

Nuclear Plants Face System-Wide Earthquake Safety Review

roger6t6 | September 2, 2011 at 12:29 am |



By Roger Witherspoon

The Nuclear Regulatory Commission may force the nation's nuclear power plants to reevaluate their earthquake detection and safety systems and the manner in which they calculate their resistance to earthquakes as a result of unexpected damage to American and foreign reactor complexes caused by recent earthquakes.

The agency has been studying the need to upgrade earthquake protections and evaluations since 2005, in partial recognition of the inadequacy of nuclear plant designs based on the fledgling science of seismology in the 1950s and early 1960s. But the extensive damage to the six-reactor Fukushima Daiichi nuclear complex in Japan, and unexpected damage to the twin North Anna nuclear power plants in Virginia caused by the August 23 earthquake has given new impetus to the NRC's ongoing work. Though the damage to the North Anna Units 1 & 2, about 40 southeast of Richmond, are considered minor, the plants remain shut pending a

special inspection ordered by Victor McCree, director of Region II, which encompasses southern nuclear operations and the construction of any new reactors anywhere in the country.

The decision to send a formal Augmented Inspection Team followed the notification by Dominion Power, which owns and operates the North Anna plants that the ground motion of the Virginia earthquake, measured at 5.8 in magnitude, “may have exceeded the ground motion for which it was designed.”

All of the nation’s nuclear power plants, which were designed in the 1950s and 1960s, were supposed to be able to handle the acceleration of the ground motion and shaking associated with the largest historically recorded earthquake within a 50 mile radius of the site. For North Anna, a ground motion of .12 of normal gravity is the “design basis” incorporated into the plant’s license. That was based on an earthquake of a magnitude 4.8, and the plant was designed to withstand the gravitational tug resulting from an earthquake of 5.1 in magnitude.

McCree said in a statement that “the AIT provides us with the resources needed to completely understand all of the effects at North Anna and gather important information for the NRC’s continuing evaluation of earthquake risk at all U.S. nuclear plants.”

While the major safety and structural systems at North Anna are apparently undamaged, the transformer providing off site power failed, causing an immediate “station blackout” and shutdown. The plant’s diesel generators kept the reactors and spent fuel pools cool until off site power was restored.

“Not only are the operating reactors getting special attention,” said NRC spokesman Roger Hannah, “but we are also looking at the spent fuel pools and the dry cask storage area, where 25 of the 27 casks moved slightly during the earthquake. They weigh 100 tons or so when fully loaded, and it would take significant movement of the earth for them to fall over. But they moved from a half inch to 4.5 inches on their pad.”

It had been thought that the massive concrete and steel dry casks would be impervious to any eastern earthquakes. In this case, said Hannah, none of the casks appear to have been breached.

A Shaky Infrastructure

But on Thursday, the regulatory agency signaled its intention to issue a “generic letter” to all 104 nuclear power plants requesting a new evaluation of the manner in which earthquakes were analyzed and incorporated into their designs, and what steps, if any, may be needed to strengthen the plants and their support systems. A special inspection of all the nation’s nuclear plants after the meltdowns at the Fukushima Daiichi plants this spring discovered that while most plants should be able to withstand known levels of regional earthquakes, their support systems were not protected. In many cases, should an earthquake trigger a fire, the buildings on plant sites housing firefighting equipment, and the water mains from the municipal water systems were not designed to meet any earthquake standards and could be wrecked in a severe earthquake.



In addition, all nuclear plants have miles of underground pipes and conduits – many of these encased in concrete and inaccessible to inspections. Virtually all of the ageing plants have leaked radioactive water into the surrounding environment, primarily through these underground systems, or deteriorated spent fuel pools. New York’s Indian Point plants have continuously leaked into what amounts to a radioactive lake under the plants, about 25 miles north of New York City, which is steadily seeping into the Hudson River.

In New Jersey, the twin Salem nuclear plants in Lower Alloways Creek Township have leaked radioactive water into catch basins flowing into the Delaware River, and the Oyster Creek nuclear power plant, in Lacey Township, is still cleaning up a radioactive leak in 2002 that contaminated Barnegat Bay.

The major problem with the earthquake-proof designs of current operating reactors is that the basis for their calculations was wrong.

“All of these numbers were derived in the late 60s,” said Lyn Sykes, Higgins Professor Emeritus of Earth and Environmental Science at the Columbia University Lamont-Doherty Earth Observatory in New York. “At that time, they didn’t have recordings of earthquakes from the eastern and central part of the US, so they used western earthquakes as models.



“The difference is that for a given sized earthquake, like the last one at 5.8, earthquakes in the east are felt out to a much larger distance. In California, with softer ground, an earthquake is not felt out to a large distance and damage doesn’t occur out to a large distance. And that does call into question the reliability of their standards.”

Last week’s earthquake, Sykes said, was larger than the design basis for Salem 1&2, Hope and Oyster Creek nuclear plants in New Jersey, and Indian Point 2 & 3 in New York. “For the basis of their designs,” said Sykes, “they used the 1884 earthquake off Sandy Hook near the mouth of New York Harbor, near Coney Island – which gave the quake its name. That quake was about 5.25 in magnitude.”

In that case, he said, the energy associated with last week’s 5.8-magnitude earthquake would be about five times the design basis for these nuclear facilities.

As a percentage of gravitational forces, the design basis used in the construction is 0.15 G for Indian Point; 0.184 for Oyster Creek; and 0.20 for Hope Creek and Salem 1&2. The difference in their design requirements is based on the solidity of the rocks they are built on.

Building on Jello

Jon Armbruster a geophysicist at the Earth Institute and co-author with Sykes of an analysis of earthquakes over the last 300 years from Philadelphia to New York, “When they designed these plants, they chose an earthquake and the design basis figure represented how strongly the 1884 quake was felt in the area. There were two other quakes of that magnitude, in 1737 and 1783, and they were felt from Maine to Virginia and caused some chimneys to fall down. The 1884 quake also caused a railway embankment in Peekskill to slump into the river.

In Virginia, the largest earthquake ever recorded was a magnitude 4.8. In the New York City area we have some 300 to 400-year histories and the largest earthquakes known were of a magnitude 5 or 5.3 I don’t think they have been allowing a large enough margin of uncertainty to have planned for a magnitude 5.8.

“What we have learned is that earthquakes around here can occur at a pretty shallow depth. In California, a shallow depth is one or two miles. I’ve been to places around here where earthquakes are not more than 100 meters from the surface. In 1994 there was a magnitude 4.5 earthquake near Redding, Pa., and as closely as we could measure, it was centered 100 yards below the surface. “



When these five regional nuclear power plants were designed, Armbruster added, it was not known that earthquakes could be generated at shallow depths and designers utilized what little data was available from California and other western earthquakes in their planning. “The difference between a California quake and one here was not clearly known back then. Now it is known and quantified that the shaking around here is quite different.

“The nuclear plants in southern New Jersey are not built on actual solid rock, though it is on pretty strong material. To an extent, that reduces the shaking. Each reactor design is different and has its peculiarities of design that need to be individually analyzed in a seismic hazard study.

“It’s like building on jello. If you put the apartment building on jello and you shake the bowl, the jello quivers and the apartment building shakes a lot. To be safe in the earth equivalent of jello you would have to build your nuclear power plant in what amounts to a concrete boat, so it could essentially float when the jello shook and be strong enough to remain standing.”

Jim Norville, a spokesman for Dominion, said the company’s engineers and the NRC inspectors are seeking greater understanding of the differences between east and west coast earthquakes and its implications for the plants critical systems.

We found no significant damage,” he said. But we want a better understanding of why the units shut down.”

So does the NRC. Spokeswoman Diane Screnci said the agency is seeking public comment on a proposed “generic Letter” to plant operators on a review of seismic hazards and design techniques. A generic letter does not carry the weight of an order. Plant managers can dismiss its recommendations by declaring that it is not applicable to their particular operation. But the letter could be turned into an order if there is significant public demand for during the comment period, which is open until October 31. The response from the North Anna inspection and the public input on the generic letter may determine if the NRC mandates retrofitted improvements on existing critical buildings and systems.

Roger Witherspoon writes Energy Matters at www.RogerWitherspoon.com