Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

Joseph M. Farley Nuclear Plant, Unit 2	Manual Reactor Trip due to Loss of 2B Startup Auxiliary Transformer	
Event Date: 10/14/2014	**LER:** 364-2014-002 **IR:** 50-364/14-005	**CCDP =** 6×10^{-6}
Plant Type: Pressurized-Water Reactor (PWR) Westinghouse 3-Loop with Dry, Ambient Pressure Containment		
Plant Operating Mode (Reactor Power Level): Mode 1 (82% Reactor Power)		

Analyst:	**Reviewer:**	**Contributors:**	**BC Review Date:**
Jonathan DeJesus	David Aird	N/A	3/31/2016

EXECUTIVE SUMMARY

On October 14, 2014, while conducting planned maintenance on emergency diesel generator (EDG) 2B, a lighting strike in the Unit 2 switchyard caused the 2B startup auxiliary transformer (SAT) to de-energize. The 2B SAT and 2B EDG provide the normal and backup power, respectively, to the 2G 4160 V bus that supplies power to the B train component cooling water (CCW) pumps and other loads. Since the loss of the 2B SAT and the 2B EDG unavailability affected the on-service train (i.e., the B train) of CCW, operators followed procedures and manually tripped the reactor. The reactor trip resulted in a valid actuation of the auxiliary feedwater system (AFW).

According to the modeling assumptions used in this Accident Sequence Precursor (ASP) analysis, the most likely core damage sequence is a transient initiating event (IE-TRANS) followed by the failure of AFW, failure of main feedwater, and failure of feed and bleed cooling. This accident sequence accounts for approximately 63% of the conditional core damage probability (CCDP) for the event. This event was determined to be a precursor with a CCDP of 5.5×10^{-6}.

EVENT DETAILS

Event Description. On October 14, 2014, a lighting strike in the Unit 2 switchyard caused the 2B startup auxiliary transformer (SAT) to de-energize. The 2B SAT was the normal power supply to the 2G 4160 V bus that supplied power to the B train component cooling water (CCW) pumps and other loads. When the 2B SAT de-energized, power was lost to the B train CCW pumps that were aligned as the on-service train supplying cooling water to the reactor coolant pump (RCP) oil coolers and thermal barrier heat exchangers. Normally, the 2B emergency diesel generator (EDG) would automatically start and provide power to the B train CCW pumps. However, with the 2B EDG unavailable due to planned maintenance, there was no automatic power supply to the B train CCW pumps. Procedures directed the operators to manually trip the reactor and stop all RCPs if the on-service train of CCW was affected. Accordingly, the licensee manually tripped the reactor and stopped all RCPs. The reactor trip resulted in a valid actuation of the auxiliary feedwater system. All other safety systems responded as designed. Additional information is provided in Reference 1 (licensee event report) and Reference 2 (inspection report).

Causes. The direct cause of this event was a loose termination from a missing nut in the power circuit breaker (PCB) 944 current transformer circuit connection to the instantaneous overcurrent relay, which in addition to the continued fault on the 500 kV bus side of the PCB 112 led to the B train loss of site power. The root cause was inadequate verification practices during wiring installations that led to the nut not being installed on its terminal.

Inspection Report/Significance Determination Process Result. The inspectors reviewed the event and determined that the licensee failed to take actions to mitigate the increased risk of a reactor trip with the B train of CCW as the on-service train while the 2B EDG was unavailable due to planned maintenance. The result was a self-revealing, Green finding. This LER is closed.

MODELING ASSUMPTIONS

Analysis Type. The staff used version 8.21 of Farley's Units 1 and 2 Standardized Plant Analysis Risk (SPAR) model, created in September 2013, to perform the analysis (i.e., initiating event assessment). Farley's SPAR model is based on Unit 1, but the event occurred in Unit 2. Therefore, surrogate components in Unit 1 were adjusted to account for the equivalent equipment affected in Unit 2. This event was modeled as a general transient initiating event.

Analysis Rules. The ASP program uses Significance Determination Process results for degraded conditions when available and appropriate to meet ASP Program needs. In this case, while the inspection program classified this event as a Green finding, an ASP analysis was performed consistent with ASP Program practices and guidance to analyze all initiating events.

Key Modeling Assumptions. The analysis contains the following modeling assumptions and basic event probability changes:

- The probability of IE-TRANS (*General Transient Initiating Event*) was set to 1.0; all other initiating event probabilities were set to zero.
- Basic event ACP-TFM-FC-SUT1B (*230 to 4.2 kV Startup Transformer 1B Fails*) was set to TRUE.
- Basic event EPS-DGN-TM-DG1B (*Diesel Generator 1B Unavailable due to Test and Maintenance*) was set to TRUE.
- EDG 2C is designated as the station blackout (SBO) diesel and can supply power to Unit 1 or Unit 2 when the 1B or 2B EDG is not available. Basic event EPS-DG2C-UNIT2 (*Diesel 2C Required for SBO on Unit 2*) was set to FALSE because EDG 2C[1] was not required for an SBO event on the other unit (i.e., Unit 1, but modeled as Unit 2 in this analysis).

[1] The staff considered setting the test and maintenance basic event for EDG 2C (*EPS-DGN-TM-DG2C*) to FALSE. However, Farley's Technical Specifications (Reference 3 – see Condition E of Limiting Condition for Operation 3.8.1) do not preclude the licensee from placing EDG 2C in test and maintenance while another EDG is also undergoing test and maintenance. A sensitivity analysis was performed and it had a minimal reduction in CCDP.

ANALYSIS RESULTS

CCDP. The point estimate CCDP for this event is 5.5×10^{-6}. 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 main feedwater or loss of condenser heat sink, whichever is greater. This CCDP equivalent is 1.7×10^{-6} for both cases. Therefore, this event resulted in a precursor for Farley, Unit 2.

Dominant Sequence. The dominant accident sequence is TRANS Sequence 20 (CCDP = 3.5×10^{-6}) that contributes approximately 63% of the total internal events CCDP. Figure 1 in Appendix B illustrates this sequence. The cut sets and sequences that contribute to the top 95% and/or at least 1% of the total internal events CCDP are provided in Appendix A.

The events and component failures in TRANS Sequence 20 are:

- A transient occurs,
- Reactor trip succeeds,
- Auxiliary feedwater fails,
- Main feedwater fails, and
- Feed and bleed cooling fails.

REFERENCES

1. Southern Nuclear Operating Company, Inc., "Joseph M. Farley Nuclear Plant – Unit 2, Licensee Event Report 2014-002-00, Manual Reactor Trip due to Loss of 2B Startup Auxiliary Transformer and Loss of Offsite Power," dated December 12, 2014 (ML14346A391).

2. U.S. Nuclear Regulatory Commission, "Joseph M. Farley Nuclear Plant – NRC Integrated Inspection Report 05000348/2014005; and 05000364/2014005 and Exercise of Enforcement Discretion," dated February 9, 2015 (ML15040A564).

3. Appendix A, "Technical Specifications," to Joseph M. Farley Nuclear Plant, Unit 2 Renewed Facility Operating License No. NPF-8 (ML052780033[2]).

[2] Farley, Unit 2 uses the same Technical Specifications as Farley, Unit 1.

Appendix A: Analysis Results

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
ACP-TFM-FC-SUT1B	230 TO 4.2 KV STARTUP TRANSFORMER 1B FAILS	TRUE	2.27E-5
EPS-DG2C-UNIT2	DIESEL 2C REQUIRED FOR SBO ON UNIT 2	FALSE	1.14E-2
EPS-DGN-TM-DG1B	DG 1B UNAVAILABLE DUE TO TEST AND MAINTENANCE	TRUE	1.43E-2
IE-TRANS	TRANSIENT	1.00E+0[a]	6.90E-1

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

Dominant Sequence Results

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

Event Tree	Sequence	CCDP	% Contribution	Description
TRANS	20	3.49E-6	63.2%	/RPS, AFW, MFW, FAB
TRANS	21-16	8.78E-7	15.9%	RPS, RCSPRESS
TRANS	21-15	7.22E-7	13.1%	RPS, /RCSPRESS, MFW, AFW-A
TRANS	19	2.86E-7	5.2%	/RPS, AFW, MFW, /FAB, SSCR, HPR
TRANS	21-14	1.15E-7	2.1%	RPS, /RCSPRESS, MFW, /AFW-A, BORATION
Total		**5.52E-6**	**100.0%**	

Referenced Fault Trees

Fault Tree	Description
AFW	AUXILIARY FEEDWATER
AFW-A	AUXILIARY FEEDWATER SYSTEM
BORATION	EMERGENCY BORATION
FAB	FEED AND BLEED
HPR	HPR PRESSURE RECIRCULATION
MFW	MAIN FEEDWATER
RCSPRESS	RCS PRESSURE LIMITED
RPS	REACTOR TRIP
SSCR	SECONDARY SIDE COOLING RECOVERED

Cut Set Report - TRANS 20

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

#	CCDP	TOTAL%	CUT SET
	3.49E-6	100	
1	1.00E-6	28.71	IE-TRANS,ACP-BAC-LP-1F,EPS-DGN-FR-DG2C
2	6.66E-7	19.09	IE-TRANS,ACP-BAC-LP-1F,EPS-XHE-XM-STRT2C
3	4.78E-7	13.70	IE-TRANS,ACP-BAC-LP-1F,EPS-DGN-TM-DG2C
4	9.63E-8	2.76	IE-TRANS,ACP-BAC-LP-1F,EPS-DGN-FS-DG2C
5	9.45E-8	2.71	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,HPI-XHE-XM-FB
6	7.51E-8	2.15	IE-TRANS,AFW-ACX-CF-MDPABR,AFW-TDP-FR-P02,HPI-XHE-XM-FB
7	6.28E-8	1.80	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,HPI-XHE-XM-FB

#	CCDP	TOTAL%	CUT SET
8	6.15E-8	1.76	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,HPI-XHE-XM-FB
9	4.51E-8	1.29	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-TM-DG2C,HPI-XHE-XM-FB
10	4.09E-8	1.17	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,HPI-XHE-XM-FB
11	3.96E-8	1.13	IE-TRANS,ACP-BAC-LP-1K,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C
12	3.76E-8	1.08	IE-TRANS,AFW-MDP-CF-START,AFW-TDP-FR-P02,HPI-XHE-XM-FB

Cut Set Report - TRANS 21-16

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

#	CCDP	TOTAL%	CUT SET
	8.79E-7	100	
1	1.18E-7	13.42	IE-TRANS,PPR-MOV-FC-8000A,RPS-BME-CF-RTBAB
2	1.18E-7	13.42	IE-TRANS,PPR-MOV-FC-8000B,RPS-BME-CF-RTBAB
3	9.83E-8	11.19	IE-TRANS,PPR-MOV-FC-8000B,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
4	9.83E-8	11.19	IE-TRANS,PPR-MOV-FC-8000A,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
5	8.86E-8	10.08	IE-TRANS,PPR-MOV-FC-8000A,RPS-ROD-CF-RCCAS
6	8.86E-8	10.08	IE-TRANS,PPR-MOV-FC-8000B,RPS-ROD-CF-RCCAS
7	6.66E-8	7.59	IE-TRANS,PPR-MOV-FC-8000B,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
8	6.66E-8	7.59	IE-TRANS,PPR-MOV-FC-8000A,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
9	2.03E-8	2.31	IE-TRANS,RCS-PHN-MODPOOR,RCS-PHN-PL,RPS-BME-CF-RTBAB
10	1.69E-8	1.93	IE-TRANS,RCS-PHN-MODPOOR,RCS-PHN-PL,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
11	1.52E-8	1.74	IE-TRANS,RCS-PHN-MODPOOR,RCS-PHN-PL,RPS-ROD-CF-RCCAS
12	1.15E-8	1.31	IE-TRANS,RCS-PHN-MODPOOR,RCS-PHN-PL,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL

Cut Set Report - TRANS 21-15

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

#	CCDP	TOTAL%	CUT SET
	7.22E-7	100	
1	6.36E-8	8.81	IE-TRANS,AFW-TDP-FR-P02,RPS-BME-CF-RTBAB
2	5.31E-8	7.35	IE-TRANS,AFW-TDP-FR-P02,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
3	4.84E-8	6.71	IE-TRANS,EPS-DGN-FR-DG2C,RPS-BME-CF-RTBAB
4	4.78E-8	6.62	IE-TRANS,AFW-TDP-FR-P02,RPS-ROD-CF-RCCAS
5	4.04E-8	5.60	IE-TRANS,EPS-DGN-FR-DG2C,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
6	3.64E-8	5.04	IE-TRANS,EPS-DGN-FR-DG2C,RPS-ROD-CF-RCCAS
7	3.60E-8	4.98	IE-TRANS,AFW-TDP-FR-P02,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
8	3.22E-8	4.46	IE-TRANS,EPS-XHE-XM-STRT2C,RPS-BME-CF-RTBAB
9	2.74E-8	3.79	IE-TRANS,EPS-DGN-FR-DG2C,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL

#	CCDP	TOTAL%	CUT SET
10	2.69E-8	3.72	IE-TRANS,EPS-XHE-XM-STRT2C,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
11	2.42E-8	3.35	IE-TRANS,EPS-XHE-XM-STRT2C,RPS-ROD-CF-RCCAS
12	2.31E-8	3.20	IE-TRANS,EPS-DGN-TM-DG2C,RPS-BME-CF-RTBAB
13	1.93E-8	2.67	IE-TRANS,EPS-DGN-TM-DG2C,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
14	1.82E-8	2.52	IE-TRANS,EPS-XHE-XM-STRT2C,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
15	1.74E-8	2.40	IE-TRANS,EPS-DGN-TM-DG2C,RPS-ROD-CF-RCCAS
16	1.31E-8	1.81	IE-TRANS,EPS-DGN-TM-DG2C,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
17	1.05E-8	1.45	IE-TRANS,AFW-TDP-FS-P02,RPS-BME-CF-RTBAB
18	8.72E-9	1.21	IE-TRANS,AFW-TDP-FS-P02,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
19	8.68E-9	1.20	IE-TRANS,AFW-TDP-TM-P02,RPS-BME-CF-RTBAB
20	7.86E-9	1.09	IE-TRANS,AFW-TDP-FS-P02,RPS-ROD-CF-RCCAS
21	7.25E-9	1.00	IE-TRANS,AFW-TDP-TM-P02,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL

Cut Set Report - TRANS 19

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

#	CCDP	TOTAL%	CUT SET
	2.86E-7	100	
1	9.99E-9	3.49	IE-TRANS,DCP-BDC-LP-BUS1A,EAS-MDC-FR-M002A,EPS-DGN-FR-DG2C
2	9.45E-9	3.31	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,HPI-XHE-XM-RECIRC
3	7.51E-9	2.63	IE-TRANS,AFW-ACX-CF-MDPABR,AFW-TDP-FR-P02,HPI-XHE-XM-RECIRC
4	6.79E-9	2.37	IE-TRANS,DCP-BDC-LP-BUS1A,EPS-DGN-FR-DG2C,IAS-XHE-XM-EAS
5	6.70E-9	2.34	IE-TRANS,AFW-TDP-FR-P02,DCP-BDC-LP-BUS1A,EPS-DGN-FR-DG2C
6	6.64E-9	2.32	IE-TRANS,DCP-BDC-LP-BUS1A,EAS-MDC-FR-M002A,EPS-XHE-XM-STRT2C
7	6.28E-9	2.20	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,HPI-XHE-XM-RECIRC
8	6.15E-9	2.15	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,HPI-XHE-XM-RECIRC
9	4.76E-9	1.67	IE-TRANS,DCP-BDC-LP-BUS1A,EAS-MDC-FR-M002A,EPS-DGN-TM-DG2C
10	4.55E-9	1.59	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,RHR-MOV-CC-8812A
11	4.55E-9	1.59	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,RHR-MOV-CC-8811A
12	4.55E-9	1.59	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,HPI-MOV-CC-8706A
13	4.51E-9	1.58	IE-TRANS,DCP-BDC-LP-BUS1A,EPS-XHE-XM-STRT2C,IAS-XHE-XM-EAS
14	4.51E-9	1.58	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-TM-DG2C,HPI-XHE-XM-RECIRC

#	CCDP	TOTAL%	CUT SET
15	4.48E-9	1.57	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,RHR-MDP-FS-P1A
16	4.46E-9	1.56	IE-TRANS,AFW-TDP-FR-P02,DCP-BDC-LP-BUS1A,EPS-XHE-XM-STRT2C
17	4.09E-9	1.43	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,HPI-XHE-XM-RECIRC
18	3.76E-9	1.31	IE-TRANS,AFW-MDP-CF-START,AFW-TDP-FR-P02,HPI-XHE-XM-RECIRC
19	3.24E-9	1.13	IE-TRANS,DCP-BDC-LP-BUS1A,EPS-DGN-TM-DG2C,IAS-XHE-XM-EAS
20	3.20E-9	1.12	IE-TRANS,AFW-TDP-FR-P02,DCP-BDC-LP-BUS1A,EPS-DGN-TM-DG2C
21	3.03E-9	1.06	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,RHR-MOV-CC-8812A
22	3.03E-9	1.06	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,RHR-MOV-CC-8811A
23	3.03E-9	1.06	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,HPI-MOV-CC-8706A
24	2.98E-9	1.04	IE-TRANS,AFW-MDP-TM-P1A,AFW-TDP-FR-P02,EPS-XHE-XM-STRT2C,RHR-MDP-FS-P1A
25	2.96E-9	1.04	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,HPI-MOV-CC-8706A
26	2.96E-9	1.04	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,RHR-MOV-CC-8811A
27	2.96E-9	1.04	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,RHR-MOV-CC-8812A
28	2.94E-9	1.03	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-TM-DG2C,HPI-XHE-XM-RECIRC
29	2.91E-9	1.02	IE-TRANS,AFW-ACX-FR-MDPA,AFW-TDP-FR-P02,EPS-DGN-FR-DG2C,RHR-MDP-FS-P1A
30	2.90E-9	1.01	IE-TRANS,DCP-BDC-LP-BUS1A,EAS-MDC-FS-M002A,EPS-DGN-FR-DG2C

Cut Set Report - TRANS 21-14

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

#	CCDP	TOTAL%	CUT SET
	1.15E-7	100	
1	3.22E-8	28.01	IE-TRANS,CVC-XHE-XM-BOR,RPS-BME-CF-RTBAB
2	2.69E-8	23.37	IE-TRANS,CVC-XHE-XM-BOR,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
3	2.42E-8	21.05	IE-TRANS,CVC-XHE-XM-BOR,RPS-ROD-CF-RCCAS
4	1.82E-8	15.84	IE-TRANS,CVC-XHE-XM-BOR,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL
5	3.22E-9	2.80	IE-TRANS,CVC-XHE-XM-RWSTXF,RPS-BME-CF-RTBAB
6	2.69E-9	2.34	IE-TRANS,CVC-XHE-XM-RWSTXF,/RPS-CCP-TM-CHA,RPS-TXX-CF-6OF8,RPS-XHE-XE-NSGNL
7	2.42E-9	2.10	IE-TRANS,CVC-XHE-XM-RWSTXF,RPS-ROD-CF-RCCAS
8	2.08E-9	1.81	IE-TRANS,CVC-XHE-XM-BOR,RPS-UVL-CF-UVDAB,RPS-XHE-XE-SIGNL
9	1.82E-9	1.58	IE-TRANS,CVC-XHE-XM-RWSTXF,/RPS-CCP-TM-CHA,RPS-CCX-CF-6OF8,RPS-XHE-XE-NSGNL

Referenced Events

Event	Description	Probability
ACP-BAC-LP-1F	4160 VAC BUS 1F IS UNAVAILABLE	3.33E-5
ACP-BAC-LP-1K	4160 VAC BUS 1K IS UNAVAILABLE	3.33E-5
AFW-ACX-CF-MDPABR	MDAFW PUMP A & B ROOM COOLER FTR DUE TO COMMON CAUSE	9.50E-5
AFW-ACX-FR-MDPA	MDAFW PUMP A ROOM COOLER FTR DUE TO RANDOM FAULTS	2.59E-3
AFW-MDP-CF-START	CCF OF AFW MDPS TO START	4.76E-5
AFW-MDP-TM-P1A	AFW MDP UNAVAILABLE DUE TO TEST AND MAINTENANCE	3.98E-3
AFW-TDP-FR-P02	TURBINE DRIVEN FEED PUMP P02 FAILS TO RUN	3.95E-2
AFW-TDP-FS-P02	TURBINE DRIVEN FEED PUMP P02 FAILS TO START	6.49E-3
AFW-TDP-TM-P02	FEED PUMP P02 IS IN TEST OR MAINTENANCE	5.39E-3
CVC-XHE-XM-BOR	OPERATOR FAILS TO INITIATE EMERGENCY BORATION	2.00E-2
CVC-XHE-XM-RWSTXF	OPERATOR FAILS TO TRANSFER CHG SUCTN TO RWST ON LOCCW	2.00E-3
DCP-BDC-LP-BUS1A	125 VDC BUS 1A FAILS	5.64E-6
EAS-MDC-FR-M002A	EMERGENCY AIR COMPRESSOR Q1P18C002A FAILS TO RUN	5.89E-2
EAS-MDC-FS-M002A	EMERGENCY AIR COMPRESSOR Q1P18C002A FAILS TO START	1.71E-2
EPS-DGN-FR-DG2C	DIESEL GENERATOR 2C FAILS TO RUN	3.01E-2
EPS-DGN-FS-DG2C	DIESEL GENERATOR 2C FAILS TO START	2.89E-3
EPS-DGN-TM-DG2C	DG 2C UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.43E-2
EPS-XHE-XM-STRT2C	OPERATOR FAILS TO START/ALIGN DG 2C	2.00E-2
HPI-MOV-CC-8706A	HPR/RHR RECIRC SUCTN VLV 8706A FAILS TO OPEN	9.63E-4
HPI-XHE-XM-FB	OPERATOR FAILS TO INITIATE FEED AND BLEED COOLING	2.00E-2
HPI-XHE-XM-RECIRC	OPERATOR FAILS TO START HIGH PRESSURE RECIRC	2.00E-3
IAS-XHE-XM-EAS	OPERATOR FAILS TO ALIGN EMERGENCY AIR SYSTEM	4.00E-2
IE-TRANS	TRANSIENT	1.00E+0
PPR-MOV-FC-8000A	PORV 445A BLOCK VALVE IS CLOSED DURING FULL POWER	7.32E-2
PPR-MOV-FC-8000B	PORV 444B BLOCK VALVE IS CLOSED DURING FULL POWER	7.32E-2
RCS-PHN-MODPOOR	MODERATOR TEMP COEFFICIENT NOT ENOUGH NEGATIVE	1.40E-2
RCS-PHN-PL	POWER AT HIGH LEVEL	9.00E-1
RHR-MDP-FS-P1A	RHR PUMP 1A FAILS TO START	9.47E-4
RHR-MOV-CC-8811A	PUMP 1A SUMP INBOARD SUCTN VLV 8811A FAILS TO OPEN	9.63E-4
RHR-MOV-CC-8812A	PUMP 1A SUMP OUTBOARD SUCTN VLV 8812A FAILS TO OPEN	9.63E-4
RPS-BME-CF-RTBAB	CCF OF RTB-A AND RTB-B (MECHANICAL)	1.61E-6
RPS-CCX-CF-6OF8	CCF 6 ANALOG PROCESS LOGIC MODULES IN 3 OF 4 CHANNELS	1.83E-6
RPS-ROD-CF-RCCAS	CCF 10 OR MORE RCCAS FAIL TO DROP	1.21E-6
RPS-TXX-CF-6OF8	CCF 6 BISTABLES IN 3 OF 4 CHANNELS	2.70E-6
RPS-UVL-CF-UVDAB	CCF UV DRIVERS TRAINS A AND B (2 0F 2)	1.04E-5
RPS-XHE-XE-NSGNL	OPERATOR FAILS TO RESPOND WITH NO RPS SIGNAL PRESENT	5.00E-1
RPS-XHE-XE-SIGNL	OPERATOR FAILS TO RESPOND WITH RPS SIGNAL PRESENT	1.00E-2

Appendix B: Dominant Sequence

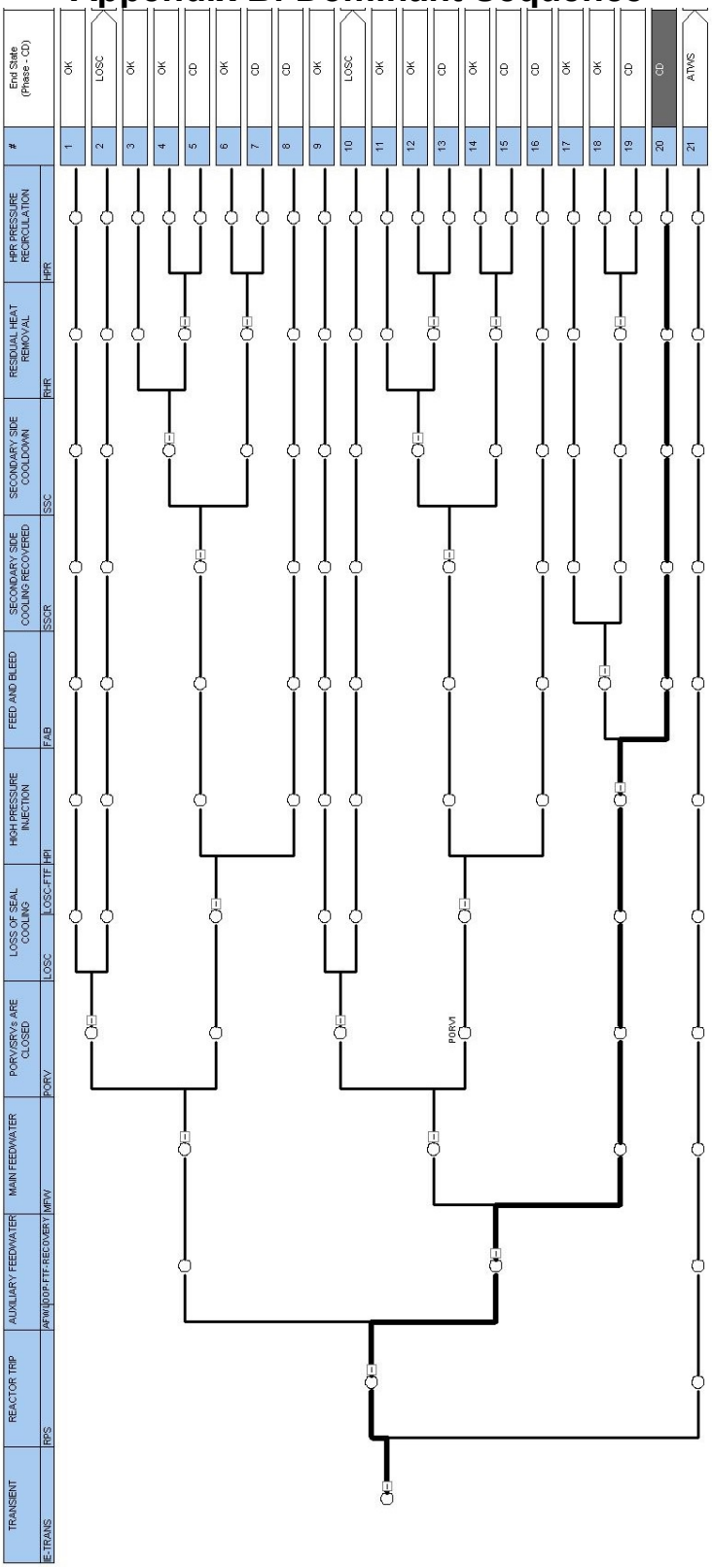

Figure 1: Dominant Sequence TRANS-20