NUCLEAR CRISIS
JAPAN & THE FUTURE OF ENERGY POLICY

1. REGULATION: U.S. nuclear plants are safer than Japan's, but operational quality needs work *(ClimateWire, 03/21/2011)*

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Are U.S. nuclear reactors safe?

The short answer is "yes," Nuclear Regulatory Commission Chairman Gregory Jaczko tried to convey to anxious, impatient senators at a congressional hearing last week. The nation's chief nuclear regulator could give no other answer -- an unsafe reactor would have to be shut down and fixed, or closed.

Taken as a whole, the 104 U.S. commercial nuclear reactors have significantly improved their operating reliability and are more closely watched by on-site NRC inspectors and regional staff than in any other time in the industry's half-century history, according to NRC. From the 2005 to 2009 fiscal years, NRC recorded no "abnormal occurrences" -- accidents or deficiencies that caused a major reduction in the protection of public health and safety.

The median measure of nuclear plant outage time and power reductions from equipment failures and human error was 1.2 percent in 2009. The figure exceeded 5 percent in the mid-1990s, according to the industry's Nuclear Energy Institute.

Behind that solitary "yes" to the question of safety, however, are caveats, conditions and footnotes that help fill NRC's enormous document library, addressing such crucial underlying questions: "how safe?" and "safe from what?"

Nuclear plants are considered the most sensitive, fault-intolerant industrial complexes that exist and the consequences of the worst-case failure of systems or equipment in emergencies can be catastrophic. A report last week by the Union of Concerned Scientists, an industry watchdog and critic, described a relative handful of cases in NRC records documenting startling operating errors that caused emergency reactor shutdowns and instances where emergency equipment failed to work. In some cases, the causes of problems had been known for months or years without correction, the report said.

"The reality is that equipment can sometime fail. Humans can make mistakes, and these are complex machines," said Anthony Pietrangelo, chief nuclear officer of the NEI. But the overall industry's performance, based on safety indicator benchmarks, is at or exceeding all-time highs, he said. The industry owners understand better than anyone the consequences of a serious failure, he said.

Charles "Chip" Pardee, chief operating officer of Exelon Generation, the largest U.S. nuclear plant operator, acknowledged the operating challenges to the audience at this month's NRC-sponsored conference for nuclear operators. "We have entered a period where we have allowed ourselves perhaps a bit to stray from the basics of high-quality operations, such as quality operator -- control room teamwork, the basic processes by which we operate our power plants 24 hours a day, seven days a week.

"We don't have the quality that we should have when we're out fixing or replacing equipment in our power plants. And associated with that is quality of repairs that that we're able to procure right now. ... We have too many premature [equipment] failures. All those are a high priority for industry," he said.

Addressing the fears from Fukushima

Today, the NRC staff will brief the commission on the staff's response to the worst such crisis in a quarter century -- the devastation to the Fukushima Daaichi nuclear complex in Japan, which propelled fears and issues about nuclear power safety to the front of the world's consciousness.

NRC addressed those fears Friday in a unusual "information notice" to reactor operators that was released to the public to document the actions taken to strengthen U.S. reactors after the Sept. 11, 2001, terrorist attacks. The possibility of a suicide attack on a nuclear reactor by terrorists in a seized commercial jetliner had never

been part of the reaction protection scenarios, officials said then, and NRC ordered measures to protect reactors, control rooms and spent fuel storage pools against the conflagrations that could cause.

Those actions mark a difference between U.S. reactors and Japanese counterparts of the same design, NRC says.

In response to the 9/11 order, issued in 2002, all U.S. reactor licensees have verified their ability to "mitigate conditions that result from severe adverse events," including the loss of crucial operating and safety systems due "natural events, fires, aircraft impact and explosions," NRC said.

The plants can withstand a total loss of electric power -- the "station blackout" condition that crippled the reactor and spent fuel cooling systems at Fukushima. And the plants are adequately protected against flooding from inside or outside the plant and have developed strategies for dealing with potential earthquake damage to critical facilities, the NRC statement said.

NRC and the NEI have noted that the GE Mark 1 design reactors at the Fukushima complex were retrofitted in the United States and installed with hardened vents that would remove hydrogen that escaped the primary reactor containment shell and carry it outside the second containment building. The Japanese reactors lacked that retrofit, Pietrangelo said, and so vented hydrogen collected inside the secondary containment buildings in Units 1 and 3, where it eventually exploded. The U.S. reactor owners made the retrofits, and had they not, NRC would have ordered it, Pietrangelo said. "That's just one example," he said.

The Union of Concerned Scientists agreed last week that changes since 9/11 have indeed strengthened U.S. reactors. "[T]here are more temporary generators, backup generators and firefighting capabilities than we had prior to 9/11," said David Lochbaum, UCS director of nuclear safety.

"While many of our plants may not be vulnerable to the one-two punch of earthquake and then tsunami, many of our reactors are in situations where earthquakes or hurricanes in the Gulf or ice storms in the Northeast or a tree in Cleveland can cause an extensive blackout that puts us in a very similar situation," he said.

Concern about spent fuel ponds

The area of greatest concern is the capacity of backup batteries at U.S. reactors, which in many cases, can last four hours, half as long as most of the batteries at the Fukushima plant, Lochbaum said. The U.S. plants may be able withstand what happened in Japan if battery capacity is increased, he said. "That's a question that remains to be answered."

The pools at the General Electric Mark 1 reactors, implicated in Japan's crisis, are at the top of the reactor building. Other reactor designs place the pools at ground level, where "they're less vulnerable to either acts of nature or acts of malice," according to Lochbaum.

"If I was king for the day or maybe for the week, the first thing I'd change would be our spent fuel pools in the reactors like the one in Japan [which] are almost filled to the brim," Lochbaum said. "And the risks from the spent fuel pools, either from an accident or from an act of malice, are about as high as you could possibly make them."

The new measures ordered by NRC include additional safeguards for the spent fuel pools, including means of adding makeup water and spraying water on spent fuel, two of the desperate measures Japan's Self-Defense Force has used to control radiation from exposed spent fuel at the Fukushima complex. NRC has issued confidential directives on handling spent reactor fuel on a case-by-case basis, but the 23 Mark 1 reactors in the United States still have their spent fuels "in the attic," Lochbaum said.

The actions to strengthen reactors noted in NRC's information notice Friday took years to complete and verify. NRC ordered the additional measures in February 2002. In December 2006, after completing plant assessments, the NEI issued guidelines for meeting the NRC requirements, and the NRC staff endorsed these strategies.

It took until December 2008 for the NRC staff to verify that all of the reactors were in compliance, NRC said.

The response by the industry and its regulator demonstrate the reality that protecting reactors is a function of judgment and economics, Lochbaum said in a phone briefing for reporters last week. Judgment determined how severe a threat reactors must be ready to withstand. Economics plays a crucial part in how far regulators go in demanding safety measures.

Lochbaum said that his predecessor at UCS, Bob Pollard, "used to say that he has no doubts in his mind that you could design and operate an inherently safe reactor, and he has no doubt in his mind that he could -- you could design and operate an inherently economic reactor. Where doubts arose was where you tried to do both. You could design a reactor to be bullet-proof, but nobody's willing to pay for it.So, that's the challenge."

Jaczko described to senators the NRC process that assess natural disaster threats to reactor plants, a methodology based on historical worst-case threats, which adds a substantial margin of protection over that. When new information is received, the calculation is repeated. For example, new data about earthquake severity in the central and eastern U.S. has been compiled by the U.S. Geological Survey and will be used to re-evaluate hazards facing plants. If action is needed, it will be taken, NRC says.

The judgment factor in assessing risk remains, however. One extreme example reviewed recently by the Federal Energy Regulatory Commission, centers on the extreme peril of a once-in-a-century solar flare -- a geomagnetic storm -- that if large enough, could disable large sections of the power, leaving reactors dependent upon diesel-fired backup generation. In that emergency, would the power outage prevent fueling depots to replenish diesel fuel to keep emergency systems working at the nuclear plants until the grid's power could be brought back up? Is that risk considered too remote to be included in the threat scenarios reactors must be prepared to survive?

Building safer new reactors

The spurt of new reactor construction around the world -- including two U.S. projects whose developers are anticipating NRC license approval -- involved new reactors that are generally considered to be safer than the 40-year-old designs built during the nuclear industry's expansion in the 1960s and '70s.

Some experts believe that the reactors designed by France's Areva SA are the safest of the new designs because of the additional redundancy of safety measures and emergency systems, including four emergency response systems and a "core catcher" structure that is meant to capture and spread out molten nuclear fuel that burned through the reactor vessel to prevent a resumption of a chain reaction.

Areva was jolted in 2009 by the loss of $40 billion contract to build new reactors in the United Arab Emirates, which selected a less expensive design from Korean Electric Power Co. Following last week's Japanese crisis, Areva CEO Anne Lauvergeon stressed the high safety standards of Areva's new EPR reactor and its ability to survive earthquakes and plane crashes, noted a report last week in MarketWatch. She told reporters that the EPR would have withstood the 9.0 quake in Japan and the tsunami without leaking. "At one time, the EPR was criticized for being too safe. Today with the Fukushima castrophe that is over," she said.

The NRC's role, however, is to determine whether each proposed reactor design that comes before it is safe, not to assess which design is safest, and make that the standard for approval.

While new designs are seen as safety that the older U.S. reactors, the older models have not remained unchanged.

NRC's Jaczko was pressed last week by Sen. Frank Lautenberg (D-N.J) about the relatively safety of the GE Mark 1 plant and tried to explain that there have been several significant safety improvements to the original design. Moreover, all of the older U.S. reactors are undergoing a constant replacement of pumps, valves, piping, electronics, turbines, steam units and even reactor vessel heads.

Jaczko tried to make an analogy to aircraft that are refitted to keep flying (perhaps thinking of the Air Force B52 bomber, some of which are still in service a half-century after production stopped), but Lautenberg dismissed that reasoning, chastising Jaczko for "poor judgment."

In fact, U.S. reactors undergo changes not merely to retrofit old equipment but to expand the capacity of old plants.

Changes that increase the capacity of existing plants

NRC's website reports that as of January 2008, the commission had approved 116 uprates, resulting in a gain of about 5,200 megawatts capacity -- equivalent to more than five new reactors. Applications for another 5,000 megawatts of uprates are anticipated, according to an October 2009 review in Power Electronics -- equivalent to another five new reactors. The U.S. nuclear "renaissance" thus far is largely a case of renovation.

Uprates require new equipment and so does extending the lives of the existing reactors. The changes can improve safety by exchanging older equipment for improved new versions. But they create opportunities for errors by installers and contractors.

Of the 104 U.S. commercial nuclear reactors, 62 have been approved to operate for an additional 20 years beyond the initial 40-year license period and most of the rest are expected to seek license renewals, including the Diablo Canyon plant near San Luis Obispo, Calif., which faces threats from onshore and offshore seismic faults.

The NRC staff of 4,000 is required to assure continued safe operations in passing on applications for relicensing and uprates, at the same time that it reviews safety of new designs, sites for new reactors and

oversees the hour-by-hour safety performance of existing reactors. While its staff has grown substantially, half have been at NRC less than five years.

NRC documents significant operating "incidents" that its on-site inspectors find or that the reactor owners self-report, and if a pattern of issues appears, the NRC staff will impose steadily increasing inspection requirements, coupled with publicly reported grades on compliance.

The Union of Concerned Scientists and other NRC critics say that the federal commission does not come down hard enough on safety violations. "It isn't their fault," Lochbaum maintains. When NRC leans too hard, members of Congress step in, complaining, "'You are going to put these guys out of business.' So, the NRC, since their budget is controlled by the United States Congress, they listened," he said. NRC and the industry strongly disagree.

The industry's fear of another Three Mile Island accident, and NRC's increased attention, contribute to the outage rate approaching 1 percent from equipment failures and human mistakes, NEI says. The question in the aftermath of the Japanese reactor is crisis is, "Is that good enough?"