

PRECURSOR DESCRIPTION SHEET

LER No.: 346/84-003
Event Description: SFRCS Initiation Leads to Stuck-Open MSRV and Trip
Date of Event: March 28, 1984
Plant: Davis-Besse 1

EVENT DESCRIPTION

Sequence

At 1220 h on March 2, Davis-Besse 1 was operating at ~99% of full power. The plant was in full automatic control. During periodic steam and feedwater rupture control system (SFRCS) surveillance testing, a previously undetected SFRCS channel failure resulted in closure of the loop 2 MSIV. This caused an increase in feedwater to the other SG, which overcooled that side of the reactor. Flux increased because of the negative moderator coefficient. The reactor tripped on high flux ~13 s after MSIV 2 closed.

The cause of the MSIV closure was a failed optical isolator in a relay driver card for a relay in SFRCS Channel 4. This failure, undetected and in conjunction with normal testing on another channel, resulted in a close signal to MSIV 2. During troubleshooting, a wiring anomaly was found in the circuitry for MSIV 2. This anomaly, due to a circuit modification made in 1979, was the reason that the failed relay driver card had not been detected. Both an equipment failure and an installation and construction error were associated with the MSIV closure.

Following the reactor trip, steam pressure on SG 2 did not stabilize as would normally be expected. Local observation determined that main steam SRV, SP17A4, with a set pressure of 1070 psig, had not fully closed on the No. 2 steam line.

Subsequent investigation by the licensee determined that the cause of the valve sticking open was the failure of a cotter pin holding a nut in place on the valve stem. The nut rotated when the valve opened and prevented the safety valve from closing.

Manual actuation of SFRCS isolated SG 2. After AFW isolation, SG 2 boiled dry and depressurized to atmospheric pressure in ~5 min. This excessive depressurization rate caused the RCS to exceed the normal cooldown limits for a short time. Plant cooldown was conducted with SG 1, which was unaffected. At ~340°F RCS temperature, the failed MSRV was replaced. When operators attempted to restore level in SG 2, the AFW valve (AF599) failed to open. It was opened manually, and SG 2 level was restored to operable status. The plant was then cooled down to cold shutdown.

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It was determined later that an additional MSRV (SP17A1) on the No. 2 steam line had failed to open when it should have.

Corrective Action

MSRV SP17A4 was replaced. The cotter pins in all other MSRVs were replaced with stainless steel pins, and maintenance procedures were modified to ensure new pins are used after any maintenance or testing in the future.

MSRV SP17A1 was declared inoperable and gagged. It was to be repaired or replaced during the next refueling outage. The cause of its failure to lift was still unknown at the time. The RPS high-flux trips must be set <99.69% of rated thermal power with this safety inoperable.

The effects of the SG No. 2 boiling dry were analyzed, and it was concluded that the transient was within SG design limits. The effects of high main steam flow from SG 1 when MSIV 2 closed was analyzed. It was concluded that some (~100) tubes may have been unstable for a period of seconds. As corrective action, the suspect tubes were to be eddy-current tested during the next refueling outage.

The AFW valve AF599 problem was investigated. The motor operator torque switch settings were changed from 1.5 open and close to 1.0 close and 1.5 open. This was to prevent the valve disk from being jammed into its seat. This change was also made to AF608, the AFW valve for SG 1.

The faulty relay driver board in SFRCS Channel 4 was replaced. The wiring anomaly was corrected and verified not to exist in the circuitry for MSIV 1.

Plant/Event Data

Systems Involved:

Steam and feedwater rupture control, main steam relief, AFW

Components and Failure Modes Involved:

SFRCS Channel 4 relay card — failed in test

MSRV — failed to close in operation

AFW regulating valve — failed to open on demand

Component Unavailability Duration: NA

Plant Operating Mode: 1 (99% power)

Discovery Method: During testing

Reactor Age: 6.6 years

Plant Type: PWR

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Comments

Reference: Abnormal Occurrence Reports to Congress, NUREG-0090, 1(1), 36.

MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate

Transient	1.0	No recovery
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Branches Impacted and Branch Nonrecovery Estimate

MFW	Base case	Unavailable due to SFRCS trip
AFW	Base case	Degraded (one train unavailable)

Plant Models Utilized

PWR plant Class B (because it has low-head HPI, it is grouped with Class B and not Class D)

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CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

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INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00
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SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CV	
TRANS	2.6E-04
Total	2.6E-04
CD	
TRANS	1.5E-04
Total	1.5E-04
ATWS	
TRANS	3.0E-05
Total	3.0E-05

DOMINANT SEQUENCES

End State: CV	Conditional Probability:	1.2E-04
125 TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS -COND/MFW		
End State: CD	Conditional Probability:	6.1E-05
126 TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS COND/MFW		
End State: ATWS	Conditional Probability:	3.0E-05

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128 TRANS RT

SEQUENCE CONDITIONAL PROBABILITIES

	Sequence	End State	Prob	N Rec**
119	TRANS -RT AFW MFW -HPI(F/B) -HPR/-HPI PORV.OPEN -SS.DEPRESS -COND/MFW	CV	2.7E-05	6.1E-02
120	TRANS -RT AFW MFW -HPI(F/B) -HPR/-HPI PORV.OPEN -SS.DEPRESS COND/MFW	CD	1.4E-05	3.1E-02
122	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS -COND/MFW	CV	1.2E-04	3.4E-02
123	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS COND/MFW	CD	6.0E-05	1.7E-02
124	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI SS.DEPRESS	CD	6.6E-06	5.1E-02
125	TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS -COND/MFW	CV	1.2E-04 *	3.2E-02
126	TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS COND/MFW	CD	6.1E-05 *	1.6E-02
127	TRANS -RT AFW MFW HPI(F/B) SS.DEPRESS	CD	6.7E-06	4.8E-02
128	TRANS RT	ATWS	3.0E-05 *	1.2E-01

* dominant sequence for end state

** non-recovery credit for edited case

MODEL: b:\pwrmtree.cmp

DATA: b:\davispro.cmp

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
TRANS	1.0E-03	1.0E+00	
LOOP	2.3E-05	3.4E-01	
LDCA	4.2E-06	3.4E-01	
RT	2.5E-04	1.2E-01	
RT/LOOP	0.0E+00	1.0E+00	
EMERG.POWER	2.9E-03	5.1E-01	
AFW	5.0E-03 > 5.0E-02	2.7E-01	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
AFW/EMERG.POWER	5.0E-03	2.7E-01	
MFW	2.0E-01 > 1.0E+00	3.4E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.0E-01 > Unavailable		
PORV.OR.SRV.CHALL	8.0E-02	1.0E+00	
PORV.OR.SRV.RESEAT	1.0E-02	5.0E-02	
PORV.OR.SRV.RESEAT/EMERG.POWER	1.0E-02	5.0E-02	
SS.RELEAS.TERM	1.5E-02	3.4E-01	
SS.RELEAS.TERM/-MFW	1.5E-02	3.4E-01	

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HPI	1.0E-03	5.2E-01	
HPI(F/B)	1.0E-03	5.2E-01	4.0E-02
HPR/-HPI	3.0E-03	5.6E-01	4.0E-02
PORV.OPEN	1.0E-02	1.0E+00	
SS.DEPRESS	3.6E-02	1.0E+00	
COND/MFW	1.0E+00	3.4E-01	
LPI/HPI	1.0E-03	3.4E-01	
LPR/-HPI,HPR	6.7E-01	1.0E+00	
LPR/HPI	1.0E-03	1.0E+00	

*** forced

Minarick
04-12-1987
10:44:10

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