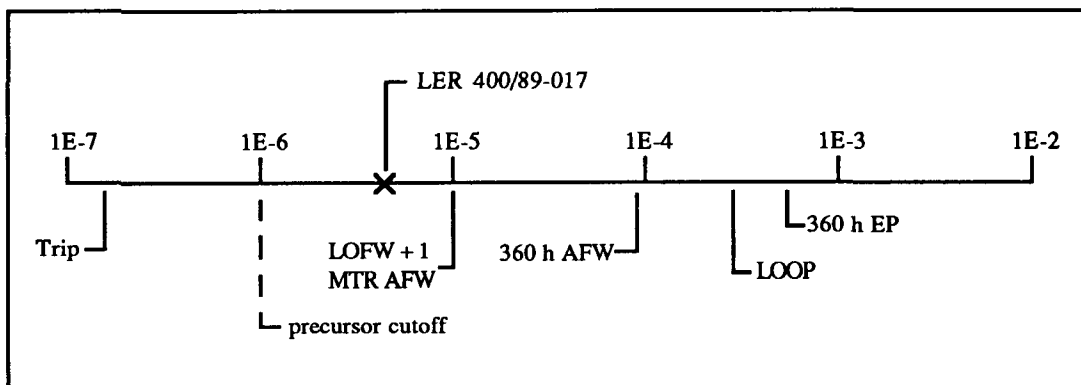


## ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No: 400/89-017  
 Event Description: Reactor trip and trip of the turbine-driven AFW pump  
 Date of Event: October 9, 1989  
 Plant: Shearon Harris

### Summary

Multiple ground faults in the main power transformer (MPT) at Shearon Harris tripped the main generator lockout relay, causing a turbine trip. The reactor tripped immediately following the turbine trip, and a steam generator low-low level during the subsequent transient initiated the auxiliary feedwater (AFW) system. The turbine-driven AFW pump tripped off shortly after it had started due to a spurious overspeed trip signal from the tachometer. The conditional core damage probability estimated for this event is  $4.4 \times 10^{-6}$ . The relative significance of this event compared with other postulated events at Shearon Harris is shown below.



### Event Description

On October 9, 1989, Shearon Harris was operating at 100% of rated power when a main power transformer differential relay trip caused a main generator lockout relay trip. The lockout relay trip, in turn, caused three things to happen very quickly: (1) the main generator output and exciter breakers tripped open, (2) onsite power transferred from the unit auxiliary transformers to the startup transformers, and (3) a turbine trip occurred. The reactor tripped immediately thereafter because of the turbine trip. An SG low-low level occurred during the subsequent transient. The main feedwater pumps tripped during the transient. All three AFW pumps started, but the turbine-driven AFW pump

tripped off shortly after it had started due to an apparent false overspeed signal from the turbine tachometer. However, the motor-driven AFW pumps were unaffected and continued supplying water to the SG.

The fault that caused the differential relay to trip resulted from aluminum debris accumulated in the isolated phase bus duct of the main generator. Previous failures of the air cooling system dampers created the debris, and arcing occurred when the debris was brought in contact with the duct enclosure. This arcing caused a fault that, in turn, caused ground faults in the MPT. The shorting of the MPT caused cracks in the transformer, which led to oil leaks. These oil leaks ignited, causing a fire in the transformer. In addition, two fires started in the main generator housing. However, these fires were all confined to nonsafety areas of the plant and were controlled and extinguished in a timely fashion.

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

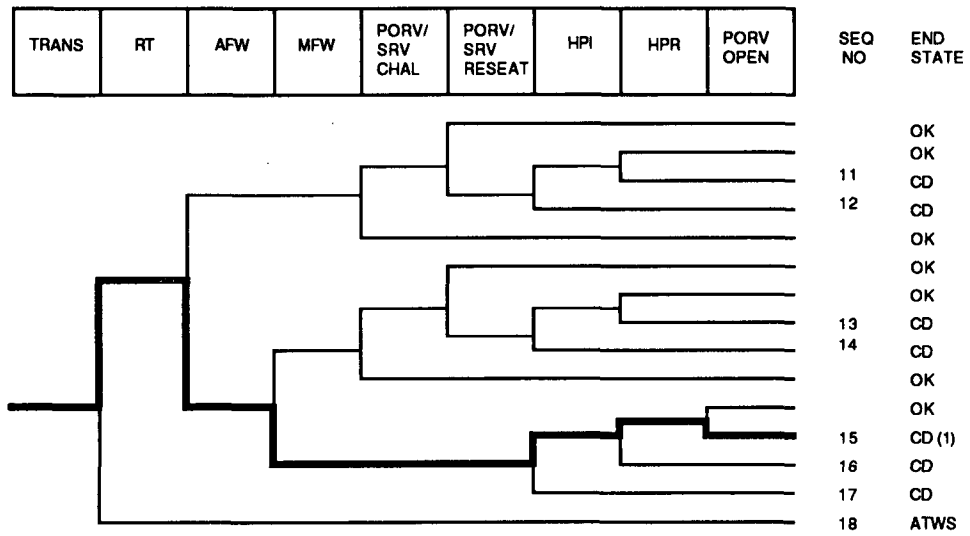
Shearon Harris' AFW system consists of two motor-driven pumps and one turbine-driven pump. All three pumps share a common suction from the condensate storage tank (CST). AFW supplies the three SGs through separate lines (one for each SG); however, any of the AFW pumps can supply the SGs.

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

This event has been modeled as a reactor scram with locally recoverable loss of main feedwater and an unavailable turbine-driven AFW pump.

### **Analysis Results**

The conditional probability of severe core damage estimated for this event is  $4.4 \times 10^{-6}$ . The dominant sequence associated with the event is highlighted on the following event tree. This sequence involves a loss of all secondary-side cooling and failure to initiate feed and bleed. Similar events at this plant involving a reactor trip and unavailability of the turbine-driven AFW pump occurred earlier this year (see LERs 400/89-001 and -006).



(1) OK for Class D

Dominant core damage sequence for LER 400/89-017

## CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 400/89-017  
 Event Description: Reactor trip and trip of the turbine-driven AFW pump  
 Event Date: 10/09/89  
 Plant: Harris 1

## INITIATING EVENT

## NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS 1.0E+00

## SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
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## CD

TRANS	4.4E-06
Total	4.4E-06

## ATWS

TRANS	3.4E-05
Total	3.4E-05

## SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

Sequence	End State	Prob	N Rec**
15 trans -rt AFW MFW -hpi(f/b) -hpr/-hpi porv.open	CD	2.1E-06	8.8E-02
17 trans -rt AFW MFW hpi(f/b)	CD	2.1E-06	7.4E-02
16 trans -rt AFW MFW -hpi(f/b) hpr/-hpi	CD	2.3E-07	8.8E-02
18 trans rt	ATWS	3.4E-05	1.2E-01

\*\* non-recovery credit for edited case

## SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

Sequence	End State	Prob	N Rec**
15 trans -rt AFW MFW -hpi(f/b) -hpr/-hpi porv.open	CD	2.1E-06	8.8E-02
16 trans -rt AFW MFW -hpi(f/b) hpr/-hpi	CD	2.3E-07	8.8E-02
17 trans -rt AFW MFW hpi(f/b)	CD	2.1E-06	7.4E-02
18 trans rt	ATWS	3.4E-05	1.2E-01

\*\* non-recovery credit for edited case

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

No Recovery Limit

## BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	5.5E-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	2.9E-03	8.0E-01	
AFW	3.8E-04 > 2.3E-03	2.6E-01	
Branch Model: 1.OF.3+ser			
Train 1 Cond Prob:	2.0E-02		

Event Identifier: 400/89-017

# B-384

Train 2 Cond Prob:	1.0E-01			
Train 3 Cond Prob:	5.0E-02 > Unavailable			
Serial Component Prob:	2.8E-04			
afw/emerg.power	5.0E-02	3.4E-01		
MFW	1.0E+00 > 1.0E+00	7.0E-02 > 3.4E-01	1.0E-03	
Branch Model: 1.OF.1+opr				
Train 1 Cond Prob:	1.0E+00			
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	3.0E-04	8.4E-01		
hpi(f/b)	3.0E-04	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				

Minarick  
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