

# PILGRIM

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## *Plymouth, MA*

**Owner:** Boston Edison

**Outage dates (duration):** April 11, 1986 to June 15, 1989 (3.2 years)

**Reactor type:** Boiling water reactor

**Reactor age when outage began:** 13.4 years

**Commercial operations began:** December 1, 1972

**Fleet status:** Only reactor owned by the company

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### Synopsis

A series of forced outages caused by recurring equipment problems revealed declining performance trends. The NRC dispatched a Diagnostic Special Inspection team in spring 1986, and two weeks after the inspection team's report was issued in April 1986, Pilgrim experienced two more forced outages. The NRC issued a Confirmatory Action Letter requiring Boston Edison to identify and fix the root causes of the recurring problems. In late May, Boston Edison estimated the repairs would take another six weeks, but by July, the company realized this estimate had been optimistic and transitioned into an early refueling outage. In August, the NRC updated its Confirmatory Action Letter to also require Boston Edison to resolve systemic problems prior to restart. Nearly a year later, the NRC formed a Restart Assessment Panel and issued its restart plan for Pilgrim.

The NRC approved Pilgrim's restart on December 30, 1988. Operators took the reactor critical that same day, but shut it back down when instrumentation monitoring the core was found to be inoperable. Operators restarted the reactor on January 2, 1989, but shut it down after workers found the drywell vacuum breakers to be inoperable. Operators restarted the reactor on January 27, but shut it down that same day because of a leak in the instrument air system. Operators restarted the reactor on February 10, but shut it down after the main transformer failed. The unit was finally connected to the grid on June 15, 1989, following replacement of the failed transformer and ending the extended outage.

### Process Changes

None.

### Commentary

If not exactly confirming the axiom "timing is everything," this outage certainly showed that timing is a whole lot. On April 2, 1986, the NRC issued a report by its Diagnostic Special Inspection team sent in to assess the causes of declining performance trends. Within two days, Pilgrim experienced an automatic reactor scram that embodied all of the findings in the NRC's report. When Boston Edison restarted Pilgrim two days later, it experienced another automatic reactor scram. This time the NRC issued a Confirmatory Action Letter requiring Boston Edison to correct a list of problems before restarting Pilgrim again.

Why did it take two automatic scrams for the NRC to act? Wasn't the evidence gathered by the Diagnostic Special Inspection sufficient? Were the team's findings truly lacking two more pieces of evidence for the NRC to take action?

This outage is one of many exposing an illogical aspect of the NRC's oversight regime: a body of evidence insufficient to require the shutdown of an operating reactor is apparently sufficient to prevent the same reactor from being restarted. That makes no sense. It is imprudent and irresponsible to make a reactor's operational status the primary factor in determining whether the reactor can be safely operated.

Pilgrim's exit from this extended outage was equally troubling. After the NRC allowed Pilgrim to restart, an inquiry by the agency's Office of the Inspector General determined that the NRC staff's evaluation of emergency planning issues at Pilgrim "was neither balanced nor thorough" and that the staff had provided inaccurate information on the subject to the commissioners. When Congress inquired how the agency had handled the staffers guilty of providing inaccurate information, the NRC's executive director for operations replied, "We called them in for a good talking to." UCS wonders if anyone was listening.

The restart was actually a series of restarts that began on December 30, 1988. It took several more shut-downs and five and a half months before Pilgrim was reconnected to the electrical grid.

### 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 |
|---------|------------|-----------------------|----------------------------------|----------------------|------------------------|-----------------|----------|----------------------------|-------------------|--|----------|
| 04/1981 | 2          | 3                     | 2                                | 2                    | 3                      | 2               | 2        | 3                          | 3                 | n/a  | n/a      |
| 10/1981 | 3          | 2                     | 3                                | 2                    | 1                      | 2               | 2        | 2                          | 3                 | n/a  | n/a      |
| 11/1982 | 3          | 2                     | 2                                | 2                    | 1                      | 3               | 2        | 2                          | n/a               | 2  | n/a      |
| 01/1984 | 2          | 2                     | 2                                | 1                    | 1                      | 1               | 2        | n/a                        | n/a               | 1  | n/a      |
| 12/1984 | 2          | 3                     | 1                                | 1                    | 3                      | 2               | 2        | 1                          | n/a               | 1  | n/a      |
| 02/1986 | 3          | 3                     | 2                                | 2                    | 3                      | n/a             | 2        | 1                          | n/a               | 1  | n/a      |
| 06/1987 | 2          | 3                     | 2                                | 3                    | 2                      | 3               | 3        | 1                          | 3                 | 2  | 2        |
| 12/1988 | 2          | 3                     | 2                                | 2                    | 2                      | 2               | 2        | n/a                        | 2                 | 2  | 2        |
|         | Operations | Radiological Controls | Maintenance/Surveillance Testing |                      | Emergency Preparedness |                 | Security | Engineering and Technology |                   | Safety Assessment and Quality Verification |          |
| 12/1989 | 2          | 2                     | 2                                |                      | 2                      |                 | 1        | 1                          |                   | 2  |          |
| 11/1990 | 2          | 1                     | 2                                |                      | 2                      |                 | 1        | 1                          |                   | 2  |          |
| 01/1992 | 2          | 1                     | 2                                |                      | 1                      |                 | 1        | 2                          |                   | 2  |          |
| 08/1993 | 1          | 1                     | 2                                |                      | 1                      |                 | 1        | 2                          |                   | 2  |          |
|         | Operations |                       | Maintenance                      |                      | Engineering            |                 |          | Plant Support              |                   |  |          |
| 11/1994 | 1          |                       | 2                                |                      | 1                      |                 |          | 1                          |                   |  |          |
| 05/1996 | 2          |                       | 2                                |                      | 1                      |                 |          | 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

*December 17, 1973:* The Atomic Energy Commission ordered Pilgrim to be shut down until fuel channel box damage could be repaired and the cause of that damage corrected.<sup>1</sup>

*December 1980:* The NRC expended 1,950 hours of inspection effort at Pilgrim between January and December 1980.<sup>2</sup>

*August 1981:* The NRC expended 2,328 hours of inspection effort at Pilgrim between September 1980 and August 1981.<sup>3</sup>

*June 1982:* The NRC expended 3,735 hours of inspection effort at Pilgrim between September 1981 and June 1982.<sup>4</sup>

*June 1983:* The NRC expended 3,234 hours of inspection effort at Pilgrim between July 1982 and June 1983.<sup>5</sup>

*September 1984:* The NRC expended 4,960 hours of inspection effort at Pilgrim between July 1983 and September 1984.<sup>6</sup>

*October 1985:* The NRC expended 3,792 hours of inspection effort at Pilgrim between October 1984 and October 1985.<sup>7</sup>

*November 1985:* An NRC safety system functional inspection determined that Boston Edison had not effectively corrected a water hammer problem that existed on the high-pressure coolant injection system turbine exhaust piping dating back to the original construction of the plant.<sup>8</sup>

*January 3, 1986:* The reactor was manually shut down due to high vibration of a main turbine generator bearing.<sup>9</sup>

*January 6, 1986:* The reactor was restarted, ending the forced outage to repair a main turbine generator bearing.<sup>10</sup>

*January 6, 1986:* The reactor automatically scrammed from 10 percent power during startup when the operators did not pay sufficient attention to water levels with the feedwater system in manual control.<sup>11</sup>

*January 16, 1986:* The reactor automatically scrammed from 100 percent power when technicians bumped a reactor pressure switch during maintenance.<sup>12</sup>

*January 29, 1986:* The reactor power had to be reduced from 100 percent power to 10 percent so the main turbine generator could be taken offline to repair high vibration on a bearing.<sup>13</sup>

*March 7, 1986:* The reactor was manually shut down when a weld leak in the four-inch-diameter reactor head spray pipe caused excessive leakage into the containment building.<sup>14</sup>

*March 12, 1986:* The reactor was restarted, ending the forced outage to repair a leaking weld on the reactor head spray pipe.<sup>15</sup>

*March 15, 1986:* The reactor was manually shut down when a weld leak in the reactor water level instrument piping caused excessive leakage into the containment building.<sup>16</sup>

*March 31, 1986:* The reactor was restarted, ending the forced outage to repair a leaking weld on the reactor water level instrumentation line.<sup>17</sup>

*April 2, 1986:* The NRC issued a report on the 961-hour Diagnostic Special Inspection conducted at Pilgrim between February 18 and March 7. The primary problems identified by the team were:

1. Incomplete staffing, particularly of operators and mid-level supervisors. (At this time, Pilgrim had eight licensed control room operators routinely working 60-hour weeks.<sup>18</sup>)
2. A prevailing view within Boston Edison that improvements made to date had corrected the problems.
3. Reluctance by Boston Edison management to acknowledge some problems identified by the NRC.
4. Dependence by Boston Edison on third parties to identify problems rather than implementing an effective self-assessment program.<sup>19</sup>

*April 4, 1986:* Operators began manually shutting down the reactor after discovering oil leaking from a pipe in the main turbine hydraulic control system. Before they could shut the reactor down, an equipment failure caused the main steam isolation valves to close, which in turn caused an automatic scram of the reactor. After the reactor was shut down, an operator error caused high water level in the scram discharge volume, which produced another automatic scram signal for the reactor.<sup>20</sup> The main steam isolation valves could not be re-opened, so operators controlled reactor pressure using the high-pressure injection system.<sup>21</sup>

*April 9, 1986:* The reactor was restarted, ending the forced outage to repair an oil leak in the turbine hydraulic control system.<sup>22</sup>

*April 11, 1986:* Operators began manually shutting down the reactor after discovering excessive leakage of reactor water past the residual heat removal (RHR) injection valves. Before they could shut the reactor down, an equipment failure caused the main steam isolation valves to close, which in turn caused an automatic scram of the reactor. Operators later had difficulty re-opening the outboard main steam isolation valves to re-establish the normal heat sink for the reactor.<sup>23</sup>

*April 12, 1986:* The NRC issued a Confirmatory Action Letter to Boston Edison requiring Pilgrim to remain shut down until the agency was satisfied that the equipment problems causing the spurious main steam isolation valve closures on April 4 and 11 and the RHR injection valve leakage on April 11 had been identified and corrected.<sup>24</sup>

*April 12, 1986:* The NRC dispatched an Augmented Inspection Team (AIT) to Pilgrim. The AIT remained onsite until April 25.<sup>25</sup>

*May 19, 1986:* The NRC met with Boston Edison to discuss the AIT report on the April 4 and 11 scrams, which concluded that Boston Edison had not satisfactorily resolved the root causes for the valve failures and had not proposed a comprehensive corrective action plan.<sup>26</sup>

*May 27, 1986:* Boston Edison President and Chief Executive Officer Stephen Sweeney conducted a press conference in which he announced that Pilgrim would remain shut down at least another six weeks as the company dealt with issues identified in the NRC's AIT report.<sup>27</sup>

*July 16, 1986:* Boston Edison President Sweeney testified before the U.S. House Energy and Commerce Committee that Pilgrim would be ready for restart by late August. NRC Chairman Lando Zech testified, "We will be completely satisfied in all respects before we allow a restart."<sup>28</sup>

*July 25, 1986:* Boston Edison decided to transition into the seventh refueling outage at Pilgrim. The company announced that its decision to undertake repairs to the Mark I containment building and complete the 10 CFR 50 Appendix R fire protection modifications during the current outage were key factors.<sup>29,30</sup>

*August 25, 1986:* The NRC informed Massachusetts Senator Edward Kennedy that the agency had conducted more than 190 inspections totaling more than 16,000 inspection hours at Pilgrim since January 1982—approximately 50 percent more inspection hours than it had expended at similar nuclear plants in the Northeast. The NRC also informed the senator that the agency had permanently assigned a third resident inspector to Pilgrim.<sup>31</sup>

*August 27, 1986:* The NRC revised its April 12 Confirmatory Action Letter, requiring that Boston Edison also resolve systemic problems.<sup>32</sup>

*November 19, 1986:* A winter storm disabled both of Pilgrim's offsite power transmission lines, causing a loss of offsite power. One of two reactor shutdown cooling loops was already out of service and the second was disabled by the loss of offsite power. It took operators about an hour to restart the shutdown cooling loop using onsite emergency power sources.<sup>33</sup>

*November 24, 1986:* The NRC met with Boston Edison about improvement activities at Pilgrim, saying the agency was "looking for strong evidence of progress at Pilgrim prior to restart."<sup>34</sup>

*January 1987:* The NRC expended 6,762 hours of inspection effort at Pilgrim between November 1985 and January 1987.<sup>35</sup>

*February 2, 1987:* The NRC met with Boston Edison to discuss improvement programs at Pilgrim.<sup>36</sup>

*February 3, 1987:* The NRC met with the state's secretary of energy and other officials to discuss the situation at Pilgrim.<sup>37</sup>

*March 2, 1987:* Following a ruling by the Massachusetts Department of Public Utilities that denied Boston Edison a rate increase, an independent three-member team hired by the utility to evaluate its management concluded that the company had an excessively adversarial stance towards its state and federal regulators. The panel stated, "A pattern of recalcitrant policies at Boston Edison sapped [regulators'] patience and undermined trust" and that Boston Edison viewed "regulation as a necessary but unpleasant evil... rather than as a legitimate precondition of public utility enterprise."<sup>38</sup>

*March 9, 1987:* The NRC regional administrator testified before the Massachusetts Joint Committee on the Investigation and Study of the Pilgrim Station.<sup>39</sup>

*March 10, 1987:* NRC Chairman Zech and the NRC regional administrator toured Pilgrim and listened to a presentation by Boston Edison.<sup>40</sup>

*April 27, 1987:* The NRC regional administrator again testified before the Massachusetts Joint Committee on the Investigation and Study of the Pilgrim Station.<sup>41</sup>

*May 1, 1987:* The NRC met with Boston Edison to discuss a violation identified in the technical specification surveillance program.<sup>42</sup>

*May 7, 1987:* The NRC conducted its 1987 Systematic Assessment of Licensee Performance (SALP) meeting in Plymouth, MA.<sup>43</sup>

*May 22, 1987:* NRC Commissioner Kenneth Carr toured Pilgrim.<sup>44</sup>

*July 8, 1987:* NRC Regional Administrator Thomas Murley formed a special Restart Assessment Panel to manage Pilgrim oversight activities.<sup>45</sup>

*July 8, 1987:* Boston Edison submitted to the NRC its Safety Enhancement Program to improve conditions at Pilgrim. Among other things, Boston Edison committed to containment upgrades and installing a diesel generator to mitigate station blackouts.<sup>46</sup>

*July 30, 1987:* The NRC issued Revision 0 of its restart plan for Pilgrim.<sup>47</sup>

*August 6, 1987:* The Federal Emergency Management Agency issued a report identifying numerous problems with Pilgrim's offsite emergency planning programs.<sup>48</sup>

*September 24, 1987:* Boston Edison officials told the NRC they were ready to reload fuel at Pilgrim and would be ready to ask for permission to restart the reactor in two weeks.<sup>49</sup> NRC Regional Administrator Murley termed that schedule "overly optimistic" and said the NRC was "very skeptical."<sup>50</sup>

*October 14, 1987:* Workers completed reloading the reactor core.<sup>51</sup>

*October 24, 1987:* NRC Commissioner James Asselstine toured Pilgrim.<sup>52</sup>

*October 26, 1987:* The NRC issued Revision 1 of its restart plan for Pilgrim.<sup>53</sup>

*November 9, 1987:* Boston Edison Senior Vice President–Nuclear Paul Bird suspended all non-essential work at Pilgrim after six workers were exposed to high levels of radiation during a series of spills of radioactively contaminated water inside the plant.<sup>54</sup>

*November 12, 1987:* A winter storm disabled both of Pilgrim's offsite power transmission lines, causing a loss of offsite power. Both of the emergency diesel generators (EDGs) automatically started, but the B generator failed about nine hours later due to a fault on its output current transformer. The NRC dispatched an AIT to Pilgrim to investigate this problem and four other recent EDG problems: fires involving the A generator during test runs on June 29 and 30 and spurious actuation of the fire suppression system for the B generator on July 2 and September 17.<sup>55</sup>

*January 7, 1988:* The director of the NRC's Office of Nuclear Reactor Regulation and the agency's Region I administrator testified before the U.S. Senate Labor and Human Resources Committee about Pilgrim.<sup>56</sup>

*January 22, 1988:* Standard & Poor's Corporation downgraded its rating on \$830 million of Boston Edison bonds, citing uncertainty about Pilgrim's restart and whether the company would be fully able to recover the costs of replacement power. Moody's downgraded its rating on \$930 million of the company's bonds for similar reasons. A Boston Edison spokesperson said Pilgrim would be ready to restart in February.<sup>57</sup>

*February 11, 1988:* Workers reported an "unusual event" in the form of a fire lasting longer than 10 minutes. Heavy smoke prevented the fire brigade from extinguishing the fire immediately.<sup>58</sup>

*February 18, 1988:* The NRC conducted a public meeting in Plymouth, MA, to solicit comments on Boston Edison's restart plan.<sup>59</sup>

*February 24, 1988:* The NRC met with Boston Edison to discuss restart readiness in terms of the company's self-assessment plans.<sup>60</sup>

*March 10, 1988:* The director of the NRC's Office of Nuclear Reactor Regulation and the agency's Region I administrator toured Pilgrim and interviewed plant staff about the design basis for the direct torus vent modification.<sup>61</sup>

*April 8, 1988:* The NRC met with Boston Edison to discuss the company's planned power ascension testing program.<sup>62</sup>

*April 8, 1988:* The *Boston Globe* reported that Boston Edison spent \$205 million on operations and maintenance and \$205 million on capital improvements during the extended outage. With replacement power costs included, the price tag for the outage exceeded \$600 million<sup>63</sup> (one billion dollars in 2006 dollars<sup>64</sup>).

*April 22, 1988:* NRC Commissioner Carr toured Pilgrim.<sup>65</sup>

*April 30, 1988:* The Massachusetts Department of Public Utilities (DPU) ordered Boston Edison to refund \$250,000 to its customers because a five-day outage at Pilgrim beginning on January 1, 1985, was caused by rubber gloves wrapped with masking tape found inside a safety tank. DPU Chairman Paul Levy said, "There's a strong implication that what was going on was that some people in the plant were wrapping tape around rubber gloves and using them as a baseball."<sup>66</sup>

*May 6, 1988:* NRC Commissioner Kenneth Rogers toured Pilgrim.<sup>67</sup>

*May 11, 1988:* The NRC conducted a public meeting in Plymouth, MA, to respond to comments on the restart plan.<sup>68</sup>

*May 1988:* The NRC expended 9,698 hours of inspection effort at Pilgrim between February 1987 and May 1988.<sup>69</sup>

*June 9, 1988:* NRC staff and Boston Edison officials briefed commissioners on Pilgrim's restart status.<sup>70</sup>

*August 26, 1988:* NRC staff and Boston Edison representatives briefed the agency's Advisory Committee on Reactor Safeguards (ACRS) on Pilgrim's restart status.<sup>71</sup>

*September 7, 1988:* NRC Region I Deputy Director for Reactor Projects Samuel J. Collins transmitted the IAT inspection report about Pilgrim to Boston Edison with a cover letter praising the facility's "excellent plant housekeeping" and noting weaknesses in radiological controls, training, and maintenance.<sup>72</sup>

*September 14, 1988:* The ACRS sent a letter to the NRC chairman about its evaluation of the proposed Pilgrim restart. The ACRS noted, "By the time of the Pilgrim plant shutdown in April of 1986, the NRC staff had developed serious reservations about the management of the plant.... More than half of the upper and middle level management personnel of the plant have been replaced since the plant last operated."<sup>73</sup>

*October 13, 1988:* The NRC informed Boston Edison that it was exercising enforcement discretion by not fining the company for 3,900 to 5,200 deficient fire barrier penetration seals identified and corrected during the extended outage.<sup>74</sup>

*October 14, 1988:* Peter Agnes, a top aide to Massachusetts Governor Michael Dukakis, was forcibly dragged out of a public NRC briefing. After NRC Chairman Zech attempted to apologize in a letter to Agnes stating, "I did not recognize who you were before the security guards had already removed you from the room," Agnes wrote back, "In my more than 13 years of public service, including 10 years as a state prosecutor, I have never been treated more rudely or with a greater disregard for my civil rights than I was at your meeting."<sup>75</sup>

*December 9, 1988:* NRC staff briefed commissioners about Pilgrim's status.<sup>76</sup>

*December 16, 1988:* NRC staff recommended that Boston Edison be permitted to restart Pilgrim.<sup>77</sup>

*December 21, 1988:* NRC commissioners voted 5-0 to approve Pilgrim's restart.<sup>78</sup>

*December 29, 1988:* NRC Regional Administrator William Russell toured Pilgrim.<sup>79</sup>

*December 30, 1988:* Regional Administrator Russell removed the restart restraint.<sup>80</sup>

*December 30, 1988:* Operators began withdrawing control rods to restart the reactor and achieved a sustained nuclear chain reaction.<sup>81</sup>

*December 31, 1988:* Operators manually shut down the reactor after detecting faulty instrumentation monitoring the nuclear chain reaction rate.<sup>82</sup>

*January 2, 1989:* The reactor was restarted and operated at low power levels for testing purposes.<sup>83</sup>

*January 10, 1989:* Operators manually shut down the reactor after discovering that the backup air supply system for the torus-to-reactor building vacuum breakers was not designed to withstand an earthquake.<sup>84</sup>

*January 27, 1989:* The reactor was restarted.<sup>85</sup>

*January 27, 1989:* Operators manually shut down the reactor after discovering a leak in the instrument air system.<sup>86</sup>

*February 10, 1989:* The reactor was restarted.<sup>87</sup>

*February 21, 1989:* The main transformer malfunctioned, forcing workers to replace it with a spare.<sup>88</sup>

*June 15, 1989:* The reactor was connected to the electrical grid, ending the extended outage.<sup>89</sup>

*July 23, 1990:* The NRC inspector general reported to the agency's chairman that the NRC staff's assessment of emergency planning problems at Pilgrim "was neither balanced nor thorough" and that the staff had provided inaccurate information to commissioners.<sup>90</sup>

*October 17, 1990:* A special task force chartered by the NRC to respond to the inspector general's report found 14 instances where the accuracy and completeness of information provided by agency staff to commissioners could be questioned. Examples included:

- NRC staff informed commissioners that they had toured the area around Pilgrim "with special emphasis on... beaches and the local emergency operating centers," but this tour was actually limited to a single visit by a single staffer escorted by a private citizen.
- During the December 9, 1988, briefing, NRC staff told commissioners that Plymouth town officials had approved 34 emergency procedures; in fact, the officials had received the procedures but not approved them.
- During the same briefing, NRC staff told commissioners that emergency procedures for all schools in the emergency planning zone had been approved at the department head level; in fact, the department heads had received the procedures but not approved them.<sup>91</sup>

*March 1991:* During a U.S. House of Representatives Interior Subcommittee on Energy and the Environment hearing, Congressman Peter Kostmayer asked NRC Executive Director for Operations James Taylor what the agency had done about staffers who provided incomplete and inaccurate information about emergency preparedness at Pilgrim. Taylor responded, "We called them in for a good talking to."<sup>92</sup>

## Notes

- <sup>1</sup> Moore, V.A. 1973. Letter to James M. Carroll, vice president and general counsel, Boston Edison Company, December 17. Voss A. Moore was assistant director, directorate of licensing, at the Atomic Energy Commission.
- <sup>2</sup> Collins, S.J. 1988. Pilgrim restart assessment panel meeting minutes. Memorandum to William T. Russell, regional administrator, Nuclear Regulatory Commission, August 15. Samuel J. Collins was deputy director of reactor projects at the Nuclear Regulatory Commission.
- <sup>3</sup> Ibid.
- <sup>4</sup> Ibid.
- <sup>5</sup> Ibid.
- <sup>6</sup> Ibid.
- <sup>7</sup> Ibid.
- <sup>8</sup> Markey, E. 1986. Letter to Gerry Studds, member, United States House of Representatives, June 26. Edward Markey is a member of the United States House of Representatives.
- <sup>9</sup> Collins, 1988.
- <sup>10</sup> Ibid.
- <sup>11</sup> Ibid.
- <sup>12</sup> Ibid.
- <sup>13</sup> Ibid.
- <sup>14</sup> Ibid.
- <sup>15</sup> Ibid.
- <sup>16</sup> Ibid.
- <sup>17</sup> Ibid.
- <sup>18</sup> Sperber, M. 1987. Boston Edison hopes restart will begin new era at Pilgrim. *Boston Globe*, September 10.
- <sup>19</sup> Collins, 1988.
- <sup>20</sup> Ibid.
- <sup>21</sup> Jordan, B. 1986. Pilgrim needs NRC approval for restart following valve malfunctions. *Nucleonics Week*, May 1.
- <sup>22</sup> Collins, 1988.
- <sup>23</sup> Ibid.
- <sup>24</sup> Ibid.
- <sup>25</sup> Ibid.
- <sup>26</sup> Lindeman, E. 1986. Boston Edison keeps Pilgrim shut while working on management problems. *Nucleonics Week*, May 29.
- <sup>27</sup> Ibid.
- <sup>28</sup> Beegan, D. 1986. Federal regulators promise close watch on Pilgrim I startup. Associated Press, July 17.
- <sup>29</sup> *Business Wire*. 1986. Boston Edison (BSE) proceeds with additional safety-related modifications to the containment at Pilgrim Nuclear Power Station, July 25.
- <sup>30</sup> Leech, P. 1986. Daily highlight: Pilgrim Nuclear Power Station. Memorandum to Distribution, Nuclear Regulatory Commission, July 25. Paul Leech was a project manager at the Nuclear Regulatory Commission.

- <sup>31</sup> Bernthal, F.M. 1986. Letter to Edward M. Kennedy, member, United States Senate, August 25. Frederick M. Bernthal was acting chairman of the Nuclear Regulatory Commission.
- <sup>32</sup> Collins, 1988.
- <sup>33</sup> Thurston, C. 1986. Boston Edison Co.'s Pilgrim lost off-site power due to weather. *Inside NRC*, December 8.
- <sup>34</sup> Collins, 1988.
- <sup>35</sup> Ibid.
- <sup>36</sup> Ibid.
- <sup>37</sup> Ibid.
- <sup>38</sup> Wessel, David. 1987. Boston Edison Co. is criticized by panel for 'adversarial' stance on regulators. *Wall Street Journal*, March 2.
- <sup>39</sup> Collins, 1988.
- <sup>40</sup> Ibid.
- <sup>41</sup> Ibid.
- <sup>42</sup> Ibid.
- <sup>43</sup> Ibid.
- <sup>44</sup> Ibid.
- <sup>45</sup> Ibid.
- <sup>46</sup> Varga, S.A. 1987. Initial assessment of Pilgrim safety enhancement program. Letter to Ralph G. Bird, senior vice president, nuclear, Boston Edison Company, August 21. Steven A. Varga was director of reactor projects at the Nuclear Regulatory Commission.
- <sup>47</sup> Collins, 1988.
- <sup>48</sup> Kerr, W. 1988. Proposed restart of the Pilgrim Nuclear Power Station. Letter to Lando W. Zech, Jr., chairman, Nuclear Regulatory Commission, September 14. William Kerr was chairman of the Advisory Committee on Reactor Safeguards at the Nuclear Regulatory Commission.
- <sup>49</sup> Bickelhaupt, S. 1987. Pilgrim officials tell NRC plant is ready for fuel. *Boston Edison*, September 25.
- <sup>50</sup> Callahan, C. 1987. Utility says Pilgrim reactor could be restarted in 8 weeks, NRC skeptical. Associated Press, September 25.
- <sup>51</sup> *PR Newswire*. 1987. All 580 fuel assemblies placed in reactor at Pilgrim Station, October 14.
- <sup>52</sup> Collins, 1988.
- <sup>53</sup> Ibid.
- <sup>54</sup> Tye, L. 1987. Pilgrim work halted after radiation found. *Boston Globe*, November 10.
- <sup>55</sup> Sperber, M. 1987. Pilgrim's loss of off-site power on November 12 has prompted NRC. *Nucleonics Week*, November 26.
- <sup>56</sup> Collins, 1988.
- <sup>57</sup> *Nucleonics Week*. 1988. Fears over Pilgrim restart lead Boston Edison ratings to be cut, January 28.
- <sup>58</sup> Nuclear Regulatory Commission (NRC). 1988. Daily Event Report No. 11488, February 11.
- <sup>59</sup> Collins, 1988.
- <sup>60</sup> Ibid.
- <sup>61</sup> Ibid.
- <sup>62</sup> Ibid.
- <sup>63</sup> Tye, L. 1988. Pilgrim's cost to Edison while shut: \$600m. *Boston Globe*, April 8.
- <sup>64</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>.

- <sup>65</sup> Collins, 1988.
- <sup>66</sup> Associated Press. 1988. Nuclear plant worker's game may have accidentally triggered shutdown, May 1.
- <sup>67</sup> Collins, 1988.
- <sup>68</sup> Ibid.
- <sup>69</sup> Ibid.
- <sup>70</sup> Chilk, S.J. 1988. Staff requirements: Briefing on status of Pilgrim, June 9. Memorandum to Victor Stello, Jr., executive director for operations, Nuclear Regulatory Commission, June 24. Samuel J. Chilk was secretary at the Nuclear Regulatory Commission.
- <sup>71</sup> Collins, 1988.
- <sup>72</sup> Sperber, M. 1988. NRC inspection team gives green light to Pilgrim restart. *Nucleonics Week*, September 15.
- <sup>73</sup> Kerr, 1988.
- <sup>74</sup> Russell, W.T. 1988. Exercise of enforcement discretion relative to Pilgrim fire barrier deficiencies. Letter to Ralph G. Bird, senior vice president, nuclear, Boston Edison Company, October 13. William T. Russell was a regional administrator at the Nuclear Regulatory Commission.
- <sup>75</sup> Tye, L. 1988. Dukakis aide who was ejected from Pilgrim meeting lambastes NRC. *Boston Globe*, October 18.
- <sup>76</sup> Stello, Jr., V. 1988. Request for commission approval for the restart of the Pilgrim Nuclear Power Station. Memorandum to commissioners, Nuclear Regulatory Commission, SECY-88-346, December 16. Victor Stello, Jr. was executive director for operations at the Nuclear Regulatory Commission.
- <sup>77</sup> Ibid.
- <sup>78</sup> Wald, M.L. 1988. 2 disputed atom power plants move nearer operation. *New York Times*, December 22.
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