B.21 LER No. 311/83-001 and 311/82-072

Event Description: Transient with One Automatic Trip Breaker Failing to Open

Date of Event: January 6, 1983

Plant: Salem 2

B.21.1 Summary

On January 6, 1983, while Salem 2 was operating at 46% power, the reactor tripped due to low level in the number 21 steam generator. Following the trip, the operator noticed that trip breaker A had failed to open on the trip signal, but trip breaker B had opened and de-energized the rod drive mechanisms, resulting in a shutdown. It was later determined that trip breaker A undervoltage relay had malfunctioned due to dirt or corrosion which interfered with proper relay operation. A similar breaker failure occurred on August 20, 1982 during a surveillance test. The conditional core damage probability estimated for the reactor trip on January 6, 1983 is 4.4×10^{-4}.

B.21.2 Event Description

On January 6, 1983, while Salem 2 was operating at 46% power, the reactor tripped due to low level in the number 21 steam generator. Following the trip, the operator noticed that trip breaker A had failed to open on the trip signal, but trip breaker B had opened and de-energized the rod drive mechanisms, resulting in a shutdown. It was later determined that the trip breaker A undervoltage relay had malfunctioned due to dirt or corrosion which interfered with proper relay operation. This dirt or corrosion resulted from the infrequent operation of the breaker, which led to insufficient self-cleaning of the relay. The debris accumulated and caused a mechanical binding of the undervoltage relay.

On August 20, 1982, during a surveillance test with the plant at 82% power, reactor trip breaker B failed to trip as required. Trip breaker A was operable. Investigation revealed that the cause of the B trip breaker was binding of the undervoltage coil. The coil was replaced and trip breaker B was reinstalled and satisfactorily tested.

B.21.3 Additional Event-Related Information

The Salem 2 reactor protection system (RPS) uses independent channels and trains which consist of sensors, transmitters, relays and trip breakers to detect and protect against unsafe plant conditions. When an unsafe plant condition occurs, the RPS signals the trip breakers to open and de-energize the rod drive mechanisms, resulting in a reactor shutdown. The reactor trip breakers are ac circuit breakers positioned in series. When either trip breaker is tripped open, holding power to the control rods is lost and the rods drop into the core. At the time of this event, one mechanism, de-energization of the undervoltage coils, could open the trip breaker. A second mechanism for tripping open the breakers was installed after the February 1983 Salem anticipated transient without scram (ATWS). This mechanism energizes the shunt trip coil. The shunt trip coils, once energized, will open the breakers.

B.21.4 Modeling Assumptions

The August 20, 1982 surveillance test failure was considered incidental to the event of interest. The January 6, 1983 reactor trip was modeled as a trip with the reactor trip system degraded. One train of the reactor trip (RT) system was set to failed. Manual scram capability was not affected by the failure of the reactor trip breakers so the RT nonrecovery probability (which models the manual scram capability of the RT system) was not modified. The potential for common cause failure exists, even when a component is failed. Therefore, the conditional probability of a common cause failure of the other train of the reactor trip system was included in the analysis.

B.21.5 Analysis Results

The conditional core damage probability for this event is 4.4×10^{-4}. The dominant sequence is a postulated ATWS sequence involving a failure to trip, success of auxiliary feedwater (AFW) given ATWS, and failure of emergency boration, and is highlighted on the event tree shown in Figure B.21.1.

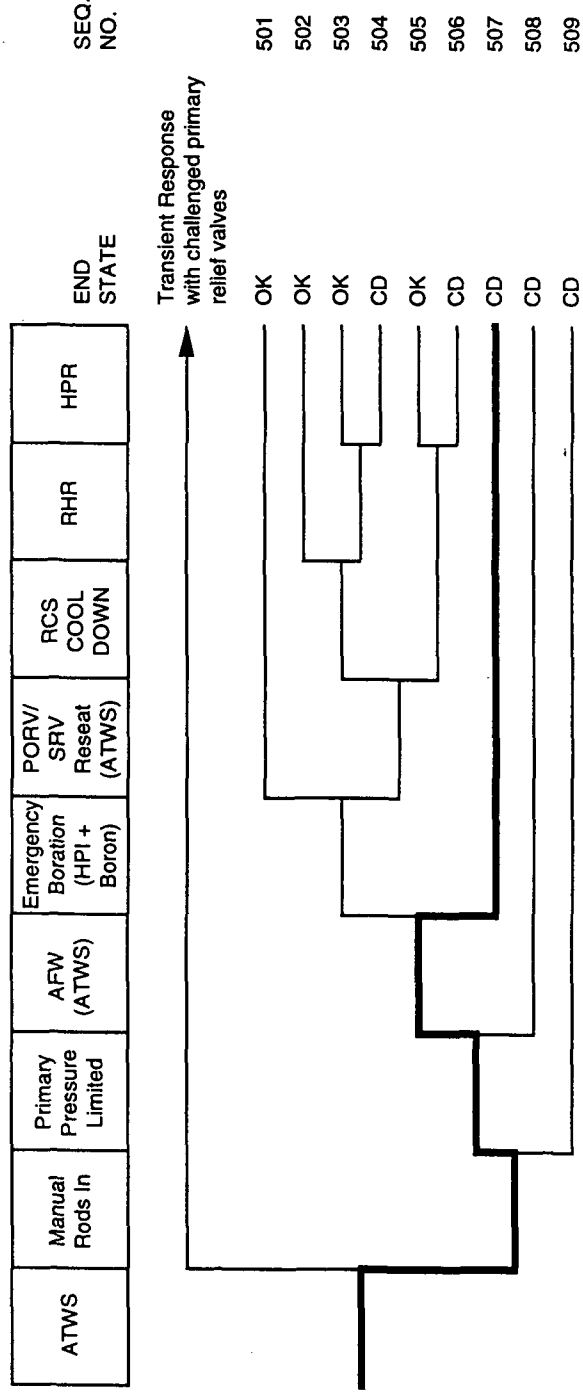

Figure B.21.1 Dominant core damage sequence for LER 311/83-001 and 311/82-072

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 311/83-001 and 311/82-072
Event Description: Transient with one automatic trip breaker failing to open
Event Date: January 6, 1983
Plant: Salem 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	4.4E-04
Total	4.4E-04

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
507	trans RT -prim.press.limited -afw/atws emrg.boration	CD	1.9E-04	1.0E-01
509	trans RT prim.press.limited	CD	1.7E-04	1.0E-01
508	trans RT -prim.press.limited afw/atws	CD	8.1E-05	1.0E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
507	trans RT -prim.press.limited -afw/atws emrg.boration	CD	1.9E-04	1.0E-01
508	trans RT -prim.press.limited afw/atws	CD	8.1E-05	1.0E-01
509	trans RT prim.press.limited	CD	1.7E-04	1.0E-01

** non-recovery credit for edited case

SEQUENCE MODEL: c:\aspcode\models\pwrb8283.cmp
BRANCH MODEL: c:\aspcode\models\salem2.82
PROBABILITY FILE: c:\aspcode\models\pwr8283.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	2.1E-03	1.0E+00	

loop	1.6E-05	5.3E-01	
loca	2.4E-06	5.4E-01	
sgtr	1.6E-06	1.0E+00	
RT	2.8E-04 > 1.9E-01	1.0E-01	
Branch Model: 1.0F.2			
Train 1 Cond Prob:	1.5E-03 > Failed		
Train 2 Cond Prob:	1.9E-01		
rt(loop)	0.0E+00	1.0E+00	
afw	3.8E-04	4.5E-01	
afw/atws	4.3E-03	1.0E+00	
afw/ep	5.0E-02	3.4E-01	
mfw	2.0E-01	3.4E-01	1.0E-03
porv.chall	4.0E-02	1.0E+00	
porv.chall/afw	1.0E+00	1.0E+00	
porv.chall/loop	1.0E-01	1.0E+00	
porv.chall/sbo	1.0E+00	1.0E+00	
porv.reseat	2.0E-02	1.1E-02	
porv.reseat/ep	2.0E-02	1.0E+00	
srv.reseat(atws)	1.0E-01	1.0E+00	
hpi	1.0E-05	8.9E-01	
feed.bleed	2.0E-02	1.0E+00	1.0E-02
emrg.boration	0.0E+00	1.0E+00	1.0E-02
recov.sec.cool	2.0E-01	1.0E+00	
recov.sec.cool/offsite.pwr	3.4E-01	1.0E+00	
rcs.cooldown	3.0E-03	1.0E+00	1.0E-03
rhr	2.2E-02	7.0E-02	1.0E-03
rhr.and.hpr	1.0E-03	1.0E+00	1.0E-03
hpr	4.0E-03	1.0E+00	1.0E-03
ep	5.4E-04	8.9E-01	
seal.loca	2.7E-01	1.0E+00	
offsite.pwr.rec/-ep.and.-afw	2.2E-01	1.0E+00	
offsite.pwr.rec/-ep.and.afw	6.7E-02	1.0E+00	
offsite.pwr.rec/seal.loca	5.7E-01	1.0E+00	
offsite.pwr.rec/-seal.loca	7.0E-02	1.0E+00	
sg.iso.and.rcs.cooldown	1.0E-02	1.0E-01	
rcs.cool.below.rhr	3.0E-03	1.0E+00	3.0E-03
prim.press.limited	8.8E-03	1.0E+00	

* branch model file
** forced