

## **B.7-1**

### **B.7 LER No. 260/83-074**

Event Description: Trip with HPCI Inoperable

Date of Event: November 10, 1983

Plant: Browns Ferry 2

#### **B.7.1 Summary**

Unit 2 was operating at approximately 98% power when a reactor scram occurred. Reactor vessel level dropped sufficiently to provide an auto-initiation signal to the high pressure coolant injection (HPCI) system. HPCI started and immediately isolated when a turbine exhaust rupture diaphragm ruptured, rendering HPCI inoperable. The conditional core damage probability estimated for the event is  $3.2 \times 10^{-5}$ .

#### **B.7.2 Event Description**

On November 10, 1983, while operating at essentially full power, Unit 2 experienced a scram. Reactor vessel level dropped sufficiently to result in HPCI auto-initiation; however, HPCI immediately isolated when its turbine exhaust rupture diaphragm ruptured.

The cause of the failure was not determined with certainty. An exhaust diaphragm rupture which occurred during testing five days earlier had been attributed to inadequate draining of condensate from HPCI steam lines. Apparently, the November 5 rupture disk failure may have been caused by the impact of a slug of water which accelerated in the steam exhaust line after the turbine started. While the disk rupture patterns were found to be similar in both events, the November 10 failure was tentatively attributed to control system problems. Testing conducted later, in February of 1984, suggested that improper HPCI control system behavior could lead to exhaust line pressure fluctuations, perhaps great enough to cause failure of the rupture disk. Adjustments were made to the control system to minimize these fluctuations.

#### **B.7.3 Additional Event-Related Information**

High-pressure makeup sources at Browns Ferry include the turbine-driven main feedwater pumps, HPCI, the reactor core isolation cooling system (RCIC) and the control rod drive (CRD) pumps. For events involving isolation of the reactor vessel, only HPCI can provide high flow-rate (5,000 gpm) makeup to the reactor.

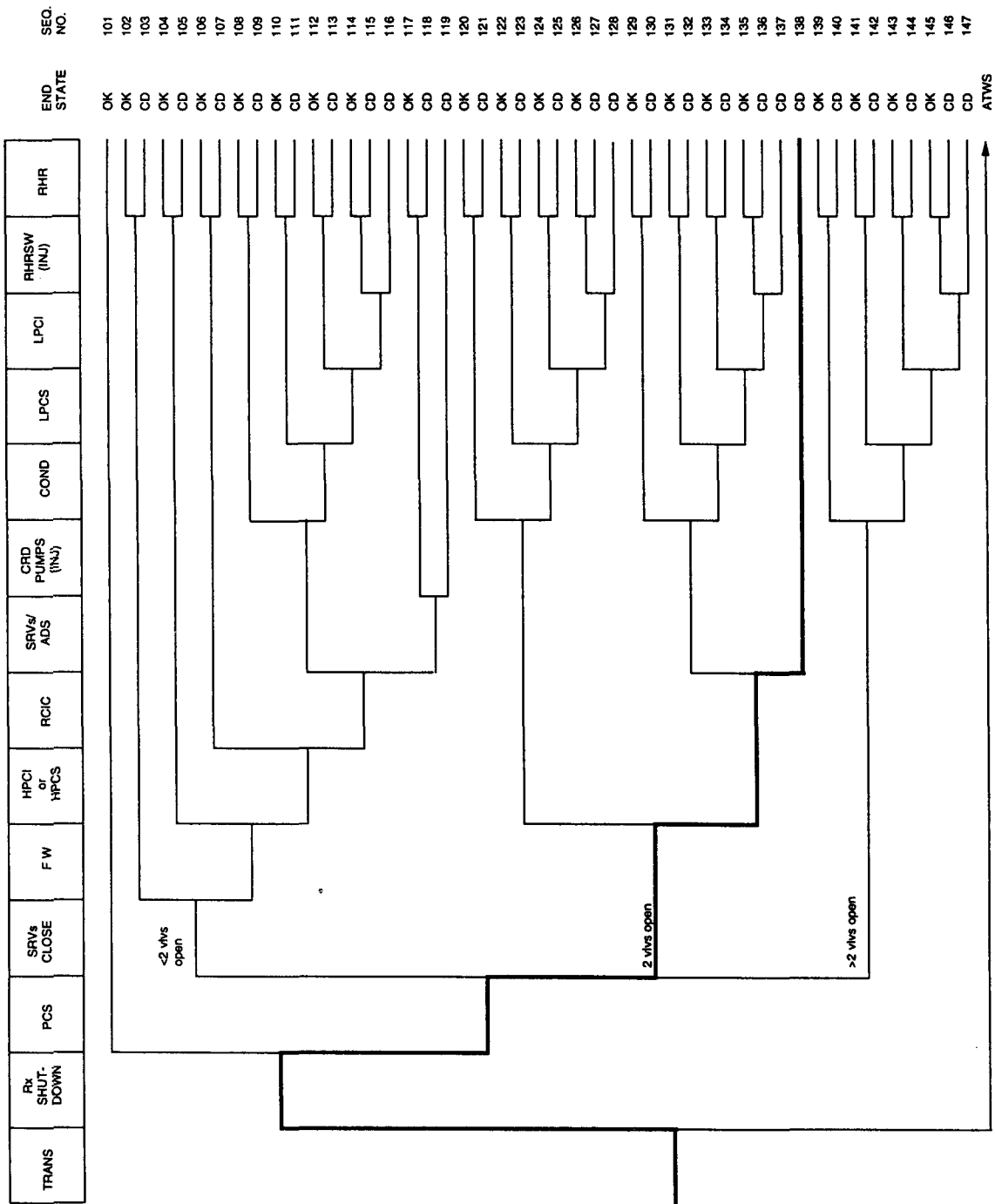
#### **B.7.4 Modeling Assumptions**

This event was modeled as a scram with HPCI assumed unavailable and not recoverable. Because the HPCI auto-initiation reported indicates that reactor vessel level had dropped to -51.5 inches below instrument zero, it can be assumed that the main steam isolation valves (MSIVs) isolated, causing an initial loss of main feedwater and power conversion systems. The nonrecovery probability for the power conversion system (PCS) was revised to 0.017 to reflect initial assumed closure of main steam isolation valves.

### **B.7.5 Analysis Results**

The conditional core damage probability estimated for this event is  $3.2 \times 10^{-5}$ . The dominant core damage sequence, highlighted on the event tree in Figure B.7.1, involves the observed trip, unavailability of the power conversion system, failure of two safety relief valves (SRVs) to close, unavailability of HPCI, and failure of the automatic depressurization system (ADS).

**B.7-3**



**Figure B.7.1 Dominant core damage sequence for LER 260/83-074**

**LER No. 260/83-074**

## B.7-4

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### CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 260/83-074  
Event Description: Scram with HPCI inoperable  
Event Date: November 10, 1983  
Plant: Browns Ferry 2

#### INITIATING EVENT

#### NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS 1.0E+00

#### SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	3.2E-05
Total	3.2E-05

#### SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
138	trans -rx.shutdown PCS srv.ftc.2 HPCI srv.ads	CD	1.6E-05	7.0E-01
103	trans -rx.shutdown PCS srv.ftc.<2 -MFW RHR.AND.PCS.NREC	CD	6.6E-06	1.8E-04
119	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI rcic srv.ads c	CD	3.6E-06	1.7E-01
	rd(inj)			
107	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI -rcic RHR.AND.PC	CD	3.3E-06	9.1E-05
	S.NREC			
414	trans rx.shutdown rpt	CD	6.7E-07	1.0E-01

\*\* 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	6.6E-06	1.8E-04
107	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI -rcic RHR.AND.PC	CD	3.3E-06	9.1E-05
	S.NREC			
119	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI rcic srv.ads c	CD	3.6E-06	1.7E-01
	rd(inj)			
138	trans -rx.shutdown PCS srv.ftc.2 HPCI srv.ads	CD	1.6E-05	7.0E-01
414	trans rx.shutdown rpt	CD	6.7E-07	1.0E-01

\*\* non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\1982-83\bwrc8283.cmp  
BRANCH MODEL: c:\asp\1982-83\brown2.82  
PROBABILITY FILE: c:\asp\1982-83\bwr8283.pro

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LER No. 260/83-074

# B.7-5

No Recovery Limit

## BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	2.0E-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+00	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	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 > 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 > 1.0E+00	7.0E-01 > 1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.9E-02 > 1.0E+00		
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	1.6E-02	1.0E-05
RHR.AND.PCS.NREC	1.5E-04 > 1.5E-04	8.3E-03 > 2.7E-04	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+00	1.0E-05
rhr/lpci	1.0E+00	1.0E+00	1.0E-05
rhr(spcool)	2.1E-03	1.0E+00	1.0E-03
rhr(spcool)/-lpci	2.0E-03	1.0E+00	1.0E-03
ep	7.5E-03	8.7E-01	
ep.rec	1.4E-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