Attachment 7

PWR Sample Problem 1

Shutdown Cooling Flow Perturbations

Initial Conditions for this Event

- The plant was in Mode 5 with the RCS level at mid-loop.
- The RCS was aligned for vacuum fill; no RCS vent was in place.
- Train "A" RHR was in service providing shutdown cooling.
- Train "B" RHR was in standby aligned for shutdown cooling.
- Secondary sides of the steam generators were filled.
- All plant equipment was available except for the non-safety related "C" normal service water pump and the non-safety related normal charging pump (NCP).
- Accumulators are isolated from the RCS by closure of their motor-operated discharge valves. Automatic safety injection signal is also disabled in this mode/configuration.
- Wolf Creek plant had shut down on 5/13/02 for retrieval of foreign objects (loose parts) from the "D" steam generator bowl.
- 2 Primary PORVS were available for Feed and Bleed
- 1 Assume only 1 SG PORV per SG available for heat removal
- Assume 2 charging pumps and 2 SI pumps in addition to the RHR pumps for RCS injection
- Assume RWST depletion occurs before 16 hours with extended feed.

Event

In order to accomplish object retrieval, the level in the RCS was reduced to mid-loop to allow opening of the steam generator manways. Following foreign object retrieval on 5/17/02, the steam generator manways were installed and the RCS was aligned for vacuum fill and vent.

While drawing a vacuum on the RCS, the "A" train RHR pump, which was in service for shutdown cooling, experienced flow perturbations.

RHR flow rate was reduced which initially decreased the perturbations, but as the RCS temperature increased, RHR flow perturbations were again experienced.

The "A" CCP was aligned to deliver water from the RWST and as soon as RCS loop level began to increase, the RHR flow perturbations stopped.

The licensee continued with their planned filling of the RCS.

RHR/RCS temperature did not exceed the Technical Specification limit of 140°F.

Performance Deficiency

The cause of the flow perturbation was operating the RHR pump at a flow rate greater than 2000 gpm, which is a violation of licensee procedures. The resident stated that control room operators were not aware of the caution in the procedures.

Supporting Facts for Analysis

The licensee's action on the discharge side of the pump (throttling) initially solved the flow perturbations. Once the heat-up and/or the drawing of a vacuum in the RCS negated the effects of throttling the RHR pump discharge, charging quickly returned RHR pump performance to normal.

The licensee states that the operators were seeing very early indications of problems with the RHR system, and that the problems were easily corrected. The resident agrees with the licensee's assessment that pump performance was slightly degraded.

All instrumentation was reported to be working normally, and recovery actions were easily identified and implemented by the licensee in a matter of a few minutes.

PWR Problem 1
Answers

Using Table 4.3, IEL for LOLC

Loss of RHR did not occur, nor would it have in less than 10 minutes. RHR pump indications were available and being closely watched. The cause of the perturbations was clearly the plant evolution in progress. The resident and the utility stated that the pump would probably continue to run for a long time, and seemed to prefer a 30 to 60 minute time-to-failure estimate. Analyst used a 30 minutes estimate.

IEL=1

Use Worksheet 1. LOLC POS 1

Safety Function	Equipment Credit	Operator Credit	Credit For Function
SG	All Four SGs were available; inventory was assumed to last for 24 hours; operator limited	3	3
FEED&BLEED	Injection credit = 4 (2 diverse trains) Bleed credit = 4 (2 PORVs)	4	4
RHR-R	Two trains available for RHR recovery; Credit = 3	3	3
RWSTMU	One injection path; credit =2	1 (RWSTMU required before 16 hours)	1

Circle Affected Functions	IEL	Mitigation Credit	Result
LOLC- SG-RHR-R-RWSTMU (4)	1	3+3+1	8
LOLC-SG-FEED&BLEED (5)	1	3+4	8

PWR Sample Problem 2

During the Unit 2 outage in February 2002, the licensee discovered that the Coolant Charging Pumps (CCPs) suction path to the Reactor Water Storage Tank (RWST) was unavailable due to gas binding. The source of gas causing the binding was the Volume Control Tank (VCT). The cause of the condition was improper preventive maintenance to the VCT shutoff valve

PLANT OPERATION STATES

On February 1, 2002, the licensee performed preventive maintenance to replace the valve diaphragm.

- The valve maintenance activity was completed on February 1, 2002, while the affected Unit 2 was defueled.
- On February 10, 2002, the plant entered Mode 6 (Refueling).
- On February 12, 2002, the core reload was completed. On this day, while the refueling cavity was full, SI pumps were unavailable for 2 ½ hours.
- On February 15, 2002, the plant entered mid-loop reduced inventory conditions. The licensee was conducting a vacuum refill of the RCS on February 15 and February 16. The NRC inspectors estimate that the RCS was in a reduced inventory condition for about 23 hours, with most of that time spent with the RCS below atmospheric pressure.
- Based on a review of the Unit 2 shutdown risk status sheets during the period of Feb. 15 and 16, 2002, the inspectors determined that the minimum time to boil upon a loss of core cooling was 13 minutes. The time to boil with the reactor coolant not in a reduced inventory condition was estimated to be approximately 2 hours.
- On February 16, 2002, while performing the vacuum refill of the RCS, the event occurred while shifting CCP suction from the VCT to the RWST. The steam generators were not available for core cooling.
- On February 17, 2002, the gas binding event was over. The affected systems and components were retested satisfactorily and declared operational.

The staff was concerned about air binding of other systems that have suction lines to the RWST, but, after investigation, determined that to be extremely unlikely. Other information about the plant status:

- To support LTOP requirements, the breakers for both SI pumps were racked out. Estimated 30 minutes to restore pumps to service.

- The remote unit has the capability to provide high head injection via a unit cross tie. Operation, training and surveillance of x-tie equipment covered Appendix R.

EVENT

On February 16, 2002, while performing a vacuum refill of the reactor coolant system (RCS), control room operators shifted the RWST suction source from the VCT to the RWST and isolated the VCT. Shortly thereafter, the CCP exhibited indications of gas binding, including a drop in motor current and a reduction in flow to near 0 gpm. After operators shifted the suction back to the VCT, CCP performance returned to normal. The operators then made a second attempt to shift the CCP suction source from the VCT to the RWST, but again experienced the same symptoms and restored the suction back to the VCT. Based on the unexpected system response, the licensee declared the RWST boration flow path inoperable.

The licensee performed several corrective actions for this condition, including: (1) adjustment of the stop nut and closing of 2-CS-369; (2) venting of the SI pump and CCP suction headers; and (3) testing of the CCP. The licensee declared the RWST boration flow path operable on February 17, 2002, approximately 23 hours after the event.

PERFORMANCE DEFICIENCY

The performance deficiency that caused the event was the failure to have VCT shutoff valve 2-CS-369 fully closed, which, due to the pressure difference between the VCT (~2 atmospheres) and the RWST (atmospheric), allowed gas to vent from the top of the VCT directly to the CCP suction line. Valve 2-CS-369 is in the system to allow reactor coolant pump (RCP) seal return flow to go directly to the VCT. During normal operation, 2-CS-369 is sealed closed to prevent VCT cover gas intrusion directly to the CCP suction. Incorrect maintenance restoration, coupled with an inadequate post-maintenance retest rendered this valve in the partially open position and unclosable. The presence of the gas in the suction lines to the CCPs clearly rendered both the pumps inoperable.

PWR Sample Problem 2
Answers

Determine IELs

This performance deficiency is categorized as a condition finding. Using Table 5 to determine the IELs.

POS 1 - (Since the licensee spent one day at vaccum)

LOI = 4
LORHR = 3
LOLC = 2

POS 2 (briefly)

LOLC = 2 (dominated by a demand failure during drain down)

POS 3 (In POS 3 for 5 days)

LOI = 3

Worksheets - (only manipulating sequences that have a change in the FEED probability to obtain a delta CDF)

Using Table Worksheet 1, LOLC in POS 1, IEL = 2

Safety Function	Equipment Credit	Operator Credit	Credit for Safety Function
SG			0
FEED and BLEED	For Feed, the licensee, the licensee had two redundant trains of SI. Credit = 3 For Bleed the licensee had a single PORV available. Credit = 3	4	(no change for the credit for the safety function since the equipment credit does not change)

Circle Affected Functions	IEL	Mitigation Credit	Recovery	Result

LOLC -SG-FEED&BLEED (5)				(No Change from conditions w/o deficiency

Using Worksheet 5 for LOI , POS 1, IEL = 4

Safety Function	Equipment Credit	Operator Credit	Credit for Safety Function
FEED	Credit = 3 (two redundant trains of SI) (Credit was 6 w/o deficiency)	4	3

Circle Affected Functions	IEL	Mitigation Credit	Recovery	Result
LOI - FEED-SG (9)	4	3 + 0		7
LOI-FEED-LEAKSTOP2 (10)	4			Scenario is not added since SG cooling is not available.

Using Worksheet 8 for LORHR-POS 1, IEL = 3

Safety Function	Equipment Credit	Operator Credit	Credit for Safety Function
FEED&BLEED	For Feed, the licensee , the licensee had two redundant trains of SI. Credit = 3 For Bleed the licensee had a single PORV available. Credit = 3	4	No change of the credit for the safety function with deficiency since the equipment credit does not change Scenario not added.

Circle Affected Functions	IEL	Mitigation Credit	Recovery	Result

LORHR-RHR-S-SG-FEED&BLEED (6)	3	0+0+3		No Change from conditions w/o deficiency

Using Worksheet 2, for LOLC -POS 2, IEL = 2

Safety Function	Equipment Credit	Operator Credit	Credit for Safety Function
FEED	For Feed, the licensee , the licensee had two redundant trains of SI. And a X-tie from other unit (credit = 2) Equipment credit = 5	5	5

Circle Affected Functions	IEL	Mitigation Credit	Recovery	Result
LOLC -FEED (4)	2	0+ 5		7

Using Worksheet 6, LOI, POS -3, IEL = 3

Only one sequence impacted.

Safety Function	Equipment Credit	Operator Credit	Credit for Safety Function
FEED	For Feed, the licensee , the licensee had two redundant trains of SI. And a X-tie from other unit (credit = 2) Equipment credit = 5	5	5

Circle Affected Functions	IEL	Mitigation Credit	Recovery	Result
LOI -FEED (4)	3			7

BWR SAMPLE PROBLEM 1
Loss of Inventory at a BWR/4

Event Details

- Licensee in cold shutdown
- Licensee conduced an infrequently performed procedure to flush hot spots from the RHR piping.
- Procedure required the RHR system to be aligned in the LPCI mode.
- Operators made pen and ink change to the procedure to allow the evolution to be conducted in the shutdown cooling mode.
- When operators started the 3D RHR pump to flush the line, a siphon was creased from the vessel through the 3B RHR pump and heat exchanger to the torus
- Operators diagnosed the event and terminated the leak path
- Level was inadvertent reduced from +200 inches to + 158" in 4.5 minutes
- 8500 gallons displaced from vessel to torus.
- Time to RHR shutoff head 3 hours

Plant Configuration

- Low Low vessel level isolation was in service and would have terminated the leak path with an additional 1" of level decrease.
- 2 SRVs were available for long term cooling and pressure control.
- At low-low low level (-160 inches), a train of core spray and **a train of** LPCI would have automatically injected into the vessel.
- The operators were able to terminate the leak path using valves other than the RHR suction valves.
- Time to RHR shutoff head was 3 hours
- Containment venting is available.
- Long term source of water is available.
- For problem estimate that containment Cooling or venting not needed for 24 hours. **Both trains of DC needed for venting at this site.**

Answers Sample Problem One
Loss of Inventory at A BWR/4

SOLUTION

IEL = 0 , (loss of inventory was imminent)

Safety Function	Equipment Credit	Operator Credit	Credit for Function
ISOL	Credit =3, loss thru downcomer and Isolation on Level 3 is available	N/A	3
AECCS	2 diverse trains Credit = 4	n/a	4
MINJ	1 train of LPCI, if 1st train of LPCI failed, then operator would use other train of LPCI and LPCS manually Credit = 5	Credit = 4	4
MINJX	If the LPCI and LPCS failed to automatically actuate then the operator could manually inject with the other train of LPCI Credit = 2	Credit = 4	2
RHRREC	2 multi trains of RHR available Credit = 3	Credit = 2 +1 additional credit since time to RHR shutoff head = 3 hours	3
RHRRECX	Can only assume that one train of LPCI would be available to configure for the RHR function Credit = 2	Credit = 2+1 additional credit since time to RHR shutoff head = 3 hours	2
SRV	2 SRVs Credit = 3	Credit = 3	3
MINJY	Assume credit = 1	Credit = 1	1

CV	Multiple Containment Venting Paths Instrument Air , EPAC-A 4160 and 480 V bus A and EPAC-B 4160 AND 480 VAC BUS B available Credit = 2 since need both divisions of AC power to accomplish venting	Credit = 3	2

Circle Affected Functions	IEL	Mitigation Credit	Result
LOI-RHRREC-CV (3)	0	3+2	5
LOI -RHRREC-SRV (4)	0	3+3	6
LOI-MINJ -CV (6)	0	4+2	6
LOI-MINJ -MINJY (7)	0	4+1	5
LOI-ISOL-RHRRECX-CV (10)	0	3+2+2	7
LOI-ISOL-RHRRECX-SRV (11)	0	3+2+3	8
LOI-ISOL-AECCS-CV (13)	0	3+4+2	9
LOI-ISOL-AECCS-SRV (14)	0	3+4+3	10
LOI-ISOL-AECCS-MINJX (15)	0	3+4+2	9