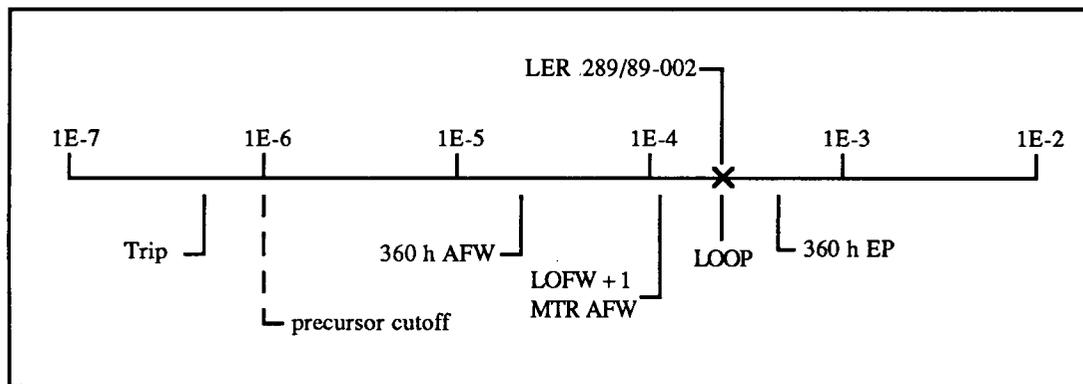


## ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No: 289/89-002  
 Event Description: Oil sludge renders emergency diesels inoperable  
 Date: November 14, 1989  
 Plant: Three Mile Island 1

### Summary

Emergency diesel generator (EDG) 1A failed during testing due to inadequate lubrication of the engine cooling radiator fan drive. After it was repaired and returned to service, EDG 1B was inspected and found to have similar lubrication deficiencies. (EDG 1B was tested daily while EDG was being repaired.) The core damage probability estimated for this event is  $2.4 \times 10^{-4}$ . The relative significance of this event compared with other potential events at TMI is shown below.



### Event Description

On November 2, 1989, Three Mile Island 1 was operating at 100% power when EDG 1A was started for testing. Within a few minutes, smoke was seen coming from the engine cooling radiator housing enclosure, and the diesel was shut down. It was found that a clutch assembly connecting the engine drive shaft and a right angle gear drive (which transmitted power to the cooling fan) was overheated. Upon further investigation, it was discovered that the clutch overheated because a bearing at the top of the right angle gear drive shaft was not being lubricated properly and had seized.

The right angle gear drive and its forced-feed lubrication system were disassembled and inspected. A check valve on the suction side of the forced-feed lubrication system pump

was found to be clogged with sludge. Large quantities of sludge were found in the right angle drive gear assembly.

During the time that 1A EDG was out of service, 1B EDG was verified to be operable daily. Emergency diesel 1A was repaired and returned to service on November 5, 1989. On November 13, EDG 1B was removed from service to perform an annual inspection. The following day, its right angle gear drive and forced-feed lubrication system were disassembled for examination. This revealed that the check valve, suction piping, and strainer on the suction side of the forced-feed lubrication system pump were clogged with sludge. Large quantities of sludge were found in the right angle gear drive unit oil sump, as well. The right angle drive upper bearing was found to be dry (unlubricated).

The right angle gear drive units' lubrication systems failed because of sludge accumulation in the lubricating oil. It is believed that the sludge was created when immersion oil heaters overheated the oil, breaking down additives.

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

The diesel generators at Three Mile Island are Fairbanks-Morse 12 cylinder units, capable of generating approximately 3 MWe. The engines are water-cooled, and the cooling water is cooled by a radiator and fan system. It is the drive system for this fan that failed.

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

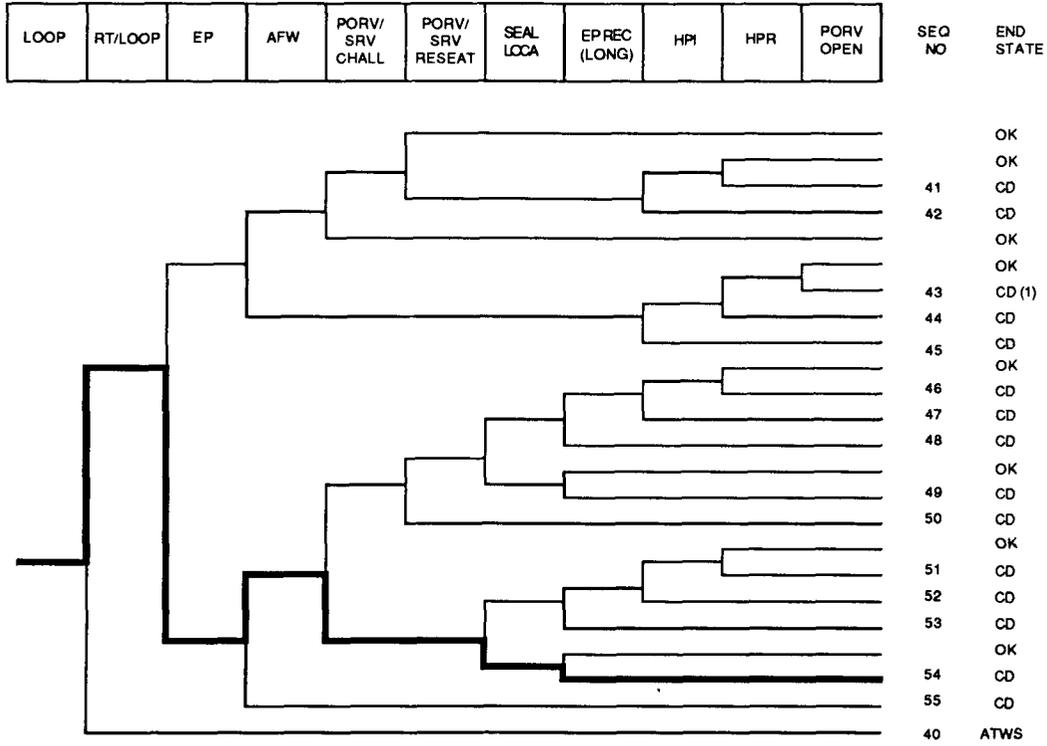
The event has been modeled as a potential LOOP for one-half of a monthly test period, and with the assumption that 3 h of life remained on EDG 1B when the failure was discovered on EDG 1A. This assumption is based on the fact that EDG 1B was confirmed operable on a daily basis while EDG 1A was being repaired. (The assumption may not be conservative, since three 1-h periods of operation may place less stress on the clutch and right angle drive than one 3-h run.)

To address these assumptions, only LOOPS of greater than 3-h duration were addressed. Based on the LOOP recovery models used in the ASP program, the probability of not recovering from a LOOP in 3 h or less at TMI 1 is 0.065. The likelihood of not recovering from the LOOP in the ASP model was revised to reflect this value. In addition, the probabilities of not recovering AC power prior to core uncover if an RCP seal LOCA occurred and prior to battery depletion if an RCP seal LOCA did not occur were also modified to reflect values appropriate for a 4 to 5 h period following a LOOP.

## Analysis Results

The conditional probability of core damage estimated for the event is  $2.4 \times 10^{-4}$ . The dominant sequence associated with the event (highlighted on the following event tree) involves unavailability of emergency power following the postulated LOOP, with failure to recover AC power prior to battery depletion.

If both EDGs had failed at the start of the LOOP, the conditional probability estimated is  $6.0 \times 10^{-4}$ . This estimate is not significantly different from the probability estimated for the event because of the reduction in the likelihood of recovering AC power prior to battery depletion given station blackout for cases involving station blackout at the time of LOOP and at LOOP plus 3 h.



(1) OK for Class D

Dominant core damage sequence for LER 289/89-002

# B-51

## CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 289/89-002  
Event Description: Oil sludge renders diesel generators inoperable  
Event Date: 12/14/89  
Plant: Three Mile Island 1

UNAVAILABILITY, DURATION= 360

### NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 3.8E-04

### SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	2.4E-04
Total	2.4E-04
ATWS	
LOOP	0.0E+00
Total	0.0E+00

### SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
54	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - seal.loca EP.REC	CD	2.0E-04	6.4E-02
49	LOOP -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power -seal.loca EP.REC	CD	1.7E-05	6.4E-02
53	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca EP.REC(SL)	CD	1.1E-05	6.4E-02
55	LOOP -rt/loop EMERG.POWER afw/emerg.power	CD	6.3E-06	2.2E-02

\*\* non-recovery credit for edited case

### SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
49	LOOP -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power -seal.loca EP.REC	CD	1.7E-05	6.4E-02
53	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall seal.loca EP.REC(SL)	CD	1.1E-05	6.4E-02
54	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - seal.loca EP.REC	CD	2.0E-04	6.4E-02
55	LOOP -rt/loop EMERG.POWER afw/emerg.power	CD	6.3E-06	2.2E-02

\*\* 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\pwrseal.cmp  
BRANCH MODEL: c:\asp\1989\tml1.sll  
PROBABILITY FILE: c:\asp\1989\pwr\_bsll.pro

No Recovery Limit

### BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
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Event Identifier: 289/89-002

B-52

trans	1.3E-04	1.0E+00	
LOOP	1.6E-05 > 1.6E-05	5.3E-01 > 6.5E-02	
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 > 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		
afw	2.3E-03	2.6E-01	
afw/emerg.power	5.0E-02	3.4E-01	
mfw	2.0E-01	3.4E-01	
porv.or.srv.chall	8.0E-02	1.0E+00	
porv.or.srv.reseat	1.0E-02	1.1E-02	
porv.or.srv.reseat/emerg.power	1.0E-02	1.0E+00	
seal.loca	4.6E-02	1.0E+00	
EP.REC(SL)	5.7E-01 > 7.2E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	5.7E-01 > 7.2E-01		
EP.REC	1.6E-01 > 6.2E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	1.6E-01 > 6.2E-01		
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
* branch model file			
** forced			

Minarick  
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