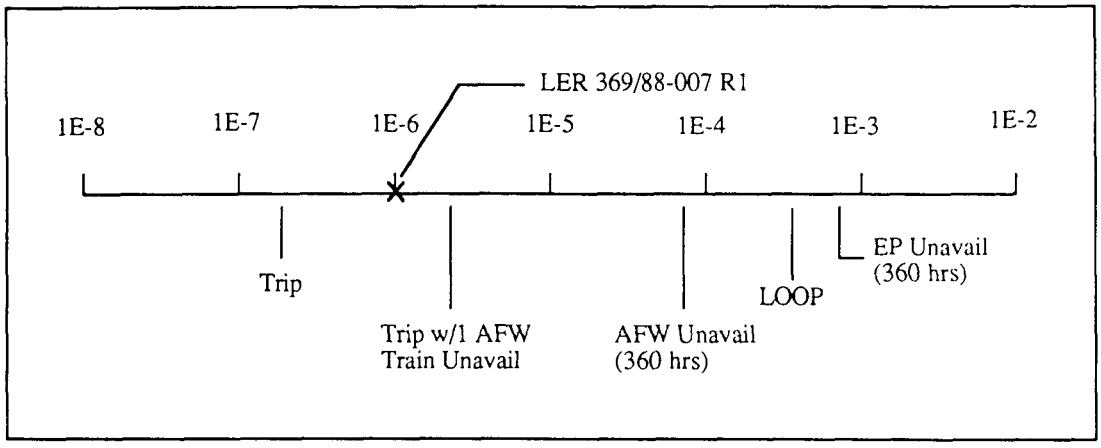
Accident Sequence Precursor Program Event Analysis

LER No.: 369/88-007 R1
Event Description: Trip and the turbine-driven AFW pump fails to start
Date of Event: April 16, 1988
Plant: McGuire Unit 1

Summary

While at 100% power, a feedwater regulating valve spuriously closed, causing a steam generator level decrease. Recognizing an imminent automatic trip, operators manually tripped the turbine generator and the reactor. Following the trip, the turbine auxiliary feedwater pump failed to start as designed. The conditional probability for core damage has been calculated at 1.0×10^{-6}. The relative significance of this event compared with other potential events at McGuire 1 is shown below.



Event Description

While at 100% power, the controller card for the power supply to valve 1CF-20 failed, causing the valve to close. This valve closure caused the level in the steam generator 1C to decrease at the rate of 25% per minute. Recognizing that the unit would trip on low steam generator signal, operators manually tripped the turbine generator, which subsequently tripped the reactor. On reactor trip, the main feedwater valves closed and auxiliary feedwater was initiated; however, the turbine-driven auxiliary feedwater failed when the steam supply failed to actuate due to damage to the valve 1SA49 limit switch. This damage was caused by valve packing leakage.

Corrective actions included replacing the power controller card for valve 1CF-20 and the limit switch for valve 1SA-49.

Event-Related Plant Design Information

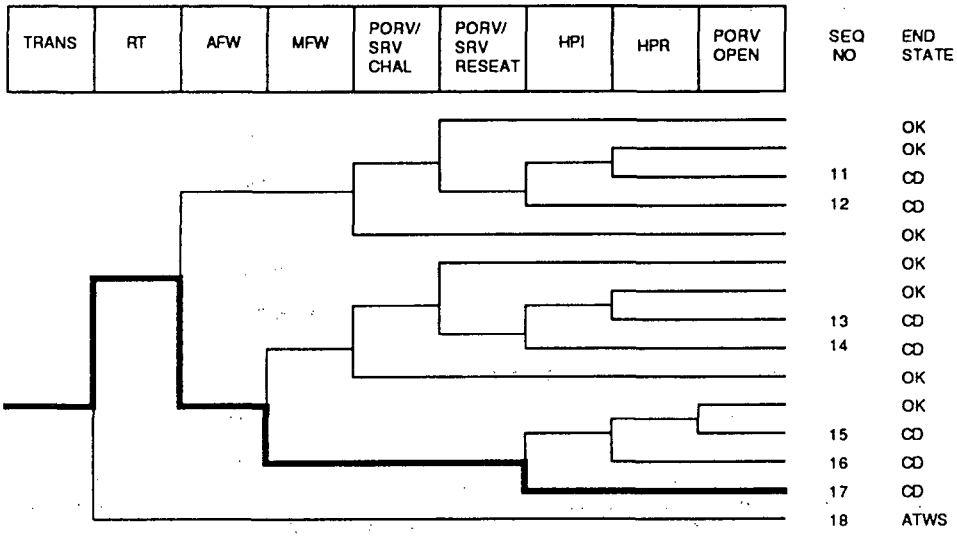
The main feedwater system includes a feedwater regulating valve and an isolation valve in the flow path to each steam generator. These valves are designed to fail in the closed position. If either valve fails closed during full-power operation, the water level in the affected steam generator would begin to rapidly decrease.

ASP Modeling Assumptions and Approach

This event has been modeled as a trip with the turbine-driven auxiliary feedwater pump failed.

Analysis Results

The conditional probability of core damage is estimated to be 1.0×10^{-6}. The dominant core damage sequence (highlighted on the following event tree) is associated with a failure of the remaining trains of AFW ($p = 6.0 \times 10^{-4}$), failure to reinitiate main feedwater ($p = 0.071$), and failure of feed and bleed ($p = 0.012$).



Dominant Core Damage Sequence for LER 369/88-007 R1

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 369/88-007
Event Description: Trip and the turbine-driven AFW train fails to start
Event Date: 04/16/88
Plant: McGuire 1

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	1.0E-06
Total	1.0E-06
ATWS	
TRANS	3.4E-05
Total	3.4E-05

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
17	trans -rt AFW mfw hpi(f/b)	CD	5.0E-07	1.5E-02
15	trans -rt AFW mfw -hpi(f/b) -hpr/-hpi porv.open	CD	4.3E-07	1.8E-02
16	trans -rt AFW mfw -hpi(f/b) hpr/-hpi	CD	4.8E-08	1.8E-02
11	trans -rt -AFW porv.or.srv.chall porv.or.srv.reseat -hpi hpr/-hpi	CD	1.5E-08	1.1E-02
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	1.5E-08	1.1E-02
15	trans -rt AFW mfw -hpi(f/b) -hpr/-hpi porv.open	CD	4.3E-07	1.8E-02
16	trans -rt AFW mfw -hpi(f/b) hpr/-hpi	CD	4.8E-08	1.8E-02
17	trans -rt AFW mfw hpi(f/b)	CD	5.0E-07	1.5E-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\mcguire.sll
PROBABILITY FILE: c:\asp\sealmod\pwr_bsll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	4.3E-04	1.0E+00	
loop	1.6E-05	3.6E-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	2.9E-03	8.0E-01	
AFW	3.8E-04 > 2.3E-03	2.6E-01	
Branch Model: 1.OF.3+ser			
Train 1 Cond Prob:	2.0E-02		
Train 2 Cond Prob:	1.0E-01		
Train 3 Cond Prob:	5.0E-02 > Failed		
Serial Component Prob:	2.8E-04		
afw/emerg.power	5.0E-02	3.4E-01	
mfw	1.0E+00	7.0E-02	1.0E-03
porv.or.srv.chall	4.0E-02	1.0E+00	
porv.or.srv.reseat	3.0E-02	1.1E-02	
porv.or.srv.reseat/emerg.power	3.0E-02	1.0E+00	
seal.loca	0.0E+00	1.0E+00	
ep.rec(sl)	0.0E+00	1.0E+00	
ep.rec	4.5E-01	1.0E+00	
hpi	1.0E-03	8.4E-01	
hpi(f/b)	2.2E-03	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

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