ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

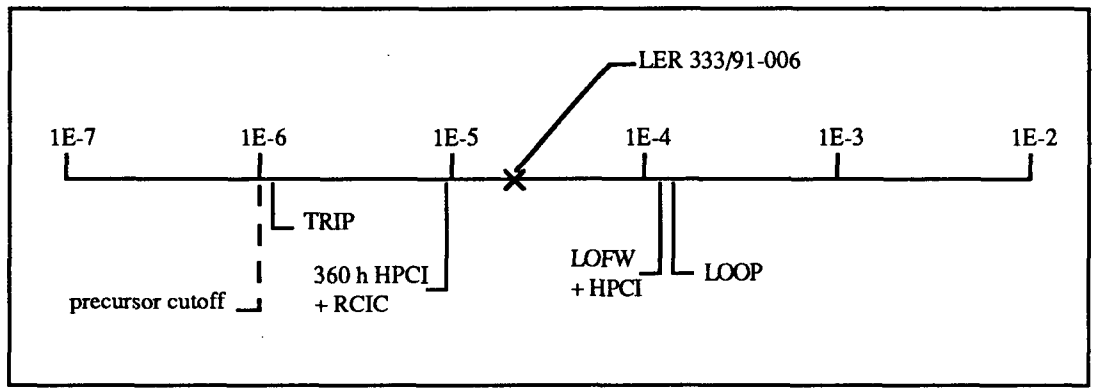
LER No.: 333/91-006
Event Description: Trip with both LPCI trains inoperable
Date of Event: May 7, 1991
Plant: Fitzpatrick

Summary

During a surveillance test, the "A" residual heat removal (RHR) / low-pressure coolant injection (LPCI) outboard containment isolation valve failed to provide required containment isolation. Later, it was found that the valve stem had fractured and the valve disk and seat had sustained severe damage.

Subsequently, the same surveillance procedure was performed on the "B" RHR/LPCI train. When the inboard RHR/LPCI containment isolation valve was operated, it opened partially and stopped. Efforts to further open or close it were unsuccessful. Plant operators then reduced power and scrammed the unit so that repairs could be made.

The conditional core damage probability for this event is estimated at 2.0 x 10^{-5}. The relative significance of the event compared to other postulated events at Fitzpatrick is shown below.



Event Description

While preparing to demonstrate operability of the loop "A" RHR/LPCI inboard containment isolation valve, 10MOV-25A, plant personnel attempted to pressurize the space between the inboard valve and the outboard valve, 10MOV-27A, to facilitate opening the inboard valve. When these attempts were unsuccessful, it was determined that the outboard LPCI loop "A" isolation valve was incapable of performing its isolation function.

When the "B" train valves were tested, the inboard isolation valve, 10MOV-25B, opened partially and then failed. Subsequent attempts to open and close the valve were unsuccessful. Attempts at manual operation of the valve also failed.

Subsequently, power was reduced and the plant was scrammed to allow repairs to the RHR/LPCI system. RHR loop "A" was placed in service for shutdown cooling. Testing revealed that it was possible to force approximately 5000 gpm past the defective loop "A" outboard isolation valve.

The loop "B" inboard isolation valve, 10MOV-25B, was isolated for repair. Its valve stem threads were found to be worn and broken, and pieces of the threads were found in the fixed valve stem nut. When repairs to the loop "B" inboard isolation valve were completed, shutdown cooling (SDC) was transferred from loop "A" to loop "B". Investigation revealed that the loop "A" outboard isolation valve had sustained severe seat, disk, and disk guide rib damage. In addition, the valve stem was fractured.

Additional Event-Related Information

The definition of LPCI success may vary with circumstances. However, the minimum requirement when LPCI is demanded is that full flow from one pump be provided, approximately 7000 gpm. As the loop "A" flow was determined to be 5000 gpm and only limited flow through loop "B" was possible, it appears that neither LPCI loop was capable of performing its safety function.

ASP Modeling Assumptions and Approach

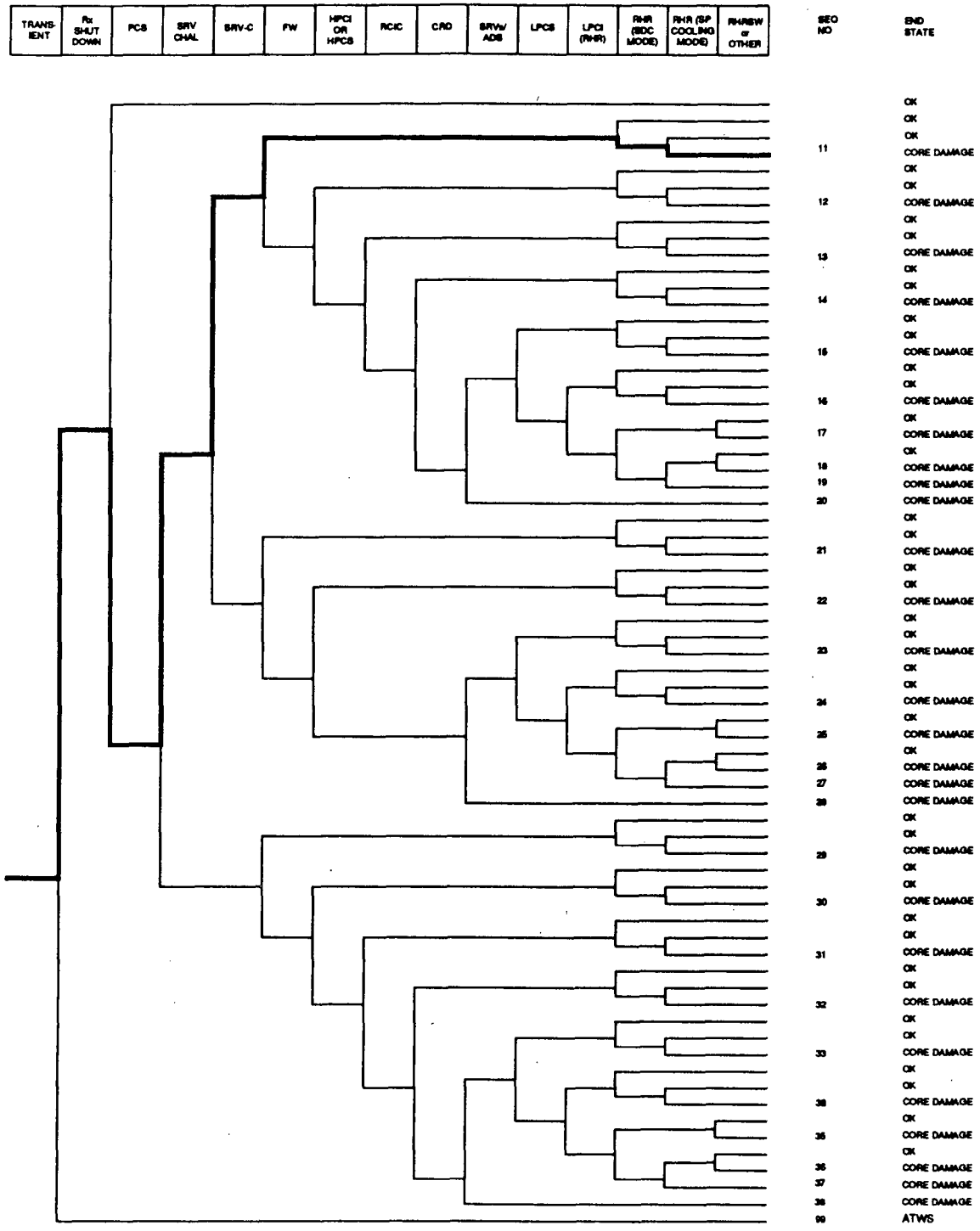
This event was modeled as a scram with LPCI and one train of RHR unavailable. Although one train of RHR functioned during the event, its injection valve was found to be significantly damaged. A failure probability of 0.5 was assumed for this train.

The Accident Sequence Precursor (ASP) models assume that RHR-suppression pool cooling is more likely to fail if LPCI and RHR-SDC are failed. In this event, the suppression pool cooling function should not have been impacted by the failure of the LPCI isolation valves. Therefore, the failure probability for suppression pool cooling given unavailability of LPCI and RHR(SDC) was reduced to 2.0×10^{-3}. This value is consistent with values used elsewhere in the model.

The ASP models also address the potential use of RHR service water (RHRSW) for low-pressure injection, given that LPCI is failed. In this event, the dominant failure mode for LPCI is failure of both injection valves. If these valves fail, RHRSW is also failed. A failure probability of 1.0 was assumed in this analysis.

Analysis Results

The conditional core damage probability for this event is estimated at 2.0×10^{-5}. The dominant sequence, as highlighted on the following event tree, involves trip, failure of the power conversion system, successful safety/relief valve operation, feedwater success, and failure of both shutdown cooling and suppression pool cooling in the long term.



Dominant core damage sequence for LER 333/91-006

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 333/91-006
Event Description: Trip with both LPCI trains and one RHR train unavailable
Event Date: 05/07/91
Plant: Fitzpatrick

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	2.0E-05
Total	2.0E-05
ATWS	
TRANS	3.0E-05
Total	3.0E-05

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
11	trans -rx.shutdown pcs/trans srv.chall/trans.-scram -srv.close -fw/pcs.trans RHR(SDC) rhr(spcool)/rhr(sdc)	CD	1.6E-05	1.0E-01
12	trans -rx.shutdown pcs/trans srv.chall/trans.-scram -srv.close fw/pcs.trans -hpci RHR(SDC) rhr(spcool)/rhr(sdc)	CD	3.0E-06	3.9E-02
21	trans -rx.shutdown pcs/trans srv.chall/trans.-scram srv.close -fw/pcs.trans RHR(SDC) rhr(spcool)/rhr(sdc)	CD	6.2E-07	1.0E-01
99	trans rx.shutdown	ATWS	3.0E-05	1.0E+00

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
11	trans -rx.shutdown pcs/trans srv.chall/trans.-scram -srv.close -fw/pcs.trans RHR(SDC) rhr(spcool)/rhr(sdc)	CD	1.6E-05	1.0E-01
12	trans -rx.shutdown pcs/trans srv.chall/trans.-scram -srv.close fw/pcs.trans -hpci RHR(SDC) rhr(spcool)/rhr(sdc)	CD	3.0E-06	3.9E-02
21	trans -rx.shutdown pcs/trans srv.chall/trans.-scram srv.close -fw/pcs.trans RHR(SDC) rhr(spcool)/rhr(sdc)	CD	6.2E-07	1.0E-01
99	trans rx.shutdown	ATWS	3.0E-05	1.0E+00

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\1989\bwrcseal.cmp
BRANCH MODEL: c:\asp\1989\fitzpatr.sll
PROBABILITY FILE: c:\asp\1989\bwr_csll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	3.4E-04	1.0E+00	
loop	1.6E-05	3.6E-01	
loca	3.3E-06	5.0E-01	
rx.shutdown	3.0E-05	1.0E+00	
rx.shutdown/ep	3.5E-04	1.0E+00	
pcs/trans	1.7E-01	1.0E+00	
srv.chall/trans.-scram	1.0E+00	1.0E+00	
srv.chall/loop.-scram	1.0E+00	1.0E+00	
srv.close	3.6E-02	1.0E+00	
emerg.power	2.9E-03	8.0E-01	
ep.rec	1.6E-01	1.0E+00	
fw/pcs.trans	4.6E-01	3.4E-01	
fw/pcs.loca	1.0E+00	3.4E-01	
hpci	2.9E-02	7.0E-01	
rcic	6.0E-02	7.0E-01	
crd	1.0E-02	1.0E+00	1.0E-02
srv.ads	3.7E-03	7.1E-01	1.0E-02
lpcs	3.0E-03	3.4E-01	
LPCI(RHR)/LPCS	1.0E-03 > 5.0E-01	7.1E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > 5.0E-01		
RHR(SDC)	2.1E-02 > 5.1E-01	3.4E-01	1.0E-03
Branch Model: 1.OF.2+ser+opr			
Train 1 Cond Prob:	3.0E-03 > Failed		
Train 2 Cond Prob:	3.0E-01 > 5.0E-01		
Serial Component Prob:	2.0E-02		
rhr(sdc)/-lpci	2.0E-02	3.4E-01	1.0E-03
rhr(sdc)/lpci	1.0E+00	1.0E+00	1.0E-03
rhr(spcool)/rhr(sdc)	2.0E-03	3.4E-01	
rhr(spcool)/-lpci.rhr(sdc)	2.0E-03	3.4E-01	
RHR(SPCOOL)/LPCI.RHR(SDC)	9.3E-02 > 2.0E-03 **	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	9.3E-02		
RHRSW	2.0E-02 > 1.0E+00	3.4E-01 > 1.0E+00	2.0E-03
Branch Model: 1.OF.1+opr			
Train 1 Cond Prob:	2.0E-02 > 1.0E+00		

* branch model file
** forced

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Event Identifier: 333/91-006