B.49 LER No. 387/82-061

Event Description: ESW Pumps B and D Fail to Start

Date of Event: December 22, 1982

Plant: Susquehanna 1

B.49.1 Summary

On December 22, 1982, while performing the loss of offsite power (LOOP) test, the B and D emergency service water (ESW) pumps failed to start. This resulted in a loss of train B of ESW, which would have subsequently failed residual heat removal (RHR) pumps B and C. Earlier in the day, the reactor scrammed following turbine valve fast closure. The conditional core damage probability estimated for this event is 4.3×10^{-5}.

B.49.2 Event Description

On December 22, 1982, while performing the LOOP test, the B and D ESW pumps failed to start. This resulted in a loss of train B of ESW. The operators manually started the pumps prior to overheating of the serviced equipment (i.e., residual heat removal (RHR) pumps B and C, etc.). An investigation revealed that the pump B failure was the result of loose wires on a relay terminal, while the pump D failure was the result of loose wires on relay terminals, a loose states link, and an out-of-adjustment instantaneous contact. These problems were corrected, train A equipment was examined to determine whether the same failures were present (they were not), and the pumps retested.

Earlier in the day, as part of scheduled startup testing, generator output breakers were opened, causing a reactor scram on turbine control valve fast closure trip.

B.49.3 Additional Event-Related Information

Susquehanna's emergency service water system consists of two independent divisions (trains A and B), each of which is designed to supply 100 percent of the flow required by one division in both units plus cooling for four emergency diesel generators (i.e., DGs A, B, C, and D). Each division has two motor-driven pumps, each of which is capable of providing sufficient flow to remove the heat from the loads cooled by the division. ESW pumps A and C comprise train A and pumps B and D comprise train B. Train B provides cooling for diesel generators A, B, C, and D; pump cooling for RHR pumps B and C; plus cooling for other loads.

Susquehanna's RHR pumps can be operated in several modes. These include low-pressure coolant injection (LPCI), suppression pool cooling, shutdown cooling, containment spray, reactor head spray, and fuel pool cooling. Susquehanna's individual plant examination (IPE) submittal states that the RHR pumps can be operated 30 minutes without pump cooling.

B.49.4 Modeling Assumptions

The event was modeled as a transient with two ESW pumps (train B) failed. This failure results in the loss of the B and C RHR pumps owing to loss of pump cooling. Unavailability of these two pumps affects RHR. To reflect the potential failure of the other two pumps due to the same failure mode, trains 1 and 2 of RHR, and RHR(SPCOOL) model were set to failed. The potential for common cause failure exists, even when a component is failed. Therefore, the conditional probability of a common cause failure was included in the analysis for those components that were assumed to have been failed as a part of the postulated event.

Because the scram was a part of the startup test program, the analysis assumed the unit was operating normally and was stable prior to the scram. The failure probability for power conversion system (PCS) was revised to only address potential failures after the scram occurred. A value of 0.01 was utilized, consistent with the Susquehanna IPE. The nonrecovery probability for RHR was revised to 0.054 to reflect the RHRSW failures (see Appendix A). For sequences involving potential RHR or PCS recovery, the nonrecovery estimate was revised to 0.054 x 0.52 (PCS nonrecovery), or 0.028.

B.49.5 Analysis Results

The estimated conditional core damage probability for the event is 4.3×10^{-5}. The dominant sequence highlighted on the event tree in Figure B.49.1 involved a transient initiator followed by successful reactor shutdown, failure of the power conversion system, successful feedwater recovery, and failure of the residual heat removal system.

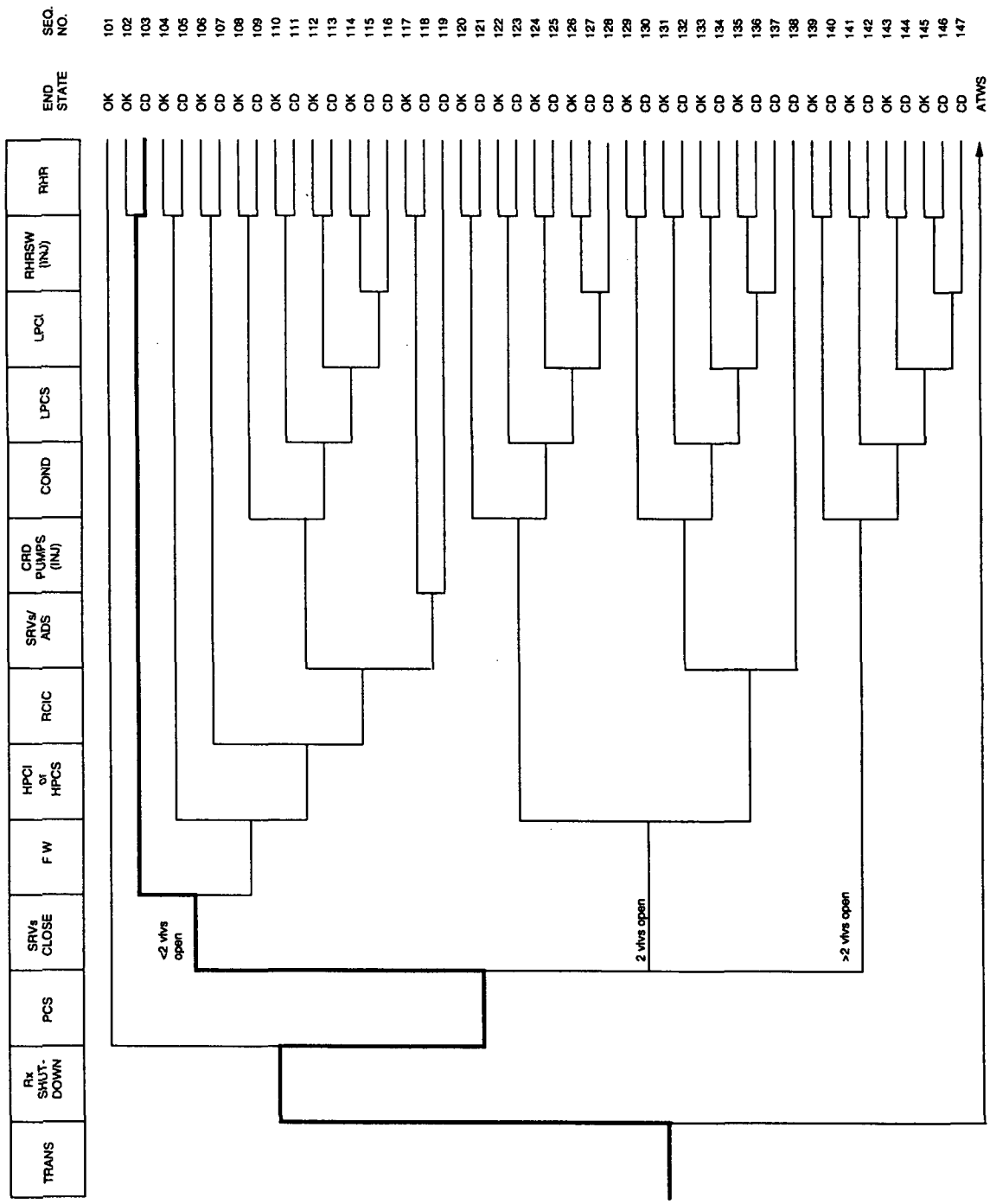

Figure B.49.1 Dominant core damage sequence for LER 387/82-061

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 387/82-061
Event Description: ESW pumps B and D fail to start
Event Date: December 22, 1982
Plant: Susquehanna 1

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	4.3E-05
Total	4.3E-05

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
103	trans -rx.shutdown PCS srv.ftc.<2 -MFW RHR.AND.PCS.NREC	CD	2.8E-05	1.8E-02
105	trans -rx.shutdown PCS srv.ftc.<2 MFW -hpci RHR.AND.PCS.NREC	CD	1.4E-05	9.5E-03

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
103	trans -rx.shutdown PCS srv.ftc.<2 -MFW RHR.AND.PCS.NREC	CD	2.8E-05	1.8E-02
105	trans -rx.shutdown PCS srv.ftc.<2 MFW -hpci RHR.AND.PCS.NREC	CD	1.4E-05	9.5E-03

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\1982-83\bwrc8283.cmp
BRANCH MODEL: c:\asp\1982-83\susque.82
PROBABILITY FILE: c:\asp\1982-83\bwr8283.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	1.5E-03	1.0E+00	
loop	1.6E-05	2.4E-01	
loca	3.3E-06	6.7E-01	
rx.shutdown	3.5E-04	1.0E-01	

PCS	1.7E-01 > 1.0E-02	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	1.7E-01 > 1.0E-02		
srv.ftc.<2	1.0E+00	1.0E+00	
srv.ftc.2	1.3E-03	1.0E+00	
srv.ftc.>2	2.2E-04	1.0E+00	
MFW	4.6E-01 > 1.0E+00	3.4E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	4.6E-01 > 1.0E+00		
hpci	2.9E-02	7.0E-01	
rcic	6.0E-02	7.0E-01	
srv.ads	3.7E-03	7.0E-01	1.0E-02
crd(inj)	1.0E-02	1.0E+00	1.0E-02
cond	1.0E+00	3.4E-01	1.0E-03
lpcs	1.7E-03	1.0E+00	
lpci	1.1E-03	1.0E+00	
rhrsw(inj)	2.0E-02	1.0E+00	1.0E-02
RHR	1.5E-04 > 1.5E-01	1.6E-02 > 5.4E-02	1.0E-05
Branch Model: 1.OF.4+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01		
Train 4 Cond Prob:	5.0E-01		
RHR.AND.PCS.NREC	1.5E-04 > 1.5E-01	8.3E-03 > 2.8E-02	1.0E-05
Branch Model: 1.OF.4+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01		
Train 4 Cond Prob:	5.0E-01		
RHR/-LPCI	0.0E+00 > 1.5E-01	1.0E+00 > 5.4E-02	1.0E-05
Branch Model: 1.OF.1+opr			
Train 1 Cond Prob:	0.0E+00 > 1.5E-01		
rhr/lpci	1.0E+00	1.0E+00	1.0E-05
RHR(SPCOOL)	2.1E-03 > 1.5E-01	1.0E+00	1.0E-03
Branch Model: 1.OF.4+ser+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01		
Train 4 Cond Prob:	5.0E-01		
Serial Component Prob:	2.0E-03		
RHR(SPCOOL)/-LPCI	2.0E-03 > 1.5E-01	1.0E+00	1.0E-03
Branch Model: 1.OF.1+ser+opr			
Train 1 Cond Prob:	0.0E+00 > 1.5E-01		
Serial Component Prob:	2.0E-03		
ep	1.4E-03	8.7E-01	
ep.rec	2.1E-01	1.0E+00	
rpt	1.9E-02	1.0E+00	
slcs	2.0E-03	1.0E+00	1.0E-02
ads.inhibit	0.0E+00	1.0E+00	1.0E-02
man.depress	3.7E-03	1.0E+00	1.0E-02

* branch model file
** forced