NRC ignored signs of danger

Agency was warned that Indian Point 2 tubes could rupture, documents show

Roger Witherspoon
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For nearly a decade before a tube failure triggered the first emergency in the history of Indian Point 2, the U.S. Nuclear Regulatory Commission ignored repeated internal warnings that the industry's integrity tests for steam generator tubes were faulty and could not adequately detect dangerous cracks, agency documents show.

NRC officials say that they have confidence in the current evaluation program and tube-repair procedures, but that further research may not be completed before 2004. Yet agency documents state that the NRC cannot guarantee the structural integrity of cracked and aging steam generator tubes that carry pressurized radioactive water at about 50 of the nation's 103 nuclear reactors.

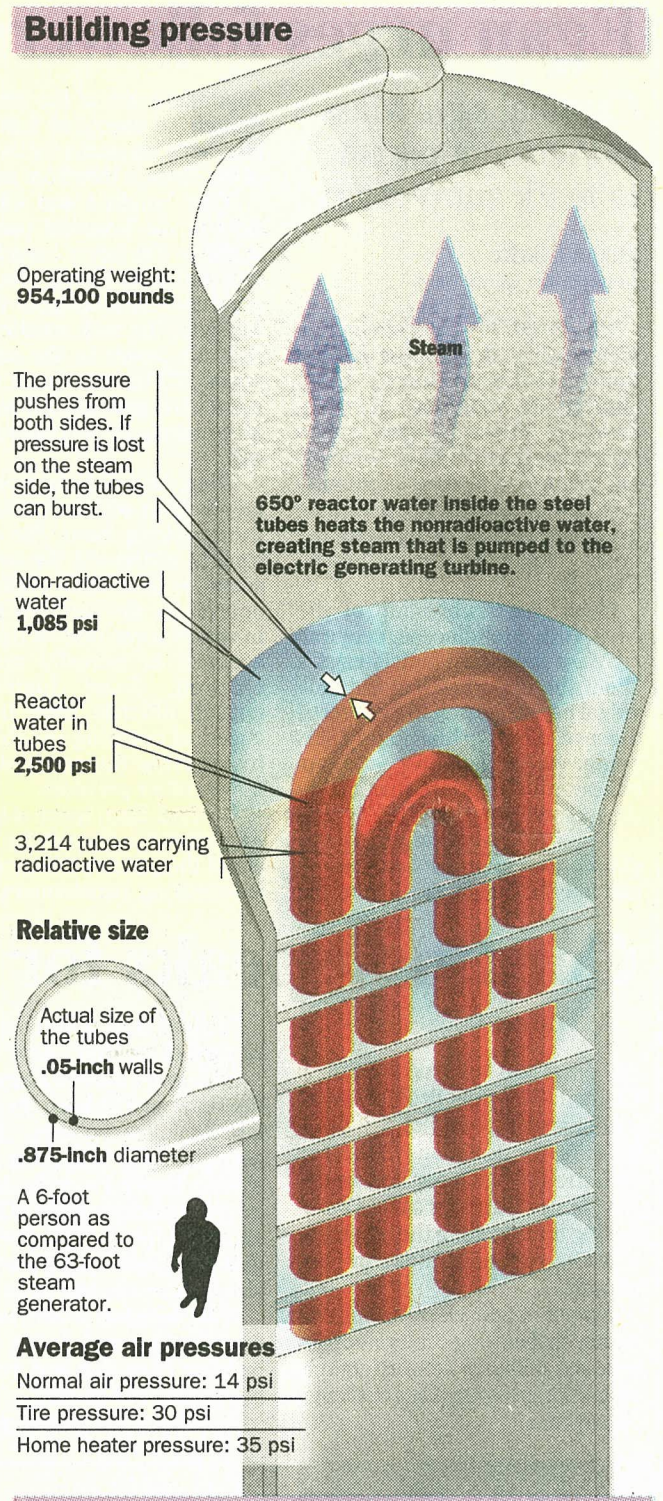
The NRC's internal debate about the effectiveness of steam generator tube evaluations was revealed in hundreds of agency documents related to the Feb. 15, 2000, steam tube rupture at Indian Point 2 in Buchanan. The rupture resulted in the spill of 20,000 gallons of radioactive water — some of which flowed into the Hudson River in a diluted state — and a small amount of radioactive steam into the atmosphere, forcing the plant to shut down for 10 months.

The documents were reviewed by The Journal News after being obtained under the Freedom of Information Act. They include what are known as Differing Professional Opinion, or DPO reports, a formal process that allows NRC engineers to raise safety issues and challenge existing practices; memos between agency staffers; and a review committee's report.

The NRC's records show that at least five times before the tube rupture at Indian Point 2, an engineer in the agency's Office of

Inside a steam generator

Steam generators use heat created in the nuclear reactor's core to boil water. The resulting steam turns the turbine in an adjacent building, thereby generating electricity.



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GENERATOR, from 1A

the issue in 1987 following the rupture of a pipe carrying pressurized water to the steam generators at the Surrey nuclear power plant near Williamsburg, Va. Three workers were killed in that incident.

"They didn't listen to me," Hopenfeld said in an interview, "because in '91, when suddenly many of these reactors started developing all these cracks, there was a concern that a large number of reactors would have to be shut down. Indian Point 2 was an example of how these things run away."

"There was a lot of money involved," he said. "In November '92, there was an accident at the Trojan plant (in Oregon) and the tubes were found to have millions of cracks. But they still didn't change. They didn't listen even then because it would mean considerable cost to the industry."

NRC records show that Hopenfeld's concerns were either ignored or dismissed by senior NRC staff as unnecessary.

"Hopenfeld became more and more bitter and more and more shrill because he felt his concerns were being blown off," said David Lochbaum, a nuclear systems engineer at the Union of Concerned Scientists. "NRC people heard the shrillness and reacted to it and ignored the message. So it snowballed, and nothing was accomplished."

Consolidated Edison, which owned Indian Point 2 at the time of the accident, declined comment on the documents' findings. Bob Cullen, the steam generator program engineer for Indian Point 3, said Entergy, which now owns Indian Point 2 and 3, did not believe in taking chances with steam tubes and did not repair or continue using cracked tubes.

"If we were to find cracks, our protocol is to plug those tubes," Cullen said. "We believe we cannot size cracks, so we do not leave *cracked tubes in service. We do not use the* alternative repair allowed by the NRC."

Steam generators at nuclear power plants use thousands of steel tubes to carry streams of pressurized, super-heated water from the nuclear reactor. Nonradioactive water pumped over these hot tubes turns to steam, which is pumped to an adjacent building where it is blown over the blades of a huge turbine that generates electricity.

The NRC did not begin investigating problems regarding steam tube evaluations until October 2000, eight months after the steam generator tube ruptured at Indian Point 2.

The review was prompted by two factors: an investigation by the NRC's Office of Inspector General into the agency's handling of internal dissent regarding safety issues, and a petition filed by the Union of Concerned Scientists, the Nuclear Information Research Center and Public Citizen demanding a formal resolution of the issues raised by Hopenfeld before Indian Point 2 would be allowed to restart.

NRC actions criticized

The NRC's Advisory Committee on Reactor Safeguards, which conducted the review, issued its report in March 2001. It stated that, "The (NRC) staff does not currently have a technically defensible analysis of how steam generator tubes, which may be flawed, will behave under severe accident conditions in which the reactor coolant system remains pressurized."

The issue of steam generator tube strength is crucial to the safe operation of nuclear power plants. Tube breaks, the committee report said, "can lead to melting of the reactor core and massive releases of radioactivity" that could not be held within the reactor's massive containment building. The committee also that said NRC guidelines for the repair of cracked steam tubes should "adequately protect the public health and safety" but that the agency needed to thoroughly test those procedures.

In addition, the advisory committee, a formal structure used to investigate technical problems facing the industry and NRC regulations, found that:

- NRC staff used inappropriate models to determine the risk of some types of catastrophic accidents involving steam generator tubes; underestimated the potential for human error during a crisis; and had not fully considered the possibility that blackouts and other accidents involving a plant's nonnuclear side could disrupt the production of steam in the generator and cause tubes to break.
- The NRC relied on lab analyses of the growth of a single crack or stress point in a sample tube when, in reality, tubes develop multiple cracks that grow independently until they link, allowing large cracks to develop undetected.
- Reactor operators were not trained to recognize certain types of steam tube bursts or how to control them, giving them less time than projected to prevent a meltdown of the reactor core and a release of radiation into the environment.

Steam rises from the Con Edison Indian Point 2 nuclear power plant in Buchanan in February 2000. A leak in a steam generator resulted in a brief release of radioactive steam but it was below dangerous levels, power company officials said.

File photo
The Journal News

The committee also criticized the way in which nuclear plant operators determined the strength of steam generator tubes, by measuring the size and number of cracks during biannual refuelings then comparing the data with records from two years earlier. That method was recommended by Westinghouse Electric, which built the steam generators, and approved by the NRC. But the committee said the process incorrectly assumed that stress and corrosion developed at a steady, even pace.

Ken Karwoski, the NRC's senior advisor for steam generators, said that despite the agency's treatment of Hopenfeld's warnings, the NRC was constantly looking into issues concerning steam tube integrity.

"It's not like the NRC did *not do anything*," he said.

Even though research has not been concluded, Karwoski said existing safety systems were adequate enough to ensure that plant operations are safe. He said that nuclear plant operators continually monitor the strength of the tubes and that plants operating "with significant leakage" are shut down.

He said improvements would be added in the future.

"We cannot guarantee that a tube will not fail, but plants are designed with safety systems and procedures to bring them to shutdown if that should occur," Karwoski said. "That is our basis for believing the plants are safe to continue operating while we investigate to see if additional actions are necessary. We do have time to investigate these issues."

Diane Screnci, an NRC spokeswoman, said that while the agency "could have done a better job in administratively formalizing the review process in a timely manner . . . The central issues were known and considered by the staff, which has put a significant effort into addressing steam generator issues. In addition, there is now a system in place to assure DPOs/DPVs are dealt with in a timely manner."

Tubes 'a loaded gun'

Steam generator tubes are about 1/20 of an inch — or about as wide as this letter "r" — thin enough so heat can easily transfer from the radioactive water inside the tubes to the clean water being turned to steam.

The tubes are not uniform. They have minor stress points and ripples from the manufacturing process that are affected by continued use in a high-pressure, radioactive environment. The scouring from the hot water and radioactive particles, known as the degradation of the tubes, erodes the tubes from the inside, while pressure, vibrations and friction result in cracking on the outside. If the cracks go through the tubes' walls, they can break.

The tubes' vulnerability has long been a concern of the NRC. Kenneth Rogers, a former NRC commissioner, said during a 1988 industry conference on corrosion issues that "degradation would decrease the safety margins so that, in essence, we have a 'loaded gun' — an accident waiting to happen."

Nonetheless, Hopenfeld's reports appear to never have been investigated, according to agency documents. In November 1999, NRC staff decided — without a formal review — that Hopenfeld was incorrect and that there were no safety issues involving steam tubes. In December, two months before the Indian Point 2 tube break, Hopenfeld responded with a memo that said the agency's latest position on steam tube examinations was wrong.

"It misstates material facts, ignores major documents, and focuses on minor issues instead of addressing all concerns in an objective and professional manner," Hopenfeld wrote. "Some of the models proposed by the staff to refute these issues border on fiction."

There is no recorded response to that memo. Two months after the Indian Point accident, in April 2001, Hopenfeld filed another: "The IP2 event is a precursor to the much more serious accident . . . which is an unresolved, high priority, generic safety issue . . . The NRC permitted Con Edison to operate their plant's steam generators with indeterminably defective tubes on the presumption that cracks would grow slowly because they had done so for 23 years. This presumption was proven to be wrong at IP2."

That same month, Hopenfeld initiated a meeting with Lochbaum and Jim Riccio of Public Citizen to discuss his concerns about steam generator tubes, prompting the civic groups to file a formal petition with the NRC.

"We wanted the issues Hopenfeld raised resolved before the plant restarted," Lochbaum said.

Oversight called lax

At the same time, the NRC's Office of Inspector General, which was investigating the agency's oversight of Indian Point 2, discovered the Differing Professional Opinion reports and memos, interviewed Hopenfeld, and began a second investigation into the agency's handling of internal dissent. The office, in a report released in September 2000, said that some internal criticism within the NRC lingered for years without action, and that a majority of employees believed that filing such dissents would bring retaliation from management.

The Inspector General's report on the NRC's oversight of Indian Point 2 was issued earlier that summer, and said that the NRC's lax oversight of the plant contributed to the Feb. 15, 2000, accident.

In October 2000, the NRC set up a study group within its Advisory Committee on Reactor Safeguards to investigate the issues Hopenfeld had raised for a nearly a decade. That report, issued in March 2001, upheld Hopenfeld's major contentions, and the agency launched a series of research projects that May.

"After 9/11, they have to look at everything differently," Hopenfeld said. "They were talking about what kind of damage you would get if a 747 hits the containment dome. But there are many areas which are much more vulnerable because when (the plants) were designed, this was not a consideration."

The advisory committee has upheld the NRC's plan to allow plant operators to repair damaged steam tubes by welding a thin metal sheet to their inner walls. Karwoski, of the NRC, said that method "can adequately protect public health and safety."

He added that steam tubes are now treated so that the thin steel better withstands pressure and scouring.

Riccio, now nuclear safety director for Greenpeace, said the NRC must assure the public that it can accurately detect cracks in steam generator tubes to ensure that another accident like the one at Indian Point does not occur.

Following that accident, Con Edison agreed to the $150 million installation of new steam generators under intense pressure that it not merely replace the broken equipment. The old steam generators had been used in the plant since it opened in 1974 and were the oldest of their kind still in operation at a U.S. nuclear reactor. Con Edison had new steam generators in storage at the plant, but had not been planning to install them for another few years.

While Hopenfeld said he was glad his findings were finally being addressed, Lochbaum was less satisfied.

"I feel so bad that he worked for 10 years and couldn't get one single safety issue resolved," he said. "That would have been a far better reward for his years of dedicated service than a watch."

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