PRECURSOR DESCRIPTION SHEET

LER No.: 331/84-028
Event Description: LOOP and HPCI Trip
Date of Event: July 14, 1984
Plant: Duane Arnold

EVENT DESCRIPTION

Sequence

On July 14, 1984 at 1524 h, with the reactor at 0% thermal power, in the startup mode at 176 psig, the essential buses were automatically transferred from offsite to onsite power because of degraded offsite grid voltage. As per design, the reactor protection system was de-energized, resulting in a scram. The two essential and two nonessential 4160-kV buses were receiving offsite power via the startup transformer when the essential bus's undervoltage protection instrumentation sensed grid voltage <92.3% of nominal for +8 s. Consequently, the essential bus breakers tripped, as per design. The nonessential buses remained energized, and no load shedding occurred because grid voltage did not drop below 65% of nominal. Both DGs auto started upon loss of power to the essential buses and within 10 s had assumed the essential bus's loads. The degraded voltage was caused by the accidental motoring of a 650-MW(e) generator for over 20 s at the Louisa Generating Station.

The HPCI inboard steam supply valve (BJ-ISV-2238) closed following the scram. Although this was not per design, if necessary the valve could have been opened within a short time by manual operation after resetting the HPCI logic. This was done later at 1810 h after Operations personnel had returned other systems to normal. The false isolation signal due to the power loss was received from the SLDS. The isolation may have been due to a spurious signal from one or both SLDS temperature switches.

The reactor scram was reset at 1556 h, following the restarting of the reactor protection system M-G sets. All required systems were returned to normal by 1600 h. At 1620 h after the Iowa Electric system control center had advised the plant that recurrence of the grid voltage excursion was unlikely, the essential buses were transferred back to the startup transformer, and both diesels were unloaded. The diesels were secured at 1642 h. After a postevent review determined the operability of all safety-related systems and concluded that there had been no effect upon safe plant operation, startup of the reactor was commenced at 1901 h.

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Corrective Action

On October 15, 1984, a special test procedure was run on the "A" logic of the HPCI SLDS. The reactor was in the shutdown mode for a planned maintenance outage, with RV pressure below that at which Technical Specifications requires HPCI to be operable. A review of the isolation logic for the HPCI inboard steam supply valve indicated that the spurious isolation of this valve following the LOOP on July 14, 1984, most likely originated in the HPCI SLDS isolation logic (temperature switches).

Three trials of the test procedure were performed. On the first and third trials, the suspected temperature switches (TS-2261A and TDS-2260A) closed and quickly reopened upon restoration of power. The result was an isolation signal of short duration that was sealed into the HPCI isolation logic. The second test produced no isolation signal. Test results proved that a random signal could be expected from the two suspect instruments upon reenergizing after LOOP.

After review, a minor design change was instituted to eliminate the random HPCI ac power dependency that results from powering up the HPCI SLDS logic. The design change implemented in both the "A" and "B" logic trains was to introduce a short time delay of ~1 s on restoration of ac power.

Plant/Event Data

Systems Involved:
HPCI and electrical power

Components and Failure Modes Involved:
HPCI isolation valve — spurious operation
Essential buses — transferred to onsite power

Component Unavailability Duration: NA
Plant Operating Mode: 2 (0% power)
Discovery Method: Operational event
Reactor Age: 10.3 years
Plant Type: BWR

Comments

The assumption for this analysis is that the Louisa station generator motoring, which initiated the event, could have occurred while Duane Arnold was at power.

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MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate

LOOP	0.34	Potential grid recovery considered possible within 30 min

Branches Impacted and Branch Non-Recovery Estimate

HPCI	0.12	Recovery possible from control room after HPCI logic reset

Plant Models Utilized

BWR plant Class C

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CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

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Event Description: LOOP and HPCI Trip
Event Date: 7/14/84
Plant: Duane Arnold

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	3.4E-01

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CV	
LOOP	5.8E-07
Total	5.8E-07
CD	
LOOP	7.3E-05
Total	7.3E-05
ATWS	
LOOP	7.1E-06
Total	7.1E-06

DOMINANT SEQUENCES

End State: CV Conditional Probability: 5.7E-07

226 LOOP -EMERG.POWER SCRAM -SLC.OR.RODS HPCI RCIC/TRANS.OR.LOOP -SRV.ADS -LPCS -RHR(SDC)

End State: CD Conditional Probability: 5.0E-05

215 LOOP -EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM SRV.CLOSE HPCI RCIC/LOCA SRV.ADS

End State: ATWS Conditional Probability: 6.9E-06

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240 LOOP -EMERG.POWER SCRAM SLC.OR.RODS

SEQUENCE CONDITIONAL PROBABILITIES

	Sequence	End State	Prob	N Rec**
201	LOOP -EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM -SRV.CLOSE -HP CI RHR(SDC) RHR(SPCOOL)/-LPCI.RHR(SDC) C.I.AND.V/RHR(SDC).RHR(SPCOOL)	CD	1.4E-05	3.5E-02
202	LOOP -EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM -SRV.CLOSE HP CI -RCIC/TRANS.OR.LOOP RHR(SDC) RHR(SPCOOL)/-LPCI.RHR(SDC) C.I.AND.V/RHR(SDC).RHR(SPCOOL)	CD	1.8E-06	4.6E-03
208	LOOP -EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM -SRV.CLOSE HP CI RCIC/TRANS.OR.LOOP CRD SRV.ADS	CD	3.5E-06	2.3E-02
215	LOOP -EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM SRV.CLOSE HP CI RCIC/LOCA SRV.ADS	CD	5.0E-05 *	4.1E-02
226	LOOP -EMERG.POWER SCRAM -SLC.OR.RODS HPCI RCIC/TRANS.OR.LOOP -SRV.ADS -LPCS -RHR(SDC)	CV	5.7E-07 *	2.3E-02
240	LOOP -EMERG.POWER SCRAM SLC.OR.RODS	ATWS	6.9E-06 *	3.4E-01
243	LOOP EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM -SRV.CLOSE HP CI RCIC/TRANS.OR.LOOP	CD	2.2E-06	1.2E-02
246	LOOP EMERG.POWER -SCRAM SRV.CHALL/LOOP.-SCRAM SRV.CLOSE HP CI RCIC/LOCA	CD	1.6E-06	2.1E-02

* dominant sequence for end state
** non-recovery credit for edited case

MODEL: b:\BWRCTREE.CMP
DATA: b:\ARNOLPRO.CMP

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
TRANS	1.1E-03	1.0E+00	
LOOP	1.3E-05	3.4E-01	
LOCA	3.3E-06	3.4E-01	
SCRAM	4.1E-04	1.0E+00	
SLC.OR.RODS	1.0E-02	1.0E+00	4.0E-02
PCS/TRANS	1.7E-01	1.0E+00	
PCS/LOCA	1.0E+00	1.0E+00	
SRV.CHALL/TRANS.-SCRAM	1.0E+00	1.0E+00	
SRV.CHALL/TRANS.SCRAM	1.0E+00	1.0E+00	
SRV.CHALL/LOOP.-SCRAM	1.0E+00	1.0E+00	
SRV.CHALL/LOOP.SCRAM	1.0E+00	1.0E+00	
SRV.CLOSE	2.6E-02	1.0E+00	
EMERG.POWER	2.9E-03	5.1E-01	

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FW/PCS.TRANS	2.9E-01	3.4E-01	
FW/PCS.LOCA	4.0E-02	3.4E-01	
HPCI	1.0E-01 > 1.0E+00	5.7E-01 > 1.2E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	1.0E-01 > Failed		
RCIC/TRANS.OR.LOOP	6.7E-02	5.7E-01	
RCIC/LOCA	1.0E+00	1.0E+00	
CRD	1.0E-02	1.0E+00	4.0E-02
SRV.ADS	6.7E-03	1.0E+00	4.0E-02
COND/FW.PCS	1.0E+00	3.4E-01	
LPCS	3.0E-03	3.4E-01	
LPCI(RHR)/LPCS	4.0E-04	3.4E-01	
RHRSW/LPCS.LPCI.TRANS	5.0E-01	1.0E+00	4.0E-02
RHRSW/LPCS.LPCI.LOOP	5.0E-01	1.0E+00	4.0E-02
RHRSW/LPCS.LPCI.LOCA	5.0E-01	1.0E+00	4.0E-02
RHR(SDC)	2.0E-02	3.4E-01	
RHR(SDC)/-LPCI	2.0E-02	3.4E-01	
RHR(SDC)/LPCI	1.0E+00	1.0E+00	
RHR(SPCOOL)/-LPCI.RHR(SDC)	2.0E-02	1.0E+00	
RHR(SPCOOL)/LPCI.RHR(SDC)	5.2E-01	1.0E+00	
C.I.AND.V/RHR(SDC).RHR(SPCOOL)	1.0E+00	3.4E-01	

*** forced

Minarick
04-12-1987
16:32:12

Event Identifier: 331/84-028