

Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

Shearon Harris Nuclear Power Plant		Manual Reactor Trip in Response to 480V Transformer Failure	
Event Date: 1/18/2014		LER: 400/14-001 IR: 50-400/14-02	CCDP = 6×10^{-6}
Plant Type: Westinghouse Three-Loop Pressurized-Water Reactor (PWR) with a Dry, Ambient Pressure Containment			
Plant Operating Mode (Reactor Power Level): Mode 1 (75 Percent Reactor Power)			
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EXECUTIVE SUMMARY

On January 18, 2014, at 9:31 a.m., Harris Nuclear Plant (HNP) commenced a rapid down-power from 100 percent power in accordance with plant procedures in preparation for de-energizing the 480V 1D2 transformer due to ground faults. Loss of power to the 1D2 bus would result in the main feedwater (MFW) pump recirculation valves fully opening, thus reducing MFW flow to the steam generators. Attempts were made to isolate the grounds per plant procedures, but were unsuccessful. Subsequently, smoke was seen by an operator and was taken as an indication of a fire in the 1D2 transformer cubicle. At 10:11 a.m., while operating at 75 percent power, operators manually tripped the reactor. At 10:13 a.m., the auxiliary feedwater (AFW) system actuated as expected based on low steam generator levels. Auxiliary bus 1D was de-energized at 10:14 a.m. to de-energize the 1D2 transformer, which resulted in a loss of power to the 6.9kV 1A-SA safety bus and the "A" motor-driven AFW pump. The "A" emergency diesel generator automatically started at 10:15 a.m. and re-energized the 1A-SA safety bus and the "A" motor-driven AFW pump. All safety systems responded as expected during this event.

According to the risk analysis modeling assumptions used in this ASP analysis, the most likely core damage sequence is a loss of main feedwater (LOMFW) initiating event with subsequent loss of AFW and failure of feed and bleed cooling. This accident sequence accounts for approximately 46 percent of the CCDP for the event. The second most likely core damage sequence is an LOMFW initiating event followed by a loss of reactor coolant pump (RCP) seal cooling with failure of a RCP seal, failure of high pressure injection, and failure of steam generator secondary side cool down. This accident sequence accounts for approximately 39 percent of the CCDP for the event. In general, these results are consistent with at-power LOMFW events previously analyzed by the ASP Program at other PWRs.

EVENT DETAILS

Event Description. On January 18, 2014, at 9:31 a.m., HNP commenced a rapid down-power from 100 percent power in accordance with plant procedures in preparation for de-energizing the 480V 1D2 transformer due to ground faults. See Figure 1 (Harris 6.9kV and 480V One-Line Diagram) for a drawing of the electrical system showing the affected components. Loss of power to the 1D2 bus would result in the main feedwater (MFW) pump recirculation valves fully

opening, thus reducing MFW flow to the steam generators. Attempts were made to isolate the grounds per plant procedures. A ground was located on the "C" pressurizer heater, but removing the pressurizer heater from service did not result in resetting the ground indications on either side of the transformer. Operations personnel observed indications of heating to the 1D2 transformer cubicle. Subsequently, smoke was seen by an operator and was taken as an indication of a fire in the 1D2 transformer cubicle.

At 10:11 a.m. (40 minutes after the start of the event), while operating at 75 percent power, the reactor protection system was manually actuated in anticipation of inadequate MFW flow to maintain steam generator water levels as a result of de-energizing the 1D2 transformer. At 10:13 a.m., the AFW system actuated as expected based on low steam generator levels as a result of the reactor trip. Auxiliary bus 1D was de-energized at 10:14 a.m. in order to de-energize the 1D2 transformer, which resulted in a loss of power to the 6.9kV 1A-SA safety bus and the "A" motor-driven AFW pump. The turbine-driven AFW pump and the "B" motor driven AFW pump actuated due to under-voltage on the 1A-SA safety bus. The "A" EDG automatically started at 10:15 a.m. and re-energized the 1A-SA safety bus, which automatically started the "A" motor-driven AFW pump, "A" emergency service water pump, and "C" charging/safety injection pump. All safety systems responded as expected during this event. Unit 1 was stable in Mode 3 at 1:43 p.m. Additional information can be found in [Reference 1](#) and [Reference 2](#).

Cause. The root cause for the 1D2 transformer failure was a combination of age and various electro-magnetic environmental conditions (such as transients and breaker switching), which led to failure of the high to low side insulation barrier over time and ultimately a primary to secondary short. An actual fire did not occur in this event.

SYSTEM DRAWING

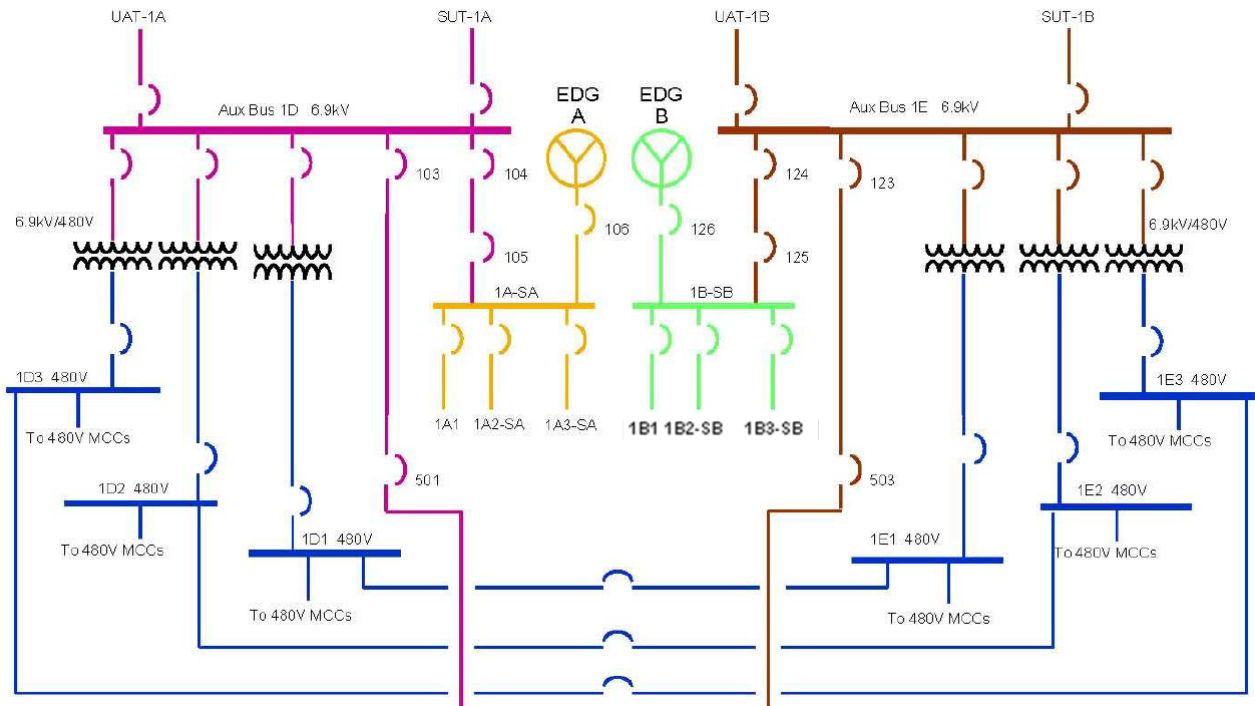


Figure 1: Harris 6.9kV and 480V One-Line Diagram

MODELING ASSUMPTIONS

Analysis Type. The HNP Standardized Plant Analysis Risk (SPAR) Model, Revision 8.27, created in May 2014, was used for this event analysis. This event was modeled as an LOMFW initiating event.

SDP Results/Basis for ASP Analysis. The inspectors reviewed this issue and one Green finding was identified, as discussed in Reference 2. A self-revealing Green finding was identified for failure to implement an adequate corrective action to prevent recurrence (CAPR) for a significant condition adverse to quality (SCAQ), as required by licensee procedure. Specifically, when the 1E2 transformer failed in August 2013, the licensee determined the event to be an SCAQ, but failed to implement an adequate CAPR to prevent the failure of the 1D2 transformer.

The SDP assesses the risk significance of individual inspection findings considering only those systems, structures, and components (SSCs) directly associated with the licensee performance deficiency. The ASP Program assesses the risk significance of operational events considering all SSC failures and unavailabilities (e.g., equipment out for test and maintenance), regardless of whether performance deficiencies were identified. The ASP Program uses SDP results for degraded conditions when possible; however, an independent ASP analysis is performed for initiating events. Therefore, an ASP analysis was performed for this initiating event.

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

- The probability of IE-LOMFW (*Loss of Main Feedwater Initiating Event*) was set to 1.0; all other initiating event probabilities were set to zero.
- The probability of basic event ACP-BAC-LP-1D (*6.9KV AC AUX BUS 1D Fails*) was set to TRUE because the 1D auxiliary bus was de-energized in order to de-energize the 1D2 transformer.
- The probability of basic event ACP-TFM-FC-1D2 (*AC Transformer 1D2 Fails to Function*) was set to TRUE because the 1D2 transformer failed in this event.

ANALYSIS RESULTS

CCDP. The CCDP for this analysis is 5.9×10^{-6} . The ASP Program acceptance threshold is 1.0×10^{-6} or the CCDP equivalent to an uncomplicated reactor trip with non-recoverable loss of MFW and condenser heat sink, whichever is greater. This CCDP equivalent for Shearon Harris is 1.0×10^{-6} . Therefore, this event is a precursor.

Dominant Sequence. The dominant accident sequence is LOMFW sequence 12 (CCDP = 2.7×10^{-6}) which contributes approximately 46 percent of the total internal events CCDP. LOMFW sequence 02-02-11 (CCDP = 2.3×10^{-6}) contributes approximately 39 percent of the total internal events CCDP. The cut sets/sequences that contribute to the top 95 percent and/or at least 1 percent of the total internal events CCDP are provided in Appendix A.

The events and important component failures in LOMFW Sequence 12 are:

- LOMFW initiating event occurs
- Reactor scram succeeds

- AFW fails
- Feed and bleed fails

The events and important component failures in LOMFW Sequence 02-02-11 are:

- LOMFW initiating event occurs
- Reactor scram succeeds
- AFW succeeds
- Power operated relief valves (PORVs) close
- Loss of RCP seal cooling occurs
- RCP trip succeeds
- Rapid secondary side depressurization succeeds
- First stage RCP seal succeeds
- Second stage RCP seal fails
- High pressure injection fails
- Secondary side cooldown fails

REFERENCES

1. Shearon Harris Nuclear Power Plant – Unit 1, “LER 400/14-001 – Manual Reactor Trip Due to Indications of a Fire,” dated March 19, 2014 (ML14078A320).
2. U.S. Nuclear Regulatory Commission, “Shearon Harris Nuclear Power Plant - NRC Integrated Inspection Report 05000400/2014002,” dated April 28, 2014 (ML14118A441).

Appendix A: Analysis Results

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
ACP-BAC-LP-1D	6.9KV AC AUX BUS 1D FAILS	TRUE	3.331E-5
ACP-TFM-FC-1D2	AC TRANSFORMER 1D2 FAILS TO FUNCTION	TRUE	2.265E-5
IE-LOMFW	LOSS OF MAIN FEEDWATER	1.000 ^a	6.890E-2

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

Dominant Sequence Results

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

Event Tree	Sequence	CCDP	% Contribution	Description
LOMFW	12	2.691E-6	45.9%	/RPS, AFW, FAB
LOMFW	02-02-11	2.289E-6	39.0%	/RPS, /AFW, /PORV, LO SC, /RCPT, /RSD, /BP1, BP2, /FW, HPI, SSC1
LOMFW	11	4.572E-7	7.8%	/RPS, AFW, /FAB, SSCR, HPR
LOMFW	02-03-11	1.115E-7	1.9%	/RPS, /AFW, /PORV, LO SC, /RCPT, /RSD, BP1, /BP2, /FW, HPI, SSC1
LOMFW	13-14	7.658E-8	1.3%	RPS, /RCSPRESS, MFW, /AFW-A, BORATION
Total		5.868E-6	100.0%	

Referenced Fault Trees

Fault Tree	Description
AFW	AUXILIARY FEEDWATER
BORATION	EMERGENCY BORATION
BP1	RCP SEAL STAGE 1 INTEGRITY (BINDING/POPPING)
BP2	RCP SEAL STAGE 2 INTEGRITY (BINDING/POPPING)
FAB	FEED AND BLEED
HPI	HIGH PRESSURE INJECTION
HPR	HIGH PRESSURE RECIRC
LO SC	LOSS OF SEAL COOLING
MFW	MAIN FEEDWATER
RPS	REACTOR PROTECTION SYSTEM
SSC1	SECONDARY SIDE RCS COOLDOWN
SSCR	SECONDARY SIDE COOLING RECOVERED

Cut Set Report - LOMFW 12

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

#	CCDP	Total%	Cut Set
	2.691E-6	100	Displaying 2624 Cut Sets. (2624 Original)
1	2.400E-7	8.92	IE-LOMFW,AFW-XHE-XM-OPER35,ESF-ASL-CF-SGLT,HPI-XHE-XM-FB
2	1.696E-7	6.31	IE-LOMFW,DCP-BDC-LP-1BSB,EPS-DGN-FR-1A
3	1.495E-7	5.55	IE-LOMFW,AFW-PMP-CF-ALL,HPI-XHE-XM-FB
4	8.617E-8	3.20	IE-LOMFW,AFW-MDP-TM-1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,HPI-XHE-XM-FB
5	8.550E-8	3.18	IE-LOMFW,ACP-CRB-CC-122,AFW-TDP-FR-1X,EPS-DGN-FR-1A,EPS-DGN-FR-1B
6	8.550E-8	3.18	IE-LOMFW,ACP-CRB-OO-121,AFW-TDP-FR-1X,EPS-DGN-FR-1A,EPS-DGN-FR-1B
7	8.093E-8	3.01	IE-LOMFW,DCP-BDC-LP-1BSB,EPS-DGN-TM-1A
8	7.467E-8	2.78	IE-LOMFW,DCP-BDC-LP-1BSB,ESW-MDP-TM-1A

#	CCDP	Total%	Cut Set
9	4.079E-8	1.52	IE-LOMFW,ACP-CRB-CC-122,AFW-TDP-FR-1X,EPS-DGN-FR-1B,EPS-DGN-TM-1A
10	4.079E-8	1.52	IE-LOMFW,ACP-CRB-OO-121,AFW-TDP-FR-1X,EPS-DGN-FR-1B,EPS-DGN-TM-1A
11	4.079E-8	1.52	IE-LOMFW,ACP-CRB-OO-121,AFW-TDP-FR-1X,EPS-DGN-FR-1A,EPS-DGN-TM-1B
12	4.079E-8	1.52	IE-LOMFW,ACP-CRB-CC-122,AFW-TDP-FR-1X,EPS-DGN-FR-1A,EPS-DGN-TM-1B
13	4.042E-8	1.50	IE-LOMFW,AFW-XVM-OC-1CE34,HPI-XHE-XM-FB
14	3.958E-8	1.47	IE-LOMFW,ACP-BAC-LP-1BSB,AFW-TDP-FR-1X,EPS-DGN-FR-1A
15	3.763E-8	1.40	IE-LOMFW,ACP-CRB-OO-121,AFW-TDP-FR-1X,EPS-DGN-FR-1B,ESW-MDP-TM-1A
16	3.763E-8	1.40	IE-LOMFW,ACP-CRB-CC-122,AFW-TDP-FR-1X,EPS-DGN-FR-1B,ESW-MDP-TM-1A
17	3.763E-8	1.40	IE-LOMFW,ACP-CRB-OO-121,AFW-TDP-FR-1X,EPS-DGN-FR-1A,ESW-MDP-TM-1B
18	3.763E-8	1.40	IE-LOMFW,ACP-CRB-CC-122,AFW-TDP-FR-1X,EPS-DGN-FR-1A,ESW-MDP-TM-1B
19	3.758E-8	1.40	IE-LOMFW,AFW-MDP-CF-START,AFW-TDP-FR-1X,HPI-XHE-XM-FB
20	3.744E-8	1.39	IE-LOMFW,AFW-PMP-FR-MDP1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,HPI-XHE-XM-FB

Cut Set Report - LOMFW 02-02-11

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

#	CCDP	Total%	Cut Set
	2.289E-6	100	Displaying 2320 Cut Sets. (2320 Original)
1	3.456E-7	15.10	IE-LOMFW,ASI-PDP-FR-E001,CVC-ARUN-BSTBY,EPS-DGN-FR-1A,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
2	3.456E-7	15.10	IE-LOMFW,ASI-PDP-FR-E001,CVC-BRUN-ASTBY,EPS-DGN-FR-1A,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
3	2.022E-7	8.84	IE-LOMFW,CVC-BRUN-ASTBY,EPS-DGN-FR-1A,EPS-DGN-FR-DSDG,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
4	2.022E-7	8.84	IE-LOMFW,CVC-ARUN-BSTBY,EPS-DGN-FR-1A,EPS-DGN-FR-DSDG,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
5	1.023E-7	4.47	IE-LOMFW,CVC-BRUN-ASTBY,EPS-DGN-FR-1A,EPS-DGN-TM-DSDG,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
6	1.023E-7	4.47	IE-LOMFW,CVC-ARUN-BSTBY,EPS-DGN-FR-1A,EPS-DGN-TM-DSDG,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
7	3.322E-8	1.45	IE-LOMFW,ASI-PDP-FR-E001,CVC-ARUN-BSTBY,EPS-DGN-FS-1A,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2
8	3.322E-8	1.45	IE-LOMFW,ASI-PDP-FR-E001,CVC-BRUN-ASTBY,EPS-DGN-FS-1A,ESW-TRN-TM-1B,/RCS-MDP-LK-BP1,RCS-MDP-LK-BP2

Cut Set Report - LOMFW 11

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

#	CCDP	Total%	Cut Set
	4.572E-7	100	Displaying 1766 Cut Sets. (1766 Original)
1	2.400E-8	5.25	IE-LOMFW,AFW-XHE-XM-OPER35,ESF-ASL-CF-SGLT,RHR-XHE-XM-CCW
2	2.400E-8	5.25	IE-LOMFW,AFW-XHE-XM-OPER35,ESF-ASL-CF-SGLT,HPI-XHE-XM-RECIRC
3	2.221E-8	4.86	IE-LOMFW,AFW-MDP-TM-1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,RHR-MDP-TM-1B
4	2.063E-8	4.51	IE-LOMFW,AFW-MDP-TM-1B,AFW-TDP-FR-1X,CCW-MDP-TM-1B,EPS-DGN-FR-1A
5	1.495E-8	3.27	IE-LOMFW,AFW-PMP-CF-ALL,RHR-XHE-XM-CCW
6	1.495E-8	3.27	IE-LOMFW,AFW-PMP-CF-ALL,HPI-XHE-XM-RECIRC

#	CCDP	Total%	Cut Set
7	9.649E-9	2.11	IE-LOMFW,AFW-PMP-FR-MDP1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,RHR-MDP-TM-1B
8	8.962E-9	1.96	IE-LOMFW,AFW-PMP-FR-MDP1B,AFW-TDP-FR-1X,CCW-MDP-TM-1B,EPS-DGN-FR-1A
9	8.617E-9	1.89	IE-LOMFW,AFW-MDP-TM-1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,HPI-XHE-XM-RECIRC
10	8.617E-9	1.89	IE-LOMFW,AFW-MDP-TM-1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,RHR-XHE-XM-CCW
11	5.802E-9	1.27	IE-LOMFW,AFW-MDP-FS-1B,AFW-TDP-FR-1X,EPS-DGN-FR-1A,RHR-MDP-TM-1B
12	5.389E-9	1.18	IE-LOMFW,AFW-MDP-FS-1B,AFW-TDP-FR-1X,CCW-MDP-TM-1B,EPS-DGN-FR-1A
13	4.653E-9	1.02	IE-LOMFW,AFW-MDP-TM-1B,AFW-TDP-FR-1X,CCW-MDP-FS-1B,EPS-DGN-FR-1A

Cut Set Report - LOMFW 02-03-11

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

#	CCDP	Total%	Cut Set
	1.115E-7	100	Displaying 488 Cut Sets. (488 Original)
1	1.750E-8	15.70	IE-LOMFW,ASI-PDP-FR-E001,CVC-ARUN-BSTBY,EPS-DGN-FR-1A,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
2	1.750E-8	15.70	IE-LOMFW,ASI-PDP-FR-E001,CVC-BRUN-ASTBY,EPS-DGN-FR-1A,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
3	1.024E-8	9.18	IE-LOMFW,CVC-BRUN-ASTBY,EPS-DGN-FR-1A,EPS-DGN-FR-DSDG,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
4	1.024E-8	9.18	IE-LOMFW,CVC-ARUN-BSTBY,EPS-DGN-FR-1A,EPS-DGN-FR-DSDG,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
5	5.180E-9	4.65	IE-LOMFW,CVC-BRUN-ASTBY,EPS-DGN-FR-1A,EPS-DGN-TM-DSDG,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
6	5.180E-9	4.65	IE-LOMFW,CVC-ARUN-BSTBY,EPS-DGN-FR-1A,EPS-DGN-TM-DSDG,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
7	1.682E-9	1.51	IE-LOMFW,ASI-PDP-FR-E001,CVC-ARUN-BSTBY,EPS-DGN-FS-1A,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2
8	1.682E-9	1.51	IE-LOMFW,ASI-PDP-FR-E001,CVC-BRUN-ASTBY,EPS-DGN-FS-1A,ESW-TRN-TM-1B,RCS-MDP-LK-BP1,/RCS-MDP-LK-BP2

Cut Set Report - LOMFW 13-14

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

#	CCDP	Total%	Cut Set
	7.658E-8	100	Displaying 15 Cut Sets. (15 Original)
1	2.420E-8	31.60	IE-LOMFW,CVC-XHE-XM-BOR,RPS-ROD-CF-RCCAS
2	1.610E-8	21.02	IE-LOMFW,RPS-ASL-FC-AMSAC,RPS-BME-CF-RTBAB
3	1.343E-8	17.54	IE-LOMFW,RPS-ASL-FC-AMSAC,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
4	1.210E-8	15.80	IE-LOMFW,RPS-ASL-FC-AMSAC,RPS-ROD-CF-RCCAS
5	9.104E-9	11.89	IE-LOMFW,RPS-ASL-FC-AMSAC,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
6	1.040E-9	1.36	IE-LOMFW,RPS-ASL-FC-AMSAC,RPS-UVL-CF-UVDAB,RPS-XHE-XE-SIGNL

Referenced Events

Event	Description	Probability
ACP-BAC-LP-1BSB	DIVISION 1B-SB AC POWER 6.9KV BUS FAILS	3.331E-5
ACP-CRB-CC-122	CIRCUIT BREAKER 122 FROM UAT B FAILS TO OPEN	2.392E-3
ACP-CRB-OO-121	CIRCUIT BREAKER 121 FROM SUT B FAILS TO CLOSE	2.392E-3
AFW-MDP-CF-START	COMMON CAUSE FAILURE OF MOTOR DRIVEN PUMPS TO START	4.756E-5
AFW-MDP-FS-1B	AFW MDP 1B FAILS TO START	9.474E-4
AFW-MDP-TM-1B	AFW MDP 1B UNAVAILABLE DUE TO T&M	3.626E-3
AFW-PMP-CF-ALL	COMMON CAUSE FAILURE OF AFW PUMPS	7.473E-6
AFW-PMP-FR-MDP1B	AFW MDP-1B PUMP FAILS TO RUN	1.576E-3
AFW-TDP-FR-1X	AFW TDP 1X FAILS TO RUN	3.950E-2
AFW-XHE-XM-OPER35	OPERATOR FAILS TO START AFW PUMPS	1.000E-2
AFW-XVM-OC-1CE34	MANUAL VALVE 1CE-34 CST OUTLET TRANSFERS CLOSED	2.021E-6
ASI-PDP-FR-E001	ALTERNATE SEAL INJECTION PUMP FAILS TO RUN	4.848E-2
CCW-MDP-FS-1B	CCW MDP 1B FAILS TO START	1.080E-3
CCW-MDP-TM-1B	CCW MDP 1B UNAVAILABLE DUE TO TEST AND MAINTENANCE	4.787E-3
CVC-ARUN-BSTBY	CVC MDP 1A RUNNING CVC MDP 1B STANDBY	5.000E-1
CVC-BRUN-ASTBY	CVC MDP 1B RUNNING CVC MDP 1A STANDBY	5.000E-1
CVC-XHE-XM-BOR	OPERATOR FAILS TO INITIATE EMERGENCY BORATION	2.000E-2
DCP-BDC-LP-1BSB	DIVISION 1B 125VDC BUS DP-1B-SB FAILS	5.640E-6
EPS-DGN-FR-1A	DIESEL GENERATOR A FAILS TO RUN	3.008E-2
EPS-DGN-FR-1B	DIESEL GENERATOR B FAILS TO RUN	3.008E-2
EPS-DGN-FR-DSDG	DEDICATED SHUTDOWN DIESEL GENERATOR FAILS TO RUN	2.837E-2
EPS-DGN-FS-1A	DIESEL GENERATOR A FAILS TO START	2.891E-3
EPS-DGN-TM-1A	DIESEL GENERATOR 1A UNAVAILABLE DUE TO T&M	1.435E-2
EPS-DGN-TM-1B	DIESEL GENERATOR 1B UNAVAILABLE DUE TO T&M	1.435E-2
EPS-DGN-TM-DSDG	DEDICATED SHUTDOWN DIESEL GENERATOR UNAVAILABLE DUE TO T&M	1.435E-2
ESF-ASL-CF-SGLT	CCF - 9 OF 9 LEVEL TRANSMITTERS SGS	1.200E-3
ESW-MDP-TM-1A	ESW MDP 1A UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.324E-2
ESW-MDP-TM-1B	ESW MDP 1B UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.324E-2
ESW-TRN-TM-1B	ESW HEADER 1B UNAVAILABLE DUE TO TEST AND MAINTENANCE (PSA)	2.400E-3
HPI-XHE-XM-FB	OPERATOR FAILS TO INITIATE FEED AND BLEED COOLING	2.000E-2
HPI-XHE-XM-RECIRC	OPERATOR FAILS TO START HIGH PRESSURE RECIRC	2.000E-3
IE-LOMFW	LOSS OF MAIN FEEDWATER	1.000E+0
RCS-MDP-LK-BP1	RCP SEAL STAGE 1 INTEGRITY (BINDING/POPPING OPEN) FAILS	1.250E-2
RCS-MDP-LK-BP2	RCP SEAL STAGE 2 INTEGRITY (BINDING/POPPING OPEN) FAILS	2.000E-1
RHR-MDP-TM-1B	RHR MDP 1B UNAVAILABLE DUE TO TEST AND MAINTENANCE	5.154E-3
RHR-XHE-XM-CCW	OPERATOR FAILS TO ESTABLISH CCW FOR CL RECIRC	2.000E-3
RPS-ASL-FC-AMSAC	AMSAC FAILS	1.000E-2
RPS-BME-CF-RTBAB	CCF OF RTB-A AND RTB-B (MECHANICAL)	1.610E-6
RPS-CCX-CF-6OF8	CCF 6 ANALOG PROCESS LOGIC MODULES IN 3 OF 4 CHANNELS	1.830E-6
RPS-ROD-CF-RCCAS	CCF 10 OR MORE RCCAS FAIL TO DROP	1.210E-6
RPS-TXX-CF-6OF8	CCF 6 BISTABLES IN 3 OF 4 CHANNELS	2.700E-6
RPS-UVL-CF-UVDAB	CCF UV DRIVERS TRAINS A AND B (2 OF 2)	1.040E-5
RPS-XHE-XE-NSGNL	OPERATOR FAILS TO RESPOND WITH NO RPS SIGNAL PRESENT	5.000E-1
RPS-XHE-XE-SIGNL	OPERATOR FAILS TO RESPOND WITH RPS SIGNAL PRESENT	1.000E-2

Appendix B: Loss of Main Feedwater Event Tree

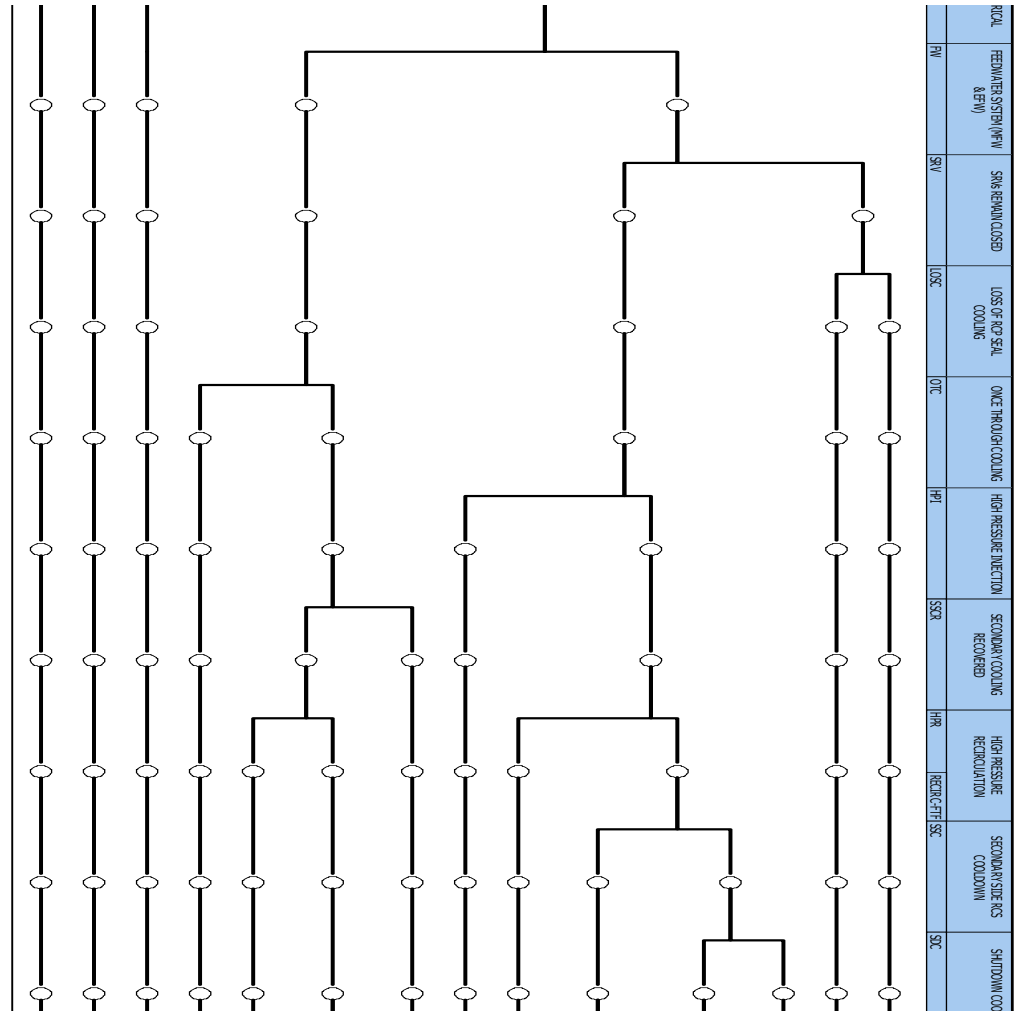


Figure B-1: Shearon Harris LOMFW Event Tree