AP IMPACT: US nuke regulators weaken safety rules

By JEFF DONN, AP National Writer – Mon Jun 20, 3:38 am ET

AP – This photo made available by the Nuclear Regulatory Commission shows a 10-gallon-per-minute leak which ...

LACEY TOWNSHIP, N.J. – Federal regulators have been working closely with the nuclear power industry to keep the nation's aging reactors operating within safety standards by repeatedly weakening those standards, or simply failing to enforce them, an investigation by The Associated Press has found.

Time after time, officials at the U.S. Nuclear Regulatory Commission have decided that original regulations were too strict, arguing that safety margins could be eased without peril, according to records and interviews.

The result? Rising fears that these accommodations by the NRC are significantly undermining safety — and inching the reactors closer to an accident that could harm the public and jeopardize the future of nuclear power in the United States.

Examples abound. When valves leaked, more leakage was allowed — up to 20 times the original limit. When rampant cracking caused radioactive leaks from steam generator tubing, an easier test of the tubes was devised, so plants could meet standards.

Failed cables. Busted seals. Broken nozzles, clogged screens, cracked concrete, dented containers, corroded metals and rusty underground pipes — all of these and thousands of other problems linked to aging were uncovered in the AP's yearlong investigation. And all of them could escalate dangers in the event of an accident.

Yet despite the many problems linked to aging, not a single official body in government or industry has studied the overall frequency and potential impact on safety of such breakdowns in recent years, even as the NRC has extended the licenses of dozens of reactors.

Industry and government officials defend their actions, and insist that no chances are being taken. But the AP investigation found that with billions of dollars and 19 percent of America's electricity supply at stake, a cozy relationship prevails between the industry and its regulator, the NRC.

Records show a recurring pattern: Reactor parts or systems fall out of compliance with the rules. Studies are conducted by the industry and government, and all agree that existing standards are "unnecessarily conservative."

Regulations are loosened, and the reactors are back in compliance.

"That's what they say for everything, whether that's the case or not," said Demetrios Basdekas, an engineer retired from the NRC. "Every time you turn around, they say `We have all this built-in conservatism.'"

The ongoing crisis at the stricken, decades-old Fukushima Dai-ichi nuclear facility in Japan has focused attention on the safety of plants elsewhere in the world; it prompted the NRC to look at U.S. reactors, and a report is due in July.

But the factor of aging goes far beyond the issues posed by the disaster at Fukushima.

Commercial nuclear reactors in the United States were designed and licensed for 40 years. When the first ones were being built in the 1960s and 1970s, it was expected that they would be replaced with improved models long before those licenses expired.

But that never happened. The 1979 accident at Three Mile Island, massive cost overruns, crushing debt and high interest rates ended new construction proposals for several decades.

Instead, 66 of the 104 operating units have been relicensed for 20 more years, mostly with scant public attention. Renewal applications are under review for 16 other reactors.

By the standards in place when they were built, these reactors are old and getting older. As of today, 82 reactors are more than 25 years old.

The AP found proof that aging reactors have been allowed to run less safely to prolong operations. As equipment has approached or violated safety limits, regulators and reactor operators have loosened or bent the rules.

Last year, the NRC weakened the safety margin for acceptable radiation damage to reactor vessels — for a second time. The standard is based on a measurement known as a reactor vessel's "reference temperature," which predicts when it will become dangerously brittle and vulnerable to failure. Over the years, many plants have violated or come close to violating the standard.

As a result, the minimum standard was relaxed first by raising the reference temperature 50 percent, and then 78 percent above the original — even though a broken vessel could spill its radioactive contents into the environment.

"We've seen the pattern," said nuclear safety scientist Dana Powers, who works for Sandia National Laboratories and also sits on an NRC advisory committee. "They're ... trying to get more and more out of these plants."

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SHARPENING THE PENCIL

The AP collected and analyzed government and industry documents — including some never-before released. The examination looked at both types of reactor designs: pressurized water units that keep radioactivity confined to the reactor building and the less common boiling water types like those at Fukushima, which send radioactive water away from the reactor to drive electricity-generating turbines.

Tens of thousands of pages of government and industry studies were examined, along with test results, inspection reports and regulatory policy statements filed over four decades. Interviews were conducted with scores of managers, regulators, engineers, scientists, whistleblowers, activists, and residents living near the reactors, which are located at 65 sites, mostly in the East and Midwest.

AP reporting teams toured some of the oldest reactors — the unit here at Oyster Creek, near the Atlantic coast 50 miles east of Philadelphia, and two units at Indian Point, 25 miles north of New York City along the Hudson River.

Called "Oyster Creak" by some critics because of its aging problems, this boiling water reactor began running in 1969 and ranks as the country's oldest operating commercial nuclear power plant. Its license was extended in 2009 until 2029, though utility officials announced in December that they'll shut the reactor 10 years earlier rather than build state-ordered cooling towers. Applications to extend the lives of pressurized water units 2 and 3 at Indian Point, each more than 36 years old, are under review by the NRC.

Unprompted, several nuclear engineers and former regulators used nearly identical terminology to describe how industry and government research has frequently justified loosening safety standards to keep aging reactors within operating rules. They call the approach "sharpening the pencil" or "pencil engineering" — the fudging of calculations and assumptions to yield answers that enable plants with deteriorating conditions to remain in compliance.

"Many utilities are doing that sort of thing," said engineer Richard T. Lahey Jr., who used to design nuclear safety systems for General Electric Co., which makes boiling water reactors. "I think we need nuclear

power, but we can't compromise on safety. I think the vulnerability is on these older plants."

Added Paul Blanch, an engineer who left the industry over safety issues but later returned to work on solving them: "It's a philosophical position that (federal regulators) take that's driven by the industry and by the economics: What do we need to do to let those plants continue to operate? They somehow sharpen their pencil to either modify their interpretation of the regulations, or they modify their assumptions in the risk assessment."

In public pronouncements, industry and government say aging is well under control. "I see an effort on the part of this agency to always make sure that we're doing the right things for safety. I'm not sure that I see a pattern of staff simply doing things because there's an interest to reduce requirements — that's certainly not the case," NRC chairman Gregory Jaczko said in an interview at agency headquarters in Rockville, Md.

Neil Wilmshurst, director of plant technology for the industry's Electric Power Research Institute, acknowledged that the industry and NRC often collaborate on research that supports rule changes. But he maintained that there's "no kind of misplaced alliance ... to get the right answer."

Yet agency staff, plant operators, and consultants paint a different picture in little-known reports, where evidence of industry-wide problems is striking:

_The AP reviewed 226 preliminary notifications — alerts on emerging safety problems — issued by the NRC since 2005. Wear and tear in the form of clogged lines, cracked parts, leaky seals, rust and other deterioration contributed to at least 26 alerts over the past six years. Other notifications lack detail, but aging also was a probable factor in 113 additional alerts. That would constitute up to 62 percent in all. For example, the 39-year-old Palisades reactor in Michigan shut Jan. 22 when an electrical cable failed, a fuse blew, and a valve stuck shut, expelling steam with low levels of radioactive tritium into the air outside. And a one-inch crack in a valve weld aborted a restart in February at the LaSalle site west of Chicago.

_One 2008 NRC report blamed 70 percent of potentially serious safety problems on "degraded conditions." Some involve human factors, but many stem from equipment wear, including cracked nozzles, loose paint, electrical problems, or offline cooling components.

_Confronted with worn parts that need maintenance, the industry has repeatedly requested — and regulators have often allowed — inspections and repairs to be delayed for months until scheduled refueling outages. Again and again, problems worsened before they were fixed. Postponed inspections inside a steam generator at Indian Point allowed tubing to burst, leading to a radioactive release in 2000. Two years later, cracking was allowed to grow so bad in nozzles on the reactor vessel at the Davis-Besse plant near Toledo, Ohio, that it came within two months of a possible breach, the NRC acknowledged in a report. A hole in the vessel could release radiation into the environment, yet inspections failed to catch the same problem on the replacement vessel head until more nozzles were found to be cracked last year.

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TIME CRUMBLES THINGS

Nuclear plants are fundamentally no more immune to the incremental abuses of time than our cars or homes: Metals grow weak and rusty, concrete crumbles, paint peels, crud accumulates. Big components like 17-story-tall concrete containment buildings or 800-ton reactor vessels are all but impossible to replace. Smaller parts and systems can be swapped, but still pose risks as a result of weak maintenance and lax regulation or hard-to-predict failures. Even when things are fixed or replaced, the same parts or others nearby often fail later.

Even mundane deterioration at a reactor can carry harsh consequences.

For example, peeling paint and debris can be swept toward pumps that circulate cooling water in a reactor accident. A properly functioning containment building is needed to create air pressure that helps clear those pumps. The fact is, a containment building could fail in a severe accident. Yet the NRC has allowed operators to make safety calculations that assume containment buildings will hold.

In a 2009 letter, Mario V. Bonaca, then-chairman of the NRC's Advisory Committee on Reactor Safeguards, warned that this approach represents "a decrease in the safety margin" and makes a fuel-melting accident more likely. At Fukushima, hydrogen explosions blew apart two of six containment buildings, allowing radiation to escape from overheated fuel in storage pools.

Many photos in NRC archives — some released in response to AP requests under the federal Freedom of Information Act — show rust accumulated in a thick crust or paint peeling in long sheets on untended equipment at nuclear plants. Other breakdowns can't be observed or predicted, even with sophisticated analytic methods — especially for buried, hidden or hard-to-reach parts.

Industry and government reports are packed with troubling evidence of unrelenting wear — and repeated regulatory compromises.

Four areas stand out:

BRITTLE VESSELS: For years, operators have rearranged fuel rods to limit gradual radiation damage to the steel vessels protecting the core and to keep them strong enough to meet safety standards.

It hasn't worked well enough.

Even with last year's weakening of the safety margins, engineers and metal scientists say some plants may be forced to close over these concerns before their licenses run out — unless, of course, new compromises with regulations are made. But the stakes are high: A vessel damaged by radiation becomes brittle and prone to cracking in certain accidents at pressurized water reactors, potentially releasing its radioactive contents into the environment.

LEAKY VALVES: Operators have repeatedly violated leakage standards for valves designed to bottle up radioactive steam in the event of earthquakes and other accidents at boiling water reactors.

Many plants have found they could not adhere to the general standard allowing each of these parts — known as main steam isolation valves — to leak at a rate of no more than 11.5 cubic feet per hour. In 1999, the NRC decided to permit individual plants to seek amendments of up to 200 cubic feet per hour for all four steam valves combined.

But plants keep violating even those higher limits. For example, in 2007, Hatch Unit 2, in Baxley, Ga., reported combined leakage of 574 cubic feet per hour.

CRACKED TUBING: The industry has long known of cracking in steel alloy tubing originally used in the steam generators of pressurized water reactors. Ruptures were rampant in these tubes containing radioactive coolant; in 1993 alone, there were seven. Even today, as many as 18 reactors are still running on old generators.

Problems can arise even in a newer metal alloy, according to a report of a 2008 industry-government workshop.

CORRODED PIPING: Nuclear operators have failed to stop an epidemic of leaks in pipes and other underground equipment in damp settings. The country's nuclear sites have suffered more than 400 accidental radioactive leaks during their history, the activist Union of Concerned Scientists reported in September.

Plant operators have been drilling monitoring wells and patching hidden or buried piping and other equipment for several years to control an escalating outbreak.

Here, too, they have failed. Between 2000 and 2009, the annual number of leaks from underground piping shot up fivefold, according to an internal industry document obtained and analyzed by the AP.

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CONCERNS OF LONG STANDING

Even as they reassured the public, regulators have been worrying about aging reactors since at least the 1980s, when the first ones were entering only their second decade of operation. A 1984 report for the NRC blamed wear, corrosion, crud and fatigue for more than a third of 3,098 failures of parts or systems within the first 12 years of industry operations; the authors believed the number was actually much higher.

A decade later, in 1994, the NRC reported to Congress that the critical shrouds lining reactor cores were cracked at a minimum of 11 units, including five with extensive damage. The NRC ordered more aggressive maintenance, but an agency report last year said cracking of internal core components — spurred by radiation — remains "a major concern" in boiling water reactors.

A 1995 study by Oak Ridge National Laboratory covering a seven-year period found that aging contributed to 19 percent of scenarios that could have ended in severe accidents.

In 2001, the Union of Concerned Scientists, which does not oppose nuclear power, told Congress that aging problems had shut reactors eight times within 13 months.

And an NRC presentation for an international workshop that same year warned of escalating wear at reactor buildings meant to bottle up radiation during accidents. A total of 66 cases of damage were cited in the presentation, with corrosion reported at a quarter of all containment buildings. In at least two cases — at the two-reactor North Anna site 40 miles northwest of Richmond, Va., and the two-unit Brunswick facility near Wilmington, N.C. — steel containment liners designed to shield the public had rusted through.

And in 2009, a one-third-inch hole was discovered in a liner at Beaver Valley Unit 1 in Shippingport, Pa.

Long-standing, unresolved problems persist with electrical cables, too.

In a 1993 report labeled "official use only," an NRC staffer warned that electrical parts throughout plants were subject to dangerous age-related breakdowns unforeseen by the agency. Almost a fifth of cables failed in testing that simulated the effects of 40 years of wear. The report warned that as a result, reactor core damage could occur much more often than expected.

Fifteen years later, the problem appeared to have worsened. An NRC report warned in 2008 that rising numbers of electrical cables are failing with age, prompting temporary shutdowns and degrading safety. Agency staff tallied 269 known failures over the life of the industry.

Two industry-funded reports obtained by the AP said that managers and regulators have worried increasingly about the reliability of sometimes wet, hard-to-reach underground cables over the past five-to-10 years. One of the reports last year acknowledged many electrical-related aging failures at plants around the country.

"Multiple cable circuits may fail when called on to perform functions affecting safety," the report warned.

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EATEN AWAY FROM WITHIN

Few aging problems have been more challenging than chemical corrosion from within.

In one of the industry's worst accidents, a corroded pipe burst at Virginia's Surry 2 reactor in 1986 and showered workers with scalding steam, killing four.

In summer 2001, the NRC was confronted with a new problem: Corrosive chemicals were cracking nozzles on reactors. But the NRC let operators delay inspections to coincide with scheduled outages. Inspection finally took place in February 2002 at the Davis-Besse unit in Ohio.

What workers found shocked the industry.

They discovered extensive cracking and a place where acidic boron had spurted from the reactor and eaten a gouge as big as a football. When the problem was found, just a fraction of an inch of inner lining remained. An NRC analysis determined that the vessel head could have burst within two months — what former NRC Commissioner Peter Bradford has called a "near rupture" which could have released large amounts of radiation into the environment.

In 2001-3 alone, at least 10 plants developed these cracks, according to an NRC analysis.

Industry defenders blame human failings at Davis-Besse. Owner FirstEnergy Corp. paid a $28 million fine, and courts convicted two plant employees of hiding the deterioration. NRC spokesman Scott Burnell declared that the agency "learned from the incident and improved resident inspector training and knowledge-sharing to ensure that such a situation is never repeated."

Yet on the same March day last year that Burnell's comments were released, Davis-Besse workers again found dried boron on the nozzles of a replacement vessel head, indicating more leaks. Inspecting further, they again found cracks in 24 of 69 nozzles.

"We were not expecting this issue," said plant spokesman Todd Schneider.

In August, the operator applied for a 20-year license extension. Under pressure from the NRC, the company has agreed to replace the replacement head in October.

As far back as the 1990s, the industry and NRC also were well aware that the steel-alloy tubing in many steam generators was subject to chemical corrosion. It could crack over time, releasing radioactive gases that can bypass the containment building. If too much spurts out, there may be too little water to cool down the reactor, prompting a core melt.

In 1993, NRC personnel reported seven outright ruptures inside the generators, several forced outages per year, and some complete replacements. Personnel at the Catawba plant near Charlotte, N.C., found more than 8,000 corroded tubes — more than half its total.

For plants with their original generators, "there is no end in sight to the steam generator tube degradation problems," a top agency manager declared. NRC staffers warned: "Crack depth is difficult to measure reliably and the crack growth rate is difficult to determine."

Yet no broad order was issued for shutdowns to inspect generators.

Instead, the staff began to talk to operators about how to deal with the standard that no cracks could go deeper than 40 percent through the tube wall.

In 1995, the NRC staff put out alternative criteria that let reactors keep running if they could reach positive results with remote checks known as "eddy-currents tests." The new test standard gave more breathing room to reactors.

According to a 2001 report by the Advisory Committee on Reactor Safeguards, the staff "acknowledged that there would be some possibility that cracks of objectionable depth might be overlooked and left in the steam generator for an additional operating cycle." The alternative, the report said, would be to repair or remove potentially many tubes from service.

NRC engineer Joe Hopenfeld, who had worked previously in the industry, challenged this approach at the time from within the agency. He warned that multiple ruptures in corroded tubing could release radiation. The NRC said radiation would be confined.

Hopenfeld now says this conclusion wasn't based on solid analysis but "wishful thinking" and research meant to reach a certain conclusion — another instance of "sharpening the pencil."

"It was a hard problem to solve, and they did not want to say it was a problem, because if they really said it was a problem, they would have to shut down a lot of reactors."

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AGE IS NO ISSUE, SAYS INDUSTRY

With financial pressures mounting in the 1990s to extend the life of aging reactors, new NRC calculations using something called the "Master Curve" put questionable reactor vessels back into the safe zone.

A 1999 NRC review of the Master Curve, used to analyze metal toughness, noted that energy deregulation had put financial pressure on nuclear plants. It went on: "So utility executives are considering new operational scenarios, some of which were unheard of as little as five years ago: extending the licensed life of the plant beyond 40 years." As a result, it said, the industry and the NRC were considering "refinements" of embrittlement calculations "with an eye to reducing known over-conservatisms."

Asked about references to economic pressures, NRC spokesman Burnell said motivations are irrelevant if a technology works.

Former NRC commissioner Peter Lyons said, "There certainly is plenty of research ... to support a relaxation of the conservativisms that had been built in before. I don't see that as decreasing safety. I see that as an appropriate standard."

Though some parts are too big and too expensive to replace, industry defenders also point out that many others are routinely replaced over the years.

Tony Pietrangelo, chief nuclear officer of the industry's Nuclear Energy Institute, acknowledges that you'd expect to see a growing failure rate at some point — "if we didn't replace and do consistent maintenance."

In a sense, then, supporters of aging nukes say an old reactor is essentially a collection of new parts.

"When a plant gets to be 40 years old, about the only thing that's 40 years old is the ink on the license," said NRC chief spokesman Eliot Brenner. "Most, if not all of the major components, will have been changed out."

Oyster Creek spokesman David Benson said the reactor "is as safe today as when it was built."

Yet plant officials have been trying to arrest rust on its 100-foot-high, radiation-blocking steel drywell for decades. The problem was declared solved long ago, but a rust patch was found again in late 2008. Benson said the new rust was only the size of a dime, but acknowledged there was "some indication of water getting in."

In an effort to meet safety standards, aging reactors have been forced to come up with backfit on top of backfit.

As Ivan Selin, a retired NRC chairman, put it: "It's as if we were all driving Model T's today and trying to bring them up to current mileage standards."

For example, the state of New Jersey — not the NRC — had ordered Oyster Creek to build cooling towers to protect sea life in nearby Barnegat Bay. Owner Exelon Corp. said that would cost about $750 million and force it to close the reactor — 20-year license extension notwithstanding. Even with the announcement to close in 2019, Oyster Creek will have been in operation for 50 years.

Many of the safety changes have been justified by something called "risk-informed" analysis, which the industry has employed widely since the 1990s: Regulators set aside a strict check list applied to all systems and focus instead on features deemed to carry the highest risk.

But one flaw of risk-informed analysis is that it doesn't explicitly account for age. An older reactor is not viewed as inherently more unpredictable than a younger one. Ed Lyman, a physicist with the Union of Concerned Scientists, says risk-informed analysis has usually served "to weaken regulations, rather than strengthen them."

Even without the right research, the NRC has long reserved legal wiggle room to enforce procedures, rules and standards as it sees fit. A 2008 position paper by the industry group EPRI said the approach has brought "a more tractable enforcement process and a significant reduction in the number of cited violations."

But some safety experts call it "tombstone regulation," implying that problems fester until something goes very wrong. "Until there are tombstones, they don't regulate," said Blanch, the longtime industry engineer who became a whistleblower.

Barry Bendar, a database administrator who lives one mile from Oyster Creek, said representatives of Exelon were asked at a public meeting in 2009 if the plant had a specific life span.

"Their answer was, `No, we can fix it, we can replace, we can patch,'" said Bendar. "To me, everything reaches an end of its life span."

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The AP National Investigative Team can be reached at investigate(at)ap.org

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Mr.Magoo Mon Jun 20, 2011 02:56 am PDT | Report Abuse

269 16

It has been a long time since I have trusted government. The revolving door of personnel between Wall Street and Washinton make what is right wrong and what is wrong right. Until those bonds are destroyed expect more of the same. Above the laws these folks are.
When you are late with a payment does the bank say it is ok, when you run a red light does the policeman say it is ok. You have to be accountable why should not the titans of industry.

Replies (7)

MerriMagic 22 hours ago | Report Abuse

63 1

We're heading the way of a 3rd world country. Our citizens are losing jobs or being forced to work for less money, no insurance, and we're not even safe in our homes, because the government isn't doing it's job. It's too busy using our tax dollars to fund Capitol Hill's lawmaker's cushy lifestyles, or to send our boys to die in foreign lands in battles we cannot win. Government sucks. I read where the average lifespand of a country's government is about 200 years. It takes that long to go from well intentioned lawmakers, to a corrupt group of officials who are more interested in feathering their own nests than helping the common ordinary citizens. If that's true, when we're way overdue for a collapse and overthrow.

Replies (2)

Tenth Man Mon Jun 20, 2011 02:06 am PDT | Report Abuse

350 24

Classic demise of an empire; spending money on foolish never ending wars all the while ignoring the structure that supported the ability to field an army in the first place.

Replies (9)

Weed Omaniac Mon Jun 20, 2011 12:34 am PDT | Report Abuse

233 17

Those who fail to learn from past mistakes are DOOMED to repeat them.

Replies (5)

Emily Mon Jun 20, 2011 03:03 am PDT | Report Abuse

170 15

So typical. Execs make hundreds of millions of dollars by putting people's life in danger, and no one's going to do anything about it until someone dies.

Replies (9)

Mark Mon Jun 20, 2011 12:33 am PDT | Report Abuse

213 20

Does this really surprise anyone?

Replies (8)

Snorri Sturluson Mon Jun 20, 2011 03:39 am PDT | Report Abuse

91 7

I hope there is a comprehensive table of organization showing the names of "regulators" responsible for making improper decisions to accomodate the industry. If someone I loved were injured or killed because of their decisions, I would want a way to track them down.

Replies (5)

Alkoholic Mon Jun 20, 2011 03:44 am PDT | Report Abuse

192 19

The only thing our "government" is interested in is the money being placed in their bank accounts by BIG business.

Replies (3)

Harry Mon Jun 20, 2011 03:38 am PDT | Report Abuse

195 23

While not an article about job creation it is an example of the fallacy of lessening regulations on industry. Anytime you hear politicians saying we need to reduce regulations what they're really saying is that someone's safety (workers, the public) is secondary to business interests.

Replies (11)

Smartyone Mon Jun 20, 2011 02:03 am PDT | Report Abuse 137 16

As always, we can't trust government to protect us. Do these inspectors have no conscience? If/when there is a radiation disaster, I suggest we put these engineers in the frontline to clean up the mess.

Replies (12)

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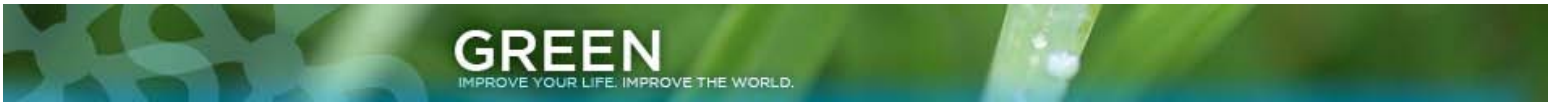

AP IMPACT: Tritium leaks found at many nuke sites

Associated Press

By JEFF DONN, AP National Writer – 2 hrs 2 mins ago

AP – In this Tuesday, Dec. 14, 2010 photo, retiree Bob Scamen stands near a discharge pipe for the Braidwood …

BRACEVILLE, Ill. – Radioactive tritium has leaked from three-quarters of U.S. commercial nuclear power sites, often into groundwater from corroded, buried piping, an Associated Press investigation shows.

The number and severity of the leaks has been escalating, even as federal regulators extend the licenses of more and more reactors across the nation.

Tritium, which is a radioactive form of hydrogen, has leaked from at least 48 of 65 sites, according to U.S. Nuclear Regulatory Commission records reviewed as part of the AP's yearlong examination of safety issues at aging nuclear power plants. Leaks from at least 37 of those facilities contained concentrations exceeding the federal drinking water standard — sometimes at hundreds of times the limit.

While most leaks have been found within plant boundaries, some have migrated offsite. But none is known to have reached public water supplies.

At three sites — two in Illinois and one in Minnesota — leaks have contaminated drinking wells of nearby homes, the records show, but not at levels violating the drinking water standard. At a fourth site, in New Jersey, tritium has leaked into an aquifer and a discharge canal feeding picturesque Barnegat Bay off the Atlantic Ocean.

Previously, the AP reported that regulators and industry have weakened safety standards for decades to keep the nation's commercial nuclear reactors operating within the rules. While NRC officials and plant operators argue that safety margins can be eased without peril, critics say these accommodations are inching the reactors closer to an accident.

Any exposure to radioactivity, no matter how slight, boosts cancer risk, according to the National Academy of Sciences. Federal regulators set a limit for how much tritium is allowed in drinking water. So far, federal and industry officials say, the tritium leaks pose no health threat.

But it's hard to know how far some leaks have traveled into groundwater. Tritium moves through soil quickly, and when it is detected it often indicates the presence of more powerful radioactive isotopes that are often spilled at the same time.

For example, cesium-137 turned up with tritium at the Fort Calhoun nuclear unit near Omaha, Neb., in 2007. Strontium-90 was discovered with tritium two years earlier at the Indian Point nuclear power complex,

where two reactors operate 25 miles north of New York City.

The tritium leaks also have spurred doubts among independent engineers about the reliability of emergency safety systems at the 104 nuclear reactors situated on the 65 sites. That's partly because some of the leaky underground pipes carry water meant to cool a reactor in an emergency shutdown and to prevent a meltdown. More than a mile of piping, much of it encased in concrete, can lie beneath a reactor.

Tritium is relatively short-lived and penetrates the body weakly through the air compared to other radioactive contaminants. Each of the known releases has been less radioactive than a single X-ray.

The main health risk from tritium, though, would be in drinking water. The U.S. Environmental Protection Agency says tritium should measure no more than 20,000 picocuries per liter in drinking water. The agency estimates seven of 200,000 people who drink such water for decades would develop cancer.

Still, the NRC and industry consider the leaks a public relations problem, not a public health or accident threat, records and interviews show.

"The public health and safety impact of this is next to zero," said Tony Pietrangelo, chief nuclear officer of the industry's Nuclear Energy Institute. "This is a public confidence issue."

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LEAKS ARE PROLIFIC

Like rust under a car, corrosion has propagated for decades along the hard-to-reach, wet underbellies of the reactors — generally built in a burst of construction during the 1960s and 1970s. As part of an investigation of aging problems at the country's nuclear reactors, the AP uncovered evidence that despite government and industry programs to bring the causes of such leaks under control, breaches have become more frequent and widespread.

There were 38 leaks from underground piping between 2000 and 2009, according to an industry document presented at a tritium conference. Nearly two-thirds of the leaks were reported over the latest five years.

Here are some examples:

_At the three-unit Browns Ferry complex in Alabama, a valve was mistakenly left open in a storage tank during modifications over the years. When the tank was filled in April 2010 about 1,000 gallons of tritium-laden water poured onto the ground at a concentration of 2 million picocuries per liter. In drinking water, that would be 100 times higher than the EPA health standard.

_At the LaSalle site west of Chicago, tritium-laden water was accidentally released from a storage tank in July 2010 at a concentration of 715,000 picocuries per liter — 36 times the EPA standard.

_The year before, 123,000 picocuries per liter were detected in a well near the turbine building at Peach Bottom west of Philadelphia — six times the drinking water standard.

_And in 2008, 7.5 million picocuries per liter leaked from underground piping at Quad Cities in western Illinois — 375 times the EPA limit.

Subsurface water not only rusts underground pipes, it attacks other buried components, including electrical cables that carry signals to control operations. They too have been failing at high rates.

A 2008 NRC staff memo reported industry data showing 83 failed cables between 21 and 30 years of service — but only 40 within their first 10 years of service. Underground cabling set in concrete can be extraordinarily difficult to replace.

Under NRC rules, tiny concentrations of tritium and other contaminants are routinely released in monitored increments from nuclear plants; leaks from corroded pipes are not permitted.

The leaks sometimes go undiscovered for years, the AP found. Many of the pipes or tanks have been patched, and contaminated soil and water have been removed in some places. But leaks are often discovered later from other nearby piping, tanks or vaults. Mistakes and defective material have contributed to some leaks. However, corrosion — from decades of use and deterioration — is the main cause. And, safety engineers say, the rash of leaks suggest nuclear operators are hard put to maintain the decades-old systems.

Over the history of the U.S. industry, more than 400 known radioactive leaks of all kinds of substances have occurred, the activist Union of Concerned Scientists reported in September.

Several notable leaks above the EPA drinking-water limit for tritium happened five or more years ago, and from underground piping: 397,000 picocuries per liter at Tennessee's Watts Bar unit in 2005 — 20 times the EPA standard; four million at the two-reactor Hatch plant in Georgia in 2003 — 200 times the limit; 750,000

at Seabrook in New Hampshire in 1999 — nearly 38 times the standard; and 4.2 million at the three-unit Palo Verde facility in Arizona, in 1993 — 210 times the drinking-water limit.

Many safety experts worry about what the leaks suggest about the condition of miles of piping beneath the reactors. "Any leak is a problem because you have the leak itself — but it also says something about the piping," said Mario V. Bonaca, a former member of the NRC's Advisory Committee on Reactor Safeguards. "Evidently something has to be done."

However, even with the best probes, it is hard to pinpoint partial cracks or damage in skinny pipes or bends. The industry tends to inspect piping when it must be dug up for some other reason. Even when leaks are detected, repairs may be postponed for up to two years with the NRC's blessing.

"You got pipes that have been buried underground for 30 or 40 years, and they've never been inspected, and the NRC is looking the other way," said engineer Paul Blanch, who has worked for the industry and later became a whistleblower. "They could have corrosion all over the place."

Nuclear engineer Bill Corcoran, an industry consultant who has taught NRC personnel how to analyze the cause of accidents, said that since much of the piping is inaccessible and carries cooling water, the worry is if the pipes leak, there could be a meltdown.

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EAST COAST ISSUES

One of the highest known tritium readings was discovered in 2002 at the Salem nuclear plant in Lower Alloways Creek Township, N.J. Tritium leaks from the spent fuel pool contaminated groundwater under the facility — located on an island in Delaware Bay — at a concentration of 15 million picocuries per liter. That's 750 times the EPA drinking water limit. According to NRC records, the tritium readings last year still exceeded EPA drinking water standards.

And tritium found separately in an onsite storm drain system measured 1 million picocuries per liter in April 2010.

Also last year, the operator, PSEG Nuclear, discovered 680 feet of corroded, buried pipe that is supposed to carry cooling water to Salem Unit 1 in an accident, according to an NRC report. Some had worn down to a quarter of its minimum required thickness, though no leaks were found. The piping was dug up and replaced.

The operator had not visually inspected the piping — the surest way to find corrosion_ since the reactor went on line in 1977, according to the NRC. PSEG Nuclear was found to be in violation of NRC rules because it hadn't even tested the piping since 1988.

Last year, the Vermont Senate was so troubled by tritium leaks as high as 2.5 million picocuries per liter at the Vermont Yankee reactor in southern Vermont (125 times the EPA drinking-water standard) that it voted to block relicensing — a power that the Legislature holds in that state.

Activists placed a bogus ad on the Web to sell Vermont Yankee, calling it a "quaint Vermont fixer-upper from the last millennium" with "tasty, pre-tritiated drinking water."

The gloating didn't last. In March, the NRC granted the plant a 20-year license extension, despite the state opposition. Weeks ago, operator Entergy sued Vermont in federal court, challenging its authority to force the plant to close.

At 41-year-old Oyster Creek in southern New Jersey, the country's oldest operating reactor, the latest tritium troubles started in April 2009, a week after it was relicensed for 20 more years. That's when plant workers discovered tritium by chance in about 3,000 gallons of water that had leaked into a concrete vault housing electrical lines.

Since then, workers have found leaking tritium three more times at concentrations up to 10.8 million picocuries per liter — 540 times the EPA's drinking water limit — according to the New Jersey Department of Environmental Protection. None has been directly measured in drinking water, but it has been found in an aquifer and in a canal discharging into nearby Barnegat Bay, a popular spot for swimming, boating and fishing.

An earlier leak came from a network of pipes where rust was first discovered in 1991. Multiple holes were found, "indicating the potential for extensive corrosion," according to an analysis released to an environmental group by the NRC. Yet only patchwork repairs were done.

Tom Fote, who has fished in the bay near Oyster Creek, is unsettled by the leaks. "This was a plant that was up for renewal. It was up to them to make sure it was safe and it was not leaking anything," he said.

Added Richard Webster, an environmental lawyer who challenged relicensing at Oyster Creek: "It's symptomatic of the plants not having a handle on aging."

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EXELON'S PIPING PROBLEMS

To Exelon — the country's biggest nuclear operator, with 17 units — piping problems are just a fact of life. At a meeting with regulators in 2009, representatives of Exelon acknowledged that "100 percent verification of piping integrity is not practical," according to a copy of its presentation.

Of course, the company could dig up the pipes and check them out. But that would be costly.

"Excavations have significant impact on plant operations," the company said.

Exelon has had some major leaks. At the company's two-reactor Dresden site west of Chicago, tritium has leaked into the ground at up to 9 million picocuries per liter — 450 times the federal limit for drinking water.

At least four separate problems have been discovered at the 40-year-old site since 2004, when its two reactors were awarded licenses for 20 more years of operation. A leaking section of piping was fixed that year, but another leak sprang nearby within two years, a government inspection report says. The Dresden leaks developed in systems that help cool the reactor core in an emergency. Leaks also have contaminated offsite drinking water wells, but below the EPA drinking water limit.

There's also been contamination of offsite drinking water wells near the two-unit Prairie Island plant southeast of Minneapolis, then operated by Nuclear Management Co. and now by Xcel Energy, and at Exelon's two-unit Braidwood nuclear facility, 10 miles from Dresden. The offsite tritium concentrations from both facilities also were below the EPA level.

The Prairie Island leak was found in the well of a nearby home in 1989. It was traced to a canal where radioactive waste was discharged.

Braidwood has leaked more than six million gallons of tritium-laden water in repeated leaks dating back to the 1990s — but not publicly reported until 2005. The leaks were traced to pipes that carried limited, monitored discharges of tritium into the river.

"They weren't properly maintained, and some of them had corrosion," said Exelon spokeswoman Krista Lopykinski.

Last year, Exelon, which has acknowledged violating Illinois state groundwater standards, agreed to pay $1.2 million to settle state and county complaints over the tritium leaks at Braidwood and nearby Dresden and Byron sites. The NRC also sanctioned Exelon.

Tritium measuring 1,500 picocuries per liter turned up in an offsite drinking well at a home near Braidwood. Though company and industry officials did not view any of the Braidwood concentrations as dangerous, unnerved residents took to bottled water and sued over feared loss of property value. A consolidated lawsuit was dismissed, but Exelon ultimately bought some homes so residents could leave.

Exelon refused to say how much it paid, but a search of county real estate records shows it bought at least nine properties in the contaminated area near Braidwood since 2006 for a total of $6.1 million.

Exelon says it has almost finished cleaning up the contamination, but the cost persists for some neighbors.

Retirees Bob and Nancy Scamen live in a two-story house within a mile of the reactors on 18 bucolic acres they bought in 1988, when Braidwood opened. He had worked there, and in other nuclear plants, as a pipefitter and welder — even sometimes fixing corroded piping. For the longest time, he felt the plants were well-managed and safe.

His feelings have changed.

An outlet from Braidwood's leaky discharge pipe 300 feet from his property poured out three million gallons of water in 1998, according to an NRC inspection report. The couple didn't realize the discharge was radioactive.

The Scamens no longer intend to pass the property on to their grandchildren for fear of hurting their health. The couple just wants out. But the only offer so far is from a buyer who left a note on the front door saying he'd pay the fire-sale price of $10,000.

They say Exelon has refused to buy their home because it has found tritium directly behind, but not beneath, their property.

"They say our property is not contaminated, and if they buy property that is not contaminated, it will set a

precedent, and they'll have to buy everybody's property," said Scamen.

Their neighbors, Tom and Judy Zimmer, are also hoping for an offer from Exelon for the land and home they built on it, spending $418,000 for both.

They had just moved into the house in November 2005, and were laying the tile in their new foyer when two Exelon representatives appeared at the door.

"They said, `We're from Exelon, and we had a tritium spill. It's nothing to worry about,'" recalls Tom Zimmer. "I didn't know what tritium even meant."

But his wife says she understood right away that it was bad news — and they hadn't even emptied their moving boxes yet: "I thought, `Oh, my God. We're not even in this place. What are we going to do?'"

They say they had an interested buyer who backed out when he learned of the tritium. No one has made an offer since.

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PUBLIC RELATIONS EFFORT

The NRC is certainly paying attention. How can it not when local residents fret over every new groundwater incident? But the agency's reports and actions suggest a preoccupation with image and perception.

An NRC task force on tritium leaks last year dismissed the danger to public health. Instead, its report called the leaks "a challenging issue from the perspective of communications around environmental protection." The task force noted ruefully that the rampant leaking had "impacted public confidence."

For sure, the industry also is trying to stop the leaks. For several years now, plant owners around the country have been drilling more monitoring wells and taking a more aggressive approach in replacing old piping when leaks are suspected or discovered.

For example, Exelon has been performing $14 million worth of work at Oyster Creek to give easier access to 2,000 feet of tritium-carrying piping, said site spokesman David Benson.

But such measures have yet to stop widespread leaking.

Meantime, the reactors keep getting older — 66 have been approved for 20-year extensions to their original 40-year licenses, with 16 more extensions pending. And, as the AP has been reporting in its ongoing series, Aging Nukes, regulators and industry have worked in concert to loosen safety standards to keep the plants operating.

In an initiative started last year, NRC Chairman Gregory Jaczko asked his staff to examine regulations on buried piping to evaluate if stricter standards or more inspections were needed.

The staff report, issued in June, openly acknowledged that the NRC "has not placed an emphasis on preventing" the leaks.

The authors concluded there are no significant health threats or heightened risk of accidents.

And they predicted even more leaks in the future.

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The AP National Investigative Team can be reached at investigate(at)ap.org

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Photo: Chairman of the U.S. NRC Gregory Jaczko attends a press briefing …

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Oh SHIT 8 hours ago | Report Abuse

285 14

Its all about the $.
Cheaper to pay fines than to follow strict rules.

Replies (11)

Brad 8 hours ago | Report Abuse

356 19

It seems that nearly all federal regulatory agencies - energy, nuclear, financial, transportation, pharmaceutical, etc., are working for the industries they oversee rather than for the public good. Industry runs congress and through them, the country. The people don't count for anything but sheeplike ideological votes.

Replies (24)

Bingo 4 hours ago | Report Abuse

169 7

"Any exposure to radioactivity, no matter how slight, boosts cancer risk, according to the National Academy of Sciences."

Soooo, then body scans at airports are completely safe for folks who often fly"? Somebody's lying to somebody...

Replies (26)

A. Palmer Jr. 4 hours ago | Report Abuse

87 3

Sounds like time to spend some money on maintenance here rather than overseas.

Replies (2)

Real 8 hours ago | Report Abuse

239 17

Can we do anything right in America anymore?

Finding and fixing these dangerous problems should be law.

Replies (24)

Alan 7 hours ago | Report Abuse 374 30

Cesium and Strontium contamination, we don't have to worry about terrorists poisoning us with a dirty bomb, corporate America will gladly do it to us in the name of the almighty dollar.

Replies (10)

EUGENE 8 hours ago | Report Abuse 198 14

you cannot belive anything our goverment tells us anymore / tried of there lies have to wait years before the truth comes out

Replies (7)

Dave Vincent 5 hours ago | Report Abuse 132 10

kinda like: If Johnny can not pass the math test, lower the passing score! Profits do not mean continued maintenance of the facility...it means Porsche's, Master's tix, dom perignon, et cetera... if it is not in their backyard, why so they care about the American people...

Reply

Tres Maddox 6 hours ago | Report Abuse 53 2

I am no expert, but it seems to me that Nuclear Power Plants are the type of infrastructure we should pay to keep from falling apart.

Replies (6)

James 8 hours ago | Report Abuse 177 21

According to government and industry "experts", nuclear power is very safe, and so are PCB and asbestos, DDT, dioxin, Agent Orange, RBST, factory-farmed chicken, American beef fed with hormones, sugar substitutes, etc... until the public learns of truth about all the hanky-panky going-ons between goverment and industry greedy SOBs. Am I the only one to see a pattern here?

Replies (14)

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