## Accident Sequence Precursor Program Event Analysis

LER No: 366/88-017
Event Description: Reactor trip and failure of RCIC pump
Date of Event: May 27, 1988
Plant: Hatch Unit 2

Summary

A deficient condensate and feedwater pump vent and fill procedure resulted in air binding in the condensate booster pumps, which caused a trip of main feedwater and subsequent reactor trip. As the reactor level dropped in response to the reduced feedwater flow, HPCI and RCIC started as designed; however, RCIC failed to inject because of a failed limit switch. The conditional probability of core damage has been estimated at 2.0×10^{-5}. The relative significance of this event compared with other potential events at Hatch 2 is shown below.
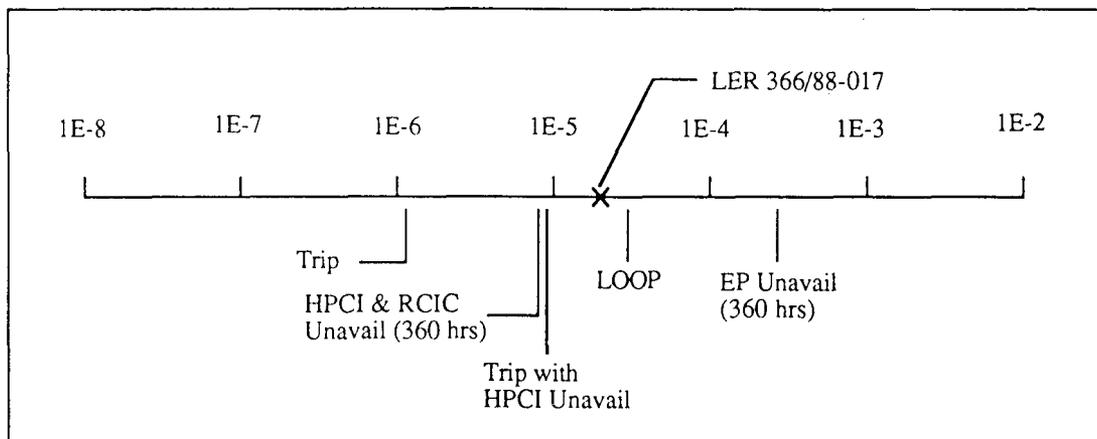
Event Description

While at 98%, operators were preparing a condensate pump for service later in the day. In the process of filling and venting the pump, an air bubble was released into the condensate system, which tripped the condensate booster pumps and the reactor feedwater pumps. Reactor level dropped, causing a reactor scram and automatic initiation of the HPCI and RCIC pumps. Although RCIC started as designed, the pump failed to ramp up due to a failed limit switch on valve 2E51-F045. As a consequence of the failed limit switch, the RCIC woodward controller would not respond to speed demands.
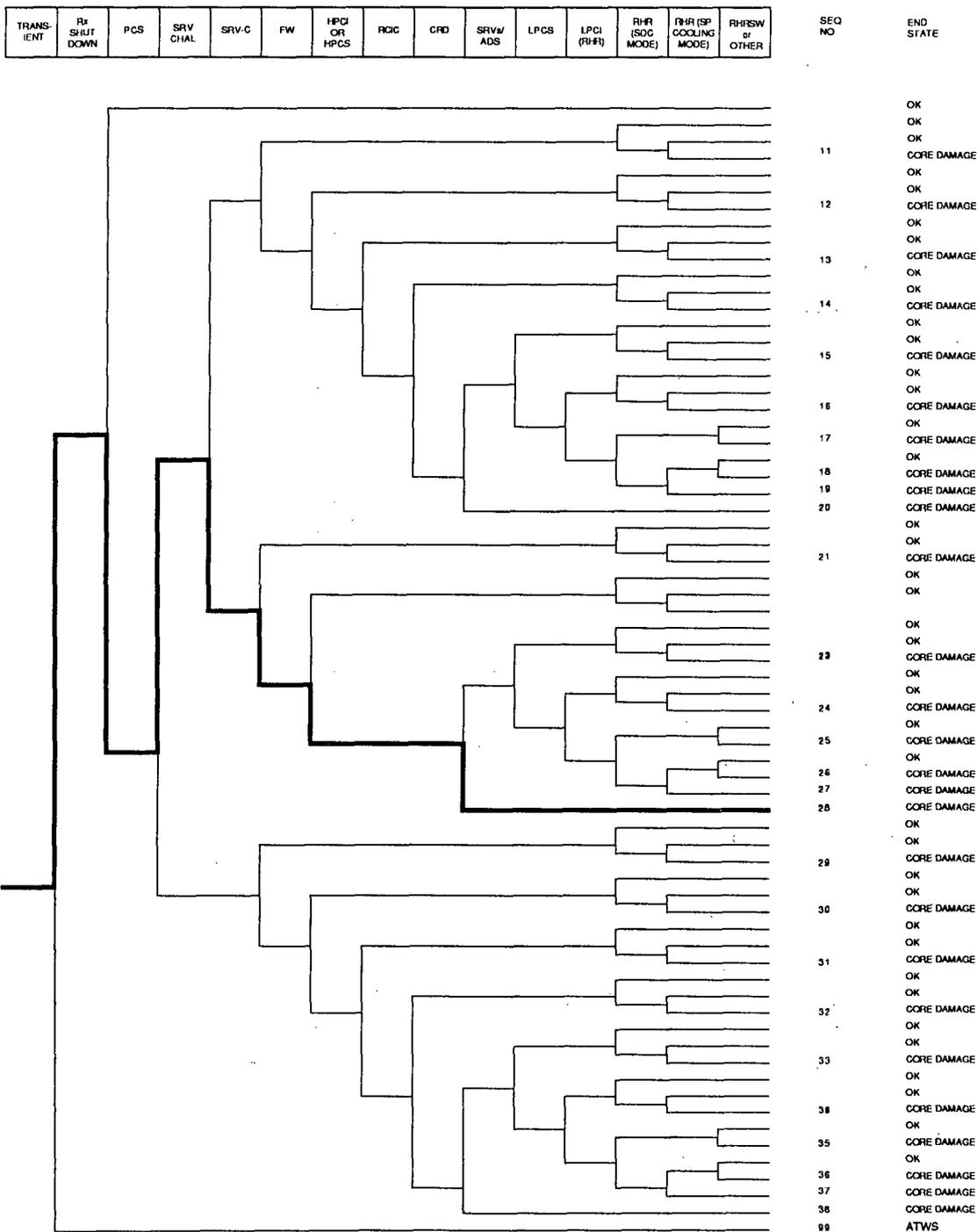
The root cause of the event has been identified as a deficient conden-
sate and feedwater vent and fill procedure while the unit is at power.
Additionally, the limit switch on valve 2E51-F045 was replaced.

ASP Modeling Assumptions and Approach

This event as been modeled as a loss of feedwater and reactor trip with
RCIC failed.

Analysis Results

The conditional probability estimated for the event is 2.0×10^{-5}, a
moderate significance event. The dominant sequence to core damage
($p = 9.3 \times 10^{-6}$) involves failure of an SRV to close following the trip
($p = 0.036$), failure of HPCI ($p = 0.02$), and failure to depressurize
using ADS ($p = 0.013$). The failure of RCIC impacts the third most domi-
nant sequence (4.9×10^{-6}). In this sequence, all SRVs successfully
close, but all high-pressure injection plus depressurization capability
is lost. The dominant core damage sequence is shown on the following
event tree.

TRANS-IENT	Rx SHUT DOWN	PCS	SRV CHAL	SRV-C	FW	HPCI OR HPCS	RCIC	CRD	SRVs/ ADS	LPCS	LPCI (RHR)	RHR (SDC MODE)	RHR (SP COOLING MODE)	RHRSW or OTHER

SEQ NO	END STATE
	OK
	OK
	OK
11	CORE DAMAGE
	OK
	OK
12	CORE DAMAGE
	OK
	OK
13	CORE DAMAGE
	OK
	OK
14	CORE DAMAGE
	OK
	OK
15	CORE DAMAGE
	OK
	OK
16	CORE DAMAGE
	OK
17	CORE DAMAGE
	OK
18	CORE DAMAGE
19	CORE DAMAGE
20	CORE DAMAGE
	OK
	OK
21	CORE DAMAGE
	OK
	OK
	OK
	OK
23	CORE DAMAGE
	OK
	OK
24	CORE DAMAGE
	OK
25	CORE DAMAGE
	OK
26	CORE DAMAGE
27	CORE DAMAGE
28	CORE DAMAGE
	OK
	OK
29	CORE DAMAGE
	OK
	OK
30	CORE DAMAGE
	OK
	OK
31	CORE DAMAGE
	OK
	OK
32	CORE DAMAGE
	OK
	OK
33	CORE DAMAGE
	OK
	OK
3I	CORE DAMAGE
	OK
35	CORE DAMAGE
	OK
36	CORE DAMAGE
37	CORE DAMAGE
38	CORE DAMAGE
99	ATWS

Dominant Core Damage Sequence for LER 366/88-017

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 366/88-017
Event Description: LOFW and RCIC fails to inject water
Event Date: 05/27/88
Plant: Hatch 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS   1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

     End State/Initiator   Probability

CD

     TRANS   2.0E-05

     Total   2.0E-05

ATWS

     TRANS   3.0E-05

     Total   3.0E-05

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence				End State	Prob	N Rec**
28	trans -rx.shutdown PCS/TRANS srv.chall/trans.-scram srv.close FW/PCS.TRANS hpci srv.ads				CD	9.3E-06	5.0E-01
12	trans -rx.shutdown PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS -hpci rhr(sdc) rhr(spcool)/rhr(sdc)				CD	5.2E-06	1.1E-01
20	trans -rx.shutdown PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS hpci RCIC crd srv.ads				CD	4.9E-06	5.0E-01
99	trans rx.shutdown				ATWS	3.0E-05	1.0E+00

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence				End State	Prob	N Rec**
12	trans -rx.shutdown PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS -hpci rhr(sdc) rhr(spcool)/rhr(sdc)				CD	5.2E-06	1.1E-01
20	trans -rx.shutdown PCS/TRANS srv.chall/trans.-scram -srv.close FW/PCS.TRANS hpci RCIC crd srv.ads				CD	4.9E-06	5.0E-01
28	trans -rx.shutdown PCS/TRANS srv.chall/trans.-scram srv.close FW/PCS.TRANS hpci srv.ads				CD	9.3E-06	5.0E-01
99	trans rx.shutdown				ATWS	3.0E-05	1.0E+00

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\sealmod\bwrcseal.cmp
BRANCH MODEL: c:\asp\sealmod\hatch.sll
PROBABILITY FILE: c:\asp\sealmod\bwr_csll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	6.1E-04	1.0E+00	
loop	1.6E-05	3.6E-01	
loca	3.3E-06	5.0E-01	

Event Identifier: 366/88-017

```
rx.shutdown                        3.0E-05              1.0E+00
rx.shutdown/ep                     3.5E-04              1.0E+00
PCS/TRANS                          1.7E-01 > 1.0E+00    1.0E+00
    Branch Model:  1.OF.1
    Train 1  Cond Prob:            1.7E-01 > Failed
srv.chall/trans.-scram             1.0E+00              1.0E+00
srv.chall/loop.-scram              1.0E+00              1.0E+00
srv.close                          3.6E-02              1.0E+00
emerg.power                        5.4E-04              8.0E-01
ep.rec                             1.6E-01              1.0E+00
FW/PCS.TRANS                       4.6E-01 > 1.0E+00    3.4E-01 > 1.0E+00
    Branch Model:  1.OF.1
    Train 1  Cond Prob:            4.6E-01 > Failed
fw/pcs.loca                        1.0E+00              3.4E-01
hpci                               2.9E-02              7.0E-01
RCIC                               6.0E-02 > 1.0E+00    7.0E-01 > 1.0E+00
    Branch Model:  1.OF.1
    Train 1  Cond Prob:            6.0E-02 > Failed
crd                                1.0E-02              1.0E+00              1.0E-02
srv.ads                            3.7E-03              7.1E-01              1.0E-02
lpcs                               3.0E-03              3.4E-01
lpci(rhr)/lpcs                     1.0E-03              7.1E-01
rhr(sdc)                           2.1E-02              3.4E-01              1.0E-03
rhr(sdc)/-lpci                     2.0E-02              3.4E-01              1.0E-03
rhr(sdc)/lpci                      1.0E+00              1.0E+00              1.0E-03
rhr(spcool)/rhr(sdc)               2.0E-03              3.4E-01
rhr(spcool)/-lpci.rhr(sdc)         2.0E-03              3.4E-01
rhr(spcool)/lpci.rhr(sdc)          9.3E-02              1.0E+00
rhrsw                              2.0E-02              3.4E-01              2.0E-03
```

* branch model file
** forced

Minarick
11-13-1989
17:24:28

Event Identifier: 366/88-017