

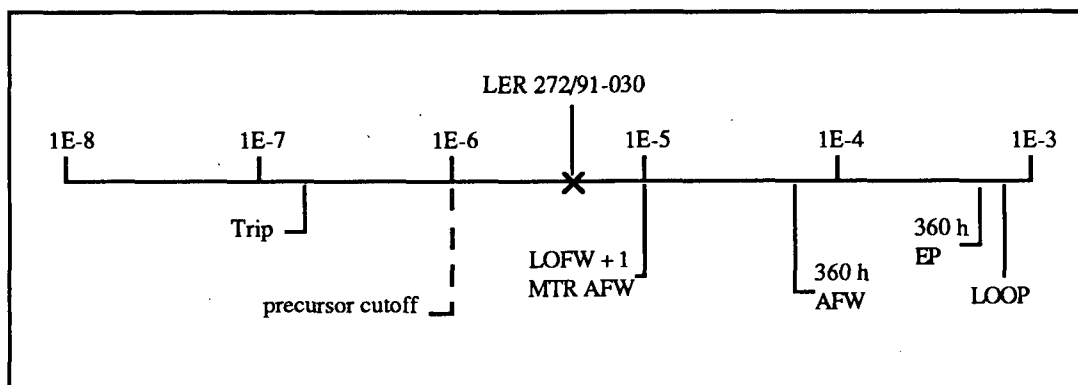
## ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No: 272/91-030  
 Event Description: Both PORVs failed due to leaking actuators  
 Date of Event: September 20, 1991  
 Plant: Salem 1

### Summary

The power-operated relief valves (PORVs) at Salem 1 were inoperable because of leakage from the flange bolting area on the air-operated PORV actuators. It is assumed that both PORVs were inoperable for one half of their surveillance period (81 d).

The conditional probability of core damage estimated for this event is  $4.4 \times 10^{-6}$ . The relative significance of the event compared to other postulated events at Salem 1 is shown below.



### Event Description

The plant was in Mode 4 ( $200^{\circ}\text{F} < T_{\text{avg}} < 350^{\circ}\text{F}$ ) with a plant shutdown to Mode 5 ( $T_{\text{avg}} \leq 200^{\circ}\text{F}$ ) in progress to support a maintenance outage. Technical Specifications require that the pressurizer PORVs be used to provide pressurizer overpressure protection when one or more of the reactor cooling system (RCS) cold legs is less than or equal to  $312^{\circ}\text{F}$  (except with the reactor head removed). The PORVs were functionally checked and failed to open upon demand. At the time of these functional tests, the control room alarm for PORV accumulator low air pressure actuated. Investigations showed that both the 1PR1 and 1PR2 valve actuators leaked. The valve actuator diaphragm bolts were observed to be loose, which allowed air leakage from the flange bolting area. The valves successfully stroked after the actuator bolts were tightened.

Investigations indicated that the 1PR1 and 1PR2 actuator diaphragms appeared to be in a functional condition. Further assessment showed that the diaphragm material (Buna-N rubber) is subject to "creep," where the diaphragm may change from its original geometry under load and over time. This phenomena can be exacerbated by uneven torquing of the actuator joint. Leak paths may develop that were not present at the time of original installation. The 1PR1 and 1PR2 actuator diaphragms had been replaced on March 21, 1991, and April 12, 1991, respectively.

#### **Additional Event-Related Information**

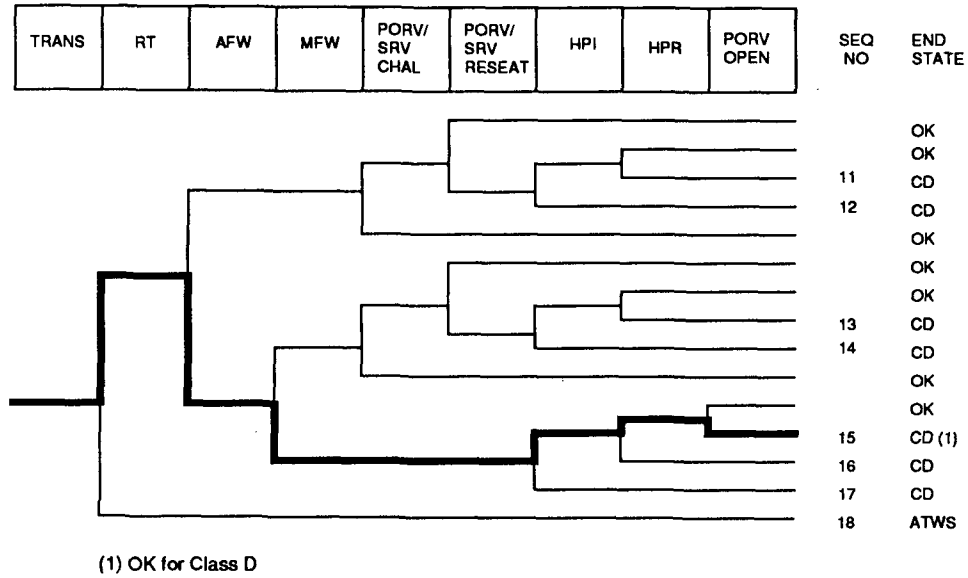
At Salem, the PORVs and pressurizer spray valves are used to help mitigate the consequences of a steam generator (SG) tube rupture. Additionally, the PORVs are used for a total loss of feedwater (LOFW) accident. During a LOFW with failure of auxiliary feedwater, decay heat removal would be provided by utilizing the PORVs and the safety injection (SI) pumps in a "feed and bleed" mode. This is addressed in the station emergency operating procedures (EOPs) in FRHS-1, "Functional Restoration of Heat Sink."

#### **ASP Modeling Assumptions and Approach**

It was assumed that both PORVs were inoperable for half the period from April 12, 1991, to September 20, 1991 (81 d). Unavailability of either PORV results in failure of feed and bleed capability. One of the PORVs (1PR2) was assumed to be still capable of performing its pressure relief function (since it apparently lifted partially during testing).

#### **Analysis Results**

The conditional probability of subsequent core damage estimated for this event is  $4.4 \times 10^{-6}$ . The dominant core damage sequence, highlighted on the following event tree, involves a postulated transient with unavailable secondary-side cooling and unavailability of feed and bleed.



Dominant core damage sequence for LER 272/91-030

## CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 272/91-030  
 Event Description: Both PORVs failed due to leaking actuators  
 Event Date: 09/20/91  
 Plant: Salem 1

UNAVAILABILITY, DURATION= 1944

## NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	5.2E-01
LOOP	1.7E-02
LOCA	2.0E-03

## SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	2.8E-06
LOOP	1.6E-06
LOCA	1.4E-08
Total	4.4E-06
ATWS	
TRANS	0.0E+00
LOOP	0.0E+00
LOCA	0.0E+00
Total	0.0E+00

## SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

Sequence	End State	Prob	N Rec**
15 trans -rt afw mfw -hpi(f/b) -hpr/-hpi PORV.OPEN	CD	2.8E-06	1.8E-02
43 loop -rt/loop -emerg.power afw -hpi(f/b) -hpr/-hpi PORV.OPEN	CD	1.6E-06	1.4E-01

\*\* non-recovery credit for edited case

## SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

Sequence	End State	Prob	N Rec**
15 trans -rt afw mfw -hpi(f/b) -hpr/-hpi PORV.OPEN	CD	2.8E-06	1.8E-02
43 loop -rt/loop -emerg.power afw -hpi(f/b) -hpr/-hpi PORV.OPEN	CD	1.6E-06	1.4E-01

\*\* non-recovery credit for edited case

Note: For unavailabilities, conditional probability values are differential values which reflect the added risk due to failures associated with an event. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

SEQUENCE MODEL: c:\asp\1989\pwrseal.cmp  
 BRANCH MODEL: c:\asp\1989\salem1.sll  
 PROBABILITY FILE: c:\asp\1989\pwr\_bsll.pro

Event Identifier: 272/91-030

No Recovery Limit

## BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	2.7E-04	1.0E+00	
loop	1.6E-05	5.3E-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	7.5E-03	8.0E-01	
afw	3.8E-04	2.6E-01	
afw/emerg.power	5.0E-02	3.4E-01	
mfw	1.0E+00	7.0E-02	
porv.or.srv.chall	4.0E-02	1.0E+00	
porv.or.srv.reseat	2.0E-02	1.1E-02	
porv.or.srv.reseat/emerg.power	2.0E-02	1.0E+00	
seal.loca	2.7E-01	1.0E+00	
ep.rec(s1)	5.7E-01	1.0E+00	
ep.rec	7.0E-02	1.0E+00	
hpi	1.0E-03	8.4E-01	
hpi(f/b)	1.0E-03	8.4E-01	1.0E-02
hpr/-hpi	1.5E-04	1.0E+00	1.0E-03
PORV.OPEN	1.0E-02 > 1.0E+00	1.0E+00	4.0E-04
Branch Model: 1.OF.1+opr			
Train 1 Cond Prob:		1.0E-02 > Failed	

\* branch model file  
 \*\* forced

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 06-07-1992  
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Event Identifier: 272/91-030