

Energy Matters

[Riding out the Storm: Sandy vs. the Nuclear Plants](#)

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By Roger Witherspoon

The roaring winds, at times approaching 100 miles per hour, were relentless as Hurricane Sandy pushed the Atlantic Ocean towards the eastern seaboard.

The sheer breadth of the Superstorm, with hurricane-force winds radiating some 250 miles from Sandy's eye, meant 34 nuclear power plants from North Carolina to Vermont would experience extreme weather. While the winds themselves posed little danger to the primary physical structures at nuclear installations, the storm was bound to send trees crashing into utility lines and transformers, causing station blackouts which, along the coasts, could well be accompanied by flood waters. In the latter cases, Sandy would provide a test of some of the safety improvements ordered by the Nuclear Regulatory Commission in the wake of the triple meltdown at Fukushima Daiichi in 2011.

At particular risk were nuclear plants along the coastlines of New Jersey and New York, directly in the path of the strongest part of the hurricane.

Massive amounts of ocean water were pounded into storm surges sweeping up the Delaware River and other coastal tributaries along the Jersey Shore; or rammed through Long Island Sound and squeezed up the Hudson River. The combination of storm surge and wind would trigger the declaration of an “alert” at the Oyster Creek on Barnegat Bay, and a forced atmospheric steam vent at the nearby Salem 1 nuclear plant along the Delaware River in New Jersey. In New York, the twin Indian Point plants rode out floods along the Hudson River, but Indian Point 3 and Nine Mile Point 2, upstate near Syracuse, were shut down by malfunctions caused by hurricane force winds.

In the view of the NRC, the plants all functioned as designed, even if the weather was unpredictable and some problems were not expected. Eleven northeastern nuclear plants in the direct path of Sandy – including all four in New Jersey – were placed on a special alert status several days before the storm struck that featured additional federal monitors and plans to shut down if the winds or waves exceeded pre-determined storm limits.

That special watch list included Calvert Cliffs in Lusby, Md.; Peach Bottom, in Delta, Pa.; Three Mile Island 1, in Middletown, Pa.; Susquehanna, in Salem Township, Pa.; and Millstone, in Waterford, Conn. None of these were as hard hit as the plants in New Jersey and New York. Millstone 3 and Susquehanna 2 reduced power to 75 percent to accommodate strained regional power grids. But the others operated throughout the storm at 100 percent power.

New Jersey was a different case. As the Superstorm approached, plant officials tested their backup generators and topped off their diesel generator tanks in case they were cut off from the grid and had to rely on their own power to keep reactors and spent fuel pools cooled.

At high tide the Delaware River running past Artificial Island, home to PSE&G’s Salem 1&2, and Hope Creek nuclear power plants, has a normal depth of 89 feet. Salem 1 and Hope Creek were running at full power, while Salem 2 and Oyster Creek were shut for refueling and maintenance. Joe Delmar, spokesman for PSEG Nuclear, said refueling operations were suspended Sunday at 6 PM and unnecessary workers had been sent home.



Under NRC guidelines, Salem and Hope Creek had to shut down if there were sustained winds of 74 miles per hour or the river reached 99 feet in depth. The plants' "design basis" states the sea wall would repel water up to 120 feet, a level only anticipated with a Category 4 hurricane.

But Delmar said the storm pushed water levels in the Delaware River Monday night to 98 feet, and "the winds created additional waves approximately 12 feet high."

That was problematic. Hope Creek has a massive cooling tower to cool the hot water and steam generated by its reactor. Salem, on the other hand, uses the Delaware River to form a critical third loop in a three-part, "once-through" cooling system. The first, or primary loop, is the water superheated to 549 degrees within the reactor and piped through thousands of small tubes within the steam generators. The reactor system is pressurized to 2,235 pounds per square inch to keep the water liquid. The standard home water heater operates at 35 pounds per square inch of pressure.

The second loop is relatively clean water which flows over the tubes in the steam generator, is heated to steam, and then blows over the fans on the 40-ton electric generating turbine. The steam then flows over a heat exchanger featuring the third loop, containing cold Delaware River water. The steam is cooled, condenses back to a liquid, and is piped back to the steam generator to complete the power cycle. The warm water in the third loop is returned to the Delaware River.

But just after 4 AM Tuesday morning, while Sandy's eye was barreling down on the Jersey Shore, the high waves in the river swamped four of the six massive pumps in a building along the river's edge which pull in the water through a 40-foot wide conduit jutting into the river. The loss of these pumps caused a chain reaction of events:

- The loss of river water meant the steam in the secondary loop was no longer being condensed, sending hot steam back into the carefully calibrated system.
- The added work load, coupled with accumulating junk clogging Salem's underwater intake pipe, caused the two remaining pumps to fail.
- With its cooling system compromised, operators stopped the fission process by

slamming the boron control rods into the reactor.

Now, however, operators faced the problem of what to do with the heat in the reactor. The automated system opened a relief valve and thousands of gallons of superheated water from the steam generator were released in an “atmospheric steam dump.”

“It sounds like a train whistle from a steam locomotive,” explained David Lochbaum, nuclear safety expert with the Union of Concerned Scientists and a former consultant to the NRC and Oyster Creek. “People who live near the plant can hear it, and it looks like a steam blast. You can see it from quite a distance away.”

The steam may contain some radioactive particles which were in the reactor’s water and escaped into the secondary loop through minute cracks in the steam generator’s tubes. But the amount is small and, according to the NRC barely detectable.

“The irony is that the plant routinely vents radioactive gas into the atmosphere,” said Lochbaum, “and if Salem had stayed up and running the amount of radiation released through those pathways is almost always higher – and less dramatic – than anything in the steam vents.”



Oyster Creek faced a different problem. The wind and water knocked out 36 of the 43 Emergency Planning Zone sirens needed to warn the more than 100,000 residents within 10 miles of the site of any major emergency. Then just before 7 PM Monday, officials at Exelon, which owns the plant, declared an “Unusual Event,” the lowest of four levels of nuclear alert, due to high water in the intake building controlling the plant’s cooling system. At the same time, the regional grid shut down and the plant had to rely on its diesel generators to keep its safety systems operating.

Oyster Creek is a boiling water reactor, the same type as those at the ill-fated Fukushima Daiichi in Japan. Its spent fuel pool is on top of the reactor and both are in the same containment building. Exelon elevated the plant’s status to the second level “Alert” status as its generators took over efforts to keep the spent fuel pool cooled.

“It was a very quick switchover,” explained NRC spokesman Neil Sheehan. “The system sensed there was a problem with the loss of outside power lines, and switched over to the diesel generators. At the same time, it isolated the containment building and shut off venting valves.

“The problem with the rising water was that if the water got high enough the motors for the large pumps would be knocked out of service. If that occurred, they would have to go to other options, including the use of portable pumps, or connecting to the main fire suppression system using city water to keep the spent fuel pool cool.”



About 150 miles north, the Hudson River was rising rapidly. There was virtually no rain in the region, an unusual occurrence with a hurricane. The storm had been expected to dump a foot or more of rain on the region between Manhattan and West Point, and some 400 miles of streams feeding into the Hudson would have added to the storm surge rushing to Indian Point. As it was, a pair of Cougar Military Transport trucks headed for nearby Camp Smith stalled in four feet of river water two miles from the nuclear plants. Yet the plant’s intake pipes remained clear and dry.

But Sandy’s winds hurled debris into the transformer yard at Indian Point 3, causing one of its main breakers to fail and cut the plant off from the grid. This triggered an immediate shutdown though its sister plant, Indian Point 2, was unaffected and the rising river rolled on by.



The following is a summary of U.S. nuclear power plant performance during Hurricane Sandy:

North Carolina:

Brunswick 1 and 2—continued operating at 100 percent power.

Virginia:

Surry 1 and 2—continued operating at 100 percent power

North Anna 1 and 2—continued operating at 100 percent power.

Maryland:

Calvert Cliffs 1 and 2—continued operating at 100 percent power.

New Jersey:

Oyster Creek—shut down for refueling outage; alert declared Oct. 29 due to high water level at water intake structure

Hope Creek 1—continued operating at 100 percent power

Salem 1—manual safe shut down from 100 percent power on Oct. 30 due to high water level at water intake structure

Salem 2—shut down for refueling outage.

Pennsylvania:

Peach Bottom 2 and 3—continued operating at 100 percent power

Three Mile Island 1—continued operating at 100 percent power

Limerick 1 and 2—safely reduced power from 100 percent to 50 percent and 22 percent respectively on Oct. 30 due to storm effects and at the request of the regional electric grid operator

Beaver Valley 1—continued operating at 100 percent power

Beaver Valley 2—shut down for refueling outage

Susquehanna 1—shut down for turbine inspection

Susquehanna 2—continued operating at 75 percent power.

Ohio:

Perry 1—safely reduced power from 100 percent to 91 percent on Oct. 30 at the request of the regional electric grid operator

Davis-Besse—continued operating at 100 percent power.

New York:

Indian Point 2—continued operating at 100 percent power

Indian Point 3—manual safe shut down from 100 percent power on Oct. 30 due to an electric grid disruption

Ginna—shut down for refueling outage

Fitzpatrick—continued operating at 100 percent power

Nine Mile Point 1—manual safe shut down from 100 percent power on Oct. 29 due to an electric grid disruption

Nine Mile Point 2—continued operating at 100 percent power.

Connecticut:

Millstone 2—shut down for refueling outage

Millstone 3—safely reduced power from 100 percent to 75 percent on Oct. 29 at the request of the electric grid operator.

Massachusetts:

Pilgrim 1—continued operating at 100 percent power.

New Hampshire:

Seabrook 1—shut down for refueling outage, but safely restarted Oct. 30 and is at 20 percent power.

Vermont:

Vermont Yankee—safely reduced power from 100 percent to 90 percent on Oct. 30 at the request of the regional electric grid operator.

Source: Nuclear Energy Institute (www.NEI.org)