PRECURSOR DESCRIPTION AND ANALYSIS

LER No.: 346/85-013
Event Description: LOFW and AFW Failure
Date of Event: June 9, 1985
Plant: Davis-Besse 1

EVENT DESCRIPTION

Sequence

While operating at 90% of full power, the No. 1 MFW pump turbine tripped on overspeed because of a control failure. An automatic plant runback was initiated because the No. 2 pump did not have adequate capacity for the existing reactor power, but the reactor still tripped on high RCS pressure 30 s later. The pump was under manual control because of ICS control problems. Within 8 s of the reactor trip, a spurious Steam and Feedwater Rupture Control System (SFRCS) full trip occurred, closing both MSIVs, resulting in isolation of steam to the No. 2 MFW pump turbine. This spurious trip resulted in only a partial actuation of the SFRCS components because only the MSIVs closed. With MFW unavailable, steam generator water levels decreased to the low SG level trip set point of the SFRCS, and SFRCS Channel 1 initiated the No. 1 AFW pump.

To align the No. 2 AFW pump, a control room operator attempted to manually initiate the SFRCS but incorrectly initiated SFRCS on low steam pressure instead of low SG level. He also actuated it for both SGs, resulting in isolation of AFW to both SGs. Independently of the SG isolation, both AFW pumps tripped on overspeed. The SFRCS was manually reset, but the AFW isolation valves failed to open on demand automatically or from the control room.

RCS temperature and pressure increased because of the loss of heat transfer. The pressurizer PORV actuated three times and did not reseat at the proper RCS pressure after the third actuation. The control room operator closed the PORV block valve but did not realize the PORV had remained open. Operators placed the startup feed pump in operation, locally opened the AFW isolation valves, and restored both AFW to service. The quench tank contained the discharges from the PORV.

The RCS cooldown had lowered RCS pressure to 1720 psig. The operators manually initiated the No. 1 HPI pump in piggyback mode to restore pressure. Adequate subcooled margin was available throughout the transient. Several other equipment malfunctions that did not affect the physical response of the plant occurred. Two source range nuclear instrumentation channels were inoperable (emergency boration was successfully initiated manually, as a result). The display units for the SPDS, including SG level, were inoperable in the control room at the

time of the trip. Twenty-three minutes into the transient, the suction of the No. 1 AFW pump automatically transferred from the CST, to the SW system. The operator manually realigned the pump suction back to the CST. One main turbine bypass valve was discovered failed closed.

Corrective Action

Additional information on the event is provided in the two-volume "Davis-Besse Course of Action" submittals. See LER pp. 8 and 18—20.

Plant/Event Data

Systems Involved:
SFRCS, MFW, main steam isolation, AFW, and PORV

Components and Failure Modes Involved:
SFRCS — design failure and operator actuation error

AFW pumps — failed on demand
AFW isolation valves — failed to open on demand
PORV — failed to close on demand
One MFW pump — made unavailable because of spurious SFRCS actuation
Other MFW pump — failed on demand

Component Unavailability Duration: NA
Plant Operating Mode: 90% power
Discovery Method: Operational event
Reactor Age: 7.8 years
Plant Type: PWR

Comments

The plant has been shut down since this event. See LER pp. 8 and 9 for previous failures related to this event.

MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate

| | | |
|---|---|---|
| Transient | 1.0 | Nonrecoverable |

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Branches Impacted and Branch Nonrecovery Estimate

| | | |
|---|---|---|
| MFW and AFW | 0.34 | The probability of failing to restore either MFW or AFW was combined and estimated at 0.34. Difficult manual action locally at the AFW pumps, as well as use of the startup feed pump, would have restored feedwater to the SGs. (Note that the combined nonrecovery estimate is modeled by assuming no recovery on the AFW branch and carrying the 0.34 on the MFW branch.) |
| PORV challenged | 1.0 | The PORV was challenged in the transient |
| PORV reseats | 0.005 | 0.1 × 0.05 : 0.1 reflects the increased probability that the PORV would fail to reseat at design pressure given the failures during the event; 0.05 reflects the probability of failure to close the PORV block valve — 0.04 for the operator action plus 0.01 for the equipment component |
| Bleed and feed | See calculations | Branch tailoring was done to reflect the bleed-and-feed procedure implemented implemented during the event and to reflect the use of LPI as a suction source for HPR |
| HPR | See calculations | Branch tailoring was done to reflect the bleed-and-feed procedure implemented during the event and to reflect the use of LPI as a suction source for HPR |
| LPR | See calculations | Branch tailoring was done to reflect the bleed-and-feed procedure implemented during the event and to reflect the use of LPI as a suction source for HPR |

Plant Models Utilized

PWR plant Class B

CONDITIONAL CORE DAMAGE CALCULATIONS

LER Number: 346/85-013
Event Description: LOFW and AFW Failure
Event Date: 6/9/85
Plant: Davis-Besse

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

| | |
|---|---|
| TRANS | 1.000E+00 |

SEQUENCE CONDITIONAL PROBABILITY SUMS

| End State/Initiator | Probability |
|---|---|
| CV | |
| TRANS | 1.956E-02 |
| Total | 1.956E-02 |
| CD | |
| TRANS | 1.132E-02 |
| Total | 1.132E-02 |
| ATWS | |
| TRANS | 3.000E-05 |
| Total | 3.000E-05 |

DOMINANT SEQUENCES

End State: CV Conditional Probability: 9.085E-03

125 TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS -COND/MFW

End State: CD Conditional Probability: 4.680E-03

126 TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS COND/MFW

End State: ATWS Conditional Probability: 3.000E-05

128 TRANS RT

Event Identifier: 346/85-013

SEQUENCE CONDITIONAL PROBABILITIES

| | Sequence | End State | Seq. Prob | Non-Recov** |
|---|---|---|---|---|
| 119 | TRANS -RT AFW MFW -HPI(F/B) -HPR/-HPI PORV.OPEN -SS.DEPRESS -COND/MFW | CV | 1.987E-03 | 2.066E-01 |
| 120 | TRANS -RT AFW MFW -HPI(F/B) -HPR/-HPI PORV.OPEN -SS.DEPRESS COND/MFW | CD | 1.024E-03 | 1.064E-01 |
| 122 | TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS -COND/MFW | CV | 8.488E-03 | 1.325E-02 |
| 123 | TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS COND/MFW | CD | 4.373E-03 | 6.825E-03 |
| 124 | TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI SS.DEPRESS | CD | 4.803E-04 | 2.007E-02 |
| 125 | TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS -COND/MFW | CV | 9.085E-03 * | 1.388E-02 |
| 126 | TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS COND/MFW | CD | 4.680E-03 * | 7.148E-03 |
| 127 | TRANS -RT AFW MFW HPI(F/B) SS.DEPRESS | CD | 5.140E-04 | 2.102E-02 |
| 128 | TRANS RT | ATWS | 3.000E-05 * | 1.200E-01 |

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

Note:

Conditional probability values are differential values which reflect the added risk due to observed failures. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

MODEL: b:pwrbtree.cmp
DATA: b:davispro.cmp

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

| Branch | System | Non-Recov | Opr Fail |
|---|---|---|---|
| TRANS | 1.030E-03 | 1.000E+00 | |
| LOOP | 2.280E-05 | 3.400E-01 | |
| LOCA | 4.170E-06 | 3.400E-01 | |
| RT | 2.500E-04 | 1.200E-01 | |
| RT/LOOP | 0.000E+00 | 1.000E+00 | |
| EMERG.POWER | 2.850E-03 | 5.100E-01 | |
| AFW | 5.000E-03 > 1.000E+00 | 2.700E-01 > 1.000E+00 | |
| Branch Model: 1.OF.2 | | | |
| Train 1 Cond Prob: | 5.000E-02 > Failed | | |
| Train 2 Cond Prob: | 1.000E-01 > Failed | | |
| AFW/EMERG.POWER | 5.000E-03 > 1.000E+00 | 2.700E-01 > 1.000E+00 | |
| Branch Model: 1.OF.2 | | | |
| Train 1 Cond Prob: | 5.000E-02 > Failed | | |
| Train 2 Cond Prob: | 1.000E-01 > Failed | | |
| MFW | 2.000E-01 > 1.000E+00 | 3.400E-01 | |
| Branch Model: 1.OF.1 | | | |

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| | | | | |
|---|---|---|---|---|
| Train 1 Cond Prob: | 2.000E-01 > Failed | | | |
| PORV.OR.SRV.CHALL | 8.000E-02 > 1.000E+00 | 1.000E+00 | | |
| Branch Model: 1.OF.1 | | | | |
| Train 1 Cond Prob: | 8.000E-02 > 1.000E+00 | | | |
| PORV.OR.SRV.RESEAT | 1.000E-02 > 1.000E-01 | 5.000E-02 | | |
| Branch Model: 1.OF.1 | | | | |
| Train 1 Cond Prob: | 1.000E-02 > 1.000E-01 | | | |
| PORV.OR.SRV.RESEAT/EMERG.POWER | 1.000E-02 > 1.000E-01 | 5.000E-02 | | |
| Branch Model: 1.OF.1 | | | | |
| Train 1 Cond Prob: | 1.000E-02 > 1.000E-01 | | | |
| SS.RELEAS.TERM | 1.500E-02 | 3.400E-01 | | |
| SS.RELEAS.TERM/-MFW | 1.500E-02 | 3.400E-01 | | |
| HPI | 1.000E-03 | 5.200E-01 | | |
| HPI(F/B) | 1.000E-03 > 4.000E-03 | 5.200E-01 | | 4.000E-02 |
| Branch Model: 1.OF.2+opr | | | | |
| Train 1 Cond Prob: | 1.000E-02 > 4.000E-02 | | | |
| Train 2 Cond Prob: | 1.000E-01 | | | |
| HPR/-HPI | 3.000E-03 > 1.000E-03 | 5.600E-01 > 1.000E+00 | | 4.000E-02 |
| Branch Model: 1.OF.2+opr | | | | |
| Train 1 Cond Prob: | 3.000E-02 > 1.000E-02 | | | |
| Train 2 Cond Prob: | 1.000E-01 | | | |
| PORV.OPEN | 1.000E-02 | 1.000E+00 | | |
| SS.DEPRESS | 3.600E-02 | 1.000E+00 | | |
| COND/MFW | 1.000E+00 | 3.400E-01 | | |
| LPI/HPI | 1.000E-03 | 3.400E-01 | | |
| LPR/-HPI.HPR | 6.700E-01 > 1.000E+00 | 1.000E+00 | | |
| Branch Model: 1.OF.1 | | | | |
| Train 1 Cond Prob: | 6.700E-01 > 1.000E+00 | | | |
| LPR/HPI | 1.000E-03 | 1.000E+00 | | |

*** forced

Austin
08-13-1986
05:23:03

Event Identifier: 346/85-013