

B.10-1

B.10 LER No. 272/83-033 and -034

Event Description: Loss of Offsite Power with Auxiliary Feedwater Pump 13 Failed

Date of Event: August 11, 1983

Plant: Salem 1

B.10.1 Summary

On August 11, 1983, with Salem 1 operating at 99% power and Salem 2 operating at 100% power, both units tripped due to debris which clogged the circulation water system (CWS) intake screens. A decrease in condenser vacuum led to the trip of feedwater pump 11 and an undervoltage condition which resulted in a loss of offsite power (LOOP) at Unit 1. Following the LOOP at Unit 1, auxiliary feedwater (AFW) pump 13 (a turbine-driven pump) failed to start. A LOOP did not occur at Unit 2, and Unit 2 was brought to a stable shutdown condition. The conditional core damage probability estimated for the event at Unit 1 is 1.2×10^{-4} .

B.10.2 Event Description

On August 11, 1983, with Salem 1 operating at 99% power and Salem 2 operating at 100% power, both units tripped due to debris which clogged the CWS intake screens. The clogged intake screens led to a trip of the CWS and a decrease in condenser vacuum which required rapid load reductions at both units. The combined load reduction and vacuum decrease resulted in a Unit 1 steam generator feedwater pump 11 trip, which in turn led to a decrease in feedwater flow and steam generator levels, which then induced a Unit 1 trip. A few minutes later, an undervoltage condition occurred on all vital buses at Unit 1 associated with the transfer of the group buses to the station power transformers. The undervoltage condition led to a LOOP. At the same time, a low-low steam generator level signal occurred at Unit 1, but Unit 1 AFW turbine-driven pump 13 failed to start due to the trip valve which was left in the tripped position following a test due to a malfunction of the valve position indicator. During these events at Unit 1, Unit 2 experienced the CWS trip, the turbine generator was successfully unloaded, and Unit 2 tripped. Unit 2 experienced no LOOP and was placed in a stable shutdown condition.

B.10.3 Additional Event-Related Information

Salem 1 AFW system consists of two motor-driven pumps and one turbine-driven pump. The motor-driven pumps are actuated on the receipt of a safety injection signal, a low-low steam generator level signal or the trip of both steam generator feedwater pumps. The turbine-driven pump is actuated upon the loss of offsite power, the receipt of a low-low steam generator level signal for two of four steam generators, or an undervoltage in group buses using one-of-two-taken-twice logic.

B.10.4 Modeling Assumptions

This event was modeled as a plant-centered LOOP at Unit 1 with a degraded AFW system. Offsite power non-recovery probabilities and the probability of seal LOCA were modified as shown in Table 1 to reflect those values associated with a plant-centered LOOP (see ORNL/NRC/LTR 89/11, *Revised LOOP Recovery and PWR Seal LOCA Models*, August 1989).

Table 1. Revised LOOP Probabilities

Event	Default Probability	Revised Probability
LOOP short-term nonrecovery	0.53	0.5
Seal LOCA probability	0.27	0.23
Offsite power nonrecovery prior to battery depletion given no seal LOCA	7.0E-2	4.3E-2
Offsite power nonrecovery given seal LOCA	0.57	0.48
Offsite power nonrecovery within 2 hours (OFFSITE.PWR.REC/-EP.AND.-AFW)	0.22	0.14
Offsite power nonrecovery within 6 hours (OFFSITE.PWR.REC/-EP.AND.AFW)	6.7E-2	9.9E-4

AFW pump 13 failed to start due to a trip valve which was left in its tripped position during a test. AFW pump 13 is the turbine-driven pump and is modeled as train 3 in the ASP model. In the ASP model, this train was set to failed for the AFW (AFW) and AFW given failure of emergency power (AFW/EP) branches. These are the two branches associated with the LOOP sequences.

B.10.5 Analysis Results

The estimated conditional core damage probability for the LOOP at Unit 1 in this analysis is 1.2×10^{-4} . The dominant core damage sequence involves the observed LOOP and successful reactor trip, failure of emergency power, and failure of AFW given the failure of emergency power and is highlighted on the event tree shown in Figure B.10.1.

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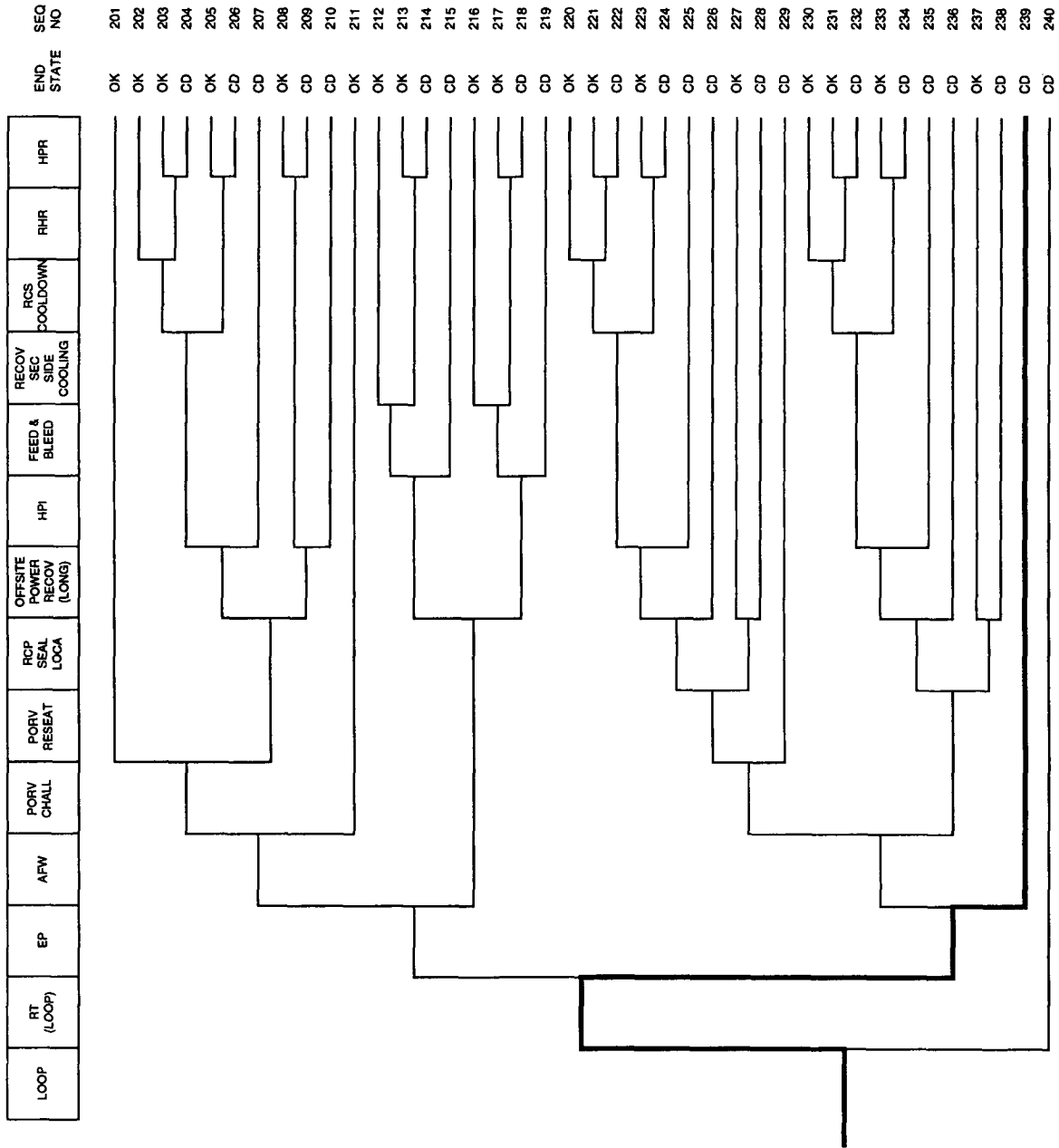


Figure B.10.1 Dominant core damage sequence for LER 272/83-033 and -034

LER No. 272/83-033 and -034

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CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 272/83-033 and -034
Event Description: Plant centered LOOP with turbine-driven AFW pump inop.
Event Date: August 11, 1983
Plant: Salem 1

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 5.0E-01

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	1.2E-04
Total	1.2E-04

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

Sequence	End State	Prob	N Rec**
239 LOOP -rt(loop) ep AFW/EP	CD	8.2E-05	1.5E-01
226 LOOP -rt(loop) ep -AFW/EP porv.chall/sbo -porv.reset/ep SEAL .LOCA OFFSITE.PWR.REC/SEAL.LOCA	CD	1.7E-05	2.9E-01
215 LOOP -rt(loop) -ep AFW -OFFSITE.PWR.REC/-EP.AND.AFW feed.bleed	CD	1.5E-05	2.2E-01
228 LOOP -rt(loop) ep -AFW/EP porv.chall/sbo -porv.reset/ep -SEAL .LOCA OFFSITE.PWR.REC/-SEAL.LOCA	CD	5.2E-06	2.9E-01
229 LOOP -rt(loop) ep -AFW/EP porv.chall/sbo porv.reset/ep	CD	3.2E-06	2.9E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

Sequence	End State	Prob	N Rec**
215 LOOP -rt(loop) -ep AFW -OFFSITE.PWR.REC/-EP.AND.AFW feed.bleed	CD	1.5E-05	2.2E-01
226 LOOP -rt(loop) ep -AFW/EP porv.chall/sbo -porv.reset/ep SEAL .LOCA OFFSITE.PWR.REC/SEAL.LOCA	CD	1.7E-05	2.9E-01
228 LOOP -rt(loop) ep -AFW/EP porv.chall/sbo -porv.reset/ep -SEAL .LOCA OFFSITE.PWR.REC/-SEAL.LOCA	CD	5.2E-06	2.9E-01
229 LOOP -rt(loop) ep -AFW/EP porv.chall/sbo porv.reset/ep	CD	3.2E-06	2.9E-01
239 LOOP -rt(loop) ep AFW/EP	CD	8.2E-05	1.5E-01

** non-recovery credit for edited case

SEQUENCE MODEL: c:\aspcode\models\pwr8283.cmp
BRANCH MODEL: c:\aspcode\models\salem1.82
PROBABILITY FILE: c:\aspcode\models\pwr8283.pro

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No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	1.2E-03	1.0E+00	
LOOP	1.6E-05 > 1.4E-05	5.3E-01 > 5.0E-01	
Branch Model: INITOR			
Initiator Freq:	1.6E-05 > 1.4E-05		
loca	2.4E-06	5.4E-01	
sgtr	1.6E-06	1.0E+00	
rt	2.8E-04	1.0E-01	
rt(loop)	0.0E+00	1.0E+00	
AFW	3.8E-04 > 2.3E-03	4.5E-01	
Branch Model: 1.OF.3+ser			
Train 1 Cond Prob:	2.0E-02		
Train 2 Cond Prob:	1.0E-01		
Train 3 Cond Prob:	5.0E-02 > Failed		
Serial Component Prob:	2.8E-04		
afw/atws	4.3E-03	1.0E+00	
AFW/EP	5.0E-02 > 1.0E+00	3.4E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	5.0E-02 > Failed		
mfw	2.0E-01	3.4E-01	1.0E-03
porv.chall	4.0E-02	1.0E+00	
porv.chall/afw	1.0E+00	1.0E+00	
porv.chall/loop	1.0E-01	1.0E+00	
porv.chall/sbo	1.0E+00	1.0E+00	
porv.reset	2.0E-02	1.1E-02	
porv.reset/ep	2.0E-02	1.0E+00	
srv.reset(atws)	1.0E-01	1.0E+00	
hpi	1.0E-05	8.9E-01	
feed.bleed	2.0E-02	1.0E+00	1.0E-02
emrg.boration	0.0E+00	1.0E+00	1.0E-02
recov.sec.cool	2.0E-01	1.0E+00	
recov.sec.cool/offsite.pwr	3.4E-01	1.0E+00	
rsc.cooldown	3.0E-03	1.0E+00	1.0E-03
rhr	2.2E-02	7.0E-02	1.0E-03
rhr.and.hpr	1.0E-03	1.0E+00	1.0E-03
hpr	4.0E-03	1.0E+00	1.0E-03
ep	5.4E-04	8.9E-01	
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		
OFFSITE.PWR.REC/-EP.AND.-AFW	2.2E-01 > 1.4E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.2E-01 > 1.4E-01		
OFFSITE.PWR.REC/-EP.AND.AFW	6.7E-02 > 9.9E-04	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	6.7E-02 > 9.9E-04		
OFFSITE.PWR.REC/SEAL.LOCA	5.7E-01 > 4.8E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	5.7E-01 > 4.8E-01		
OFFSITE.PWR.REC/-SEAL.LOCA	7.0E-02 > 4.3E-02	1.0E+00	
Branch Model: 1.OF.1			

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Train 1 Cond Prob:	7.0E-02 > 4.3E-02		
sg.iso.and.rcs.cooldown	1.0E-02	1.0E-01	
rsc.cool.below.rhr	3.0E-03	1.0E+00	3.0E-03
prim.press.limited	8.8E-03	1.0E+00	

* branch model file
** forced