B.10 LER Number 261/92-017, 261/92-013, and 261/92-018

Event Description: Loss of Offsite Power

Date of Event: August 22, 1992

Plant: H. B. Robinson, Unit 2

B.10.1 Summary

On August 22, 1992, with the plant operating at 100% power, the loss of the startup transformer resulted in loss of one of the two emergency buses and an instrument bus. Following a subsequent reactor/turbine trip, the transfer of the other emergency bus to offsite power failed and resulted in a total loss of offsite power (LOOP). Two days after the LOOP, on August 24, 1992, the "B" SI pump recirculation line was found to be obstructed with the plastic sheeting material. The plastic sheeting had been used during a design modification while in a refueling outage that ended on June 18, 1992. The conditional core damage probability for the LOOP event is 2.1×10^{-4}. The relative significance of this event compared to other postulated events at H. B. Robinson Unit 2 is shown in Fig. B.13.

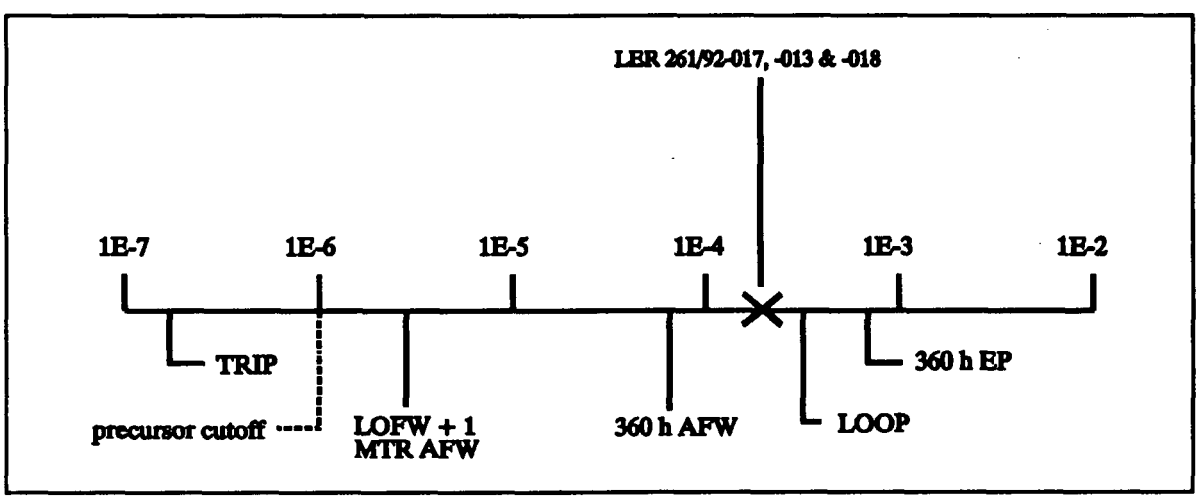

Fig. B.13. Relative event significance of LERs 261/92-017, -013, and -018 compared with other potential events at H. B. Robinson 2.

B.10.2 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 August 22, 1992, with the plant at 100% power, a LOOP occurred at 1007 hours because of the loss of the startup transformer. The loss of the startup transformer caused a loss of emergency bus E-2 and instrument bus 4, and a turbine runback. The "B" emergency diesel generator (EDG) started and supplied emergency bus E-2. At 1009 hours, the turbine and reactor tripped on high steam generator level. At 1010 hours the auxiliary transformer tried to transfer its loads to the startup transformer but failed because the startup transformer was not operational. This resulted in a LOOP to the other emergency bus (E-1). The "A" EDG started and supplied emergency bus E-1. A manual SI was initiated at 1018 hours because the pressurizer level had fallen to less than 10% during the initial transient. At 1037 hours the manual SI was terminated. At 1103 hours natural circulation was verified, with RCS temperatures stabilized at 500°F. Repairs to the startup transformer were completed and normal power alignment restored to the emergency busses between 0014 and 0050 hours on August 23, 1992.

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 utility 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 utility 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.10.3 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.

During power operation the main generator supplies 4160-Vac buses 1 and 4 via the unit auxiliary transformer (UAT) (see Fig. B.14). Buses 2 and 5 are also supplied from the UAT via buses 1 and 4,

respectively. Bus 3 is supplied from offsite power via the startup transformer (SUT). Emergency bus E-1 is supplied from the main generator via the UAT, bus 1 and bus 2. Emergency bus E-2 is supplied from offsite power via the SUT and bus 3. Upon loss of the main generator, the UAT transfers all loads to the SUT. If this transfer fails, the emergency buses are isolated from the nonsafety-related buses and the EDGs start and load onto the buses.

Figure removed during SUNSI review.

Fig. B.14. H.B. Robinson electrical distribution system.

The Dedicated Shutdown Diesel Generator (DSDG) is designed primarily to bring the plant to a hot shutdown condition in the event of a fire in the control room, cable spreading room and certain other areas of the plant. The DSDG supplies power to the "A" charging pump, "A" component cooling water pump, "D" service water pump, and MCC 5. MCC 5 in turn supplies power to two of the instrument busses via one of the battery chargers. This equipment is sufficient to prevent reactor coolant pump seal LOCAs and battery depletion if the diesel is aligned to the bus within one hour of the loss of all ac power.

B.10.4 Modeling Assumptions

The LOOP event was modeled as plant-centered. The probabilities for failure to recover ac power prior to battery depletion were set to 1.0 because of the extended period the plant was without offsite power (~14 hours). During this 14-h time period, about 3 h was spent investigating the failure of the startup transformer, 4.5 h was spent repairing the failed relay, and 6.5 h was spent attempting to restore power to specific loads (NRC Inspection Report 50-261/92-25). Therefore, off-site power could not have been quickly recovered during this period if problems were experienced with the on-site power supplies.

The DSDG was modeled as shown in Fig. B.15. A DSDG event was added to the LOOP tree following the PORV/SRV RESEAT event for those sequences with emergency power failure (Sequences 46–49 and 51-54) (see Appendix A, Sect. A.3.1 for the original tree). If the PORV/SRV is challenged (up branch), reseats (up branch), and the DSDG is successfully loaded, RCP seal LOCA will be prevented and a battery charger will be operational. Therefore offsite power recovery and use of HPI and HPR are not required. As a result the end state for this sequence is OK. If the PORV/SRV is challenged (up branch), reseats (up branch), and the DSDG is not successfully loaded, the remainder of the original tree is applicable (sequences 46–49). If the PORV/SRV is challenged and fails to reseat, the loading of the DSDG does not prevent core damage since the equipment supplied by it cannot provide sufficient makeup in this situation. Therefore this sequence still goes to core damage. If the PORV/SRV is not challenged, successful loading of the DSDG leads to an OK end state since RCP seal cooling and a battery charger are restored. If the DSDG is not loaded, then the remainder of the original tree is applicable (sequences 51–54).

To compute the estimated CCDP values, the original computer model was not modified. Instead, the results of the computer program for sequences 46–49 and 51–54 were multiplied by the failure probability of the DSDG to be successfully loaded. The results of this hand calculation are shown on the calculational forms. The failure probability for loading the DSDG was set to 0.075. This consists of a 0.05 equipment failure probability and a 0.025 operator failure probability. The 0.05 equipment failure probability value is the typical value used for safeguards emergency DGs in ASP analyses. Data supplied by the licensee indicated that the non-safeguards DSDG experienced fewer failures to start, fewer run time failures and had higher availability than the safeguards diesels at Robinson. Therefore it is reasonable to use the same value as is normally used for safeguards DGs . This value is somewhat nonconservative in that common cause failures between the safeguards DGs and the DSDG are not

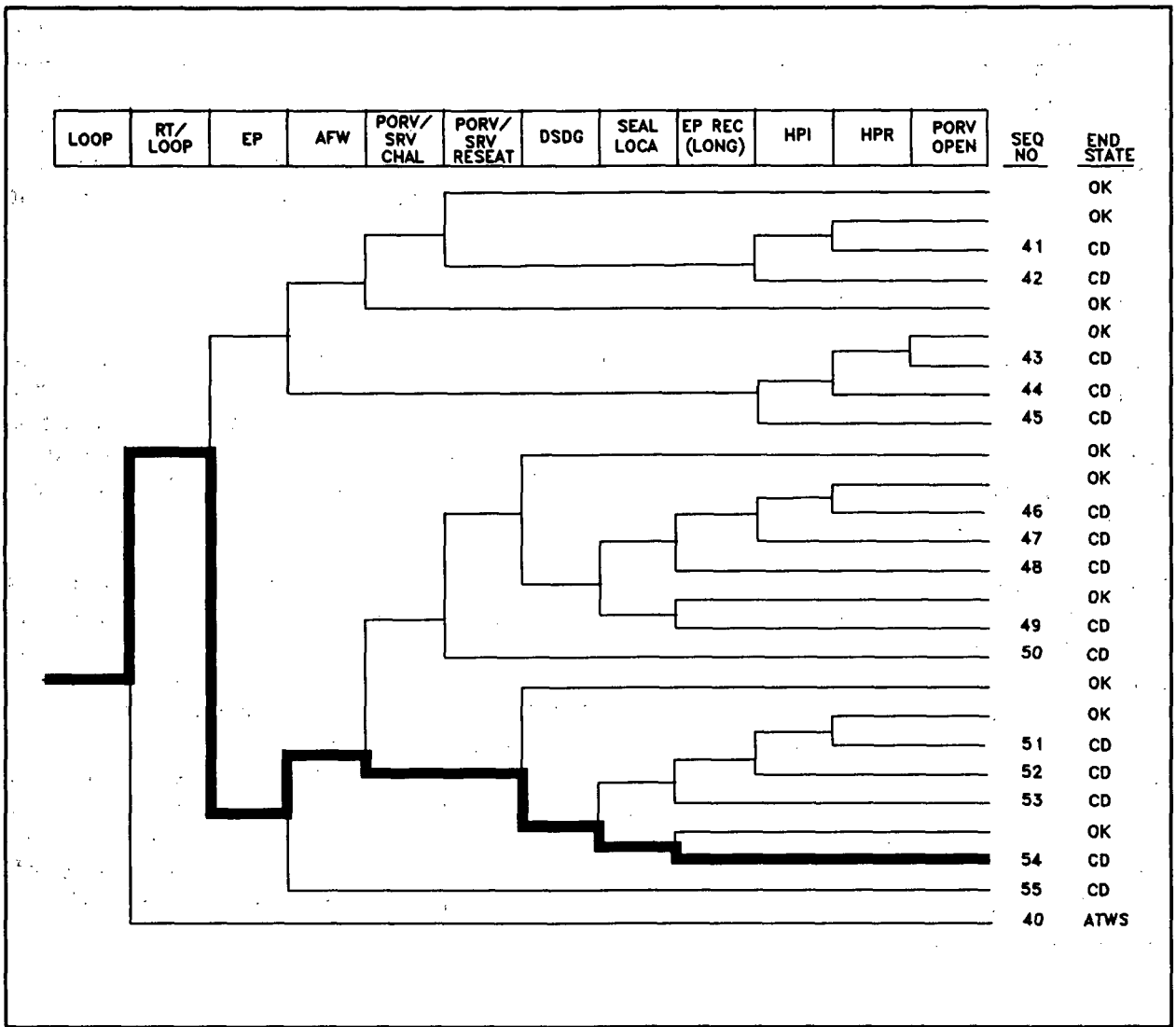

Fig. B.15. LOOP event tree for LERs 261/92-017, -013, and -018 including DSDG event and indicating the dominant core damage sequence.

included in this value. The operator failure probability was determined using time reliability correlations from *Human Reliability Analysis*, E.M. Dougherty, Jr. and J.R. Fragola, 1988, Wiley & Sons. Information from the licensee indicated that it would take approximately 30 min to complete the loading of the DSDG. The safegaurds battery lifetime is only 1 hour. Therefore the DSDG must be successfully loaded within this one hour time period. This leaves 30 min of available time (1 hr. - 30 min.) to begin the procedure and recover from errors. Using the recovery with hesitancy curve from Figure 11-4 of the previous reference, the operator failure probability is 0.025.

The procedure for the loading of the DSDG states that if limited manpower is available, recovery of the safeguards diesels should be postponed until the DSDG is successfully aligned. Since this particular event occurred on a Saturday morning, it was assumed that the recovery actions for the DSDG would be completed before recovery of the safeguards diesels would be pursued. Therefore, the nonrecovery value for the safeguards diesels was set to 1.0. Due to the extended period of time to recover offsite power ($\sim$ 14 hours), the long term nonrecovery probabilities for offsite electric power were set to 1.0.

The failure probability for the "A" SI pump was doubled. 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.

The nonrecovery values for the high pressure injection (HPI) and high pressure injection for feed and bleed (HPI(F/B)) were also modified. The nonrecovery values for both HPI and HPI(F/B) were set to 1.0. This is 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.

B.10.5 Analysis Results

The conditional core damage probability for this event is 2.1×10^{-4}. The dominant core damage sequence for this event, shown in Fig. B.15, involves a postulated failure of emergency power, failure to load the DSDG, and failure to restore ac power prior to core uncovery.

CONDITIONAL CORE DAMAGE PROBABILITY CALCULATIONS

Event Identifier: 261/92-017, 013, 018
Event Description: LOOP with SI pump "B" inoperable
Event Date: 08/22/92
Plant: Robinson 2

INITIATING EVENT

NON-RECOVERABLE INITIATING EVENT PROBABILITIES

LOOP 1.0E+00

SEQUENCE CONDITIONAL PROBABILITY SUMS

End State/Initiator	Probability (w/o DSDG)	Probability (w/ DSDG)
CD		
LOOP	2.9E-03	2.1E-04
Total	2.9E-03	2.1E-04
ATWS		
LOOP	0.0E+00	
Total	0.0E+00	

SEQUENCE CONDITIONAL PROBABILITIES (PROBABILITY ORDER)

	Sequence	End State	Prob	N Rec**
54[2]	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	2.1E-03	9.9E-01
53[2]	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall SEAL.LOCA EP.REC(SL)	CD	6.2E-04	9.9E-01
49[2]	LOOP -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power -SEAL.LOCA EP.REC	CD	8.5E-05	9.9E-01

** non-recovery credit for edited case

SEQUENCE CONDITIONAL PROBABILITIES (SEQUENCE ORDER)

	Sequence	End State	Prob	N Rec**
49[2]	LOOP -rt/loop EMERG.POWER -afw/emerg.power porv.or.srv.chall - porv.or.srv.reseat/emerg.power -SEAL.LOCA EP.REC	CD	8.5E-05	9.9E-01
53[2]	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall SEAL.LOCA EP.REC(SL)	CD	6.2E-04	9.9E-01
54[2]	LOOP -rt/loop EMERG.POWER -afw/emerg.power -porv.or.srv.chall - SEAL.LOCA EP.REC	CD	2.1E-03	9.9E-01

** non-recovery credit for edited case

SEQUENCE MODEL: c:\asppra\special\pwrbseal.cmp
BRANCH MODEL: c:\asppra\special\robinson.sl2

Event Identifier: 261/92-017, 013, 018

PROBABILITY FILE: c:\asppra\special\pwr_bs11.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	5.3E-01 > 1.0E+00	
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 > 2.9E-03	8.0E-01 > 1.0E+00	
Branch Model: 1.OF.2			
Train 1 Cond Prob:	5.0E-02		
Train 2 Cond Prob:	5.7E-02		
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 > 2.3E-01	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	2.7E-01 > 2.3E-01		
EP.REC(SL)	5.7E-01 > 1.0E+00	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	5.7E-01 > 1.0E+00		
EP.REC	7.0E-02 > 1.0E+00	1.0E+00	
Branch Model: 1.OF.1			
Train 1 Cond Prob:	7.0E-02 > 1.0E+00		
HPI	1.0E-03 > 2.0E-01	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

NOTES:

[1] Value obtained by performing hand caclulation. See Modeling Assumptions section for a description of how this value was obtained.

[2] Sequences affected by DSDG. See Modeling Assumptions section for a description of this modification.

Event Identifier: 261/92-017, 013, 018