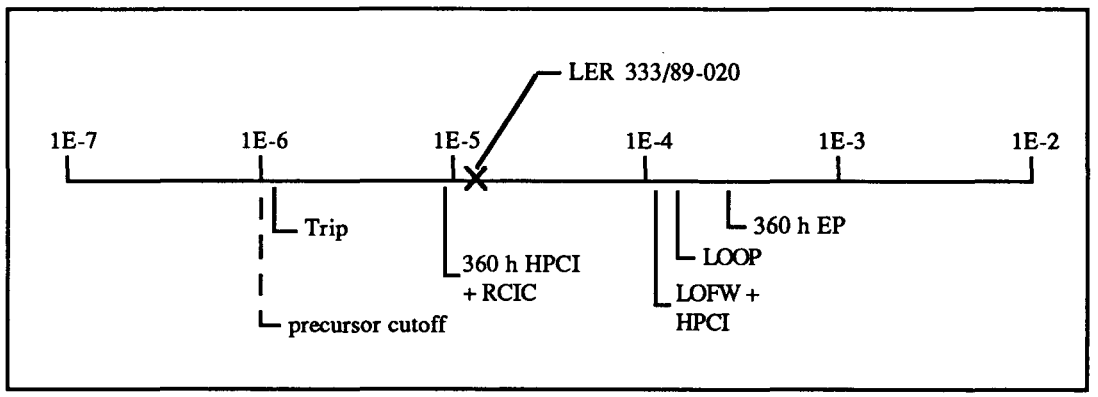
ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No: 333/89-020
Event Description: Reactor scram with HPCI system inoperable
Date of Event: November 5, 1989
Plant: Fitzpatrick

Summary

The reactor scrammed from 100% power, and the high-pressure coolant injection (HPCI) system was inoperable. The conditional probability of core damage associated with this event is estimated to be 1.3 x 10^{-5}. The relative significance of this event compared with other potential events at Fitzpatrick is shown below.



Event Description

Fitzpatrick was operating at 100% power on November 5, 1989, when the reactor scrammed due to an apparent failure in the electrohydraulic control (EHC) system of the main turbine. HPCI had been previously removed from service when a ground was discovered in the speed control circuit for the HPCI turbine. The plant scrammed on high neutron flux when closure of the turbine control valves caused a pressure spike in the reactor. The rapid pressure rise caused a collapse of voids in the reactor coolant, enhancing moderation and causing a flux increase. The turbine control valve closure was from an unknown signal source (or failure) that probably originated in the EHC system; however, no component failures were found. RCIC was used for reactor vessel makeup.

Additional Event-Related Information

The HPCI system is a high-pressure injection system designed for small-break LOCAs that do not depressurize the reactor. HPCI is an independent system, uses a turbine-driven pump, and automatically initiates on reactor low water level. HPCI can deliver ~5000 gpm of makeup water to the vessel through the feedwater piping.

Closure of the turbine control valves will ordinarily generate an anticipatory scram signal. Low EHC oil pressure, about 850 psi to the control valves, will indicate that the valves are about to begin closing and will initiate a scram. This provides a margin to core thermal-hydraulic limits during the subsequent transient. During this event, the turbine control valve fast closure relays apparently failed to operate, and the reactor subsequently scrammed on high flux.

ASP Modeling Assumptions and Approach

This event has been modeled as a reactor scram with HPCI unavailable during the scram and subsequent recovery actions.

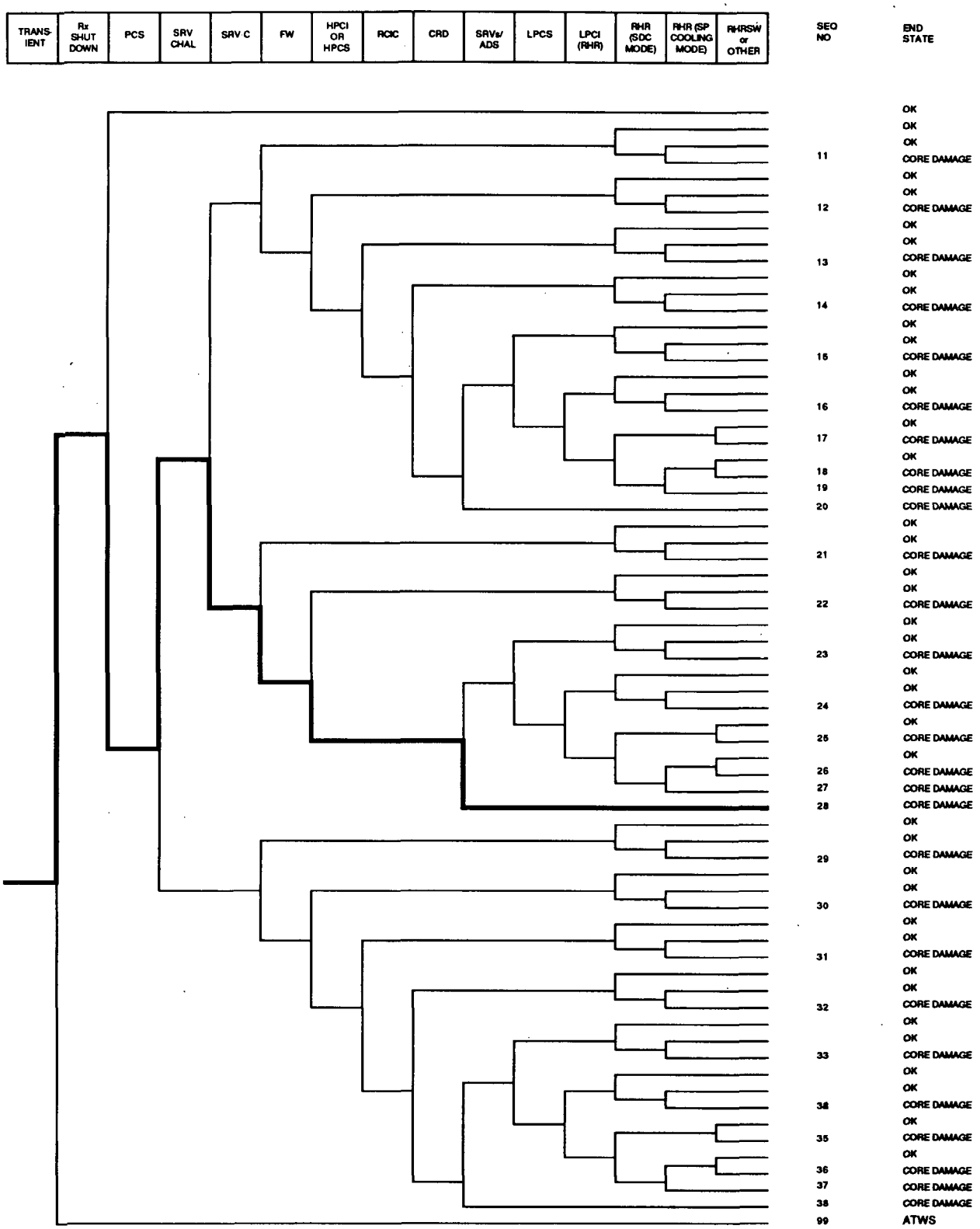
Analysis Results

The conditional probability of severe core damage for this event is 1.3×10^{-5}. The dominant sequence, highlighted on the following event tree, involves a reactor scram with failure of the power conversion system, SRV challenge and subsequent failure of one of the valves to close, failure of main feedwater, failure to recover HPCI, and failure to depressurize using ADS.

Other LERs that involved HPCI and/or RCIC inoperability in conjunction with power operations at Fitzpatrick are: 333/89-002, -003, -005, -014, -019, -021, and -023. A chronology of HPCI-related events that occurred during 1989 is shown on the following page.

Chronology of Fitzpatrick HPCI-related events in 1989

Date	Time	Power Level	LER	Remarks
3/2	1330	100	002	HPCI inoperable — failure during related speed test
3/6	1415	100	003	SRV opened momentarily during testing following HPCI inoperability
3/7	1930	100	002	HPCI declared operable
4/12	1225	100	005	HPCI inoperable — speed control circuit failure
4/13	2035	100	005	HPCI declared operable
8/17	0820	100	014	HPCI inoperable due to steam leak — lube oil replaced
8/18	0820	100	014	HPCI declared operable
10/3	0625	100	019	HPCI inoperable due to speed control circuit failure
10/31	1149	100	021, 019	RCIC inoperable — injection valve motor fails
10/31	1958	100	021, 019	RCIC declared operable
10/31	2110	100	019	HPCI declared operable
11/3	0300	100	019	HPCI inoperable due to speed control circuit failure
11/5	1523	100	020	Reactor scram with HPCI inoperable
11/8	----	0	019	HPCI mods complete — needs surveillance test
11/12	1734	10	023	Reactor scram at low power during relief valve testing
11/14	----	----	019	HPCI declared operable



Dominant core damage sequence for LER 333/89-020

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 333/89-020
Event Description: Reactor scram with HPCI system inoperable
Event Date: 11/05/89
Plant: Fitzpatrick

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	1.3E-05
Total	1.3E-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	1.2E-05	2.4E-01
11	trans -rx.shutdown pcs/trans srv.chall/trans.-scram -srv.close -fw/pcs.trans rhr(sdc) rhr(spcool)/rhr(sdc)	CD	7.6E-07	1.0E-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**
11	trans -rx.shutdown pcs/trans srv.chall/trans.-scram -srv.close -fw/pcs.trans rhr(sdc) rhr(spcool)/rhr(sdc)	CD	7.6E-07	1.0E-01
28	trans -rx.shutdown pcs/trans srv.chall/trans.-scram srv.close fw/pcs.trans HPCI srv.ads	CD	1.2E-05	2.4E-01
99	trans rx.shutdown	ATWS	3.0E-05	1.0E+00

** non-recovery credit for edited case

SEQUENCE MODEL: a:\1989\bwrcseal.cmp
BRANCH MODEL: a:\1989\fitzpatr.sll
PROBABILITY FILE: a:\1989\bwr_csll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	3.4E-04	1.0E+00	
loop	1.6E-05	3.6E-01	
loca	3.3E-06	5.0E-01	
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	
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	2.9E-03	8.0E-01	
ep.rec	1.6E-01	1.0E+00	
fw/pcs.trans	4.6E-01	3.4E-01	
fw/pcs.loca	1.0E+00	3.4E-01	
HPCI	2.9E-02 > 1.0E+00	7.0E-01 > 1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.9E-02 > Unavailable		
rcic	6.0E-02	7.0E-01	
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
06-16-1990
13:49:40

Event Identifier: 333/89-020