# Accident Sequence Precursor Program Event Analysis

LER No: 286/88-002
Event Description: Plant trip and one of three AFW pumps fails
Date of Event: March 31, 1988
Plant: Indian Point Unit 3

Summary

While at 100% power, a main boiler feed pump tripped due to maintenance activities, which subsequently caused an automatic plant trip. Both motor-driven auxiliary feedwater pumps started as designed; however, one tripped on overcurrent as a result of excessive flow caused by a damaged flow controller. The conditional probability of core damage estimated for the event is 1.0×10^{-5}. The relative significance of this event compared to other potential events is shown below.
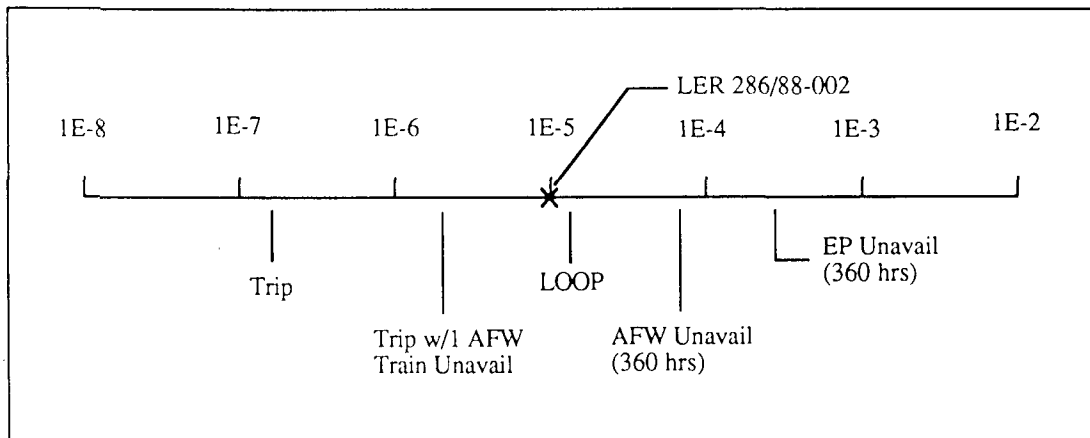
Event Description

During routine maintenance operations, cycling of main feedwater recirculation valve FCV-1116 for MFW pump 32 was performed to test a faulty limit switch on the valve operator. The cycling was performed with the isolation valve closed, causing a water hammer. The water hammer vibration caused MFW pump 32 to trip off when a false "discharge valve not fully open" signal was generated.

The operators took manual control of the plant and started AFW pumps 31 and 33. Turbine runback was also initiated. SG levels initially decreased and then began to increase. The operators were unable to prevent a plant trip on high SG level in SG 31. During the post-trip recovery, AFWP 33 tripped on overcurrent. The operators had previously closed its recirculation valve to control the flow. When the valve was

placed in auto operation, it erroneously opened full due to undetected damage to its flow controller (broken glass faceplate, cause unknown). The subsequent runout flow condition caused the pump to trip on over-current.

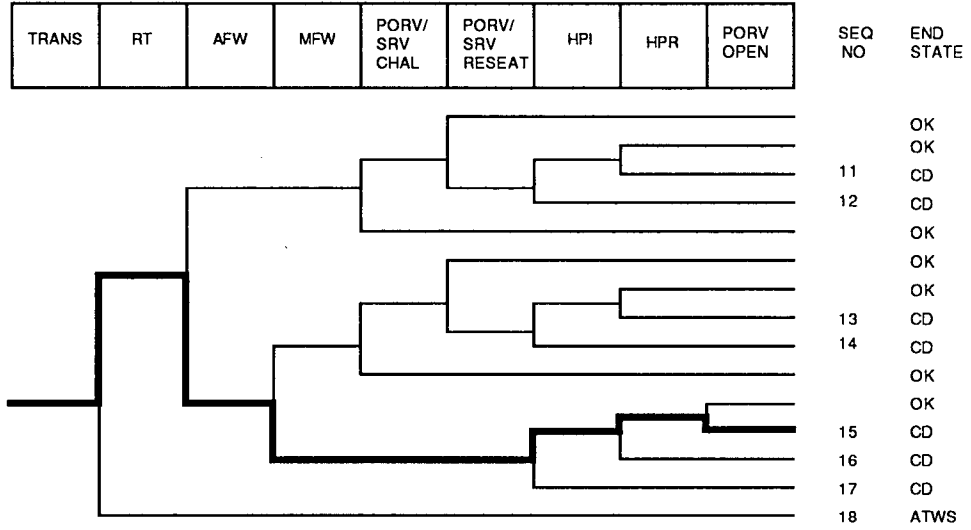## Event-Related Plant Design Information

Indian Point 3 has three auxiliary feedwater trains. Two of these trains are motor driven and one is turbine driven. The turbine-driven auxiliary feedwater pump was available during the trip had it been required.

ASP Modeling Assumptions and Approach

The event has been modeled as a transient with main feedwater unavailable and one of three auxiliary feedwater trains failed.

Analysis Results

The conditional probability of core damage associated with the event is estimated at 1.0×10^{-5}. The dominant sequence involves unavailability of AFW ($p = 1.4 \times 10^{-3}$), failure to recover main feedwater ($p = 0.34$), and failure of feed and bleed ($p = 0.02$). This sequence is highlighted on the following event tree.

TRANS	RT	AFW	MFW	PORV/ SRV CHAL	PORV/ SRV RESEAT	HPI	HPR	PORV OPEN	SEQ NO	END STATE

										OK
										OK
									11	CD
									12	CD
										OK
										OK
										OK
									13	CD
									14	CD
										OK
										OK
									15	CD
									16	CD
									17	CD
									18	ATWS

Dominant Core Damage Sequence for LER 286/88-002

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 286/88-002
Event Description: Trip and one AFW pump fails to run
Event Date: 03/31/88
Plant: Indian Point 3

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS   1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

      End State/Initiator   Probability

CD

    TRANS   1.0E-05

    Total   1.0E-05

ATWS

    TRANS   3.4E-05

    Total   3.4E-05

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
15	trans -rt AFW MFW -hpi(f/b) -hpr/-hpi porv.open	CD	4.8E-06	8.8E-02
17	trans -rt AFW MFW hpi(f/b)	CD	4.8E-06	7.4E-02
16	trans -rt AFW MFW -hpi(f/b) hpr/-hpi	CD	5.3E-07	8.8E-02
11	trans -rt -AFW porv.or.srv.chall porv.or.srv.reseat -hpi hpr/ -hpi	CD	1.0E-08	1.1E-02
12	trans -rt -AFW porv.or.srv.chall porv.or.srv.reseat hpi	CD	2.2E-09	9.2E-03
13	trans -rt AFW -MFW porv.or.srv.chall porv.or.srv.reseat -hpi hpr/-hpi	CD	9.2E-12	1.9E-03
14	trans -rt AFW -MFW porv.or.srv.chall porv.or.srv.reseat hpi	CD	2.0E-12	1.6E-03
18	trans rt	ATWS	3.4E-05	1.2E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
11	trans -rt -AFW porv.or.srv.chall porv.or.srv.reseat -hpi hpr/ -hpi	CD	1.0E-08	1.1E-02
12	trans -rt -AFW porv.or.srv.chall porv.or.srv.reseat hpi	CD	2.2E-09	9.2E-03
13	trans -rt AFW -MFW porv.or.srv.chall porv.or.srv.reseat -hpi hpr/-hpi	CD	9.2E-12	1.9E-03
14	trans -rt AFW -MFW porv.or.srv.chall porv.or.srv.reseat hpi	CD	2.0E-12	1.6E-03
15	trans -rt AFW MFW -hpi(f/b) -hpr/-hpi porv.open	CD	4.8E-06	8.8E-02
16	trans -rt AFW MFW -hpi(f/b) hpr/-hpi	CD	5.3E-07	8.8E-02
17	trans -rt AFW MFW hpi(f/b)	CD	4.8E-06	7.4E-02
18	trans rt	ATWS	3.4E-05	1.2E-01

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\sealmod\pwrbseal.cmp
BRANCH MODEL: c:\asp\sealmod\indpoint.sll
PROBABILITY FILE: c:\asp\sealmod\pwr_bsll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Event Identifier: 286/88-002

Branch	System		Non-Recov	Opr Fail
trans	4.6E-04		1.0E+00	
loop	3.1E-05		1.7E-01	
loca	2.4E-06		4.3E-01	
rt	2.8E-04		1.2E-01	
rt/loop	0.0E+00		1.0E+00	
emerg.power	5.4E-04		8.0E-01	
AFW	3.8E-04 >	5.3E-03	2.6E-01	
Branch Model: 1.OF.3+ser				
Train 1 Cond Prob:	2.0E-02 >	Failed		
Train 2 Cond Prob:	1.0E-01			
Train 3 Cond Prob:	5.0E-02			
Serial Component Prob:	2.8E-04			
afw/emerg.power	5.0E-02		3.4E-01	
MFW	2.0E-01 >	1.0E+00	3.4E-01	
Branch Model: 1.OF.1				
Train 1 Cond Prob:	2.0E-01 >	Unavailable		
porv.or.srv.chall	4.0E-02		1.0E+00	
porv.or.srv.reseat	2.0E-02		1.1E-02	
porv.or.srv.reseat/emerg.power	2.0E-02		1.0E+00	
seal.loca	2.1E-01		1.0E+00	
ep.rec(sl)	6.0E-01		1.0E+00	
ep.rec	5.6E-02		1.0E+00	
hpi	3.0E-04		8.4E-01	
hpi(f/b)	3.0E-04		8.4E-01	1.0E-02
hpr/-hpi	1.5E-04		1.0E+00	1.0E-03
porv.open	1.0E-02		1.0E+00	4.0E-04

  * branch model file
  ** forced

Minarick
11-13-1989
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Event Identifier: 286/88-002