B.2 LER No. 247/82-019 and -020

Event Description: Transient with Two AFW Pumps Inoperable

Date of Event: May 17, 1982

Plant: Indian Point 2

B.2.1 Summary

During hot shutdown following a trip on May 17, 1982, No. 23 auxiliary feedwater (AFW) motor-driven pump failed while in operation, due to a damaged thrust bearing. Two days later, also during hot shutdown, No. 22 turbine-driven AFW pump failed while in operation, due to a governor failure. When the turbine-driven pump failed, AFW pump No. 23 was out of service, due to repairs on the damaged thrust bearing. Only one AFW pump was available, so the plant commenced cooldown. The estimated conditional core damage probability of this event is 1.2×10^{-4}.

B.2.2 Event Description

During hot shutdown following a reactor trip on May 17, 1982, No. 23 AFW pump failed while in operation. The pump failure was due to a damaged thrust bearing. The bearing damage was caused by the oil pressure equalizing line check valve hanging up, thus negating positioning control of the balancing drum. The pump was taken out of service to replace the bearing and check valve internals. Two days later, during hot shutdown, No. 22 turbine-driven AFW pump failed while in operation. AFW pump 22 tripped due to erratic speed control by the governor on its steam turbine drive. The governor bearing was observed smoking. The governor and governor valve were rebuilt. At the time the turbine-driven pump was determined inoperable, No. 23 AFW motor-driven pump was still out of service. Since only motor-driven AFW pump 21 was operable, the plant commenced cooldown.

The reactor trip which occurred on May 17, 1982 was initiated by feedwater system perturbations (NUREG-0020).

B.2.3 Additional Event-Related Information

Indian Point 2 has three AFW pumps. Two (21 and 23) are motor-driven pumps and one (22) is a turbine-driven pump. Each motor-driven pump feeds two steam generators. Bearing design on the 21 AFW pump is identical to the 23 AFW pump which failed.

The single turbine-driven pump can feed all four steam generators. In the event of a loss of offsite power and a loss of emergency power, the turbine-driven pump can supply all steam generators. Because Indian Point was concerned about a potential common-cause failure of the 21 pump, the bearing oil pressure equalizing line check valve internals was removed.

B.2.4 Modeling Assumptions

Since the AFW pump failures occurred following the trip, the event was modeled as a transient with degraded AFW. The turbine-driven pump failure, although observed two days after the trip, was assumed to be present at the time of the trip (i.e., it was assumed that the turbine-driven pump had not been demanded at the time of the trip).

For sequences involving AFW, given a successful reactor trip, one of three AFW pumps provides success. Based on the nature of the AFW pump 23 and pump 22 failures, the conditional failure probability of the remaining AFW pump was assumed to be 0.1. For sequences involving AFW given a trip failure anticipated transient without scram (ATWS), two of three pumps are assumed necessary for success. Since two of the three pumps were inoperable, AFW was assumed failed for ATWS sequences. The potential for common cause failure exists, even when a component is failed. Therefore, the conditional probability of a common-cause failure was included in the analysis for those components that were assumed to have been failed as part of the postulated event.

Since the reactor trip was initiated due to feedwater system perturbations, but there is no information indicating that main feedwater (MFW) was inoperable, MFW was assumed operable at the time of the event.

B.2.5 Analysis Results

The estimated conditional core damage probability for this event is 1.2×10^{-4}. The dominant core damage sequence, shown on the event tree in Figure B.2.1, involves a successful reactor trip, failure of AFW, failure of MFW, and failure of feed and bleed.

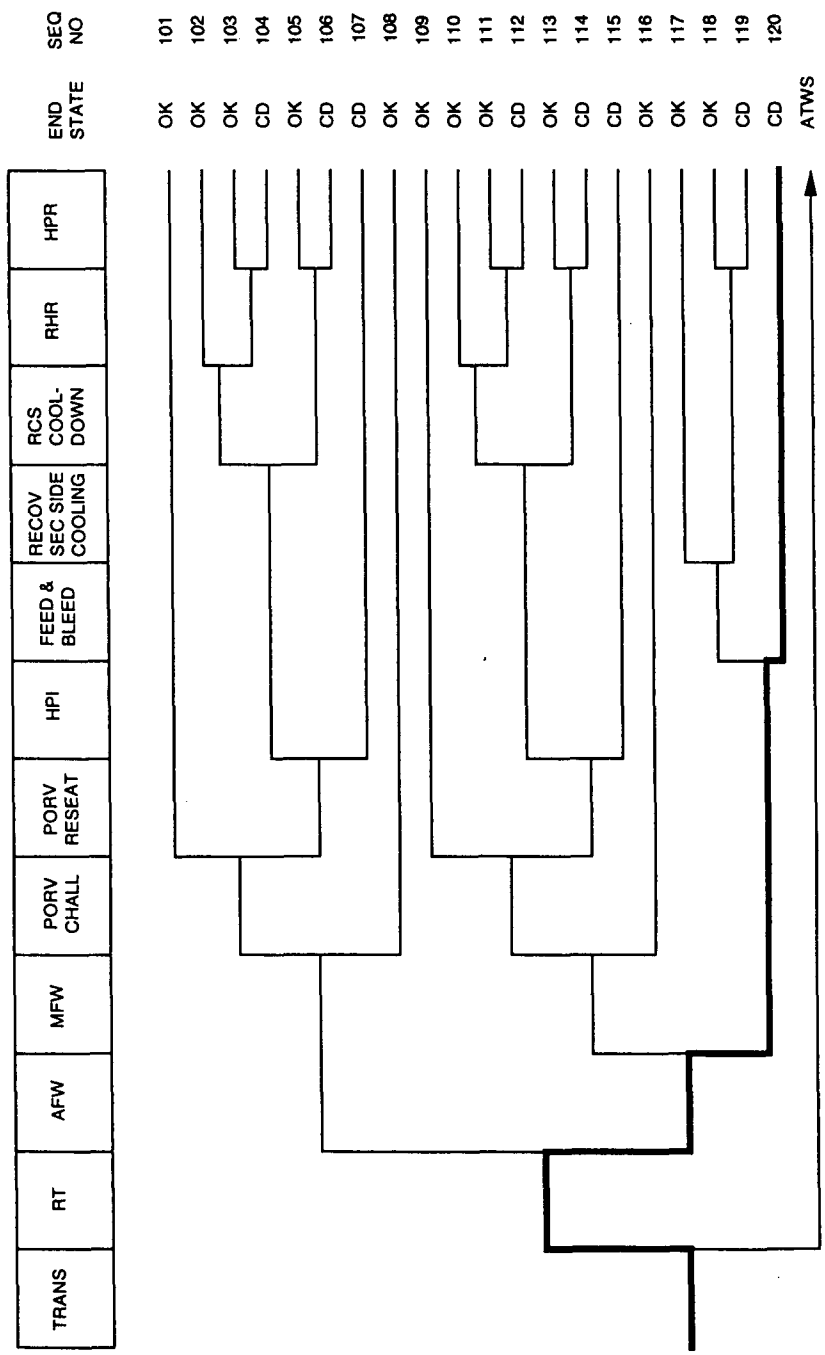

Figure B.2.1 Dominant core damage sequence for LER 247/82-019 and -020

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 247/82-019 and -020
Event Description: Transient with two AFW pumps inoperable
Event Date: May 17, 1982
Plant: Indian Point 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	1.2E-04
Total	1.2E-04

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
120	trans -rt AFW mfw feed.bleed	CD	9.4E-05	1.5E-01
508	trans rt -prim.press.limited AFW/ATWS	CD	2.8E-05	1.0E-01
119	trans -rt AFW mfw -feed.bleed recov.sec.cool hpr	CD	3.0E-06	1.5E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
119	trans -rt AFW mfw -feed.bleed recov.sec.cool hpr	CD	3.0E-06	1.5E-01
120	trans -rt AFW mfw feed.bleed	CD	9.4E-05	1.5E-01
508	trans rt -prim.press.limited AFW/ATWS	CD	2.8E-05	1.0E-01

** non-recovery credit for edited case

SEQUENCE MODEL: c:\aspcode\models\pwrb8283.cmp
BRANCH MODEL: c:\aspcode\models\ipoint2.82
PROBABILITY FILE: c:\aspcode\models\pwr8283.pro

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail

trans	1.3E-03	1.0E+00	
loop	3.1E-05	1.7E-01	
loca	2.4E-06	5.4E-01	
sgtr	1.6E-06	1.0E+00	
rt	2.8E-04	1.0E-01	
rt(loop)	0.0E+00	1.0E+00	
AFW	3.8E-04 > 1.0E-01	4.5E-01	
Branch Model: 1.OF.3+ser			
Train 1 Cond Prob:	2.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01		
Train 3 Cond Prob:	5.0E-02 > Failed		
Serial Component Prob:	2.8E-04		
AFW/ATWS	4.3E-03 > 1.0E+00	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	4.3E-03 > Failed		
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	3.0E-04	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	2.1E-01	1.0E+00	
offsite.pwr.rec/-ep.and.-afw	1.9E-01	1.0E+00	
offsite.pwr.rec/-ep.and.afw	8.0E-02	1.0E+00	
offsite.pwr.rec/seal.loca	6.0E-01	1.0E+00	
offsite.pwr.rec/-seal.loca	5.6E-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