PRECURSOR DESCRIPTION SHEET

LER No.: 312/84-015
Event Description: Hydrogen Explosion Causes Transient and Subsequent Loss of NNIX
Date of Event: March 19, 1984
Plant: Rancho Seco

EVENT DESCRIPTION

Sequence

Rancho Seco was operating at 92% power when MCC 2E1 bus became deenergized when its supply breaker from the 3E bus tripped. This supply breaker could not be reclosed. The loss of MCC 2E1 was due to a ground fault on a gland steam exhaust motor and resulted in a loss of the hydrogen-side seal oil pump that is powered from that MCC. The plant procedures allow full-load operation with the hydrogen-side pump shut down. Seal oil problems eventually resulted in the escape of hydrogen from the generator and subsequent explosions.

When the hydrogen-side seal-oil pump is off, hydrogen-side seal oil is supplied by the air-side pump. The oil that flows to the hydrogen seals ends up in the drain regulator tank and is rejected to the suction of the air-side pump. Prior to the loss of the hydrogen-side pump, swing shift logs were taken, and defoaming tank levels were normal. Shortly after the pump stopped, the defoaming tank levels were found high, and generator moisture detector level switches were dry. The operator was instructed to operate the drain tank level control valves manually to reduce defoaming tank level. He overrode the automatic level control valves on the drain regulator tank, observed a slow level decrease, and then left the area to find another operator to control tank level while he checked defoaming tank levels. Before the second operator reached the drain regulator tank (~2 min) the regulator tank emptied, which allowed hydrogen to enter the suction of the air-side seal-oil pump. This caused reduction in seal oil pressures and allowed hydrogen and seal oil to blow out of the generator seals. Hydrogen escaped for several minutes before it exploded.

A reduction in power to 85% was initiated at a maximum rate of 99 MW/min. Shortly after, a second and larger explosion occurred. The generator remained on the line: No automatic trip signals were received because the explosion did not damage the generator or exciter. The shift supervisor was notified that the exciter was on fire. He immediately tripped the turbine, which then tripped the reactor.

The reactor trip was normal except that a TBV stuck open and was closed within 6 min. The RCS cooled to 505°F (40°F below the nominal posttrip temperature). The pressurizer level remained on scale, and RCS pressure reached a minimum of 1794 psig (~50 psig below nominal posttrip minimum). Operators manually started both HPI pumps and opened one of four HPI valves to help control RCS pressure and pressurizer level.

About an hour after the reactor trip nonnuclear instrumentation train X(NNIX) ±24 V dc was lost for ~4 min because of drift in the overvoltage trip relay set point that resulted in a false trip signal. In initiating the SFAS manually by procedure for loss of NNI, full HPI flow increased RCS pressure. A pressurizer code safety valve lifted 140 psi below its 2500-psi set point to relieve pressure.

When NNIX dc power was lost, it was incorrectly diagnosed as a total loss of NNI based on control room indications, and the applicable casualty procedure was then followed. This procedure required, among other things, manual initiation of SFAS channels 1A and 1B. This resulted in both the "A" and "B" HPI pumps starting and the HPI valves opening. Due to HPI injection, RCS pressure began to increase. At a pressure of ~2350 psig, pressurizer code safety valve PSV-21507 lifted prematurely, blew down RCS pressure 100 psig, and then reseated. Pressure began to increase again, and the code safety again lifted and then reseated. During the second lifting of the code safety valve, the HPI injection valves were being throttled based on pressure and temperature indications on instrumentation that was unaffected by the loss of NNIX. HPI was manually controlled per procedure and RCS pressure and pressurizer level restored to normal valves. An atmosphere dump valve that opened due to loss of NNIX was immediately recognized and closed from the control room.

Corrective Action

Hydrogen Seal Oil. A recommendation regarding on-line testing of panel alarms will be prepared. Also, a determination will be made of what preventive maintenance, if any, should be performed on the alarm panel.

An investigation of the need for additional instrumentation in the seal oil system, to allow better monitoring of system performance, will also be performed. In addition, a review will be done on the seal-oil installation for conformance to the manufacturer's recommendations, particularly in regard to component elevations and piping configuration.

Also, the seal-oil-system casualty procedures will be revised. Modifications to level gages will consist of interim markings until permanent dial face changes can be made if necessary. Finally, appropriate prestartup tests, as recommended by the manufacturer to ensure proper system operation, will be performed.

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Carbon Dioxide Tank. The instructions in the operating procedure regarding manual termination of automatic carbon dioxide discharge will be verified and revised, if necessary, to ensure that it is applicable to all carbon dioxide zones.

NNI. All of the NNIX and ±24-V power supplies overvoltage and undervoltage trip set points will be calibrated and set to the manufacturer's recommended setting. Also, the problem with the ±24-V power supply's failure to trip on overvoltage will be resolved prior to startup.

Pressurizer Code Safety Valve. The pressurizer code safety valve PSV-21507 will be reset during plant heatup.

Plant/Event Data

Systems Involved:
main generator, NNI, turbine bypass, and pressurizer relief

Components and Failure Modes Involved:
NNI — failed in operation
TBS/ASD — failed in operation
Primary-system RV — lifted early but reclosed

Component Unavailability Duration: NA
Plant Operating Mode: 1 (85% power)
Discovery Method: Operational event
Reactor Age: 7.5 years
Plant Type: PWR

Comments

Reference: Abnormal Occurrence Reports to Congress, NUREG-0090, 7(2), 24 and 32.

MODELING CONSIDERATIONS AND DECISIONS

Initiators Modeled and Initiator Nonrecovery Estimate

Transient	1.0	No recovery

Branches Impacted and Branch Nonrecovery Estimate

Secondary side relief terminated	0.12	Atmospheric dump valve was closed from control room

Plant Models Utilized

PWR plant Class D

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CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

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Event Description: Hydrogen Explosion Causes Transient and Subsequent Loss of NNI-X
Event Date: 3/19/84
Plant: Rancho Seco

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CV	
TRANS	2.1E-05
Total	2.1E-05
CD	
TRANS	2.2E-06
Total	2.2E-06
ATWS	
TRANS	3.0E-05
Total	3.0E-05

DOMINANT SEQUENCES

End State: CV Conditional Probability: 1.7E-05

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

End State: CD Conditional Probability: 1.1E-06

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: 3.0E-05

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128 TRANS RT

SEQUENCE CONDITIONAL PROBABILITIES

	Sequence	End State	Prob	N Rec**
101	TRANS -RT -AFW PORV.OR.SRV.CHALL -PORV.OR.SRV.RESEAT SS.RELEAS.TERM HPI	CV	1.5E-06	6.2E-02
102	TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HPR/-HPI -SS.DEPRESS -LPR/-HPI.HPR	CV	5.3E-07	2.8E-02
103	TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HPR/-HPI -SS.DEPRESS LPR/-HPI.HPR	CD	1.1E-06 *	2.8E-02
104	TRANS -RT -AFW PORV.OR.SRV.CHALL PORV.OR.SRV.RESEAT -HPI HPR/-HPI SS.DEPRESS	CD	6.0E-08	2.8E-02
109	TRANS -RT -AFW -PORV.OR.SRV.CHALL SS.RELEAS.TERM HPI	CV	1.7E-05 *	6.2E-02
122	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS -COND/MFW	CV	9.0E-07	3.4E-02
123	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI -SS.DEPRESS COND/MFW	CD	4.6E-07	1.7E-02
124	TRANS -RT AFW MFW -HPI(F/B) HPR/-HPI SS.DEPRESS	CD	5.1E-08	5.1E-02
125	TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS -COND/MFW	CV	9.0E-07	3.2E-02
126	TRANS -RT AFW MFW HPI(F/B) -SS.DEPRESS COND/MFW	CD	4.6E-07	1.6E-02
127	TRANS -RT AFW MFW HPI(F/B) SS.DEPRESS	CD	5.1E-08	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:\pwrdtree.cmp
DATA: b:\ranchpro.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	
LOCA	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	1.9E-03	2.7E-01	
AFW/EMERG.POWER	5.0E-02	3.4E-01	
MFW	2.0E-01	3.4E-01	
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 > 1.0E+00	3.4E-01 > 1.2E-01	
Branch Model: 1.OF.1			

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Train 1 Cond Prob:	1.5E-02 > Failed		
SS.RELEAS.TERM/-MFW	1.5E-02 > 1.0E+00	3.4E-01 > 1.2E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	1.5E-02 > Failed		
HPI	3.0E-04	5.2E-01	
HPI(F/B)	3.0E-04	5.2E-01	4.0E-02
HPR/-HPI	3.0E-03	5.6E-01	4.0E-02
SS.DEPRESS	3.6E-02	1.0E+00	
COND/MFW	1.0E+00	3.4E-01	
LPI/HPI	2.0E-03	3.4E-01	
LPR/-HPI.HPR	6.7E-01	1.0E+00	
LPR/HPI	1.0E-03	1.0E+00	

*** forced

Minarick
04-11-1987
16:07:40

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