PRECURSOR DESCRIPTION SHEET

LER No.: 312/85-025
Event Description: Loss of Integrated Control System and Loss of Feedwater
Date of Event: December 26, 1985
Plant: Rancho Seco

EVENT DESCRIPTION

Sequence

At 0414 h on December 26, 1985, the plant was operating at 76% power, when a loss of integrated control system (ICS) dc power occurred because of a single failure. The plant had just finished a 2-d outage to repair essential valves. The plant computer was out of service, and the core decay heat level was still very low. The plant was operating normally, otherwise.

The ICS failure was a result of a failed power supply monitor that opened switches S1 and S2 to the 120V-dc ICS. The loss of dc power to the ICS (a non-safety-related system) caused a number of feedwater and steam valves to reposition automatically and also caused the loss of remote control of the affected valves from the control room. In addition, the MFW pump turbines slowed to minimum speed, and the AFW pumps started. This sequence was the normally expected response to the loss of ICS transient; however, the operators did not realize that an ICS failure had occurred until 2 min after the initial failure. The immediate result was an RCS undercooling condition that resulted in the reactor tripping on high pressure. The reactor trip was followed by an overcooling condition that resulted in safety features actuation and excessive RCS cooldown.

The shift supervisor opened the pressurizer PORV to control RCS pressure. The atmospheric steam dump (ASD) and turbine bypass system (TBS) valves also opened to the halfway position on ICS failure. Rapid SG and RCS depressurization by means of the PORV, ASD, TBS, and AFW began. The low core decay heat exacerbated the RCS cooldown rate. The operators did not find open switches S1 and S2 for 26 min despite checking the applicable cabinets several times. The operators were not immediately able to restore dc power within the ICS. As a result, nonlicensed operators were sent to isolate the affected steam and feedwater valves locally with handwheels. The operators failed to realize they could more quickly control the ASD and TBS valves from the remote shutdown panel or the ASD valves from their manual control station. The ASD valves and TBS valves were isolated within 9 min after the reactor trip. However, the operators experienced difficulty closing the ICS-controlled AFW flow control valves. One of the AFW flow control valves finally shut; however, the second AFW flow control valve was damaged and failed open.

The associated AFW manual isolation valve was found to be stuck open. Therefore, both AFW pumps continued to feed and overfill one steam generator. Because the plant has no main steam isolation valves, water began to overflow into the main steam lines. During the first 7 min of the incident, the excessive steam and feedwater flows resulted in a rapid RCS cooldown of >100°F. The pressurizer emptied, and a small bubble formed in the reactor vessel head. The RCS cooldown continued, and the RCS depressurized to ~1064 psig and then began to repressurize. Vessel level was recovered by means of HPI. The safety features actuation system had actuated on low RCS pressure as designed, and this contributed to the rapid cooldown. About 26 min after the reactor trip, the operators restored power within the ICS by reclosing S1 and S2 switches. The operators were then able to close the open AFW flow control valve from the control room, which stopped the RCS cooldown, and started stabilizing the plant. The RCS had cooled down a total of 180°F in this 26-min period. The RCS repressurization resulted in the RCS entering the B&W-designated pressurized thermal shock (PTS) region.

During changing of a valve lineup in the suction of the pump used to supply RCS makeup (HPI pump), the last suction valve to the pump was inadvertently shut. This resulted in the overheating and destruction of the pump. About 450 gal of contaminated water was spilled on the floor. This failure did not directly affect the incident because an additional HPI pump was available to supply RCS makeup. In addition, the spilled water did not result in any significant onsite or offsite radioactivity release or personnel dose.

Corrective Action

The plant was taken to cold shutdown. The event was subsequently the subject of an NRC special investigation.

Plant/Event Data

Systems Involved:
ICS, MFW, HPI, atmospheric dumps, and TBS

Components and Failure Modes Involved:
120-V-dc power supply to ICS — failed during operation
MFW pumps — experienced inadvertent runback during operation
ASD and TBS valves — failed to close on demand
AFW flow control valve and isolation valve — failed to close on demand
HPI pump — failed in operation because suction valve was inadvertently closed

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Component Unavailability Duration: NA
Plant Operating Mode: 1 (76% power)
Discovery Method: Operational event
Reactor Age: 11.3 years
Plant Type: PWR

Comments

A complex event with safety train failures and an overcooling of the RCS

MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate

Transient	1.0

Branches Impacted and Branch Nonrecovery Estimate

HPI	Base case	One train failed
Secondary-side release terminated	0.34	Valves 50% open because of ICS failure; assumed potentially recoverable locally
MFW	0.12	Assumed recoverable from control room, not a procedurally based response given the uncertainties imposed by the ICS failure
PORV challenged	1.0	Opened by operator

Plant Models Utilized

PWR plant Class D

Event Identifier: 312/85-025

CONDITIONAL CORE DAMAGE CALCULATIONS

LER Number: 312/85-025
Event Description: Loss of Integrated Control System and Loss of Feedwater
Event Date: 12/26/85
Plant: Rancho Seco

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.000E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CV	
TRANS	1.867E-04
Total	1.867E-04
CD	
TRANS	1.601E-05
Total	1.601E-05
ATWS	
TRANS	3.000E-05
Total	3.000E-05

DOMINANT SEQUENCES

End State: CV Conditional Probability: 1.766E-04

101 TRANS -RT -AFW PORV.OR.SRV.CHALL -PORV.OR.SRV.RESEAT SS.RELEAS.TERM HPI

End State: CD Conditional Probability: 1.342E-05

103 TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HPR/-HPI -SS.DEPRESS LPR/-HPI.HPR

End State: ATWS Conditional Probability: 3.000E-05

128 TRANS RT

Event Identifier: 312/85-025

SEQUENCE CONDITIONAL PROBABILITIES

	Sequence	End State	Seq. Prob	Non-Recov‡‡
101	TRANS -RT -AFW PORV.OR.SRV.CHALL -PORV.OR.SRV.RESEAT SS.RELE AS.TERM HPI	CV	1.766E-04 ‡	1.768E-01
102	TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HP R/-HPI -SS.DEPRESS -LPR/-HPI.HPR	CV	6.612E-06	2.964E-03
103	TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HP R/-HPI -SS.DEPRESS LPR/-HPI.HPR	CD	1.342E-05 ‡	2.964E-03
104	TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HP R/-HPI SS.DEPRESS	CD	7.482E-07	2.964E-03
123	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS COND/MFW	CD	8.137E-07	6.268E-04
126	TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS COND/MFW	CD	8.253E-07	5.030E-04
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:pwrdtree.cmp
DATA: b:ranchpro.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	1.919E-03	2.700E-01	
AFW/EMERG.POWER	5.000E-02	3.400E-01	
MFW	2.000E-01 > 1.000E+00	3.400E-01 > 1.200E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.000E-01 > 1.000E+00		
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	5.000E-02	
PORV.OR.SRV.RESEAT/EMERG.POWER	1.000E-02	5.000E-02	

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SS.RELEAS.TERM	1.500E-02 > 1.000E+00	3.400E-01		
Branch Model: 1.0F.1				
Train 1 Cond Prob:	1.500E-02 > 1.000E+00			
SS.RELEAS.TERM/-MFW	1.500E-02 > 1.000E+00	3.400E-01		
Branch Model: 1.0F.1				
Train 1 Cond Prob:	1.500E-02 > 1.000E+00			
HPI	3.000E-04 > 1.000E-03	5.200E-01		
Branch Model: 1.0F.3				
Train 1 Cond Prob:	1.000E-02			
Train 2 Cond Prob:	1.000E-01			
Train 3 Cond Prob:	3.000E-01 > 1.000E+00			
HPI(F/B)	3.000E-04 > 1.000E-03	5.200E-01		4.000E-02
Branch Model: 1.0F.3+opr				
Train 1 Cond Prob:	1.000E-02			
Train 2 Cond Prob:	1.000E-01			
Train 3 Cond Prob:	3.000E-01 > 1.000E+00			
HPR/-HPI	3.000E-03	5.600E-01		4.000E-02
SS.DEPRESS	3.600E-02	1.000E+00		
COND/MFW	1.000E+00	3.400E-01		
LPI/HPI	2.000E-03	3.400E-01		
LPR/-HPI.HPR	6.700E-01	1.000E+00		
LPR/HPI	1.000E-03	1.000E+00		

forced

JD HARRIS
10-07-1986
13:27:07

Event Identifier: 312/85-025