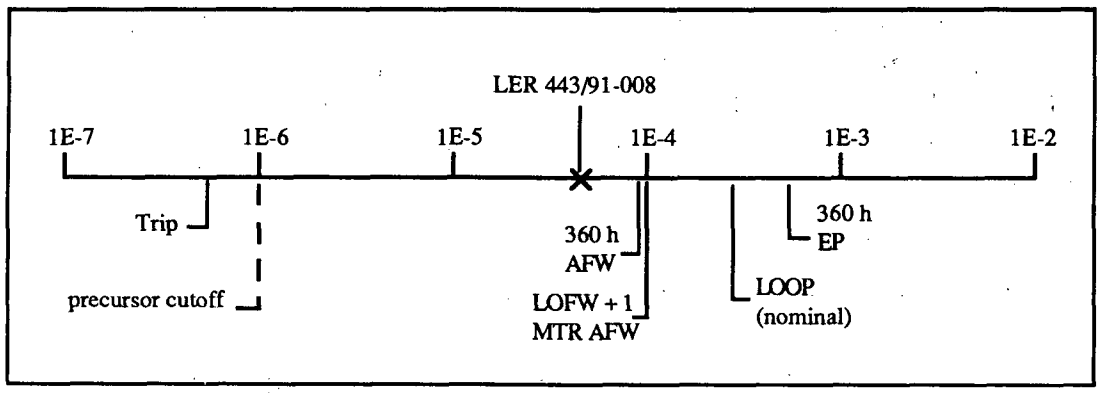
ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No.: 443/91-008
Event Description: Loss of offsite power
Date of Event: June 27, 1991
Plant: Seabrook

Summary

Seabrook underwent a loss of offsite power (LOOP) on June 27, 1991. Following the LOOP, the main turbine generator tripped, causing the reactor to scram from 100% power. Both emergency diesel generators (EDGs) started and energized their respective buses and loads. Normal power was restored to the plant's emergency buses 36 min after the LOOP. The plant was stabilized in Operational Mode 3, Hot Standby, within 1 h. The conditional core damage probability estimated for this event is 4.4×10^{-5}. The relative significance of this event compared to other postulated events at Seabrook is shown below.



Event Description

Seabrook was operating at 100% of rated power at 1334 hours on June 27, 1991, when two 345-kV switchyard circuit breakers tripped open while returning a relay to service following preventative maintenance. The relay had two break-before-make switches instead of one break-before-make and one make-before-break as required. Consequently, the two switchyard breakers opened without generating a signal to open the unit auxiliary transformer (UAT) supply breakers for onsite buses 1-4, E5, and E6. This prevented the automatic transfer to the reserve auxiliary transformer (RAT). Both EDGs automatically started and energized their respective buses and loads. The opening of the switchyard breakers caused a turbine trip followed by a reactor scram. When the

turbine tripped, the turbine control valves fast-closed causing a steam line high-pressure spike. This, in turn, generated a high-high steam generator (SG) level signal, which isolated feedwater. The actual SG level never approached the high-high level setpoint, but the loss of feedwater (LOFW) caused an emergency feedwater (EFW) actuation. After the LOOP, the shift superintendent confirmed within 5 min with the load dispatcher that power was available to the RAT. Buses 1-4 were energized from offsite sources within 20 min of the LOOP. Following the trip, the atmospheric steam dump valves (ASDV) opened to limit steam line pressure. When the operators started reactor coolant pump (RCP) C to establish forced coolant flow, ASDV C did not modulate to control pressure; consequently, the SRV on SG C lifted. Vital buses E5 and E6 were energized from offsite sources within 36 min of the LOOP, and the EDGs were secured within 45 min. The plant was stabilized in Operational Mode 3, Hot Standby, within 1 h of the LOOP.

Additional Event-Related Information

Seabrook is supplied 345-kV from three offsite sources distributed between two buses that, in turn, supply the two RATs. The RATs are the alternate supply for the 4.16-kV emergency buses, E5 and E6. The normal supply for E5 and E6 comes from the UATs, which receive power from either a 345-kV offsite source or the unit main generator via a generator step-up transformer connection. Each UAT and RAT is a three-phase, three-winding transformer, with one wye-connected 13.8-kV output winding and one delta-connected 4.16-kV output winding. The 4.16-kV windings supply buses 3, 4, E5, and E6. Buses E5 and E6 supply vital, 4.16-kV safety-related loads and are backed up with emergency power from the EDGs. Buses 3 and 4 supply 4.16-kV nonsafety-related loads.

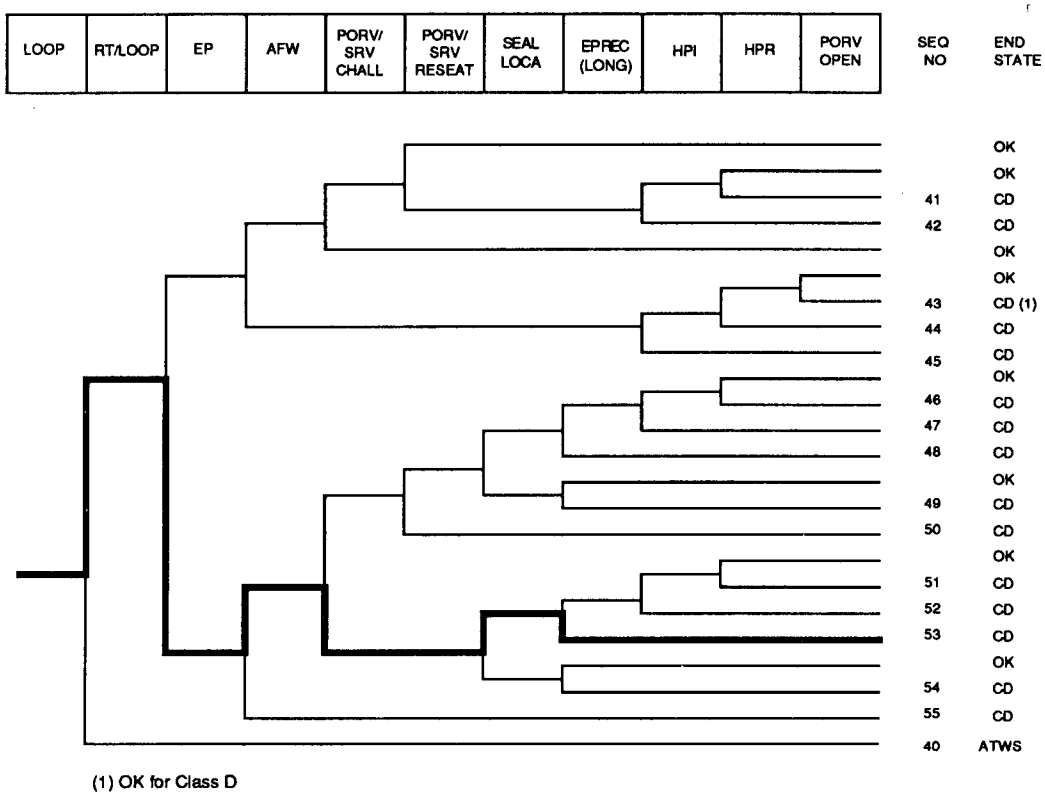
ASP Modeling Assumptions and Approach

The event has been modeled as a plant-centered LOOP. Probabilities for AC power nonrecovery following an RCP seal loss-of-coolant accident (LOCA) and prior to battery depletion, and for a seal LOCA, were revised to reflect values associated with a plant-centered LOOP (see ORNL/NRC/LTR-89/11, *Revised LOOP Recovery and PWR Seal LOCA Models*, August 1989). Since power was available to the RAT, the LOOP nonrecovery probability used in the analysis was revised from that assumed for a nominal plant-centered LOOP at Seabrook to 0.12, to reflect burdened recovery in the control room had the EDGs failed.

Analysis Results

The conditional probability of core damage estimated for this event is 4.4×10^{-5}. The dominant core damage sequence, highlighted on the following event tree, involves a

LOOP, failure of emergency power, an RCP seal LOCA, and failure to recover AC power before core uncovery.



Dominant core damage sequence for LER 443/91-008

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 443/91-008
Event Description: Loss of offsite power
Event Date: 06/27/91
Plant: Seabrook 1

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	1.2E-01

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	4.4E-05
Total	4.4E-05
ATWS	
LOOP	0.0E+00
Total	0.0E+00

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
53	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall SEAL.LOCA EP.REC(SL)	CD	2.9E-05	9.5E-02
54	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	8.5E-06	9.5E-02
55	LOOP -rt/loop emerg.power afw/emerg.power	CD	4.7E-06	3.3E-02
48	LOOP -rt/loop emerg.power -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power SEAL.LOCA EP.REC(SL)	CD	1.2E-06	9.5E-02

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
48	LOOP -rt/loop emerg.power -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power SEAL.LOCA EP.REC(SL)	CD	1.2E-06	9.5E-02
53	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall SEAL.LOCA EP.REC(SL)	CD	2.9E-05	9.5E-02
54	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	8.5E-06	9.5E-02
55	LOOP -rt/loop emerg.power afw/emerg.power	CD	4.7E-06	3.3E-02

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\1989\pwrbseal.cmp
BRANCH MODEL: c:\asp\1989\seabrook.sll
PROBABILITY FILE: c:\asp\1989\pwr_bsll.pro

Event Identifier: 443/91-008

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	5.3E-04	1.0E+00	
LOOP	1.6E-05 > 1.6E-05	5.3E-01 > 1.2E-01	
Branch Model: INITOR			
Initiator Freq:	1.6E-05		
loca	2.4E-06	4.3E-01	
rt	2.8E-04	1.2E-01	
rt/loop	0.0E+00	1.0E+00	
emerg.power	2.9E-03	8.0E-01	
afw	1.3E-03	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 > 2.3E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.7E-01 > 2.3E-01		
EP.REC(SL)	5.7E-01 > 4.8E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	5.7E-01 > 4.8E-01		
EP.REC	7.0E-02 > 4.3E-02	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	7.0E-02 > 4.3E-02		
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	4.0E-04

* branch model file
** forced

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Event Identifier: 443/91-008