B.42 LER No. 366/82-084, -085

Event Description: RHRSW Pumps A, C, and D Failed

Date of Event: August 13, 1982

Plant: Hatch 2

B.42.1 Summary

On August 13, 1982, residual heat removal service water (RHRSW) pumps A and C were declared inoperable when they failed to meet their minimum flow requirements. On the same day, the D RHRSW pump was declared inoperable when it failed to meet its minimum flow requirements. The increase in core damage probability over the duration of the event, or importance, is 2.4×10^{-4}. The base-case core damage probability (CDP) over the duration of the event is 2.7×10^{-6}, resulting in an estimated conditional core damage probability (CCDP) of 2.4×10^{-4}.

B.42.2 Event Description

On August 13, 1982, RHRSW pumps A and C were declared inoperable when they failed to meet their minimum flow requirements during testing procedures. The cavitrol trim (an anticavitation device) on the downstream side of the flow control valve in the outlet of the A loop RHRSW heat exchanger was found to have both broken and bent tubes, which caused the restricted flow.

On August 13, 1982, the D RHRSW pump failed to meet its minimum discharge pressure and flow requirement during testing. The cause of the failure was the failure of the B pump discharge check valve to close. The check valve was freed and the D pump was returned to service within 8 hours.

B.42.3 Additional Event-Related Information

The RHRSW system provides cooling water from the ultimate heat sink (the Altamaha River) to remove decay heat via the residual heat removal (RHR) heat exchangers. By means of a crosstie with the RHR system, the RHRSW system also can supply makeup to the reactor coolant system (RCS) when all emergency core cooling systems have failed.

B.42.4 Modeling Assumptions

RHRSW (and thus RHR) were assumed to be degraded at the time the event was reported on August 13, 1982. RHRSW train I (pumps A and C) was assumed to be inoperable, due to the failure of the cavitrol trim device, which was discovered by flow testing. In addition, testing on August 13, 1982 identified that the B pump discharge check valve was stuck in the open position. The train II discharge check valve was stuck in the open position. Train II (pumps B and D) was assumed to be operable, but with an increased failure probability. With the B pump discharge check valve stuck open, train II would be operable only if pump B was operable.

Failure of pump B was assumed to fail the entire train by allowing diversion of flow from pump D. It was not known how long the failures in the RHRSW system had existed, so it was assumed in the analysis that they had existed for half of a one-month surveillance interval, or 360 hours.

The analysis assumed that common cause failures would dominate the system failure probability, given the observed failure in RHRSW loop A. 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 part of the postulated event. Although the specific failure discovered during testing (in this case, the cavitrol trim device) was apparently not present in loop B at the time of the loop A failure, other common cause failure modes remained and could have affected system performance. Interestingly, the licensee noted that a similar problem had occurred with the loop B cavitrol trim device during the previous year.

The probability of RHR failing is given by the probability of RHRSW train II failing, which was estimated as follows:

$P_{rhrsw\ loop\ 2}$ = 0.1 (Probability that loop II flow control valve fails, given that loop I flow control valve has failed.)

+ .01 (Probability that RHRSW pump B fails to start and run.)

= 0.11

The nonrecovery probability for RHR was revised to 0.054 to reflect the RHRSW failures (see Appendix A). For sequences involving potential RHR or power conversion system (PCS) recovery, the nonrecovery estimate was revised to 0.054 x 0.052 (PCS nonrecovery), or 0.028.

B.42.5 Analysis Results

The estimated increase in core damage probability over the duration of the event is 2.4×10^{-4}. The base case CDP (not shown in calculation) is 2.1×10^{-6}, resulting in an estimated CCDP of 2.4×10^{-4}. The dominant sequence, highlighted in the event tree in Figure B.42.1, involves a postulated trip during the unavailability period, failure of the power conversion system, success of feedwater, and failure of RHR.

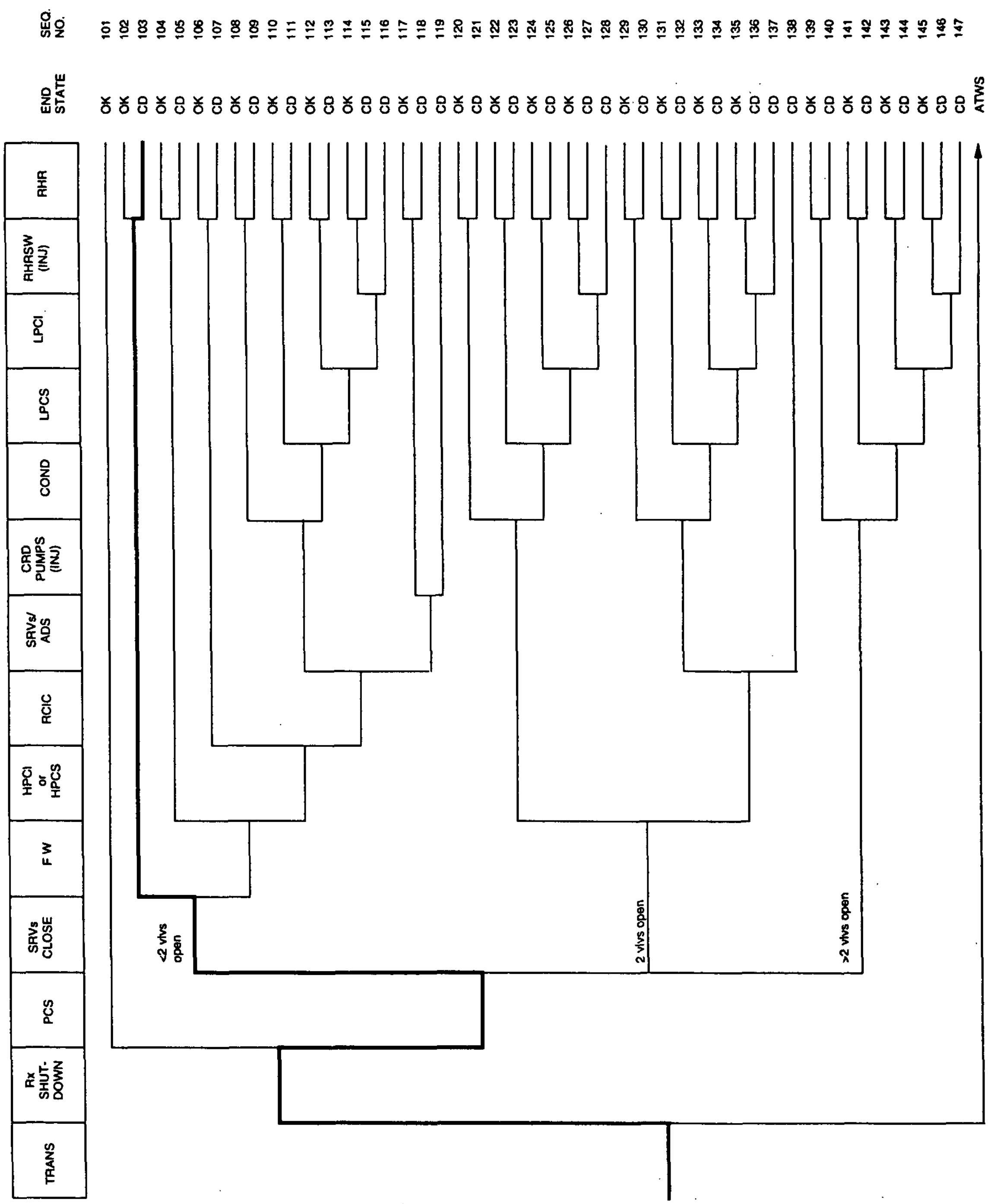

Figure B.42.1 Dominant core damage sequence for LER 366/82-084

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 366/82-084
Event Description: RHRSW pumps A, C, D failed
Event Date: August 13, 1982
Plant: Hatch 2

UNAVAILABILITY, DURATION= 360

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	5.5E-01
LOOP	2.1E-03
LOCA	8.0E-04

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	2.2E-04
LOOP	1.3E-05
LOCA	8.0E-07
Total	2.4E-04

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	1.9E-04	2.5E-02
105	trans -rx.shutdown pcs srv.ftc.<2 mfw -hpci RHR.AND.PCS.NREC	CD	3.4E-05	9.5E-03
202	loop -rx.shutdown -ep srv.ftc.<2 -hpci RHR	CD	1.2E-05	1.9E-02

** 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	1.9E-04	2.5E-02
105	trans -rx.shutdown pcs srv.ftc.<2 3.4E-05	9.5E-03		
202	loop -rx.shutdown -ep srv.ftc.<2 -hpci RHR	CD	1.2E-05	1.9E-02

** non-recovery credit for edited case

Note: For unavailabilities, conditional probability values are differential values which reflect the added risk due to failures associated with an event. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

SEQUENCE MODEL: d:\asp\models\bwrc8283.cmp
BRANCH MODEL: d:\asp\models\hatch2.82
PROBABILITY FILE: d:\asp\models\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	3.6E-01	
loca	3.3E-06	6.7E-01	
rx.shutdown	3.5E-04	1.0E-01	
pcs	1.7E-01	1.0E+00	
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	3.4E-01	
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	2.0E-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 > 1.1E-01 **	1.6E-02 > 5.4E-02	1.0E-05
Branch Model: 1.OF.4+opr			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01		
Train 3 Cond Prob:	3.0E-01		
Train 4 Cond Prob:	5.0E-01		
RHR.AND.PCS.NREC	1.5E-04 > 1.1E-01 **	8.3E-03 > 2.8E-02	1.0E-05
Branch Model: 1.OF.4+opr			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01		
Train 3 Cond Prob:	3.0E-01		
Train 4 Cond Prob:	5.0E-01		
RHR/-LPCI	0.0E+00 > 1.1E-01	1.0E+00 > 5.4E-02	1.0E-05
Branch Model: 1.OF.1+opr			
Train 1 Cond Prob:	0.0E+00 > 1.1E-01		
rhr/lpci	1.0E+00	1.0E+00	1.0E-05
RHR(SPCOOL)	2.1E-03 > 1.1E-01 **	1.0E+00	1.0E-03
Branch Model: 1.OF.4+ser+opr			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01		
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 > 1.1E-01 **	1.0E+00	1.0E-03
Branch Model: 1.OF.1+ser+opr			
Train 1 Cond Prob:	0.0E+00		
Serial Component Prob:	2.0E-03		
ep	2.9E-03	8.7E-01	
ep.rec	1.6E-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