Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

Braidwood 2	Loss of Offsite Power Coincident with Reactor Trip Due to Loss of Reactor Coolant Pump	
Event Date: 07/30/2009	**LER:** 457/09-002 **IR:** 50-457/09-04	**CCDP =** 4×10^{-5}

EVENT SUMMARY

Event Description. At 2059 on July 30, 2009, Braidwood, Unit 2 received a sudden pressure relay (SPR) actuation on System Auxiliary Transformer (SAT) 242-1. As a result, the feed breakers for SAT 242-1 and SAT 242-2 opened as designed, which de-energized the 6.9 kV Buses 258 and 259. Both buses automatically transferred to Unit Auxiliary Transformers (UATs) 241-1 and 241-2. Following the transfer of Bus 258 to UAT 241-2, Reactor Coolant Pump (RCP) 2C, which was powered by Bus 258, tripped unexpectedly on over-current. This resulted in a Unit 2 reactor trip due to less than four RCPs running at greater than 30 percent reactor power. The reactor trip resulted in a turbine generator trip that caused UATs 241-1 and 241-2 to become de-energized, which in turn caused the remaining three RCPs to trip off due to loss of power to their buses. The loss of both SATs and both UATs resulted in a loss of offsite power (LOOP) to all Unit 2 emergency and nonemergency electrical buses. The licensee declared an Unusual Event due to a loss of offsite power greater than 15 minutes.

Following the reactor trip, Emergency Diesel Generators (EDGs) 2A and 2B started and loaded 4 kV safety-related Buses 241 and 242 and Auxiliary Feedwater (AFW) Pumps 2A and 2B started. Since non-safety-related equipment was not powered immediately following the reactor trip, operators were unable to use steam dump valves and the condenser for normal heat removal. Therefore, the operators used a “feed & bleed” method of cooling and depressurizing by pumping water into the steam generators with the AFW pumps and removing the steam through steam generator power-operated relief valves to the atmosphere. This process continued until the afternoon of July 31, 2009, when reactor coolant system pressure was low enough to place the residual heat removal (RHR) system in the shutdown cooling mode.

The Unusual Event was terminated at 0036 on August 2, 2009, when offsite power was restored to the safety-related 4 kV buses through SAT 242-2.

Additional information is provided in References 1 and 2.

Cause. The root causes of the Unit 2 reactor trip were determined to be:

- RCP 2C breaker tripped inappropriately due to a combination of an over-current trip setpoint time delay shorter than minimum acceptable per relay setting order, and an over-current drop out reset value too low to allow the relay to reset within the time delay window of the relay.

- The procedure for the calibration of over-current protective relays did not contain guidance to take an as-found reading/calibration and functional check of the over-current drop out reset value.

Recovery Opportunities. Offsite power was restored to the first safety bus approximately 50 hours after the LOOP occurred. However, offsite power was available to be supplied to the Unit 2 safety buses from the Unit 1 SATs 142-1 and 142-2 immediately after the event occurred. See Appendix C for further details.

ANALYSIS RESULTS

Conditional Core Damage Probability. The point estimate conditional core damage probability (CCDP) value for this event is 4.2×10^{-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 Braidwood is 1×10^{-5}.

Dominant Sequence. The dominant accident sequence, Loss of Offsite Power Switchyard (LOOPSC) Sequence 15 (CCDP = 4.0×10^{-6}) contributes 95% of the total internal events CCDP. Additional sequences that contribute greater than 1% of the total internal events CCDP are provided in Appendix A.

The dominant sequence is shown graphically in Figure B-1 in Appendix B. The events and important component failures in LOOP Sequence 15 are:

- LOOP occurs,
- Reactor scram succeeds,
- EDGs succeed,
- AFW fails, and
- Feed and bleed fails.

SAPHIRE 8 Report. The SAPHIRE 8 Initiating Event Assessment Report (Appendix A) provides the following:

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

MODELING ASSUMPTIONS

Analysis Type. The Revision 8.51 of the Braidwood 1 & 2 SPAR model created in July 2010 was used for this event analysis. This event was modeled as a LOOP initiating event.

Analysis Rules. The ASP program uses Significance Determination Process results for degraded conditions when available. However, the ASP Program performs independent initiating event analysis when an initiator occurs. Therefore, this analysis focuses solely on the risk of the loss of offsite power to the safety buses and subsequent reactor trip that occurred.

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

- This analysis models the July 30, 2009 reactor trip at Braidwood, Unit 2 as a switchyard LOOP initiating event.

- Offsite power recovery to a Unit 2 safety bus was possible immediately after the LOOP occurred.

Basic Event Probability Changes. The following initiating event frequencies and basic event probabilities were modified for this event analysis:

- The switchyard LOOP initiating event frequency (IE-LOOPSC) was set 1.0 to represent the operational event that occurred at Braidwood, Unit 2 on July 30, 2009. All other initiating events frequencies were set to zero.

- The non-recovery probability for basic event OEP-XHE-XL-NR01H was changed to 6.0×10^{-3}. See Appendix C for further details.

- The non-recovery probabilities for basic events OEP-XHE-XL-NR02H, OEP-XHE-XL-NR03H, OEP-XHE-XL-NR04H, and OEP-XHE-XL-NR06H were changed to 2.4×10^{-3}. See Appendix C for further details.

REFERENCES

1. Exelon Generation Company, "LER 457/09-002– Loss of Offsite Power Coincident with a Reactor Trip due to a Loss of 2C Reactor Coolant Pump," dated September 28, 2009.

2. U.S. Nuclear Regulatory Commission, "Braidwood Station Integrated Inspection Report 05000457/2009004," dated November 13, 2009.

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

Appendix A
SAPHIRE 8 Initiating Event Assessment Report

SAPHIRE Version: 8.0.7.10
SPAR Model: Braidwood, Units 1 & 2 Revision 8.51 (July 2010)

Initiating Event Assessment Summary

Initiating Event	**IE-LOOPSC**
CCDP	**4.22E-5**

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
IE-DLOESW	LOSS OF ESW AT BOTH UNITS (1 AND 2)	0.00E+0	2.44E-4
IE-ISL-HPI	ISLOCA IE 2-CKV HPI INTERFACE	0.00E+0	3.27E-6
IE-ISL-LPI	ISLOCA IE 2-CKV LPI INTERFACE	0.00E+0	3.27E-6
IE-ISL-RHR	RHR PIPE RUPTURES	0.00E+0	5.62E-6
IE-LDCA	LOSS OF DC BUS 111	0.00E+0	6.00E-4
IE-LDCB	LOSS OF DC BUS 112	0.00E+0	6.00E-4
IE-LLOCA	LARGE LOCA INITIATING EVENT	0.00E+0	2.50E-6
IE-LOCCW	LOSS OF COMPONENT COOLING WATER	0.00E+0	4.00E-4
IE-LOCHS	LOSS OF CONDENSER HEAT SINK	0.00E+0	8.00E-2
IE-LOESW	LOSS OF ESSENTIAL SERVICE WATER	0.00E+0	4.00E-4
IE-LOMFW	LOSS OF MAIN FEED WATER	0.00E+0	1.00E-1
IE-LONSW	LOSS OF NON-ESSENTIAL SERVICE WATER INITIATING EVENT	0.00E+0	4.00E-4
IE-LOOPGR	LOSS OF OFFSITE POWER INITIATOR (GRID-RELATED)	0.00E+0	1.86E-2
IE-LOOPPC	LOSS OF OFFSITE POWER INITIATOR (PLANT-CENTERED)	0.00E+0	2.07E-3
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-RELATED)	1.00E+0	1.04E-2
IE-LOOPWR	LOSS OF OFFSITE POWER INITIATOR (WEATHER-RELATED)	0.00E+0	4.83E-3
IE-MLOCA	MEDIUM LOCA	0.00E+0	2.00E-4
IE-SGTR	SG TUBE RUPTURE	0.00E+0	4.00E-3
IE-SLOCA	SMALL LOCA	0.00E+0	6.00E-4
IE-TRANS	TRANSIENT	0.00E+0	8.00E-1
IE-XLOCA	REACTOR VESSEL RUPTURE INITIATING EVENT	0.00E+0	1.00E-7
OEP-XHE-XL-NR01HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (SWITCHYARD)	6.00E-3	3.78E-1
OEP-XHE-XL-NR02HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2 HOURS (SWITCHYARD)	2.40E-3	1.94E-1
OEP-XHE-XL-NR03HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 3 HOURS (SWITCHYARD)	2.40E-3	1.18E-1
OEP-XHE-XL-NR04HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (SWITCHYARD)	2.40E-3	7.86E-2
OEP-XHE-XL-NR06HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 6 HOURS (SWITCHYARD)	2.40E-3	4.12E-2

Dominant Sequence Results

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

Event Tree	Sequence	CCDP	% Contribution	Description
LOOPSC	15	4.02E-5	95.3%	/RPS, /EPS, AFW-L, FAB-L
LOOPSC	12	5.35E-7	1.3%	/RPS, /EPS, AFW-L, /FAB-L, /OPR-06H, HPR
Total		**4.22E-5**	**100.0%**	

Referenced Fault Trees

Fault Tree	Description
AFW-L	AUXILIARY FEEDWATER
FAB-L	FEED AND BLEED COOLING (LOOP)
HPR	HIGH PRESSURE RECIRC

Cutset Report - LOOPSC 15

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

#	Prob/Freq	Total%	Cutset
	4.02E-5	100	Displaying 15048 of 15048 Cutsets.
1	2.24E-6	5.57	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-TM-1B,EPS-DGN-FR-1A,OEP-VCF-LP-SITESC
2	1.18E-6	2.94	IE-LOOPSC,AFW-PMP-CF-FSALL,HPI-XHE-XM-FB
3	9.51E-7	2.37	IE-LOOPSC,AFW-EDP-TM-1B,EPS-DGN-FR-1A,EPS-DGN-FR-2B,FLAG-DG2B-AWAY,OEP-VCF-LP-SITESC
4	9.51E-7	2.37	IE-LOOPSC,AFW-EDP-TM-1B,EPS-DGN-FR-1A,EPS-DGN-FR-2A,OEP-VCF-LP-SITESC
5	8.96E-7	2.23	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-XHE-XM-FUEL,EPS-DGN-FR-1A,OEP-VCF-LP-SITESC
6	8.96E-7	2.23	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-FS-1B,EPS-DGN-FR-1A,OEP-VCF-LP-SITESC
7	7.99E-7	1.99	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-FR-1B,EPS-DGN-FR-1A,OEP-VCF-LP-SITESC
8	5.38E-7	1.34	IE-LOOPSC,AFW-EDP-TM-1B,EPS-DGN-FR-1A,EPS-DGN-TM-2B,FLAG-DG2B-AWAY,OEP-VCF-LP-SITESC
9	5.38E-7	1.34	IE-LOOPSC,AFW-EDP-TM-1B,EPS-DGN-FR-1A,EPS-DGN-TM-2A,OEP-VCF-LP-SITESC
10	5.27E-7	1.31	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-TM-1B,EPS-DGN-FS-1A,OEP-VCF-LP-SITESC
11	5.06E-7	1.26	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-FS-1B,EPS-DGN-TM-1A,OEP-VCF-LP-SITESC
12	5.06E-7	1.26	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-XHE-XM-FUEL,EPS-DGN-TM-1A,OEP-VCF-LP-SITESC
13	4.73E-7	1.18	IE-LOOPSC,AFW-PMP-CF-FSALL,PPR-SRV-CC-455A
14	4.73E-7	1.18	IE-LOOPSC,AFW-PMP-CF-FSALL,PPR-SRV-CC-456
15	4.52E-7	1.12	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-FR-1B,EPS-DGN-TM-1A,OEP-VCF-LP-SITESC
16	4.22E-7	1.05	IE-LOOPSC,ACP-XHE-XM-XTIEA,AFW-EDP-TM-1B,EPS-MOD-CC-1VD009,OEP-VCF-LP-SITESC

Cutset Report - LOOPSC 12

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

#	Prob/Freq	Total%	Cutset
	5.35E-7	100	Displaying 5036 of 5036 Cutsets.
1	1.18E-7	22	IE-LOOPSC,AFW-PMP-CF-FSALL,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
2	3.19E-8	5.97	IE-LOOPSC,AFW-MDP-TM-1A,AFW-XHE-XM-FUEL,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
3	3.19E-8	5.97	IE-LOOPSC,AFW-EDP-FS-1B,AFW-MDP-TM-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC

#	Prob/Freq	Total%	Cutset
4	2.99E-8	5.6	IE-LOOPSC,AFW-EDP-TM-1B,AFW-MDP-FS-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
5	2.85E-8	5.32	IE-LOOPSC,AFW-EDP-FR-1B,AFW-MDP-TM-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
6	2.29E-8	4.29	IE-LOOPSC,AFW-CKV-CF-ALL8,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
7	2.00E-8	3.73	IE-LOOPSC,AFW-EDP-TM-1B,ESW-SOV-CC-AFWA,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
8	1.20E-8	2.24	IE-LOOPSC,AFW-MDP-FS-1A,AFW-XHE-XM-FUEL,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
9	1.20E-8	2.24	IE-LOOPSC,AFW-EDP-FS-1B,AFW-MDP-FS-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
10	1.07E-8	2.01	IE-LOOPSC,AFW-EDP-TM-1B,AFW-MDP-FR-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
11	1.07E-8	2	IE-LOOPSC,AFW-EDP-FR-1B,AFW-MDP-FS-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
12	9.58E-9	1.79	IE-LOOPSC,AFW-AOV-CC-1SX168,AFW-MDP-TM-1A,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
13	7.98E-9	1.49	IE-LOOPSC,AFW-XHE-XM-FUEL,ESW-SOV-CC-AFWA,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
14	7.98E-9	1.49	IE-LOOPSC,AFW-EDP-FS-1B,ESW-SOV-CC-AFWA,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
15	7.12E-9	1.33	IE-LOOPSC,AFW-EDP-FR-1B,ESW-SOV-CC-AFWA,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
16	7.06E-9	1.32	IE-LOOPSC,AFW-FCV-CF-ALL8,HPR-XHE-XM-RECIRC,/OEP-XHE-XL-NR06HSC
17	5.90E-9	1.1	IE-LOOPSC,AFW-PMP-CF-FSALL,HPR-ASL-MC-RWST,/OEP-XHE-XL-NR06HSC

Referenced Events

Event	Description	Probability
ACP-XHE-XM-XTIEA	OPERATOR FAILS TO CROSS-CONNECT ALT POWER TO DIV A	5.00E-2
AFW-AOV-CC-1SX168	FAILURE OF DD AFW PUMP CUBICLE COOLER AOV 1SX0168 TO OPEN	1.20E-3
AFW-CKV-CF-ALL8	CCF OF ALL 8 PUMP DISC CKVS (PSA)	1.15E-5
AFW-EDP-FR-1B	AFW DIESEL DRIVEN PUMP FAILS TO RUN	3.57E-3
AFW-EDP-FS-1B	AFW DIESEL DRIVEN PUMP FAILS TO START	4.00E-3
AFW-EDP-TM-1B	AFW DDP FAILS DUE TO TEST AND MAINTENANCE	1.00E-2
AFW-FCV-CF-ALL8	AFW 8 FCVS 005A-H FAIL FROM CCF (PSA)	3.54E-6
AFW-MDP-FR-1A	AFW MOTOR-DRIVEN PUMP FAILS TO RUN	5.38E-4
AFW-MDP-FS-1A	AFW MOTOR-DRIVEN PUMP 1A FAILS TO START	1.50E-3
AFW-MDP-TM-1A	AFW MDP UNAVAILABLE DUE TO TEST AND MAINTENANCE	4.00E-3
AFW-PMP-CF-FSALL	COMMON CAUSE FAILURE OF AFW PUMPS TO START - PSA	5.91E-5
AFW-XHE-XM-FUEL	OPERATOR FAILS TO REFILL AFW DDP DAY TANK	4.00E-3
EPS-DGN-FR-1A	DIESEL GENERATOR 1A FAILS TO RUN	2.12E-2
EPS-DGN-FR-2A	DIESEL GENERATOR 2A FAILS TO RUN	2.12E-2
EPS-DGN-FR-2B	DIESEL GENERATOR 2B FAILS TO RUN	2.12E-2
EPS-DGN-FS-1A	DIESEL GENERATOR 1A FAILS TO START	5.00E-3
EPS-DGN-TM-1A	DG 1A UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.20E-2
EPS-DGN-TM-2A	DG 2A UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.20E-2

Event	Description	Probability
EPS-DGN-TM-2B	DG 2B UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.20E-2
EPS-MOD-CC-1VD009	DG ROOM 1A FAN SUCTION DAMPER 1VD009 FAILS TO OPEN	4.00E-3
ESW-SOV-CC-AFWA	AFW MDP 1A OIL COOLER VALVE 1SX101A FAILS	1.00E-3
FLAG-DG2B-AWAY	DG2B ALIGNED TO U2 DUE TO FAILURE OF DG2A	1.00E+0
HPI-XHE-XM-FB	OPERATOR FAILS TO INITIATE FEED AND BLEED COOLING	2.00E-2
HPR-ASL-MC-RWST	RWST LOW LEVEL COMPONENTS MISCALIBRATED	1.00E-4
HPR-XHE-XM-RECIRC	OPERATOR FAILS TO START HIGH PRESSURE RECIRC	2.00E-3
IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-RELATED)	1.00E+0
OEP-VCF-LP-SITESC	SITE LOOP (SWITCHYARD-RELATED)	2.11E-1
PPR-SRV-CC-455A	PORV 455A FAILS TO OPEN ON DEMAND	8.00E-3
PPR-SRV-CC-456	PORV 456 FAILS TO OPEN ON DEMAND	8.00E-3

Appendix B
Key Event Tree

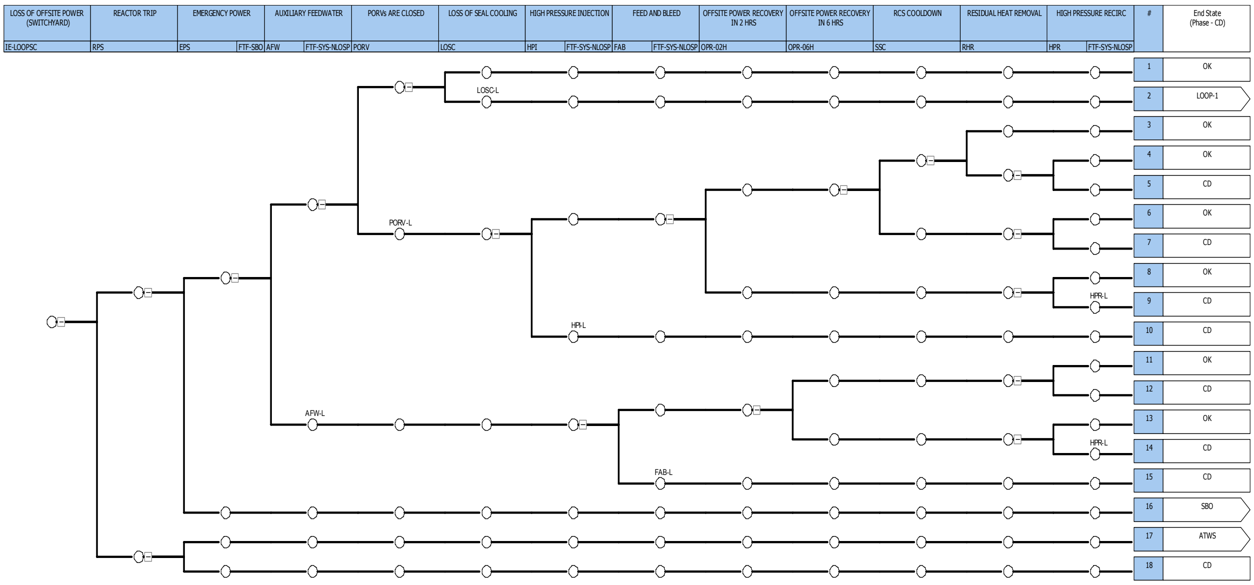

Figure B-1. Braidwood, Unit 2 Switchyard LOOP Event Tree.

Appendix C
Offsite Power Recovery Modeling

Background and Modeling Details of Offsite Power Recovery[1]

The time required to restore offsite power to plant emergency equipment is a significant factor in modeling the CCDP given a LOOP. SPAR LOOP/SBO models include various sequence-specific AC power recovery factors that are based on the time available to recover power to prevent core damage. For a sequence involving failure of all of the cooling sources, approximately 1 hour would be available to recover power to help avoid core damage. On the other hand, sequences involving successful early inventory control and decay heat removal, but failure of long-term decay heat removal, would accommodate several hours to recover AC power prior to core damage.

In this analysis, offsite power recovery probabilities are based on (1) known information about when power was restored to the switchyard and (2) estimated probabilities of failing to realign power to emergency buses for times after offsite power was restored to the switchyard. Power restoration times are provided in References 1 and 2.

Failure to recover offsite power to plant safety-related loads (if needed because EDGs fail to supply the loads), given recovery of power to the switchyard, could result from (1) operators failing to restore proper breaker line-ups, (2) breakers failing to close on demand, or (3) a combination of operator and breaker failures. The dominant contributor to failure to recover offsite power to plant safety-related loads in this situation is operators failing to restore proper breaker line-ups. The SPAR-H Human Reliability Analysis Method (Reference 3) was used to estimate non-recovery probabilities as a function of time following restoration of offsite power to the switchyard.

Diagnosis, Action, and Dependency

The SPAR Human Reliability Analysis Method considers the following three factors:

- Probability of failure to diagnose the need for action,
- Probability of failure to successfully perform the desired action, and
- Dependency on other operator actions involved in the specific sequence of interest.

This analysis considers the probability of failure to diagnose the need for action and the probability of failure to successfully perform the desired action. However, dependency between operator power recovery tasks and any other operator tasks is not considered. Dependency is considered only when multiple operator actions are present in the same cutset. This analysis does not have any cutsets containing multiple human error basic events.

Performance Shaping Factors

The probability of failure to perform an action is the product of a nominal failure probability (1×10^{-3}) and the following eight performance shaping factors (PSFs):

- Available Time
- Stress

[1] This section provides background information and details involving recovery of offsite power for this event. In an ASP analysis, offsite power recovery constitutes the recovery of power to the unit vital busses once power has been restored to the switchyard. ASP analyses do not deal with offsite recovery actions outside the switchyard.

- Complexity
- Experience/Training
- Procedures
- Ergonomics
- Fitness for Duty
- Work Processes

Time

New human reliability analysis (HRA) guidance currently being developed directs the analyst to determine if time is available to perform the action. If sufficient time is available to perform the action, the time available (best estimate) for operators to perform to action is subtracted from the total time available for the recovery action, with the remainder of the time being available for diagnosis activities. Under this new guidance, the time available PSF for action is not modified unless sufficient time to perform the operator action is not available.

Operators would have a minimum of one hour available to restore offsite during a postulated blackout event. With two breakers needing to be shut, the action portion time for recovery of offsite power to a vital bus is minimal (< 5 minutes). Therefore, the 1-hour recovery action (OEP-XHE-XL-NR01H) PSF for time available is set to extra time (i.e., 1 to 2× nominal and > 30 minutes). Expansive time (i.e., 2× nominal and > 30 minutes) is used for the time available PSF for all recovery actions greater than or equal to two hours. The PSF for time available for action is set to nominal for all recovery actions.

Stress

The PSF for diagnosis and action stress is assigned a value of 2 (i.e., High Stress) for all AC power non-recovery probabilities. Factors considered in assigning this PSF level "higher than nominal level" include sudden onset of the LOOP initiating event, multiple alarms/annunciators, actual and/or postulated compounding equipment failures, and resulting core uncovery and imminent core damage.

Complexity

The PSF for diagnosis complexity is assigned a value of 2 (i.e., Moderately Complex) for all non-recovery probabilities. Factors considered in assigning this PSF level include multiple equipment unavailabilities, communications with grid-operators to ensure offsite power is stable, and the concurrent actions/multiple procedures used during a station blackout. The PSF for action complexity is set to nominal for all recovery actions.

All Other PSFs

For all of the AC power non-recovery probabilities, the diagnosis and action PSFs for experience/training, procedures, ergonomics, fitness for duty, and work processes are set to nominal (i.e., are assigned values of 1.0). Details of the event, plant response, and crew performance did not warrant a change from nominal for these PSFs.

Tables C-1 though C-4 contain the PSF adjustments and non-recovery probabilities for all of the offsite power recovery operator actions.

Table C-1. PSF adjustments for operator recovery actions of offsite power.

	DIAGNOSIS				ACTION	
Recovery Basic Event	**Time**	**Stress**	**Complexity**	**All Other PSFs**	**Stress**	**All Other PSFs**
OEP-XHE-XL-NR01H	Extra Time	High	Moderate	Nominal	High	Nominal
OEP-XHE-XL-NR02H	Expansive Time	High	Moderate	Nominal	High	Nominal
OEP-XHE-XL-NR03H	Expansive Time	High	Moderate	Nominal	High	Nominal
OEP-XHE-XL-NR04H	Expansive Time	High	Moderate	Nominal	High	Nominal
OEP-XHE-XL-NR06H	Expansive Time	High	Moderate	Nominal	High	Nominal

Table C-2. Diagnosis non-recovery probabilities for operator recovery actions of offsite power.

Recovery Basic Event	Base Probability	Time	Stress	Complexity	All Other PSFs	Diagnosis Probability
OEP-XHE-XL-NR01H	1×10^{-2}	×0.1	×2	×2	×1	4×10^{-3}
OEP-XHE-XL-NR02H	1×10^{-2}	×0.01	×2	×2	×1	4×10^{-4}
OEP-XHE-XL-NR03H	1×10^{-2}	×0.01	×2	×2	×1	4×10^{-4}
OEP-XHE-XL-NR04H	1×10^{-2}	×0.01	×2	×2	×1	4×10^{-4}
OEP-XHE-XL-NR06H	1×10^{-2}	×0.01	×2	×2	×1	4×10^{-4}

Table C-3. Action non-recovery probabilities for operator recovery actions of offsite power.

Recovery Basic Event	Base Probability	Stress	All Other PSFs	Action Probability
OEP-XHE-XL-NR01H	1×10^{-3}	×2	×1	2×10^{-3}
OEP-XHE-XL-NR02H	1×10^{-3}	×2	×1	2×10^{-3}
OEP-XHE-XL-NR03H	1×10^{-3}	×2	×1	2×10^{-3}
OEP-XHE-XL-NR04H	1×10^{-3}	×2	×1	2×10^{-3}
OEP-XHE-XL-NR06H	1×10^{-3}	×2	×1	2×10^{-3}

Table C-4. Total non-recovery probabilities for operator recovery actions of offsite power.

Recovery Basic Event	Diagnosis Probability	Action Probability	Final Probability
OEP-XHE-XL-NR01H	4×10^{-3}	2×10^{-3}	6.0×10^{-3}
OEP-XHE-XL-NR02H	4×10^{-4}	2×10^{-3}	2.4×10^{-3}
OEP-XHE-XL-NR03H	4×10^{-4}	2×10^{-3}	2.4×10^{-3}
OEP-XHE-XL-NR04H	4×10^{-4}	2×10^{-3}	2.4×10^{-3}
OEP-XHE-XL-NR06H	4×10^{-4}	2×10^{-3}	2.4×10^{-3}