B.43 LER No. 366/83-042, -055, and -056

Event Description: Reactor Trip with RCIC and RHR Loop A Unavailable

Date of Event: July 14, 1983

Plant: Hatch 2

B.43.1 Summary

On July 14, 1983, during startup following a refueling outage, Hatch 2 started losing condenser vacuum and the turbine was tripped. The reactor was manually scrammed when one control rod was found in an "out of sequence" position. The reactor core isolation cooling system (RCIC) was unavailable at the time. While placing the A loop of residual heat removal (RHR) in the shutdown cooling mode to achieve a cold shutdown condition, the A loop heat exchanger outlet valve failed to open. The conditional core damage probability estimated for the event is 1.5×10^{-4}.

B.43.2 Event Description

On July 13, 1983, with the plant at approximately 14% power, and again on July 21, 1983, with the plant at approximately 60% power, the RCIC pump failed to deliver the minimum required flow of 400 gpm, and was declared unavailable. On July 14, 1983, the plant was starting up from a refueling outage and was at approximately 7% power, when the unit started losing condenser vacuum. The turbine was tripped, and control room personnel scrammed individual rods with the scram switches at the scram timing panel in an effort to quickly reduce power. The rod worth minimizer (RWM) was bypassed, and at one point the "emergency rod in" control was used to achieve the greatest possible insertion rate. After several rods had been inserted, one rod was found in an out-of-sequence position, and the reactor was manually scrammed.

RCIC failed to meet its minimum required flow because its electric governor remote (EGR) actuator was out of adjustment, which caused the governor valve to fail to open completely. The EGR actuator was adjusted and RCIC was returned to operability on July 21, 1983.

Following the turbine trip on July 14, 1983, control rods were being rapidly inserted to reduce power. Control room personnel attempted to lower reactor power quickly so that the mechanical vacuum pump could be placed in service before the decreasing vacuum reached the reactor feed pump low vacuum trip point. A reactor feed pump low vacuum trip results in a loss of feedwater flow to the vessel. Since RCIC was unavailable, operators were trying to avoid losing feedwater flow.

On July 15, 1983, while placing the A loop of RHR in the shutdown cooling mode to achieve a cold shutdown condition, the A loop heat exchanger outlet valve failed to open because the valve motor was faulted.

The failed RHR loop A heat exchanger outlet valve motor was replaced, and RHR loop A was returned to service on July 15, 1983.

B.43.3 Additional Event-Related Information

On July 14, 1983, during normal startup activities from a refueling outage, the plant was operating at about 25% power. Problems with the main condenser vacuum had occurred and air ejector troubleshooting had been in progress. Condenser vacuum began to decrease and the turbine was unloaded and tripped. Control rods were inserted in an attempt to reduce reactor power to within the limit of the mechanical vacuum pump so that it could be placed in service in order to maintain vacuum above the trip set point of the reactor feed pumps. A reactor feed pump low vacuum trip would cause a loss of feedwater flow to the vessel.

To reduce power more quickly, the licensee bypassed the RWM and assigned a second licensed operator to verify control rod movement as permitted by the Technical Specifications. At one point, the "emergency rod in" control was used to achieve the greatest possible insertion rate.

When the operator reached groups of low worth peripheral rods in the sequence, a discussion among the licensed operators and supervisors in the control room resulted in a decision to scram individual rods by using the individual scram switches at the scram timing panel which was already set up for scram time testing. This was not an approved procedure and resulted in the insertion of rods in an out-of-sequence manner. Vacuum at the time was about 0.5 inches above the trip point.

While the plant operator continued inserting rods at the front panel, two other operators began to insert rods at the scram timing panel with the individual scram switches. When the front panel operator observed those rods going in, he stopped inserting and verified further insertions from the scram panel. A process computer printout indicated that several rods were not fully inserted (i.e., scram toggle switches were not held down sufficiently long). These rods were subsequently rescrammed. One rod was also found in a position which was not expected based upon the rod manipulations performed by the operators. The reason for this was not determined. At this point, the vacuum pump was placed in service and vacuum stabilized at a low level. Because the one rod was improperly positioned, the reactor was scrammed as required by procedure.

During this event, the rod sequence control system (RSCS) was effectively bypassed. The RSCS is a backup system to the RWM and independently imposes restrictions on control rod movements to mitigate the effects of a control rod drop accident. The plant's Technical Specifications require the RSCS to be operable when reactor power is below 20%. However, the use of the "emergency rod in" control and the scram switches on the scram timing panel circumvented the RSCS.

B.43.4 Modeling Assumptions

This event was modeled as a reactor scram with RCIC and one train (2 pumps) of RHR unavailable. The ASP model assumes the dominant failure mode is a common cause failure of the RHR pumps. 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 failed as part of the event. To address the failure of the heat exchanger outlet valve, the model was modified. Failure of the heat exchanger outlet valve disables all functions of a complete train of RHR. For this analysis, one train of RHR (all modes) was assumed failed. The probability of the second train failing was assumed to be 0.1. Pretrip actions related to rod insertion are not addressed in this analysis.

B.43.5 Analysis Results

The conditional core damage probability estimated for this event is 1.5×10^{-4}. The dominant core damage sequences, highlighted on the event tree in Figure B.43.1, involves the observed transient, failure of the power conversion system, main feedwater system success, and failure of the residual heat removal system.

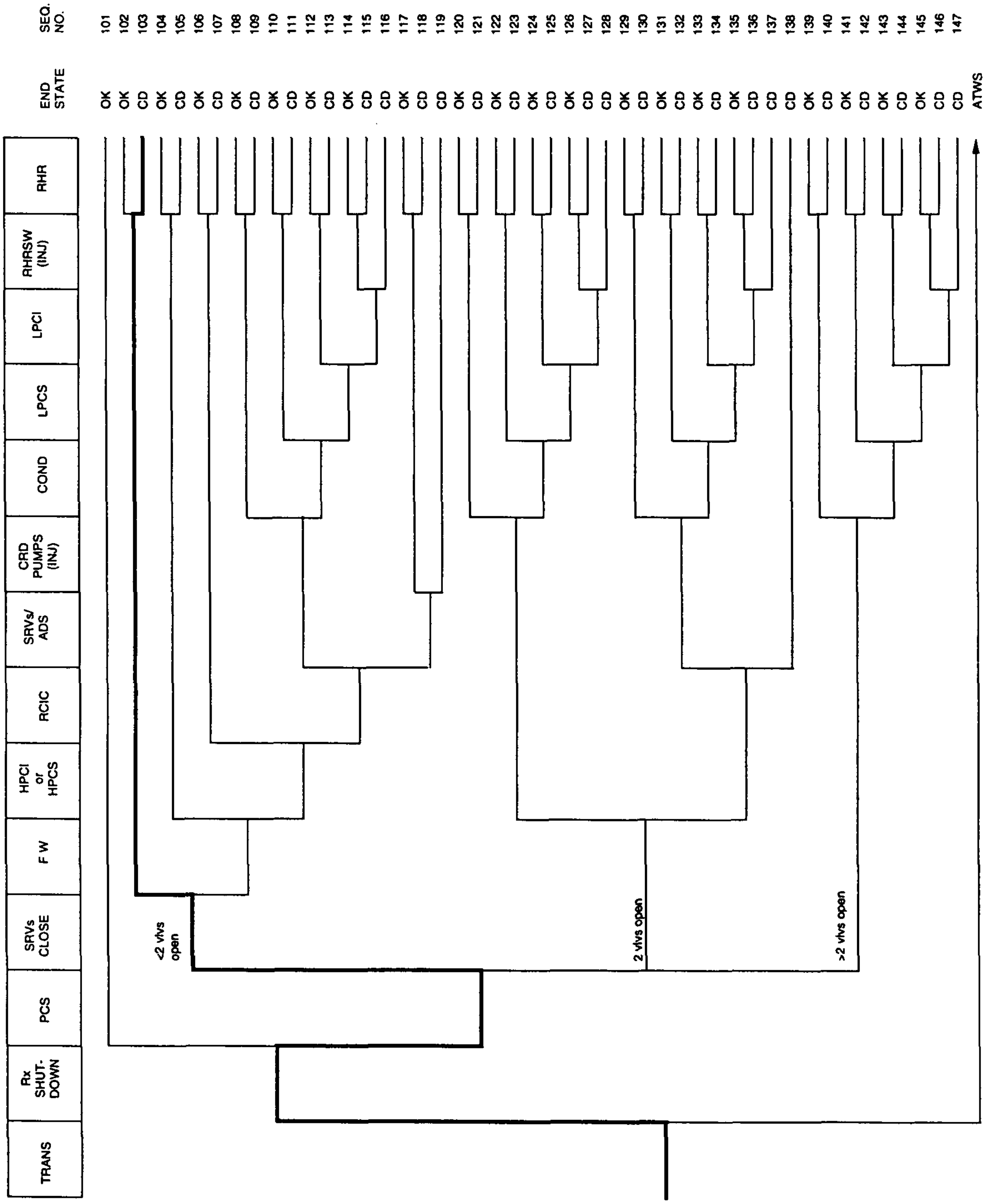

Figure B.43.1 Dominant core damage sequence for LER 366/83-042, -055, and -056

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 366/83-042
Event Description: Scram with RCIC and RHR loop A unavailable
Event Date: July 14, 1983
Plant: Hatch 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	1.5E-04
Total	1.5E-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	1.2E-04	7.3E-03
105	trans -rx.shutdown pcs srv.ftc.<2 mfw -hpci RHR.AND.PCS.NREC	CD	2.2E-05	2.8E-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	1.2E-04	7.3E-03
105	trans -rx.shutdown pcs srv.ftc.<2 mfw -hpci RHR.AND.PCS.NREC	CD	2.2E-05	2.8E-03

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\1982-83\bwrc8283.cmp
BRANCH MODEL: c:\asp\1982-83\hatch2.82
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	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 > 1.0E+00	7.0E-01 > 1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	6.0E-02 > Failed		
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 > 1.0E-01 **	1.6E-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 > 1.0E-01 **	8.3E-03	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 > 1.0E-01 **	1.0E+00	1.0E-05
Branch Model: 1.OF.1+opr			
Train 1 Cond Prob:	0.0E+00		
rhr/lpci	1.0E+00	1.0E+00	1.0E-05
RHR(SPCOOL)	2.1E-03 > 1.0E-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 > 1.0E-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