINE CRB 22S3-24D-2 FROM RSST TO OPEN | 2.39E-3 |
| ACP-XHE-XM-ALT | OPERATOR FAILS TO START AND ALIGN SBO DGN | 5.00E-2 |
| AFW-AOV-CF-FW43AB | COMMON CAUSE FAILURE OF FLOW CONTROL VALVES 2-FW-43A/43B | 3.19E-5 |
| AFW-MDP-TM-9A | AFW MOTOR-DRIVEN PUMP 9A UNAVAILABLE DUE TO T & M | 3.98E-3 |
| AFW-MDP-TM-9B | AFW MOTOR-DRIVEN PUMP 9B UNAVAILABLE DUE TO T & M | 3.98E-3 |
| AFW-TDP-FR-TDP | AFW TURBINE- DRIVEN PUMP FAILS TO RUN | 1.22E-2 |
| AFW-TDP-FS-TDP | AFW TURBINE- DRIVEN PUMP FAILS TO START | 6.49E-3 |
| AFW-TDP-TM-TDP | AFW TURBINE- DRIVEN PUMP UNAVAILABLE DUE TO T & M | 5.39E-3 |
| AFW-XHE-XM-BYPASS | OPERATOR FAILS TO OPEN BYPASS VALVES FW-56A OR 56B | 1.00E-1 |
| AFW-XHE-XM-TDP | OPERATOR FAILS TO LOCALLY START/OPERATE TDP | 2.00E-2 |
| AFW-XHE-XM-TDP1 | OPERATOR FAILS TO LOCALLY START TDP | 6.90E-2 |
| DCP-BCH-CF-CHR | CCF OF BATTERY CHARGERS | 2.64E-6 |

| Event | Description | Probability |
|---|---|---|
| DCP-XHE-XM-CH201C | OPERATOR FAILS TO ALIGN CHARGE 201C TO FAILED BUS | 1.00E+0 |
| EPS-DGN-CF-RUN | COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN | 1.12E-4 |
| EPS-DGN-CF-RUN3 | COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN | 3.65E-5 |
| EPS-DGN-CF-START | COMMON CAUSE FAILURE OF DIESEL GENERATORS TO START | 3.61E-5 |
| EPS-DGN-CF-START3 | COMMON CAUSE FAILURE OF DIESEL GENERATORS TO START | 1.14E-5 |
| EPS-DGN-FR-DGA | DIESEL GENERATOR A FAILS TO RUN | 8.21E-3 |
| EPS-DGN-FR-DGB | DIESEL GENERATOR B FAILS TO RUN | 8.21E-3 |
| EPS-DGN-FS-DGA | DIESEL GENERATOR A FAILS TO START | 2.89E-3 |
| EPS-DGN-FS-DGB | DIESEL GENERATOR B FAILS TO START | 2.89E-3 |
| EPS-DGN-TM-DGA | DIESEL GENERATOR A UNAVAILABLE DUE T & M | 1.43E-2 |
| EPS-DGN-TM-DGB | DIESEL GENERATOR B UNAVAILABLE DUE T & M | 1.43E-2 |
| EPS-XHE-XL-NR01H | OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR | 8.71E-1 |
| HPI-XHE-XM-FBL | OPERATOR FAILS TO INITIATE F&B COOLING GIVEN A LOOP | 2.00E-2 |
| IAS-MDC-FR-IAF3A | INSTRUMENT AIR COMPRESSOR F3A FAILS TO RUN | 5.89E-2 |
| IAS-MDC-FR-IAF3B | INSTRUMENT AIR COMPRESSOR F3B FAILS TO RUN | 5.89E-2 |
| IE-LOOP | LOSS OF OFFSITE POWER | 1.00E+0 |
| PPR-MOV-FC-BLK1 | PORV 402 BLOCK VALVE 403 CLOSED DURING POWER | 6.99E-2 |
| PPR-MOV-FC-BLK2 | PORV 404 BLOCK VALVE 405 CLOSED DURING FULL POWER | 6.99E-2 |

# Appendix B: Unit 3 Analysis Results

### Summary of Conditional Event Changes

| Event | Description | Cond. Value | Nominal Value |
|---|---|---|---|
| AFW-XHE-XM-FIREW | OPERATOR FAILS TO ALIGN FWS OR OTHER SOURCE TO AFW SUCTION | TRUE | 1.00E-3 |
| CCE-XHE-XM-ACOOL | OPERATOR FAILS TO ESTABLISH FIRE WATER TO CCE HTXs | TRUE | 2.00E-2 |
| EPS-DGN-FC-UNIT2 | BLACKOUT DIESEL IS REQUIRED BY UNIT 2 | 6.80E-4 | 0.00E+0 |
| IE-LOOPGR[a] | LOSS OF OFFSITE POWER (GRID-RELATED) | 1.00E+0 | 2.84E-2 |
| LOOP-DUAL-UNIT | DUAL UNIT LOOP | TRUE | 5.82E-1 |
| LOOP-SNGL-UNIT | SINGLE UNIT LOOP | FALSE | 4.18E-1 |
| OEP-XHE-XL-NR01HGR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (GRID-RELATED) | TRUE | 6.59E-1 |
| OEP-XHE-XL-NR02HGR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2 HOURS (GRID-RELATED) | TRUE | 3.91E-1 |
| OEP-XHE-XL-NR04HGR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (GRID-RELATED) | 1.00E-3 | 1.69E-1 |
| OEP-XHE-XL-NR06HGR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 6 HOURS (GRID-RELATED) | 1.00E-3 | 8.68E-2 |
| OEP-XHE-XL-NR08HGR | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 8 HOURS(GRID-RELATED) | 1.00E-3 | 5.00E-2 |
| PPR-SRV-CO-L | PORVs/SRVs OPEN DURING LOOP | TRUE | 1.48E-1 |
| PPR-SRV-CO-SBO | PORVs/SRVs OPEN DURING SBO | TRUE | 3.70E-1 |
| PPR-SRV-OO-455A | PORV 455A FAILS TO RECLOSE AFTER OPENING | 5.80E-3 | 9.66E-4 |
| PPR-SRV-OO-456 | PORV 456 FAILS TO RECLOSE AFTER OPENING | 4.80E-3 | 9.66E-4 |
| ZT-DGN-FR-L | DIESEL GENERATOR FAILS TO RUN | 2.70E-3 | 2.47E-2 |
| ZT-TDP-FR-L | TURBINE DRIVEN PUMP FAILS TO RUN | 7.80E-3 | 3.52E-2 |

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

### Dominant Sequence Results

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

| Event Tree | Sequence | CCDP | % Contribution | Description |
|---|---|---|---|---|
| LOOPGR | 16-01-04 | 3.65E-6 | 23.3% | /RPS-L, EPS, /EPS-SBO, /RSD, /BP1, BP2, OPR-02H, /HPI-B, HPR-B |
| LOOPGR | 09 | 2.87E-6 | 18.3% | /RPS-L, /EPS, /AFW-L, PORV-L, /HPI-L, OPR-02H, HPR-L |
| LOOPGR | 02-04 | 2.41E-6 | 15.4% | /RPS-L, /EPS, /AFW-L, /PORV-L, LOSC-L, /RSD, /BP1, BP2, OPR-02H, /HPI-L, HPR-L |
| LOOPGR | 02-05 | 1.85E-6 | 11.8% | /RPS-L, /EPS, /AFW-L, /PORV-L, LOSC-L, /RSD, /BP1, BP2, OPR-02H, HPI-L |
| LOOPGR | 16-46 | 1.65E-6 | 10.5% | /RPS-L, EPS, EPS-SBO, AFW-B, OPR-01H, DGR-01H |
| LOOPGR | 16-01-05 | 8.15E-7 | 5.2% | /RPS-L, EPS, /EPS-SBO, /RSD, /BP1, BP2, OPR-02H, HPI-B |
| LOOPGR | 16-43 | 7.20E-7 | 4.6% | /RPS-L, EPS, EPS-SBO, /AFW-B, PORV-B, OPR-01H, DGR-01H |
| LOOPGR | 15 | 6.82E-7 | 4.4% | /RPS-L, /EPS, AFW-L, FAB-L |
| LOOPGR | 16-01-08 | 1.82E-7 | 1.2% | /RPS-L, EPS, /EPS-SBO, /RSD, BP1, /BP2, OPR-02H, /HPI-B, HPR-B |
| **Total** | | **1.56E-5** | **100.0%** | |

**Referenced Fault Trees**

| Fault Tree | Description |
|---|---|
| AFW-B | AUXILIARY FEEDWATER SYSTEM DURING SBO |
| AFW-L | AUXILIARY FEEDWATER SYSTEM DURING LOOP |
| BP1 | RCP SEAL STAGE 1 INTEGRITY |
| BP2 | RCP SEAL STAGE 2 INTEGRITY |
| DGR-01H | OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR |
| EPS | EMERGENCY POWER |
| EPS-SBO | STATION BLACKOUT POWER |
| FAB-L | FEED AND BLEED DURING LOOP |
| HPI-B | HIGH PRESSURE INJECTION SBO SEQUENCES W/ SBO DGN OPERATING |
| HPI-L | HIGH PRESSURE INJECTION |
| HPR-B | HIGH PRESSURE RECIRCULATION SBO SEQUENCES W/ SBO DGN OPERATING |
| HPR-L | HIGH PRESSURE RECIRC |
| LOSC-L | RCP SEAL COOLING MAINTAINED DURING LOOP |
| OPR-01H | OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR |
| OPR-02H | OFFSITE POWER RECOVERY IN 2 HRS |
| PORV-B | PORVs/SRVs OPEN DURING STATION BLACKOUT |
| PORV-L | PORVs ARE CLOSED DURING LOOP |

**Cut Set Report - LOOPGR 16-01-04**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 3.65E-6 | 100 | Displaying 1786 Cut Sets. (1786 Original) |
| 1 | 9.44E-8 | 2.58 | IE-LOOPGR,ACP-BAC-LP-32U,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 2 | 9.44E-8 | 2.58 | IE-LOOPGR,ACP-BAC-LP-32T,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 3 | 6.42E-8 | 1.76 | IE-LOOPGR,ACP-TFM-FC-34D21X,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 4 | 6.42E-8 | 1.76 | IE-LOOPGR,ACP-TFM-FC-34C31X,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 5 | 5.40E-8 | 1.48 | IE-LOOPGR,ACP-BAC-LP-32T,EPS-DGN-FR-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 6 | 5.40E-8 | 1.48 | IE-LOOPGR,ACP-BAC-LP-32U,EPS-DGN-FR-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 7 | 3.92E-8 | 1.07 | IE-LOOPGR,CVC-MOV-OO-8512B,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 8 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,RHR-MOV-OO-8812A,SBO-DGN-ALIGN34C |
| 9 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,RHR-MOV-OO-8812B,SBO-DGN-ALIGN34D |
| 10 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,LPI-MOV-CC-8804A,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 11 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,LPI-MOV-CC-8804B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 12 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,HPI-MOV-OO-8813,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 13 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,HPI-MOV-OO-8814,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| 14 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,HPI-MOV-OO-8920,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 15 | 3.92E-8 | 1.07 | IE-LOOPGR,CVC-MOV-OO-8511A,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 16 | 3.92E-8 | 1.07 | IE-LOOPGR,CVC-MOV-OO-8512A,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 17 | 3.92E-8 | 1.07 | IE-LOOPGR,CVC-MOV-OO-8511B,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 18 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C,SWS-MOV-OO-50A |
| 19 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D,SWS-MOV-OO-50B |
| 20 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C,SWS-MOV-OO-71A |
| 21 | 3.92E-8 | 1.07 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D,SWS-MOV-OO-71B |
| 22 | 3.67E-8 | 1.01 | IE-LOOPGR,ACP-TFM-FC-34C31X,EPS-DGN-FR-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 23 | 3.67E-8 | 1.01 | IE-LOOPGR,ACP-TFM-FC-34D21X,EPS-DGN-FR-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |

**Cut Set Report - LOOPGR 09**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 2.87E-6 | 100 | Displaying 826 Cut Sets. (826 Original) |
| 1 | 1.66E-7 | 5.81 | IE-LOOPGR,EPS-DGN-TM-DGA,HPI-XHE-XM-RECIRC,PPR-SRV-OO-455A |
| 2 | 1.38E-7 | 4.80 | IE-LOOPGR,EPS-DGN-TM-DGB,HPI-XHE-XM-RECIRC,PPR-SRV-OO-456 |
| 3 | 9.52E-8 | 3.32 | IE-LOOPGR,EPS-DGN-FR-DGA,HPI-XHE-XM-RECIRC,PPR-SRV-OO-455A |
| 4 | 8.02E-8 | 2.80 | IE-LOOPGR,CVC-MOV-OO-8512B,EPS-DGN-TM-DGA,PPR-SRV-OO-455A |
| 5 | 8.02E-8 | 2.80 | IE-LOOPGR,EPS-DGN-TM-DGA,HPI-MOV-OO-8813,PPR-SRV-OO-455A |
| 6 | 8.02E-8 | 2.80 | IE-LOOPGR,EPS-DGN-TM-DGA,PPR-SRV-OO-455A,RHR-MOV-OO-8812B |
| 7 | 8.02E-8 | 2.80 | IE-LOOPGR,EPS-DGN-TM-DGA,PPR-SRV-OO-455A,SWS-MOV-OO-50B |
| 8 | 8.02E-8 | 2.80 | IE-LOOPGR,EPS-DGN-TM-DGA,LPI-MOV-CC-8804B,PPR-SRV-OO-455A |
| 9 | 8.02E-8 | 2.80 | IE-LOOPGR,EPS-DGN-TM-DGA,PPR-SRV-OO-455A,SWS-MOV-OO-71B |
| 10 | 8.02E-8 | 2.80 | IE-LOOPGR,CVC-MOV-OO-8511B,EPS-DGN-TM-DGA,PPR-SRV-OO-455A |
| 11 | 7.88E-8 | 2.75 | IE-LOOPGR,EPS-DGN-FR-DGB,HPI-XHE-XM-RECIRC,PPR-SRV-OO-456 |
| 12 | 6.63E-8 | 2.31 | IE-LOOPGR,EPS-DGN-TM-DGB,HPI-MOV-OO-8814,PPR-SRV-OO-456 |
| 13 | 6.63E-8 | 2.31 | IE-LOOPGR,EPS-DGN-TM-DGB,HPI-MOV-OO-8920,PPR-SRV-OO-456 |
| 14 | 6.63E-8 | 2.31 | IE-LOOPGR,EPS-DGN-TM-DGB,LPI-MOV-CC-8804A,PPR-SRV-OO-456 |
| 15 | 6.63E-8 | 2.31 | IE-LOOPGR,EPS-DGN-TM-DGB,PPR-SRV-OO-456,SWS-MOV-OO-50A |
| 16 | 6.63E-8 | 2.31 | IE-LOOPGR,EPS-DGN-TM-DGB,PPR-SRV-OO-456,RHR-MOV-OO-8812A |
| 17 | 6.63E-8 | 2.31 | IE-LOOPGR,EPS-DGN-TM-DGB,PPR-SRV-OO-456,SWS-MOV-OO-71A |
| 18 | 6.63E-8 | 2.31 | IE-LOOPGR,CVC-MOV-OO-8511A,EPS-DGN-TM-DGB,PPR-SRV-OO-456 |
| 19 | 6.63E-8 | 2.31 | IE-LOOPGR,CVC-MOV-OO-8512A,EPS-DGN-TM-DGB,PPR-SRV-OO-456 |
| 20 | 4.59E-8 | 1.60 | IE-LOOPGR,CVC-MOV-OO-8512B,EPS-DGN-FR-DGA,PPR-SRV-OO-455A |
| 21 | 4.59E-8 | 1.60 | IE-LOOPGR,EPS-DGN-FR-DGA,HPI-MOV-OO-8813,PPR-SRV-OO-455A |
| 22 | 4.59E-8 | 1.60 | IE-LOOPGR,EPS-DGN-FR-DGA,PPR-SRV-OO-455A,RHR-MOV-OO-8812B |
| 23 | 4.59E-8 | 1.60 | IE-LOOPGR,EPS-DGN-FR-DGA,PPR-SRV-OO-455A,SWS-MOV-OO-50B |
| 24 | 4.59E-8 | 1.60 | IE-LOOPGR,EPS-DGN-FR-DGA,LPI-MOV-CC-8804B,PPR-SRV-OO-455A |

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| 25 | 4.59E-8 | 1.60 | IE-LOOPGR,EPS-DGN-FR-DGA,PPR-SRV-OO-455A,SWS-MOV-OO-71B |
| 26 | 4.59E-8 | 1.60 | IE-LOOPGR,CVC-MOV-OO-8511B,EPS-DGN-FR-DGA,PPR-SRV-OO-455A |
| 27 | 3.80E-8 | 1.32 | IE-LOOPGR,EPS-DGN-FR-DGB,HPI-MOV-OO-8814,PPR-SRV-OO-456 |
| 28 | 3.80E-8 | 1.32 | IE-LOOPGR,EPS-DGN-FR-DGB,HPI-MOV-OO-8920,PPR-SRV-OO-456 |
| 29 | 3.80E-8 | 1.32 | IE-LOOPGR,EPS-DGN-FR-DGB,LPI-MOV-CC-8804A,PPR-SRV-OO-456 |
| 30 | 3.80E-8 | 1.32 | IE-LOOPGR,EPS-DGN-FR-DGB,PPR-SRV-OO-456,SWS-MOV-OO-50A |
| 31 | 3.80E-8 | 1.32 | IE-LOOPGR,EPS-DGN-FR-DGB,PPR-SRV-OO-456,RHR-MOV-OO-8812A |
| 32 | 3.80E-8 | 1.32 | IE-LOOPGR,EPS-DGN-FR-DGB,PPR-SRV-OO-456,SWS-MOV-OO-71A |
| 33 | 3.80E-8 | 1.32 | IE-LOOPGR,CVC-MOV-OO-8511A,EPS-DGN-FR-DGB,PPR-SRV-OO-456 |
| 34 | 3.80E-8 | 1.32 | IE-LOOPGR,CVC-MOV-OO-8512A,EPS-DGN-FR-DGB,PPR-SRV-OO-456 |
| 35 | 3.35E-8 | 1.17 | IE-LOOPGR,EPS-DGN-FS-DGA,HPI-XHE-XM-RECIRC,PPR-SRV-OO-455A |

**Cut Set Report - LOOPGR 02-04**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 2.41E-6 | 100 | Displaying 4493 Cut Sets. (4493 Original) |
| 1 | 4.70E-8 | 1.95 | IE-LOOPGR,ACP-BAC-LP-32W,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 2 | 4.70E-8 | 1.95 | IE-LOOPGR,ACP-BAC-LP-32W,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 3 | 4.70E-8 | 1.95 | IE-LOOPGR,ACP-BAC-LP-32R,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 4 | 4.70E-8 | 1.95 | IE-LOOPGR,ACP-BAC-LP-32R,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 5 | 3.19E-8 | 1.32 | IE-LOOPGR,ACP-TFM-FC-34D41X,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 6 | 3.19E-8 | 1.32 | IE-LOOPGR,ACP-TFM-FC-34D41X,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 7 | 3.19E-8 | 1.32 | IE-LOOPGR,ACP-TFM-FC-34C51X,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 8 | 3.19E-8 | 1.32 | IE-LOOPGR,ACP-TFM-FC-34C51X,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 9 | 2.69E-8 | 1.11 | IE-LOOPGR,ACP-BAC-LP-32W,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-FR-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 10 | 2.69E-8 | 1.11 | IE-LOOPGR,ACP-BAC-LP-32W,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-FR-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 11 | 2.69E-8 | 1.11 | IE-LOOPGR,ACP-BAC-LP-32R,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-FR-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 12 | 2.69E-8 | 1.11 | IE-LOOPGR,ACP-BAC-LP-32R,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-FR-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |

**Cut Set Report - LOOPGR 02-05**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 1.85E-6 | 100 | Displaying 3360 Cut Sets. (3360 Original) |
| 1 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3AOP-P3BSTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1CRUN-1ASTBY,SWS-1DRUN-1BSTBY,SWS-MDP-CF-START |
| 2 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3AOP-P3BSTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1ARUN-1CSTBY,SWS-1DRUN-1BSTBY,SWS-MDP-CF-START |
| 3 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3AOP-P3BSTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1ARUN-1CSTBY,SWS-1BRUN-1DSTBY,SWS-MDP-CF-START |

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| 4 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3BOP-P3ASTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1ARUN-1CSTBY,SWS-1DRUN-1BSTBY,SWS-MDP-CF-START |
| 5 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3BOP-P3ASTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1ARUN-1CSTBY,SWS-1BRUN-1DSTBY,SWS-MDP-CF-START |
| 6 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3BOP-P3ASTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1CRUN-1ASTBY,SWS-1DRUN-1BSTBY,SWS-MDP-CF-START |
| 7 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3AOP-P3BSTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1BRUN-1DSTBY,SWS-1CRUN-1ASTBY,SWS-MDP-CF-START |
| 8 | 4.81E-8 | 2.60 | IE-LOOPGR,CVC-P3BOP-P3ASTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-1BRUN-1DSTBY,SWS-1CRUN-1ASTBY,SWS-MDP-CF-START |
| 9 | 2.12E-8 | 1.15 | IE-LOOPGR,CCW-1A1BRUN-1CSTBY,CVC-MDP-TM-P3A,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGB,HPI-MDP-TM-P1A,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 10 | 2.12E-8 | 1.15 | IE-LOOPGR,CCW-1A1BRUN-1CSTBY,CVC-MDP-TM-P3B,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGA,HPI-MDP-TM-P1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 11 | 2.08E-8 | 1.12 | IE-LOOPGR,CVC-P3BOP-P3ASTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-FAN-CF-HVY2ABS,SWS-XHE-XL-VENT |
| 12 | 2.08E-8 | 1.12 | IE-LOOPGR,CVC-P3AOP-P3BSTBY,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SWS-FAN-CF-HVY2ABS,SWS-XHE-XL-VENT |
| 13 | 1.95E-8 | 1.05 | IE-LOOPGR,CCE-MDP-TM-P1A,CCE-P3BOP-P3ASTBY,CCW-1A1BRUN-1CSTBY,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGB,HPI-MDP-TM-P1A,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |
| 14 | 1.95E-8 | 1.05 | IE-LOOPGR,CCE-MDP-TM-P1B,CCE-P3AOP-P3BSTBY,CCW-1A1BRUN-1CSTBY,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGA,HPI-MDP-TM-P1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2 |

**Cut Set Report - LOOPGR 16-46**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 1.64E-6 | 100 | Displaying 701 Cut Sets. (701 Original) |
| 1 | 3.87E-7 | 23.55 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 2 | 2.06E-7 | 12.52 | IE-LOOPGR,AFW-TDP-FS-P2,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 3 | 1.71E-7 | 10.40 | IE-LOOPGR,AFW-TDP-TM-P2,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H |
| 4 | 1.21E-7 | 7.37 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H |
| 5 | 6.45E-8 | 3.92 | IE-LOOPGR,AFW-TDP-FS-P2,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H |
| 6 | 5.35E-8 | 3.26 | IE-LOOPGR,AFW-TDP-TM-P2,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H |
| 7 | 2.19E-8 | 1.33 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H,EPS-XHE-XM-SBO |
| 8 | 1.80E-8 | 1.09 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR01H |
| 9 | 1.80E-8 | 1.09 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-DGN-TM-SBO,EPS-XHE-XL-NR01H |
| 10 | 1.80E-8 | 1.09 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H |
| 11 | 1.71E-8 | 1.04 | IE-LOOPGR,AFW-TDP-FR-P2,EPS-DGN-CF-RUN,EPS-DGN-TM-SBO,EPS-XHE-XL-NR01H |

**Cut Set Report - LOOPGR 16-01-05**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 8.15E-7 | 100 | Displaying 1419 Cut Sets. (1419 Original) |
| 1 | 9.44E-8 | 11.58 | IE-LOOPGR,ACP-BAC-LP-34D,EPS-DGN-TM-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| 2 | 9.44E-8 | 11.58 | IE-LOOPGR,ACP-BAC-LP-34C,EPS-DGN-TM-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 3 | 6.16E-8 | 7.55 | IE-LOOPGR,ACP-TFM-CF-C3D2,CVC-P3BOP-P3ASTBY,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 4 | 6.16E-8 | 7.55 | IE-LOOPGR,ACP-TFM-CF-C3D2,CVC-P3AOP-P3BSTBY,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 5 | 5.40E-8 | 6.63 | IE-LOOPGR,ACP-BAC-LP-34C,EPS-DGN-FR-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 6 | 5.40E-8 | 6.63 | IE-LOOPGR,ACP-BAC-LP-34D,EPS-DGN-FR-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 7 | 3.54E-8 | 4.34 | IE-LOOPGR,ACP-BAC-LP-32U,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGA,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 8 | 3.54E-8 | 4.34 | IE-LOOPGR,ACP-BAC-LP-32T,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGB,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 9 | 2.41E-8 | 2.95 | IE-LOOPGR,ACP-TFM-FC-34D21X,CVC-P3BOP-P3ASTBY,EPS-DGN-TM-DGA,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 10 | 2.41E-8 | 2.95 | IE-LOOPGR,ACP-TFM-FC-34C31X,CVC-P3AOP-P3BSTBY,EPS-DGN-TM-DGB,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 11 | 2.03E-8 | 2.49 | IE-LOOPGR,ACP-BAC-LP-32U,CVC-P3BOP-P3ASTBY,EPS-DGN-FR-DGA,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 12 | 2.03E-8 | 2.49 | IE-LOOPGR,ACP-BAC-LP-32T,CVC-P3AOP-P3BSTBY,EPS-DGN-FR-DGB,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 13 | 1.90E-8 | 2.33 | IE-LOOPGR,ACP-BAC-LP-34C,EPS-DGN-FS-DGB,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 14 | 1.90E-8 | 2.33 | IE-LOOPGR,ACP-BAC-LP-34D,EPS-DGN-FS-DGA,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 15 | 1.38E-8 | 1.69 | IE-LOOPGR,ACP-TFM-FC-34D21X,CVC-P3BOP-P3ASTBY,EPS-DGN-FR-DGA,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 16 | 1.38E-8 | 1.69 | IE-LOOPGR,ACP-TFM-FC-34C31X,CVC-P3AOP-P3BSTBY,EPS-DGN-FR-DGB,NOTWINTER,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |

**Cut Set Report - LOOPGR 16-43**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 7.21E-7 | 100 | Displaying 365 Cut Sets. (365 Original) |
| 1 | 1.84E-7 | 25.52 | IE-LOOPGR,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H,PPR-SRV-OO-455A |
| 2 | 1.52E-7 | 21.12 | IE-LOOPGR,EPS-DGN-CF-RUN3,EPS-XHE-XL-NR01H,PPR-SRV-OO-456 |
| 3 | 5.76E-8 | 7.99 | IE-LOOPGR,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H,PPR-SRV-OO-455A |
| 4 | 4.76E-8 | 6.61 | IE-LOOPGR,EPS-DGN-CF-START3,EPS-XHE-XL-NR01H,PPR-SRV-OO-456 |
| 5 | 1.04E-8 | 1.44 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H,EPS-XHE-XM-SBO,PPR-SRV-OO-455A |
| 6 | 8.61E-9 | 1.20 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H,EPS-XHE-XM-SBO,PPR-SRV-OO-456 |
| 7 | 8.54E-9 | 1.19 | IE-LOOPGR,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR01H,PPR-SRV-OO-455A |
| 8 | 8.54E-9 | 1.19 | IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR01H,PPR-SRV-OO-455A |
| 9 | 8.54E-9 | 1.19 | IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-DGN-TM-SBO,EPS-XHE-XL-NR01H,PPR-SRV-OO-455A |
| 10 | 8.10E-9 | 1.12 | IE-LOOPGR,EPS-DGN-CF-RUN,EPS-DGN-TM-SBO,EPS-XHE-XL-NR01H,PPR-SRV-OO-455A |

**Cut Set Report - LOOPGR 15**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 6.82E-7 | 100 | Displaying 1663 Cut Sets. (1663 Original) |
| 1 | 2.84E-8 | 4.16 | IE-LOOPGR,AFW-PMP-CF-STRT,HPI-XHE-XM-FB |
| 2 | 1.39E-8 | 2.04 | IE-LOOPGR,AFW-MDP-TM-1A,AFW-TDP-FR-P2,EPS-DGN-TM-DGB,HPI-XHE-XM-FB |
| 3 | 1.39E-8 | 2.04 | IE-LOOPGR,AFW-MDP-TM-1B,AFW-TDP-FR-P2,EPS-DGN-TM-DGA,HPI-XHE-XM-FB |
| 4 | 1.16E-8 | 1.70 | IE-LOOPGR,AFW-MDP-CF-START,AFW-TDP-FR-P2,HPI-XHE-XM-FB |
| 5 | 8.74E-9 | 1.28 | IE-LOOPGR,AFW-TNK-FC-DWST,HPI-XHE-XM-FB |
| 6 | 7.98E-9 | 1.17 | IE-LOOPGR,AFW-MDP-TM-1A,AFW-TDP-FR-P2,EPS-DGN-FR-DGB,HPI-XHE-XM-FB |
| 7 | 7.98E-9 | 1.17 | IE-LOOPGR,AFW-MDP-TM-1B,AFW-TDP-FR-P2,EPS-DGN-FR-DGA,HPI-XHE-XM-FB |
| 8 | 7.41E-9 | 1.09 | IE-LOOPGR,AFW-MDP-TM-1A,AFW-TDP-FS-P2,EPS-DGN-TM-DGB,HPI-XHE-XM-FB |
| 9 | 7.41E-9 | 1.09 | IE-LOOPGR,AFW-MDP-TM-1B,AFW-TDP-FS-P2,EPS-DGN-TM-DGA,HPI-XHE-XM-FB |

**Cut Set Report - LOOPGR 16-01-08**

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

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| | 1.82E-7 | 100 | Displaying 554 Cut Sets. (554 Original) |
| 1 | 4.78E-9 | 2.63 | IE-LOOPGR,ACP-BAC-LP-32U,EPS-DGN-TM-DGA,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 2 | 4.78E-9 | 2.63 | IE-LOOPGR,ACP-BAC-LP-32T,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 3 | 3.25E-9 | 1.79 | IE-LOOPGR,ACP-TFM-FC-34D21X,EPS-DGN-TM-DGA,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 4 | 3.25E-9 | 1.79 | IE-LOOPGR,ACP-TFM-FC-34C31X,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 5 | 2.73E-9 | 1.51 | IE-LOOPGR,ACP-BAC-LP-32T,EPS-DGN-FR-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 6 | 2.73E-9 | 1.51 | IE-LOOPGR,ACP-BAC-LP-32U,EPS-DGN-FR-DGA,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 7 | 1.98E-9 | 1.09 | IE-LOOPGR,CVC-MOV-OO-8512B,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 8 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,RHR-MOV-OO-8812A,SBO-DGN-ALIGN34C |
| 9 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,RHR-MOV-OO-8812B,SBO-DGN-ALIGN34D |
| 10 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,LPI-MOV-CC-8804A,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 11 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,LPI-MOV-CC-8804B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 12 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,HPI-MOV-OO-8813,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |
| 13 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,HPI-MOV-OO-8814,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 14 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,HPI-MOV-OO-8920,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 15 | 1.98E-9 | 1.09 | IE-LOOPGR,CVC-MOV-OO-8511A,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 16 | 1.98E-9 | 1.09 | IE-LOOPGR,CVC-MOV-OO-8512A,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 17 | 1.98E-9 | 1.09 | IE-LOOPGR,CVC-MOV-OO-8511B,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |

| # | CCDP | Total% | Cut Set |
|---|---|---|---|
| 18 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C,SWS-MOV-OO-50A |
| 19 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D,SWS-MOV-OO-50B |
| 20 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C,SWS-MOV-OO-71A |
| 21 | 1.98E-9 | 1.09 | IE-LOOPGR,EPS-DGN-TM-DGA,EPS-DGN-TM-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D,SWS-MOV-OO-71B |
| 22 | 1.86E-9 | 1.02 | IE-LOOPGR,ACP-TFM-FC-34C31X,EPS-DGN-FR-DGB,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34C |
| 23 | 1.86E-9 | 1.02 | IE-LOOPGR,ACP-TFM-FC-34D21X,EPS-DGN-FR-DGA,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2,SBO-DGN-ALIGN34D |

**Referenced Events**

| Event | Description | Probability |
|---|---|---|
| ACP-BAC-LP-32R | FAILURE OF 480V AC BUS 32R | 3.33E-5 |
| ACP-BAC-LP-32T | FAILURE OF 480V AC BUS 32T | 3.33E-5 |
| ACP-BAC-LP-32U | FAILURE OF 480V AC BUS 32U | 3.33E-5 |
| ACP-BAC-LP-32W | FAILURE OF 480V AC BUS 32W | 3.33E-5 |
| ACP-BAC-LP-34C | 4160 VAC BUS 34C FAILS | 3.33E-5 |
| ACP-BAC-LP-34D | 4160 VAC BUS 34D FAILS | 3.33E-5 |
| ACP-TFM-CF-C3D2 | CCF OF 4160/480V TRANSFORMERS 34C3-1X/34D2-1X | 8.31E-7 |
| ACP-TFM-FC-34C31X | FAILURE OF 4160/480V TRANSFORMER 34C3-1X TO OPERATE | 2.27E-5 |
| ACP-TFM-FC-34C51X | FAILURE OF 4160/480V TRANSFORMER 34C5-1X TO OPERATE | 2.27E-5 |
| ACP-TFM-FC-34D21X | FAILURE OF 4160/480V TRANSFORMER 34D2-1X TO OPERATE | 2.27E-5 |
| ACP-TFM-FC-34D41X | FAILURE OF 4160/480V TRANSFORMER 34D4-1X TO OPERATE | 2.27E-5 |
| AFW-MDP-CF-START | CCF OF AFW MDPS TO START | 4.76E-5 |
| AFW-MDP-TM-1A | AFW MDP UNAVAILABLE DUE TO TEST AND MAINTENANCE | 3.98E-3 |
| AFW-MDP-TM-1B | AFW MDP UNAVAILABLE DUE TO TEST AND MAINTENANCE | 3.98E-3 |
| AFW-PMP-CF-STRT | CCF OF AFW PUMPS TO START (EXCLUDING DRIVER) - PSA | 1.42E-6 |
| AFW-TDP-FR-P2 | TURBINE DRIVEN FEED PUMP P2 FAILS TO RUN | 1.22E-2 |
| AFW-TDP-FS-P2 | TURBINE DRIVEN FEED PUMP P2 FAILS TO START | 6.49E-3 |
| AFW-TDP-TM-P2 | FEED PUMP P2 IS IN TEST OR MAINTENANCE | 5.39E-3 |
| AFW-TNK-FC-DWST | DWST EXTERNAL LEAKAGE | 4.37E-7 |
| CCE-MDP-TM-P1A | CCE MDP P1A UNAVAILABLE DUE TO TEST AND MAINTENANCE | 7.12E-3 |
| CCE-MDP-TM-P1B | CCE MDP P1B UNAVAILABLE DUE TO TEST AND MAINTENANCE | 7.12E-3 |
| CCE-P3AOP-P3BSTBY | CCE P1A IN OPERATION WHILE PUMP P1B IN STANDBY | 5.00E-1 |
| CCE-P3BOP-P3ASTBY | CCE P1B IN OPERATION WHILE PUMP P1A IN STANDBY | 5.00E-1 |
| CCW-1A1BRUN-1CSTBY | CCW MDP 1A RUNNING CCW MDP 1B RUNNING CCW MDP 1C STANDBY | 9.95E-1 |
| CVC-MDP-TM-P3A | PUMP P3A IS IN TEST OR MAINTENANCE | 3.88E-3 |
| CVC-MDP-TM-P3B | PUMP P3B IS IN TEST OR MAINTENANCE | 3.88E-3 |
| CVC-MOV-OO-8511A | CHARGING PUMP TRAIN A MINFLOW MOV 8511A FAILS TO CLOSE | 9.63E-4 |
| CVC-MOV-OO-8511B | CHARGING PUMP TRAIN B MINFLOW MOV 8511B FAILS TO CLOSE | 9.63E-4 |
| CVC-MOV-OO-8512A | CHARGING PUMP TRAIN B MINFLOW MOV 8512A FAILS TO CLOSE | 9.63E-4 |
| CVC-MOV-OO-8512B | CHARGING PUMP TRAIN A MINFLOW MOV 8512B FAILS TO CLOSE | 9.63E-4 |
| CVC-P3AOP-P3BSTBY | CHARGING PUMP 3A IN OPERATION WHILE PUMP 3B IN STANDBY | 5.00E-1 |
| CVC-P3BOP-P3ASTBY | CHARGING PUMP 3B IN OPERATION WHILE PUMP 3A IN STANDBY | 5.00E-1 |

| Event | Description | Probability |
|---|---|---|
| EPS-DGN-CF-RUN | COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN | 1.12E-4 |
| EPS-DGN-CF-RUN3 | COMMON CAUSE FAILURE OF 3 DIESEL GENERATORS TO RUN | 3.64E-5 |
| EPS-DGN-CF-START3 | COMMON CAUSE FAILURE OF 3 DIESEL GENERATORS TO START | 1.14E-5 |
| EPS-DGN-FR-DGA | DIESEL GENERATOR A FAILS TO RUN | 8.21E-3 |
| EPS-DGN-FR-DGB | DIESEL GENERATOR B FAILS TO RUN | 8.21E-3 |
| EPS-DGN-FR-SBO | STATION BLACKOUT DIESEL FAILS TO RUN | 8.21E-3 |
| EPS-DGN-FS-DGA | DIESEL GENERATOR A FAILS TO START | 2.89E-3 |
| EPS-DGN-FS-DGB | DIESEL GENERATOR B FAILS TO START | 2.89E-3 |
| EPS-DGN-TM-DGA | DG A UNAVAILABLE DUE TO TEST AND MAINTENANCE | 1.43E-2 |
| EPS-DGN-TM-DGB | DG B UNAVAILABLE DUE TO TEST AND MAINTENANCE | 1.43E-2 |
| EPS-DGN-TM-SBO | SBO DIESEL UNAVAILABLE DUE TO TEST AND MAINTENANCE | 1.43E-2 |
| EPS-XHE-XL-NR01H | OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR | 8.71E-1 |
| EPS-XHE-XM-SBO | OPERATOR FAILS TO START & ALIGN SBO DIESEL | 1.00E-2 |
| HPI-MDP-TM-P1A | HPI PUMP TRAIN P1A IS IN TEST OR MAINTENANCE | 3.88E-3 |
| HPI-MDP-TM-P1B | HPI PUMP TRAIN P1B IS IN TEST OR MAINTENANCE | 3.88E-3 |
| HPI-MOV-OO-8813 | SI PUMP MINFLOW VLV 8813 FAILS TO CLOSE | 9.63E-4 |
| HPI-MOV-OO-8814 | SI PUMP MINFLOW VLV 8814 FAILS TO CLOSE | 9.63E-4 |
| HPI-MOV-OO-8920 | SI PUMP MINFLOW VLV 8920 FAILS TO CLOSE | 9.63E-4 |
| HPI-XHE-XM-FB | OPERATOR FAILS TO INITIATE FEED AND BLEED COOLING | 2.00E-2 |
| HPI-XHE-XM-RECIRC | OPERATOR FAILS TO START HIGH PRESSURE RECIRC | 2.00E-3 |
| IE-LOOPGR | LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED) | 1.00E+0 |
| LPI-MOV-CC-8804A | LPSI TO SI ISOLN VALVE 8804A FAILS TO OPEN | 9.63E-4 |
| LPI-MOV-CC-8804B | LPSI TO SI ISOLN VALVE 8804B FAILS TO OPEN | 9.63E-4 |
| NOTWINTER | NOT WINTER OPERATION (SUMMER TIME) | 7.50E-1 |
| PPR-SRV-OO-455A | PORV 455A FAILS TO RECLOSE AFTER OPENING | 5.80E-3 |
| PPR-SRV-OO-456 | PORV 456 FAILS TO RECLOSE AFTER OPENING | 4.80E-3 |
| RCS-MDP-LK-BP1 | RCP SEAL STAGE 1 INTEGRITY (BINDING/POPPING OPEN) FAILS | 1.25E-2 |
| RCS-MDP-LK-BP2 | RCP SEAL STAGE 2 INTEGRITY (BINDING/POPPING OPEN) FAILS | 2.00E-1 |
| RHR-MOV-OO-8812A | RHR PUMP P1A RWST SUCTN VLV 8812A FAILS TO CLOSE (INTERLOCK W/ 8837/8A) | 9.63E-4 |
| RHR-MOV-OO-8812B | RHR PUMP P1B RWST SUCTN VLV 8812B FAILS TO CLOSE (INTERLOCK W/ 8837/8B) | 9.63E-4 |
| SBO-DGN-ALIGN34C | SBO DIESEL GENERATOR ALIGNED TO BUS 34C | 1.00E+0 |
| SBO-DGN-ALIGN34D | SBO DIESEL GENERATOR ALIGNED TO BUS 34D | 1.00E+0 |
| SWS-1ARUN-1CSTBY | SWS MDP 1A RUNNING SWS MDP 1C STANDBY | 5.00E-1 |
| SWS-1BRUN-1DSTBY | SWS MDP 1B RUNNING SWS MDP 1D STANDBY | 5.00E-1 |
| SWS-1CRUN-1ASTBY | SWS MDP 1C RUNNING SWS MDP 1A STANDBY | 5.00E-1 |
| SWS-1DRUN-1BSTBY | SWS MDP 1D RUNNING SWS MDP 1B STANDBY | 5.00E-1 |
| SWS-FAN-CF-HVY2ABS | CCF OF SWS VENTILLATION FANS TO START | 2.11E-5 |
| SWS-MDP-CF-START | PUMPS FAIL FROM COMMON CAUSE TO START | 1.95E-6 |
| SWS-MOV-OO-50A | COMPONENT COOLING WATER ISOLATION VLV FAILS TO CLOSE | 9.63E-4 |
| SWS-MOV-OO-50B | COMPONENT COOLING WATER ISOLATION VLV FAILS TO CLOSE | 9.63E-4 |
| SWS-MOV-OO-71A | TBCCW ISOLATION VALVE FAILS TO CLOSE | 9.63E-4 |
| SWS-MOV-OO-71B | TBCCW ISOLATION VALVE FAILS TO CLOSE | 9.63E-4 |
| SWS-XHE-XL-VENT | OPERATOR FAILS TO PROVIDE ALTERNATE VENTILATION TO SWS | 1.00E-2 |

# Appendix C: Key Event Trees

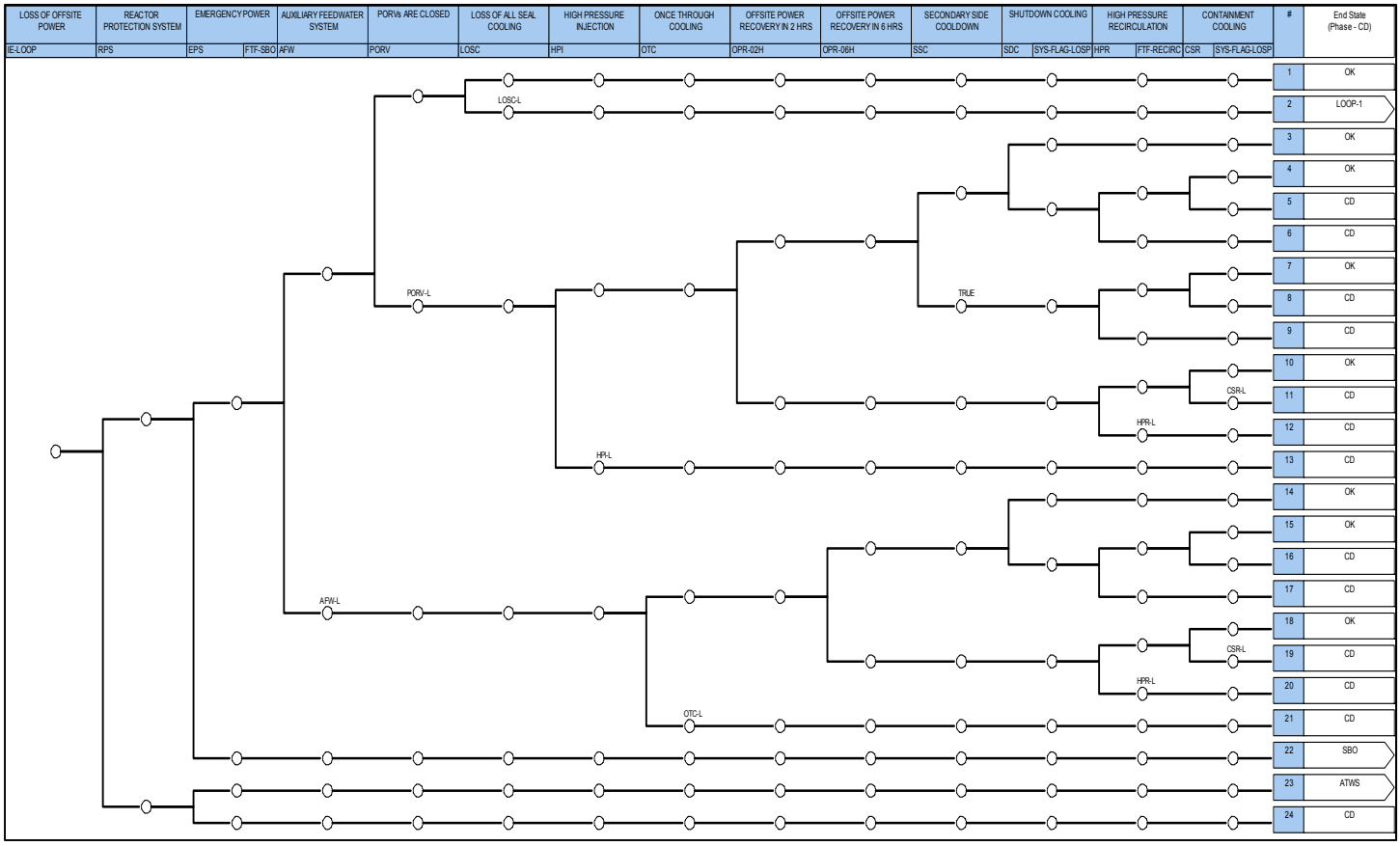


**Figure C-1.** Millstone Power Station Unit 2, LOOP Event Tree.

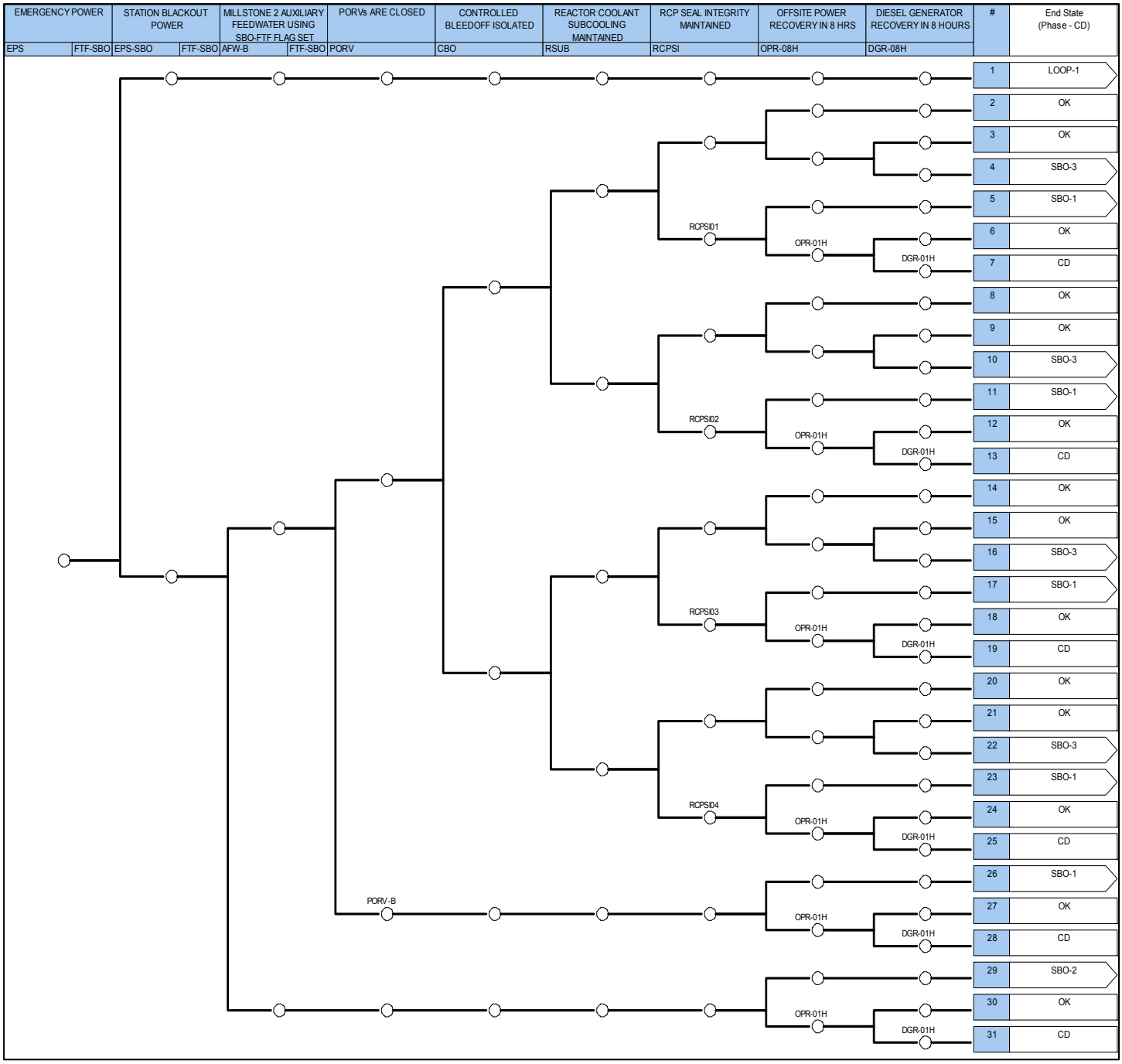


**Figure C-2.** Millstone Power Station Unit 2, SBO Event Tree.

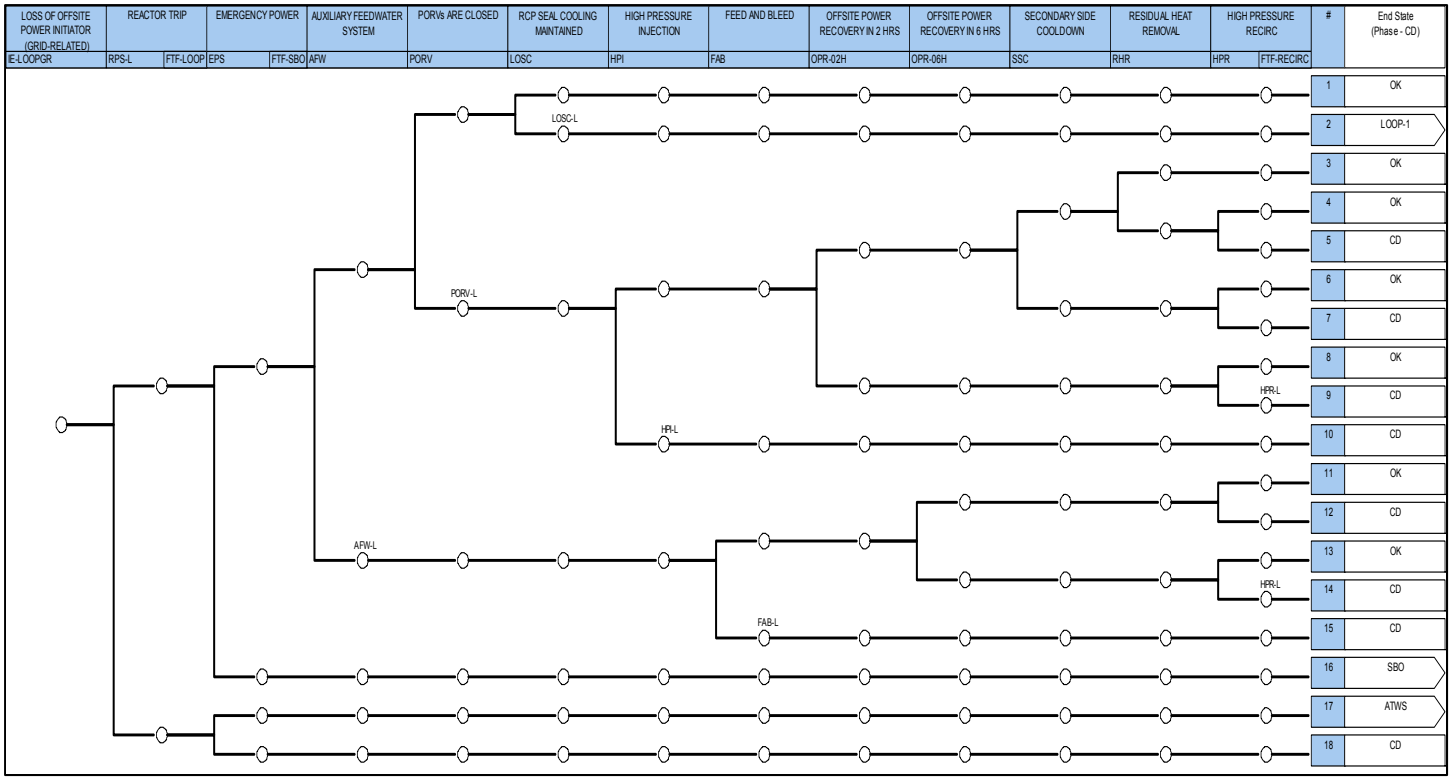


**Figure C-3.** Millstone Power Station Unit 3, Grid-Related LOOP Event Tree.

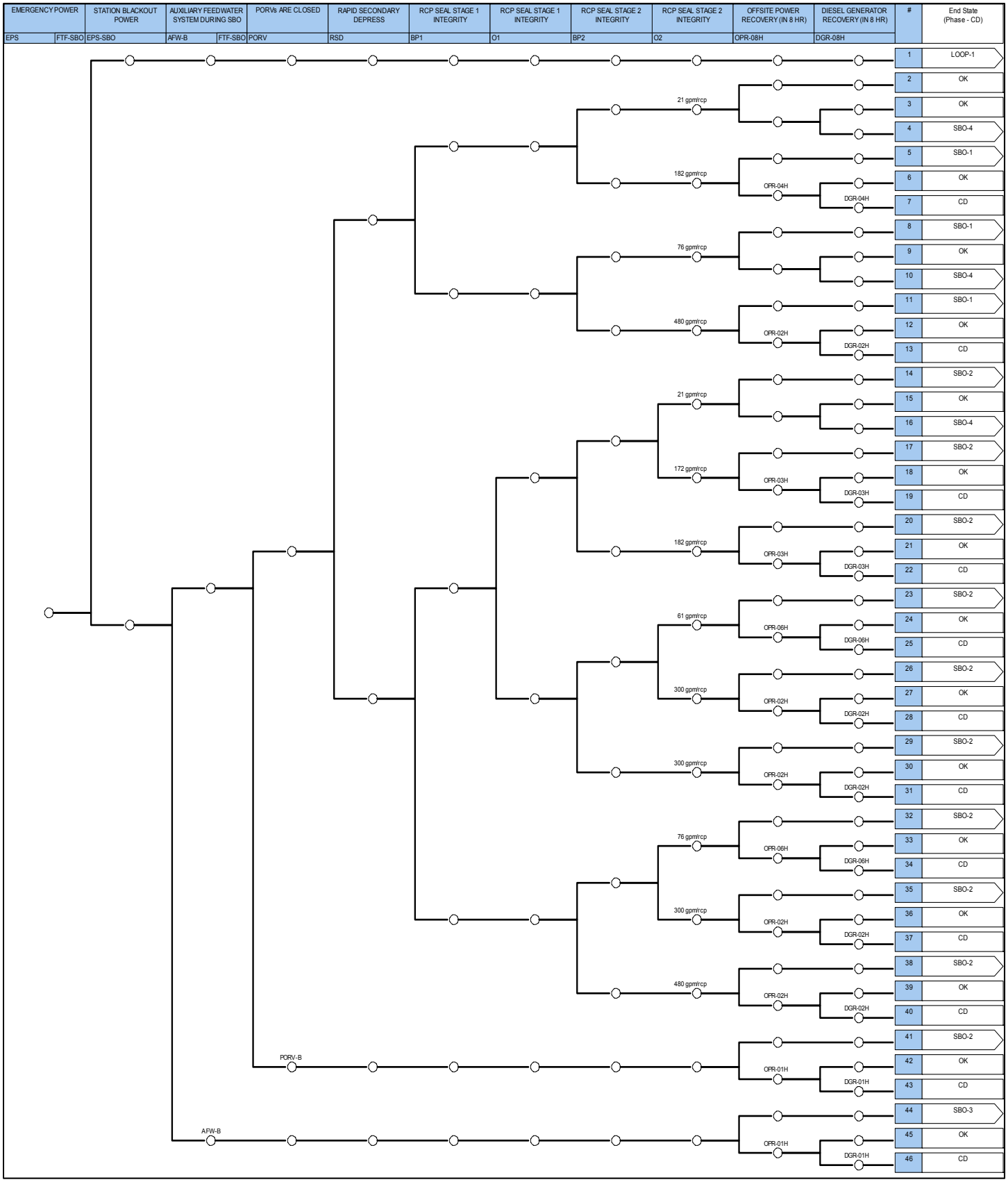


**Figure C-4.** Millstone Power Station Unit 3, SBO Event Tree.