B.30 LER Nos. 327/82-048 and -050

Event Description: Unavailability of One Emergency Diesel Generator and One Motor-Driven Auxiliary Feedwater Pump

Date of Event: April 13, 1982

Plant: Sequoyah 1

B.30.1 Summary

On April 8, 1982, an automatic control valve in the auxiliary feedwater (AFW) system at Sequoyah Unit 1 failed to open on demand. The failure was caused by a faulty soldered connection to the electrohydraulic actuator of the valve. A similar event occurred on April 10, 1982. In this case, it was found that the servo valve oil passages were blocked by an accumulation of foreign matter in the filters. In both instances, the motor-driven pump in train B was rendered inoperable by the failures. Five days later (April 13, 1982), emergency diesel generator (EDG) 1A-A was declared inoperable when power fuses opened in the control circuitry. The estimated increase in core damage probability, or importance, over the duration of the event is 2.6×10^{-5}. The base-case core damage probability (CDP) over the duration of the event is 2.2×10^{-6}, resulting in an estimated conditional core damage probability (CCDP) of 2.8×10^{-5}.

B.30.2 Event Description

On April 8, 1982, Sequoyah Unit 1 was operating at 100% power when an automatic control valve (1-PCV-3-132) in the AFW system was declared inoperable due to failure to open on demand. A similar event occurred on April 10, 1982. The first event was due to a faulty soldered connection to the electrohydraulic actuator of the valve. The connector was repaired and the valve was returned to service on April 8, 1982. In the second event, it was found that the servo valve oil passages were blocked by an accumulation of foreign matter in the filters. The valve was replaced, and the control valve was returned to service on April 11, 1982.

On April 13, 1982, with Unit 1 still at 100% power, emergency diesel generator 1A-A was declared inoperable when power fuses opened in the control circuitry. The failure was due to a broken lead in the annunciator horn which had shorted to ground, causing the fuses to open due to excessive current. The horn was replaced, and the EDG was declared operable on April 13, 1982.

B.30.3 Additional Event-Related Information

The failure of valve 1-PCV-3-132 disables train B of the AFW system, since it is located in the discharge line of motor-driven pump (MDP) B. EDG 1A-A is one of two diesel generators that provide emergency power to Unit 1.

B.30.4 Modeling Assumptions

These events are modeled as a combined unavailability of one EDG and an AFW MDP. EDG 1A-A is assumed to have been inoperable for half of the 30-day surveillance period prior to April 13, 1982, i.e. starting on March 29, 1982. Similarly, MDP B is assumed to have been unavailable starting on March 24, 1982, 15 days prior to April 8, 1982. Using these assumptions, the period during which both systems were unavailable began on March 29, 1982. The end of the overlap period is April 8, 1982, when the valve which made MDP B inoperable was first returned to service and before EDG 1A-A was discovered to be inoperable. This gives an overlap period of 10 days or 240 hours, longer than the overlap associated with the second valve failure on April 10, 1982. To reflect the inoperability of EDG 1A-A, train 1 of the emergency power system was failed. EDG 1B-B was therefore subject to failure due to the same (common) cause. The potential for common cause failure exists, even when a component is failed. Therefore, the conditional probability of a common cause failure was included in the analysis for those components that were assumed to have been failed as part of the postulated event. In the AFW model, the unavailability of train B was represented by setting train 1 to failed. This recognizes the potential for a similar failure in the other train due to common cause. To represent the unavailability of power from EDG 1A-A, the second AFW train was made unavailable. In the high-pressure injection (HPI) system model, the train 2 safety injection (SI) pump was made unavailable due to the loss of EDG 1A-A. Train 1, the other SI pump, was thus susceptible only to random failures. Since train 3 of the HPI model represents the two charging pumps, which have a 2 of 2 success criterion, this train was made unavailable. Feed-and-bleed operations use the HPI system. Therefore the modifications made to the HPI model were also made to the FEED.BLEED model. In the HPR model, train 2, which represents the same SI pump used in the HPI system, was made unavailable due to the loss of EDG 1A-A, leaving train 1 subject to random failures. Finally, train 2 in the RHR and RHR.AND.HPR models and the serial component in the RHR model (representing the series RHR suction valves) were also set to unavailable due to the loss of the EDG. A loss-of-offsite power (LOOP) was used as the potential initiator for the unavailability analysis. The base-case CDP (not shown in calculation) is 2.2×10^{-6} and the CCDP is 2.8×10^{-5}.

B.30.5 Analysis Results

The increase in core damage probability over the duration of the event is 2.6×10^{-5}. The base-case CDP (not shown in calculation) is 2.2×10^{-6}, resulting in an estimated CCDP of 2.8×10^{-5}. The dominant core damage sequence, shown in Figure B.30.1, involves a postulated LOOP, failure of emergency power, an RCP seal LOCA, and failure to recover offsite power prior to core uncovery.

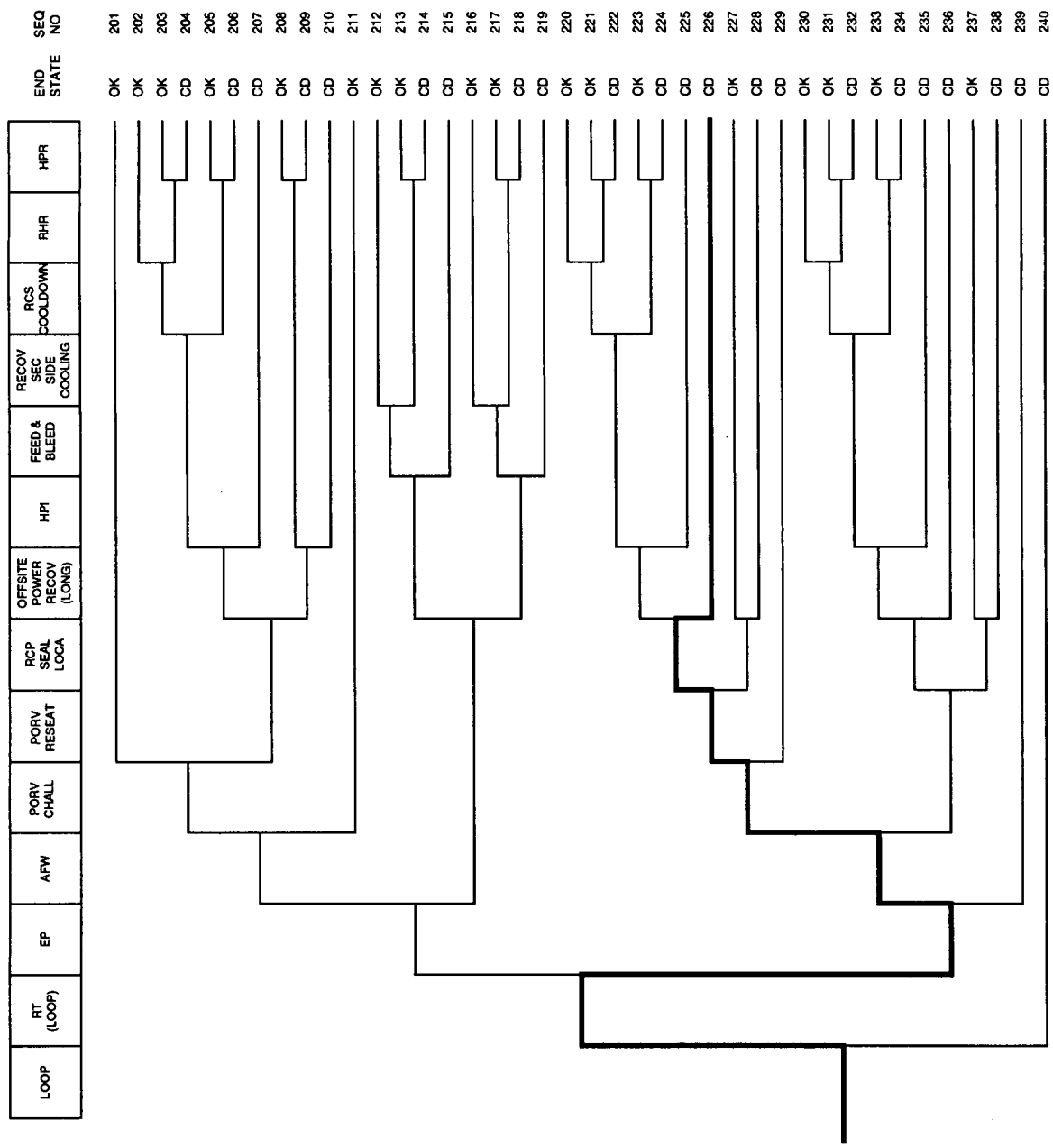

Figure B.30-1 Dominant core damage sequence for LER Nos. 327/82-048 and -050

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 327/82-048
Event Description: EDG unavailable, AFW MDP discharge valve fails
Event Date: April 13, 1982
Plant: Sequoyah 1

UNAVAILABILITY, DURATION= 240

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	2.1E-03

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	2.6E-05
Total	2.6E-05

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
226	loop -rt(loop) EP -afw/ep porv.chall/sbo -porv.reseat/ep seal .loca offsite.pwr.rec/seal.loca	CD	1.5E-05	4.7E-01
228	loop -rt(loop) EP -afw/ep porv.chall/sbo -porv.reseat/ep -seal .loca offsite.pwr.rec/-seal.loca	CD	4.9E-06	4.7E-01
229	loop -rt(loop) EP -afw/ep porv.chall/sbo porv.reseat/ep	CD	2.0E-06	4.7E-01
239	loop -rt(loop) EP afw/ep	CD	1.7E-06	1.6E-01
215	loop -rt(loop) -EP AFW -offsite.pwr.rec/-ep.and.afw FEED.BLEED	CD	1.6E-06	2.4E-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	1.6E-06	2.4E-01
226	loop -rt(loop) EP -afw/ep porv.chall/sbo -porv.reseat/ep seal .loca offsite.pwr.rec/seal.loca	CD	1.5E-05	4.7E-01
228	loop -rt(loop) EP -afw/ep porv.chall/sbo -porv.reseat/ep -seal .loca offsite.pwr.rec/-seal.loca	CD	4.9E-06	4.7E-01
229	loop -rt(loop) EP -afw/ep porv.chall/sbo porv.reseat/ep	CD	2.0E-06	4.7E-01
239	loop -rt(loop) EP afw/ep	CD	1.7E-06	1.6E-01

** non-recovery credit for edited case

Note: For unavailabilities, conditional probability values are differential values which reflect the added risk due to failures associated with an event. Parenthetical values indicate a reduction in risk compared to a similar period without the existing failures.

SEQUENCE MODEL: c:\asp\1982-83\pwrb8283.cmp

BRANCH MODEL: c:\asp\1982-83\sequoy1.82
PROBABILITY FILE: c:\asp\1982-83\pwr8283.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	1.6E-03	1.0E+00	
loop	1.6E-05	5.3E-01	
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 > 5.0E-02	4.5E-01	
Branch Model: 1.OF.3+ser			
Train 1 Cond Prob:	2.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
Train 3 Cond Prob:	5.0E-02		
Serial Component Prob:	2.8E-04		
afw/atws	4.3E-03	1.0E+00	
afw/ep	5.0E-02	3.4E-01	
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.RESEAT	2.0E-02 > 2.0E-02	1.1E-02 > 5.0E-01	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.0E-02		
porv.reseat/ep	2.0E-02	1.0E+00	
srv.reseat(atws)	1.0E-01	1.0E+00	
HPI	1.0E-05 > 1.0E-02	8.9E-01	
Branch Model: 1.OF.3			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
Train 3 Cond Prob:	1.0E-02 > Unavailable		
FEED.BLEED	2.0E-02 > 3.0E-02	1.0E+00	1.0E-02
Branch Model: 1.OF.3+ser+opr			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
Train 3 Cond Prob:	1.0E-02 > Unavailable		
Serial Component Prob:	2.0E-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	
rcs.cooldown	3.0E-03	1.0E+00	1.0E-03
RHR	2.2E-02 > 1.0E+00	5.7E-02	1.0E-03
Branch Model: 1.OF.2+ser+opr			
Train 1 Cond Prob:	2.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
Serial Component Prob:	2.0E-02 > 1.0E+00		
RHR.AND.HPR	1.0E-03 > 1.0E-02	1.0E+00	1.0E-03
Branch Model: 1.OF.2+opr			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
HPR	4.0E-03 > 4.0E-02	1.0E+00	1.0E-03

Branch Model: 1.OF.2+opr			
Train 1 Cond Prob:	4.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
EP	2.9E-03 > 5.7E-02	8.9E-01	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02 > Failed		
Train 2 Cond Prob:	5.7E-02		
seal.loca	2.7E-01	1.0E+00	
offsite.pwr.rec/-ep.and.-afw	2.2E-01	1.0E+00	
offsite.pwr.rec/-ep.and.afw	6.7E-02	1.0E+00	
offsite.pwr.rec/seal.loca	5.7E-01	1.0E+00	
offsite.pwr.rec/-seal.loca	7.0E-02	1.0E+00	
sg.iso.and.rcs.cooldown	1.0E-02	1.0E-01	
rcs.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