Browns Ferry Unit 3

Athens, AL

Owner: Tennessee Valley Authority

Reactor type: Boiling water reactor

Commercial operations began: March 1, 1977

Outage dates (duration): September 7, 1983 to November 28, 1984 (1.2 years)

Reactor age when outage began: 6.5 years

Fleet status: Third oldest of five reactors owned by the company

Synopsis

The Tennessee Valley Authority (TVA) shut down Unit 3 in September 1983 to comply with an NRC order to conduct inspections of recirculation system piping. The mandated inspections revealed extensive cracking that required piping sections to be replaced. The repairs were slowed by TVA's efforts to concurrently address programmatic problems affecting all three Browns Ferry units. In November 1984, the NRC agreed that TVA had addressed all items from its order and allowed Unit 3 to restart.

Process Changes

Browns Ferry Unit 3 was but one of several reactors experiencing year-plus outages in the 1985 to 1990 time frame. Fort St. Vrain, Browns Ferry Units 1 and 2, Davis-Besse, Sequoyah Units 1 and 2, Rancho Seco, Pilgrim, Peach Bottom Units 2 and 3, Nine Mile Point Unit 1, and Surry Unit 2 all had year-plus outages in this period. Changes, such as the adoption of the senior management meeting process by the NRC, resulted from the collective experience more than from any single outage.

Commentary

On August 26, 1983, the NRC issued an order requiring TVA to shut down Unit 3 no later than September 6, 1983. TVA shut down Unit 3 on September 7, 1983. This act of defiance typified the challenge the NRC faced in regulating TVA in the 1980s. After serious cracking was found in the recirculation system piping at Nine Mile Point Unit 1 in 1982 and confirmed at, of all places, Browns Ferry Unit 2, the NRC issued Bulletin 83-02 requiring owners of other potentially affected boiling water reactors to inspect their piping by December 31, 1983. TVA balked, claiming that Unit 3 was essentially invulnerable to the phenomenon. The NRC overcame TVA's resistance by pointing out that the recirculation system piping was the exact same material from the same fabricator as for Browns Ferry Unit 1, which had extensive cracking when inspected.

The NRC allowed TVA to restart Browns Ferry Unit 3 when the recirculation system piping was repaired despite knowledge that equally serious programmatic problems were not even patched. During the extended outage, the NRC as well as TVA's internal audit group reported that the quality assurance program at Browns

Ferry was inadequate. An adequate quality assurance program was required by Appendix B to Title 10 of the Code of Federal Regulations (10 CFR) Part 50. That the inadequate quality assurance program was more than a paperwork glitch was reflected in the numerous problems Unit 3 encountered after restart—virtually all of them involving inadequate identification and correction of root causes such that problems recurred. Just 101 days after Unit 3 restarted from this extended outage, TVA shut it down for what turned out to be an even longer extended outage.

The NRC should not have allowed TVA to restart Unit 3 from this extended outage until both the known recirculation system piping cracking *and* the known quality assurance program problems were corrected.

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
1/1981	2	3	2	2	2	2	2	2	3	n/a	n/a
11/1982	3	3	2	2	n/a	3	2	2	3	n/a	n/a
6/1983	3	3	3	2	2	2	3	1	3	2	n/a
6/1984	3	3	3	2	2	n/a	3	3	3	2	n/a
9/1985	3	2	3	3	2	3	3	n/a	3	3	2

	Operations	Radiological Controls	Maintenance/Surveillance Testing	Emergency Preparedness	Security	Engineering and Technology	Safety Assessment and Quality Verification
6/1990	2	1	3	2	2	2	3

	Operations	Maintenance	Engineering	Plant Support
8/1990	2	3	2	1/2/2
9/1992	1	2	2	1/1/2
11/1993	1	2	2	1
4/1995	2	2	2	1

NOTE: A rating of 1 designates 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

March 4, 1983: The NRC issued Bulletin 83-02 to TVA requiring the recirculation system piping on Unit 3 to be inspected in September 1983.[1]

July 21, 1983: The NRC requested TVA to show cause for why Unit 3 could be safely operated prior to completing the inspections of recirculation system piping for intragranular stress corrosion cracking as required by NRC Bulletin 83-02.[2]

August 4, 1983: TVA responded to the NRC's July 21 letter detailing its reasons for believing Unit 3 piping and welds had not experienced significant stress corrosion cracking.[3]

August 9, 1983: In a public meeting, TVA presented the NRC with (1) costs and consequences of accelerating the inspections, (2) scope and value of an augmented leakage monitoring system, (3) visual inspections for leakage during shutdown, and (4) plans for educating the control room operators about pipe cracks and response procedures. The NRC responded by pointing out that inspections already conducted on Browns Ferry Unit 1 revealed many cracks and the piping for Unit 3 came from the same fabricator.[4]

August 19, 1983: TVA committed to shutting down Unit 3 no later than September 6, 1983, for the piping inspections required by Bulletin 83-02.[5]

August 26, 1983: The NRC issued a Confirmatory Order requiring TVA to shut down Unit 3 by September 6, 1983, for piping inspections per Bulletin 83-02.[6]

September 7, 1983: TVA shut down Unit 3 to inspect piping and welds for cracks.[7]

January 23, 1984: TVA laid off 400 to 500 workers as part of its plan to slow the planned restart of Unit 3 until its efforts to improve management controls developed more fully.[8]

January 24, 1984: The Browns Ferry plant manager wrote to the TVA manager of power calling for substantive changes. He wrote:

> *"We all feel that some positive, immediate action is required in order to elevate Browns Ferry's regulatory performance to the level consistent with the division policy of complete compliance.… In the past, we have established management control consisting of paper programs that address all possible deficiencies and provide for reviews of that paper by higher level personnel. As deficiencies have been identified, we have provided for more review at higher levels. We have created such a perfect paper program for assuring compliance that it cannot be implemented by the workers."*[9]

February 24, 1984: The NRC conducted its 13th enforcement conference since January 1983 with TVA regarding violations at Browns Ferry. Between 1981 and 1984, NRC inspectors identified 652 violations at Browns Ferry and the agency imposed $413,000 in fines.[10]

May 4, 1984: TVA submitted its plans for improving performance at Browns Ferry to the NRC.[11]

June 1984: The NRC's SALP reported that TVA provided "lack of management attention to the identification of the root cause of problems" and had a "lack of an effective quality assurance program."[12]

July 13, 1984: The NRC issued Confirmatory Order EA 84-54 to TVA requiring it to implement the promised improvement steps and mandating progress reports be provided to the NRC.[13]

September 14, 1984: TVA submitted a revision to its Regulatory Performance Improvement Program (RPIP) to NRC. It was RPIP Revision 12.[14]

September 24, 1984: TVA released a report by its Nuclear Safety Review Staff (NSRS) that included results from a survey of engineers at Browns Ferry showing that they do not believe management is serious about a program to improve compliance with NRC regulations and believe that once the NRC is placated, management will revert to "the old way of doing business." The NSRS report additionally indicated that quality assurance department managers "believe plant management would allow quality and nuclear safety to deteriorate significantly in favor of production." And the NSRS reported that engineers believe the high pressure coolant injection (HPCI) system—a vital safety system—is so unreliable they are afraid to test it because it might break.[15]

October 9, 1984: The NRC sent a letter to TVA reporting that it had reviewed the quality assurance program document against the requirements of Appendix B to 10 CFR Part 50 and found it acceptable.[16]

October 22, 1984: During a shutdown margin test for the reactor core during startup, numerous and serious departures from operating procedures caused the unit to be shut down.[17]

October 25, 1984: The NRC issued a confirmatory action letter detailing actions the TVA committed to complete prior to restarting Unit 3 following the October 22 event.[18]

November 7, 1984: TVA met with the NRC in the agency's Region II offices to discuss corrective actions for the October 22 startup problems.[19]

November 16, 1984: The NRC sent TVA a letter concurring that Unit 3 is ready to restart.[20]

November 19, 1984: The reactor was restarted.[21]

November 20, 1984: Operators manually shut down the reactor from four percent power when the indicated water level inside the reactor vessel dropped below the setpoint for an automatic reactor scram, but the automatic safety feature did not engage. The operators had prepared to test the relief valve capability during the restart. When the reactor vessel water level dropped as reactor power level increased with the feedwater control system in manual, the operators attempted to start other condensate booster pumps to restore the water level, but the local control switches had been left in the "stop" position due to a procedure error.[22]

November 22, 1984: The reactor was restarted.[23]

November 23, 1984: Operators manually shut down the reactor after the flow control valve on the HPCI system was found to be broken.[24]

November 24, 1984: The reactor was restarted.[25]

November 28, 1984: The unit was connected to the electrical grid to end the extended outage.[26]

November 28, 1984: The generator was taken offline due to excessive turbine vibrations.[27]

November 29, 1984: The unit was connected to the electrical grid.[28]

November 29, 1984: The generator was taken offline again due to excessive turbine vibrations.[29]

November 30, 1984: Operators manually shut down the reactor to allow work to correct the vibrations.[30]

November 30, 1984: The reactor was restarted.[31]

December 1, 1984: The unit was connected to the electrical grid.[32]

December 9, 1984: Operators manually scrammed the reactor from 36 percent power after an in-plant electrical transient tripped a condensate pump and the backups could not be started from the control room because local switches had been left in the wrong positions.[33]

December 18, 1984: The reactor was restarted.[34]

December 19, 1984: The unit was connected to the electrical grid.[35]

February 13, 1985: During another reactor startup, three instruments monitoring the water level in the reactor vessel indicated significantly different levels. Rather than pausing to correct the disparate indications, the operators focused on increasing the power level even after the water level indications caused a half-scram. Similar disparate water level indications had also been experienced on November 20, 1984, but nothing had been done to correct the problem or even train operators on how to properly respond to it.[36]

February 27, 1985: The NRC proposed a $112,500 fine on TVA for violations stemming from the October 22, 1984, aborted startup.[37]

March 9, 1985: Operators manually shut down the reactor to allow reactor vessel water level instrumentation problems to be investigated.[38]

March 18, 1985: TVA ceased operations at all three Browns Ferry units to focus on making programmatic improvements.[39]

Notes

[1] Nuclear Regulatory Commission (NRC). 1983. Stress corrosion cracking in large-diameter stainless steel recirculation system piping at BWR plants, Bulletin No. 83-02. Washington, DC. March 4.

[2] Vassallo, D.B. 1983. IGSCC inspection order confirming shutdown. Letter to Hugh G. Parris, manager of power, Tennessee Valley Authority, August 26. Domenic B. Vassallo was chief, operating reactors branch #2 at the NRC.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Ibid.

[7] Browns Ferry Nuclear Plant. 1983. *Monthly operating report to NRC: September 1, 1983 – September 30, 1983*. Knoxville, TN: Tennessee Valley Authority.

[8] *New York Times*, 1984. TVA lays off hundreds over nuclear plant safety, January 24.

[9] General Accounting Office (GAO). 1996. *Nuclear regulation: Oversight of quality assurance at nuclear power plants needs improvement*, GAO/RCRD-96-41. Washington, DC. January.

[10] Ibid.

[11] Ibid.

[12] Ibid.

[13] Varga, S.A. 1991. Closure of confirmatory order EA 84-54 – Browns Ferry Nuclear Plant, units 1, 2 and 3. Letter to Dan A. Nauman, senior vice president, nuclear power, Tennessee Valley Authority, June 12. Steven A. Varga was director, reactor projects at the NRC.

[14] O'Reilly, J.P. 1984. Regulatory performance improvement program (RPIP) for Browns Ferry. Letter to Hugh G. Parris, manager of power and engineering, Tennessee Valley Authority, October 9. James P. O'Reilly was regional administrator at the NRC.

[15] Gentry, P. 1984. Browns Ferry safety system said unreliable. *Decatur Daily*, September 25.

[16] Lewis, R.C. 1984. TVA quality assurance program. Letter to Hugh G. Parris, manager of power, Tennessee Valley Authority, October 12. Richard C. Lewis was director, reactor projects at the NRC.

[17] O'Reilly, J.P. 1984. Confirmation of action – Browns Ferry Unit Nos. 50-259, 50-260 and 50-296. Letter to Hugh G. Parris, manager of power, Tennessee Valley Authority, October 25. James P. O'Reilly was regional administrator at the NRC.

[18] Ibid.

[19] *Nucleonics Week*. 1984. "Browns Ferry-3 Startup Delayed While NRC Reviews TVA Procedures," November 15.

[20] O'Reilly, J.P. 1984. Confirmation of concurrence – Browns Ferry Unit 1, 2 and 3 docket nos. 50-259, 50-260 and 50-296. Letter to Hugh G. Parris, manager of power, Tennessee Valley Authority, November 16. James P. O'Reilly was regional administrator at the NRC.

[21] Browns Ferry Nuclear Plant. 1984a. *Monthly Operating Report to NRC: November 1, 1984 – November 30, 1984*. Knoxville, TN: Tennessee Valley Authority.

[22] Jones, G.T. 1984. Tennessee Valley – Browns Ferry Nuclear Plant (BFN) Unit 3 – docket no. 50-296 – facility operating license DPR-68 – reportable occurrence report BFRO-50-296/84012. Letter to the NRC, December 20. George T. Jones was plant manager at Browns Ferry Nuclear Plant.
[23] Browns Ferry Nuclear Plant, 1984a.
[24] Ibid.
[25] Ibid.
[26] Ibid.
[27] Ibid.
[28] Ibid.
[29] Ibid.
[30] Ibid.
[31] Ibid.
[32] Browns Ferry Nuclear Plant, 1984b. *Monthly Operating Report to NRC: December 1, 1984 – December 31, 1984*. Knoxville, TN: Tennessee Valley Authority.
[33] Ibid.
[34] Ibid.
[35] Ibid.
[36] NRC. 1986. Report to Congress on abnormal occurrences, NUREG-0090, Vol. 8, No. 3. Washington, DC. February.
[37] Ibid.
[38] Hudgins, C. 1985. TVA shuts Browns Ferry to get control of operations and modifications. *Nucleonics Week,* April 4, 26(14): 1.
[39] GAO. 1987. *Nuclear regulation: efforts to ensure nuclear power plant safety can be strengthened*, GAO/RCED-87-141. Washington, DC. August.