## Accident Sequence Precursor Program Event Analysis

LER No: 280/88-011 R1
Event Description: Inoperable PORVs due to incorrectly torqued bolts
                         and screws
Date of Event: April 15, 1988
Plant: Surry Unit 1

Summary

During RCS depressurization, two power-operated relief valves failed to manually open on demand. PORV failure was caused by improperly torqued bolts and screws, which allowed the actuator diaphragm to shift. Unavailability of the PORVs results in unavailability of feed and bleed, which can provide core cooling in the event of loss of all feedwater. The core damage estimate for this event is calculated at 1.5×10^{-5}. The relative significance of this event compared to other potential events at Surry 1 is shown below.
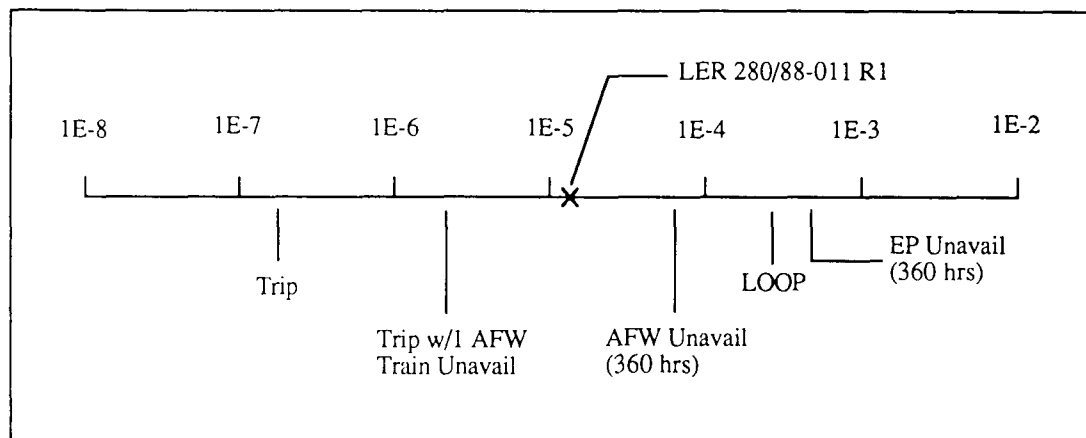
Event Description

At 0505 on April 15, 1988, Surry 1 was in cold shutdown with the reactor coolant temperature at 130°F and pressure at 40 psig. When the RCS temperature is below 350°F, Technical Specifications require that both PORVs be operational to provide relief capability to minimize pressure transients. During routine RCS depressurization operations, power-operated relief valves PCV-1455C and PCV-1456 failed to manually open when operators tested the valves. The operators unsuccessfully attempted to open both PORVs from their respective control room three-position selector switches by turning each switch from the AUTO to the

OPEN position. Both valves were later opened by turning their switch from the CLOSE to the OPEN position. Upon failure of the valves, both valves were declared inoperable and left open per plant Technical Specification.

The cause of the PORV failures was a result of lack of procedural guidance regarding the correct torque values for the actuator diaphragm hold-down screws and bolts. The improperly torqued screws and bolts allowed the actuator diaphragm to shift, resulting in intermittent PORV failure.

Event-Related Plant Design Information

Two PORVs are provided on Surry 1. These valves serve the following purposes:

- PORVs are designed to lift prior to the safety valves, thereby preventing unnecessary safety valve challenges. Each PORV is provided with a series block valve, which can be closed to isolate the PORV if it fails open. (Such a series valve is not allowed in a safety valve discharge path.)

- PORV lift setpoints can be lowered to provide for overpressure protection during cold shutdown, when peak RCS pressure must be limited to values substantially below RCS design pressure.

- PORVs, in conjunction with the safety injection system, provide feed and bleed capability that can be used to remove core decay heat in the event of unavailability of both main and auxiliary feedwater.

ASP Modeling Assumptions and Approach

This event has been modeled as a loss of feed and bleed capability for the duration of one refueling cycle. It is assumed that this problem existed at power and would not normally be detected except in a refueling outage during PORV operational testing. The plant was critical for approximately 11 990 h since the last refueling outage, which ended on July 17, 1986. This is the plant vulnerability period assumed.

While operator action in the control room subsequently opened the valves (by placing the three-way switches first in the close position), the cause of the valve failures is believed to render such action unpredictable, and hence a nonrecovery likelihood of 1.0 for the valves has been conservatively assumed.

Analysis Results

The conditional probability of core damage for this event is estimated to be 1.5×10^{-5}. The dominant sequence for this event (highlighted on the following event tree) involves a postulated loss of offsite power occurring during the plant vulnerability period ($p = 0.1$), a postulated failure of the auxiliary feedwater system ($p = 9.9 \times 10^{-5}$), and PORV failure (which faults feed and bleed). A sequence of almost the same significance involves a postulated LOFW with AFW failure and bleed and feed failure (again because of the faulted PORVs).

LOOP	RT/LOOP	EP	AFW	PORV/ SRV CHALL	PORV/ SRV RESEAT	SEAL LOCA	EP REC (LONG)	HPI	HPR	PORV OPEN	CSR	SEQ NO	END STATE
													OK
													OK
												41	CD
												42	CD
													OK
													OK
												56	CD
												43	CD
												44	CD
												45	CD
													OK
												46	CD
												47	CD
												48	CD
													OK
												49	CD
												50	CD
													OK
												51	CD
												52	CD
												53	CD
													OK
												54	CD
												55	CD
												40	ATWS
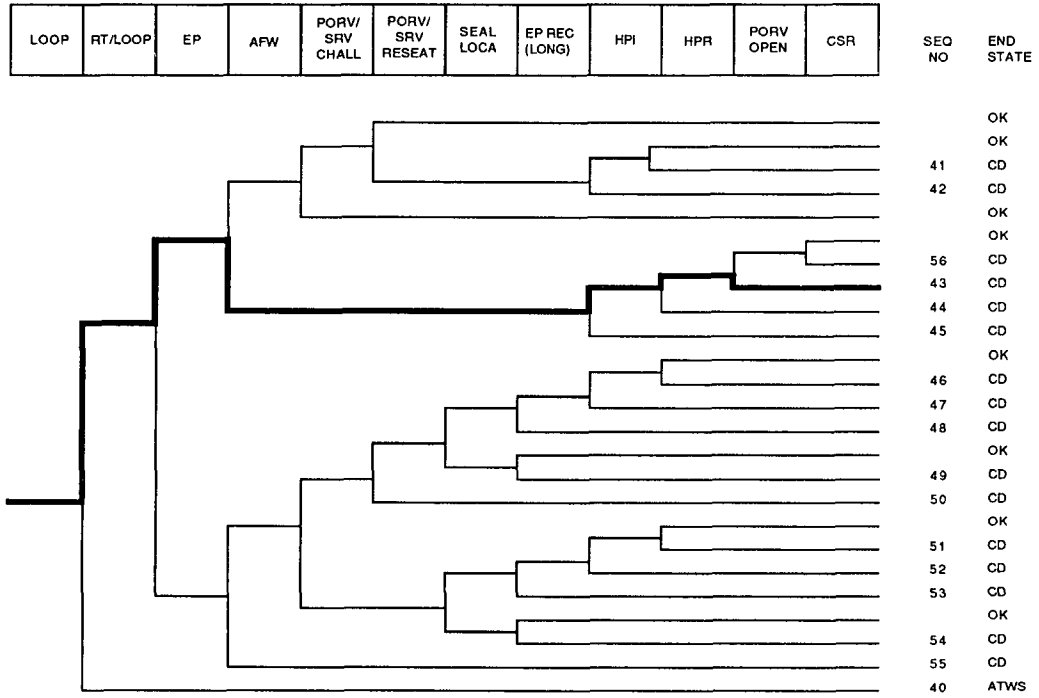
Dominant Core Damage Sequence for LER 280/88-011 R1

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 280/88-011
Event Description: Inoperable PORVs
Event Date: 04/15/88
Plant: Surry 1

UNAVAILABILITY, DURATION= 11990

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS   4.8E+00
LOOP   1.0E-01
LOCA   1.2E-02

SEQUENCE CONDITIONAL PROBABILITY SUMS

        End State/Initiator   Probability

CD

    TRANS   6.2E-06
    LOOP   9.1E-06
    LOCA   7.7E-08

    Total   1.5E-05

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**

43 loop -rt/loop -emerg.power afw -hpi(f/b) -hpr/-hpi PORV.OPEN   CD   9.1E-06   1.4E-01
15 trans -rt afw mfw -hpi(f/b) -hpr/-hpi PORV.OPEN   CD   6.2E-06   8.8E-02

** 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   6.2E-06   8.8E-02
43 loop -rt/loop -emerg.power afw -hpi(f/b) -hpr/-hpi PORV.OPEN   CD   9.1E-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\sealmod\pwraseal.cmp
BRANCH MODEL: c:\asp\sealmod\surry1.sll
PROBABILITY FILE: c:\asp\sealmod\pwr_bsll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	4.0E-04	1.0E+00	
loop	1.6E-05	5.3E-01	
loca	2.4E-06	4.3E-01	

Event Identifier: 280/88-011

rt	2.8E-04	1.2E-01	
rt/loop	0.0E+00	1.0E+00	
emerg.power	2.9E-03	8.0E-01	
afw	3.8E-04	2.6E-01	
afw/emerg.power	5.0E-02	3.4E-01	
mfw	1.9E-01	3.4E-01	
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(sl)	5.7E-01	1.0E+00	
ep.rec	7.0E-02	1.0E+00	
hpi	1.5E-03	8.4E-01	
hpi(f/b)	1.5E-03	8.4E-01	1.0E-02
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		
hpr/-hpi	1.5E-04	1.0E+00	1.0E-03
csr	9.3E-05	1.0E+00	

* branch model file
** forced

Minarick
11-09-1989
11:55:15

Event Identifier: 280/88-011