

## PRECURSOR DESCRIPTION SHEET

LER No.: 285/87-025, 87-033, 88-010  
Event Description: Undetected failures from instrument air-water intrusion  
Date of Event: 7/6/87  
Plant: Fort Calhoun

## EVENT DESCRIPTION

Sequence

In 1985 the DG room fire system was converted from a water wet-pipe system to a water dry-pipe system to prevent any possibility of freezing pipes during winter operations. Instrument air was supplied to the dry-pipe up to valve FP-513 through two check valves (IA-575, -576) and an air maintenance device intended to hold the valve clapper closed. When the fire system is actuated (in test or for real), the air pressure is rapidly dropped and the valve opens to admit water to the deluge headers. Once opened, the dry-pipe valve must be manually closed. During testing of the fire system on 7/16/87, the check valves failed open from foreign material (unspecified) and the operator failed to properly reset the dry-pipe valve due to inadequate training and procedures. The air maintenance device was bypassed. Water then entered the instrument air system since the fire system water pressure was 30 psi higher than the air pressure. The operator saw that the air side/water side pipe pressure gauges were at the fire main pressure and realized that this could only occur if the dry-pipe valve had failed to reset. He closed an isolation valve (FP-514). It was estimated that 10-15 gal of water entered the air system.

Over the next several hours several problems occurred. The DG fuel oil bubbler level gage failed high. The CCW SDC heat exchanger outlet valve opened. The demineralizer water makeup flow controller to the boric acid system had water at its flow control valve.

The dry-pipe check valves were repaired and the dry-pipe valve was properly reset. The instrument air system was blown down to remove the water. Engineers began a study to see what other corrective actions would be required.

The immediate system blowdown indicated that the water intrusion was confined to the lower two levels of the auxiliary building. No water was found in the turbine building or intake structure. By the end of the day, it was believed that most of the water had been removed from the air system. On July 9, 515 individual components had been blown down and the safety-related air accumulators had been drained (except for the DG 2 radiator exhaust damper accumulators, which were overlooked). Water was found in <10% of the components. Many valves were also cycled and tested. Eight components on four risers had some water and were scheduled for rechecking in September.

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On Sept. 23, during a test, the DG 2 automatically shut down due to high coolant temperature. The radiator exhaust dampers failed to fully open due to the prior water intrusion incident on 7/6/87. The lack of full air flow through the radiator resulted in the high coolant temperature. The pilot orifice valve was found to be blocked by foreign material, most likely from the interaction of O-ring lubricant and water. The backup air accumulator for the pilot valve was found to contain 50% water (2 quarts). Because the problem might exist on DG 1, the damper valves on DG 1 were fully opened. Water was subsequently found in the accumulator for DG 1.

On April 15, 1988, a further problem due to the water intrusion was discovered. Leak tests were being performed on four check valves upstream of air accumulators on lines feeding the safety injection and refueling water tank (SIRWT) bubbler level control sensors. These bubblers cause ECCS suction to switch to the sump on low tank level. The four check valves were unable to hold a back-pressure. On a loss of instrument air, the bubblers would sense a false low level and switch ECCS suction to the sump. The recirculation actuation signal would also lock out the LPI pumps, which do not have sump recirculation capability. The sump would not likely have sufficient water level to provide proper suction to the HPI and containment spray pumps, and the pumps would fail.

#### Corrective Action

Procedure changes were made. The bubbler check valves were replaced. The SG air problems were corrected. Other repairs were made.

#### Plant/Event Data

##### Systems Involved:

- Instrument air
- Fire
- ECCS
- Emergency power

##### Components and Failure Modes Involved:

- Unauthorized fire water/air line connection in maintenance
- Water on DG air start system causes test failure
- Water in instrument air fails sump recirculation isolation valves in test

Component Unavailability Duration: 1986 h for EPS  
6096 h for recirculation failure

Plant Operating Mode: 1 (100%)

Discovery Method: Testing

Reactor Age: 14.7 y

Plant Type: PWR

Event Identifier: 285/87-025,87-033,88-010

Comments

The operating personnel failed to identify all the consequences of the water intrusion into the instrument air system. Their testing of components served by the air system was incomplete, so the DG and recirculation failures were only detected as they occurred during subsequent safety system surveillance tests.

Air compressors at Fort Calhoun are not automatically loaded on the diesel-backed buses following LOOP (although they can be manually loaded). Loss of IA on LOOP is assumed for the purposes of this analysis.

Two calculations have been provided to assess the impact of this event:

1. unavailability of EPS and HPI, HPR, F&B, and LPI for 1896 h [ $p(cd) = 6.2 \times 10^{-4}$ ]
2. unavailability of HPI, HPR, F&B, and LPI for 4110 h [ $p(cd) = 7.7 \times 10^{-7}$ ]

Overall core damage probability estimate =  $6.2 \times 10^{-4}$

MODELING CONSIDERATION AND DECISIONSInitiators Modeled and Initiator Nonrecovery Estimate

Postulated LOOP	Base case nonrecovery
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Branches Impacted and Branch Nonrecovery Estimate

EPS	1.0	Short-term recovery is unlikely
HPI, HPR,	1.0	HPI pump failure expected on early
B&F		transfer of suction to the
		containment sump on loss of
		instrument air

Plant Models Utilized

PWR plant Class G

## CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 285/87-025, 87-033, 88-010  
 Event Description: Undetected failures from IA water intrusion (calc 1)  
 Event Date: 07/06/87  
 Plant: Fort Calhoun

UNAVAILABILITY, DURATION= 1896

## NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 3.4E-03

## SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	6.2E-04
Total	6.2E-04
CV	
LOOP	1.4E-05
Total	1.4E-05
ATWS	
LOOP	0.0E+00
Total	0.0E+00

## SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

Sequence	End State	Prob	N Rec**
217 loop -rt/loop EMERG.POWER ep.rec	CD	5.7E-04	6.6E-02
216 loop -rt/loop EMERG.POWER -ep.rec afw/emerg.power	CD	4.8E-05	1.1E-01
215 loop -rt/loop EMERG.POWER -ep.rec -afw/emerg.power -porv.or.srv .chall ss.releas.term	CV	1.3E-05	1.1E-01
213 loop -rt/loop EMERG.POWER -ep.rec -afw/emerg.power porv.or.srv .chall -porv.or.srv.reseat/emerg.power ss.releas.term	CV	5.5E-07	1.1E-01

\*\* non-recovery credit for edited case

## SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

Sequence	End State	Prob	N Rec**
213 loop -rt/loop EMERG.POWER -ep.rec -afw/emerg.power porv.or.srv .chall -porv.or.srv.reseat/emerg.power ss.releas.term	CV	5.5E-07	1.1E-01
215 loop -rt/loop EMERG.POWER -ep.rec -afw/emerg.power -porv.or.srv .chall ss.releas.term	CV	1.3E-05	1.1E-01
216 loop -rt/loop EMERG.POWER -ep.rec afw/emerg.power	CD	4.8E-05	1.1E-01
217 loop -rt/loop EMERG.POWER ep.rec	CD	5.7E-04	6.6E-02

\*\* non-recovery credit for edited case

Note: For unavailabilities, conditional probability values are differential values which reflect the added risk due to failures associated with an event. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

SEQUENCE MODEL: c:\asp\newmodel\pwr\_gnew.cmp  
 BRANCH MODEL: c:\asp\newmodel\calhoun.new  
 PROBABILITY FILE: c:\asp\newmodel\pwr\_bnew.pro

Event Identifier: 285/87-025, 87-033, 88-010

No Recovery Limit

## BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	4.8E-04	1.0E+00	
loop	4.6E-06	3.9E-01	
loca	2.4E-06	4.3E-01	
rt	2.8E-04	1.2E-01	
rt/loop	0.0E+00	1.0E+00	
EMERG.POWER	2.9E-03 > 1.0E+00	8.0E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02 > Failed		
Train 2 Cond Prob:	5.7E-02 > Failed		
ep.rec	1.0E+00	1.7E-01	
afw	3.8E-04	2.6E-01	
afw/emerg.power	5.0E-02	3.4E-01	
mfw	2.0E-01	3.4E-01	
porv.or.srv.chall	4.0E-02	1.0E+00	
porv.or.srv.reseat	2.0E-02	1.1E-02	
porv.or.srv.reseat/emerg.power	2.0E-02	1.0E+00	
ss.releas.term	1.5E-02	3.4E-01	
ss.depress	3.6E-02	1.0E+00	
cond/mfw	1.0E+00	3.4E-01	1.0E-02
HPI	3.0E-04 > 1.0E+00	8.4E-01 > 1.0E+00	
Branch Model: 1.OF.3			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01 > Failed		
HPI (F/B)	3.0E-04 > 1.0E+00	8.4E-01 > 1.0E+00	1.0E-02
Branch Model: 1.OF.3+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01 > Failed		
porv.open	1.0E-02	1.0E+00	4.0E-04
hpr/-hpi	1.5E-04	1.0E+00	
csr	2.0E-03	3.4E-01	
* branch model file			
** forced			

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## CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 285/87-025, 87-033, 88-010  
 Event Description: Undetected failures from IA water intrusion (calc 2)  
 Event Date: 07/06/87  
 Plant: Fort Calhoun

UNAVAILABILITY, DURATION= 4110

## NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 7.4E-03

## SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	7.7E-07
Total	7.7E-07
CV	
LOOP	3.7E-05
Total	3.7E-05
ATWS	
LOOP	0.0E+00
Total	0.0E+00

## SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
212	loop -rt/loop -emerg.power afw HPI(F/B)	CD	7.1E-07	1.0E-01
252	loop -rt/loop -emerg.power -afw porv.or.srv.chall porv.or.srv. reset HPI	CD	6.4E-08	4.3E-03
209	loop -rt/loop -emerg.power -afw -porv.or.srv.chall ss.releas.te rm HPI	CV	3.6E-05	1.3E-01
201	loop -rt/loop -emerg.power -afw porv.or.srv.chall -porv.or.srv. reset ss.releas.term HPI	CV	1.5E-06	1.3E-01

\*\* non-recovery credit for edited case

## SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
201	loop -rt/loop -emerg.power -afw porv.or.srv.chall -porv.or.srv. reset ss.releas.term HPI	CV	1.5E-06	1.3E-01
252	loop -rt/loop -emerg.power -afw porv.or.srv.chall porv.or.srv. reset HPI	CD	6.4E-08	4.3E-03
209	loop -rt/loop -emerg.power -afw -porv.or.srv.chall ss.releas.te rm HPI	CV	3.6E-05	1.3E-01
212	loop -rt/loop -emerg.power afw HPI(F/B)	CD	7.1E-07	1.0E-01

\*\* non-recovery credit for edited case

Note: For unavailabilities, conditional probability values are differential values which reflect the added risk due to failures associated with an event. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

SEQUENCE MODEL: c:\asp\newmodel\pwr\_gnew.cmp  
 BRANCH MODEL: c:\asp\newmodel\calhoun.new

Event Identifier: 285/87-025, 87-033, 88-010

PROBABILITY FILE: c:\asp\newmodel\pwr\_bnew.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	4.8E-04	1.0E+00	
loop	4.6E-06	3.9E-01	
loca	2.4E-06	4.3E-01	
rt	2.8E-04	1.2E-01	
rt/loop	0.0E+00	1.0E+00	
emerg.power	2.9E-03	8.0E-01	
ep.rec	1.0E+00	1.7E-01	
afw	3.8E-04	2.6E-01	
afw/emerg.power	5.0E-02	3.4E-01	
mfw	2.0E-01	3.4E-01	
porv.or.srv.chall	4.0E-02	1.0E+00	
porv.or.srv.reseat	2.0E-02	1.1E-02	
porv.or.srv.reseat/emerg.power	2.0E-02	1.0E+00	
ss.releas.term	1.5E-02	3.4E-01	
ss.depress	3.6E-02	1.0E+00	
cond/mfw	1.0E+00	3.4E-01	1.0E-02
HPI	3.0E-04 > 1.0E+00	8.4E-01 > 1.0E+00	
Branch Model: 1.OF.3			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01 > Failed		
HPI (F/B)	3.0E-04 > 1.0E+00	8.4E-01 > 1.0E+00	1.0E-02
Branch Model: 1.OF.3+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
Train 3 Cond Prob:	3.0E-01 > Failed		
porv.open	1.0E-02	1.0E+00	4.0E-04
hpr/~hpi	1.5E-04	1.0E+00	
csr	2.0E-03	3.4E-01	

\* branch model file  
\*\* forced

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