B.19 LER Number 327/92-027

Event Description: Loss of Offsite Power

Date of Event: December 31, 1992

Plant: Sequoyah 1 & 2

B.19.1 Summary

Shortly after a switchyard tie breaker was installed, it faulted and caused an undervoltage condition in the switchyard. This resulted in the tripping of both units from 100% power after both unit's reactor coolant pumps (RCPs) tripped on undervoltage. Because of the momentary undervoltage condition on the safeguards buses, the emergency diesel generators started and loaded. The conditional core damage probability estimated for this event is 1.8×10^{-4} per unit. The relative significance of this event compared to other postulated events at Sequoyah is shown in Fig. B.40.

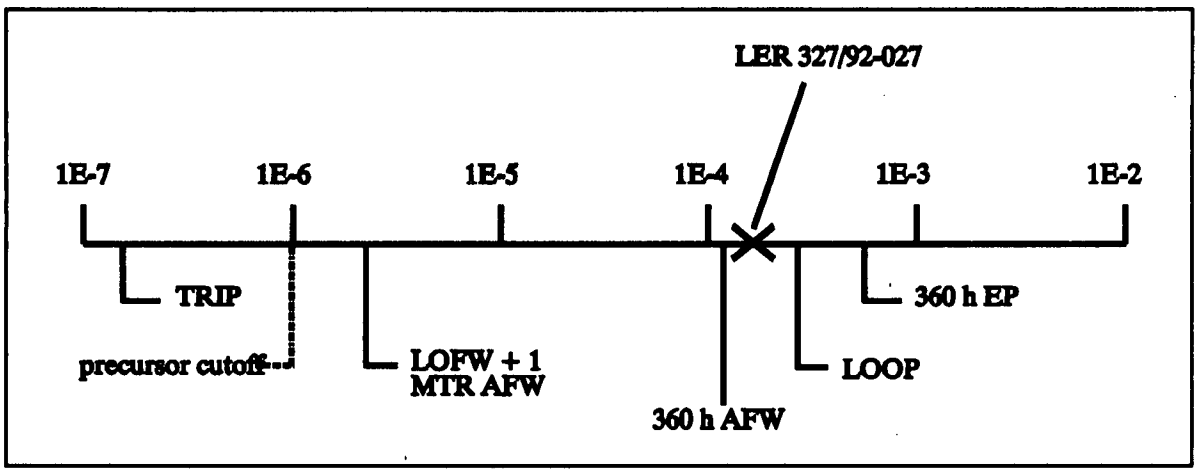

Fig. B.40. Relative event significance of LER 327/92-027 compared with other potential events at Sequoyah 1 & 2.

B.19.2 Event Description

On December 31, 1992, with both units at 100% power, work was progressing on the installation of a 500-kV/161-kV switchyard inter-tie breaker (see figure in LER 327/92-027). For testing purposes, the primary relay protection for the breaker was disabled. At 2148 hours, 11 min after the breaker was placed in service, both units tripped following the loss of the RCPs from an undervoltage signal. The undervoltage was caused by an internal fault in the inter-tie breaker that resulted in decreased voltage throughout the entire switchyard. After the switchyard fault was cleared (in 88 cycles), offsite power was available to the station.

Following the plant trips and the clearing of the switchyard fault, loads automatically transferred as designed from the unit station service transformers to the common station service transformers. However, because of the undervoltage sensed on the shutdown (safeguards) buses, the emergency diesel generators started and loaded. At 2313 hours the safeguards buses were realigned to offsite power. By 0013 hours on January 1, 1993, both units were stabilized in hot shutdown.

Due to limited staffing levels, the unit 2 recovery progressed with only one senior reactor operator (SRO) and one reactor operator (RO). During the recovery process, cooling to the RCP seals was placed in a degraded condition. For a period of 20 seconds, all charging pumps and thermal barrier booster pumps (TBBPs) were stopped. The charging pumps provide RCP seal injection while the TBBPs boost component cooling water (CCW) pressure to the RCP thermal barriers. During this 20 second time period, the CCW pumps continued to run and supplied approximately 70% of normal CCW flow to the RCP seals. This was sufficient flow to assure long term seal cooling.

B.19.3 Additional Event-Related Information

The Sequoyah switchyard consists of a 500-kV section and a 161-kV section. Unit 1 is directly connected to the 500-kV switchyard and unit 2 is directly connected to the 161-kV portion of the yard. The two sections are joined by the inter-tie transformer. Power circuit breaker (PCB) 5058 connects one of the 500-kV buses to the inter-tie transformer. During startup and shutdown, power to both units is supplied by the 161-kV system via the common station service transformers. Normally, primary relaying will isolate PCB 5058 in 3.5 cycles. Since PCB 5058 was removed from service, the undervoltage relays on the RCP trip actuated instead (in 17.5 cycles). Also, the undervoltage relays on the safeguards busses actuated (in 30 cycles) before the secondary relaying could isolate the fault (normally, in 88 cycles).

B.19.4 Modeling Assumptions

Since the LOOP was caused by a substation fault, this event was modeled as a plant-centered LOOP. Probabilities for LOOP nonrecovery (short term), failure to recover ac power prior to battery depletion, and RCP seal LOCA probabilities 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). The event was modeled for a single unit. The event sequence was essentially the same for both units.

B.19.5 Analysis Results

The conditional probability of core damage estimated for this event is 1.8×10^{-4} per unit. The dominant core damage sequence, highlighted on the event tree in Fig. B.41, involves failure of emergency power restoration resulting in an RCP seal LOCA.

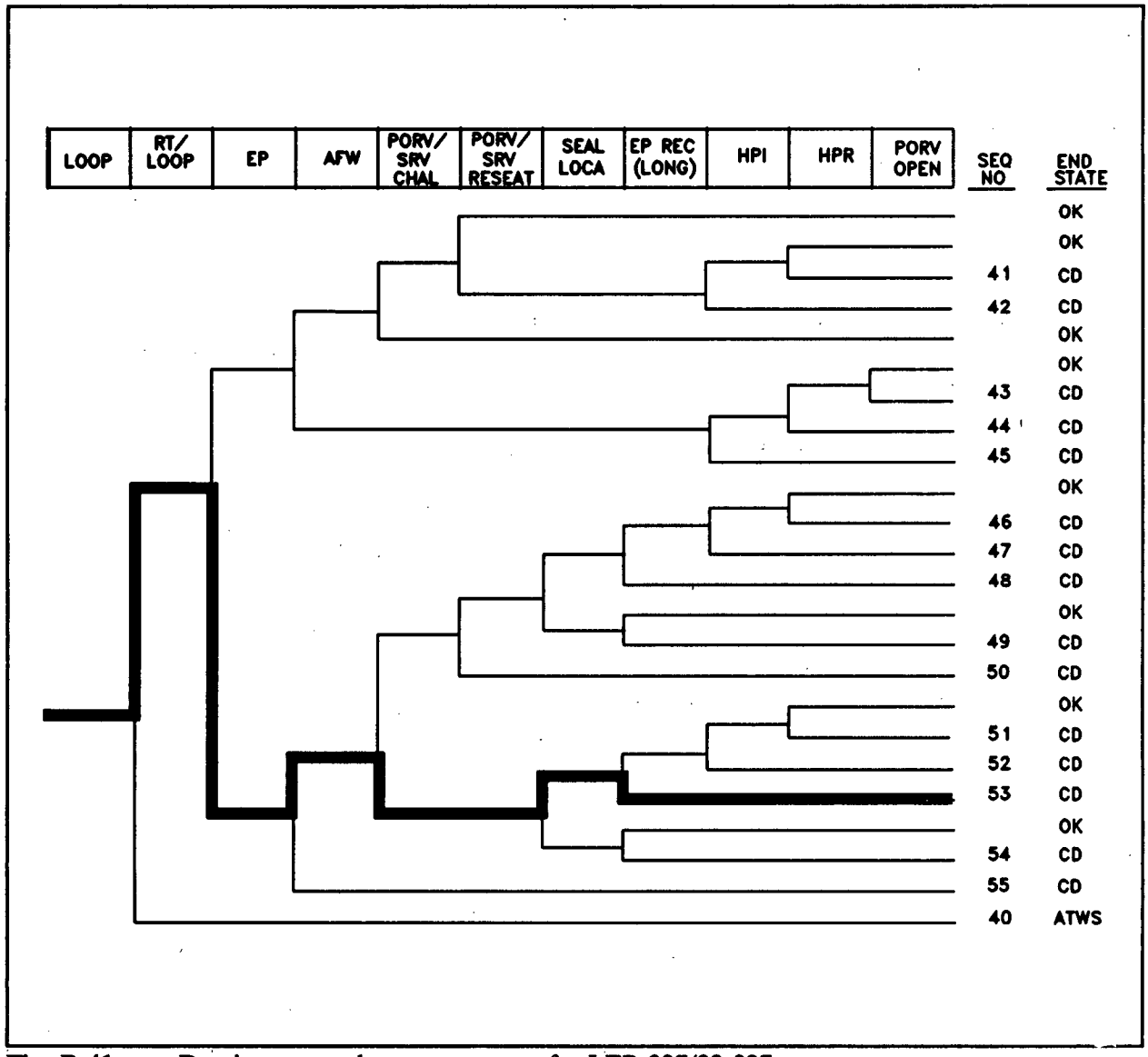

Fig. B.41. Dominant core damage sequence for LER 327/92-027.

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 327/92-027
Event Description: Loss of Offsite Power
Event Date: 12/31/92
Plant: Sequoyah 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 5.0E-01

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	1.8E-04
Total	1.8E-04
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	1.2E-04	4.0E-01
54	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	3.6E-05	4.0E-01
55	LOOP -rt/loop emerg.power afw/emerg.power	CD	1.9E-05	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	4.8E-06	4.0E-01

** 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	4.8E-06	4.0E-01
53	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall SEAL.LOCA EP.REC(SL)	CD	1.2E-04	4.0E-01
54	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	3.6E-05	4.0E-01
55	LOOP -rt/loop emerg.power afw/emerg.power	CD	1.9E-05	1.4E-01

** non-recovery credit for edited case

SEQUENCE MODEL: C:\asppra\models\pwrbseal.cmp
BRANCH MODEL: C:\asppra\models\sequoyah.sl1
PROBABILITY FILE: C:\asppra\models\pwr_bsl1.pro

Event Identifier: 327/92-027

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	7.7E-04	1.0E+00	
LOOP	1.6E-05 > 1.6E-05	5.3E-01 > 5.0E-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	3.8E-04	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

Event Identifier: 327/92-027