

SURRY UNIT 2

Surry, VA

Owner: Virginia Electric Power Company

Outage dates (duration): September 10, 1988 to September 19, 1989 (1.0 year)

Reactor type: Pressurized water reactor

Reactor age when outage began: 15.4 years

Commercial operations began: May 1, 1973

Fleet status: Second oldest of four reactors owned by the company

Synopsis

While shutting the reactor down for a scheduled refueling outage, a transient resulted in an automatic trip from four percent power. The refueling outage was extended initially when pipe wall thicknesses were discovered to be thinning at a faster rate than predicted, forcing the replacement of many sections of piping. The outage was then extended by the discovery of motor-operated valve problems. The outage was further extended to address programmatic problems that produced an overall decline in performance at Surry.

Process Changes

None.

Commentary

The pipe wall thinning problem that initially extended the refueling outage was found during inspections conducted in response to NRC Bulletin No. 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," dated July 9, 1987. The as-found pipe wall thicknesses remained above the minimum needed for safety, but were thinning at a rate faster than predicted. Thus, this is a good example of the NRC responding in a timely and effective manner in order to prevent recurrences.

The motor-operated valve problem that then extended the refueling outage was used by the NRC, along with motor-operated valve problems identified at other nuclear plant sites, as the basis for its Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," dated June 28, 1989.

The majority of the extended outages at U.S. nuclear power plants followed long periods during which reactors continued to operate with safety problems known to and tolerated by the plant owner and the NRC. This specific outage is different in that the safety problems were unknown to both the plant owner and the NRC when the outage began and, when the problems were discovered, they were corrected before the reactor was restarted.

NRC Systematic Assessment of Licensee Performance (SALP) History

Date	Operations	Radiological Controls	Maintenance	Surveillance Testing	Emergency Preparedness	Fire Protection	Security	Outage Management	Quality Assurance	Licensing	Training
12/1/1980	3	2	2	2	2	2	2	2	2	n/a	n/a
11/1/1982	3	2	2	2	n/a	2	2	2	3	2	n/a
4/1/1983	1	2	2	1	2	2	1	2	2	2	n/a
2/1/1984	2	3	2	1	1	2	1	1	2	1	n/a
5/1/1985	2	1	2	3	2	N/a	1	1	2	1	n/a
12/1/1986	1	2	2	2	2	1	2	2	2	1	2
9/1/1988	2	2	2	2	2	2	2	2	2	1	1
	Operations	Radiological Controls	Maintenance/Surveillance Testing		Emergency Preparedness	Security	Engineering and Technology		Safety Assessment and Quality Verification		
11/1/1989	3	3	3		3	1	2		3		
7/1/1990	2	2	3		1	1	2		2		
	Operations		Maintenance		Engineering		Plant Support				
7/1/1991	2		2		2		1/1/1				
7/1/1992	1		2		2		1/1/1				
10/1/1993	1		2		2		1/1/1				
2/1/1995	1		2		1		1				

NOTE: A rating of 1 designates a superior level of performance where NRC attention may be reduced. A 2 rating designates a good level of performance with NRC attention at normal levels. A rating of 3 designates an acceptable level of performance where increased NRC attention may be appropriate. A rating of n/a was given in those areas that were not assessed on that date.

Details

December 9, 1985: Erosion/corrosion of the piping on the suction side of the main feedwater pump caused thinning of the piping. The piping ruptured and released high-temperature water/steam into the area, scalding eight workers. Four workers died from their injuries.¹

May 15, 1988: Unit 2 automatically tripped from 100 percent power due. Auxiliary feedwater system problems led to the operators manually initiating the safety injection system.²

May 17, 1988: During Unit 1 refueling, the refueling cavity floor seal failed, causing the loss of about 28,000 gallons of borated water from the refueling cavity to the containment sump. Evaluation and troubleshooting of the auxiliary feedwater system problems on Unit 2 were still the focus of management and operations staff (and the NRC). The company did not report the event to the NRC.³

August 30, 1988: The NRC’s resident inspectors at Surry became aware of an internal report by the Independent Offsite Evaluation Review group concerning the May 17, 1988, refueling cavity seal failure.⁴

August 31, 1988: The NRC regional administrator dispatched an augmented inspection team to Surry to investigate the refueling cavity seal failure.⁵

September 1988: Virginia Electric Power Company (VEPCO) hired a new vice president of nuclear operations.⁶

September 6, 1988: The NRC issued a Confirmatory Action Letter specifying tasks that must be completed by VEPCO in response to the refueling cavity seal failure.⁷

September 10, 1988: During a controlled shutdown for a refueling outage, the reactor automatically tripped from about four percent power. Operators were attempting to maintain the main turbine at rated speed with the generator output breakers open. An inadequate procedure coupled with a faulty valve position indicator resulted in the first-stage turbine pressure rising unexpectedly to the point where an automatic turbine trip and reactor trip were signaled.⁸

September 13, 1988: Operators manually shut down Unit 1 due to concerns about emergency diesel generator operability.⁹

September 16, 1988: Workers measured the thickness of the pipe wall on the suction side of the main feedwater pump. The thickness exceeded the minimum allowable thickness but the thinning was greater than predicted by the erosion/corrosion monitoring program.¹⁰

September 26, 1988: NRC Region II reported that workers measured the thickness of the pipe wall on the inlet side of the steam generator. The thickness was below the minimum allowable thickness.¹¹

September 26, 1988: *Inside NRC* reported that the NRC ordered VEPCO to suspend refueling of Unit 2 until procedural and design problems revealed by the May 17, 1988, refueling cavity seal failure on Unit 1 could be corrected.¹²

September 30, 1988: The NRC issued the report written by the Augmented Inspection Team (AIT) sent to investigate the Unit 1 refueling cavity seal failure. Among other things, the AIT found that the seal failure resulted in the loss of approximately 27,800 gallons of water from the refueling cavity in four minutes—for a leak rate of nearly 6,950 gallons per minute. The NRC noted that the design flow rate of one low head safety injection pump is 3,250 gallons per minute, although none of the low head safety injection pumps were operable at the time of the event.¹³

October 8, 1988: The NRC supplemented its September 6, 1988, Confirmatory Action Letter with four additional tasks that VEPCO would be required to complete prior to restart:

1. Issues arising from the safety system functional inspection
2. Issues arising from main feedwater piping wall thinning
3. Issues related to emergency diesel generator operability
4. Issues related to the control room envelope ventilation system¹⁴

October 13, 1988: *Nucleonics Week* reported that VEPCO might be forced to bring Unit 1 and Unit 2 down in spring 1989 for a maintenance outage to replace piping whose walls had thinned more than expected. Unit 2 was in a refueling outage planned to end in December 1988.¹⁵

October 19, 1988: VEPCO submitted its Restart Action Plan to the NRC, detailing the steps to be taken to address the four issues listed on the NRC's letter of October 8, 1988.¹⁶

1. Issues arising from the safety system functional inspection: For a postulated loss of coolant accident with a concurrent loss of offsite power, the intake canal (the source of water for emergency equipment) had less capacity than needed. For the same postulated scenario coupled with failure of

the non-accident unit's emergency diesel generator, the circulating water system valves lacked the power to close and the intake canal draindown far exceeded needed inventory. VEPCO outlined procedural changes, plant modifications, and administrative controls to correct the problems.

2. Issues arising from main feedwater piping wall thinning: The original and even some of the replacement piping in the condensate and feedwater systems was thinning faster than expected. VEPCO proposed more extensive pipe wall thickness measurements to verify margins and establish baselines upon which to derive wear rates.
3. Issues related to emergency diesel generator operability: An analysis determined that the emergency diesel generators might not be able to handle the essential post-accident loads if a loss of offsite power were to occur at any time other than simultaneously with the loss of coolant accident. VEPCO committed to modifications installing load-sequencing logic circuits that would stagger reloading equipment onto electrical buses powered by the emergency diesel generators.
4. Issues related to the control room envelope ventilation system: Age-related degradation of the air conditioning system for the control room, coupled with higher heat loads from equipment added to the control room and switchgear room over the years, made it impossible to conclusively evaluate whether the system would function as needed following an accident. VEPCO committed to performing a test to measure system capacity and undertake corrective actions, if needed, based on the test results.

November 1988: VEPCO named a new station manager at Surry.¹⁷

November 11, 1988: The NRC proposed a \$50,000 fine on VEPCO for failing to prevent debris from collecting in the containment sump, which could impair the post-accident recirculation phase of emergency core cooling system operation.¹⁸

November 22, 1988: The NRC issued Information Notice 88-92 to all plant owners regarding the May 17, 1988, refueling cavity seal failure at Surry Unit 1. The NRC noted that the configuration at Surry could have drained the spent fuel pool down to within 13 inches of the tops of irradiated fuel assemblies, yielding a radiation dose of 50 rem/hour on the operating deck.¹⁹

January 1989: VEPCO created a new management position (superintendent of engineering) responsible for engineering at both Surry and its North Anna plant in Virginia.²⁰

February 1989: VEPCO named a new operations and assistant station manager for maintenance at Surry. VEPCO also named a new operations superintendent at Surry.²¹

February 16, 1989: VEPCO reported that problems with motor-operated valves (MOVs) delayed the projected restart of Surry Units 1 and 2 until April 1989. The MOV problems included missing parts, improperly sized motors, undersized actuators, incorrectly wired limit switches, broken gear teeth, and pinion gears installed backward.²²

March 1989: VEPCO reorganized its corporate structure, creating a senior vice president—nuclear, vice president—nuclear services, vice president—nuclear engineering, and assistant vice president—nuclear operations. VEPCO also named a new quality assurance manager.²³

March 9, 1989: The NRC supplemented its Confirmatory Action Letter for Unit 2 to include three tasks related to the MOV problems and their resolutions.²⁴

April 1989: VEPCO named a new president and chief executive officer.²⁵

May 19, 1989: The NRC proposed a \$500,000 fine on VEPCO for 12 violations related to the May 1988 refueling cavity seal failure at Surry Unit 1. VEPCO agreed to pay the fine.²⁶

June 1, 1989: The NRC put Surry on its Watch List.²⁷

July 28, 1989: VEPCO submitted its Restart Action Plan for addressing the three items added to the Confirmatory Action Letter by the NRC on March 9, 1989. VEPCO committed to system walkdowns to verify that equipment was located in the appropriate train per station drawings, to verifications of electrical separation between components of different trains, and to logic tests to demonstrate proper actuation of engineered safety features.²⁸

September 8, 1989: The NRC notified VEPCO that its inspections confirmed completion of all items on the Confirmatory Action Letter.²⁹

September 16, 1989: Operators withdrew control rods to achieve criticality of the Unit 2 reactor.³⁰

September 19, 1989: Unit 2 was connected to the electrical grid, ending its extended outage. Moments later, the reactor automatically tripped after the operator raised the turbine's output too rapidly, triggering a transient that caused the water level in the steam generators to drop to the trip setpoint.³¹

Notes

- ¹ Nuclear Regulatory Commission (NRC). 1986. Feedwater line break. Information Notice no. 86-106, December 16.
- ² Grace, J.N. 1988. Augmented inspection team reports nos. 50-280/88-34 and 50-281/88-34. Letter to W.R. Cartwright, vice president, nuclear operations, Virginia Electric and Power Company, September 30. J. Nelson Grace was regional administrator at the Nuclear Regulatory Commission.
- ³ Ibid.
- ⁴ Ibid.
- ⁵ Ibid.
- ⁶ Ebnetter, S.D. 1989a. NRC inspection report nos. 50-280.89-16 and 50-218/89-16. Letter to W.L. Stewart, senior vice president, nuclear, Virginia Electric and Power Company, September 22. Stewart D. Ebnetter was regional administrator at the Nuclear Regulatory Commission.
- ⁷ Ernst, M.L. 1988. Surry issues requiring followup action. Letter to W.R. Cartwright, vice president, nuclear operations, Virginia Electric and Power Company, October 8. Malcolm L. Ernst was acting regional administrator at the Nuclear Regulatory Commission.
- ⁸ Benson, D.L. 1988. Letter to Nuclear Regulatory Commission, October 10. David L. Benson was station manager at the Virginia Electric and Power Company.
- ⁹ Cartwright, W.R. 1988. Virginia Electric and Power Company Surry Power Station Units 1 and 2 monthly operating report. Letter to Nuclear Regulatory Commission, October 14. W.R. Cartwright was vice president, nuclear, at the Virginia Electric and Power Company.
- ¹⁰ Jaudon, J.J. 1988. The operating reactors events meeting September 27, 1988—meeting 88-38. Memorandum to Charles E. Rossi, director, operational events assessment, Nuclear Regulatory Commission, September 28. Johns P. Jaudon was acting chief of the events assessment branch at the Nuclear Regulatory Commission.
- ¹¹ Ibid.
- ¹² Airozo, D. 1988. Incident rekindles NRC interest in reactor cavity seals. *Inside NRC*, September 26.
- ¹³ Grace, 1988.
- ¹⁴ Ernst, 1988.
- ¹⁵ Sperber, M. 1988. New pipe thinning may require Surry to schedule spring outage. *Nucleonics Week*, October 13.
- ¹⁶ Cartwright, W.R. 1988. Virginia Electric and Power Company Surry Power Station Units 1 and 2 restart action plan. Letter to Malcolm L. Ernst, acting regional administrator, Nuclear Regulatory Commission, October 19. W.R. Cartwright was vice president, nuclear, at the Virginia Electric and Power Company.
- ¹⁷ Ebnetter, 1989a.
- ¹⁸ NRC. 1988a. Enforcement action EA-88-215, November 11.
- ¹⁹ NRC. 1988b. Potential for spent fuel pool draindown. Information Notice no. 88-92, November 22
- ²⁰ Ebnetter, 1989a.
- ²¹ Ibid.
- ²² Jordan, B. 1989. MOV problems contribute to delay as Surry restart setback again. *Nucleonics Week*, February 16.
- ²³ Ebnetter, 1989a.

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- ²⁴ Stewart, W.L. 1989. Virginia Electric and Power Company Surry Power Station Unit 2 operational readiness assurance program request for NRC concurrence. Letter to Nuclear Regulatory Commission, July 28. W.L. Stewart was senior vice president, power, at the Virginia Electric and Power Company.
- ²⁵ Ebnetter, 1989a.
- ²⁶ Jordan, B. 1989. Virginia Power agrees to pay \$500,000 fine for 12 violations at Surry. *Inside NRC*, June 5.
- ²⁷ Cohn, D'V. 1989. Surry nuclear plant is fired up to run. *Washington Post*, July 9.
- ²⁸ Stewart, 1989.
- ²⁹ Ebnetter, S.D. 1989b. Confirmation of concurrence regarding completion of items prior to restart of Surry Unit 2. Letter to W.L. Stewart, senior vice president, power, Virginia Electric and Power Company, September 8. Stewart D. Ebnetter was regional administrator at the Nuclear Regulatory Commission.
- ³⁰ NRC. 1989. Surry Unit 2 restart. Preliminary Notification of Event or Unusual Occurrence, PNO-II-89-65, September 20.
- ³¹ Kansler, M.R. 1989. Letter to Nuclear Regulatory Commission, October 13. Michael R. Kansler was station manager at the Virginia Electric and Power Company.