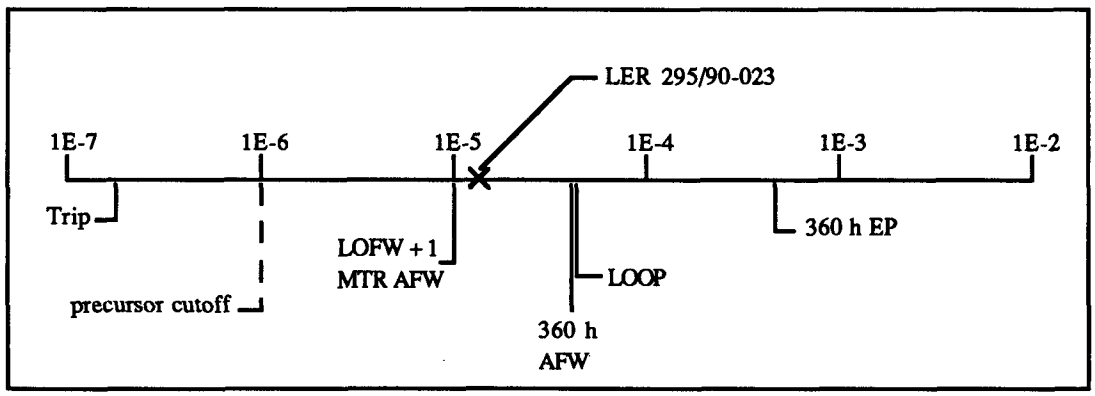
ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No: 295/90-023
Event Description: Two of three diesel generators inoperable
Date of Event: November 6, 1990
Plant: Zion 1

Summary

During the performance of a surveillance test the "0" emergency diesel generator (EDG) tripped due to a leaking manual air start valve. Approximately 20 h later, during the performance of the "1A" EDG performance test, the "1A" EDG tripped due to a bad contact in the control room switch. Both EDGs were inoperable for approximately 35.3 h. In the event of a loss of offsite power (LOOP), safety injection (SI) and containment spray (CS) systems would have been unavailable. In addition, the auxiliary feedwater (AFW), charging, residual heat removal (RHR), component cooling water (CCW), and service water systems would have been degraded. The conditional core damage probability estimated for this event is 1.4×10^{-5}. The relative significance of this event compared to other events at Zion is shown below.



Event Description

At 1603 on November 5, 1990, the "0" EDG tripped during a scheduled periodic test. A Unit 2 SI pump was out of service concurrently and a Unit 2 shutdown was required. The SI pump was repaired prior to the completion of the Unit 2 shutdown, and Unit 2 was returned to power. During this period the other train of SI and both dedicated EDGs for Unit 2 were available.

At 1317 on November 6, 1990, the "1A" EDG tripped during the performance test being run because of the "0" EDG being out of service.

At 0037 on November 8, 1990, the "0" EDG was returned to service. EDGs "0" and "1A" were out of service concurrently for 35 h and 20 min.

At 0500 on 11/9/90, the "1A" EDG was returned to service.

The cause of the "0" EDG trip was degradation of the "O" rings in the two engine-mounted manual air-start valves. This degradation was caused by contamination of the pressurized air used in the control system and the elevated ambient temperatures (approximately 105°F) of the diesel room. The cause of the "1A" EDG trip was corrosion of the contact surfaces in the "slip-close" portion of the control room switch.

Additional Event-Related Information

The emergency power system at Zion consists of 5 EDGs. Each diesel is capable of producing 5,000 kW at 4,160 V. Two EDGs are dedicated to each unit ("1A" and "1B" for Unit 1 and "2A" and "2B" for Unit 2) and one EDG (the "0" EDG) is a swing diesel that can be used by either Zion unit. EDG "1A" supplies power to bus 148, "1B" to bus 149, and "0" to bus 147 or bus 247. The loads supplied by these EDGs are shown in Table 1.

Table 1: Emergency Diesel Generator Loads at Zion

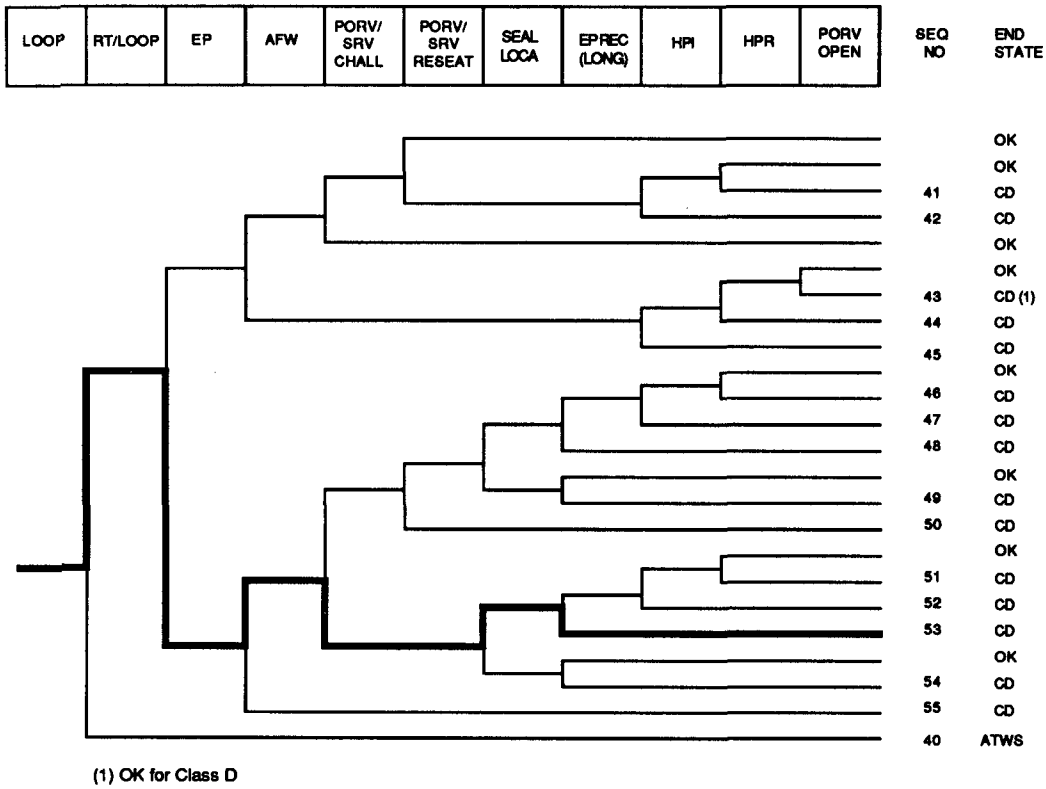
Table removed during SUNSI review

ASP Modeling Assumptions and Approach

The event has been modeled as a potential LOOP during the 35.3 h period during which both EDGs were inoperable. Consistent with Table 1, the SI system and one motor-driven AFW pump were also assumed to be unavailable.

Analysis Results

The conditional probability of severe core damage estimated for this event is 1.4×10^{-5}. The dominant core damage sequence, highlighted on the following event tree, involves a postulated LOOP, unavailability of emergency power, a subsequent RCP seal LOCA and failure to recover AC power in the long term.



(1) OK for Class D

Dominant core damage sequence for LER 295/90-023

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 295/90-023
Event Description: Two of three diesel generators inoperable
Event Date: 11/06/90
Plant: Zion 1

UNAVAILABILITY, DURATION= 35.3

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	3.0E-04

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	1.4E-05
Total	1.4E-05
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	6.7E-06	4.2E-01
52	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca -ep.rec(sl) HPI	CD	5.1E-06	4.2E-01
54	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - seal.loca ep.rec	CD	9.9E-07	4.2E-01
55	loop -rt/loop EMERG.POWER afw/emerg.power	CD	7.9E-07	1.4E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
52	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca -ep.rec(sl) HPI	CD	5.1E-06	4.2E-01
53	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca ep.rec(sl)	CD	6.7E-06	4.2E-01
54	loop -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - seal.loca ep.rec	CD	9.9E-07	4.2E-01
55	loop -rt/loop EMERG.POWER afw/emerg.power	CD	7.9E-07	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:\asp\1989\pwrbseal.cmp
BRANCH MODEL: c:\asp\1989\zion.sl1
PROBABILITY FILE: c:\asp\1989\pwr_bsl1.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	1.5E-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	5.4E-04 > 1.9E-01	8.0E-01	
Branch Model: 1.OF.3			
Train 1 Cond Prob:	5.0E-02 > Failed		
Train 2 Cond Prob:	5.7E-02 > Failed		
Train 3 Cond Prob:	1.9E-01		
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	2.0E-01	3.4E-01	
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	3.1E-02	1.0E+00	
HPI	1.0E-03 > 1.0E+00	8.4E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	1.0E-02 > Unavailable		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
HPI(F/B)	1.0E-03 > 1.0E+00	8.4E-01 > 1.0E+00	1.0E-02
Branch Model: 1.OF.2+opr			
Train 1 Cond Prob:	1.0E-02 > Unavailable		
Train 2 Cond Prob:	1.0E-01 > Unavailable		
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

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Event Identifier: 295/90-023