

# Earthquake science advances does nuclear safety keep up?

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WASHINGTON The 104 nuclear reactors providing 20 percent of America's electric power were designed and built in the 1960s and '70s, an era when seismologists knew much less about earthquakes than they do today.

Now that Japan's 9.0-magnitude earthquake has focused world attention on desperate efforts to halt the release of deadly radiation and on warnings to parents not to give their young children radiation-tainted tap water in Tokyo, U.S. regulators and nuclear industry advocates are scrambling to convince the public that America's reactors are safe.

To be sure, the Nuclear Regulatory Commission has been attentive to earthquake risk and has done regular assessments and upgrades as warranted over the 40 to 50 years since the reactors were first designed. In sum, the NRC says it's satisfied that all U.S. plants, including those in California in the highest quake-risk zones, are built to withstand the biggest quake that can reasonably be expected, plus an extra margin of safety.

But the increased seismic activity in Japan, New Zealand, Chile, Haiti and elsewhere is raising new questions.

"As we learned in Japan, we believe the strongest we have seen in the past is probably not the strongest we can see in the future," said John E. Ebel, a seismologist and professor at Boston College. "So that's the easy call. The hard call for the seismologist is how much stronger."

One nuclear safety expert, Najmedin Meshkati of the University of Southern California, described the crisis at the four side-by-side reactors in Japan as "a rude awakening" to regulators and the nuclear industry that it isn't enough to offer a pat expression of confidence that "it couldn't happen here."

Therein lies the conundrum for regulators and the industry.

If the estimate of potential earthquake magnitude goes up too much - especially with no concrete evidence of large quakes in an area - engineers will warn about spending too much money to design nuclear plants.

So earlier this week, the NRC announced immediate and long-term reviews of the nation's atomic plants. The agency wants to gauge the plants' ability to survive power blackouts, as

occurred after the earthquake and tsunami hit Japan's northeast coast, or equipment failures and other problems that would hamper the ability to keep the radioactive fuel cool.

The Japan temblor was stronger than anything seen off its eastern coast for a century or more.

Nicholas Sitar, a professor in the civil and environmental engineering department at the University of California, Berkeley, said that seismologists and earthquake engineers have learned an enormous amount in the past 40-plus years about ground motions generated by different types of faults and how the energy from an earthquake is transmitted into structures.

"So it would not be accurate to assume that the older-generation nuclear power plants have not been reanalyzed since they were built," Sitar said.

Scientists today know more about what triggers earthquakes and how the combination of an earthquake's source and site conditions determine damage. New faults have been discovered. In addition, the earth's geology reveals information about big quakes that took place before recorded history.

The only part of the United States where a 9.0-scale earthquake is expected again (geologists discovered that one occurred there on Jan. 26, 1700) is the 750-mile-long Cascadia subduction zone off the coasts of Washington, Oregon and Northern California. A subduction zone - a place where faults in the Earth's crust are wide enough for plates of rock to "slip" past each other - also produced the March 11 Tohoku earthquake in Japan.

Robert Yeats, a geology professor at Oregon State University, was one of the first to suggest in the 1980s that the Pacific Northwest might be vulnerable to a 9.0 subduction zone earthquake.

Today, there are tsunami-warning signs on the coast and a better understanding of earthquake risks in the region affected by the zone, but there are no nuclear power plants there. The only commercial nuclear plant in the Northwest, the Columbia Generating Station near Richland, Wash., is 225 miles from the affected area.

The San Onofre Nuclear Generating Station north of San Diego was built to withstand a 7.0 earthquake centered within five miles of the plant. Southern California Edison, the plant owner, says there hasn't been "significant seismic activities" in the area in 120,000 years.

The San Onofre plant is located within five miles of two faults. Southern California Edison has a seismic program that evaluated the site when the plant's two reactors were built in the 1980s, updated the work in 1995, and re-evaluated it recently, said spokesman Charles Coleman. The company concluded that the plant has the "engineering features, processes and procedures" needed to protect the public if the plant were hit by a 7.0 quake.

In 2008, federal scientists discovered a new earthquake fault a half-mile offshore from California's other nuclear power plant, Diablo Canyon in San Luis Obispo.

Republican state Sen. Sam Blakeslee, a former geophysicist, said this week that detailed studies are needed on the characteristics of that fault and its relationship with another one nearby.

Blakeslee accused PG&E, the owner of the Diablo Canyon plant, of tolerating a "culture of disregarding risk" for not suspending the plant's license renewal activities until better earthquake studies are completed.

PG&E president Chris Johns on March 18 told The Tribune newspaper in San Luis Obispo that the three- to five-year license renewal process allows enough time to incorporate safety information from earthquake studies and from the Japan disaster.

More than 7 million people live within 50 miles of San Onofre, and 424,000 live within that range of Diablo Canyon, California Democratic Sens. Barbara Boxer and Dianne Feinstein said in a letter to NRC chairman Gregory Jaczko last week, asking for a thorough inspection to answer questions about the plants ability to withstand an earthquake and tsunami.

Greg Beroza, an earthquake expert who is chairman of Stanford University's Department of Geophysics, said that scientists still are evaluating the shaking power of earthquakes, but now have supercomputers that can simulate their seismic impact and "begin to explore the range of worst-case scenarios."

That, he said, should help the nuclear industry design future reactors with safety margins.

California's earthquakes are famous, but the east and central parts of the country, where most of the nuclear power plants are, have active seismic zones, too.

The NRC reported last year that seismic experts had determined that, in some parts of the region, there's a greater probability than previously thought that reactors will be rocked by a stronger earthquake than they were designed to withstand.

The commission in 2005 began a review of the seismic durability of 29 reactors at 17 plant sites in the eastern and central U.S., based on USGS data.

The NRC reported that that the increased risk is small, and within the extra margin of safety built into the plants. For now, regulators say, no additional steps are needed to strengthen any nuclear plants to survive an earthquake.

The USGS and the Electric Power Research Institute, which is funded by the utility industry, plan to finish a more detailed model late this year.

"The expectation is that a more detailed analysis will help plants spot tweaks to their design that would improve their ability to deal with what can be expected at the site," said NRC spokesman Scott Burnell.

(David Sneed of The Tribune in San Luis Obispo, Calif., contributed to this report.)