B.11 LER No. 278/83-002 and -003

Event Description: Transient with HPCI and ESF Bus 23 Inoperable

Date of Event: January 26, 1983

Plant: Peach Bottom 3

B.11.1 Summary

While Peach Bottom Unit 3 was operating at 860 MWe on January 26, 1983, the isolation valve on the high pressure coolant injection (HPCI) system turbine exhaust vacuum breaker failed to fully close during a local leak rate test. Surveillance testing of backup systems was initiated. During the surveillance test, the reactor core isolation cooling system (RCIC) turbine throttle valve motor breaker tripped during the reset capability test for the turbine remote throttle valve. Shutdown was initiated, and RCIC was returned to service within 30 minutes. HPCI was repaired and restored to service late on January 27. On January 27, an HEA relay on the E23 emergency safeguard bus tripped the normal supply and locked out the backup and diesel supplies. The E234 emergency auxiliary load center de-energized and tripped the offgas air ejector, which resulted in reducing the condenser vacuum. Operators manually scrammed the reactor approximately 20 minutes later in anticipation of a low vacuum scram. The conditional core damage probability estimated for the event is 3.4×10^{-5}.

B.11.2 Event Description

While Peach Bottom Unit 3 was operating at 860 MWe on January 26, 1983, the isolation valve for the HPCI system turbine exhaust vacuum breaker failed to fully close during a local leak rate test. A manual valve in the same line was closed, HPCI was declared inoperable, and surveillance testing of redundant backup systems was initiated. The HPCI vacuum breaker isolation valve limit torque operator prevented the valve from fully closing. Examination of the valve internals revealed that the gear train lubricating grease had solidified. The limitorque operator was cleaned and new lubricant was added, and HPCI was restored to service late on January 27. On the 26th, while testing redundant backup systems and when the RCIC surveillance test was performed, the turbine throttle valve motor breaker tripped during the remote throttle valve reset capability test. Shutdown was initiated. Within 30 minutes, the linkage on the RCIC turbine throttle valve motor breaker thermal reset switch was adjusted and the surveillance test was successful on the valve and RCIC. On January 27, an HEA relay on the E23 emergency safeguard bus tripped the normal supply and locked out the backup and diesel supplies. The E234 emergency auxiliary load center de-energized and tripped the offgas air ejector, which resulted in reducing the condenser vacuum. Operators manually scrammed the reactor approximately 20 minutes later in anticipation of a low vacuum scram. It was later determined that the HEA relay trip may have been caused by a defective activating device. All devices were to be checked during the refueling outage.

B.11.3 Additional Event-Related Information

The motor-operated HPCI vacuum breaker isolation valve is normally open to allow the vacuum breakers to break vacuum between the HPCI turbine exhaust line and the suppression pool air space. The valve closes automatically if primary coolant pressure is less than 100 psig and drywell pressure is greater than 2 psig. The closure of the valve isolates the suppression pool air space from the HPCI turbine exhaust line during periods when HPCI is not required, and seals the HPCI exhaust line check valve with suppression pool water after HPCI operation is no longer required. With the vacuum breaker line isolated, initial operation of HPCI would not be affected; however, cycling of the HPCI could lead to failure.

The emergency safeguard bus 23 powers the high pressure service water (HPSW) pump B, residual heat removal (RHR) system pump B, and emergency service water (ESW) pump A. The HPSW system is a four-train system which supplies cooling water to the RHR heat exchangers. One of four pumps supplying one of four RHR heat exchangers is sufficient to properly cool the RHR system. Pumps B or D can be crosstied to the RHR system for another source of injection. The RHR system is a four-train system with four pumps and four heat exchangers. It operates in four modes: low pressure coolant injection (LPCI) mode, suppression pool cooling (SPCOOL) mode, containment spray mode, and shutdown cooling (SDC) mode. LPCI provides coolant makeup to the reactor vessel from the suppression pool. Suppression pool cooling is used to remove heat from the suppression pool whenever the water temperature exceeds 95°F. Containment spray is used in the event of a nuclear system break within the primary containment to prevent excessive containment pressure and temperature by condensing steam and cooling noncondensable gases. Shutdown cooling can be used during normal shutdown and cooldown to remove decay heat once the reactor coolant temperature is low enough that the steam supply pressure is not sufficient to maintain turbine shaft gland seals or vacuum in the main condenser. Successful operation of RHR requires the use of at least one pump and one heat exchanger. The ESW system provides cooling to the pumps and rooms of the emergency core cooling systems (ECCS) and cooling to the emergency diesel generator (EDG) jacket coolers in the event that normal service water is lost. The ESW system has two main pump trains, A and B, which provide cooling water to the various systems. One of the two pump trains is sufficient to supply cooling to all ECCS and EDG jacket coolers.

B.11.4 Modeling Assumptions

Since the HPCI valve was not fixed until late on January 27, HPCI was assumed to be inoperable at the time of the trip on January 27. One train of RHR and LPCI was unavailable due to the loss of ESF bus 23. It was assumed that since the bus failure was due to the HEA relay for bus 23 only, the other ESF buses would not be affected by the failure of bus 23. Since ESW and HPSW had redundant pumps which were not inoperable due to the loss of bus 23 at the time of the trip and normal service water was operable, HPSW and service water cooling were assumed to be functioning. Since the loss of bus 23 made HPSW pump B unavailable, HPSW injection had only one pump (pump D) available for injection. RCIC was inoperable for less than thirty minutes during the time the HPCI vacuum breaker line was isolated. Since RCIC was inoperable for such a short time over the two day period of the event, it was assumed operable at the time of the trip. The loss of condenser vacuum would result in the closure of the main steam isolation valves (MSIVs), thus making the power conversion (PCS) and feedwater (FW) systems unavailable. Thus, the event was modeled as a transient

with HPCI failed, one train of RHR and LPCI unavailable, PCS and FW unavailable, and the HPSW injection [(RHRSW(INJ))] probability modified to reflect the unavailability of one of the pumps.

B.11.5 Analysis Results

The estimated conditional core damage probability for this event is 3.4×10^{-5}. The dominant sequence involved the observed transient with failure of PCS and RHR and is highlighted on the event tree in Figure B.11.1. A slightly less probable sequence involves failure of two safety relief valves (SRVs) to close following lift, failure of HPCI, and failure of the automatic depressurization system (ADS).

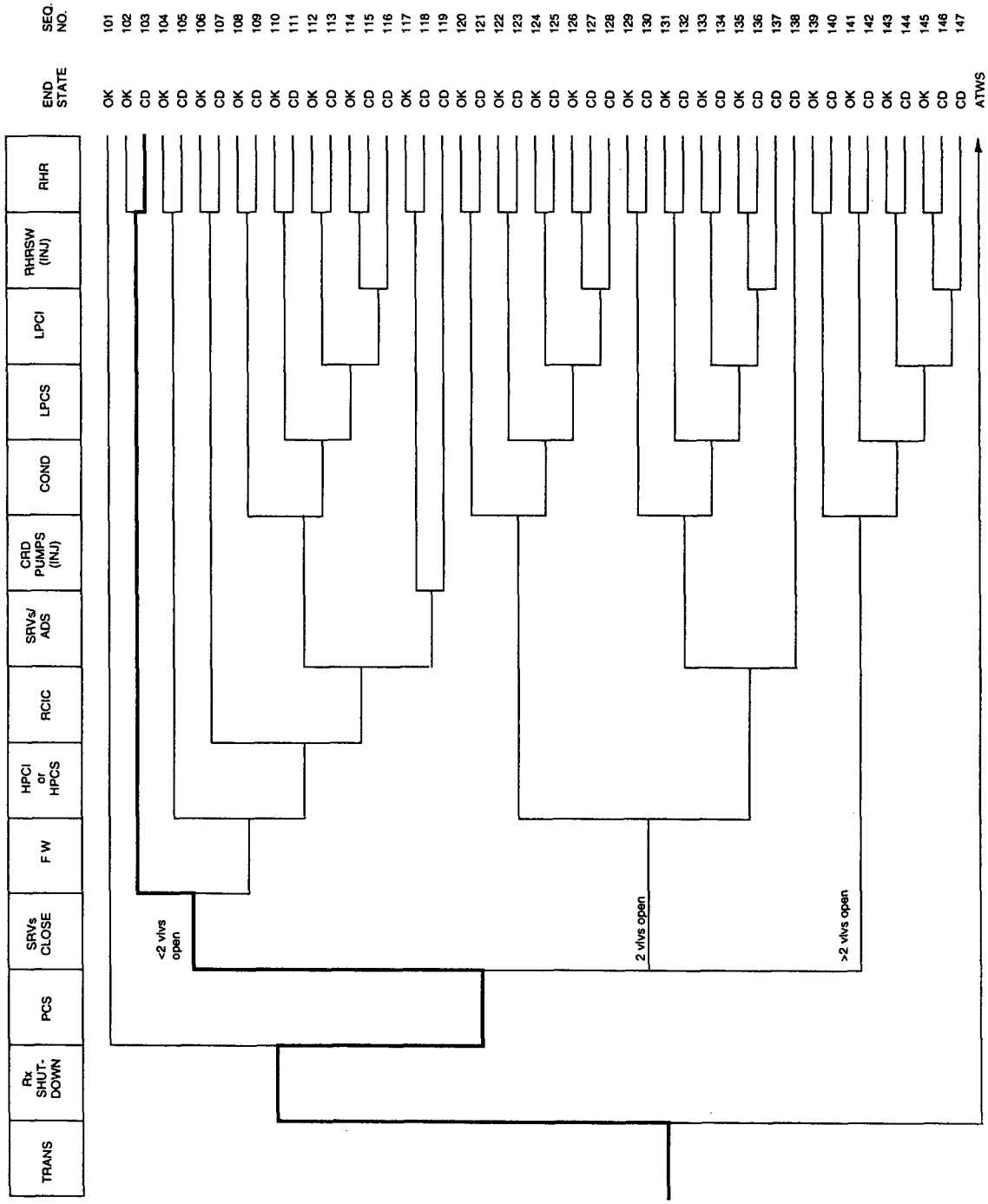

Figure B.11.1 Dominant core damage sequence for LER 278/83-002 and -003

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 278/83-002
Event Description: Transient with HPCI and ESF bus 23 inop
Event Date: January 26, 1983
Plant: Peach Bottom 3

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	3.4E-05
Total	3.4E-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	1.2E-05	1.8E-02
138	trans -rx.shutdown PCS srv.ftc.2 HPCI srv.ads	CD	1.1E-05	4.9E-01
107	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI -rcic RHR.AND.PCS.NREC	CD	4.2E-06	6.6E-03
119	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI rcic srv.ads crd(inj)	CD	2.5E-06	1.2E-01
105	trans -rx.shutdown PCS srv.ftc.<2 MFW -HPCI RHR.AND.PCS.NREC	CD	1.9E-06	2.9E-03
414	trans rx.shutdown rpt	CD	6.7E-07	1.0E-01
413	trans rx.shutdown -rpt slcs	CD	4.1E-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	1.2E-05	1.8E-02
105	trans -rx.shutdown PCS srv.ftc.<2 MFW -HPCI RHR.AND.PCS.NREC	CD	1.9E-06	2.9E-03
107	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI -rcic RHR.AND.PCS.NREC	CD	4.2E-06	6.6E-03
119	trans -rx.shutdown PCS srv.ftc.<2 MFW HPCI rcic srv.ads crd(inj)	CD	2.5E-06	1.2E-01
138	trans -rx.shutdown PCS srv.ftc.2 HPCI srv.ads	CD	1.1E-05	4.9E-01
413	trans rx.shutdown -rpt slcs	CD	4.1E-07	1.0E-01
414	trans rx.shutdown rpt	CD	6.7E-07	1.0E-01

** non-recovery credit for edited case

SEQUENCE MODEL: d:\asp\models\bwrc8283.cmp
BRANCH MODEL: d:\asp\models\peach3.82
PROBABILITY FILE: d:\asp\models\bwr8283.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	4.8E-04	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	
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 > 1.3E-03	1.0E+00	
Branch Model: 1.OF.4+ser			
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 > 1.0E+00		
Serial Component Prob:	1.0E-03		
RHRSW(INJ)	2.0E-02 > 3.0E-02 **	1.0E+00	1.0E-02
Branch Model: 1.OF.1+opr			
Train 1 Cond Prob:	2.0E-02		
RHR	1.5E-04 > 3.0E-04	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 > 1.0E+00		
RHR.AND.PCS.NREC	1.5E-04 > 3.0E-04	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 > 1.0E+00		

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 > 2.3E-03	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 > 1.0E+00		
Serial Component Prob:	2.0E-03		
rhr(spcool)/-lpci	2.0E-03	1.0E+00	1.0E-03
ep	7.5E-03	8.7E-01	
ep.rec	6.1E-02	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