

PRECURSOR DESCRIPTION SHEET

LER No.: 285/86-001
Event Description: Trip occurs, and automatic depressurization and turbine bypass sytem fails to open
Date of Event: July 2, 1986
Plant: Ft. Calhoun

EVENT DESCRIPTION

Sequence

At 0534 h, during normal operation while the reactor was at 100% power, an instrument inverter trouble alarm was received in the control room. Control room operators quickly diagnosed a failed instrument inverter feeding bus AI-40A. They dispatched an equipment operator to the switchgear room to reenergize the bus manually by closing the breaker on a bypass transformer also feeding bus AI-40A. The inverter failure placed the RPS in a half-trip condition because the RPS operates on a two-out-of-four logic and the failed inverter was one of four feeding the independent channels of the RPS. About 10 s after the inverter failure, a reactor trip occurred when a second channel trip was received on the SG B low-level trip unit.

Several unusual transients were noted in the moments following the trip:

1. RCS pressure increased to ~2400 psia for a short period of time. This caused PORVs to be actuated.
2. SG pressure increased to the set point of the secondary safety valves, causing them to be actuated.
3. Overfeeding the SG resulted in abnormally high level and subsequent overcooling of the primary system. As a result, RCS pressure decreased to a low of ~1725 psia. The overfeeding occurred because the main feed regulating valves failed to ramp down; the failure was due to loss of power to a relay when the inverter failed.
4. Steam dump and bypass valves could not be opened because the inverter power was lost to their controllers as well as to a relay that causes the dump valve to open.
5. The operating charging pump stopped, and the two backup pumps could not be started because of loss of inverter power to the relay that controls the backup pump's operations. Although the operating pump should not have stopped, for an unknown reason it did.

Within 1 min of the reactor trip, the equipment operator had reenergized the lost instrument bus, and control room operators were soon able to restore the plant to normal shutdown condition.

Event Identifier: 285/86-001

A diagnosis of the information revealed the following. The deenergized instrument bus AI-40A supplies power to electrohydraulic-control panel AI-50 with no alternate power. A turbine first-stage pressure transmitter that sends a signal to the electrohydraulic-control load-control circuitry is powered from AI-50. Loss of power caused a loss of signal to the load-control unit, resulting in the turbine control valves closing without a reactor trip. This explains the high pressure seen in the primary system and the low SG level earlier in the transient.

Corrective Action

Modification was made to the bus and inverter power transfer controls to provide backup power.

Plant/Event Data

Systems Involved:

Atmospheric steam dump, turbine bypass, charging, and electrical

Components and Failure Modes Involved:

Inverter — failed in operation

Automatic depressurization and turbine bypass system — failed on demand

Charging — failed in operation

Component Unavailability Duration:

Plant Operating Mode: 1 (100% power)

Discovery Method: Operational event

Reactor Age: 12.9 years

Plant Type: PWR

Comments

None

MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate

| | | |
|-----------|-----|-------------|
| Transient | 1.0 | No recovery |
|-----------|-----|-------------|

Branches Impacted and Branch Nonrecovery Estimate

| | | |
|---------------------|------|-----------------------------------|
| SS depressurization | 0.34 | Recoverable locally at the valves |
|---------------------|------|-----------------------------------|

Plant Models Utilized

PWR plant Class G

Event Identifier: 285/86-001

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 285/86-001
 Event Description: Trip and ADS/TBS/ Fails to Open
 Event Date: 7/2/86
 Plant: Fort Calhoun

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS 1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

| End State/Initiator | Probability |
|---------------------|-------------|
| CV | |
| TRANS | 1.5E-06 |
| Total | 1.5E-06 |
| CD | |
| TRANS | 4.1E-05 |
| Total | 4.1E-05 |
| ATWS | |
| TRANS | 3.4E-05 |
| Total | 3.4E-05 |

DOMINANT SEQUENCES

| | |
|---|----------------------------------|
| End State: CV | Conditional Probability: 1.3E-06 |
| 101 TRANS -RT -AFW PORV.OR.SRV.CHALL -PORV.OR.SRV.RESEAT SS.RELEAS.TERM HPI | |
| End State: CD | Conditional Probability: 4.0E-05 |
| 102 TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HPR/-HPI | |
| End State: ATWS | Conditional Probability: 3.4E-05 |

Event Identifier: 285/86-001

121 TRANS RT

SEQUENCE CONDITIONAL PROBABILITIES

| | Sequence | End State | Prob | N Rec** |
|-----|---|-----------|-----------|---------|
| 101 | TRANS -RT -AFW PORV.OR.SRV.CHALL -PORV.OR.SRV.RESEAT SS.RELE AS.TERM HPI | CV | 1.3E-06 * | 2.9E-01 |
| 102 | TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HP R/-HPI | CD | 4.0E-05 * | 5.0E-02 |
| 115 | TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS -COND/MFW | CV | 1.1E-07 | 3.9E-02 |
| 118 | TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS -COND/MFW | CV | 1.2E-07 | 3.2E-02 |
| 121 | TRANS RT | ATWS | 3.4E-05 * | 1.2E-01 |

* dominant sequence for end state

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\newmodel\pwrqtree.cmp
 BRANCH MODEL: c:\asp\newmodel\calhoun.txt
 PROBABILITY FILE: c:\asp\newmodel\pwr_b.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 | 5.4E-04 | 8.0E-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 ** | 1.0E+00 | |
| Branch Model: 1.OF.1 | | | |
| Train 1 Cond Prob: | | | |
| PORV.OR.SRV.RESEAT | 2.0E-02 | 5.0E-02 | |
| PORV.OR.SRV.RESEAT/EMERG.POWER | 2.0E-02 | 1.0E+00 | |
| SS.RELEAS.TERM | 1.5E-02 | 3.4E-01 | |
| SS.RELEAS.TERM/-MFW | 1.5E-02 | 3.4E-01 | |
| SS.DEPRESS | 3.6E-02 > 1.0E+00 | 1.0E+00 > 3.4E-01 | |
| Branch Model: 1.OF.1 | | | |
| Train 1 Cond Prob: | | | |
| COND/MFW | 1.0E+00 | 3.4E-01 | |
| HPI | 3.0E-04 | 8.4E-01 | |
| HPI(F/B) | 3.0E-04 | 8.4E-01 | 4.0E-02 |

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| | | |
|-----------|---------|---------|
| PORV.OPEN | 1.0E-02 | 1.0E+00 |
| HPR/-HPI | 1.5E-04 | 1.0E+00 |
| CSR | 2.0E-03 | 3.4E-01 |

* branch model file
** forced

Austin
09-11-1987
12:25:00