

## Sample Problem One

## BWR 4 Plant

## Event Details

- Licensee in cold shutdown
- Licensee conducted 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, 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 given an extended loss of RHR was 3 hours
- Containment venting is available.
- Long term source of water is available.
- For problem, assumes that both AC trains needed for containment venting hours.

## PWR Sample Problem 2

### **GAS BINDING OF COOLANT CHARGING PUMPS**

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.

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