

Final ASP Program Analysis – Reject

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research			
Pilgrim Nuclear Power Station		Concurrent Unavailabilities of Two Emergency Diesel Generators	
Event Date: 4/12/2016		LER: 293-2016-001 IRs: TBD	Δ CDP = 5×10^{-7}
Plant Type: Boiling-Water Reactor (BWR); General Electric 3 with a Mark I Containment			
Plant Operating Mode (Reactor Power Level): Mode 1 (100% Reactor Power)			
Analyst: Chris Hunter	Reviewer: David Aird	Contributors: N/A	BC Approved Date: 9/9/2016

EVENT DETAILS

Event Description. On April 10, 2016, at 7:00 p.m., with the reactor at 100 percent power, emergency diesel generator (EDG) B was tagged out of service for planned preventative maintenance. At approximately 9:30 p.m. on April 11th, as part of an operator’s tour of the EDG building, a water leak from panel C103C was identified. The leak ran across the EDG A floor towards the floor drain. This leak (approximately 130 drops per minute) was evaluated and determined to be a leak from the EDG A cooling water system pressure boundary. At 12:50 a.m. on April 12th, EDG A was declared inoperable due to the jacket water pressure boundary leak. Pilgrim Nuclear Power Station entered an unplanned 24-hour limiting condition for operation (LCO) action statement per Technical Specification (TS) 3.5.F.1 due to both EDGs being inoperable. The pipe fitting was replaced and EDG A was restored to operable status at approximately 11:00 a.m. on April 12th. Additional information is provided in [licensee event report \(LER\) 293-2016-001](#) (Ref. 1).

Cause. The apparent cause of the EDG A jacket water pressure boundary leak was stress corrosion cracking that eventually led to failure of a bulkhead pipe fitting.

MODELING

SDP Results/Basis for ASP Analysis. The ASP Program performs independent analyses for concurrent degraded conditions (i.e., overlapping exposure periods).

No inspection reports have been released that cover this event or the operating period in which the event occurred. Discussions with Region 1 staff indicated that no performance deficiency has been identified to date; however, the LER remains open.

An independent ASP analysis is required because both safety-related EDGs were unavailable at the same time due to different causes. Therefore, any SDP analysis performed (given a licensee performance deficiency is identified) would be limited to an evaluation of the impact of the jacket water leak for EDG A.

Analysis Type. An interim Pilgrim Standardized Plant Analysis Risk (SPAR) Model, created in April 2016, was used for this condition assessment.¹

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

- Basic event EPS-DGN-TM-B (*EDG-B X107B is unavailable because of maintenance*) was set to TRUE because EDG B was undergoing planned preventive maintenance.²
- Basic event EPS-DGN-FR-DGA (*EDG-A X107A fails to continue to run*) was set to TRUE as a bounding assumption (i.e., leak results in loss of safety function of EDG A).³
- Basic events EPS-XHE-XL-NR30M (*operator fails to recover emergency diesel in 30 minutes*), EPS-XHE-XL-NR01H (*operator fails to recover emergency diesel in 1 hour*), EPS-XHE-XL-NR03H (*operator fails to recover emergency diesel in 3 hours*), EPS-XHE-XL-NR04H (*operator fails to recover emergency diesel in 4 hours*), EPS-XHE-XL-NR08H (*operator fails to recover emergency diesel in 8 hours*), EPS-XHE-XL-NR12H (*operator fails to recover emergency diesel in 12 hours*), EPS-XHE-XL-NR24H (*operator fails to recover emergency diesel in 24 hours*) were set to TRUE as a bounding assumption that the EDGs were not recoverable.⁴
- Given that EDG B was out of service for planned maintenance, key equipment/systems were reviewed on which concurrent maintenance would not be allowed according to TS or those expected to substantially increase the station blackout (SBO) risk profile of the plant. From this review, basic events EPS-DGN-TM-SBO (*SBO diesel generator is unavailable because of maintenance*) and FWS-EDP-TM-P140 (*engine driven fire pump P-140 is in test or maintenance*) were set to FALSE.
- All other safety systems were determined to be capable of fulfilling their safety function.

Exposure Period. A bounding estimate of 24 hours was chosen.⁵

¹ 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.

² Using the SAPHIRE event and condition workspace automatically recalculates the associated common-cause failure parameters associated with this piece of equipment. [Appendix A](#) presents the results of these calculations.

³ Based on discussions with Region 1 inspectors, it is not believed that the small jacket water leak would have resulted in a loss of safety function of EDG A. However, there is some uncertainty in this assumption since if the EDG had been started the jacket water pressure would have increased, which could have resulted in an increased leakage rate.

⁴ During a postulated SBO, the fitting from the gauge-line from EDG B could be used to replace the cracked EDG A fitting (as was completed successfully during this event). Operators could potentially recover EDG A within 2 hours during a postulated SBO.

⁵ Note that an event is screened out of the ASP Program if it has an exposure period of less than applicable TS LCO. In this case, the LCO for two EDGs being inoperable at Pilgrim Nuclear Power Station is 24 hours. Therefore, minimum exposure period of 24 hours was selected for this bounding assessment.

ANALYSIS RESULTS

Importance. The increase in core damage probability (Δ CDP) for this analysis is 5.3×10^{-7} . The ASP Program acceptance threshold is a Δ CDP of 1×10^{-6} ; and therefore, this event is not a precursor.

Dominant Sequence. The dominant accident sequence is grid-related loss of offsite power (LOOP) sequence 28-04 (Δ CDP = 1.4×10^{-7}), which contributes approximately 26 percent of the total internal events Δ CDP. The sequences and cut sets that contribute to the top 95 percent and/or at least 1 percent of the total Δ CDP for this analysis are provided in [Appendix A](#).

The dominant sequence is shown graphically in [Figure B-1](#) and [Figure B-2](#) in [Appendix B](#). The events and important component failures in grid-related LOOP sequence 28-04 are:

- A LOOP initiating event occurs,
- Reactor trip succeeds,
- Emergency power system fails,
- Safety relief valves reclose (if opened),
- High-pressure injection succeeds,
- Manual reactor depressurization succeeds,
- Firewater injection succeeds,
- DC load shedding succeeds,
- Operators fail to recover offsite power, and
- Operators fail to recover an EDG.

REFERENCES

1. Pilgrim Nuclear Power Station, "LER 293/16-001 – Both Emergency Diesel Generators Inoperable," dated June 9, 2016 (ML16168A030).

Appendix A: SAPHIRE 8 Worksheet

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
EPS-DGN-FR-DGA	EDG-A X107A FAILS TO CONTINUE TO RUN	TRUE	2.837E-2
EPS-DGN-TM-DGB	EDG-B X107B IS UNAVAILABLE BECAUSE OF MAINTENANCE	TRUE	1.435E-2
EPS-DGN-TM-SBO	DG SBO IS UNAVAILABLE BECAUSE OF MAINTENANCE	FALSE	1.435E-2
EPS-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR	TRUE	8.712E-1
EPS-XHE-XL-NR03H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 3 HOURS	TRUE	7.451E-1
EPS-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS	TRUE	6.984E-1
EPS-XHE-XL-NR08H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 8 HOURS	TRUE	5.604E-1
EPS-XHE-XL-NR12H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 12 HOURS	TRUE	4.648E-1
EPS-XHE-XL-NR24H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 24 HOURS	TRUE	2.905E-1
EPS-XHE-XL-NR30M	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 30 MINUTES	TRUE	9.181E-1
FWS-EDP-TM-P140	ENGINE DRIVEN FIRE PUMP P-140 IS IN TEST OR MAINT	FALSE	7.452E-3

Automatic RASP CCF Parameter Changes

Event	Description	Cond. Value	Nominal Value
EPS-DGN-FR-DGB	EDG-B X107B FAILS TO CONTINUE TO RUN	1.000E+0	2.837E-2
EPS-DGN-FS-DGA	EDG-A X107A ENGINE FAILS TO START	FALSE	2.891E-3
EPS-DGN-FS-DGB	EDG-B X107B ENGINE FAILS TO START	1.000E+0	2.891E-3
EPS-DGN-TM-DGA	EDG-A X107A IS UNAVAILABLE BECAUSE OF MAINTENANCE	TRUE	1.435E-2
EPS-DGN-CF-START	DIESEL GENERATORS COMMON CAUSE FAIL TO START	0.000E+0	3.614E-5
EPS-DGN-CF-RUN	DIESEL GENERATORS COMMON CAUSE FAIL TO RUN	7.940E-3	2.253E-4
EPS-DGN-FR-DGB	EDG-B X107B FAILS TO CONTINUE TO RUN	1.000E+0	2.837E-2
EPS-DGN-FS-DGA	EDG-A X107A ENGINE FAILS TO START	FALSE	2.891E-3
EPS-DGN-FS-DGB	EDG-B X107B ENGINE FAILS TO START	1.000E+0	2.891E-3
OEP-XHE-XX-NR03HWR1	CONVOLUTION FACTOR FOR 1FTR-OPR (03H-WR)	1.486E-2	5.238E-1

Event Tree Dominant Results

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

Event Tree	CCDP	CDP	Δ CDP	Description
LOOPGR	2.237E-7	1.250E-9	2.224E-7	LOSS OF OFFSITE POWER
LOOPWR	1.375E-7	5.621E-10	1.370E-7	LOSS OF OFFSITE POWER
LOOPSC	1.127E-7	1.028E-9	1.117E-7	LOSS OF OFFSITE POWER
TRAN	5.873E-8	2.456E-8	3.417E-8	GENERAL PLANT TRANSIENT
LOOPPC	1.622E-8	1.815E-10	1.604E-8	LOSS OF OFFSITE POWER
LOCHS	1.229E-8	6.098E-9	6.196E-9	LOSS OF CONDENSER HEAT SINK
Total	5.879E-7	5.651E-8	5.313E-7	

Dominant Sequence Results

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

Event Tree	Sequence	CCDP	CDP	Δ CDP	Description
LOOPGR	28-04	1.405E-7	6.326E-10	1.399E-7	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-12H
LOOPWR	28-04	8.715E-8	2.989E-10	8.685E-8	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-12H
LOOPGR	28-11	7.737E-8	3.647E-10	7.701E-8	/RPS, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
LOOPSC	28-04	7.055E-8	5.197E-10	7.003E-8	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-12H
LOOPWR	28-11	4.800E-8	1.819E-10	4.782E-8	/RPS, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
LOOPSC	28-11	3.885E-8	2.964E-10	3.855E-8	/RPS, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
TRAN	44-28-04	3.559E-8	1.422E-8	2.137E-8	/RPS, OEP, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-12H
TRAN	44-28-11	1.959E-8	8.047E-9	1.154E-8	/RPS, OEP, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
LOOPPC	28-04	1.013E-8	9.332E-11	1.004E-8	/RPS, EPS, /SRV, /HPI-B, /DEP, /FWS-EXT, /DCL, OPR-03H, DGR-12H
LOOPPC	28-11	5.575E-9	5.173E-11	5.524E-9	/RPS, EPS, /SRV, /HPI-B, /DEP, FWS-EXT, OPR-03H, DGR-08H
Total		5.879E-7	5.651E-8	5.313E-7	

Referenced Fault Trees

Fault Tree	Description
DCL	OPERATORS SHED DC LOADS
DEP	MANUAL REACTOR DEPRESSURIZATION
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
OEP	OFFSITE ELECTRICAL POWER
OPR-03H	FAILURE TO RECOVER OFFSITE PWR IN 3 HRS (STATION BAT LIMITING)
RPS	REACTOR PROTECTION SYSTEM
SRV	STUCK OPEN SRVs

Cut Set Report – LOOPGR 28-04

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

#	CCDF	Total %	Cut Set
	5.129E-5	100	Displaying 78 Cut Sets. (78 Original)
1	3.966E-5	77.32	IE-LOOPGR,/DCP-XHE-XM-DCLSHED, EPS-XHE-XM-SBO,/FWS-EXT, OEP-XHE-XL-NR03HGR
2	5.733E-6	11.18	IE-LOOPGR,/DCP-XHE-XM-DCLSHED, EPS-DGN-FS-SBO,/FWS-EXT, OEP-XHE-XL-NR03HGR
3	4.743E-6	9.25	IE-LOOPGR, ACP-CRB-OO-801,/DCP-XHE-XM-DCLSHED, /FWS-EXT, OEP-XHE-XL-NR03HGR

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

#	CCDF	Total %	Cut Set
	3.181E-5	100	Displaying 78 Cut Sets. (78 Original)
1	2.445E-5	76.85	IE-LOOPWR,/DCP-XHE-XM-DCLSHED, EPS-XHE-XM-SBO,/FWS-EXT, OEP-XHE-XL-NR03HWR
2	3.534E-6	11.11	IE-LOOPWR,/DCP-XHE-XM-DCLSHED, EPS-DGN-FS-SBO,/FWS-EXT, OEP-XHE-XL-NR03HWR
3	2.924E-6	9.19	IE-LOOPWR, ACP-CRB-OO-801,/DCP-XHE-XM-DCLSHED,/FWS-EXT, OEP-XHE-XL-NR03HWR
4	5.154E-7	1.62	IE-LOOPWR,/DCP-XHE-XM-DCLSHED, EPS-DGN-FR-SBO,/FWS-EXT, OEP-XHE-XL-NR03HWR, OEP-XHE-XX-NR03HWR1

Cut Set Report – LOOPGR 28-11*Only items contributing at least 1% to the total are displayed.*

#	CCDF	Total %	Cut Set
	2.824E-5	100	Displaying 288 Cut Sets. (288 Original)
1	1.827E-5	64.68	IE-LOOPGR, EPS-XHE-XM-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HGR
2	3.170E-6	11.22	IE-LOOPGR, EPS-XHE-XM-SBO, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HGR
3	2.641E-6	9.35	IE-LOOPGR, EPS-DGN-FS-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HGR
4	2.185E-6	7.74	IE-LOOPGR, ACP-CRB-OO-801, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HGR
5	4.582E-7	1.62	IE-LOOPGR, EPS-DGN-FS-SBO, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HGR
6	3.791E-7	1.34	IE-LOOPGR, ACP-CRB-OO-801, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HGR
7	3.102E-7	1.10	IE-LOOPGR, EPS-XHE-XM-SBO, FWS-EDP-FS-P140, OEP-XHE-XL-NR03HGR

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

#	CCDF	Total %	Cut Set
	2.575E-5	100	Displaying 78 Cut Sets. (78 Original)
1	1.968E-5	76.45	IE-LOOPSC,/DCP-XHE-XM-DCLSHED, EPS-XHE-XM-SBO,/FWS-EXT, OEP-XHE-XL-NR03HSC
2	2.845E-6	11.05	IE-LOOPSC,/DCP-XHE-XM-DCLSHED, EPS-DGN-FS-SBO,/FWS-EXT, OEP-XHE-XL-NR03HSC
3	2.354E-6	9.14	IE-LOOPSC, ACP-CRB-OO-801,/DCP-XHE-XM-DCLSHED,/FWS-EXT, OEP-XHE-XL-NR03HSC

Cut Set Report – LOOPWR 28-11*Only items contributing at least 1% to the total are displayed.*

#	CCDF	Total %	Cut Set
	1.752E-5	100	Displaying 249 Cut Sets. (249 Original)
1	1.126E-5	64.28	IE-LOOPWR, EPS-XHE-XM-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HWR
2	1.954E-6	11.16	IE-LOOPWR, EPS-XHE-XM-SBO, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HWR
3	1.628E-6	9.29	IE-LOOPWR, EPS-DGN-FS-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HWR
4	1.347E-6	7.69	IE-LOOPWR, ACP-CRB-OO-801, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HWR
5	2.825E-7	1.61	IE-LOOPWR, EPS-DGN-FS-SBO, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HWR
6	2.374E-7	1.35	IE-LOOPWR, EPS-DGN-FR-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HWR, OEP-XHE-XX-NR03HWR1
7	2.337E-7	1.33	IE-LOOPWR, ACP-CRB-OO-801, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HWR
8	1.912E-7	1.09	IE-LOOPWR, EPS-XHE-XM-SBO, FWS-EDP-FS-P140, OEP-XHE-XL-NR03HWR

Cut Set Report – LOOPSC 28-11*Only items contributing at least 1% to the total are displayed.*

#	CCDF	Total %	Cut Set
	1.418E-5	100	Displaying 239 Cut Sets. (239 Original)
1	9.067E-6	63.96	IE-LOOPSC, EPS-XHE-XM-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HSC
2	1.573E-6	11.10	IE-LOOPSC, EPS-XHE-XM-SBO, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HSC
3	1.311E-6	9.25	IE-LOOPSC, EPS-DGN-FS-SBO, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HSC
4	1.084E-6	7.65	IE-LOOPSC, ACP-CRB-OO-801, FWS-XHE-XM-ERRLT, OEP-XHE-XL-NR03HSC
5	2.274E-7	1.60	IE-LOOPSC, EPS-DGN-FS-SBO, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HSC
6	1.882E-7	1.33	IE-LOOPSC, ACP-CRB-OO-801, FWS-EDP-FR-P140, OEP-XHE-XL-NR03HSC
7	1.539E-7	1.09	IE-LOOPSC, EPS-XHE-XM-SBO, FWS-EDP-FS-P140, OEP-XHE-XL-NR03HSC

Cut Set Report – TRAN 44-28-04*Only items contributing at least 1% to the total are displayed.*

#	CCDF	Total %	Cut Set
	1.299E-5	100	Displaying 147 Cut Sets. (147 Original)
1	5.876E-6	45.24	IE-TRANS, /DCP-XHE-XM-DCLSHED, EPS-XHE-XM-SBO, /FWS-EXT, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
2	4.815E-6	37.08	IE-TRANS, ACP-CRB-CF-505605, ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED, /FWS-EXT
3	8.493E-7	6.54	IE-TRANS, /DCP-XHE-XM-DCLSHED, EPS-DGN-FS-SBO, /FWS-EXT, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
4	7.027E-7	5.41	IE-TRANS, ACP-CRB-OO-801, /DCP-XHE-XM-DCLSHED, /FWS-EXT, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
5	3.408E-7	2.62	IE-TRANS, ACP-CRB-CC-505, ACP-CRB-CC-605, ACP-XHE-XM-NORECBKR, /DCP-XHE-XM-DCLSHED, /FWS-EXT

Cut Set Report – TRAN 44-28-11*Only items contributing at least 1% to the total are displayed.*

#	CCDF	Total %	Cut Set
	7.149E-6	100	Displaying 385 Cut Sets. (385 Original)
1	2.706E-6	37.86	IE-TRANS, EPS-XHE-XM-SBO, FWS-XHE-XM-ERRLT, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
2	2.218E-6	31.02	IE-TRANS, ACP-CRB-CF-505605, ACP-XHE-XM-NORECBKR, FWS-XHE-XM-ERRLT
3	4.696E-7	6.57	IE-TRANS, EPS-XHE-XM-SBO, FWS-EDP-FR-P140, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
4	3.912E-7	5.47	IE-TRANS, EPS-DGN-FS-SBO, FWS-XHE-XM-ERRLT, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
5	3.849E-7	5.38	IE-TRANS, ACP-CRB-CF-505605, ACP-XHE-XM-NORECBKR, FWS-EDP-FR-P140
6	3.237E-7	4.53	IE-TRANS, ACP-CRB-OO-801, FWS-XHE-XM-ERRLT, OEP-VCF-LP-CLOPT, OEP-XHE-XL-NR03HPC
7	1.570E-7	2.20	IE-TRANS, ACP-CRB-CC-505, ACP-CRB-CC-605, ACP-XHE-XM-NORECBKR, FWS-XHE-XM-ERRLT

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

#	CCDF	Total %	Cut Set
	3.698E-6	100	Displaying 57 Cut Sets. (57 Original)
1	2.808E-6	75.94	IE-LOOPPC, /DCP-XHE-XM-DCLSHED, EPS-XHE-XM-SBO, /FWS-EXT, OEP-XHE-XL-NR03HPC
2	4.059E-7	10.98	IE-LOOPPC, /DCP-XHE-XM-DCLSHED, EPS-DGN-FS-SBO, /FWS-EXT, OEP-XHE-XL-NR03HPC

#	CCDF	Total %	Cut Set
3	3.358E-7	9.08	IE-LOOPPC,ACP-CRB-OO-801,/DCP-XHE-XM-DCLSHED,/FWS-EXT, OEP-XHE-XL-NR03HPC

Cut Set Report – LOOPPC 28-11

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

#	CCDF	Total %	Cut Set
	2.035E-6	100	Displaying 147 Cut Sets. (147 Original)
1	1.293E-6	63.54	IE-LOOPPC,EPS-XHE-XM-SBO,FWS-XHE-XM-ERRLT,OEP-XHE-XL-NR03HPC
2	2.244E-7	11.03	IE-LOOPPC,EPS-XHE-XM-SBO,FWS-EDP-FR-P140,OEP-XHE-XL-NR03HPC
3	1.869E-7	9.18	IE-LOOPPC,EPS-DGN-FS-SBO,FWS-XHE-XM-ERRLT,OEP-XHE-XL-NR03HPC
4	1.547E-7	7.60	IE-LOOPPC,ACP-CRB-OO-801,FWS-XHE-XM-ERRLT,OEP-XHE-XL-NR03HPC
5	3.244E-8	1.59	IE-LOOPPC,EPS-DGN-FS-SBO,FWS-EDP-FR-P140,OEP-XHE-XL-NR03HPC
6	2.684E-8	1.32	IE-LOOPPC,ACP-CRB-OO-801,FWS-EDP-FR-P140,OEP-XHE-XL-NR03HPC
7	2.196E-8	1.08	IE-LOOPPC,EPS-XHE-XM-SBO,FWS-EDP-FS-P140,OEP-XHE-XL-NR03HPC

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	2.392E-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	2.392E-3
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	8.085E-5
ACP-CRB-OO-801	4.16KV CKT BRKR 152-801 FAILS TO CLOSE	2.392E-3
ACP-XHE-XM-NORECBKR	SUT OR UAT FEEDER BREAKER FAULTS TO BUS A5 OR BUS A6 NOT RECOVERED	1.200E-1
EPS-DGN-FR-SBO	DIESEL GENERATOR SBO FAILS TO RUN	2.837E-2
EPS-DGN-FS-SBO	DIESEL GENERATOR SBO FAILS TO START	2.891E-3
EPS-XHE-XM-SBO	OPERATOR FAILS TO START OR ALIGN THE SBO DIESEL	2.000E-2
FWS-EDP-FR-P140	ENGINE DRIVEN FIRE PUMP P-140 FAILS TO RUN	5.206E-2
FWS-EDP-FS-P140	ENGINE DRIVEN FIRE PUMP P-140 FAILS TO START	5.094E-3
FWS-XHE-XM-ERRLT	OPERATOR FAILS TO ALIGN FIREWATER INJECTION	3.000E-1
IE-LOOPGR	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	1.220E-2
IE-LOOPPC	LOSS OF OFFSITE POWER INITIATOR (PLANT-CENTERED)	1.930E-3
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)	1.040E-2
IE-LOOPWR	LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED)	3.910E-3
IE-TRANS	GENERAL PLANT TRANSIENT	7.620E-1
OEP-VCF-LP-CLOPT	CONSEQUENTIAL LOSS OF OFFSITE POWER - TRANSIENT	5.300E-3
OEP-XHE-XL-NR03HGR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS (GRID-RELATED)	2.496E-1
OEP-XHE-XL-NR03HPC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS (PLANT-CENTERED)	1.117E-1
OEP-XHE-XL-NR03HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS (SWITCHYARD-CENTERED)	1.453E-1
OEP-XHE-XL-NR03HWR	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS (WEATHER-RELATED)	4.800E-1
OEP-XHE-XX-NR03HWR1	CONVOLUTION FACTOR FOR 1FTR-OPR (03H-WR)	1.486E-2

Appendix B: Key Event Tree

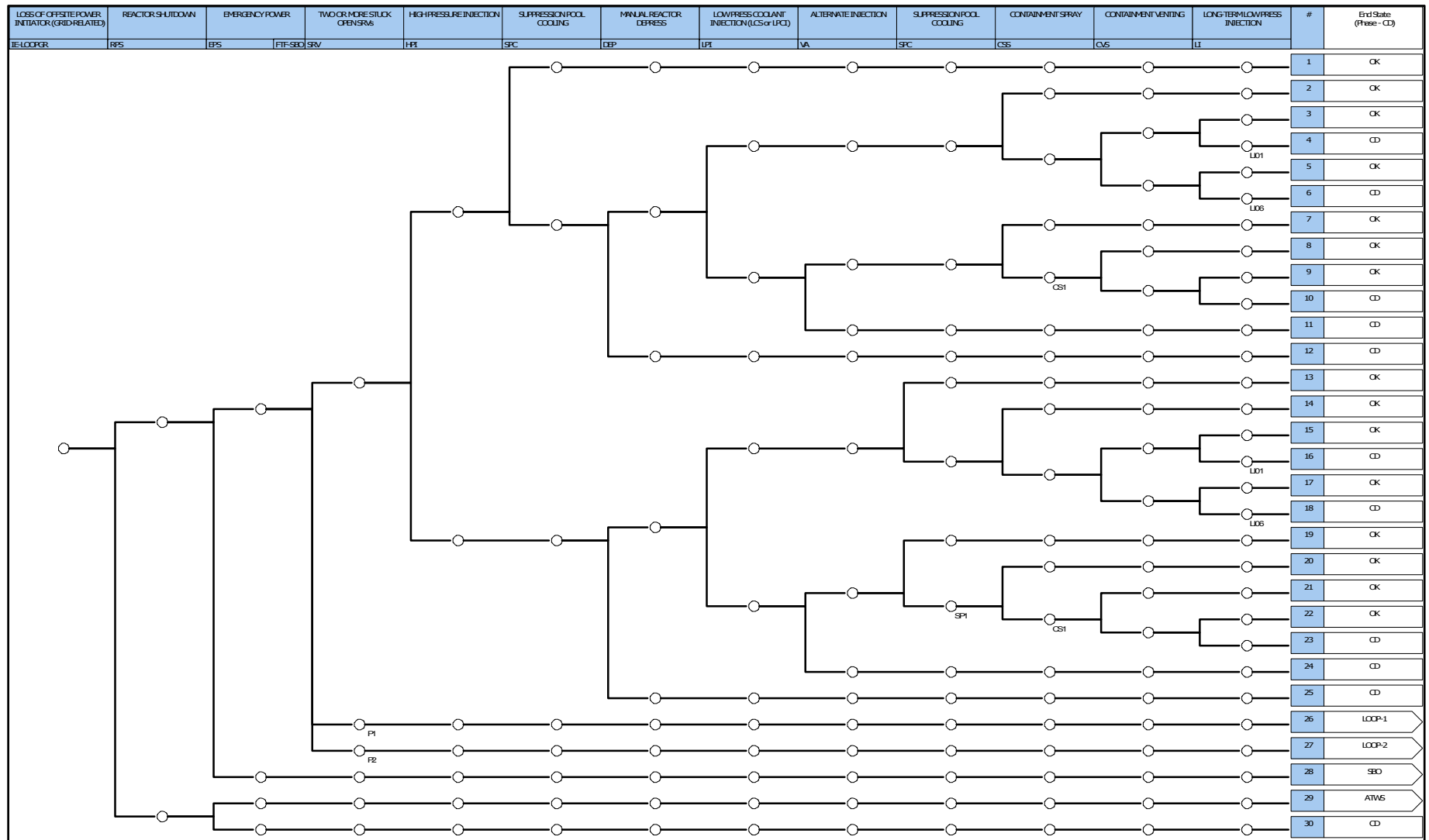


Figure B-1. LOOP (Grid-Related) Event Tree

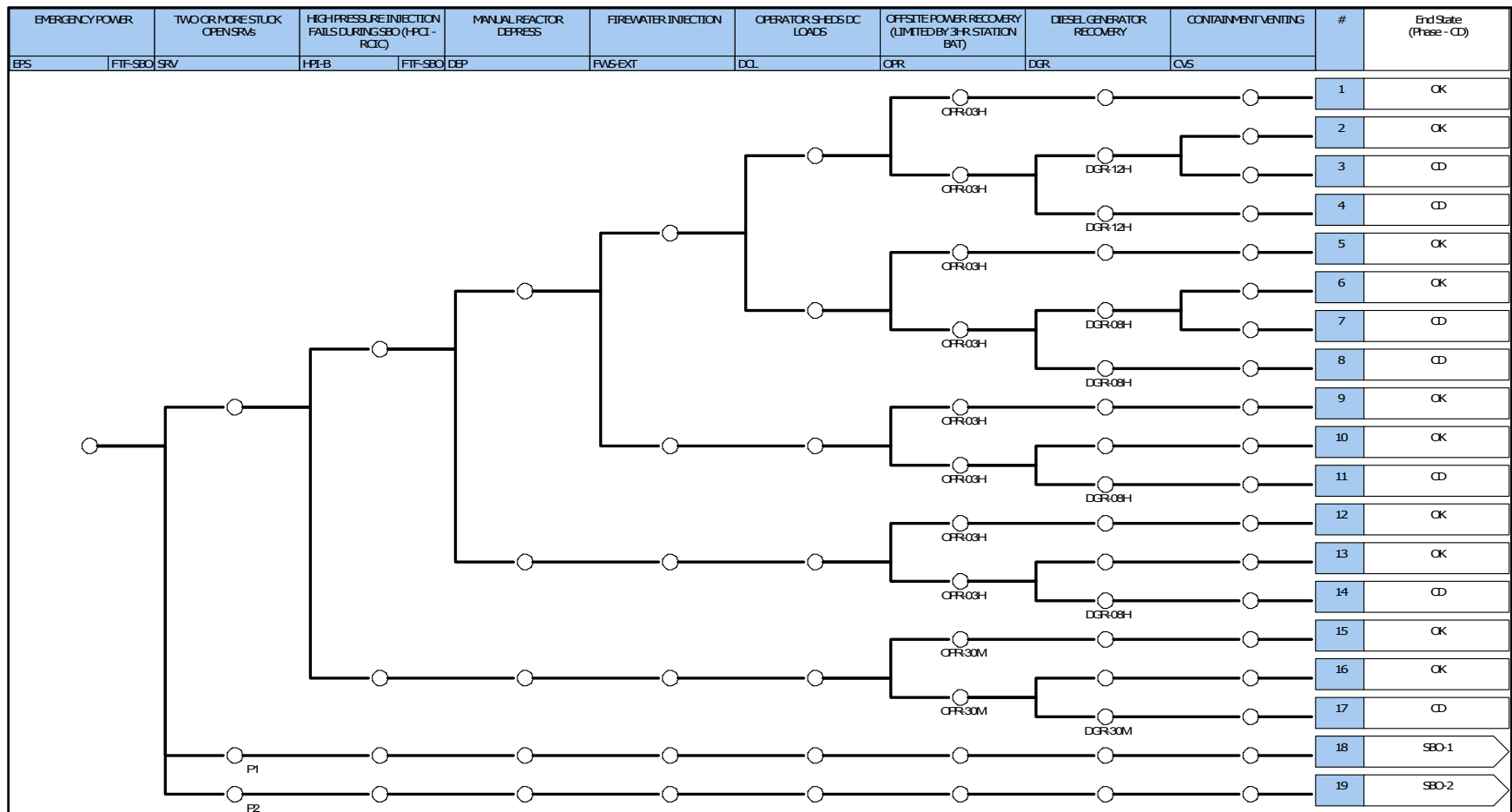


Figure B-2. SBO Event Tree