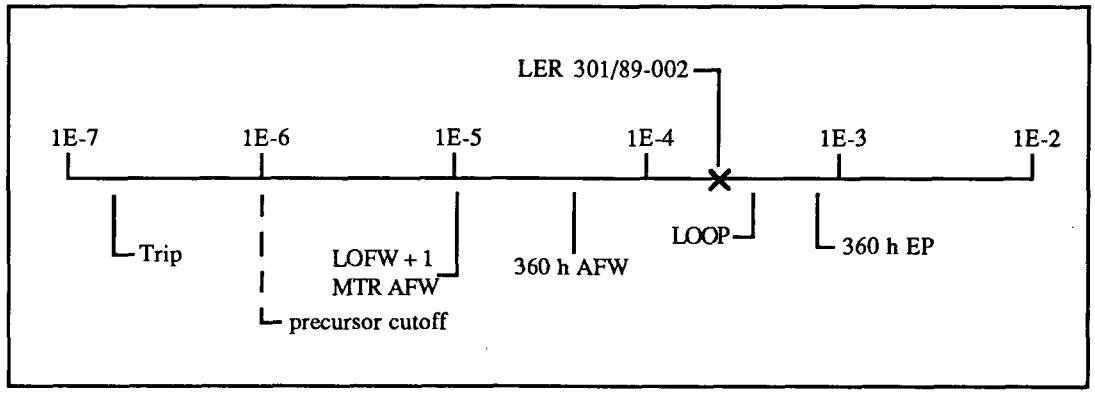
ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No: 301/89-002
Event Description: Effective LOOP due to inadvertent fire deluge system actuation
Date: March 29, 1989
Plant: Point Beach 2

Summary

Inadvertent actuation of fire protection deluge sprays caused an electrical flashover on a main transformer. This resulted in a main transformer lockout, main generator breaker trip, and subsequent turbine and reactor trips from 100% power. A switchyard bus sectionalizing breaker operated unnecessarily, resulting in a voltage degradation in the offsite power supply. The emergency diesels started and energized vital loads. The core damage probability estimated for the event is 2.5×10^{-4}. The relative significance of the event compared with other postulated events at Point Beach is shown below.



Event Description

An electrician performing a post-modification test on transformer fire protection systems inadvertently shorted contacts initiating deluge fire protection for the 2X01C main transformer. The transformer experienced an electrical flashover to ground, which resulted in a main transformer lockout, a main generator breaker trip, and subsequent turbine and reactor trips. A generator breaker trip failure relay operated prematurely and opened bus sectionalizing breakers, leaving only one 345-kV supply line to provide offsite power to station auxiliaries. Point Beach and the nearby Kewaunee station are at the end of this long line. The Kewaunee station was out of service, and line losses were sufficiently high that an undervoltage condition resulted. Consequently, undervoltages

were experienced on vital and nonvital buses. The plant's emergency diesel generators started and supplied vital buses as designed. Among the nonvital loads lost were the station air compressors. A service air compressor was locally started and continued to run at the degraded voltage. The service air system was crosstied to supply instrument and control air systems.

The bus sectionalizing breakers were reclosed, normal offsite power was restored, the emergency diesels were returned to standby, and the unusual event status was terminated ~3.25 h after the start of the event.

Additional Event-Related Information

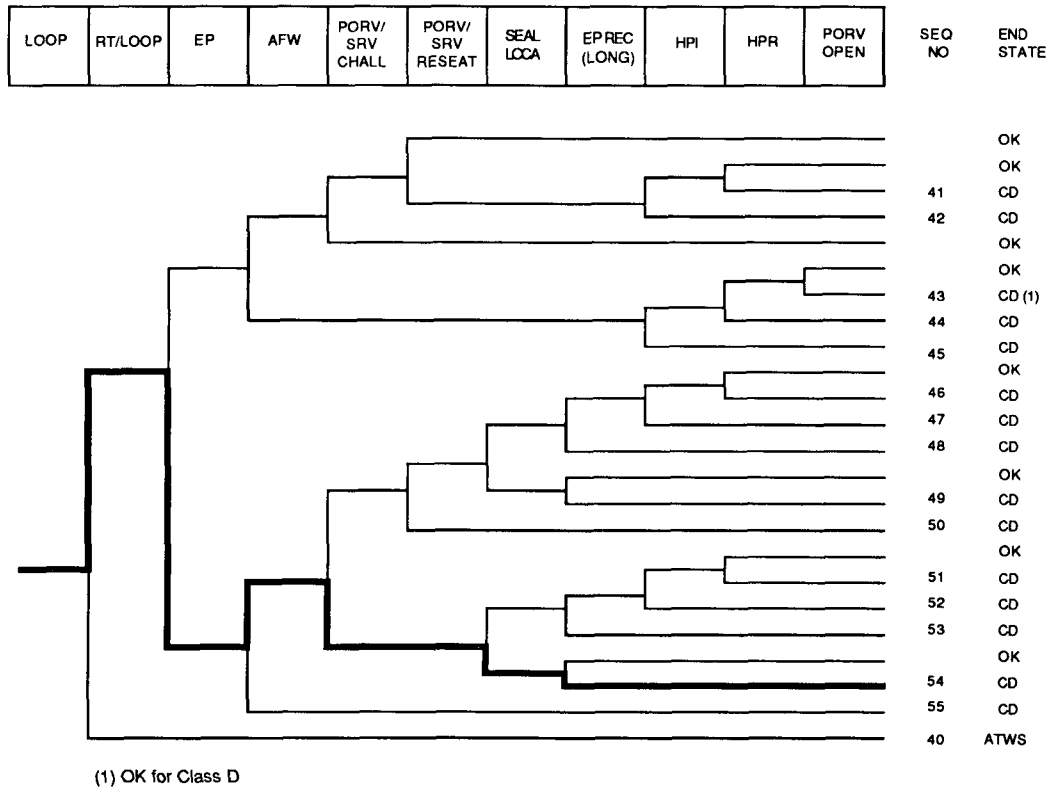
Main transformer faults are isolated by the main transformer lockout relay (2-86/X01). Actuation of this relay results in a main generator trip and lockout (2-86/TG01). Should this fail to occur, the generator breaker trip failure relay (62-142) operates to open sectionalizing breakers in the 345-kV switchyard to isolate the fault.

ASP Modeling Assumptions and Approach

The event has been modeled as a loss of offsite power due to a plant-related fault. This modeling may be conservative in that offsite power was provided to nonvital loads, but at a degraded voltage. Loads associated with three nonvital motor control centers were lost, and other loads, such as instrument air compressor K2A, would only operate when controlled locally. Because the status of nonvital loads could not be conclusively determined, they were assumed lost for the purposes of the analysis.

Analysis Results

The conditional probability of severe core damage estimated for this event is 2.5×10^{-4}. The dominant sequence to core damage involves station blackout: failure to recover from the LOOP in the short term ($p = 0.3$), emergency power failure ($p = 2.3 \times 10^{-3}$), and failure to recover AC power in the long term but prior to battery depletion ($p = 0.35$). The dominant sequence for this event is highlighted on the following event tree.



(1) OK for Class D

Dominant core damage sequence for LER 301/89-002

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 301/89-002
Event Description: Effective LOOP due to inadvertant deluge system actuation
Event Date: 03/29/89
Plant: Point Beach 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP	3.0E-01

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOOP	2.5E-04
Total	2.5E-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	2.3E-04	2.4E-01
55	LOOP -rt/loop emerg.power afw/emerg.power	CD	1.2E-05	8.2E-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	9.2E-06	2.4E-01

** 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	9.2E-06	2.4E-01
54	LOOP -rt/loop emerg.power -afw/emerg.power -porv.or.srv.chall - seal.loca EP.REC	CD	2.3E-04	2.4E-01
55	LOOP -rt/loop emerg.power afw/emerg.power	CD	1.2E-05	8.2E-02

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asp\1989\pwrbseal.cmp
BRANCH MODEL: c:\asp\1989\ptbeach2.sll
PROBABILITY FILE: c:\asp\1989\pwr_bsll.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	2.0E-04	1.0E+00	
LOOP	1.6E-05 > 1.6E-05	3.6E-01 > 3.0E-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	0.0E+00	1.0E+00	
ep.rec(sl)	0.0E+00	1.0E+00	
EP.REC	4.5E-01 > 3.5E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	4.5E-01 > 3.5E-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
porv.open	1.0E-02	1.0E+00	4.0E-04

* branch model file
** forced

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