

# BROWNS FERRY UNIT 1

---

*Athens, AL*

**Owner:** Tennessee Valley Authority

**Outage dates (duration):** March 19, 1985 to present (more than 20 years)

**Reactor type:** Boiling water reactor

**Reactor age when outage began:** 10.6 years

**Commercial operations began:** August 1, 1974

**Fleet status:** Oldest of five reactors owned by the company

---

## Synopsis

The Tennessee Valley Authority (TVA) shut down Unit 1 after several containment isolation valves failed leak rate tests. On the same day, TVA announced it was suspending operation of all three units at Browns Ferry pending resolution of broad programmatic problems affecting the site. Subsequently, TVA's other two operating reactors, Sequoyah Units 1 and 2, were also shut down while programmatic problems were remedied. In June 1985, TVA announced that it was placing Browns Ferry Unit 1 on "administrative hold" to focus resources on restarting Browns Ferry Units 2 and 3 and the two Sequoyah units. In May 2002, TVA's board of directors voted to take Unit 1 off administrative hold and restart it at a projected cost of nearly \$2 billion (\$2.21 billion in 2006 dollars).

## Process Changes

Browns Ferry Unit 1 was but one of several reactors experiencing year-plus outages in the 1985 to 1990 time frame. Fort St. Vrain, Browns Ferry Units 2 and 3, 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

Browns Ferry Unit 1 defies logical explanation. It started up in August 1974 and operated for less than a year before shutting down for longer than a year to fix damage caused by the March 1975 fire. It restarted in September 1976 and operated for less than a decade before shutting down in March 1985 for an outage lasting longer than two decades.

## 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 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

*May 4, 1984:* TVA submitted its plans for improving performance at Browns Ferry to the NRC.<sup>1</sup>

*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."<sup>2</sup>

*July 13, 1984:* The NRC issued Confirmatory Order EA 84-54 requiring TVA to implement the promised improvement steps and mandating progress reports be provided to the NRC.<sup>3</sup>

*August 14, 1984:* Sections of the core spray system piping were overpressurized during a surveillance test conducted at 100 percent power. An improperly rebuilt solenoid valve, along with an operator error and a poorly written procedure, caused the injection valve to open and high-pressure reactor water to backflow into the system piping.<sup>4</sup> The operator conducting the test did not realize what had happened. The problem was identified when a worker reported smoke in the reactor building. The fire brigade responded and determined the smoke to be coming from paint on the core spray system piping overheating when the high-pressure, high-temperature reactor water backflowed through it.<sup>5</sup>

*August 21, 1984:* TVA shut down Unit 1 to repair the core spray system piping damaged the prior week.<sup>6</sup>

*September 14, 1984:* TVA submitted a revision to its Regulatory Performance Improvement Program (RPIP) to the NRC. It was RPIP Revision 12.<sup>7</sup>

*September 24, 1984:* TVA released a report by its Nuclear Safety Review Staff 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 system—a vital safety system—is so unreliable, they are afraid to test it because it might break.<sup>8</sup>

*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 Title 10 of the Code of Federal Regulations (CFR) Part 50 and found it acceptable.<sup>9</sup>

*March 19, 1985:* TVA ceased operations at all three Browns Ferry units to focus on making programmatic improvements.<sup>10</sup> TVA shut down Unit 1 after several valves failed individual leak rate tests. It was later determined that many of these failures were caused by the motor-operated valves being reassembled with the gears installed backward.

*September 17, 1985:* The NRC’s executive director for operations sent TVA a letter stating that the RPIP had been ineffective and required TVA to develop and submit another plan for improving conditions at its nuclear plants.<sup>11</sup>

*September 24, 1985:* TVA declared all eight emergency diesel generators at Browns Ferry inoperable for two separate reasons. First, the emergency diesel generators had been in service for up to 13 years, but TVA had not performed maintenance inspections at 3, 6, and 12 years as recommended by the manufacturer. Second, the racks holding the batteries that enable the emergency diesel generators to start in event of a loss of offsite power had not been designed to survive earthquakes, even the modest earthquakes occurring in that portion of the country. The NRC resident inspector had identified the failure to properly maintain the emergency diesel generators and the NRC issued a violation on July 16, 1984. TVA promised the NRC at the time to correct the situation by October 5, 1984, but failed to do so.<sup>12</sup>

*November 1, 1985:* TVA responded to the NRC’s 50.54(f) letter of September 17 with its plan to improve performance at Browns Ferry.<sup>13</sup>

*November 7, 1985:* TVA transmitted a design control study performed by Gilbert Commonwealth along with detailed actions to be taken by TVA to rectify the identified problems.<sup>14</sup>

*November 1985:* Unsatisfactory performance by Browns Ferry operators on NRC-administered re-qualification examinations prompted TVA to retrain its operating staff.<sup>15</sup>

*January 7, 1986:* The NRC staff briefed its commissioners on major issues requiring resolution prior to restarting the Browns Ferry units.<sup>16</sup>

*January 9, 1986:* TVA briefed the NRC commissioners on its plans to address the major issues requiring resolution prior to restarting its nuclear reactor units and noted the appointment of Steven White as the new manager of nuclear power.<sup>17</sup>

*January 17, 1986:* The TVA Nuclear Safety Review Staff was renamed the Nuclear Manager’s Review Group and transferred from reporting directly to the TVA board of directors to the TVA manager of nuclear power.<sup>18</sup>

*February 7, 1986:* The NRC staff briefed its commissioners on major issues requiring resolution prior to restarting the Browns Ferry units.<sup>19</sup>

*February 12, 1986:* A consultant was hired to recommend the future mission for the Nuclear Manager's Review Group.<sup>20</sup>

*March 10, 1986:* TVA submitted a revised response to the NRC's September 17, 1985, 50.54(f) letter regarding its performance improvement plans.<sup>21</sup>

*March 11, 1986:* The NRC staff briefed its commissioners on major issues requiring resolution prior to restarting the Browns Ferry units.<sup>22</sup>

*March 27, 1986:* The consultant examining the Nuclear Manager's Review Group reported that the group felt neither TVA's senior management nor line organizations at the nuclear power plant sites had properly responded to past findings and recommendations.<sup>23</sup>

*June 2, 1986:* The General Accounting Office (GAO) concluded that TVA's employment arrangement with Steven White "constitute an improper use of a personal services contract and represented a circumvention of the statutory ceiling on salary payments to TVA employees." White took a leave of absence pending resolution of unrelated conflict-of-interest issues raised by the United States Office of Government Ethics.<sup>24</sup>

*July 17, 1986:* TVA submitted Revision 2 to its corporate nuclear performance plan to the NRC.<sup>25</sup>

*September 1986:* TVA suspended essentially all plant modification activities pending a completion of walk-downs and related efforts to verify that design drawings reflect the as-built plant configuration.<sup>26</sup>

*September 8, 1986:* The NRC proposed a \$150,000 fine for three violations: (1) cable tray support design problems, (2) cable tray overfilling problems, and (3) cable environmental qualification problems. TVA did not contest the fine.<sup>27</sup>

*August 12, 1986:* The NRC's Advisory Committee on Reactor Safeguards wrote to the commissioners with its agreement on TVA's diagnosis of management problems.<sup>28</sup>

*December 16, 1986:* NRC staff and TVA officials briefed the NRC commissioners on recovery efforts. NRC Regional Administrator J. Nelson Grace reported the results from a recent survey of TVA's nuclear power plant workers that "up to 75% lacked confidence in TVA management." The NRC staff outlined preliminary results from its own lessons learned. Among the lessons were the need to improve identification of poor performance, the need to involve utility management early in solving problems, and the need to improve long-term monitoring of utility corrective action programs.<sup>29</sup>

*March 1987:* After being unable to use results from pipe hanger support analyses performed by Stone & Webster Engineering Corporation (SWEC) under a 30-month, \$63.4 million contract because SWEC used unacceptable criteria, TVA awarded a 30-month, \$94.9 million contract to Bechtel to re-analyze the piping supports. The TVA manager responsible for the pipe hanger support effort left SWEC to join TVA two months before TVA awarded the contract to SWEC.<sup>30</sup>

*May 1987:* The TVA Inspector General (IG) released a report on its review of 100 employees in the TVA nuclear program "in key positions that could significantly affect nuclear power plant safety or efficiency." The IG concluded that 28 of the 100 did not satisfy the requirements needed for the positions and that "four provided false information regarding their qualifications."<sup>31</sup>

*August 1987:* The GAO reported to Congress:

*“GAO notes that while NRC has shut five operating plants over the past 25 years, its decisions to close these plants or allow continued operations look inconsistent because it did not take the same action for other plants with similar problems.”*<sup>32</sup>

*May 9, 1988:* The NRC requested that TVA provide it with a list of deviations from the National Fire Protection Association (NFPA) code at Browns Ferry.<sup>33</sup>

*August 3, 1988:* TVA informed the NRC that “The [fire protection] system does not fully comply with the requirements of NFPA 13, 1975 Edition, which is the code of record, or with the 1985 edition of the code, which was the basis for the evaluation.” TVA committed to making additional modifications to meet the “critical” requirements of NFPA 13.<sup>34</sup>

*May 4, 1989:* The GAO reported that the NRC had conducted five SALPs at Browns Ferry between 1980 and 1986 and issued one Category 1 rating, 21 Category 2 ratings, and 24 Category 3 ratings—far worse ratings than issued to other Boiling Water Reactors (BWRs) over the same period. Peach Bottom, which the NRC ordered shut down in March 1987, had seven SALPs over this same period and got 11 Category 1 ratings, 40 Category 2 ratings, and 13 Category 3 ratings. The ratings for BWRs during this period are as follows:<sup>35</sup>

Plant	SALP 1	SALP 2	SALP 3	SALP Average
Vermont Yankee	67.4%	32.6%	0.0%	1.3
Monticello	50.9%	45.6%	3.5%	1.5
Cooper	42.4%	52.5%	5.1%	1.6
Quad Cities	36.2%	55.3%	8.5%	1.7
FitzPatrick	21.8%	65.5%	12.7%	1.9
Dresden	23.3%	58.3%	18.3%	2.0
Hatch	12.7%	78.2%	9.1%	2.0
Peach Bottom	17.2%	62.5%	20.3%	2.0
Pilgrim	23.1%	50.0%	28.9%	2.0
Brunswick	14.9%	57.4%	27.7%	2.1
Browns Ferry	2.2%	45.7%	52.2%	2.5

*September 18, 1990:* TVA informed the NRC that all actions on its RPIP had been completed and asked the NRC to close Confirmatory Order EA 84-54.<sup>36</sup>

*January 8, 1991:* The NRC issued an inspection report documenting its determination that TVA had completed all actions on its RPIP.<sup>37</sup>

*May 2002:* The TVA Board voted to restart Unit 1 at an estimated cost of \$1.7 to \$1.8 billion<sup>38</sup> (\$1.88 to \$1.99 billion in 2006 dollars ).<sup>39</sup>

## Notes

<sup>1</sup> General Accounting Office (GAO). 1996. *Nuclear regulation: Oversight of quality assurance at nuclear power plants needs improvement*, GAO/RCRD-96-41. Washington, DC. January.

<sup>2</sup> Ibid.

<sup>3</sup> 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 Nuclear Regulatory Commission.

<sup>4</sup> NRC. 1986a. *Report to Congress on abnormal occurrences*, NUREG-0090, Vol. 8, No. 3. Washington, DC. February.

<sup>5</sup> NRC. 1985. Report to Congress on abnormal occurrences, NUREG-0090, Vol. 7, No. 3. Washington, DC. April.

<sup>6</sup> Ibid.

<sup>7</sup> O'Reilly, J.P. 1984. Regulatory performance improvement program (RPIP) for Browns Ferry. Letter to H.G. Parris, manager of power and engineering, Tennessee Valley Authority, October 9. James P. O'Reilly was regional administrator at the Nuclear Regulatory Commission.

<sup>8</sup> Gentry, Phillip. 1984. Browns Ferry safety system said unreliable. *Decatur Daily*. September 25.

<sup>9</sup> Lewis, R.C. 1984. TVA quality assurance program. Letter to H.G. Parris, manager of power, Tennessee Valley Authority, October 12. Richard C. Lewis was director, reactor projects at the Nuclear Regulatory Commission.

<sup>10</sup> GAO. 1987. *Nuclear regulation: efforts to ensure nuclear power plant safety can be strengthened*, GAO/RCED-87-141. Washington, DC. August.

<sup>11</sup> Varga, 1991.

<sup>12</sup> NRC, 1986a.

<sup>13</sup> Youngblood, B.L. 1986. TVA's November 1, 1985, response to September 17, 1985 10 CFR 50.54(f) letter. Letter to Steven A. White, manager of nuclear power, Tennessee Valley Authority. January 15. B.L. Youngblood was director, PWR projects directorate #4 at the Nuclear Regulatory Commission.

<sup>14</sup> Ibid.

<sup>15</sup> NRC. 1987. *Report to Congress on abnormal occurrences*, NUREG-0090, Vol. 9, No. 2. Washington, DC. January.

<sup>16</sup> NRC. 1986b. *Report to Congress on abnormal occurrences*, NUREG-0090, Vol. 9, No. 1. Washington, DC. September.

<sup>17</sup> Ibid.

<sup>18</sup> GAO. 1986. *TVA nuclear power: Management of the nuclear program through personal services contracts*, GAO/RCED/87-43BR. Washington, DC. October.

<sup>19</sup> NRC, 1986b.

<sup>20</sup> GAO, 1986.

<sup>21</sup> NRC, 1986b.

<sup>22</sup> Ibid.

<sup>23</sup> GAO, 1986.

<sup>24</sup> Ibid.

- <sup>25</sup> NRC. 1987. *Report to Congress on abnormal occurrences*, NUREG-0090, Vol. 9, No. 3. Washington, DC. April.
- <sup>26</sup> Ibid.
- <sup>27</sup> Ibid.
- <sup>28</sup> Ibid.
- <sup>29</sup> Wagner, M.L. 1986. Denton says jury is still out on TVA's ability to solve problems. *Inside NRC*. December 22.
- <sup>30</sup> Lindeman, E. 1989. With millions of dollars spent, TVA must rework pipe analysis. *Nucleonics Week*. June 8.
- <sup>31</sup> Ibid.
- <sup>32</sup> GAO, 1987.
- <sup>33</sup> Gridley, R. 1988. Letter to the Nuclear Regulatory Commission, August 3. R. Gridley was director, nuclear licensing and regulatory affairs at the Tennessee Valley Authority.
- <sup>34</sup> Ibid.
- <sup>35</sup> GAO. 1989. *Nuclear regulation: NRC's restart actions appear reasonable – but criteria needed*, GAO/RCED-89-95. Washington, DC. May.
- <sup>36</sup> Varga, 1991.
- <sup>37</sup> Ibid.
- <sup>38</sup> Platts. 2002. *Nuclear News Flashes*, September 10.
- <sup>39</sup> Bureau of Labor Statistics. 2006. Inflation calculator. Washington, DC: U.S. Department of Labor. Online at <http://data.bls.gov/cgi-bin/cpicalc.pl>.