# Accident Sequence Precursor Program Event Analysis

LER No: 321/88-018
Event Description: Reactor scram with loss of nonessential loads and RCIC degraded operation
Date of Event: December 17, 1988
Plant: Hatch Unit 1

Summary

Following a reactor scram, a loss of power to the nonessential loads was experienced. During the recovery from the scram, the RCIC system turbine tripped on the second and several later initiations of the system on overspeed but was successfully recovered. The conditional core damage probability associated with the event is 1.5×10^{-5}. The relative significance of this event compared with other potential transients at Hatch 1 is shown below.
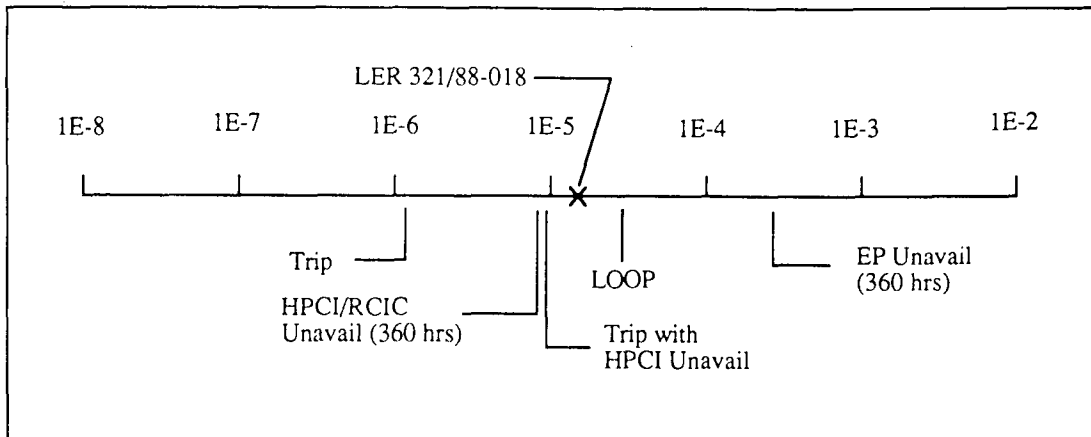
Event Description

The reactor was at ~85% power when the main turbine tripped on a loss of electrohydraulic control system (EHC) pressure, resulting in a reactor scram. It is believed that the loss of EHC system pressure was caused by an operator racking out EHC breakers for the wrong unit. Upon transfer of the nonessential loads to the startup auxiliary transformer (SAT) (as expected) the protective relaying for SAT 1D actuated (caused by a malfunctioning relay), resulting in a loss of power to the nonessential loads. The emergency diesel generators started because of a temporary undervoltage condition on the essential bus but did not load because the voltage transient was over and normal voltage was being supplied.

Because of level transients caused by the reactor trip and subsequent loss of feedwater caused by the loss of power to the nonessential loads, RCIC was manually initiated to control reactor pressure vessel water level. HPCI cycled off as designed; however, the RCIC turbine steam supply valve failed to close fully (a result of incorrectly tightened yoke bushing set screws), and upon reinitiation the RCIC turbine tripped on overspeed on several occasions. The RCIC was restored and continued to assist in controlling reactor pressure.

Nonessential loads were not recovered until 22 h after the trip. For the first 8 h, the battery-powered emergency lighting system functioned. After this time period, lighting was unavailable except in the control room.

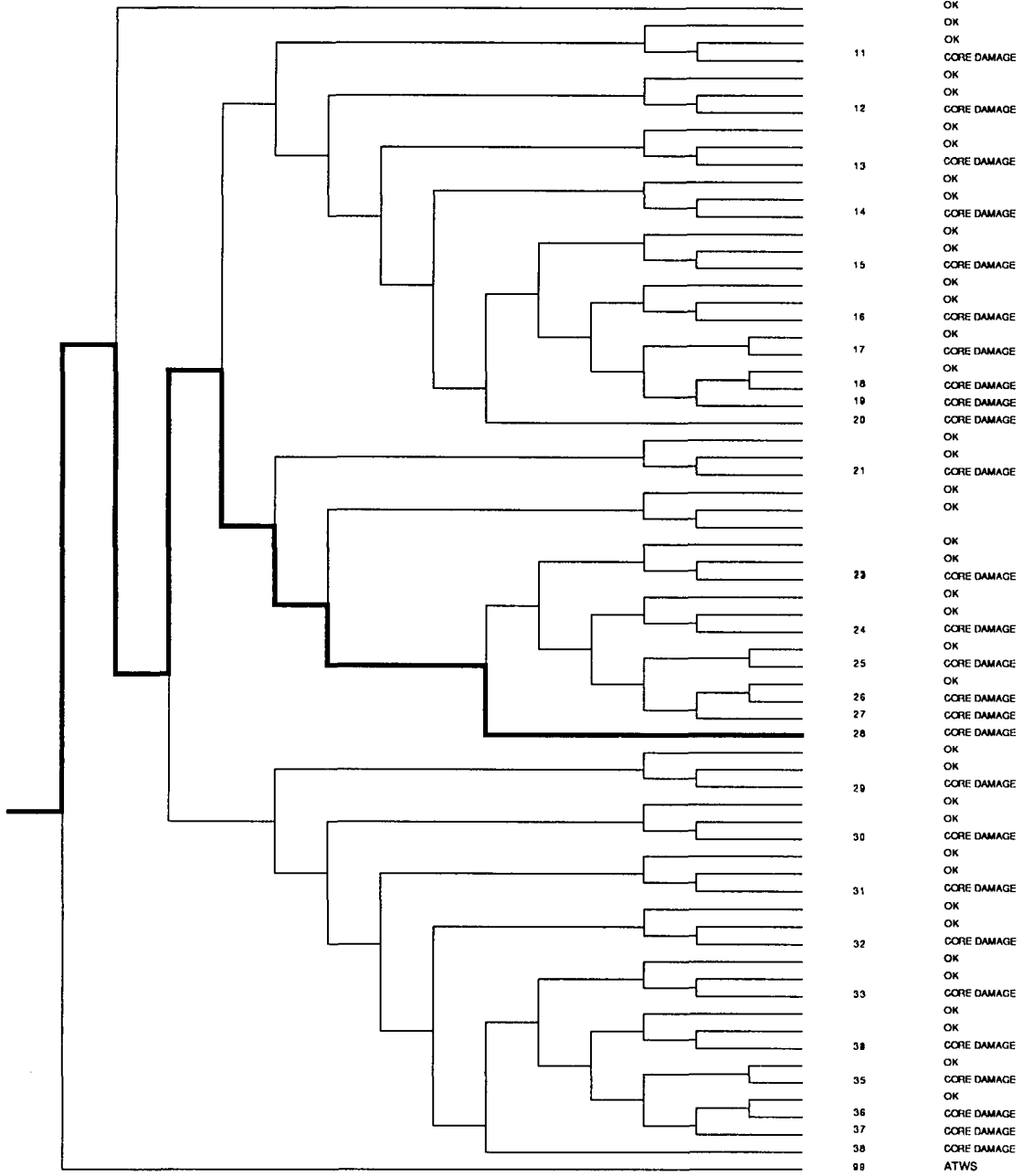## ASP Modeling Assumptions and Approach

The event has been modeled as a LOFW with failure of RCIC. The likelihood of not recovering RCIC was assumed to be 0.12.

Analysis Results

The conditional probability of severe core damage estimated for this event is 1.5×10^{-5}.

The dominant sequence postulated for this event (highlighted on the following event tree) involves a failure of one of the SRVs to close (p = 0.036) with subsequent HPCI (p = 0.02) and ADS failure (p = 0.013, including operator error to initiate depressurization). The highest probability sequence impacted by RCIC is a factor of 16 in probability below the dominant sequence, an indication of the lack of importance of RCIC failure in this event.

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

	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
	34	CORE DAMAGE
		OK
	35	CORE DAMAGE
		OK
	36	CORE DAMAGE
	37	CORE DAMAGE
	38	CORE DAMAGE
	99	ATWS

Dominant Core Damage Sequence for LER 321/88-018

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 321/88-018
Event Description: Trip with loss of non-essential loads and RCIC degraded
Event Date: 12/17/88
Plant: Hatch 1

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS   1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	1.5E-05
Total	1.5E-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	5.9E-07	6.0E-02
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	5.9E-07	6.0E-02
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: a:\sealmod\bwrcseal.cmp
BRANCH MODEL: a:\sealmod\hatch.sll
PROBABILITY FILE: a:\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: 321/88-018

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 > Unavailable		
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 > Unavailable		
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 > 1.2E-01	
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
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