B.9 LER Number 261/92-013, 261/92-014, and 261/92-018

Event Description: Safety Injection Pump Out of Service

Date of Event: June 18, 1992, through August 22, 1992

Plant: H. B. Robinson, Unit 2

B.9.1 Summary

Both safety injection (SI) pumps were out of service for 1.5 h on July 10, 1992, while H. B. Robinson was at 100% power. The "B" SI pump was rendered inoperable because plastic sheeting material obstructed the pump's recirculation line. The plastic material was believed to have been used during a design modification during the refueling outage that ended on June 18, 1992. The "A" pump was out of service for 1.5 h on July 10, 1992, because of a blown control power fuse in the pump's breaker closing circuit. On August 22, 1992, with the plant operating at 100% power, the plant experienced a total loss of offsite power (LOOP) (See LER 261/92-017). Following the LOOP, on August 24, 1992, the "B" SI pump recirculation line was again found to be obstructed with the plastic sheeting material from the outage modification.

The conditional core damage probability for the 1.5 h that both SI pumps were inoperable (LERs 261/92-013 and -014) is 6.2×10^{-8}. This is below the precursor cutoff value of 10^{-6}. Therefore, this event is not a precursor but is included here since this is when the extended inoperability of the "B" SI pump began. The conditional core damage probability for the time period when the "B" SI pump was inoperable (LERs 261/92-013 and -018) is 3.5×10^{-5}. The relative significance of this event compared to other postulated events at H. B. Robinson Unit 2 is shown in Fig. B.11.

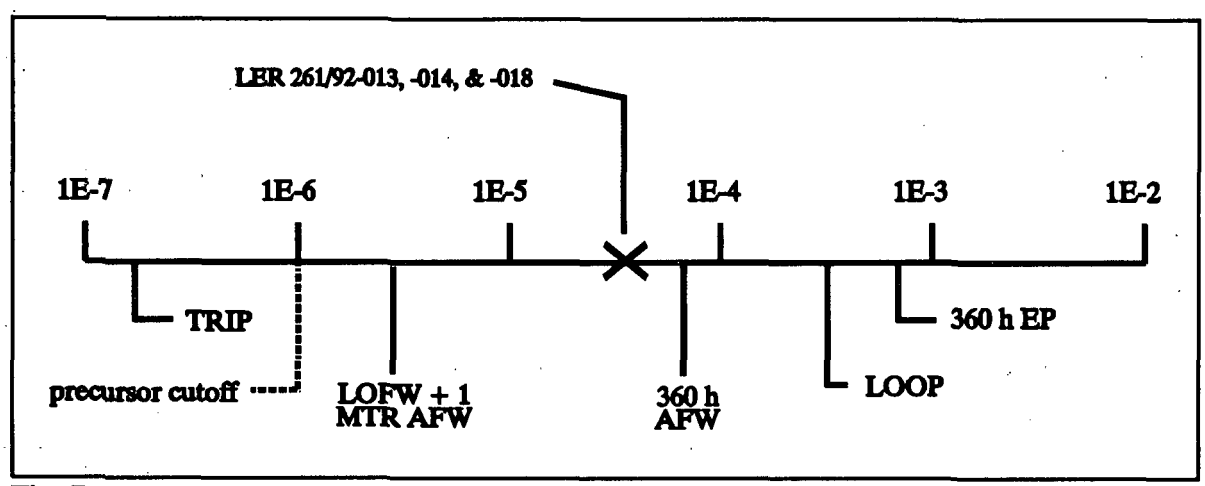

Fig. B.11. Relative event significance of LERs 261/92-013, -014, and -018 compared with other potential events at H. B. Robinson 2.

B.9.2 Event Description

On July 8, 1992, at 2307 hours, the "B" SI pump was declared out of service because of low flow on the pump's recirculation line. Plastic sheet material was found in the "B" SI pump minimum flow line. The plastic material was believed to be from a purge dam that had been fabricated for welding operations for a modification to the minimum flow line for the residual heat removal (RHR) system during the cycle 14 refueling outage. The refueling outage ended on June 18, 1992. It is believed the material was introduced as a result of breakage of one of the 9-in.-diameter purge dam pieces. A portion of the material was introduced into the RHR system, the refueling water storage tank (RWST), and SI and containment spray (CS) pump suction piping. The debris was removed through system flushing.

On July 9, 1992, at 1839 hours, with the plant still at 100% power, an attempt was made to start the "A" SI pump. During this attempt, one of the two control power fuses in the pump's breaker closing circuit blew. The fuses were replaced, and the pump was returned to service 1.5 h later, at 2009 hours on July 9, 1992. The fuse manufacturer concluded that the "fuse was progressively weakened by repeated breaker closures until it opened to clear the circuit."

At 2030 hours, on July 9, 1992, a plant shutdown to the hot shutdown condition was initiated because of the continued inoperability of the "B" SI pump. On July 12, 1992, at 0812 hours, the "B" SI pump was returned to service following repeated flushing of the SI system. Operability tests were also performed for the RHR and CS systems. The plant returned to service on July 12, 1992.

On August 22, 1992, with the plant at 100% power, a LOOP occurred at 1007 hours because of the loss of the startup transformer (see LER 261/92-017 in Appendix B). On August 24, 1992, following the LOOP and before plant restart, the "B" SI pump was tested and declared inoperable because of low flow in the recirculation line. The "A" SI pump was also declared inoperable because of reduced flow in its recirculation line. Investigation revealed that additional plastic sheeting, similar to the material found in the line on July 8, had partially blocked the "B" SI pump recirculation line. It was speculated by the licensee that a residual piece from the RHR system modification performed during the cycle 14 refueling outage that was initially too large to enter the recirculation line had been eroded by subsequent use of the SI pumps. The licensee had originally thought that the material was broken into very small pieces from the SI pump and the material would have easily entered the piping during previous flushing of the system. This was based on the fragments found in the SI pump recirculation line in July. No debris was found in the "A" pump recirculation line, and the flow was within the required limits. Therefore, the "A" line was considered to have been operable throughout the event.

B.9.3 Additional Event-Related Information

H. B. Robinson has two RHR pumps, which take suction from the RWST or the containment sump. The system can discharge to the reactor coolant system (RCS) cold legs or to the suction of the SI and CS system pumps. The RHR pump recirculation lines run back to the suction of the pumps.

The SI system uses two pumps that can take suction from the RWST or the RHR pump discharge. Each pump has a recirculation line to provide pump cooling. The recirculation lines return to the RWST. The RHR, SI, and CS pumps all share a common suction line from the RWST. The original SI system

included three pumps; however, one of the pumps has been removed from service for an extended period of time.

B.9.4 Modeling Assumptions

These three licensee event reports (LERs) are analyzed together in two separate cases because of the unavailability of the "B" SI pump throughout the entire time period. The root cause of the "B" SI pump inoperability was the plastic sheeting material from the RHR system modification performed during the cycle 14 refueling outage.

The first case was modeled assuming that the two SI pumps were inoperable for 1.5 h. For the second case, it was assumed that the "B" SI pump was inoperable from the time the plant went critical following the completion of the plant outage on June 18, 1992, until the LOOP event occurred on August 22, 1992 (64.5 d).

The failure probability for the "A" SI pump was doubled for Case 2. This was to account for the increased likelihood of "A" pump failure due to recirculation line clogging. Following the failure of the "B" SI pump due to recirculation line plugging, all flow would be through the "A" pump. This increased flow potentially increases the likelihood of failure for the "A" pump from the same cause. For Case 1 the "A" pump was failed because of the fuse failure in the starting circuit.

The nonrecovery values for the high pressure injection (HPI) and high pressure injection for feed and bleed (HPI(F/B)) were modified for both cases. For Case 1, the HPI nonrecovery was decreased from 0.84 to 0.34. This is based on the assumption that sufficient time would be available to recover the "A" SI pump by locally closing the breaker. In the HPI(F/B) case, the nonrecovery was increased from 0.84 to 1.0, assuming that neither pump would be recoverable in the required time period. For Case 2, the nonrecovery values for both HPI and HPI(F/B) were set to 1.0. This based on the assumption that the dominant failure mechanism would be blockage of the recirculation line by the plastic material and that this would not be recoverable in the required time period.

The system failure probabilities for HPI were modified to include the use of low pressure injection (LPI) in lieu of a failed high pressure injection (HPI) system. This process involves the use of the secondary side to cooldown and depressurize the RCS to below the LPI system injection pressure. A failure probability of 0.12 was assigned to the cooldown process as this a proceduralized process performed under stress (see Appendix A, Sect. A.1). This operator failure is dominant and the equipment failure rates are insignificant. The system probabilities for HPI in both cases were modified to include this recovery process.

B.9.5 Analysis Results

The conditional core damage probability for the 1.5 h that both SI pumps were inoperable (Case 1, LERs 261/92-013 and -014) is 6.2×10^{-8}. This is below the precursor cutoff. Therefore, this event is not a precursor. The conditional core damage probability for the time period when the "B" SI pump was inoperable (Case 2, LERs 261/92-013 and -018) is 3.5×10^{-5}. The dominant core damage sequence for this precursor, shown in Fig. B.12, involves a postulated loss of coolant accident (LOCA) followed by a failure of HPI.

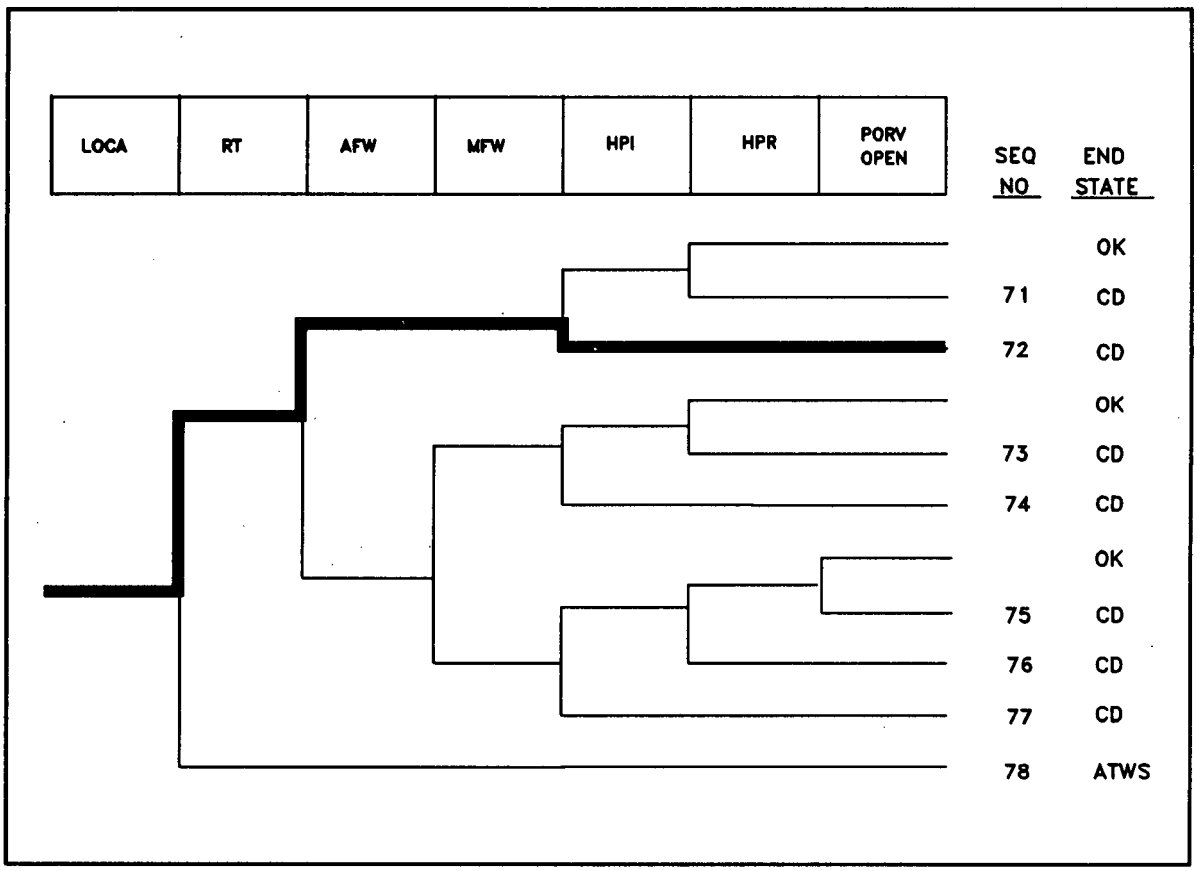

Fig. B.12. Dominant core damage sequence for LERs 261/92-013, -014, and -018 (case 2).

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 261/92-013, 014
Event Description: CASE 1: Both SI pumps inoperable for 1.5 hours
Event Date: 07/10/92
Plant: Robinson 2

UNAVAILABILITY, DURATION= 1.5

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOCA	1.5E-06

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOCA	6.2E-08
Total	6.2E-08
ATWS	
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	6.2E-08	1.5E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
72	loca -rt -afw HPI	CD	6.2E-08	1.5E-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:\asppra\special\pwrbseal.cmp
BRANCH MODEL: c:\asppra\special\robinson.sl2
PROBABILITY FILE: c:\asppra\special\pwr_bsl1.pro

Event Identifier: 261/92-013, -014

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	2.0E-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	1.0E-03
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	1.0E-03 > 1.2E-01 **	8.4E-01 > 3.4E-01	
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	2.0E-02	1.0E+00	4.0E-04

* branch model file
** forced

Event Identifier: 261/92-013, -014

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 261/92-013, 018
Event Description: CASE 2: "B" SI pump inoperable
Event Date: 06/18/92 - 08/22/92
Plant: Robinson 2

UNAVAILABILITY, DURATION= 1482

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOCA	1.5E-03

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability
CD	
LOCA	3.5E-05
Total	3.5E-05
ATWS	
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	3.5E-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	3.5E-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:\asppra\special\pwrbseal.cmp
BRANCH MODEL: c:\asppra\special\robinson.sl2
PROBABILITY FILE: c:\asppra\special\pwr_bsl1.pro

Event Identifier: 261/92-013, -018

No Recovery Limit

BRANCH FREQUENCIES/PROBABILITIES

Branch	System	Non-Recov	Opr Fail
trans	2.0E-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	1.0E-03
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	1.0E-03 > 2.4E-02 **	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 > 2.0E-01		
HPI(f/B)	1.0E-03 > 2.0E-01	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 > 2.0E-01		
hpr/-hpi	1.5E-04	1.0E+00	1.0E-03
porv.open	2.0E-02	1.0E+00	4.0E-04

* branch model file
** forced

Event Identifier: 261/92-013, -018