Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

Pilgrim Nuclear Power Station	Two Losses of Offsite Power Due to Winter Storm Nemo	
Event Date: 02/08/2013	**LER:** 293/13-003 **IR:** 50-293/13-02	**CCDP =** 8×10^{-5}
Plant Type: Boiling-Water Reactor (BWR); General Electric-3 with a Mark I Containment		
Plant Operating Mode (Reactor Power Level): Mode 1 (81% Reactor Power)[1]		

EXECUTIVE SUMMARY

On February 8, 2013, at 2117 hours, electrical faults led to a loss of offsite power (LOOP) resulting in a full load reject of the main generator, a subsequent reactor scram, and loss of the startup transformer (SUT). The emergency diesel generators (EDGs) automatically started and provided power to both safety buses. The reactor core isolation cooling (RCIC) system was placed in service to maintain reactor vessel water level. The high-pressure coolant injection (HPCI) system was placed in service to control reactor pressure. All systems performed as designed to bring the reactor to Mode 3. Ice buildup on switchyard components caused additional electrical faults while operators attempted to restore power. These faults delayed the restoration of offsite power to the non-safety buses until 1815 hours on February 9th. At 0400 hours on February 10th, offsite power was restored to safety bus A5 through the SUT. Offsite power was subsequently restored to safety bus A6 at 0830 hours.

At 1401 hours on February 10th and while the plant was in Mode 4, ice buildup caused another electrical fault leading to a second LOOP and subsequent loss of shutdown cooling. Both EDGs auto-started as designed and provided power to the safety buses. At 1426 hours, shutdown cooling was returned to service. All other plant systems responded as designed. On February 12th, at 0405 hours offsite power was restored to the non-safety buses via the main/unit auxiliary transformers. At 0601 hours offsite power was restored to safety bus A6 through the main/unit auxiliary transformers. Offsite power was restored to all non-safety and safety buses through the SUT at 2147 hours on February 12th.

According to the risk analysis modeling assumptions used in this ASP analysis of the first (at-power) LOOP event, the most likely core damage sequence is a loss of offsite power and subsequent station blackout (SBO) due to postulated failures of all EDGs (including the SBO diesel generator) and the failure to recover power to a safety bus prior to core uncovery. This accident sequence accounts for approximately 71% of the conditional core damage probability (CCDP) for the event. In general, these results are consistent with at-power LOOP events previously analyzed by the ASP Program at other BWRs.

The second LOOP event is bounded by the first LOOP event given the lower decay heat levels due to the plant being shutdown for approximately 41 hours and the potential availability of the

[1] The LER (Reference 1) states that reactor was at 85% power. However, a review of the control room logs indicates that reactor power was closer to 81% due a leaking safety relief valve.

23kV power source via the shutdown transformer (given the postulated failure of the SBO diesel generator).

EVENT DETAILS

1st Event Description. On February 8, 2013, at 2102 hours a major fault occurred on offsite line 342 which remained de-energized for the remainder of the storm. At 2117 hours a fault on line 355 occurred resulting in a full load reject of the main generator, a subsequent reactor scram, and loss of the SUT. The EDGs automatically started and provided power to safety buses A5 and A6. The RCIC system was placed in service to maintain reactor vessel water level. The HPCI system was placed in service to control reactor pressure. All systems performed as designed to bring the reactor to Mode 3, including initiation of reactor water cleanup isolation, reactor building isolation, and the standby gas treatment system.

At 2200 hours, an unusual event (UE) was declared for a LOOP to the safety buses. At 2211 hours, offsite line 355 was restored and breaker ACB-102 was closed manually to re-energize the SUT. At 2340 hours, a phase 'B' fault on the SUT bus tripped the SUT bus lockout relay. The relays that initiated the bus trip indicated the fault was within the SUT protection scheme, but external to the SUT. On February 9th, line 355 was re-energized and the SUT was energized and non-safety buses A1, A2, A3, and A4 were energized from the SUT at 1815 hours.

At 0400 hours on February 10th, offsite power was restored to safety bus A5 through the SUT via a single 345kV line. At 0830 hours, offsite power was restored to safety bus A6 through the SUT. The EDGs were secured and were placed in standby. The residual heat removal (RHR) system was in shutdown cooling mode maintaining the reactor in cold shutdown. Fuel pool cooling was in service with fuel pool temperatures trending down. At 1055 hours Pilgrim terminated the UE. Additional information is provided in Reference 1 and Reference 2.

2nd Event Information. At 1401 hours on February 10th, with all control rods fully inserted and the reactor in cold shutdown conditions, the plant experienced a second LOOP with a flashover fault on the phase ‘B’ bus work of the SUT due to salt contaminated ice bridging on the phase insulator. This resulted in the tripping of breaker ACB-102 and loss of power to the safety buses. Both EDGs auto-started as designed and provided power to the safety buses. This LOOP resulted in de-energization of both reactor protection system (RPS) channels resulting in a reactor scram signal and loss of shutdown cooling.

At 1426 hours, shutdown cooling was returned to service. All other plant systems responded as designed. Station personnel established backup power to safety buses A5 and A6 in accordance with plant procedures. On February 12th, at 0405 hours offsite power was restored to the non-safety buses via the main/unit auxiliary transformers. At 0601 hours offsite power was restored to safety bus A6 through the main/unit auxiliary transformers. At 2147 hours offsite power was restored to all buses through the SUT.

The second LOOP event is bounded by the first LOOP event given the lower decay heat levels due to the plant being shutdown for approximately 41 hours and the potential availability of the 23kV power source via the shutdown transformer (given the postulated failure of the SBO diesel generator). The analysis results for the initial at-power LOOP event have the highest CCDP; therefore, the at-power analysis is considered to be the official ASP Program result for this event.

Additional Event Information. On February 11th, operators responded to a failure of the diesel-driven instrument air system compressor (K-117) during a time when no other air compressors were available to supply the instrument air system due to the loss of offsite power. The inspectors responded to the control room to assess the impact of the loss of the K-117 air compressor and operator response to the event. Entergy implemented the loss of instrument air procedure, evaluated the impact of the loss of instrument air on plant components (e.g., spent fuel pool cooling was lost), and made preparations to install a portable compressor located onsite as part of the response to the Fukushima orders. The K-117 air compressor fuel was found contaminated; the fuel tank was emptied, cleaned, and refilled. The K-117 air compressor was restored on February 12th. The unavailability of the air compressor is expected to have a negligible impact on the CCDP of the 2nd LOOP event.

MODELING ASSUMPTIONS

Analysis Type. The Pilgrim Standardized Plant Analysis Risk (SPAR) Model Revision 8.24, created in May 2014, was used for this event analysis. This event was modeled as a grid-related LOOP initiating event.

SPAR Model Modifications. Based on comments on the preliminary analysis provided by the licensee (Reference 3) and subsequent conversations with licensee PRA staff, several event tree modifications were made within the Pilgrim SPAR model.[2] Specifically, the SBO event tree was modified as described below:

- The battery depletion time for Pilgrim was verified to be 14 hours per the licensee comment.

- Firewater injection via the diesel-driven pump was added as a new top event given successful manual depressurization of the RCS (firewater was previously modeled as part of the late injection top event).[3] Plant procedures require operators to depressurize the RCS if the suppression pool reaches its heat capacity temperature limit (HCTL). During a LOOP and subsequent SBO, Pilgrim's suppression pool is expected to reach its HCTL in approximately 5 hours given successful RCIC/HPCI operation. Depressurization will cause the unavailability of the RCIC and HPCI; therefore, the diesel-driven firewater pump (via service water and RHR systems) can provide a source of low-pressure makeup. If successful, firewater will provide makeup until the RCS repressurizes after the station batteries are depleted at 14 hours.[4]

- Recovery of offsite power during a postulated SBO (without prior recovery of an EDG) after 3 hours is not possible due to the depletion of switchyard batteries.[5]

- Potential credit for EDG recovery after the battery depletion time of 14 hours was allowed. A review of plant procedures was performed and it was determined that there is adequate

[2] The licensee comments, along with the resolutions incorporated into the final ASP analysis by NRC staff are provided in Appendix C.

[3] The late injection top event was removed from the SBO Event Tree.

[4] RCS pressure is expected to increase above the head of the diesel-driven firewater pump within 1 hour after the station batteries are depleted.

[5] The switchyard battery depletion time of 3 hours may be conservative; however, no additional information was available to provide a better estimate of battery life at this time. For this analysis, this potential conservatism does not affect the results because offsite power was not available for approximately 21 hours (i.e., the switchyard batteries will be depleted regardless of the assumed battery life for this analysis).

guidance to justify the credit for breaker manipulations (e.g., EDG output breaker and safety bus feeder breaker) without DC power. In addition, operators and technicians train on these procedures and the potential success path was verified. This potential recovery credit is for sequences in which operators are successful in shedding DC loads and firewater injection is successful until battery depletion. Based on licensee MAAP calculations, core damage would not occur until approximately 24 hours given a SBO with successful RCIC/HPCI, RCS depressurization, and firewater injection. However, the assumptions of these calculations could not be verified by NRC staff. Considering the uncertainty of the MAAP calculations and similar calculations performed for similar plants as part of NRC research, a range of 19–24 hours until core damage occurs for this scenario was determined to be valid. Because of the negligible difference in EDG non-recovery probabilities for 19–24 hours, the non-recovery probability for 24 hours was used as a simplifying assumption.[6]

- Based on MAAP calculations performed by the licensee, containment pressure will not exceed its design pressure during a SBO until 34 hours after the event initiated. The information was reviewed by NRC staff, and it was determine that containment venting would not be required within the 24-hour SPAR model mission time for this scenario. However, containment venting would still be needed to reach a safe, stable state. Therefore, the containment venting was moved to the branches in which AC power was successful recovered given successful firewater injection.

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

- This analysis models the February 8, 2013 reactor trip at Pilgrim Nuclear Station as a grid-related LOOP initiating event.
  - The probability of grid-related LOOP (*IE-LOOPGR*) was set to 1.0; all other initiating event probabilities were set to zero.

- *Offsite Power Recovery*. The key offsite power recovery times for Pilgrim that are modeled within the plant SPAR model are:
  - 30 Minutes—A LOOP and subsequent SBO combined with failures/unavailabilities to RCIC, HPCI, and reactor depressurization.
  - 1 Hour—A LOOP and subsequent SBO with two or more stuck open safety relief valves (given successful RCIC or HPCI operation).
  - 3 Hours—A LOOP and subsequent SBO with operators failing to recover offsite power prior to the depletion of the switchyard batteries.

  A fault on Phase B of the SUT occurred while operators attempted to restore offsite power at 2340 hours on February 8th. The operators did not try to restore offsite power earlier due to grid-instability. The fault was due to ice buildup caused by the storm. Offsite power was recovered to Safety Bus A5 approximately 31 hours after the LOOP had occurred. Based on the event information and conversations with the licensee, it was determined that offsite power could not have been restored prior to depletion of the switchyard batteries (3 hours).
  - Therefore, basic events OEP-XHE-XL-NR30MGR (*Operators Fail to Recover Offsite Power in 30 Minutes*), OEP-XHE-XL-NR01HGR (*Operators Fail to Recover Offsite*

[6] The EDG non-recovery probabilities are 0.35 and 0.29 for 19 and 24 hours, respectively.

Power in 1 Hour), and OEP-XHE-XL-NR03HGR (*Operators Fail to Recover Offsite Power in 3 Hours*) were set to TRUE.

- *Initiation of Firewater Injection.* The current SPAR model has a generic screening valve of 0.3 for the human error probability (HEP) for basic event FWS-XHE-XM-ERRLT (*Operators Fail to Align Firewater Injection*). For this analysis, the screening value was determined to be conservative; therefore, the human failure event was reevaluated using SPAR-H (Reference 4 and Reference 5). Tables 1 and 2 provide the key qualitative information for this human failure event (HFE) and the performance shaping factor (PSFs) adjustments required for the quantification of the HEP using SPAR-H.

Table 1. Qualitative evaluation of HFE for initiation of firewater injection.[7]

Definition	The definition for this HFE is the operators failing to align a firewater pump to provide a source of low-pressure injection to the reactor given a LOOP/SBO.
Description and Event Context	Given a LOOP/SBO, operators will depressurize the RCS if RCIC and HPCI fail or when the suppression pool reaches its HCTL. After RCS depressurization, if the other low pressure sources of injection are unavailable, operators will attempt to align the firewater system to inject via the RHR system injection loops (A or B). Only the diesel-driven firewater pump will be available during a SBO; the motor-driven pump will not have electrical power.
Operator Action Success Criteria	Initiate firewater injection to the reactor pressure vessel (RPV) from via the RHR system injection loops prior to core uncovery.
Nominal Cues	Decreasing RPV level (-125").
Procedural Guidance	Emergency operating procedure (EOP) 1 directs the operators to restore and maintain RPV level above +12" using one or more preferred injection systems and, if necessary, alternate injection systems. When RPV level decreases to -125", EOP 1 instructs the operators to start pumps and maximize injection flow with the fire water crosstie to RHR or other alternate injection subsystems per procedure 5.3.26. Section 2.1 of procedure 5.3.26 provides detailed instructions for aligning the fire water crosstie to RHR.
Diagnosis/Action	This HFE contains sufficient diagnosis and action components.

[7] Given the failure or unavailability of the motor-driven firewater pump, the day tank for the diesel-driven firewater pump would need to be refilled during operation (approximately 2.5 hours after initiation). It is believed that the HEP for basic event FWS-XHE-XM-ERRLT envelopes this due to the greater time for operators to complete the refill of the day tank.

Table 2. SPAR-H Evaluation of HFE for initiation of firewater injection.

PSF	Diagnosis/ Action Multiplier	Notes
Time Available	1 / 1	The operators would need approximately 30 minutes to perform the action component of connecting the firewater-to-RHR spool pieces and initiate. The time for diagnosis is approximately 30 minutes.[8] Therefore, available time for the diagnosis component for thirty minute recovery is assigned as *Nominal Time* (i.e., ×1). Since sufficient time was available for the action component of the recovery, the available time for the action component for all recovery times is evaluated as *Nominal* (i.e., ×1). See Reference 5 for guidance on apportioning time between the diagnosis and action components of an HFE.
Stress	2 / 2	The PSF for diagnosis and action stress is assigned a value of *High Stress* (i.e., ×2) due to the postulated LOOP/SBO and failures of other systems.
Complexity	2 / 2	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 postulated SBO. The PSF for action complexity is also assigned a value of *Moderately Complex* (i.e., ×2) because actions outside the control room are required.
Procedures Experience/Training Ergonomics/HMI Fitness for Duty Work Processes	1 / 1	No event information is available to warrant a change in these PSFs (for diagnosis and action) from *Nominal* for these HFEs.

An HEP evaluated using SPAR-H is calculated using the following formula:

Calculated HEP = (Product of Diagnosis PSFs × 0.01) + (Product of Action PSFs × 0.001)

Therefore, basic event FWS-XHE-XM-ERRLT was set to 4×10^{-2}.

ANALYSIS RESULTS

CCDP. The point estimate CCDP for this event is 7.6×10^{-5}. The Accident Sequence Precursor Program acceptance threshold is a CCDP of 1×10^{-6} or the CCDP equivalent of an uncomplicated reactor trip with a non-recoverable loss of secondary plant systems (e.g., feed water and condensate), whichever is greater. This CCDP equivalent for Pilgrim is 2.0×10^{-6}.

Dominant Sequence. The dominant accident sequence is LOOP/ SBO Sequence 28-04 (CCDP = 5.4×10^{-5}) which contributes approximately 71% of the total internal events CCDP for this analysis. The cutsets/sequences that contribute to the top 95% and/or at least 1% of the total internal events CCDP are provided in Appendix A.

[8] The estimate of 30 minutes may be a conservative for some scenarios. However, the time available PSF would likely not be changed from nominal in these cases. In addition, a further decrease in the HEP would have a negligible impact on the analysis results.

The dominant sequence is shown graphically in Figures B-1 and B-2 in Appendix B. The events and important component failures in LOOP/SBO Sequence 28-04 are:

- A non-recoverable grid-related LOOP occurs,
- Reactor scram succeeds,
- Emergency powers fails (causing SBO),
- Safety relief valves reclose (if opened),
- RCIC/HPCI succeeds,
- Operators successful depressurize the RCS,
- Diesel-driven firewater pump succeeds,
- Operators successfully shed DC loads,
- Operators fail to restore offsite power prior to switchyard battery depletion (3 hours), and
- Operators fail to recover an EDG prior to core uncovery (24 hours).

REFERENCES

1. Pilgrim Nuclear Power Station, "LER 293/13-003– Loss of Off-Site Power Events Due to Winter Storm Nemo," dated April 8, 2013 (ML13114A293).

2. U.S. Nuclear Regulatory Commission, "Pilgrim Nuclear Power Station - NRC Integrated Inspection Report 05000293/2013002," dated May 8, 2013 (ML13129A212).

3. Entergy Nuclear Operations, Inc., "Entergy Comments on Pilgrim Nuclear Power Plant-Preliminary Accident Sequence Precursor Analysis," June 10, 2014 (ML14168A216).

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

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

Appendix A: Analysis Results

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
FWS-XHE-XM-ERRLT	OPERATORS FAIL TO ALIGN FIREWATER INJECTION	4.00E-2	3.00E-1
IE-LOOPGR[a]	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	1.00E+0	1.86E-2
OEP-XHE-XL-NR01HGR	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 1 HOUR (GRID-RELATED)	TRUE	6.59E-1
OEP-XHE-XL-NR03HGR	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 3 HOURS (GRID-RELATED)	TRUE	2.50E-1
OEP-XHE-XL-NR30MGR	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 30 MINUTES (GRID-RELATED)	TRUE	8.63E-1

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	28-04	5.40E-5	71.3%	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-24H
LOOPGR	28-11	1.09E-5	14.5%	/RPS, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
LOOPGR	25	3.38E-6	4.5%	/RPS, /EPS, /SRV, HPI, DEP
LOOPGR	04	3.09E-6	4.1%	/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, CSS, /CVS, LI01
LOOPGR	28-08	1.25E-6	1.7%	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, DCL, OPR-03H, DGR-08H
LOOPGR	28-17	8.78E-7	1.2%	/RPS, EPS, /SRV, HPI-B, OPR-30M, DGR-30M
	Total	**7.57E-5**	**100.0%**	

Referenced Fault Trees

Fault Tree	Description
CSS	CONTAINMENT SPRAY
DCL	OPERATOR SHEDS DC LOADS
DEP	MANUAL REACTOR DEPRESS
DGR-08H	OPERATORS FAIL TO RECOVER EMERGENCY DIESEL IN 8 HOURS
DGR-24H	OPERATORS FAIL TO RECOVER EMERGENCY DIESEL IN 24 HOURS
DGR-30M	OPERATORS FAIL TO RECOVER EMERGENCY DIESEL IN 30 MINUTES
EPS	EMERGENCY POWER
FWS-EXT	FIREWATER INJECTION
HPI	HIGH PRESSURE INJECTION
HPI-B	HIGH PRESSURE INJECTION FAILS DURING SBO (HPCI - RCIC)
LI01	PILGRIM LATE INJECTION FAULT TREE
OPR-03H	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 3 HOURS
OPR-30M	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 30 MINUTES
SPC	SUPPRESSION POOL COOLING

Cut Set Report - LOOPGR 28-04

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

#	CCDP	Total%	Cut Set
	5.40E-5	100	
1	6.63E-6	12.29	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR24H
2	4.68E-6	8.66	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR24H,EPS-XHE-XM-SBO
3	3.35E-6	6.22	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR24H
4	3.35E-6	6.22	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-XHE-XL-NR24H
5	3.35E-6	6.22	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-TM-DGB,EPS-XHE-XL-NR24H
6	2.82E-6	5.22	IE-LOOPGR,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR24H
7	2.82E-6	5.22	IE-LOOPGR,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR24H
8	2.36E-6	4.38	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR24H,EPS-XHE-XM-SBO
9	2.36E-6	4.38	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR24H,EPS-XHE-XM-SBO
10	1.86E-6	3.44	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-DGN-FR-SBO,EPS-XHE-XL-NR24H
11	1.70E-6	3.14	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-DGN-TM-SBO,EPS-XHE-XL-NR24H
12	1.70E-6	3.14	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR24H
13	1.31E-6	2.42	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-XHE-XL-NR24H,EPS-XHE-XM-SBO
14	9.39E-7	1.74	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-DGN-TM-SBO,EPS-XHE-XL-NR24H
15	6.76E-7	1.25	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FS-SBO,EPS-XHE-XL-NR24H
16	6.76E-7	1.25	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-FS-DGA,EPS-XHE-XL-NR24H
17	6.76E-7	1.25	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-FS-DGB,EPS-XHE-XL-NR24H
18	5.59E-7	1.04	IE-LOOPGR,ACP-CRB-OO-801,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR24H

Cut Set Report - LOOPGR 28-11

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

#	CCDP	Total%	Cut Set
	1.09E-5	100	
1	6.66E-7	6.09	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
2	5.12E-7	4.68	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
3	4.70E-7	4.29	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-EDP-FR-P140
4	3.61E-7	3.30	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-XHE-XM-ERRLT
5	3.37E-7	3.08	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140

#	CCDP	Total%	Cut Set
6	3.37E-7	3.08	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-TM-DGB,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
7	3.37E-7	3.08	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
8	2.83E-7	2.59	IE-LOOPGR,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
9	2.83E-7	2.59	IE-LOOPGR,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
10	2.59E-7	2.37	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
11	2.59E-7	2.37	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-TM-DGB,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
12	2.59E-7	2.37	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
13	2.38E-7	2.17	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-EDP-FR-P140
14	2.38E-7	2.17	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-EDP-FR-P140
15	2.17E-7	1.99	IE-LOOPGR,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
16	2.17E-7	1.99	IE-LOOPGR,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
17	1.86E-7	1.70	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-DGN-FR-SBO,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
18	1.83E-7	1.67	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-XHE-XM-ERRLT
19	1.83E-7	1.67	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-XHE-XM-ERRLT
20	1.70E-7	1.56	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
21	1.70E-7	1.56	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H,FWS-EDP-FR-P140
22	1.43E-7	1.31	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-DGN-FR-SBO,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
23	1.31E-7	1.20	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO,FWS-EDP-FR-P140
24	1.31E-7	1.20	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT
25	1.31E-7	1.20	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H,FWS-XHE-XM-ERRLT

Cut Set Report - LOOPGR 25

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

#	CCDP	Total%	Cut Set
	3.38E-6	100	
1	7.80E-7	23.09	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-TDP-FR-P206
2	3.56E-7	10.52	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-P206
3	2.83E-7	8.39	IE-LOOPGR,DCP-BCH-CF-D11D12D14
4	2.27E-7	6.70	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-P205,RCI-TDP-FR-P206
5	2.01E-7	5.95	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-TDP-TM-P206

#	CCDP	Total%	Cut Set
6	1.28E-7	3.80	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-FS-P205,RCI-TDP-FR-P206
7	1.28E-7	3.80	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-TDP-FS-P206
8	9.15E-8	2.71	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-TM-P206
9	7.19E-8	2.13	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-XHE-XO-ERROR1,RCI-XHE-XO-ERROR
10	5.93E-8	1.75	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-RESTART,RCI-TDP-FS-P206RS,RCI-XHE-XL-RSTRT
11	5.84E-8	1.73	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FS-P206
12	3.93E-8	1.16	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-MOV-FC-XFER,RCI-XHE-XL-XFER
13	3.72E-8	1.10	IE-LOOPGR,ADS-XHE-XM-MDEPR,HCI-TDP-TM-P205,RCI-TDP-FS-P206

Cut Set Report - LOOPGR 04

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

#	CCDP	Total%	Cut Set
	3.09E-6	100	
1	4.45E-7	14.40	IE-LOOPGR,FWS-EDP-FR-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208BER
2	4.45E-7	14.40	IE-LOOPGR,FWS-EDP-FR-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208ADR
3	9.87E-8	3.19	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,FWS-EDP-FR-P140,RHR-HTX-TM-E207A
4	6.96E-8	2.25	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-XHE-XM-SBO,FWS-EDP-FR-P140,RHR-HTX-TM-E207A
5	6.37E-8	2.06	IE-LOOPGR,FWS-EDP-TM-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208BER
6	6.37E-8	2.06	IE-LOOPGR,FWS-EDP-TM-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208ADR
7	4.99E-8	1.61	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-SBO,FWS-EDP-FR-P140,RHR-HTX-TM-E207A
8	4.99E-8	1.61	IE-LOOPGR,EPS-DGN-FR-SBO,EPS-DGN-TM-DGB,FWS-EDP-FR-P140,RHR-HTX-TM-E207A
9	4.36E-8	1.41	IE-LOOPGR,FWS-EDP-FS-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208BER
10	4.36E-8	1.41	IE-LOOPGR,FWS-EDP-FS-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208ADR
11	4.04E-8	1.30	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,FWS-EDP-FR-P140,RHR-MOV-OO-18A
12	4.04E-8	1.30	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,FWS-EDP-FR-P140,RHR-MOV-OO-16A
13	3.52E-8	1.14	IE-LOOPGR,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR,FWS-EDP-FR-P140,RHR-HTX-TM-E207A
14	3.52E-8	1.14	IE-LOOPGR,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR,FWS-EDP-FR-P140,RHR-HTX-TM-E207A

Cut Set Report - LOOPGR 28-08

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

#	CCDP	Total%	Cut Set
	1.25E-6	100	
1	1.54E-7	12.30	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR08H
2	1.08E-7	8.67	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO
3	7.77E-8	6.22	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-TM-DGB,EPS-XHE-XL-NR08H

#	CCDP	Total%	Cut Set
4	7.77E-8	6.22	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-XHE-XL-NR08H
5	7.77E-8	6.22	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H
6	6.52E-8	5.22	IE-LOOPGR,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,DCP-XHE-XM-DCLSHED,EPS-XHE-XL-NR08H
7	6.52E-8	5.22	IE-LOOPGR,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,DCP-XHE-XM-DCLSHED,EPS-XHE-XL-NR08H
8	5.48E-8	4.38	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO
9	5.48E-8	4.38	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO
10	4.30E-8	3.44	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-CF-RUN,EPS-DGN-FR-SBO,EPS-XHE-XL-NR08H
11	3.93E-8	3.15	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H
12	3.93E-8	3.15	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H
13	3.03E-8	2.43	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-CF-RUN,EPS-XHE-XL-NR08H,EPS-XHE-XM-SBO
14	2.17E-8	1.74	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-CF-RUN,EPS-DGN-TM-SBO,EPS-XHE-XL-NR08H
15	1.56E-8	1.25	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-FS-DGB,EPS-XHE-XL-NR08H
16	1.56E-8	1.25	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-FS-DGA,EPS-XHE-XL-NR08H
17	1.56E-8	1.25	IE-LOOPGR,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FS-SBO,EPS-XHE-XL-NR08H
18	1.29E-8	1.04	IE-LOOPGR,ACP-CRB-OO-801,DCP-XHE-XM-DCLSHED,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR08H

Cut Set Report - LOOPGR 28-17

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

#	CCDP	Total%	Cut Set
	8.78E-7	100	
1	9.16E-8	10.43	IE-LOOPGR,DCP-BAT-CF-D1D2,EPS-XHE-XL-NR30M
2	3.27E-8	3.73	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206
3	2.31E-8	2.63	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR30M,EPS-XHE-XM-SBO,HCI-TDP-FR-P205,RCI-TDP-FR-P206
4	1.65E-8	1.88	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-TM-SBO,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206
5	1.65E-8	1.88	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-DGN-TM-DGA,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206
6	1.65E-8	1.88	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-SBO,EPS-DGN-TM-DGB,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206
7	1.49E-8	1.70	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR30M,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-P206
8	1.39E-8	1.58	IE-LOOPGR,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206

#	CCDP	Total%	Cut Set
9	1.39E-8	1.58	IE-LOOPGR,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206
10	1.17E-8	1.33	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-TM-DGB,EPS-XHE-XL-NR30M,EPS-XHE-XM-SBO,HCI-TDP-FR-P205,RCI-TDP-FR-P206
11	1.17E-8	1.33	IE-LOOPGR,EPS-DGN-FR-DGB,EPS-DGN-TM-DGA,EPS-XHE-XL-NR30M,EPS-XHE-XM-SBO,HCI-TDP-FR-P205,RCI-TDP-FR-P206
12	1.05E-8	1.20	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-XHE-XL-NR30M,EPS-XHE-XM-SBO,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT,HCI-XHE-XL-INJECT,RCI-TDP-FR-P206
13	9.50E-9	1.08	IE-LOOPGR,EPS-DGN-FR-DGA,EPS-DGN-FR-DGB,EPS-DGN-FR-SBO,EPS-XHE-XL-NR30M,HCI-TDP-TM-P205,RCI-TDP-FR-P206
14	9.16E-9	1.04	IE-LOOPGR,EPS-DGN-CF-RUN,EPS-DGN-FR-SBO,EPS-XHE-XL-NR30M,HCI-TDP-FR-P205,RCI-TDP-FR-P206

Referenced Events

Event	Description	Probability
ACP-CRB-CC-604	4.16KV STARTUP TRANSFORMER FEEDER CIRCUIT BKR 152-604 FAILS TO OPEN RESULTS IN LOSS OF POWER TO BUS A6	2.39E-3
ACP-CRB-CC-605	4.16KV UNIT AUXILIARY TRANSFORMER FEEDER CIRCUIT BKR 152-605 FAILS TO OPEN RESULTS IN LOSS OF POWER TO BUS A6	2.39E-3
ACP-CRB-CF-504604	CCF OF STARTUP TRANSFORMER FEEDER CIRCUIT BKR 152-504 & 604 TO OPEN RESULTS IN LOSS OF POWER TO BUS A5 & A6	8.08E-5
ACP-CRB-CF-505605	CCF OF UNIT AUXILIARY TRANSFORMER FEEDER CIRCUIT BKRs 152-505 & 605 TO OPEN RESULTS IN LOSS OF POWER TO BUS A5 & A6	8.08E-5
ACP-CRB-OO-801	4.16KV CKT BRKR 152-801 FAILS TO CLOSE	2.39E-3
ACP-XHE-XM-NORECBKR	SUT or UAT FEEDER BREAKER FAULTS TO BUS A5 or BUS A6 NOT RECOVERED	1.20E-1
ADS-XHE-XM-MDEPR	OPERATORS FAIL TO DEPRESSURIZE THE REACTOR	5.00E-4
DCP-BAT-CF-D1D2	COMMON CAUSE FAILURE OF125 VDC D1 & D2 BATTERIES	9.97E-8
DCP-BCH-CF-D11D12D14	BATTERY CHARGERS FAIL FROM COMMON CAUSE	2.83E-7
DCP-XHE-XM-DCLSHED	OPERATORS FAIL TO SHED DC LOADS	1.20E-2
EPS-DGN-CF-RUN	DIESEL GENERATORS COMMON CAUSE FAIL TO RUN	2.25E-4
EPS-DGN-FR-DGA	EDG-A X107A FAILS TO CONTINUE TO RUN	2.84E-2
EPS-DGN-FR-DGB	EDG-B X107B FAILS TO CONTINUE TO RUN	2.84E-2
EPS-DGN-FR-SBO	DIESEL GENERATOR SBO FAILS TO RUN	2.84E-2
EPS-DGN-FS-DGA	EDG-A X107A ENGINE FAILS TO START	2.89E-3
EPS-DGN-FS-DGB	EDG-B X107B ENGINE FAILS TO START	2.89E-3
EPS-DGN-FS-SBO	DIESEL GENERATOR SBO FAILS TO START	2.89E-3
EPS-DGN-TM-DGA	EDG-A X107A IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.43E-2
EPS-DGN-TM-DGB	EDG-B X107B IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.43E-2
EPS-DGN-TM-SBO	DG SBO IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.43E-2
EPS-XHE-XL-NR08H	OPERATORS FAIL TO RECOVER EMERGENCY DIESEL IN 8 HOURS	5.60E-1
EPS-XHE-XL-NR24H	OPERATORS FAIL TO RECOVER EMERGENCY DIESEL IN 24 HOURS	2.90E-1
EPS-XHE-XL-NR30M	OPERATORS FAIL TO RECOVER EMERGENCY DIESEL IN 30 MINUTES	9.18E-1

Event	Description	Probability
EPS-XHE-XM-SBO	OPERATORS FAIL TO START OR ALIGN THE SBO DIESEL	2.00E-2
FWS-EDP-FR-P140	ENGINE DRIVEN FIRE PUMP P-140 FAILS TO RUN	5.21E-2
FWS-EDP-FS-P140	ENGINE DRIVEN FIRE PUMP P-140 FAILS TO START	5.09E-3
FWS-EDP-TM-P140	ENGINE DRIVEN FIRE PUMP P-140 IS IN TEST OR MAINT	7.45E-3
FWS-XHE-XM-ERRLT	OPERATORS FAIL TO ALIGN FIREWATER INJECTION	4.00E-2
HCI-MOV-CC-IVFRO	HPCI INJECTION MOV FAILS TO REOPEN	1.50E-1
HCI-MULTIPLE-INJECT	MULTIPLE HPCI INJECTIONS REQUIRED	1.50E-1
HCI-TDP-FR-P205	HPCI PUMP TRAIN P-205 FAILS TO RUN GIVEN IT STARTED	3.95E-2
HCI-TDP-FS-P205	HPCI PUMP P-205 FAILS TO START	6.49E-3
HCI-TDP-TM-P205	HPCI TRAIN P-205 IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.15E-2
HCI-XHE-XL-INJECT	OPERATORS FAIL TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN	8.00E-1
HCI-XHE-XO-ERROR1	OPERATORS FAIL TO START/CONTROL HPCI INJECTION	1.44E-1
IE-LOOPGR	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	1.00E+0
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-P206	RCIC PUMP P-206 FAILS TO RUN GIVEN THAT IT STARTED	3.95E-2
RCI-TDP-FS-P206	RCIC PUMP P-206 FAILS TO START	6.49E-3
RCI-TDP-FS-P206RS	RCIC FAILS TO RESTART GIVEN START AND SHORT-TERM RUN	8.00E-2
RCI-TDP-TM-P206	RCIC PUMP TRAIN P-206 IS UNAVAILABLE BECAUSE OF MAINTENANCE	1.02E-2
RCI-XHE-XL-RSTRT	OPERATORS FAIL TO RECOVER RCIC FAILURE TO RESTART	2.50E-1
RCI-XHE-XL-XFER	OPERATORS FAIL TO RECOVER SUCTN XFER FAILURE	2.50E-1
RCI-XHE-XO-ERROR	OPERATORS FAIL TO START/CONTROL RCIC INJECTION	1.00E-3
RHR-HTX-TM-E207A	RHR HEAT EXCHANGER E-207A UNAVAILABLE DUE TO TEST OR MAINTENANCE	2.36E-3
RHR-MOV-OO-16A	RHR HEAT EXCHANGER BYPASS VALVE 16A FAILS TO CLOSE	9.63E-4
RHR-MOV-OO-18A	RHR LOOP A MINFLOW VALVE 18A FAILS TO CLOSE	9.63E-4
SSW-MDP-CF-FS	COMMON CAUSE FAILURE TO START OF THREE SSW PUMPS	1.71E-5
SSW-MDP-CFG-P208ADR	SSW PUMP P-208A & D RUNNING	5.00E-1
SSW-MDP-CFG-P208BER	SSW PUMP P-208B & E RUNNING	5.00E-1

Appendix B: Key Event Trees

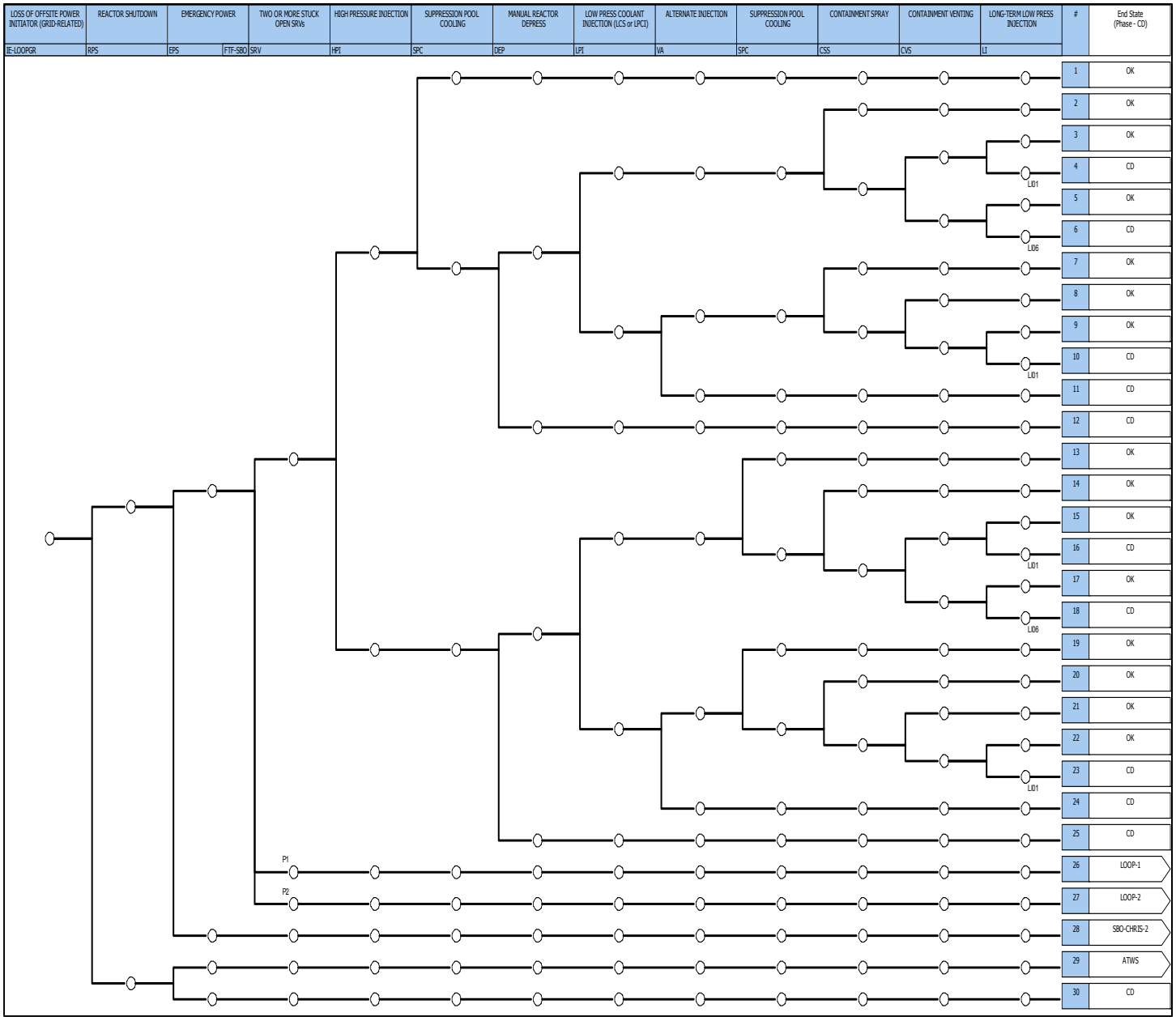

Figure B-1. Pilgrim Nuclear Power Station Grid-Related LOOP event tree.

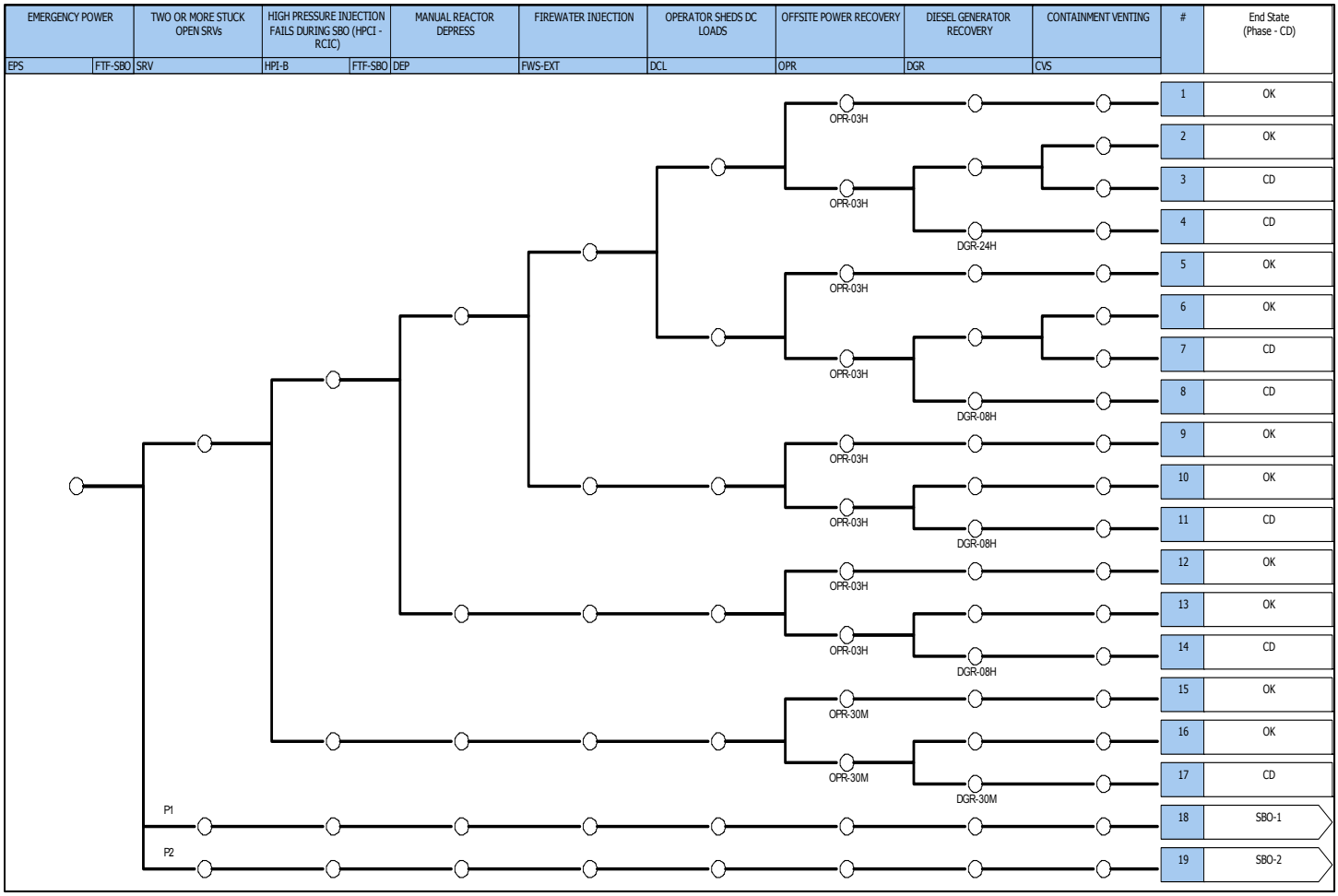

Figure B-2. Pilgrim Nuclear Power Station SBO event tree.

Appendix C: Licensee Comments and Resolutions

The NRC requested a formal analysis review from the licensee in accordance with U.S. Nuclear Regulatory Commission Regulatory Issue Summary 2006-24, "Revised Review and Transmittal Process for Accident Sequence Precursor Analyses," because the analysis had a preliminary CCDP greater than 1×10^{-4}. Licensee comments on the preliminary ASP analysis on June 10, 2014 (Reference 3). The six comments that were provided, along with the resolutions incorporated into the final ASP analysis by NRC staff are provided below.

1. **No credit for 345 kV recovery due to damaged condition prior to Startup Transformer (SUT) restoration (-21 hours) which is not challenged due to the damage. However, no credit was given for recovery of the 23kV line. There were indications from NSTAR that this line was available for 2 hours after the event and then again some 16 hours later. Had the EDGs not run, this line would have been pursued for AC power recovery.**

   The 16 hour time was based on conversations with the Pilgrim PRA staff and NSTAR. This timing assumption could not be verified by the NRC staff. Even if the 23kV line was available, the switchyard batteries would have been depleted prior to 16 hours; therefore, during a postulated SBO it would not have been recoverable during this event. Additional information is provided in the answer to the next comment.

2. **The Pilgrim PRA report contains a Station Blackout (SBO) Modular Accident Analysis Program (MAAP) run which shows that with Reactor Core Isolation Cooling (RCIC), High Pressure Coolant Injection (HPCI), and Fire Water Systems available from the beginning, and successful DC load shedding, there are up to 24 hours to recover AC power prior to core damage. Therefore, the 345kV source would have been available in time to avoid core damage.**

   After conversations with the licensee PRA staff, it was determined that offsite power was not recoverable after 3 hours due to depletion of the switchyard batteries. The 3-hour battery life may be conservative, but no documentation was provided to indicate otherwise. Note that an increased battery life would have no effect on the analysis results because offsite power was likely not recoverable for at least 21 hours (when the SUT was restored).

3. **No credit was given for breaker alignment after battery depletion, but breakers can be manipulated without DC power in accordance with Procedure 2.4.16. This will allow for some offsite power recovery which is currently not credited in the ASP assessment.**

   The 3-hour switchyard battery depletion time renders this comment moot.

4. **The ASP assessment assumes 12 hour 125VDC battery service life with DC load shedding, whereas PRA assumes 14 hour with successful DC power load shedding in accordance with Procedure 5.3.31.**

   The 14-hour 125V DC battery life was verified and changed. However, this change was rendered moot with subsequent SPAR model changes limiting offsite power restoration to switchyard battery depletion time (3 hours) and linking the EDG recovery to time of core uncovery.

5. **No credit for EDG recovery within 12 hours due to battery depletion (no DC power) yet EDGs can be started and loaded without DC in accordance with Procedure 2.4.16.**

   Procedures, along with training records, were reviewed and verified. Therefore, EDG recovery was credited beyond battery depletion given successful operation of the diesel-driven firewater pump during a postulated SBO.

6. **No credit was given for containment venting due to loss of DC power. Additionally, no credit was given for local direct torus vent operation in accordance with Procedure 5.3.36, Attachment 9.**

   The licensee provided MAAP calculations showing containment venting was not needed to prevent containment failure until 34 hours after event initiation. Therefore, the Pilgrim SPAR model was modified to only require containment venting (during a postulated SBO) to bring the plant to safe and stable (per the PRA standard) given successful DC load shedding and firewater injection.