Agency was warned that tubes could rupture, documents show

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From Page One

Generator, from 1A

The issue in 1987 following the rupture of a pipe carrying pressurized water to the early generators at the 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 reactor could have a similar accident. Indian Point 2 was an example of how these things ran 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 a thing. They didn't listen even then because it was unimportant to consider it a significant 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 plant's chief systems 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 used in 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 feasible 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 reported, "can lead to melting of the reactor core and a release of radioactivity" that could not be kept within the reactor's massive containment building. The committee also noted that 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 recommended that the NRC conduct testing to determine the potential impact of long-term exposure to radiation in the steam generator tubes. The committee also made several recommendations aimed at improving the agency's oversight of safety issues.

Ken Karwoski, the NRC's senior advisor for steam generators, said that since the agency's treatment of Hopenfeld's warnings, the NRC was constantly looking into issues concerning steam generator tubes. "It's not like the NRC didn't do anything," he said.

Even though research has not been completed, 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 Scrimenti, an NRC spokesperson, said that while the agency "could have done a better job in administratively formalizing the review process in a timely manner... the central issue was 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/DPWs are dealt with in a timely manner."

Tubes 'a loaded gun'

Steam generator tubes are about 1/20 of an inch — 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 swirling hot water and radioactive particles, known as a "suckage," cause degradation of the tubes, erodes the tubes from the inside, weakens the water 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. Commissioners have 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 is bound to happen." Nonetheless, Hopenfeld's reports appear to have never been investigated, according to agency documents. In November 1999, the NRC released a report without a formal review — that Hopenfeld was incorrect and that there were no significant 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 conclusions proposed by their staff to refute these issues border on fiction."

There is no record of response to that memo. Two months after the Indian Point 2 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 Ed to operate their plant's steam generator with indeterminate defective tubes on the presumption that cracks would grow slowly because they had done so for years. This presumption was proven to be wrong at IP2."

That same month, Hopenfeld initiated a meeting with Lochbaum and Jim Riccio, director of Public Citizen to discuss 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 was investigating the agency's oversight of Indian Point 2, discovered the differing performance and opinions and, in November 2000, Hopenfeld and a second inspector found that agency's handling of internal dissent. The office, in a report released in September 2000, said that "the internal conflict within the NRC lingered untouched, and that a majority of employees believed that filing such disputes would bring retaliation from management.

The Inspector General's report on the NRC's oversight of Indian Point 2 was issued in a final version in March 2001, upheld Hopenfeld's major contentions, and the agency launched a series of research projects that May 2001.

"And 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. There are many areas of the plant which are much more general. 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 wall. 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 scours. 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 they can still be used.

"Fifty years from now, people want to know what the NRC was doing with the one at Indian Point 2 does not exist.

Following that accident, Con Edison agreed to the $150 million installation of new steam generator tubes on a "suckage," pressure that it not merely replaced the old 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 five years.

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

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