Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research			
Pilgrim Nuclear Power Station	Loss of Offsite Power Due to Winter Storm Juno		
Event Date: 1/27/2015	**LERs:** 293-2015-001 and 293-2015-002 **IRs:** 50-293-2015-07, 50-293-2015-02, and 50-293-2015-11		**CCDP =** 4×10^{-5}
Plant Type: Boiling-Water Reactor (BWR); General Electric-3 with a Mark I Containment			
Plant Operating Mode (Reactor Power Level): Mode 1 (52% Reactor Power)			
Analyst: Christopher Hunter	**Reviewer:** David Aird	**Contributors:** N/A	**BC Review Date:** 6/15/2016

EXECUTIVE SUMMARY

On January 27, 2015, at 4:02 a.m., with the reactor at 52% power and both safety buses being powered from emergency diesel generators (EDGs) and 345kV offsite power line 355 out-of-service due to weather-related failures in the switchyard, a loss of offsite power (LOOP) occurred due to the loss of the second 345kV line 342. This resulted in a generator load reject and a reactor scram. All control rods fully inserted and main steam isolation valves were directed closed. A plant cool down commenced with reactor water level being maintained by the reactor core isolation cooling (RCIC) system and pressure controlled by high pressure coolant injection (HPCI) system. Due to complications in level control because of letdown isolation (caused by loss of instrument air), the operators cycled safety relief valves (SRVs) B and D to control reactor coolant system (RCS) pressure. Offsite power was not restored until January 29th, when line 342 was energized and aligned to the safety buses.

According to the risk analysis modeling assumptions used in this Accident Sequence Precursor (ASP) analysis, the most likely core damage scenario is a non-recoverable LOOP and subsequent station blackout (SBO) due to the failure of the feeder breakers from the startup and/or auxiliary transformers to the safety buses to open. The failure of these breakers prevents the EDGs from being able to supply power to the safety buses. If operators fail to open these breakers, then core damage is assumed to occur given the failure to reach a safe and stable state (non-recoverable SBO) within 24 hours. This accident sequence accounts for approximately 47% of the conditional core damage probability (CCDP) for the event.

The Reactor Oversight Process (ROP) identified one White finding (i.e., low to moderate safety significance) and seven Green findings (i.e., very low safety significance) associated with complications that occurred during response to this event. Six of the 8 inspection findings did not result in a loss in the safety function of mitigation equipment. The Significance Determination Process (SDP) evaluates each inspection finding (i.e., licensee performance deficiency) individually. Whereas, ASP analyses consider the occurrence of an initiating event, along with any failures, degraded conditions, or unavailabilities that were associated with initiating event and during the event response. Additional information on the similarities/differences between the ASP analysis modeling assumptions and the SDP evaluations are provided in this report.

EVENT DETAILS

Event Description. On January 27, 2015 at 4:02 a.m., with the reactor at 52% power and both safety buses being powered from EDGs and 345kV offsite power line 355 out-of-service due to weather-related failures in the switchyard, a LOOP occurred due to the loss of the second 345kV line 342. This resulted in a generator load reject and a reactor scram. All control rods fully inserted and main steam isolation valves were directed closed.

A plant cool down commenced with reactor water level being maintained by the RCIC system and pressure controlled by HPCI system. As pressure decreased to approximately 150 psi, HPCI was taken out of service. Due to complications in level control because of letdown isolation, the operators cycled the SRVs in an attempt to control pressure. SRV A was available, but was not cycled due to known pilot valve leakage; while SRV C failed to open on demand (at RCS pressure of 220 psig). As a result, SRVs B and D were cycled 52 and 53 times to control RCS pressure.

Offsite power was not restored until January 29th, when line 342 was energized and aligned to the safety buses. Additional information is provided in Licensee Event Report (LER) 293-2015-001 (Ref.1), LER 293-2015-002 (Ref. 2), Inspection Report (IR) 50-293-2015-07 (Ref. 3), and IR 50-293-2015-11 (Ref. 4).

Cause. Line 342 failed due to flashover of the switchyard insulators as a result of snow pack and salt spray.

Additional Event Information. The following 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.

- During the LOOP event, the operators planned to operate SRVs B, C, and D sequentially to reduce reactor pressure in accordance with emergency procedures. SRV A was not planned to be used due to previously identified pilot valve leakage, but was considered by operators to be available for use if needed. After successfully cycling the SRV B, operators applied an open demand on SRV C for 52 seconds at a reduced plant pressure of approximately 220 psig; however, the expected system response did not accompany the open demand. Specifically, although the tailpipe temperature increased (indicative of steam exhausting to the torus), the acoustic monitor response was less than normal, and reactor pressure continued to increase. For the next 15 minutes, operators continued to depressurize using SRVs B and D, and then attempted to cycle SRV C again. This time, the open demand remained for 83 seconds; tailpipe temperature increased and the associated acoustic monitor indicated a normal response (that the SRV was open), but reactor pressure did not respond as expected. Due to the abnormal response from SRV C, operators continued to operate SRVs B and D during a 3-hour period, cycling them 52 and 53 times, respectively. SRV D was subsequently opened and remained open for about three hours to achieve an effective pressure reduction.

  Subsequent tests on SRVs A and C were performed (both onsite and offsite). While SRV C satisfactorily stroked during both the set point test and additional low pressure (100 psig) actuation test at the testing facility, the inspection revealed notable damage to some internal valve main stage parts. For SRV A, the as-found full pressure lift, including set point verification, and the 100 psig lift were completed satisfactorily at the testing facility.

However, disassembly and inspection of the valve's internal parts yielded similar results to that of SRV C.

The failure of the SRVs to open is only modeled as part of the Automatic Depressurization System (ADS) function for manual depressurization given failure of high-pressure injection sources (RCIC and HPCI).[1] Since both valves successfully lifted during testing, they would be expected to lift during ADS actuation at higher RCS pressures. Therefore, SRVs A and C were considered able to perform their safety function as part of this analysis.

- While operators were conducting a reactor cooldown on January 27th using the SRVs, reactor level control was being augmented with the use of RCIC. Subsequently, the RCIC system tripped on high reactor vessel level when an SRV was opened to control reactor pressure. The RCIC system trip was caused by reactor vessel level swell rising above the +45-inch trip signal. Shortly after the RCIC system trip, operators manually restarted the RCIC system; however, the reactor operator failed to open cooling water supply valve MO-1301-62 in accordance with step 2 of the applicable procedure. This operator failure did not result in a loss of safety function; no temperature limits were exceeded when the RCIC system was operated in this condition. In the event of a RCIC system automatic start, the cooling water supply valve would have opened automatically.

- Operators shut down the HPCI system several hours after the reactor scram after operating in pressure control mode. Subsequently, the HPCI system was declared inoperable due to the loss of the gland seal condenser because of the loss of instrument air and the lack of appropriate procedural guidance. However, these issues did not render the HPCI system unavailable to perform its safety function.

- The loss of instrument air and lack of appropriate procedural guidance also affected the reactor water cleanup (RWCU) and control level indicators for the sea water bay and condensate storage tank (CST).
  - RWCU letdown valve CV-1239 failed closed eliminating RWCU letdown which led to the excessive cycling of the SRVs for short durations to keep reactor water level in band (less than +45 inches) so that RCIC would not isolate when level swelled.
  - Sea water bay level indicators LI-3831A and LI-3831B became inoperable, which eliminated the ability to monitor emergency action level entry conditions for abnormal sea water bay level with the lack of an established backup monitoring method.
  - The loss of CST level instrumentation (LI-3503A and LI-3503B) directly affected the operators' decision to not utilize the low-pressure core spray (LPCS) system with preferred suction aligned to the CST for reactor pressure vessel inventory control.

  While the lack of adequate procedures for loss of instrument air adversely affected several operator actions and plant equipment during the response to the LOOP event, systems were able to perform their safety functions even with the lack of guidance.

- The discharge header for LPCS train A experienced voiding due to the unavailability of the keep-fill system due to the LOOP. This voiding could potentially cause a water hammer event if the LPCS pump A was used. A sensitivity analysis was performed, which

[1] Because this ASP analysis is an initiating event analysis of a LOOP, it does not consider concurrent initiating events that may require the ADS safety function at lower RCS pressures (e.g., MLOCA).

demonstrated that conservatively modeling LPCS pump A as failed for this analysis has a negligible impact on the CCDP.

- Due to worsening storm and electrical grid conditions, plant operators aligned the EDGs to the safety buses A5 and A6 approximately two hours prior to fault on line 342. Since these alignments were completed relatively close to the time of the LOOP initiating event, no plant configuration changes (e.g., EDGs successfully started) were made as part of this analysis. ASP analyses treat successful equipment probabilistically (i.e., failure memory approach). However, the impact of postulated failures of key electrical equipment approximately two hours before a LOOP versus after the LOOP initiating could allow additional time for operators to recover certain hardware failures (e.g., EDGs or safety bus feeder breakers). Two additional hours would have a negligible effect on non-recovery probabilities of the postulated failures of the EDGs and/or breakers; and therefore, a negligible effect on the analysis results.

MODELING ASSUMPTIONS

Analysis Type. An interim Pilgrim Standardized Plant Analysis Risk (SPAR) Model created in April 2016, was used for this event analysis.[2]

SDP Results/Basis for ASP Analysis. The ASP Program uses SDP results for degraded conditions when available. The special inspection revealed a White finding (i.e. low to moderate safety significance) due to the licensee failure to establish measures to promptly identify and correct a significant condition adverse to quality involving a component that is essential to perform the ADS safety-related reactor vessel depressurization and over-pressure protection functions, or assure that the cause of the condition was determined and corrective actions taken to preclude repetition. Specifically, the licensee did not identify, evaluate, and correct the failure of SRV A to open upon manual actuation during a plant cool-down on February 9, 2013, following a LOOP event. This failure to perform the proper corrective actions resulted in SRV C failing to open due to a similar cause during the January 27th winter storm.

In addition, five Green findings (i.e., very low safety significance) were identified (see IR 50-293-2015-07 for additional information).[3,4] These findings include:

- The licensee failed to verify that the diesel-driven air compressor (K-117) was available for service prior to the January 27th winter storm. Specifically, although K-117 was tested prior to the winter storm, the test methodology did not reveal that the capacity of the starting battery was inadequate. The failure of the K-117 instrument air compressor is modeled in this ASP analysis.
- The licensee performed an inadequate past operability determination that assessed performance of SRV C after the January 27th winter storm. This performance deficiency

2 The Pilgrim SPAR model that was used in this analysis is currently posted on the test/limited use portion of the SAPHIRE webpage. This updated SPAR model is expected to be finalized and posted for unrestricted use after the model documentation is revised.

3 The SDP evaluates each inspection finding (i.e., licensee performance deficiency) individually.

4 Two additional findings were also identified. These findings involved the licensee failure to make a required event notification due to failure of emergency action level (EAL) instrumentation (Severity Level IV non-cited violation) and failing to implement compensatory measures per procedures to determine whether a sea water bay level EAL threshold had been exceeded (Green finding). Issues involving the Emergency Preparedness ROP cornerstone are not considered in the ASP Program.

was determined to not be a potential or actual loss of safety function; therefore, this finding was not considered in this ASP analysis.

- The licensee failed to include appropriate operator actions to both recognize the effects of and recover systems and components important to safety within the loss of instrument air abnormal operating procedure. This performance deficiency was determined to not be a potential or actual loss of safety function; therefore, this finding was not considered in this ASP analysis.
- The licensee operating crew failed to implement a procedure step to open the RCIC system cooling water supply valve during a manual startup of the system during post-trip activities during the January 27th winter storm. This performance deficiency was determined to not be a potential or actual loss of safety function; therefore, this finding was not considered in this ASP analysis.
- The licensee failed to identify and correct conditions adverse to quality associated with the partial voiding of the LPCS pump A discharge header following the loss of the keep-fill system caused by the LOOP due the January 27th winter storm. This performance deficiency was determined to not be a potential or actual loss of safety function; therefore, this finding was not considered in this ASP analysis.

LER 293-2015-001 and LER 293-2015-002 were closed out in IR 50-293-2015-02 (Ref. 5), with an additional Severity Level IV non-cited violation for the licensee's failure to submit an LER within 60 days of discovering that SRV C was not operable in accordance with Technical Specifications.

The ASP Program performs independent analyses for initiating events. ASP analyses of initiating events account for all failures/degraded conditions and unavailabilities (e.g., equipment out for test/maintenance) that occurred during the event, regardless of licensee performance.[5]

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

- This analysis models the January 27, 2015, reactor trip at Pilgrim Nuclear Station as a switchyard-related LOOP initiating event.
  - The probability of switchyard-related LOOP (*IE-LOOPSC*) was set to 1.0; all other initiating event probabilities were set to zero.

- *Shutdown Transformer (SDT) Availability*. The 23kV power source via the SDT was available throughout the event. Given a postulated failure of the SBO diesel generator, the SDT will automatically align to power safety buses A5 and/or A6.
  - To allow credit for the SDT availability, the house events HE-LOOP (*House Event – Loss of Offsite Power IE Has Occurred*) and HE-LOOPSC (*House Event – Switchyard-Related Loss of Offsite Power IE Has Occurred*) must be removed from the ACP-23KV (*Shutdown Transformer Offsite Power Supply*) fault tree.

- *Offsite Power Recovery*. The key offsite power recovery times for Pilgrim that are modeled within the plant SPAR model are:

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

- 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.

Offsite power was not restored until January 29th, approximately 60 hours after the LOOP initiated. Therefore, offsite power could not have been restored prior to depletion of the switchyard batteries (3 hours).

- Basic events OEP-XHE-XL-NR30MSC (*Operators Fail to Recover Offsite Power in 30 Minutes*), OEP-XHE-XL-NR01HSC (*Operators Fail to Recover Offsite Power in 1 Hour*), and OEP-XHE-XL-NR03HSC (*Operators Fail to Recover Offsite Power in 3 Hours*) were set to TRUE.

- The diesel-driven instrument air system compressor (K-117) failed to automatically start and run on low instrument air pressure. The failure of the K-117 air compressor to start resulted in a sustained loss of instrument air. Control room operators' ability to cope with and recover from the loss of instrument air was complicated by the absence of adequate procedural guidance. To account for the complete loss of instrument air during the LOOP event, basic event HE-LOIAS (*House Event: Loss of Instrument Air Initiating Event Has Occurred*) was set to TRUE.

- Due to isolation of letdown, operators cycled SRV B (52 times) and SRV D (53 times) to control RCS pressure. To account for the increased failure of these SRVs to successfully reclose after the opening, the associated failure probabilities were modified by the binominal expansion method to account for their greater likelihood of failure.[6]
  - Basic event PPR-SRV-OO-1VLV (*One SRV Fails to Close*) was set to 8.2×10^{-2}, basic event PPR-SRV-OO-2VLVS (*Two SRVs Fail to Close*) was set to 3.7×10^{-3}, and basic event PPR-SRV-OO-3VLVS (*Three or More SRVs Fail to Close*) was set to 1.0×10^{-4}.

- 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 (HFE) was reevaluated using SPAR-H (Ref. 6 and Ref. 7). Tables 1 and 2 provide the key qualitative information for this HFE and the performance shaping factor (PSF) adjustments required for the quantification of the HEP using SPAR-H.

[6] The failure-to-open probabilities for the SRVs are only considered in ADS fault tree for a LOOP initiating event. Since ADS is only queried if both RCIC and HPIC fail, the SRVs would not have been cycled during this postulated scenario (as they were during the post-trip cooldown of the actual event). Therefore, the failure-to-open probabilities were not adjusted.

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 heat capacity temperature limit. 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 residual heat removal (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 inches using one or more preferred injection systems and, if necessary, alternate injection systems. When RPV level decreases to −125 inches, 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.

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 (i.e., 30 minutes) for the diagnosis component for this operator action is assigned as *Nominal Time* (i.e., ×1). Since sufficient time was available for the diagnosis component, the available time for the action component for this operator action is evaluated as *Nominal* (i.e., ×1). See Reference 7 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.

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.

8 The estimate of 30 minutes may be 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.

PSF	Diagnosis/ Action Multiplier	Notes
Complexity	2 / 2	The PSF for diagnosis complexity is assigned a value of *Moderately Complex* (i.e., ×2) because operators would have to contend 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 4.2×10^{-5}. The ASP 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 feedwater and the condenser heat sink, whichever is greater. This CCDP equivalent for Pilgrim is 1.6×10^{-5}. Therefore, this event is a precursor.

Dominant Sequence. The dominant accident sequence is LOOP Sequence 28-04 (CCDP = 2.0×10^{-5}), which contributes approximately 47% of the total internal events CCDP. The cut sets/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 B-1 and B-2 in Appendix B. The events and important component failures in LOOP Sequence 28-04 are:

- A non-recoverable switchyard-related LOOP occurs,
- Reactor scram succeeds,
- Emergency powers fails,
- Safety relief valves reclose (if opened),
- RCIC/HPCI succeeds,
- Operators successfully depressurize the reactor,
- Firewater injection is successful,
- DC load shed is successful,
- AC power (offsite and EDGs) recovery fails.

REFERENCES

1. Pilgrim Nuclear Power Station, "LER 293/15-001 – Loss of 345KV Power Resulting in Automatic Reactor Scram during Winter Storm Juno," dated April 1, 2015 (ML15097A259).

2. Pilgrim Nuclear Power Station, "LER 293/15-002 – Main Steam Safety Relief Valves Determined to be Inoperable Following Evaluation," dated May 12, 2015 (ML15135A242).

3. U.S. Nuclear Regulatory Commission, "Pilgrim Nuclear Power Station – NRC Special Inspection Report 05000293/2015007; and Preliminary White Finding," dated May 27, 2015 (ML15147A412).

4. U.S. Nuclear Regulatory Commission, "Pilgrim Nuclear Power Station – Final Significance Determination for a White Finding and Notice of Violation – Inspection Report 05000293/2015011," dated August 11, 2015 (ML15230A217).

5. U.S. Nuclear Regulatory Commission, "Pilgrim Nuclear Power Station – Integrated Inspection Report 05000293/2015002," dated August 11, 2015 (ML15224A489).

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

7. 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	Conditional Value	Nominal Value
FWS-XHE-XM-ERRLT	OPERATORS FAIL TO ALIGN FIREWATER INJECTION	4.0E-2	3.00E-1
HE-LOIAS	HOUSE EVENT: LOSS OF INSTRUMENT AIR INITIATING EVENT HAS OCCURRED	TRUE	FALSE
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-RELATED)	1.0E+0[a]	1.04E-2
OEP-XHE-XL-NR01HSC	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 1 HOUR (SWITCHYARD-RELATED)	TRUE	4.01E-1
OEP-XHE-XL-NR03HSC	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 3 HOURS (SWITCHYARD-RELATED)	TRUE	1.45E-1
OEP-XHE-XL-NR30MSC	OPERATORS FAIL TO RECOVER OFFSITE POWER IN 30 MINUTES (SWITCHYARD-RELATED)	TRUE	6.02E-1
PPR-SRV-OO-1VLV	ONE SRV FAILS TO CLOSE	8.2E-2	8.56E-4
PPR-SRV-OO-2VLVS	TWO SRVS FAIL TO CLOSE	3.7E-3	1.36E-4
PPR-SRV-OO-3VLVS	THREE OR MORE SRVS FAIL TO CLOSE	1.0E-4	5.50E-4

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
LOOPSC	28-04	1.98E-5	47.0%	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-12H
LOOPSC	04	1.04E-5	24.7%	/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, CSS, /CVS, LI01
LOOPSC	25	2.95E-6	7.0%	/RPS, /EPS, /SRV, HPI, DEP
LOOPSC	06	2.41E-6	5.7%	/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, CSS, CVS, LI06
LOOPSC	28-11	2.38E-6	5.6%	/RPS, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
LOOPSC	28-18-03	1.63E-6	3.9%	/RPS, EPS, P1, /HPI-B, /DCL, /FWS-EXT, OPR-03H, DGR-12H
LOOPSC	24	6.59E-7	1.6%	/RPS, /EPS, /SRV, HPI, /DEP, LPI, VA
LOOPSC	27-7	4.98E-7	1.2%	/RPS, /EPS, P2, LPI
	Total	**4.2E-5**	**100%**	

Referenced Fault Trees

Fault Tree	Description
CSS	CONTAINMENT SPRAY
CVS	CONTAINMENT VENTING
CVS-EXT	CONTAINMENT VENTING
DEP	MANUAL REACTOR DEPRESS
DGR-08H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 8 HOURS
DGR-12H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 12 HOURS
EPS	EMERGENCY POWER
FWS-EXT	FIREWATER INJECTION
HPI	HIGH PRESSURE INJECTION
LI01	PILGRIM LATE INJECTION FAULT TREE
LI06	LATE INJECTION FAULT TREE

Fault Tree	Description
LPI	LOW PRESS COOLANT INJECTION (LPCS or LPCI)
OPR-03H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS
P1	1 SORV
P2	2 SORVs
SPC	SUPPRESSION POOL COOLING
VA	ALTERNATE INJECTION

Cut Set Report – LOOPSC 28-04
Only items contributing at least 1% to the total are displayed.

#	CCDP	Total%	Cut Set
	1.98E-5	100	Displaying 220 Cut Sets
1	8.60E-6	43.39	IE-LOOPSC,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT
2	8.60E-6	43.39	IE-LOOPSC,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR /DCP-XHE-XM-DCLSHED,/FWS-EXT
3	6.09E-7	3.07	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR /DCP-XHE-XM-DCLSHED,/FWS-EXT
4	6.09E-7	3.07	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR /DCP-XHE-XM-DCLSHED,/FWS-EXT
5	6.09E-7	3.07	IE-LOOPSC,ACP-CRB-CC-504,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR /DCP-XHE-XM-DCLSHED,/FWS-EXT
6	6.09E-7	3.07	IE-LOOPSC,ACP-CRB-CC-504,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR /DCP-XHE-XM-DCLSHED,/FWS-EXT

Cut Set Report – LOOPSC 4
Only items contributing at least 1% to the total are displayed.

#	CCDP	Total%	Cut Set
	1.04E-5	100	Displaying 7161 Cut Sets
1	3.73E-6	35.78	IE-LOOPSC,FWS-EDP-FR-P140,RHR-XHE-XM-ERROR1,RHR-XHE-XM-SPCERROR
2	5.55E-7	5.32	IE-LOOPSC,FWS-EDP-FR-P140,RHR-HTX-CF-E207AB
3	5.34E-7	5.12	IE-LOOPSC,FWS-EDP-TM-P140,RHR-XHE-XM-ERROR1,RHR-XHE-XM-SPCERROR
4	5.21E-7	4.99	IE-LOOPSC,FWS-EDP-FR-P140,RHR-STR-CF-NLOCA
5	4.45E-7	4.27	IE-LOOPSC,FWS-EDP-FR-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208BER
6	4.45E-7	4.27	IE-LOOPSC,FWS-EDP-FR-P140,SSW-MDP-CF-FS,SSW-MDP-CFG-P208ADR
7	4.05E-7	3.89	IE-LOOPSC,FWS-EDP-FR-P140,RHR-MOV-CF-16AB
8	4.05E-7	3.89	IE-LOOPSC,FWS-EDP-FR-P140,RHR-MOV-CF-18AB
9	3.65E-7	3.50	IE-LOOPSC,FWS-EDP-FS-P140,RHR-XHE-XM-ERROR1,RHR-XHE-XM-SPCERROR
10	1.88E-7	1.80	IE-LOOPSC,FWS-EDP-FR-P140,RBC-MDP-CF-STRT
11	1.83E-7	1.76	IE-LOOPSC,FWS-EDP-FR-P140,RHR-MDP-CF-START
12	1.18E-7	1.13	IE-LOOPSC,FWS-EDP-FR-P140,RHR-HTX-TM-E207B,RHR-MOV-OO-16A
13	1.18E-7	1.13	IE-LOOPSC,FWS-EDP-FR-P140,RHR-HTX-TM-E207B,RHR-MOV-OO-18A
14	1.18E-7	1.13	IE-LOOPSC,FWS-EDP-FR-P140,RHR-HTX-TM-E207A,RHR-MOV-OO-18B
15	1.18E-7	1.13	IE-LOOPSC,FWS-EDP-FR-P140,RHR-HTX-TM-E207A,RHR-MOV-OO-16B

Cut Set Report – LOOPSC 25

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

#	CCDP	Total%	Cut Set
	2.95E-6	100	Displaying 482 Cut Sets
1	7.80E-7	26.42	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-TDP-FR-P206
2	3.56E-7	12.04	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-FR-P206
3	2.83E-7	9.60	IE-LOOPSC,DCP-BCH-CF-D11D12D14
4	2.27E-7	7.67	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-TM-P205,RCI-TDP-FR-P206
5	2.01E-7	6.80	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-TDP-TM-P206
6	1.28E-7	4.34	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-TDP-FS-P206
7	1.28E-7	4.34	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FS-P205,RCI-TDP-FR-P206
8	9.15E-8	3.10	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-TM-P206
9	7.19E-8	2.43	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-XHE-XO-ERROR1,RCI-XHE-XO-ERROR
10	5.93E-8	2.01	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-RESTART, RCI-TDP-FS-P206RS,RCI-XHE-XL-RSTRT
11	5.84E-8	1.98	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-FS-P206
12	3.93E-8	1.33	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FR-P205,RCI-MOV-FC-XFER, RCI-XHE-XL-XFER
13	3.72E-8	1.26	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-TM-P205,RCI-TDP-FS-P206
14	3.30E-8	1.12	IE-LOOPSC,ADS-SRV-CF-203-3ABCD,HCI-TDP-FR-P205,RCI-TDP-FR-P206
15	3.30E-8	1.12	IE-LOOPSC,ADS-XHE-XM-MDEPR,HCI-TDP-FS-P205,RCI-TDP-TM-P206

Cut Set Report – LOOPSC 6

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

#	CCDP	Total%	Cut Set
	2.41E-6	100	Displaying 2328 Cut Sets
1	1.60E-6	66.21	IE-LOOPSC,CFAILED,CVS-XHE-XM-VENT1,RHR-XHE-XM-ERROR1, RHR-XHE-XM-SPCERROR
2	5.36E-7	22.24	IE-LOOPSC,CVS-XHE-XM-VENT1,FWS-EDP-FR-P140,RHR-XHE-XM-ERROR1, RHR-XHE-XM-SPCERROR
3	7.67E-8	3.18	IE-LOOPSC,CVS-XHE-XM-VENT1,FWS-EDP-TM-P140,RHR-XHE-XM-ERROR1, RHR-XHE-XM-SPCERROR
4	5.24E-8	2.18	IE-LOOPSC,CVS-XHE-XM-VENT1,FWS-EDP-FS-P140,RHR-XHE-XM-ERROR1, RHR-XHE-XM-SPCERROR

Cut Set Report – LOOPSC 28-11

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

#	CCDP	Total%	Cut Set
	2.37E-6	100	Displaying 253 Cut Sets
1	5.05E-7	21.32	IE-LOOPSC,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,FWS-EDP-FR-P140
2	5.05E-7	21.32	IE-LOOPSC,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,FWS-EDP-FR-P140
3	3.88E-7	16.38	IE-LOOPSC,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,FWS-XHE-XM-ERRLT
4	3.88E-7	16.38	IE-LOOPSC,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,FWS-XHE-XM-ERRLT
5	7.23E-8	3.05	IE-LOOPSC,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,FWS-EDP-TM-P140
6	7.23E-8	3.05	IE-LOOPSC,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,FWS-EDP-TM-P140
7	4.94E-8	2.09	IE-LOOPSC,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR,FWS-EDP-FS-P140
8	4.94E-8	2.09	IE-LOOPSC,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR,FWS-EDP-FS-P140

#	CCDP	Total%	Cut Set
9	3.57E-8	1.51	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR, FWS-EDP-FR-P140
10	3.57E-8	1.51	IE-LOOPSC,ACP-CRB-CC-504,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR, FWS-EDP-FR-P140
11	3.57E-8	1.51	IE-LOOPSC,ACP-CRB-CC-504,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR, FWS-EDP-FR-P140
12	3.57E-8	1.51	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR, FWS-EDP-FR-P140
13	2.75E-8	1.16	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR, FWS-XHE-XM-ERRLT
14	2.75E-8	1.16	IE-LOOPSC,ACP-CRB-CC-504,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR, FWS-XHE-XM-ERRLT
15	2.75E-8	1.16	IE-LOOPSC,ACP-CRB-CC-504,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR, FWS-XHE-XM-ERRLT
16	2.75E-8	1.16	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR, FWS-XHE-XM-ERRLT

Cut Set Report – LOOPSC 28-18-03

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

#	CCDP	Total%	Cut Set
	1.63E-6	100	Displaying 88 Cut Sets
1	7.05E-7	43.40	IE-LOOPSC,ACP-CRB-CF-504604,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT,PPR-SRV-OO-1VLV
2	7.05E-7	43.40	IE-LOOPSC,ACP-CRB-CF-505605,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT,PPR-SRV-OO-1VLV
3	4.99E-8	3.07	IE-LOOPSC,ACP-CRB-CC-604,ACP-CRB-OO-504,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT,PPR-SRV-OO-1VLV
4	4.99E-8	3.07	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-604,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT,PPR-SRV-OO-1VLV
5	4.99E-8	3.07	IE-LOOPSC,ACP-CRB-CC-605,ACP-CRB-OO-504,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT,PPR-SRV-OO-1VLV
6	4.99E-8	3.07	IE-LOOPSC,ACP-CRB-CC-505,ACP-CRB-CC-605,ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED,/FWS-EXT,PPR-SRV-OO-1VLV

Cut Set Report – LOOPSC 24

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

#	CCDP	Total%	Cut Set
	6.59E-7	100	Displaying 1963 Cut Sets
1	9.98E-8	15.15	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-TDP-FR-P205,RCI-TDP-FR-P206
2	6.29E-8	9.55	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-TDP-FR-P205,RCI-TDP-FR-P206
3	4.55E-8	6.90	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-FR-P206
4	2.90E-8	4.40	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-TDP-TM-P205,RCI-TDP-FR-P206
5	2.86E-8	4.35	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-FR-P206
6	2.57E-8	3.90	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-TDP-FR-P205,RCI-TDP-TM-P206
7	1.83E-8	2.77	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-TDP-TM-P205,RCI-TDP-FR-P206
8	1.64E-8	2.49	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-TDP-FR-P205,RCI-TDP-FS-P206
9	1.64E-8	2.49	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-TDP-FS-P205,RCI-TDP-FR-P206
10	1.62E-8	2.46	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-TDP-FR-P205,RCI-TDP-TM-P206

#	CCDP	Total%	Cut Set
11	1.17E-8	1.78	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-TM-P206
12	1.03E-8	1.57	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-TDP-FR-P205,RCI-TDP-FS-P206
13	1.03E-8	1.57	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-TDP-FS-P205,RCI-TDP-FR-P206
14	9.19E-9	1.39	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-XHE-XO-ERROR1,RCI-XHE-XO-ERROR
15	7.58E-9	1.15	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-TDP-FR-P205,RCI-RESTART,RCI-TDP-FS-P206RS, RCI-XHE-XL-RSTRT
16	7.47E-9	1.13	IE-LOOPSC,ATS-ASP-CF-52AB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-FS-P206
17	7.38E-9	1.12	IE-LOOPSC,ATS-ACT-CF-52AB,HCI-MOV-CC-IVFRO,HCI-MULTIPLE-INJECT, HCI-XHE-XL-INJECT,RCI-TDP-TM-P206

Cut Set Report – LOOPSC 27-7

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

#	CCDP	Total%	Cut Set
	4.98E-7	100	Displaying 287 Cut Sets
1	2.37E-7	47.54	IE-LOOPSC,ATS-ASP-CF-52AB,PPR-SRV-OO-2VLVS
2	1.49E-7	29.96	IE-LOOPSC,ATS-ACT-CF-52AB,PPR-SRV-OO-2VLVS
3	1.07E-8	2.15	IE-LOOPSC,ATS-ASP-FC-52A,ATS-ASP-FC-52B,PPR-SRV-OO-2VLVS
4	1.07E-8	2.15	IE-LOOPSC,ATS-ACT-FC-52A,ATS-ACT-FC-52B,PPR-SRV-OO-2VLVS
5	1.07E-8	2.15	IE-LOOPSC,ATS-ACT-FC-52A,ATS-ASP-FC-52B,PPR-SRV-OO-2VLVS
6	1.07E-8	2.15	IE-LOOPSC,ATS-ACT-FC-52B,ATS-ASP-FC-52A,PPR-SRV-OO-2VLVS
7	6.39E-9	1.28	IE-LOOPSC,ATS-ASP-CF-52AB,PPR-SRV-OO-3VLVS
8	6.29E-9	1.26	IE-LOOPSC,ATS-ASP-FC-52A,ATS-XHE-XM-52B,PPR-SRV-OO-2VLVS
9	6.29E-9	1.26	IE-LOOPSC,ATS-ASP-FC-52B,ATS-XHE-XM-52A,PPR-SRV-OO-2VLVS
10	6.29E-9	1.26	IE-LOOPSC,ATS-ACT-FC-52A,ATS-XHE-XM-52B,PPR-SRV-OO-2VLVS
11	6.29E-9	1.26	IE-LOOPSC,ATS-ACT-FC-52B,ATS-XHE-XM-52A,PPR-SRV-OO-2VLVS

Referenced Events

Event	Description	Probability
ACP-CRB-CC-505	4.16KV UNIT AUXILIARY TRANSFORMER FEEDER CIRCUIT BKR 152-505 FAILS TO OPEN RESULTS IN LOSS OF POWER TO BUS A5	2.39E-3
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	8.09E-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	8.09E-5
ACP-CRB-OO-504	4.16KV STARTUP TRANSFORMER FEEDER CIRCUIT BKR 152-504 FAILS TO CLOSE RESULTS IN LOSS OF POWER TO BUS A5	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-SRV-CF-203-3ABCD	SRVS RV-203-3A, 3B, 3C & 3D FAIL FROM COMMON CAUSE	2.12E-5
ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR	5.00E-4
ATS-ACT-CF-52AB	CCF OF MASTER UNITS PIS 263-52A & 52B TO OPERATE	4.03E-5
ATS-ACT-FC-52A	MASTER UNIT PIS 263-52A DOES NOT OPERATE	1.70E-3

Event	Description	Probability
ATS-ACT-FC-52B	MASTER UNIT PIS 263-52B DOES NOT OPERATE	1.70E-3
ATS-ASP-CF-52AB	CCF OF PRESSURE TXMTRS PT 263-52A & 52B TO OPERATE	6.39E-5
ATS-ASP-FC-52A	PRESSURE TXMTR PT 263-52A DOES NOT OPERATE	1.70E-3
ATS-ASP-FC-52B	PRESSURE TXMTR PT 263-52B DOES NOT OPERATE	1.70E-3
ATS-XHE-XM-52A	MISCALIBRATION OF MASTER TRIP UNIT PIS-263-52A	1.00E-3
ATS-XHE-XM-52B	MISCALIBRATION OF MASTER TRIP UNIT PIS-263-52B	1.00E-3
CFAILED	CONTAINMENT RUPTURE CAUSES LOSS OF ALL INJECTION (PSA)	1.55E-1
CVS-XHE-XM-VENT1	OPERATOR FAILS TO VENT CONTAINMENT USING DIRECT TORUS VENT	1.44E-1
DCP-BCH-CF-D11D12D14	BATTERY CHARGERS FAIL FROM COMMON CAUSE	2.83E-7
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	OPERATOR FAILS 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	OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN	8.00E-1
HCI-XHE-XO-ERROR1	OPERATOR FAILS TO START/CONTROL HPCI INJECTION	1.44E-1
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD- CENTERED)	1.00E+0
PPR-SRV-OO-1VLV	ONE SRV FAILS TO CLOSE	8.20E-2
PPR-SRV-OO-2VLVS	TWO OR MORE SRVS FAIL TO CLOSE	3.70E-3
PPR-SRV-OO-3VLVS	THREE OR MORE SRVS FAIL TO CLOSE	1.00E-4
RBC-MDP-CF-STRT	COMMON CAUSE FAILURE TO START OF RBCCW PUMPS	3.61E-6
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	OPERATOR FAILS TO RECOVER RCIC FAILURE TO RESTART	2.50E-1
RCI-XHE-XL-XFER	OPERATOR FAILS TO RECOVER SUCTN XFER FAILURE	2.50E-1
RCI-XHE-XO-ERROR	OPERATOR FAILS TO START/CONTROL RCIC INJECTION	1.00E-3
RHR-HTX-CF-E207AB	RHR HEAT EXCHANGERS FAIL FROM COMMON CAUSE	1.07E-5
RHR-HTX-TM-E207A	RHR HEAT EXCHANGER E-207A UNAVAILABLE DUE TO TEST OR MAINTENANCE	2.35E-3
RHR-HTX-TM-E207B	RHR HEAT EXCHANGER E-207B UNAVAILABLE DUE TO TEST OR MAINTENANCE	2.35E-3
RHR-MDP-CF-START	RHR PUMPS COMMON CAUSE FAIL TO START	3.52E-6
RHR-MOV-CF-16AB	RHR HTX BYPASS VALVES 16A,B FAIL FROM COMMON CAUSE	7.78E-6
RHR-MOV-CF-18AB	RHR MINFLOW VALVES 18 A, B FAIL TO CLOSE FOR ENHANCED COOLING	7.78E-6

Event	Description	Probability
RHR-MOV-OO-16A	RHR HEAT EXCHANGER BYPASS VALVE 16A FAILS TO CLOSE	9.63E-4
RHR-MOV-OO-16B	RHR HEAT EXCHANGER BYPASS VALVE 16B FAILS TO CLOSE	9.63E-4
RHR-MOV-OO-18A	RHR LOOP A MINFLOW VALVE 18A FAILS TO CLOSE	9.63E-4
RHR-MOV-OO-18B	RHR LOOP B MINFLOW VALVE 18B FAILS TO CLOSE	9.63E-4
RHR-STR-CF-NLOCA	SUPPRESSION POOL STRAINERS FAIL FROM COMMON CAUSE (NON-LOCA)	1.00E-5
RHR-XHE-XM-ERROR1	OPERATOR FAILS TO START/CONTROL CONTAINMENT SPRAY COOLING MODE OF RHR	1.43E-1
RHR-XHE-XM-SPCERROR	OPERATOR FAILS TO START/CONTROL SUPPRESSION POOL COOLING MODE OF RHR	5.00E-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

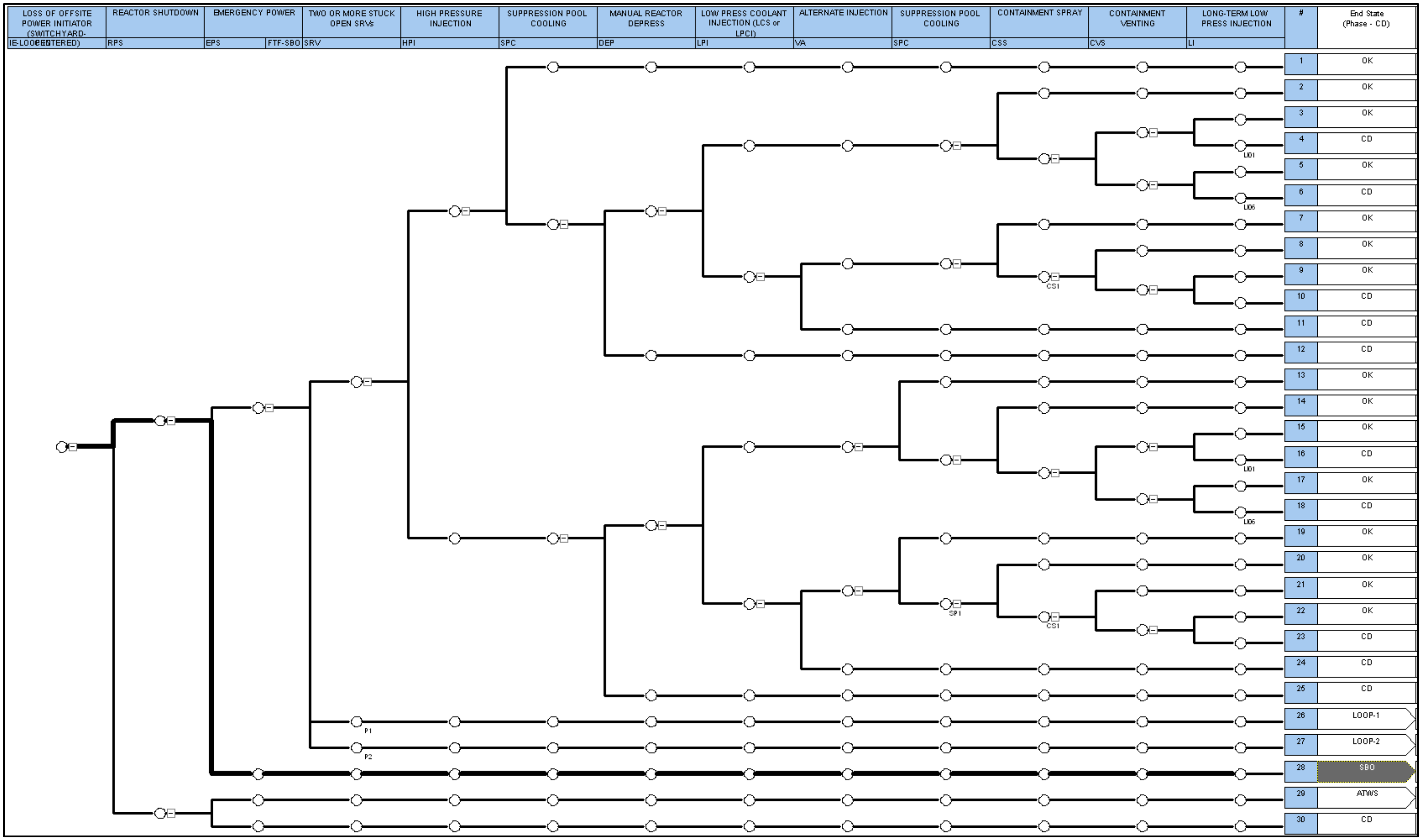

Figure B-1. Pilgrim Nuclear Power Station Switchyard-Related LOOP Event Tree

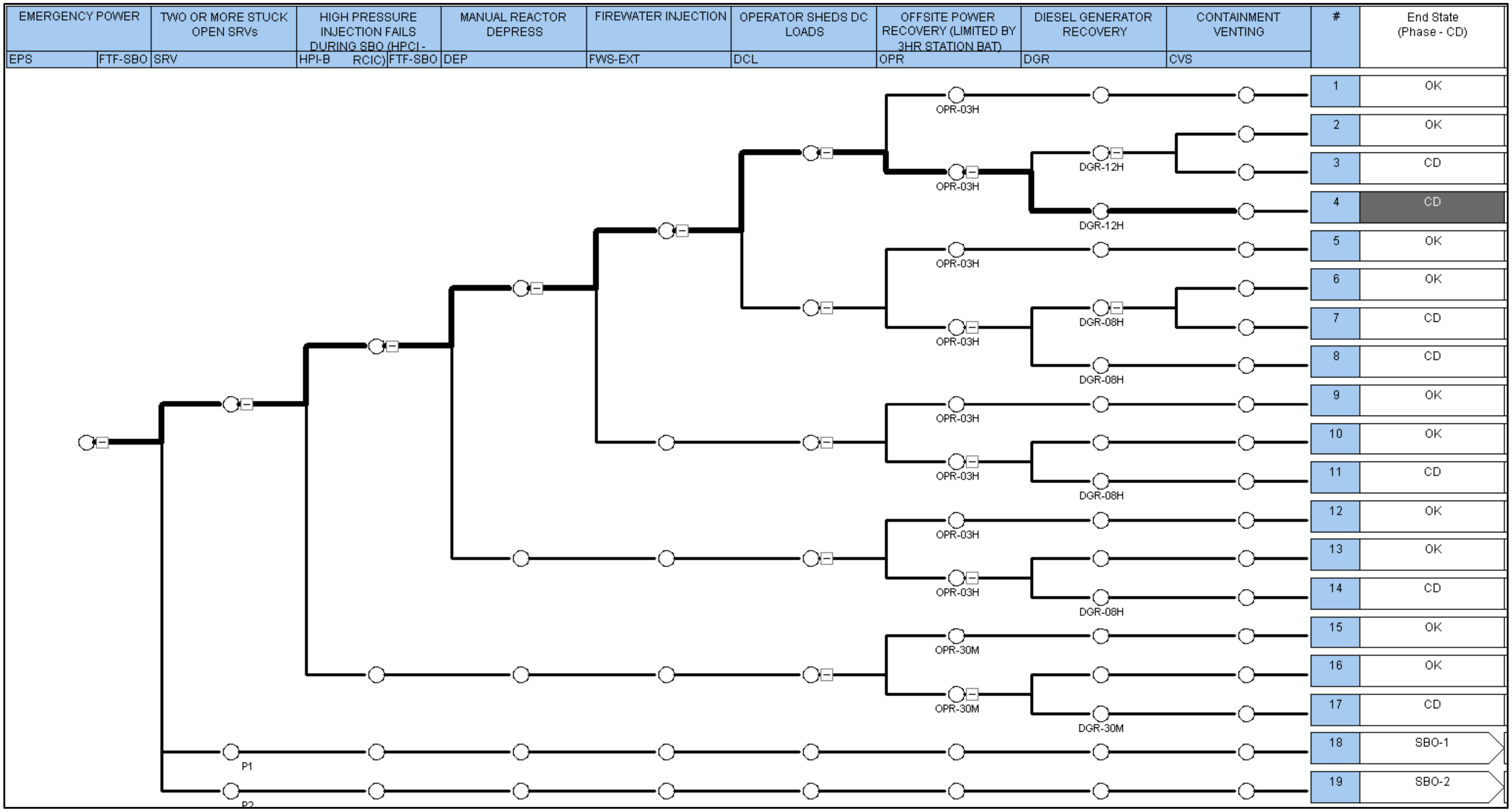

Figure B-2. Pilgrim Nuclear Power Station SBO Event Tree