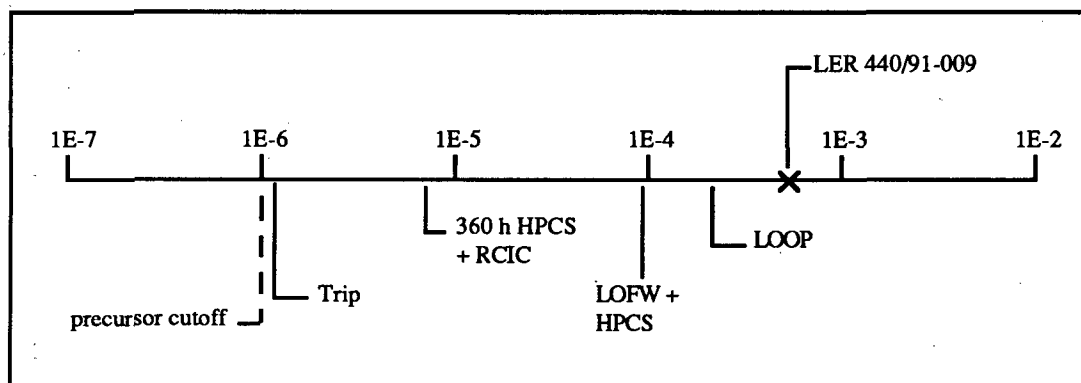


## ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No.: 440/91-009  
 Event Description: Two EDGs inoperable  
 Date of Event: March 14, 1991  
 Plant: Perry

### Summary

Perry was operating at 100% power on March 14, 1991, when the Division 2 emergency diesel generator (EDG) failed a surveillance test. Subsequently, the Division 1 EDG also failed its surveillance test. It took 11 h and 55 min to restore one EDG to operable status. It was later determined that one EDG had been inoperable for over 28 d, and the other EDG was potentially unavailable for 15 d. The conditional core damage probability estimated for this event (assuming both EDGs were unavailable for 15 d) is  $5.3 \times 10^{-4}$ . The relative significance of this event compared to other postulated events at Perry is shown below.



### Event Description

Perry was operating at 100% of rated power at 0915 hours on March 14, 1991, when the Division 2 EDG failed its monthly surveillance test. The EDG reached rated speed but was unable to generate any output voltage because the field contactor failed to close. Subsequent investigations revealed that excessive play in the pivot point of the latch mechanism allowed the latch arm to twist sideways and weld the contacts in the trip position of the K1 close coil of the field contactor. It was concluded that this could only have occurred during shutdown of the EDG during the last surveillance test performed February 14, 1991. Thus, the EDG had been out of service for the entire 28-d period between tests.

When the Division 2 EDG failed its surveillance test, plant Technical Specifications required that the Division 1 EDG be demonstrated operable. During this demonstration run, the Division 1 EDG started and came up to rated speed, but the operators were unable either remotely or locally to synchronize the generator to the grid. The Division 1 EDG was also declared inoperable. In this situation, the plant Technical Specifications require either one EDG to be returned to operability within 2 h or for shutdown to begin. In spite of this, the plant remained at full power throughout the ~12 h time required to repair the Division 2 EDG.

The plant decided to repair the Division 2 EDG first, since the failed component was known. Field contactor repair parts for the Division 2 EDG were not available from warehouse stock and were instead obtained from the Division 1 EDG. The Division 2 EDG was repaired, tested, and placed back in service at 0220 hours on March 15, 1991. At this time, investigation and troubleshooting was begun on Division 1 EDG. The utility concluded that the lower limit switch on the motor-operated potentiometer was malfunctioning although no conclusive cause was ever identified. If this was the case, then the EDG would be expected to function in the event of a loss of offsite power (LOOP). However, after inspection, cleaning, exercising, and post-maintenance testing, the problems that prevented the governor speed control from functioning during the surveillance test could not be recreated. The utility believed that the conditions causing the event were corrected during the maintenance activities. Division 1 EDG was placed back in service at 2305 hours on March 15, 1991. Both EDGs were inoperable at the same time for repairs for 11 h and 55 min. If the cause of the Division 1 EDG failure would have prevented its operation following a LOOP, then both EDGs would have been inoperable for an expected 15 d.

### **Additional Event-Related Information**

Offsite power is available to the Perry 1 345-kV switchyard from five 345-kV transmission circuits. Engineered safety features (ESF) loads are assigned to three independent load groups designated Divisions 1, 2, and 3. Divisions 1 and 2 are redundant, while Division 3 supplies power for the high-pressure core spray (HPCS) system. Each division consists of a 4.16-kV switchgear bus and assembly, diesel generator standby power supply, motor control centers, batteries, and battery chargers. The preferred power supply for the class 1E buses is the startup transformer. Alternate power is available through a manual normally-open disconnect from the unit 2 startup transformer. Emergency loads for Divisions 1 and 2 are supplied from EDGs rated at 7,000 kW.

### **ASP Modeling Assumptions and Approach**

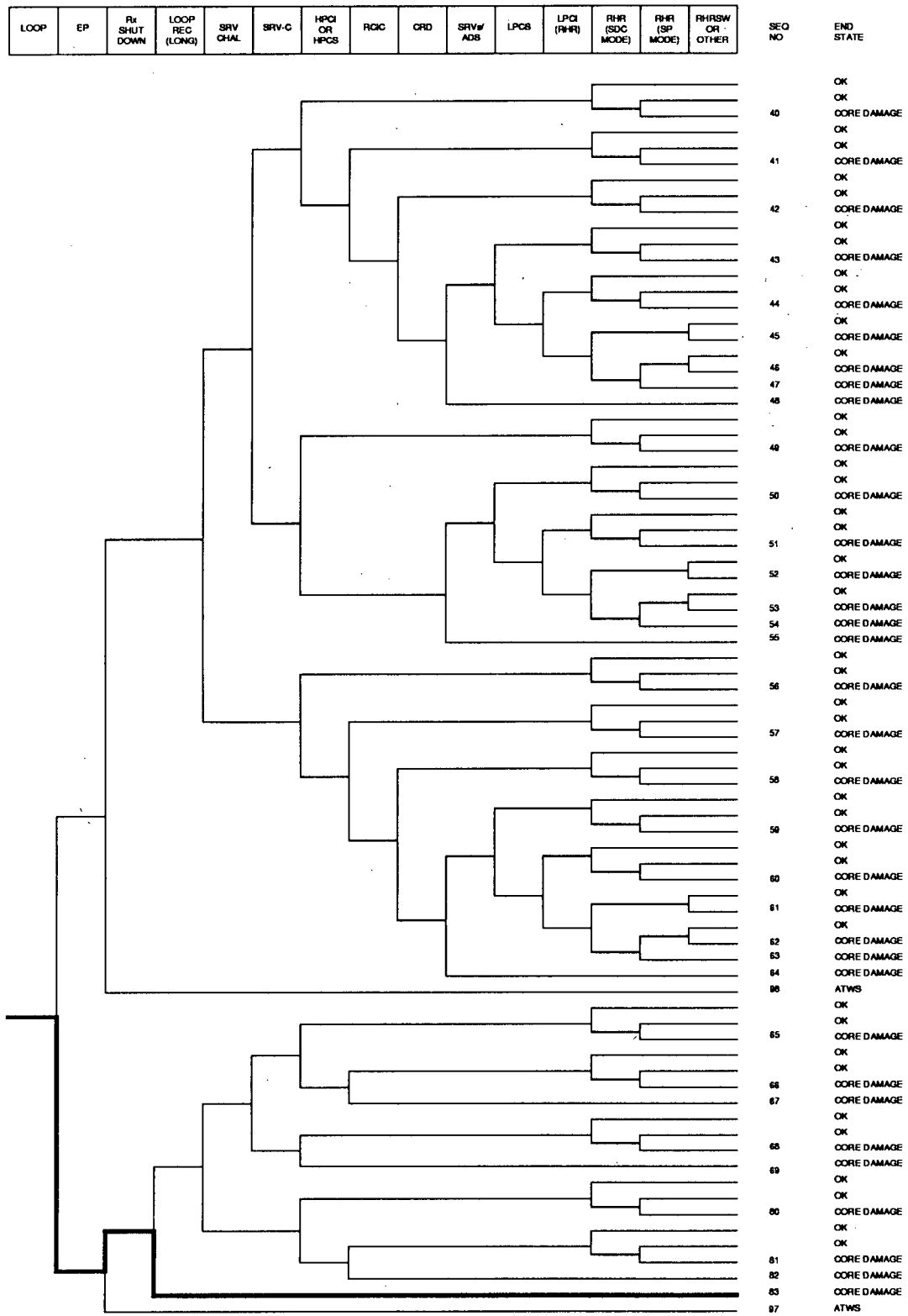
Division 2 EDG was inoperable for more than 28 d, and Division 1 EDG was unable to synchronize to the grid when required. Since the cause for the latter unavailability was

never positively identified, nor was it demonstrated that the EDG would have assumed loads following a postulated LOOP, it was assumed that the Division 1 EDG was unavailable for one half its surveillance period of 15 d. Therefore, this event has been modeled as a postulated LOOP with both the EDGs unavailable and nonrecoverable for 15 d.

### **Analysis Results**

The conditional probability of subsequent core damage estimated for two EDGs unavailable for 15 d is  $5.3 \times 10^{-4}$ . A sensitivity analysis was performed to ascertain the effect of out of service time on the conditional probability. If it is assumed that the two EDGs were only unavailable for the 11.9 h repair time, the conditional probability of core damage decreases by more than an order of magnitude to  $1.7 \times 10^{-5}$ .

The dominant core damage sequence, highlighted on the following event tree, involves a postulated LOOP, a nonrecoverable emergency power system failure, and failure to restore AC power prior to battery depletion.



Dominant core damage sequence for LER 440/91-009

## CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 440/91-009  
 Event Description: Two emergency diesel generators inoperable  
 Event Date: 03/14/91  
 Plant: Perry 1

UNAVAILABILITY, DURATION= 360

## NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 3.1E-03

## SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	5.3E-04
Total	5.3E-04
ATWS	
LOOP	0.0E+00
Total	0.0E+00

## SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

Sequence	End State	Prob	N Rec**
83 loop EMERG.POWER -rx.shutdown/ep ep.rec	CD	5.3E-04	5.3E-01

\*\* non-recovery credit for edited case

## SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

Sequence	End State	Prob	N Rec**
83 loop EMERG.POWER -rx.shutdown/ep ep.rec	CD	5.3E-04	5.3E-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\1989\bwrcseal.cmp  
 BRANCH MODEL: c:\asp\1989\perry.sll  
 PROBABILITY FILE: c:\asp\1989\bwr\_csll.pro

No Recovery Limit

## BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	7.7E-04	1.0E+00	

Event Identifier: 440/91-009

# B-472

loop	1.6E-05	5.3E-01	
loca	3.3E-06	5.0E-01	
rx.shutdown	3.0E-05	1.0E+00	
rx.shutdown/ep	3.5E-04	1.0E+00	
pcs/trans	1.7E-01	1.0E+00	
srv.chall/trans.-scram	1.0E+00	1.0E+00	
srv.chall/loop.-scram	1.0E+00	1.0E+00	
srv.close	6.3E-02	1.0E+00	
EMERG.POWER	2.9E-03 > 1.0E+00	8.0E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02 > Failed		
Train 2 Cond Prob:	5.7E-02 > Failed		
ep.rec	1.7E-01	1.0E+00	
fw/pcs.trans	4.6E-01	3.4E-01	
fw/pcs.loca	1.0E+00	3.4E-01	
hpci	2.0E-02	3.4E-01	
rcic	6.0E-02	7.0E-01	
crd	1.0E-02	1.0E+00	1.0E-02
srv.ads	3.7E-03	7.1E-01	1.0E-02
lpcs	2.0E-02	3.4E-01	
lpci(rhr)/lpcs	6.0E-04	7.1E-01	
rhr(sdc)	2.3E-02	3.4E-01	1.0E-03
rhr(sdc)/~lpci	2.0E-02	3.4E-01	1.0E-03
rhr(sdc)/lpci	1.0E+00	1.0E+00	1.0E-03
rhr(spcool)/rhr(sdc)	2.0E-03	3.4E-01	
rhr(spcool)/~lpci.rhr(sdc)	2.0E-03	3.4E-01	
rhr(spcool)/lpci.rhr(sdc)	9.3E-02	1.0E+00	
zhrrw	2.0E-02	3.4E-01	2.0E-03
* branch model file			
** forced			

Minarick  
03-14-1992  
16:23:45

Event Identifier: 440/91-009