After Fukushima, Utilities Prepare for Worst

Credit Steve Ruark for The New York Times

Lessons From Fukushima

Three years after a meltdown at the Fukushima Daiichi power plant, the crisis is still unfolding. In the United States, the disaster served as a warning to the nuclear industry.

PEACH BOTTOM, Pa. — Stored near the twin nuclear reactors here, safely above the flood level of the Susquehanna River, is a gleaming new six-wheel pickup truck with a metal blade on the front that can plow away debris from an earthquake or other disaster. Attached to the back is a trailer that carries a giant diesel-powered pump that can deliver 500 gallons of water a minute.

If the operators at the Fukushima Daiichi plant in Japan had owned suchequipment when the tsunami struck three years ago Tuesday, they might have staved off disaster, plant operators say.

Now, here at the Peach Bottom nuclear plant, which has the same design as Fukushima Daiichi, engineers and technicians are busy applying such lessons, preparing for a worst-case scenario even worse than the plant's designers envisioned in the 1970s.

"After Fukushima, we have to ask, what if we were wrong?" said Michael Pacilio, Exelon's chief nuclear officer, showing off the truck and other purchases.

Exelon operates 17 of the 100 commercial power reactors in this country, and expects to spend $400 million to $500 million in post-Fukushima upgrades.

Cooling towers at the Peach Bottom Atomic Power Station, whose reactors are of the same design as those at Fukushima.
Credit Steve Ruark for The New York Times

The truck — there are three of them here — is one of many such changes. And there are a lot of other purchases, inspired by trips by Mr. Pacilio and his counterparts to the stricken Fukushima plants. These include simple gear like army-style cots, buckets with seats that can be used as latrines, generators on wheelbarrow-like carts that resemble the ones sold at home improvement stores, and portable lighting.

If the experience at Fukushima taught anything, it was that if an earthquake or flood strikes, the reactors may have to cope with only what is on hand, at least for the first few hours.

But outside help may also be needed. Going up soon at a building near the FedEx hub in Memphis, and at a site near an airport in Phoenix, are industry depots, each with five "kits" including pumps, hoses and other emergency gear, 20 truck trailers comprising a single kit, deliverable to any reactor in the country within 24 hours.

The whole industry, despite using vastly different reactor designs, has devised a standard for hose fittings, pump types and other basic backup equipment.

It is an unusual level of coordination for a fragmented industry.

Many of the changes to hardware built into the plant, like pipes and cables, will be made this spring and fall, when reactors around the country shut down for refueling. Plumbers and electricians will swarm over the reactors' innards to allow the new portable hardware to work. Plumbers will install connection points where emergency pumps could force water into critical spots if the permanent pumps failed because of loss of electricity, as happened at Fukushima Daiichi after the tsunami, leading to the triple meltdown. Electricians will create connections where portable generators could be used.

"Fukushima woke up the world nuclear industry, not just the U.S.," said the chairwoman of the Nuclear Regulatory Commission, Allison M. Macfarlane, in an

interview. “It woke everybody up and said: ‘Hey, you didn’t even think about these different issues happening. You never thought about an earthquake that could create a tsunami that would swamp your emergency diesel generators and leave you without power for an extended period. You never planned for more than one reactor going down at a site, you have to think about that now.’ ”

At Peach Bottom, though, the plant’s designers did prepare for some situations, like a flood. Plant officials here proudly show off the “submarine doors,” at the entry to the emergency diesel generators. These open with a turn of a giant crank, like an old bank vault, and would let the diesel generators continue running even if the river’s water level somehow rose 20 feet. Diesel fuel tanks, which sat in front of the reactors at Fukushima Daiichi and were washed away by the tsunami, are buried here and would continue to function if submerged.

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Still, big fixes are needed.

Michael Pacilio is Exelon’s chief nuclear officer.
Credit Steve Ruark for The New York Times

Even before Fukushima, the United States Geological Survey updated its earthquake risk estimate for the eastern and central United States, and the nuclear plants have until the end of this month to say whether the new estimates predict a ground motion above what they are designed for.

Several are also reanalyzing for flood risk, including the chance of failure of an upstream dam. At Peach Bottom, tour guides show off a series of gray boxes that played a crucial, and tragic, role at Fukushima: these are the electrical devices that eventually move valves, power motors or perform other essential functions. At Fukushima, all were flooded with seawater, rendering them useless even if the plant still had electricity. Here, they are too high to flood, engineers say.

But there were other vulnerabilities exposed by Fukushima, and reducing them will take time because most of the work cannot be done while the plant is running. In the design used at Peach Bottom, the area immediately surrounding the reactor is pumped full of nitrogen during operations, so no one could breathe in that space.

But the reactors are seldom shut. To get more work out of the reactors — the goal is to run them 94 or 95 percent of the hours of the year — they are loaded with enriched fuel so that they need to shut down only once every two years for refueling.

With some decisions yet to be made on what exactly the American reactors should do, government officials say that the improvements could stretch out 10 years beyond the accident, which occurred in March 2011.

A major change will be to improve the vents that are supposed to allow excess steam and hydrogen to escape early in an accident, when there is very little radioactive material in the gas to be vented. Plants like Peach Bottom already

have them, but running them without electricity would be difficult. Making them more reliable is a priority, but will take time.

David Lochbaum, who has worked at several plants of the Peach Bottom and Fukushima design and is now with the Union of Concerned Scientists, a group generally critical of nuclear safety, pointed out, "If an accident occurred tomorrow that the reliable hardened vent would have solved, it makes it hard to explain."

Mr. Lochbaum praised the overall strategy, which is to have a plant be able to cope with loss of power for 72 hours, until, as he put it, "the cavalry comes over the hill" with more equipment from the emergency supply depots, delivered by truck, barge or, if necessary, helicopter. But heavy reliance on human operators to run into the plant and use muscle on a variety of parts that are normally operated remotely by electricity could be a problem if the area is filled with steam or radiation, he said. Failing to operate the parts could make it "a suicide mission," he said.

The Fukushima improvements are being introduced into a highly structured environment. In the control room, when an operator announces an update, the others will all turn to that person and say, "listening," and raise a hand. The supervisor gives a command, the operator repeats it, and the supervisor confirms he has heard the repetition.

Even if the threat seems remote, the industry and the regulators feel an urgency.

Mother Nature hit Fukushima harder than the designers expected, and they had to cope with trouble at more than one reactor at a time, two surprises that could hit an American plant, said Dr. Macfarlane of the Nuclear Regulatory Commission. With that experience in the rear view mirror, "Woe unto us if we don't respond properly," she said.