B.20 LER Number 328/92-010

Event Description: Emergency Diesel Generator and Residual Heat Removal Pump Inoperable

Date of Event: July 17, 1992

Plant: Sequoyah Nuclear Plant, Unit 2

B.20.1 Summary

During performance of a surveillance procedure on the 2B-B Residual Heat Removal (RHR) pump, it was found that the miniflow control valve continuously cycled open and closed when it should have remained opened. While the 2B-B RHR pump was inoperable, the 2A-A emergency diesel generator (EDG) was inoperable for 17 h and the 2A-A centrifugal charging pump was inoperable for 6 h. The conditional core damage probability estimated for this event is 1.9×10^{-6}. The relative significance of this event compared to other postulated events at Sequoyah, Unit 2 is shown in Fig. B.42.

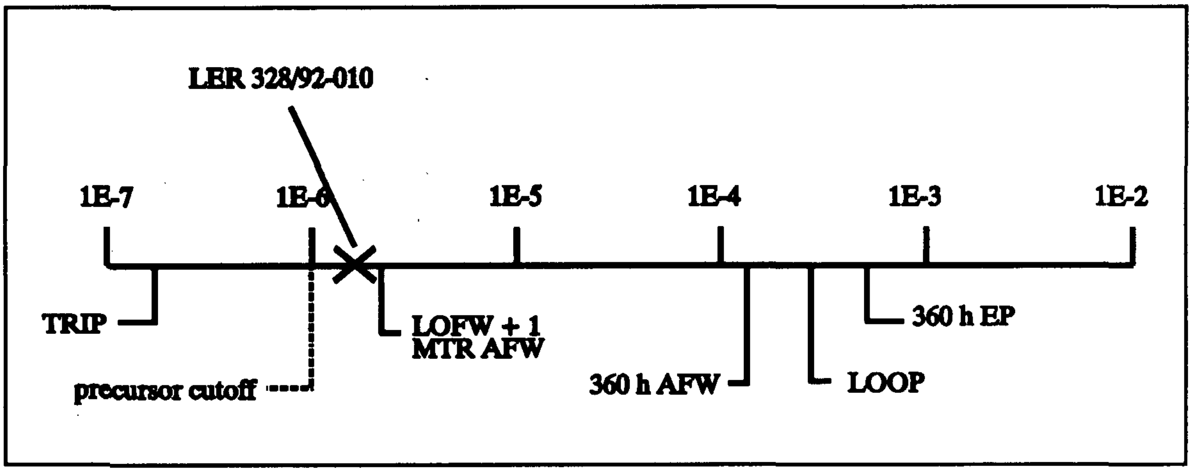

Fig. B.42. Relative event significance of LER 328/92-010 compared with other potential events at Sequoyah 2.

B.20.2 Event Description

On July 17, 1992, with the unit at 100% power, a quarterly surveillance procedure on the 2B-B RHR pump was conducted. During the test, it was discovered that the pump's miniflow line motor control valve was continuously cycling open and closed when it should have remained open.

Further investigation revealed that the valve had been miswired on July 1, 1992, during performance of the flow switch quarterly preventive maintenance procedure. Between July 1, 1992 and July 17, 1992, there were 10 instances where Train A safety equipment had been out of service. Only two of these instances were of a significant duration; EDG 2A-A was out of service for 17 h, and centrifugal charging pump (CCP) 2A-A was out of service for 6 h.

The wiring for the other RHR trains was verified to be correct.

B.20.3 Additional Event-Related Information

The Sequoyah Units have miniflow lines for each of the RHR pumps. This flow path consists of the pump, a flow sensor, the RHR heat exchanger, and a recirculation line that returns to the pump suction. The recirculation line contains a motor-operated flow control valve that varies its position, based on the pump discharge flow signal, to maintain total pump flow between 500 and 1500 gal/min. Manual control and indication of the valve's position is available in the control room.

During an accident, the pump would be aligned for reactor coolant system (RCS) injection. However, the pump would be in the recirculation mode until RCS pressure drops below the pump deadhead pressure, or the RHR system is realigned to the safety injection pump suction during the recirculation phase.

The recirculation valve does not have any thermal overloads and may fail after 15 min of continuous operation. With the valve closed and RCS pressure greater than the RHR pump deadhead pressure, insufficient flow through the pump could damage the pump because of overheating. With the valve fully open, flow to the RCS would be insufficient to ensure accident mitigation under large break LOCA conditions. Because the valve continuously cycled opened and closed, the actual time to failure of the RHR pump is more difficult to predict.

The two CCPs fulfill part of the emergency core cooling system (ECCS) function. The discharge pressure of the pumps (2670 psig) is greater than normal RCS pressure. The two high pressure safety injection (HPSI) system pumps have a discharge pressure of 1650 psig. All four pumps are used during initial injection and during long term recirculation cooling. During the recirculation mode, the 1A-A RHR pump supplies the 1A-A safety injection (SI) pump and both CCPs. The 1B-B RHR pump supplies only the 1B-B SI pump.

B.20.4 Modeling Assumptions

The event was modeled as a potential LOOP assuming the 2B-B RHR train and the 2A-A EDG were inoperable for 17 h. Equipment associated with the train 2A-A EDG (2A-A AFW pump, 2A-A SI pump, 2A-A RHR pump) is rendered inoperable due to loss of electrical power. Both trains of high-pressure recirculation were inoperable because both trains of RHR were inoperable.

The current Accident Sequence Precursor (ASP) models do not account for the separate high head CCPs and intermediate head systems (SI) that Sequoyah uses for the ECCS function. Inoperability of one train of RHR and one train of charging is not normally analyzed in the ASP program. Therefore the 6-hour CCP train/RHR train inoperability was not considered a precursor, and, as a result, was not analyzed. For the 17 h RHR train/EDG inoperability, the HPI system model was modified to incorporate the CCPs. The modification was performed as follows.

p(HPI system) = [p(HPI train 1) × p(HPI train 2)] × [p(CCP train 1) × p(CCP train 2) + p(CCP valves)]

$$= [0.01 \times 1.0] \times [0.01 \times 1.0 + 0.0011]$$
$$= 1.11 \times 10^{-4}$$

p(CCP valves) $= 4 \times [\text{vlv1} \times (\text{vlv2} + \text{BETA v})]$

$$= 4 \times [0.003 \times (0.003 + 0.088)]$$

$$= 0.001092$$

B.20.5 Analysis Results

The conditional probability of core damage estimated for this event is 1.9×10^{-6}. The dominant sequence, highlighted on the event tree in Fig. B.43, involves a postulated LOOP with failure of on-site emergency power, and failure to recover offsite power prior to a RCP seal LOCA.

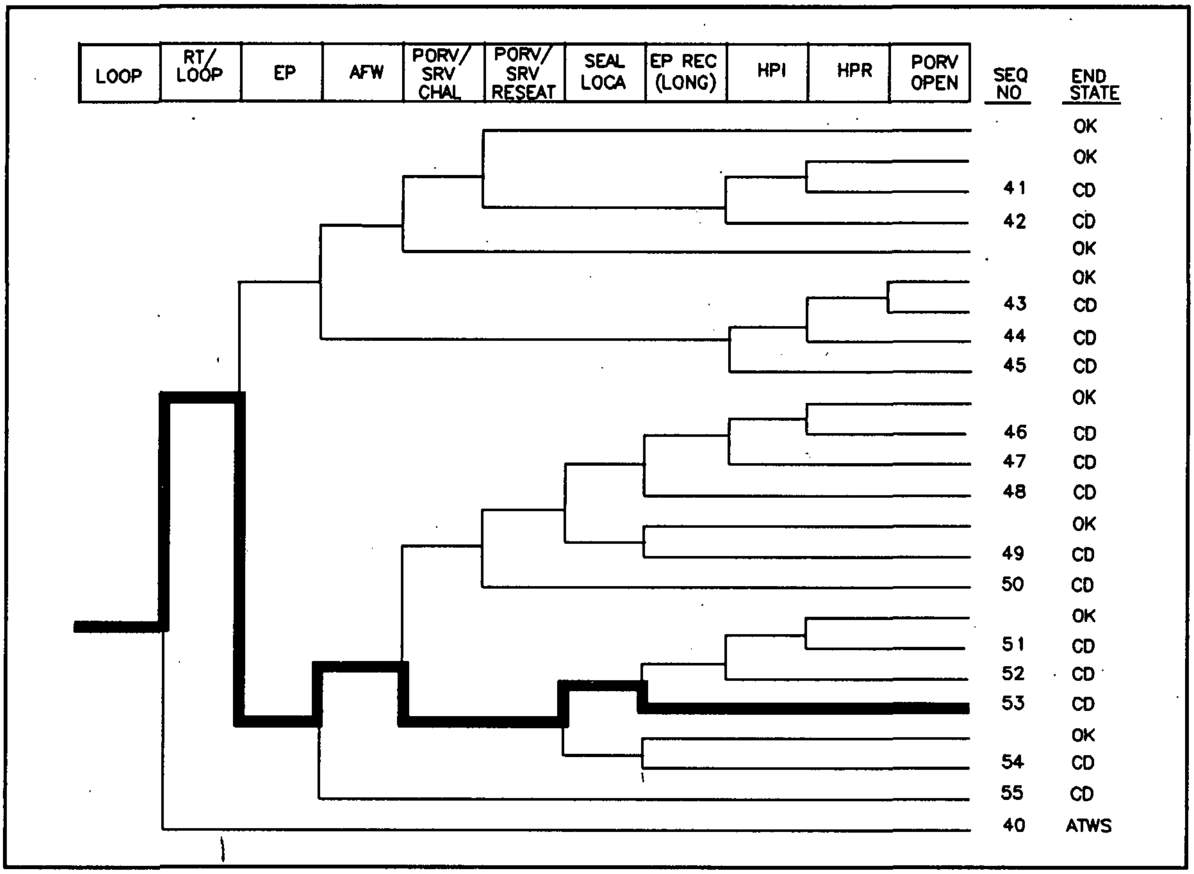

Fig. B.43. Dominant core damage sequences for LER 328/92-010

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 328/92-010
Event Description: 1A-A EDG Unavail & 1B-B RHR Unavail (LOOP Only)
Event Date: 07/17/92
Plant: Sequoyah 2

UNAVAILABILITY, DURATION= 17 h

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	1.5E-04

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	1.9E-06
Total	1.9E-06
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	8.0E-07	4.2E-01
51	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca -ep.rec(sl) -HPI HPR/-HPI	CD	6.4E-07	4.2E-01
54	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall -seal.loca ep.rec	CD	2.7E-07	4.2E-01
55	loop -rt/loop EMERG.POWER afw/emerg.power	CD	9.4E-08	1.4E-01
44	loop -rt/loop -EMERG.POWER AFW -HPI(F/B) HPR/-HPI	CD	4.6E-08	1.4E-01
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	3.3E-08	4.2E-01
46	loop -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall -porv.or.srv.reseat/emerg.power seal.loca -ep.rec(sl) -HPI HPR/-HPI	CD	2.6E-08	4.2E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
44	loop -rt/loop -EMERG.POWER AFW -HPI(F/B) HPR/-HPI	CD	4.6E-08	1.4E-01
46	loop -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall -porv.or.srv.reseat/emerg.power seal.loca -ep.rec(sl) -HPI HPR/-HPI	CD	2.6E-08	4.2E-01
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	3.3E-08	4.2E-01
51	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca -ep.rec(sl) -HPI HPR/-HPI	CD	6.4E-07	4.2E-01
53	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca ep.rec(sl)	CD	8.0E-07	4.2E-01

Event Identifier: 328/92-010

54	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall -seal.loca ep.rec	CD	2.7E-07	4.2E-01
55	loop -rt/loop EMERG.POWER afw/emerg.power	CD	9.4E-08	1.4E-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:\asppra\models\pwrbseal.cmp
BRANCH MODEL: c:\asppra\models\sequoyah.sl1
PROBABILITY FILE: c:\asppra\models\pwr_bsl1.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	7.7E-04	1.0E+00	
loop	1.6E-05	5.3E-01	
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 > 5.0E-02	8.0E-01	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02		
Train 2 Cond Prob:	5.7E-02 > Unavailable		
AFW	3.8E-04 > 1.3E-03	2.6E-01	
Branch Model: 1.OF.3+ser			
Train 1 Cond Prob:	2.0E-02		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
Train 3 Cond Prob:	5.0E-02		
Serial Component Prob:	2.8E-04		
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	1.0E+00	
ep.rec(sl)	5.7E-01	1.0E+00	
ep.rec	7.0E-02	1.0E+00	
HPI	1.0E-03 > 1.1E-04 **	8.4E-01	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01		
HPI(F/B)	1.0E-03 > 1.1E-04 **	8.4E-01	1.0E-02
Branch Model: 1.OF.2+opr			
Train 1 Cond Prob:	1.0E-02		
Train 2 Cond Prob:	1.0E-01		

Event Identifier: 328/92-010

HPR/-HPI	1.5E-04 > 1.0E+00	1.0E+00	1.0E-03
Branch Model: 1.OF.2+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.5E-02 > Unavailable		
porv.open	1.0E-02	1.0E+00	4.0E-04

* branch model file
** forced

Notes:

1. Probabilities were modified to incorporate CCPs. See the modeling assumptions section for a description of this modification.

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