

FORT ST. VRAIN

Platteville, CO

Owner: Public Service Company of Colorado

Outage dates (duration): June 23, 1984 to April 11, 1986 (1.8 years)

Reactor type: High-temperature gas-cooled reactor

Reactor age when outage began: 5.0 years

Commercial operations began: July 1, 1979

Fleet status: Only reactor owned by the company

Synopsis

More than two years of recurring problems caused by moisture intrusion into the primary coolant (helium) system culminated in the failure of 6 of 37 control rod pairs to insert upon an automatic scram signal triggered by high pressure in the reactor vessel. The outage was extended when tests of the reserve shutdown system also revealed damage caused by moisture intrusion.

Process Changes

No discernible changes were identified.

Commentary

Fort St. Vrain exposed the challenges faced by both the plant owner and the NRC from the operation of an atypical reactor. Throughout its entire history, Fort St. Vrain was the only non-LWR (light water reactor) operating in the United States. Whereas the LWRs went to great lengths to keep moisture from leaking out of the primary coolant system, Fort St. Vrain struggled to keep moisture from leaking in (its primary coolant was helium). Fort St. Vrain was the figurative square peg in the round hole. Neither the Public Service Company of Colorado (PSC) nor the NRC learned how to apply regulations and knowledge-base developed for LWRs to a non-LWR reactor.

Fort St. Vrain permanently shut down in August 1989. But its legacy may be revived by some of the non-LWR designs being contemplated. If another such reactor is constructed, the NRC must figure out to effectively regulate it. Fort St. Vrain demonstrated that need, but not its solution.

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
10/1980	2	2	2	2	2	2	3	2	2	n/a	n/a
6/1982	3	2	2	2	2	2	1	2	2	n/a	n/a
1/1983	3	2	1	2	2	1	1	n/a	2	1	n/a
6/1984	3	2	2	2	1	n/a	1	1	2	3	2
5/1985	3	1	3	2	2	2	1	2	3	3	2
7/1986	2	1	3	2	3	1	1	2	2	2	2
8/1987	2	1	2	2	3	1	1	n/a	2	2	2
	Operations	Radiological Controls	Maintenance/Surveillance Testing		Emergency Preparedness	Security		Engineering and Technology		Safety Assessment and Quality Verification	
4/1989	2	2	3		2	1		2		2	

NOTE: A rating of 1 designated a superior level of performance where NRC attention may be reduced. A 2 rating designated a good level of performance with NRC attention at normal levels. A rating of 3 designated an acceptable level of performance where increased NRC attention may be appropriate.

Details

February 22, 1982: Operators manually scrammed the reactor, but two control rods failed to insert. Subsequent investigation determined that the control rod sticking or binding could have been caused by primary coolant system contamination and moisture intrusion.¹ The two control rods that failed to insert in this event also failed to insert during a subsequent event on June 23, 1984.²

March 27, 1984: Surveillance inspection of the pre-stressed concrete reactor vessel tendons identified several wire failures caused by corrosion from water intrusion.³

May 4, 1984: As operators withdrew control rods on the approach to initial criticality in Cycle 4, moisture sensors within the plant protective system detected high moisture levels in the primary coolant and automatically scrammed the reactor.⁴

June 23, 1984: The reactor automatically scrammed from 23 percent power due to high pressure in the reactor vessel. Operators noted that 6 of the 37 control rod pairs failed to insert. They manually scrammed the reactor, but the six control rod pairs again failed to insert. The operators pulled the fuses for the scram breakers, but the six control rod pairs still failed to insert. The operators re-installed the fuses and used the control rod drive motors to insert the control rods individually. All control rods were fully inserted about 20 minutes after the initial scram signal.

The control rod insertion problem was attributed to moisture that entered the primary coolant (helium) the previous day. On June 22, the reactor was operating at about 50 percent power when an in-plant electrical transient tripped the normal bearing water supply for the A and B helium circulators. After the backup bearing water supply went into service, the moisture indication for the primary coolant rose above 100 parts per million (ppm). Operators reduced power and took steps to lower the moisture level. The high moisture content of the primary coolant caused the helium purification system to ice up and contribute to the automatic scram on high pressure. Large moisture intrusion was accounted for in the Final Safety Analysis Report, but the long-term effects from small incursions were neither clearly understood nor appreciated and these had a much greater impact on plant operations.^{5,6}

October 16, 1984: The NRC issued a letter to PSC barring Fort St. Vrain's return to service "until all control rod drives have been inspected and refurbished" or until the utility takes steps to "provide reasonable assurance that the control rods will scram automatically on receipt of a scram signal." The NRC also required that PSC retain an independent consultant to assess the company's management. The NRC letter also reported that control room operators informed NRC inspectors that the instrumentation was so unreliable that they could not trust the indicated values.⁷

November 5, 1984: During a surveillance test of the reserve shutdown system, only half of the 80 pounds of reserve shutdown material (boronated graphite balls, or B₄C) was discharged from the hopper assembly.⁸ It was believed that water intrusion into the reserve shutdown system hoppers in 1975 leached a contaminate, boron trioxide (B₂O₃), from the B₄C in the hoppers that reacted with moisture to form boric acid crystals that "glued" the balls together and prevented them from discharging during the surveillance test. High levels of the contaminant were identified in 18 of the 37 hoppers in the reserve shutdown system.⁹

March 31, 1985: The deadline mandated by federal regulations (10 CFR 50.49) for upgrading electrical equipment to withstand the environmental conditions that would exist following an accident passed without PSC filing for an extension. Consequently, the NRC determined that PSC could not operate Fort St. Vrain above 15 percent power until it complied with this regulation.¹⁰

April 1985: PSC instituted the Performance Enhancement Program at Fort St. Vrain.¹¹

1986: The Colorado Public Utilities Commission ruled to take Fort St. Vrain out of the rate base. PSC was allowed to sell Fort St. Vrain's electrical output back into the power system as a non-regulated utility.¹²

April 11, 1986: Fort St. Vrain returned to service after its extended outage.¹³

July 7, 1986: The NRC issued a security violation to PSC after inspectors identified two uncontrolled access pathways from the owner-controlled area into protected and vital areas of the plant that had existed for at least six months.¹⁴

July 1989: Fort St. Vrain has its best operating month ever, averaging 73 percent capacity.¹⁵

August 18, 1989: The reactor was shut down due to a stuck control rod problem.¹⁶

August 29, 1989: PSC announced that Fort St. Vrain would not be restarted.¹⁷

Notes

- ¹ Nuclear Regulatory Commission (NRC). 2004. *Fort Saint Vrain gas cooled operational experience*. NUREG/CR-6839, January. Washington, DC.
- ² Myers, R. 1984. NRC clobbers Public Service of Colorado. *Energy Daily*, October 18.
- ³ Public Service Company of Colorado. 1984a. Licensee Event Report No. 50-267/84-005-02, October 30.
- ⁴ Public Service Company of Colorado. 1984b. Licensee Event Report No. 50-267/84-006-01, June 26.
- ⁵ NRC, 2004.
- ⁶ Public Service Company of Colorado, 1984a.
- ⁷ Myers, 1984.
- ⁸ Public Service Company of Colorado. 1984c. Licensee Event Report No. 50-267/84-012-00, December 5.
- ⁹ NRC, 2004.
- ¹⁰ Pitman, F., and M.L. Ryan. 1985. Operations overhauled as PSC tries to get Fort St. Vrain back on line. *Inside NRC*, August 19.
- ¹¹ General Accounting Office. 1987. *Nuclear safety: Reactor design, management, and emergency preparedness at Fort St. Vrain*. GAO/RCED-88-8, November. Washington, DC.
- ¹² Colorado Department of Regulatory Agencies. 1992. *1992 sunset review of the Colorado Public Utilities Commission*, June. Denver, CO.
- ¹³ *Nucleonics Week*. 1986. Fort St. Vrain began generating electricity this week, April 17.
- ¹⁴ NRC. 1987. *Report to Congress on Abnormal Occurrences*. NUREG-0090, Vol. 9, No. 3, April. Washington, DC.
- ¹⁵ American Nuclear Society. 1989. Late news in brief. *Nuclear News*, September.
- ¹⁶ NRC, 2004.
- ¹⁷ American Nuclear Society, 1989.