

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 as 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

Event Identifier: 324/87-004

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
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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

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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/p cs.loca HPCI srv.ads	CD	1.6E-05	2.4E-02
102 trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close -FW/P CS.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/P CS.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/P CS.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/P CS.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/P CS.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/p cs.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 H PCI 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/p.cs.loca HP CI -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)

Event Identifier: 324/87-004

Sequence	End State	Prob	N Rec**
101 trans -scram PCS/TRANS srv.chall/trans.-scram -srv.close -FW/P CS.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/P CS.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/P CS.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/P CS.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/P CS.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/p cs.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/p cs.loca HPCI srv.ads	CD	1.6E-05	2.4E-02
913 trans -scram -slc.or.rods PCS/TRANS -srv.close FW/PCS.TRANS H PCI 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 HP CI -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\brunswick.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:			
srv.chall/trans.-scram	1.7E-01 > Unavailable	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:			
fw/pcs.loca	4.6E-01 > Unavailable	3.4E-01	
HPCI	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:			
rcic	2.9E-02 > Failed	7.0E-01	
crd	6.0E-02	1.0E+00	1.0E-02
srv.ads	1.0E-02	1.0E+00	1.0E-02
cond/fw.pcs	3.7E-03	7.1E-01	1.0E-02
lpcs	1.0E+00	3.4E-01	1.0E-03
lpci(rhr)/lpcs	3.0E-03	3.4E-01	
rhr(sdc)	1.0E-03	7.1E-01	
rhr(sdc)/-lpci	2.1E-02	3.4E-01	1.0E-03
rhr(sdc)/lpci	2.0E-02	3.4E-01	1.0E-03
rhr(spcool)/-lpci.rhr(sdc)	1.0E+00	1.0E+00	1.0E-03
rhr(spcool)/lpci.rhr(sdc)	2.0E-03	1.0E+00	
c.i.and.v	5.2E-01	1.0E+00	
rhrsw	1.0E-03	1.0E+00	1.0E-02
	2.0E-02	3.4E-01	2.0E-03

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rhsw(c.i.and.v)

5.0E-01

3.4E-01

* branch model file
** forced

Minarick
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