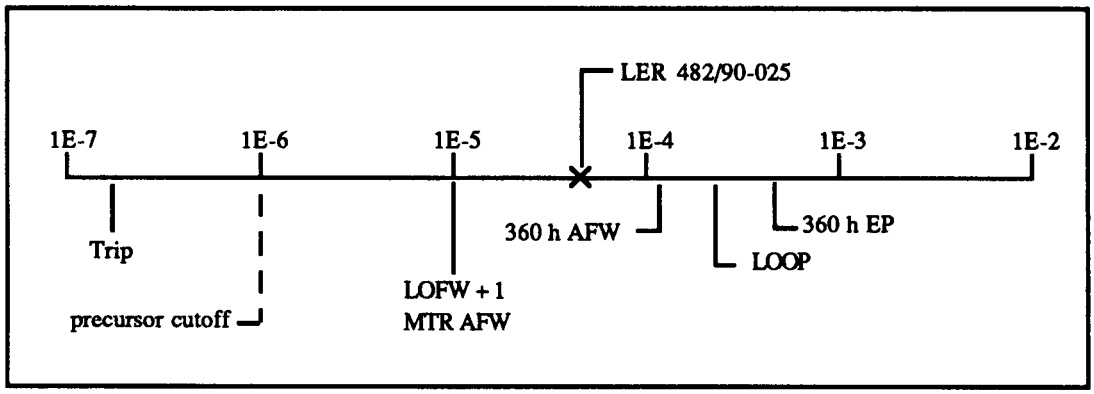
ACCIDENT SEQUENCE PRECURSOR PROGRAM EVENT ANALYSIS

LER No.: 482/90-025
Event Description: Safety injection pumps miniflow return line frozen
Date of Event: December 23, 1990
Plant: Wolf Creek

Summary

The common minimum flow return line from the safety injection (SI) pumps to the refueling water storage tank (RWST) froze when heat tracing failed. This left the pumps without protection from damage if operated under low-flow/no-flow conditions. The conditional probability of core damage associated with this event is 4.7×10^{-5}. The relative significance of the event compared to other postulated events at Wolf Creek is shown below.



Event Description

During a period of cold weather, alarms were received in the control room indicating problems with the plant freeze protection system. These included trouble alarms for the demineralized water storage tank, the condensate storage tank, and a general "freeze protection trouble" alarm. Operations and electrical maintenance personnel verified that circuit breakers for required heat trace circuits were positioned correctly, but failed to detect that a temperature switch had failed, deenergizing the heat tracing on the SI pump common minimum flow return line to the RWST.

Approximately 2 d later, an attempt was made to add water to the RWST via the same line as used by the SI minimum flow return. The flow path was found to be obstructed

and the attempt was unsuccessful. Initially, it was believed that this was due to a failed valve. When attempts to add water via another valve also failed, it was realized that the line had frozen. Electrical maintenance personnel determined that the temperature switch for the associated heat tracing had failed, and the heat tracing was deenergized.

The SI pumps were placed in "pull-to-lock" to prevent them from starting and sustaining damage in the event of an automatic start signal. The affected RWST line was thawed, the heat tracing circuit was repaired, and the SI pumps were returned to service.

Additional Event-Related Information

Two high-pressure SI pumps are available to provide relatively low flow-rate makeup to the reactor coolant system (RCS) in the event of small-break LOCAs and other accidents. These pumps are normally aligned to the RWST and auto-start to pump water into the RCS on receipt of a signal indicating occurrence of an accident. Depending on circumstances, they may auto-start but not immediately be required to provide flow to the RCS.

In this event, minimum flow lines exist to provide pump protection against "deadheading" (operation at no-flow, shutoff head conditions). When these lines are rendered inoperable, the pump work done on the water contained in the pump casing causes it to increase rapidly in temperature. Damage to the pump seals and impeller may quickly result, rendering the pump inoperable.

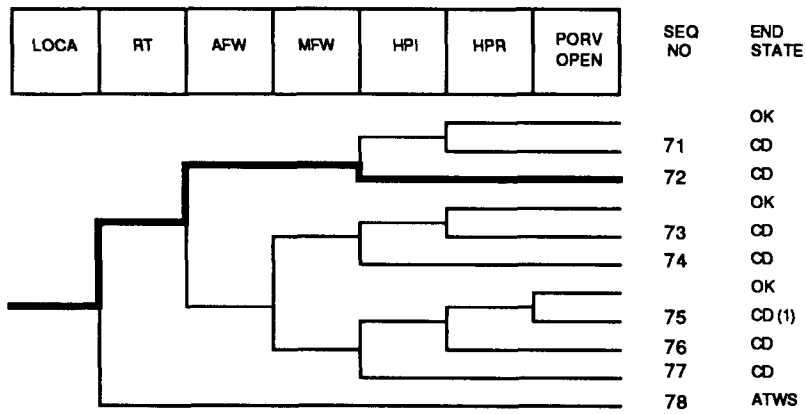
An additional source of high-pressure makeup exists at Wolf Creek. The centrifugal charging pumps (CCPs) are also capable of providing flow to the RCS. Minimum flow protection for these pumps is not directed through the affected RWST line, and therefore, these pumps are not compromised. (Note that the use of the CCPs at Wolf Creek as an alternate injection source is not currently addressed in the ASP models.)

ASP Modeling Assumptions and Approach

The event was modeled as a failure of HPI for a period of 45 h. The time period was estimated from the receipt of the RWST freeze protection trouble alarm until minimum recirculation flow was demonstrated for each pump.

Analysis Results

The conditional probability of severe core damage estimated for this event is 4.7×10^{-5}. The dominant core damage sequence, highlighted on the following event tree, involves a postulated small-break LOCA with unavailability of HPI.



(1) OK for Class D

Dominant core damage sequence for LER 482/90-025

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 482/90-025
Event Description: Safety injection pumps miniflow return line frozen
Event Date: 12/23/90
Plant: Wolf Creek 1

UNAVAILABILITY, DURATION= 45

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

TRANS	3.3E-02
LOOP	3.9E-04
LOCA	4.6E-05

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
TRANS	5.1E-07
LOOP	1.4E-07
LOCA	4.6E-05
Total	4.7E-05
ATWS	
TRANS	0.0E+00
LOOP	0.0E+00
LOCA	0.0E+00
Total	0.0E+00

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
72	loca -rt -afw HPI	CD	4.6E-05	4.3E-01

** *non-recovery credit for edited case*

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
72	loca -rt -afw HPI	CD	4.6E-05	4.3E-01

** 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\pwrbseal.cmp
BRANCH MODEL: c:\asp\1989\wolf.sll
PROBABILITY FILE: c:\asp\1989\pwr_bsll.pro

No Recovery Limit

Event Identifier: 482/90-025

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	7.4E-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	2.6E-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	2.7E-01	1.0E+00	
ep.rec(s1)	5.8E-01	1.0E+00	
ep.rec	2.5E-02	1.0E+00	
HPI	1.0E-03 > 1.0E+00	8.4E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
HPI(F/B)	1.0E-03 > 1.0E+00	8.4E-01 > 1.0E+00	1.0E-02
Branch Model: 1.OF.2+opr			
Train 1 Cond Prob:	1.0E-02 > Failed		
Train 2 Cond Prob:	1.0E-01 > Failed		
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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