

MAINE YANKEE

Wiscasset, ME

Owner: Maine Yankee Atomic Power Company

Outage dates (duration): January 14, 1995 to January 18, 1996 (1.0 years)

Reactor type: Pressurized water reactor

Reactor age when outage began: 22.0 years

Commercial operations began: December 28, 1972

Fleet status: Only reactor owned by the company

Synopsis

What began as a forced outage caused by an equipment problem (main generator ground fault) became an early refueling outage and then an extended outage when steam generator tubes with crack indications had to be repaired. The outage slid past the one-year mark when allegations of falsified safety analyses surfaced. The plant restarted on borrowed time—it was permanently shut down less than one year later.

Process Changes

The NRC and the nuclear power industry continue to struggle with monitoring steam generator tube integrity, the primary problem faced during this outage. Despite improvements made as a result of the lessons learned from Maine Yankee and later events, steam generator tube inspection methods continue to overlook and/or misdiagnose crack indications that are revealed only after leaks occur.

The NRC's Office of the Inspector General (OIG) identified a programmatic problem in the agency's failure to follow up on commitments made by plant owners. The NRC did not, however, resolve this problem, and it surfaced later as a contributing factor in the Davis-Besse debacle of 2001–2002.

Commentary

When NRC commissioners asked Maine Yankee's chairman of the board why his senior management had allowed the plant to lag behind the rest of the industry, the chairman responded that they had essentially relied on feedback from the NRC that, until recently, showed Maine Yankee was fully meeting all expectations. The NRC's Systematic Assessment of Licensee Performance (SALP) history for Maine Yankee certainly supports his point (see table). SALP scores suggest Maine Yankee was performing better than the majority of U.S. nuclear reactors, which is a sad statement on the value of these scores.

NRC Systematic Assessment of Licensee Performance (SALP) History

Date	Operations	Maintenance	Engineering	Plant Support
01/1989	1	1	2	3/1/2
05/1990	1	1	2	2/2/2
06/1991	1	1	2	2/2/2
11/1992	1	2	2	2/2/1
03/1994	1	2	2	1
10/1995	1	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

July 15, 1994: Operators manually shut down the reactor because the calculated primary-to-secondary leak rate in the B steam generator had increased to approximately 50 gallons per day. The leak rate was below the technical specification limit of 216 gallons per day, but had been steadily increasing and warranted a shutdown during the summer (when the plant's power was less needed). Examination of the tubes in the B steam generator revealed four tubes with circumferential cracks in the hot leg expansion transition region near the top of the tube sheet.¹ These four tubes, and 299 others with circumferential cracks, were plugged.²

August 9, 1994: Prior to restarting Maine Yankee, company representatives met with the NRC in a public meeting about the steam generator inspection results and repairs. A representative from reactor manufacturer ABB-CE reviewed past inspections of the four leaking tubes and noted that no crack indications were found when all four tubes had been inspected during a 1990 outage, when two were re-inspected during a 1992 outage, or when the other two were re-inspected during a 1993 outage. However, when ABB-CE went back and reviewed the raw data, circumferential crack indications were evident in the tubes during each of those past inspections.³

November 14, 1994: Maine Yankee submitted the results from steam generator tube inspections conducted during the July–August outage, stating:

“Reevaluation of the previous MRPC [motorized rotating pancake coil] inspection data on these tubes [the four cracked tubes] indicated that flaws were present during earlier inspections but were not detected using then current analysis methods. The defects previously went undetected because the cracks’ eddy current signals were not distinguished from similar signals caused by tube geometry changes occurring at the same location.”⁴

December 23, 1994: NRC Information Notice 94-88 alerted plant owners to the steam generator tube inspection deficiencies at Maine Yankee, noting that the methods employed during inspections in 1990, 1992, and 1993 had revealed no crack indications while the method employed after the July 1994 steam generator tube leak identified circumferential cracking requiring the plugging of 303 tubes. The NRC also reported that 23 tubes had circumferential cracks with an average depth exceeding 79 percent of wall thickness and 10 other tubes had cracks exceeding 89 percent of wall thickness.⁵

January 14, 1995: Operators manually tripped the reactor due to a ground fault in the main generator. The company initially expected this outage to last about three weeks.⁶

January 26, 1995: The company transitioned the generator outage into a refueling outage that had originally been scheduled to start in late February. The company now expected this outage to last until April.⁷

February 7, 1995: The NRC met with Maine Yankee representatives regarding the steam generator inspection results reported in November 1994. According to the NRC, the company estimated the average growth rate of cracks in the steam generator tubes to be 11.17 percent of wall thickness per effective full-power year.^{*8}

March 1995: Senior management formed a Cultural Assessment Team to evaluate “whether, or to what extent, Maine Yankee may have a culture that discourages employees from raising concerns, particularly nuclear safety concerns.”⁹

March 27, 1995: After inspections revealed cracking in about half of the steam generator tubes, the company extended the outage indefinitely.¹⁰

April 7, 1995: Maine Yankee’s board of directors voted to pursue an unprecedented repair plan for the steam generator tubes rather than opting for the more traditional approach of replacing the steam generators. The plan involved reinforcing tube walls by placing metal sleeves in all 17,000 tubes (10,000 of which had shown cracking in inspections). While other companies had installed metal sleeves, none had ever employed so many.¹¹

May 23, 1995: The board of directors approved the \$40 million steam generator tube sleeving plan.¹²

June 22, 1995: Activists picketed the Maine State House, asking Governor Angus King to appoint an independent team to evaluate the steam generator tube sleeving project. The governor later appoints such a team.¹³

August 10, 1995: Testing in a laboratory revealed that the 30-inch-long metal sleeves being installed in the steam generator tubes caused the tubes to bend and rub against each other. The 30-inch sleeves had to be replaced with 20-inch sleeves.¹⁴

November 8, 1995: After a series of incidents at Maine Yankee involving the mishandling of fuel assemblies, the company halted refueling activities and the NRC announced it was investigating the events.¹⁵

November 19, 1995: Workers resumed refueling activities after taking steps to address the causes of earlier fuel mishandling.¹⁶

December 4, 1995: Maine’s nuclear safety advisor received an anonymous letter (forwarded by the Union of Concerned Scientists) alleging that computer studies of Maine Yankee’s emergency core cooling system performance in the event of an accident had been adjusted to mislead the NRC about the plant’s condition.¹⁷

December 11, 1995: Workers completed the steam generator tube sleeving project on time and under budget. The company expected to restart the reactor in three weeks.¹⁸

December 18, 1995: The NRC announced it found “some legitimacy” to the anonymous allegations and would not permit Maine Yankee to resume full power operations until further analysis could be completed.¹⁹

December 20, 1995: Maine Yankee’s president agreed not to restart the reactor until the NRC had reviewed the safety analysis matter and approved the restart.²⁰

* “Effective full-power year” is a measure of a reactor’s operating lifetime. For example, if the reactor operates at an average power level of 75 percent, it will take 487 days for it to accumulate one effective full-power year (365 days divided by 0.75).

January 3, 1996: The NRC issued an order limiting the output of Maine Yankee to 90 percent of rated power until questions about the emergency core cooling system analyses could be resolved. The agency allowed Maine Yankee to operate at up to 90 percent power because the suspect analyses were performed for the power uprate, not the original analyses.²¹

January 18, 1996: The reactor was connected to the electrical grid, ending its extended outage.²²

May 8, 1996: The NRC's OIG informed commissioners about its inquiry into the agency's oversight of the Maine Yankee power uprate process, stating:

*"The inquiry determined that until the allegations arose, the NRC staff was unaware of MYAPCo's non-compliance with certain Safety Evaluation Report (SER) conditions set forth in the approval. The SER established 12 conditions in which the licensee was required to follow when using the RELAP5YA computer code. OIG found that the staff did not followup on the licensee's compliance with the conditions in the SER after it was issued in January 1989. The inquiry determined that the May 1989 NRC letter that closed out TMI Item II.K.3.31 contained several irregularities. OIG found no indication of a technical review by the staff of the licensee's response to TMI Items II.K.3.30 and .31. OIG learned that there was insufficient management involvement regarding the May 1989 letter. Further, OIG learned that the NRC Project Managers, technical staff managers and senior officials had several opportunities to resolve the erroneous closure of TMI Item II.K.3.31, but failed to do so."*²³

December 6, 1996: Operators manually shut down Maine Yankee after both sets of the manual reactor trip push buttons were declared inoperable. Workers responding to NRC Generic Letter 96-01 discovered electrical cable separation violations that caused the reactor trip system to be considered inoperable.²⁴

February 4, 1997: NRC commissioners were briefed by agency staff, representatives of Maine Yankee, and members of the public. When Commissioner Edward McGaffigan Jr. asked why Maine Yankee's management had not provided the funding necessary to handle backlogs properly, Chairman of the Board David Flanagan responded:

"As I indicated earlier, Maine Yankee has been a low-cost provider in a high-cost region and that's been an important factor to the benefit of the New England economy. We have wanted to run the plant as efficiently as we could, at the same time meeting the expectations of our industry and our regulators.

"Commissioner, we had, until the last year, we had been under the impression that we were meeting those expectations, that the level of expenditures was consistent with our obligations to the NRC and to the industry.

"As I say, I think we did not keep up with the state of the art and we were too isolated from, maybe, from what was going on in the rest of the country. But I'll tell you, personally, since I became chairman, I have gone to every SALP exit interview, I've gone to every INPO exit so that I could hear, unfiltered, whether there were any concerns that we should be addressing.

*"The management was making recommendations based on their judgment of what was needed to operate the plant safely. The objective indicators we were getting from outside were consistent with the recommendations and they were operating the plant in a way that was making a significant contribution to the economy of our state."*²⁵

August 6, 1997: Maine Yankee's board of directors voted unanimously to close the plant permanently.²⁶

Notes

- ¹ Whittier, G.D. 1994a. Steam generator tube cracking. Letter to Nuclear Regulatory Commission, August 8. G. Douglas Whittier was vice president of licensing and engineering at Maine Yankee.
- ² Whittier, G.D. 1994b. Summary report of Maine Yankee July/August, 1994, steam generator inspection. Letter to Nuclear Regulatory Commission, November 14. G. Douglas Whittier was vice president of licensing and engineering at Maine Yankee.
- ³ Trottier, E.H. 1994. Summary of August 9, 1994, meeting on Maine Yankee steam generator. Meeting minutes, August 19. E.H. Trottier was a project manager at the Nuclear Regulatory Commission.
- ⁴ Whittier, 1994b.
- ⁵ Nuclear Regulatory Commission (NRC). 1994. Inservice inspection deficiencies result in severely degraded steam generator tubes. Information Notice No. 94-88, December 23.
- ⁶ Pochna, P. 1996a. A year of trouble at Maine Yankee. *Portland Press Herald*, January 14.
- ⁷ Ibid.
- ⁸ Trottier, E.H. 1995. Summary of February 7, 1995, meeting on Maine Yankee steam generator operating and inspection history. Meeting minutes, February 23. E.H. Trottier was a project manager at the Nuclear Regulatory Commission.
- ⁹ Bradford, R.F., J.-A. Chouinard, R.H. Fallon, Jr., and J.D.E. Jeffries. 1996. Cultural assessment team report on factors affecting the reporting of issues and concerns at Maine Yankee. May 14. Maine Yankee Atomic Power Company: Wiscasset, ME.
- ¹⁰ Pochna, 1996a.
- ¹¹ Ibid.
- ¹² Ibid.
- ¹³ Ibid.
- ¹⁴ Ibid.
- ¹⁵ Ibid.
- ¹⁶ Ibid.
- ¹⁷ Ibid.
- ¹⁸ Ibid.
- ¹⁹ Ibid.
- ²⁰ Russell, W.T. 1995. Telephone calls between W.T. Russell (NRC) and C.D. Frizzle (MYAPCo) on December 20 and 21, 1995. Letter to Charles D. Frizzle, president, Maine Yankee Atomic Power Company, December 21. William T. Russell was director of nuclear reactor regulation at the Nuclear Regulatory Commission.
- ²¹ Pochna, 1996a.
- ²² Pochna, P. 1996b. Yankee putting power on line: A year after shutting down, the nuclear power plant begins sending electricity to customers. *Portland Press Herald*, January 20.

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- ²³ Norton, L.J. 1996. Event of inquiry: Maine Yankee Power Station (case no. 96-04S). Letter to chairman and commissioners, Nuclear Regulatory Commission, May 8. Leo J. Norton was acting inspector general at the Nuclear Regulatory Commission.
- ²⁴ NRC. 1996. TS reqd plant S/D due to both sets of manual Rx trip push buttons inop. Daily Event Report 31412, December 5.
- ²⁵ NRC. 1997. Briefing by Maine Yankee, NRR and Region I. Transcript, February 4.
- ²⁶ *Nuclear News*. 1997. Board votes for closure; decom to start right away, September.