PRECURSOR DESCRIPTION SHEET

LER No.: 324/87-004
Event Description: HPCI unavailability during trip recovery
Date of Event: 3/11/87
Plant: Brunswick 2

EVENT DESCRIPTION

Sequence

While the plant was at 100% power, uninterruptable AC electrical power was lost during operational troubleshooting because of operator error. The electrical failure caused reactor feedwater pump runback on loss of control power. Subsequent reactor water level reduction occurred as the feedwater flow attenuated. Reactor scram, RCIC, and HPCI were initiated when the reactor vessel low level set point was reached. Initially, HPCI performed as required, filling the vessel at a rate of 4250 gal/min. As the vessel level began to go high, flow control was used to reduce the rate to 3000 gal/min. The HPCI turbine tripped when the vessel reached the high level set point. Feedwater backflow occurred with the reduction in pump discharge pressure via the HPCI injection valve, then through a common valve from the condensate storage tank into the CST. Flashing was heard in the CST. As soon at the HPCI injection valve fully closed from the HPCI trip signal, the backflow was terminated. While returning the HPCI system to a standby state, the operator noticed that the power to the HPCI pump discharge valve was tripped. The valve motor was later found damaged (thermally bound as a result of the reverse flow condition) and could not be manually opened. HPCI would have been unavailable if required for injection later in the transient. HPCI was declared inoperable.

Corrective Action

The motor of the failed discharge valve was replaced, and the HPCI system was investigated for backflow damage. Procedures were established to require supervision on UPS transfer functions.

Plant/Event Data

Systems Involved:
- Main feedwater
- High-pressure coolant injection

Components and Failure Modes Involved:
- Feedwater - loss of flow after control power loss
- HPCI - failed after feedwater backflow

Component Unavailability Duration: N/A
Plant Operating Mode: 1 (100% power)
Discovery Method: Operational event
Reactor Age: 10.4 y
Plant Type: BWR

Comments

For the purpose of this analysis, it has been assumed that the likelihood of requiring HPCI after the high level trip was 0.1.

MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate		
Transient	1.0	No recovery assumed possible

Branches Impacted and Branch Nonrecovery Estimate		
HPCI	0.1	Assumed likelihood of requiring HPCI following high level trip
PCS	1.0	Unavailable
MFW	Base case	Assumed unavailable but recoverable due to HPCI, RCIC demand

Plant Models Utilized

BWR plant Class C

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 324/87-004
Event Description: HPCI unavailable during trip recovery
Event Date: 03/11/87
Plant: Brunswick 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	1.9E-05
Total	1.9E-05
CV	
TRANS	1.4E-05
Total	1.4E-05
ATWS	
TRANS	7.0E-06
Total	7.0E-06

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
145	trans -scram PCS/TRANS srv.chall/trans.-scram srv.close fw/pcs.loca HPCI srv.ads	CD	1.6E-05	2.4E-02
102	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close -FW/PCS.TRANS rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v rhrsw(c.i.and.v)	CD	1.7E-06	7.6E-02
105	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS -HPCI rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v rhrsw(c.i.and.v)	CD	8.0E-07	3.5E-02
101	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close -FW/PCS.TRANS rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	8.4E-06	1.9E-01
104	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS -HPCI rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	3.9E-06	9.0E-02
107	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS HPCI -rcic rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	4.2E-07	9.9E-03
126	trans -scram PCS/TRANS srv.chall/trans.-scram srv.close -fw/pcs.loca rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	3.2E-07	1.9E-01
913	trans scram -slc.or.rods PCS/TRANS -srv.close FW/PCS.TRANS HPCI rcic -srv.ads -cond/fw.pcs -rhr(sdc)	CV	3.0E-07	1.6E-02
941	trans scram -slc.or.rods PCS/TRANS srv.close fw/pcs.loca HPCI -srv.ads -cond/fw.pcs -rhr(sdc)	CV	2.7E-07	2.2E-02
963	trans scram slc.or.rods	ATWS	7.0E-06	1.0E+00

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
101	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close -FW/PCS.TRANS rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	8.4E-06	1.9E-01
102	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close -FW/PCS.TRANS rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v rhrsw(c.i.and.v)	CD	1.7E-06	7.6E-02
104	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS -HPCI rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	3.9E-06	9.0E-02
105	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS -HPCI rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v rhrsw(c.i.and.v)	CD	8.0E-07	3.5E-02
107	trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS HPCI -rcic rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	4.2E-07	9.9E-03
126	trans -scram PCS/TRANS srv.chall/trans.-scram srv.close -fw/pcs.loca rhr(sdc) rhr(spcool)/-lpci.rhr(sdc) -c.i.and.v -rhrsw(c.i.and.v)	CV	3.2E-07	1.9E-01
145	trans -scram PCS/TRANS srv.chall/trans.-scram srv.close fw/pcs.loca HPCI srv.ads	CD	1.6E-05	2.4E-02
913	trans scram -slc.or.rods PCS/TRANS -srv.close FW/PCS.TRANS HPCI rcic -srv.ads -cond/fw.pcs -rhr(sdc)	CV	3.0E-07	1.6E-02
941	trans scram -slc.or.rods PCS/TRANS srv.close fw/pcs.loca HPCI -srv.ads -cond/fw.pcs -rhr(sdc)	CV	2.7E-07	2.2E-02
963	trans scram slc.or.rods	ATWS	7.0E-06	1.0E+00

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\newmodel\bwr_cnew.cmp
BRANCH MODEL: c:\asp\newmodel\brunswck.new
PROBABILITY FILE: c:\asp\newmodel\bwr_cnew.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	8.6E-04	1.0E+00	
loop	1.7E-05	3.2E-01	
loca	3.3E-06	5.0E-01	
scram	3.5E-04	1.0E+00	
slc.or.rods	1.0E-02	1.0E+00	1.0E-02
PCS/TRANS	1.7E-01 > 1.0E+00	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	1.7E-01 > Unavailable		
srv.chall/trans.-scram	1.0E+00	1.0E+00	
srv.chall/loop.-scram	1.0E+00	1.0E+00	
srv.close	3.6E-02	1.0E+00	
emerg.power	2.9E-03	8.0E-01	
ep.rec	1.0E+00	1.7E-01	
FW/PCS.TRANS	4.6E-01 > 1.0E+00	3.4E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	4.6E-01 > Unavailable		
fw/pcs.loca	1.0E+00	3.4E-01	
HPCI	2.9E-02 > 1.0E+00	7.0E-01 > 1.0E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.9E-02 > Failed		
rcic	6.0E-02	7.0E-01	
crd	1.0E-02	1.0E+00	1.0E-02
srv.ads	3.7E-03	7.1E-01	1.0E-02
cond/fw.pcs	1.0E+00	3.4E-01	1.0E-03
lpcs	3.0E-03	3.4E-01	
lpci(rhr)/lpcs	1.0E-03	7.1E-01	
rhr(sdc)	2.1E-02	3.4E-01	1.0E-03
rhr(sdc)/-lpci	2.0E-02	3.4E-01	1.0E-03
rhr(sdc)/lpci	1.0E+00	1.0E+00	1.0E-03
rhr(spcool)/-lpci.rhr(sdc)	2.0E-03	1.0E+00	
rhr(spcool)/lpci.rhr(sdc)	5.2E-01	1.0E+00	
c.i.and.v	1.0E-03	1.0E+00	1.0E-02
rhrsw	2.0E-02	3.4E-01	2.0E-03

Event Identifier: 324/87-004

rhrsw(c.i.and.v)	5.0E-01	3.4E-01

* branch model file
** forced

Minarick
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