REMAPPING DEBATE
Asking "Why" and "Why Not"

Nuclear power plant flood risk: Sandy was just a warm-up

Original Reporting | By Heather Rogers | Energy, Infrastructure, Regulation

Dec. 19, 2012 — As Hurricane Sandy approached the East Coast late last October, more than a dozen nuclear power plants from North Carolina stretching up to New England were in its wide-ranging path. On Oct. 29, the night that the eye of the storm made landfall near Atlantic City, New Jersey, five nuclear plants were forced to either reduce power or make emergency shutdowns.

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The most serious event was at the Oyster Creek Generating Station located in Lacey Township, near Barnegat Bay, New Jersey, about 40 miles north of Atlantic City. Amid 75-mile-an-hour winds, power to the region was knocked out, including at the Oyster Creek plant, just before 7 p.m. The plant's backup diesel generators kicked on to keep its crucial cooling equipment functioning. Nevertheless, by 9 p.m. the plant's pumps were facing another danger: rising floodwaters. Nuclear Regulatory Commission (NRC) spokesperson Neil Sheehan said that Sandy brought a surge of 7.4 feet to Oyster Creek. The plant is obligated to prepare for the consequences of flooding at 8.5 feet, he said, and, at 9.0 or 9.5 feet — Sheehan wasn't sure — the plant's pump motors would begin to be flooded.

The storm surge led the plant to declare an "Alert" — the second step in the NRC's four-tiered emergency action system.

David Tillman, spokesperson for Exelon, the utility company that owns Oyster Creek, would not answer specific questions about the evening Sandy hit the plant (such as the height to which the water level rose, the height of the pump motors, or the actions taken by the plant in response to the alert). Characteristically for the industry, he insisted that everything worked perfectly and that there were no problems.

The buffer that existed this time may be of little comfort in the future. For all the damage it caused, Sandy was only a Category 1 hurricane — Hurricane Katrina, by comparison, was a Category 3. Given the challenges even Sandy brought to the Northeast's nuclear power plants, Remapping Debate decided to investigate the extent to which these facilities are prepared to deal with the flood risks widely expected to increase as a result of global warming.

What would be the consequences were a nuclear power plant to flood?

To grasp what a flood at a coastal nuclear power plant such as Oyster Creek would mean, Dave Lochbaum, director of the Nuclear Safety Project at the Union for Concerned Scientists, told Remapping Debate it is worth reflecting on Japan's Fukushima Dai-Ichi nuclear power plant disaster in 2011. First, the plant — which ran on General Electric Mark I reactors, the same design as at Oyster Creek and 22 other nuclear plants in the U.S. — lost outside power due to the earthquake. Its backup generators switched on, and "the plant weathered [the earthquake] pretty well," Lochbaum said. But then the floodwaters arrived, exceeding the facility's sea wall. "That plant wasn't unaware of the flooding potential, but the magnitude of the challenge they faced was just more than they could handle," he said. Because the backup generators and pumps were flooded, there was no means by which to keep the reactors and spent fuel pools cooled.

Once that happens, explained Michael J. Reilly, director of the Division of Planning and Response at the National Center for Disaster Preparedness at Columbia University, "it's just a matter of time before the heat and the pressure build up and then you have a reactor accident."

In the worst-case scenario, overheating in the reactor can trigger a hydrogen explosion, which can in turn lead to a breach of the containment structure, the reinforced building in which the reactor core is housed. This would lead to an uncontrolled release of radiation into the atmosphere.

In the case of a natural disaster like a hurricane, the direct impact on a single nuclear power station would likely be exacerbated by a cascade of indirect effects: a range of emergencies and failures unfolding throughout the surrounding area.

Without an adequate flow of coolant to the spent fuel pool, the heat from the rods would begin to boil the water that remained, which would then evaporate, leaving the rods exposed to the air. At that point, the spent fuel could catch fire and explode, also leading to an unchecked release of radioactive material.

These explosions and fires can damage containment structures, as occurred at the Fukushima Dai-Ichi plant, with some of its buildings reduced to shattered cement and twisted rebar. Ultimately, all of its six reactors were damaged, and three reactor cores melted down, dumping a massive amount of radioactivity into both the water and air. This release led to significant food-chain contamination and the evacuation of 70,000 people. Among the contaminants emitted from the plant was Cesium-137, a radioactive isotope with a long half-life that continues to be found in fish as far away as California.

In the case of a natural disaster like a hurricane, the direct impact on a single nuclear power station would likely be exacerbated by a cascade of indirect effects: a range of emergencies and failures unfolding throughout the surrounding area. As during Sandy, transportation would be radically curtailed with roads, bridges, tunnels, trains, and airports shut, as well as some roads blocked by floodwaters, felled trees, and large-scale debris. There could also be widespread power and water outages, fuel shortages, and downed communication lines.

The indirect effects would likely impair the response to a nuclear power plant disaster. When Hurricane Sandy hit, for example, almost a third of the sirens surrounding Pennsylvania's Peach Bottom Generating Station near Chesapeake Bay that would warn residents within 10 miles of an emergency were inoperable. The NRC-required backup plan for this situation is for first responders to drive around the area with a loudspeaker announcing the emergency. When Remapping Debate asked the NRC's Sheehan how this would happen if roads were flooded and blocked, he said the plant could send out text messages and announcements on television. What if there was no power and cell reception was down? "That's always a concern," he said.

Attempting to evacuate in the midst of a hurricane, Reilly said, is "trying to get out when the window for evacuation is over."

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> — Neil Sheehan, NRC spokesperson

Dr. Andrew S. Kanter, president of Physicians for Social Responsibility and an associate professor at Columbia University, said that it is not realistic in today's circumstances to assume that all key emergency facilities would be fully operational during a severe storm. During Sandy, for example, three major New York City hospitals lost power and were forced to evacuate.

"If there was a significant [nuclear] accident that took out all the hospitals in New York City, there's not enough hospital beds in the entire region to relocate all of those people," Kanter explained. "We're running at maximum efficiency right now [in hospitals] and there isn't a lot of excess reserve."

The likelihood and level of such calamities depends on the intensity and scope of the storm. As Reilly pointed out, for all the havoc it wreaked, Sandy was a mere Category 1 hurricane. "This wasn't the level of a Hurricane Katrina; it wasn't that devastating of a natural disaster — this was a very basic hurricane," Reilly said. "But the fact that it affected so many [nuclear power] facilities in that they seemed to have to shut reactors down, or de-power reactors, or the pumps failed, or they had to go onto generator power, or whatever the specific incident was, I think points to vulnerabilities," he said. "That says to me that these facilities need to be hardened more because if they were faced with a Category 2 or a Category 3, it makes me concerned about whether or not they'd be able to safely shut down."

Are nuclear power plants becoming more exposed to flood risks?

While climate scientists, including Dr. Michael Oppenheimer, the director of the Program in Science, Technology and Environmental Policy at Princeton University, currently project that the *frequency* of tropical cyclones such as hurricanes will stay the same, or even decrease, the *severity* of these storms is expected to rise. This is the result of warming ocean surface temperature, due to increasing atmospheric temperatures. "There will be a shift from less intense, say, Category 1 and 2 hurricanes, toward more intense hurricanes," Oppenheimer said.

Amplifying the effect of these more powerful storms will be a rise in sea level. “So there are two things expected to happen simultaneously which will increase surge levels in the future,” explained Oppenheimer. Consequently, he said, “Planning for any [nuclear] installations along the coast needs to keep that in mind.”

Does the NRC currently factor increased flooding risk due to climate change into its safety requirements?

Sheehan, the NRC spokesperson, said that the agency has not factored in the effects of climate change on nuclear plants’ flood safety.

According to Sheehan, the new NRC chief, Allison M. MacFarlane, recently told the agency’s staff that she wants to start taking into account climate change in nuclear plant safety. However, she has issued no official call, schedule, or process to include it in the NRC’s current or future regulations.

What’s more, the NRC has yet to even conduct a study focused on the risks to coastal plants of rising sea levels and storm surges caused by global warming. “We’re not at that point yet,” Sheehan said.

Nevertheless, Sheehan claimed that Oyster Creek and all the other nuclear power plants in Sandy’s path would have been fine if they had been directly hit by the storm.

Does the NRC have plans to close any nuclear power plants because of increased vulnerability to flooding?

No.

What is the NRC doing to require nuclear power plants to better withstand flooding and its consequences?

In March 2012, the NRC issued updated flood-safety “recommendations” in response to the disaster at the Fukushima Dai-Ichi plant. The recommendations require the country’s 65 nuclear power plants — which operate 104 reactors — to conduct internal assessments to ensure their facilities meet updated flood- and seismic-risk guidelines. If these reevaluations reveal inadequacies, then the facilities are required to develop remedial plans for NRC approval, and, when approved, implement those plans. But, as of now, the post-Fukushima recommendations issued by the NRC do *not* require the country’s nuclear power plants to assess their facilities in light of projected future consequences of global warming, such as a rise in sea level and more extreme storms.

The NRC is enacting its post-Fukushima recommendations in three tiers, the first of which has a deadline of 2017. However, the remaining two rounds currently have no due dates, and none of the rounds requires planning for current and future effects of global warming.

To some people, the NRC's timeline of five years for the completion of Tier 1 reassessments and changes, and the lack of deadlines for Tiers 2 and 3 is unacceptable. Among the critics is Gregory P. Jaczko, former chairman of the NRC, under whose tenure the recommendations were studied, written and issued. (Jaczko left the agency in July of this year.) He would have preferred all recommendations be carried out in a single phase as opposed to divided into three tiers, and he thinks *all* of the changes could and should be made quickly.

"I still think the right answer would have been to shoot for five years," Jaczko told Remapping Debate. It would be a lot of work, he said, noting that plants would have to bring in outside engineers, hydrogeologists, and other experts to conduct analyses and plan improvements, not to mention construction crews to make the changes. Doing so, he added, would be expensive. But neither point justifies delay, he said. "Make the metric not 'How long is this going to take us?' but 'What do we need to do in order to get it done in five years?'"

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One factor impeding faster upgrades, as Jaczko sees it, is that the NRC tends to accept the claims of many plants that assessments, analyses, and improvements can only be done when a plant shuts down a reactor for regularly scheduled refueling and maintenance, which happens every 18 to 24 months.

Indeed, Sheehan, the NRC spokesperson, takes the schedule defined by the plants' refueling windows as a given when explaining the five-year time frame for the completion of Tier 1.

Jaczko had a different view. "Changes can be made at any time if they're necessary for safety," he said. "There's no law that prevents the NRC from requiring changes during the period between scheduled outages."

What are some basic flood mitigation strategies that could be implemented quickly?

Arnie Gundersen, a former nuclear industry executive and current chief engineer at Fairewinds Energy Education, a non-profit organization critical of the nuclear industry, offered ideas for what could be done in the near future to safeguard against flooding at coastal nuclear plants.

He suggested protecting each nuclear plant's pump motors against floodwaters by reinforcing them. First, that means locating the motor in a watertight room — with no windows and a sealed flood door —

as some plants have already done. But, Gundersen said, that's not enough, because although the room is sealed, it is not designed to accommodate a surge that puts continued pressure on the structure. If the water reaches high enough levels, it can begin to undermine the room's integrity. Because of the pressure "you'll still get the water squirting in, so you have to make a sealed pump in a sealed room," he said.

Reilly of the National Center for Disaster Preparedness said that upgrades like those suggested by Gundersen, as well as higher flood walls, could and should be put in place at relevant sites immediately.

Above and beyond the physical changes at plants to mitigate flooding, there are important questions about the culture of nuclear regulation that some say need to be addressed.

Reilly thinks the NRC should take a more active role, either itself or through an independent third party, in auditing plants and formulating their upgrade plans instead of the plants doing those tasks themselves, as is currently the practice.

Lochbaum of the Union of Concerned Scientists discounted the utility of deploying independent third parties, saying that the NRC itself should be held accountable for regulating plant safety. One way to do that would be for Congress to hold the agency to safety deadlines in the same way that it now holds the agency accountable for meeting deadlines regarding "business items," such as plant-owner requests to extend the period for which a reactor is licensed, and to increase the amount of power the reactor is permitted to generate. Currently, Lochbaum said, the agency allocates far fewer staff and resources to its safety work than to those business items, and rarely sets safety deadlines that it keeps.

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