

Final ASP Program Analysis - Reject

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research			
Nine Mile Point, Unit 1		Automatic Reactor Scram Due to Main Steam Isolation Valve Closure	
Event Date: 9/4/2015	LER: 220-2015-004 IR: 50-220/2015-003	CCDP= 6.7×10^{-8}	
Plant Type: General Electric BWR-2 with a Wet Mark I Containment			
Plant Operating Mode (Reactor Power Level): Mode 1 (100 Percent Reactor Power)			
Analyst: David Aird	Reviewer: Keith Tetter	Contributors: N/A	BC Approved Date: 6/7/2016

EVENT DETAILS

Event Description. On September 4, 2015, Unit 1 at Nine Mile Point automatically scrambled due to an inadvertent Main Steam Isolation Valve (MSIV) isolation. At the time, the reactor was operating at 100% rated power. During the event, the feed and condensate pumps operated as designed and restored reactor water level to the normal level set point. The Emergency Condensers were initially utilized to maintain reactor pressure due to the MSIV isolation. Later, the Turbine Bypass Valves were utilized for pressure control following the restoration of Main Steam Line 12. Additional information is provided in LER 220-2015-004 (Ref. 1).

During the initial transient, one Solenoid-Actuated Relief Valve (ERV), ERV-122, lifted in response to the reactor pressure increase, as designed. A rapid isolation due to MSIV closure or turbine trip without bypass will open the ERVs for a short time (10-15 seconds) to reverse the pressure transient. After the scram, ERV-122 failed to fully reseat after pressure lowered below its lift setpoint. Proceduralized operator action was required to manually close ERV-122 due to lowering reactor pressure and increasing torus temperature. Nine Mile Point has six total ERVs - three per main steam line downstream of the flow restrictor and upstream of the MSIV.

Cause. While testing the second of two MSIVs, MSIV-112 failed to stop its close stroke and reopen automatically per design. The full closure of MSIV-112 caused steam flow in the opposite main steam line to rise to the high steam flow setpoint and caused a Reactor Protection System Main Steam Line Isolation signal. The closure of the remaining MSIVs caused an automatic reactor scram.

MODELING

Basis for ASP Analysis/SDP Results. The ASP Program uses Significance Determination Process (SDP) results for degraded conditions when available and applicable. 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.¹

¹ 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.

In Inspection Report (IR) 05000220/2015003 (Ref. 2), Section 4OA3, the inspectors reviewed the event and follow-up actions by the licensee. No findings were identified at the time. This LER is not yet closed.

An independent ASP analysis is required because this was an initiating event (reactor scram due to MSIV closure) with the failure of an additional component (ERV-122).

Analysis Type. An initiating event analysis was performed using the Nine Mile Point Unit 1 Standardized Plant Analysis Risk (SPAR) model Revision 8.21, created in May 2014.

SPAR Model Modifications. No SPAR model modifications were needed to perform this analysis.

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

- 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 MSS-MSV-OC-STEAM (*Steam Loop Valves Fail to Remain Open*) was set to TRUE because the MSIVs closed. Main Steam Line 12 was restored later in the event to enable utilization of the Turbine Bypass Valves to the condenser. This action was not modeled in this bounding analysis.
- Basic event PPR-SRV-OO-1VLV (*One SRV Sticks Open*) was set to TRUE because ERV-122 failed to reseal after pressure lowered below its lift setpoint. Operators, following procedure, manually closed ERV-122 fifteen minutes after the scram to stabilize reactor pressure and torus temperature. This recovery action was not modeled in this bounding analysis. The effect of one SRV sticking open is minimal in all cases except for station blackout.
- All other safety systems responded as designed.

ANALYSIS RESULTS

CCDP/Rejection Basis. The conditional core damage probability (CCDP) for this analysis is 6.7×10^{-8} . The ASP Program threshold is a CCDP of 1×10^{-6} . Therefore, this event is not a precursor and is screened out of the ASP Program.

Dominant Sequence. The dominant accident sequence is Transient (TRANS) Sequence 56-11 (CCDP = 4.1×10^{-8}) that contributes approximately 61% of the total internal events CCDP. This is an Anticipated Transient without Scram (ATWS) scenario. Figure 1 in Appendix B illustrates this sequence showing the ATWS event tree. 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 events and important component/system failures in TRANS Sequence 56-11 are:

- A plant transient occurs,
- Reactor protection system fails,
- Safety relief valve(s) fail to open.

REFERENCES

1. Nine Mile Point Nuclear Station, "LER 220-2015-004 – Automatic Reactor Scram Due to Main Steam Isolation Valve Closure," dated November 3, 2015 (ML15331A038).
2. U.S. Nuclear Regulatory Commission, "Nine Mile Point Nuclear Station, LLC – NRC Integrated Inspection Report 05000220/2015003," dated November 9, 2015 (ML15314A506).

Appendix A: SAPHIRE 8 Worksheet

Summary of Conditional Event Changes

Event	Description	Cond Value	Nominal Value
IE-TRANS	GENERAL PLANT TRANSIENT	1.00E+0 ^a	7.62E-1
MSS-MSV-OC-STEAM	STEAM LOOP VALVES FAIL TO REMAIN OPEN	True	9.22E-6
PPR-SRV-OO-1VLV	ONE SRV STICKS OPEN	True	8.56E-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.

<u>EVENT TREE</u>	<u>SEQUENCE</u>	<u>CCDP</u>	<u>% CONTRIBUTION</u>	<u>DESCRIPTION</u>
TRANS	56-11	4.05E-8	60.6%	RPS, PPR
TRANS	56-07	9.76E-9	14.6%	RPS, /PPR, /RRS, PC1, /SLC, /NX, TAF
TRANS	56-09	5.12E-9	7.6%	RPS, /PPR, /RRS, PC1, SLC
TRANS	53	3.20E-9	4.8%	/RPS, /SRV, ISO, MFW, DEP, CRD
TRANS	56-06-15	2.47E-9	3.7%	RPS, /PPR, /RRS, PC1, /SLC, /NX, /TAF, DE1
TRANS	56-06-07	2.44E-9	3.6%	RPS, /PPR, /RRS, PC1, /SLC, /NX, /TAF, /DE1, /LCS, LVL
TRANS	56-08	2.44E-9	3.6%	RPS, /PPR, /RRS, PC1, /SLC, NX
TRANS	56-10	9.42E-10	1.4%	RPS, /PPR, RRS
Total		6.69E-8	100.0%	

Referenced Fault Trees

Fault Tree	Description
CRD	CRD INJECTION (2 PUMP)
DE1	MANUAL REACTOR DEPRESS
DEP	MANUAL REACTOR DEPRESS
ISO	ISOLATION CONDENSER
LVL	RESTORE LEVEL AND PREVENT OVERFILL
MFW	FEEDWATER
NX	INHIBIT ADS
PC1	POWER CONVERSION SYSTEM
PPR	SRV'S OPEN
RPS	REACTOR PROTECTION SYSTEM
RRS	RECIRC PUMP TRIP
SLC	STANDBY LIQUID CONTROL
TAF	TRANSFER BRANCH ATWS-1

Cut Set Report - TRANS 56-11

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

#	<u>CCDP</u>	<u>TOTAL%</u>	<u>CUT SET</u>
	4.06E-8	100	Displaying 24 Cut Sets. (24 Original)
1	4.71E-9	11.61	IE-TRANS,PPR-SRV-CC-SRV5,RPS-SYS-FC-PSOVS
2	4.71E-9	11.61	IE-TRANS,PPR-SRV-CC-SRV6,RPS-SYS-FC-PSOVS
3	4.71E-9	11.61	IE-TRANS,PPR-SRV-CC-SRV3,RPS-SYS-FC-PSOVS
4	4.71E-9	11.61	IE-TRANS,PPR-SRV-CC-SRV1,RPS-SYS-FC-PSOVS
5	4.71E-9	11.61	IE-TRANS,PPR-SRV-CC-SRV2,RPS-SYS-FC-PSOVS
6	4.71E-9	11.61	IE-TRANS,PPR-SRV-CC-SRV4,RPS-SYS-FC-PSOVS
7	1.05E-9	2.60	IE-TRANS,PPR-SRV-CC-SRV5,RPS-SYS-FC-RELAY
8	1.05E-9	2.60	IE-TRANS,PPR-SRV-CC-SRV6,RPS-SYS-FC-RELAY
9	1.05E-9	2.60	IE-TRANS,PPR-SRV-CC-SRV3,RPS-SYS-FC-RELAY

#	CCDP	TOTAL%	CUT SET
10	1.05E-9	2.60	IE-TRANS,PPR-SRV-CC-SRV1,RPS-SYS-FC-RELAY
11	1.05E-9	2.60	IE-TRANS,PPR-SRV-CC-SRV2,RPS-SYS-FC-RELAY
12	1.05E-9	2.60	IE-TRANS,PPR-SRV-CC-SRV4,RPS-SYS-FC-RELAY
13	6.93E-10	1.71	IE-TRANS,PPR-SRV-CC-SRV5,RPS-SYS-FC-CRD
14	6.93E-10	1.71	IE-TRANS,PPR-SRV-CC-SRV6,RPS-SYS-FC-CRD
15	6.93E-10	1.71	IE-TRANS,PPR-SRV-CC-SRV3,RPS-SYS-FC-CRD
16	6.93E-10	1.71	IE-TRANS,PPR-SRV-CC-SRV1,RPS-SYS-FC-CRD
17	6.93E-10	1.71	IE-TRANS,PPR-SRV-CC-SRV2,RPS-SYS-FC-CRD
18	6.93E-10	1.71	IE-TRANS,PPR-SRV-CC-SRV4,RPS-SYS-FC-CRD

Cut Set Report - TRANS 56-07

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

#	CCDP	TOTAL%	CUT SET
Total	9.76E-9	100	Displaying 4 Cut Sets. (4 Original)
1	6.80E-9	69.67	IE-TRANS,OPR-XHE-CTRL-TAF,RPS-SYS-FC-PSOVS
2	1.52E-9	15.57	IE-TRANS,OPR-XHE-CTRL-TAF,RPS-SYS-FC-RELAY
3	1.00E-9	10.25	IE-TRANS,OPR-XHE-CTRL-TAF,RPS-SYS-FC-CRD
4	4.40E-10	4.51	IE-TRANS,OPR-XHE-CTRL-TAF,RPS-SYS-FC-HCU

Cut Set Report - TRANS 56-09

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

#	CCDP	TOTAL%	CUT SET
	5.12E-9	100	Displaying 12 Cut Sets. (12 Original)
1	3.40E-9	66.42	IE-TRANS,RPS-SYS-FC-PSOVS,SLC-XHE-XM-ERROR
2	7.60E-10	14.85	IE-TRANS,RPS-SYS-FC-RELAY,SLC-XHE-XM-ERROR
3	5.00E-10	9.77	IE-TRANS,RPS-SYS-FC-CRD,SLC-XHE-XM-ERROR
4	2.20E-10	4.30	IE-TRANS,RPS-SYS-FC-HCU,SLC-XHE-XM-ERROR
5	1.09E-10	2.13	IE-TRANS,RPS-SYS-FC-PSOVS,SLC-EPV-CF-VALVS

Cut Set Report - TRANS 53

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

#	CCDP	TOTAL%	CUT SET
	3.20E-9	100	Displaying 18 Cut Sets. (18 Original)
1	1.00E-9	31.25	IE-TRANS,ADS-XHE-XM-MDEPR,ISO-XHE-XM-ERROR,MFW-XHE-XO-ERROR
2	9.51E-10	29.72	IE-TRANS,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP2,ISO-XHE-XM-ERROR
3	9.51E-10	29.72	IE-TRANS,ADS-XHE-XM-MDEPR,CDS-AOV-CC-MKUP1,ISO-XHE-XM-ERROR

Cut Set Report - TRANS 56-06-15

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

#	CCDP	TOTAL%	CUT SET
Total	2.47E-9	100	Displaying 5 Cut Sets. (5 Original)
1	1.70E-9	68.96	IE-TRANS,ADS-XHE-XM-MDEP1,RPS-SYS-FC-PSOVS
2	3.80E-10	15.41	IE-TRANS,ADS-XHE-XM-MDEP1,RPS-SYS-FC-RELAY
3	2.50E-10	10.14	IE-TRANS,ADS-XHE-XM-MDEP1,RPS-SYS-FC-CRD
4	1.10E-10	4.46	IE-TRANS,ADS-XHE-XM-MDEP1,RPS-SYS-FC-HCU
5	2.53E-11	1.03	IE-TRANS,ADS-SRV-CF-VALV1,RPS-SYS-FC-PSOVS

Cut Set Report - TRANS 56-06-07*Only items contributing at least 1% to the total are displayed.*

#	CCDP	TOTAL%	CUT SET
Total	2.44E-9	100	Displaying 4 Cut Sets. (4 Original)
1	1.70E-9	69.67	IE-TRANS,OPR-XHE-NOOVRFIL,RPS-SYS-FC-PSOVS
2	3.80E-10	15.57	IE-TRANS,OPR-XHE-NOOVRFIL,RPS-SYS-FC-RELAY
3	2.50E-10	10.25	IE-TRANS,OPR-XHE-NOOVRFIL,RPS-SYS-FC-CRD
4	1.10E-10	4.51	IE-TRANS,OPR-XHE-NOOVRFIL,RPS-SYS-FC-HCU

Cut Set Report - TRANS 56-08*Only items contributing at least 1% to the total are displayed.*

#	CCDP	TOTAL%	CUT SET
Total	2.44E-9	100	Displaying 4 Cut Sets. (4 Original)
1	1.70E-9	69.67	IE-TRANS,OPR-XHE-ADSIHIB,RPS-SYS-FC-PSOVS
2	3.80E-10	15.57	IE-TRANS,OPR-XHE-ADSIHIB,RPS-SYS-FC-RELAY
3	2.50E-10	10.25	IE-TRANS,OPR-XHE-ADSIHIB,RPS-SYS-FC-CRD
4	1.10E-10	4.51	IE-TRANS,OPR-XHE-ADSIHIB,RPS-SYS-FC-HCU

Cut Set Report - TRANS 56-10*Only items contributing at least 1% to the total are displayed.*

#	CCDP	TOTAL%	CUT SET
Total	9.42E-10	100	Displaying 15 Cut Sets. (15 Original)
1	1.37E-10	14.59	IE-TRANS,RPS-SYS-FC-PSOVS,RRS-CRB-CF-PUMP1
2	1.37E-10	14.59	IE-TRANS,RPS-SYS-FC-PSOVS,RRS-CRB-CF-PUMP2
3	1.37E-10	14.59	IE-TRANS,RPS-SYS-FC-PSOVS,RRS-CRB-CF-PUMP3
4	1.37E-10	14.59	IE-TRANS,RPS-SYS-FC-PSOVS,RRS-CRB-CF-PUMP4
5	1.37E-10	14.59	IE-TRANS,RPS-SYS-FC-PSOVS,RRS-CRB-CF-PUMP5
6	3.07E-11	3.26	IE-TRANS,RPS-SYS-FC-RELAY,RRS-CRB-CF-PUMP1
7	3.07E-11	3.26	IE-TRANS,RPS-SYS-FC-RELAY,RRS-CRB-CF-PUMP2
8	3.07E-11	3.26	IE-TRANS,RPS-SYS-FC-RELAY,RRS-CRB-CF-PUMP3
9	3.07E-11	3.26	IE-TRANS,RPS-SYS-FC-RELAY,RRS-CRB-CF-PUMP4
10	3.07E-11	3.26	IE-TRANS,RPS-SYS-FC-RELAY,RRS-CRB-CF-PUMP5
11	2.02E-11	2.15	IE-TRANS,RPS-SYS-FC-CRD,RRS-CRB-CF-PUMP1
12	2.02E-11	2.15	IE-TRANS,RPS-SYS-FC-CRD,RRS-CRB-CF-PUMP2
13	2.02E-11	2.15	IE-TRANS,RPS-SYS-FC-CRD,RRS-CRB-CF-PUMP3
14	2.02E-11	2.15	IE-TRANS,RPS-SYS-FC-CRD,RRS-CRB-CF-PUMP4
15	2.02E-11	2.15	IE-TRANS,RPS-SYS-FC-CRD,RRS-CRB-CF-PUMP5

Referenced Events

Event	Description	Probability
ADS-SRV-CF-VALV1	ADS VALVES FAIL FROM COMMON CAUSE	1.49E-5
ADS-XHE-XM-MDEP1	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR	1.00E-3
ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR	1.00E-3
CDS-AOV-CC-MKUP1	HOTWELL LEVEL CONTROL VALVE 1 FAILS	9.51E-4
CDS-AOV-CC-MKUP2	HOTWELL LEVEL CONTROL VALVE 2 FAILS	9.51E-4
IE-TRANS	GENERAL PLANT TRANSIENT	1.00E+0
ISO-XHE-XM-ERROR	OPERATOR FAILS TO CONTROL ISOLATION CONDENSER COOLING	1.00E-3
MFV-XHE-XO-ERROR	OPERATOR FAILS TO START/CONTROL FEEDWATER INJECTION	1.00E-3
OPR-XHE-ADSIHIB	OPERATOR FAILS TO INHIBIT ADS	1.00E-3
OPR-XHE-CTRL-TAF	OPERATOR FAILS TO CONTROL LEVEL TO TAF	4.00E-3
OPR-XHE-NOOVRFIL	OPERATOR FAILS TO CONTROL LEVEL	1.00E-3
PPR-SRV-CC-SRV1	SAFETY RELIEF VALVE FAILS TO OPEN	2.77E-3
PPR-SRV-CC-SRV2	SAFETY RELIEF VALVE FAILS TO OPEN	2.77E-3

PPR-SRV-CC-SRV3	SAFETY RELIEF VALVE FAILS TO OPEN	2.77E-3
PPR-SRV-CC-SRV4	SAFETY RELIEF VALVE FAILS TO OPEN	2.77E-3
PPR-SRV-CC-SRV5	SAFETY RELIEF VALVE FAILS TO OPEN	2.77E-3
PPR-SRV-CC-SRV6	SAFETY RELIEF VALVE FAILS TO OPEN	2.77E-3
RPS-SYS-FC-CRD	CONTROL ROD DRIVE MECHANICAL FAILURE	2.50E-7
RPS-SYS-FC-HCU	HCU COMPONENTS FAIL	1.10E-7
RPS-SYS-FC-PSOVS	HCU SCRAM PILOT SOVS FAIL	1.70E-6
RPS-SYS-FC-RELAY	TRIP SYSTEM RELAYS FAIL	3.80E-7
RRS-CRB-CF-PUMP1	RECIRC PUMP 1 BREAKERS FAIL FROM COMMON CAUSE	8.09E-5
RRS-CRB-CF-PUMP2	RECIRC PUMP 2 BREAKERS FAIL FROM COMMON CAUSE	8.09E-5
RRS-CRB-CF-PUMP3	RECIRC PUMP 3 BREAKERS FAIL FROM COMMON CAUSE	8.09E-5
RRS-CRB-CF-PUMP4	RECIRC PUMP 4 BREAKERS FAIL FROM COMMON CAUSE	8.09E-5
RRS-CRB-CF-PUMP5	RECIRC PUMP 5 BREAKERS FAIL FROM COMMON CAUSE	8.09E-5
SLC-EPV-CF-VALVS	SLC SQUIB VALVES FAIL BY COMMON CAUSE	6.42E-5
SLC-XHE-XM-ERROR	OPERATOR FAILS START/CONTROL SLC	2.00E-3

Appendix B: Key Event Tree

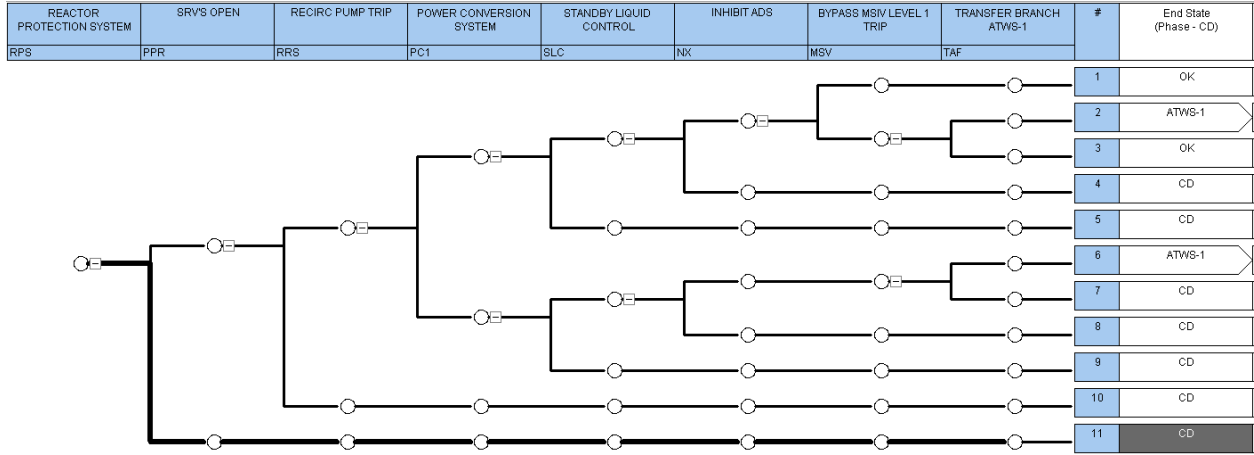


Figure 1: Nine Mile Point General Plant Transient Event Tree (Sequence 56-11 Bolded)