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U.S. Sounds Alarm on Radiation

By NORIHIKO SHIROUZU and REBECCA SMITH



Nuclear physicist James Acton and WSJ's Lee Hotz discuss whether Japan can avoid nuclear disaster as workers scramble to cool the overheating spent fuel at the Fukushima Daiichi power plant.

TOKYO—Fear about radiation dangers posed by Japan's nuclear crisis spiked as the U.S. instructed its troops and citizens to stay at least 50 miles away from the crippled reactors—establishing a "no-go" zone far wider than the buffer recommended by the Japanese government itself.

Snow Falls, Rescue Continues

And in a vivid sign that Japan's leadership is trying to move decisively to take control of the deepening crisis, the nation's military force dispatched two helicopters Thursday morning local time to dump water over the crippled Fukushima Daiichi power complex in hopes of taming its dangerously overheating nuclear facilities. The effort targeted a pool of spent



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REUTERS

Snow falls Wednesday as rescue workers search a devastated factory area in Sendai, northern Japan.

nuclear fuel at reactor No. 3. Defense Minister Toshimi Kitazawa said the water would help cool the spent fuel, lessening the risk of a catastrophic fire, if the water hit its target.

Mr. Kitazawa also said 11 water-cannon trucks were to be deployed at the plant Thursday afternoon in a further effort to cool the overheating waste.

Japan's nuclear regulator also announced that it was working to connect outside power cables to two of the units at the stricken plant, in hopes of restarting their cooling pumps. They hoped to

have the cables available by Thursday afternoon.

Restarting the pumps would mark a major advance in the effort to prevent the nuclear disaster from worsening.

Japan's widening government involvement came as international skepticism built up. Late Wednesday, the U.S. State Department authorized the [voluntary evacuation](#) of dependents of U.S.-government personnel based in northeast Japan.

Earlier in the day, the top U.S. nuclear regulator, Gregory Jaczko, called radiation levels at one of the plant's units "extremely high," adding that, "for a comparable situation in the United States we would recommend an evacuation for a much larger radius than is currently being provided in Japan."

Previously the U.S. had agreed with Japanese officials that a 12-mile evacuation zone was adequate. The change came after the NRC ran computer-modeling exercises using "the best available information we have" about the damaged reactors along with accumulated knowledge about how systems inside nuclear plants perform under "severe accident conditions," a spokesman with the Nuclear Regulatory Commission said.

Asked why the U.S. set a broader "no-go" zone than did Japan, government spokesmen Yukio Edano said in a press conference that it was understandable to make a more "conservative decision" when trying to ensure the safety of citizens abroad, in a country where it doesn't exert direct control. He reiterated that Japan's government feels it is taking appropriate measures.

Also on Wednesday, the U.K. government advised its citizens in the city of Tokyo, a full 150 miles from the nuclear site, to "consider leaving the area" due to increasing infrastructure problems. The European Union's energy chief, Guenther Oettinger, also declared the Fukushima Daiichi site "effectively out of control." A spokeswoman for Mr. Oettinger later said the commissioner's remarks reflected his own personal views, and weren't based on privileged information.

Stock markets staged large swings, reflecting the depth of anxiety world-wide. "Every investment decision is made through the prism of what is going on in Japan," said Phil Orlando, chief equity strategist at Federated Investors. The Dow Jones Industrial Average closed 2% lower at 11613. Thursday morning, Tokyo shares slid 2.1%.

Late Wednesday, the U.S. Environmental Protection Agency said it was deploying additional radiation monitors out of "an abundance of caution." The EPA already monitors the air for radiation via a national network of approximately 140 stationary and mobile devices. The agency said it sent additional monitors to Alaska and plans to send some to Hawaii.

Officials with the U.S. Nuclear Regulatory Commission and the Energy Department say they don't expect harmful radiation levels to reach the U.S.



Japan's nuclear crisis deepened as a fresh fire broke out in a quake-ravaged nuclear complex and expats fled Tokyo over warnings of radiation leaks. WSJ's Mariko Sanchanta and Yumiko Ono discuss.

As part of the government effort to take on a larger role in the crisis management, on Wednesday plant operator Tokyo Electric Power Co., or Tepco, said 20 government officials had moved into the company's offices as part of a joint crisis headquarters.

The government's use of helicopters to dump water on the site was ordered by Economics Minister Banri Kaieda. "The minister considered the situation to be dangerous and judged there was an imminent necessity to issue the order,"

said a spokesman for the Nuclear and Industrial Safety Agency, which is part of Mr. Kaieda's purview. "After learning that Tepco was not injecting cooling water, he judged it to be very dangerous."

Two helicopters made two trips each, scooping up tons of seawater in a massive bucket and then trying to dump it into a pool used to store waste-fuel at reactor No. 3. An earlier explosion had blown the roof off of the building, exposing the storage pool and making the helicopter mission possible.

Survivors' Stories



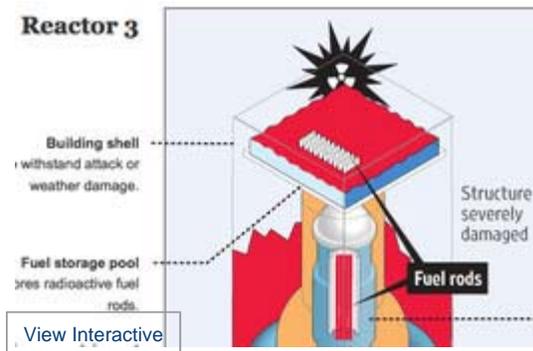
Inside the Reactors

Because of radiation risk, the helicopters had to maintain considerable altitude. A government official said it wasn't yet clear whether the water hit its target.

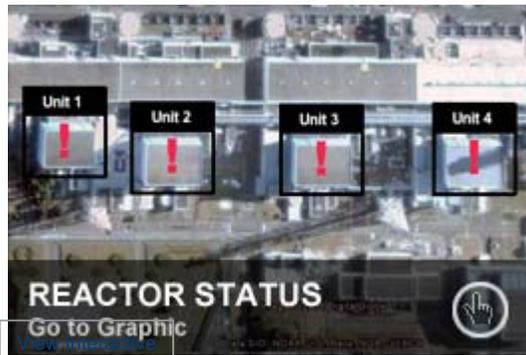
The race to build an emergency power supply for the crippled plant, combined with details from the early moments of the crisis, highlight new questions about the design and safety record of the facility, which is Japan's oldest.

Common to all nuclear plants is this fundamental design problem: Engineers try to make the equipment impervious to one threat, but that may make it vulnerable to another.

In this case, the Fukushima Daiichi nuclear complex's back-up diesel-powered generators were built below ground level. This bunker-like positioning would protect the generators from



Reactor Monitor



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earthquake. The three active reactors shut off automatically as designed, but a lack of electricity left workers unable to operate their cooling systems, leading to overheating. Tepco says the tsunami paralyzed all but one backup generator.

an air strike, cyclone or typhoon—but made them more vulnerable to an earthquake-driven tsunami.

When last week's giant waves struck, they immobilized the generators despite being designed to protect against water. The tsunami also apparently washed away the generators' fuel tanks, which were above ground.

"The earthquake and tsunami we had last week both exceeded our engineering assumptions by a long shot," said Tetsuo Ito, head of Kinki University's Atomic Energy Research Institute, near Osaka. "The nuclear industry around the world probably will have to review how we set those assumptions in designing a nuclear power plant."

Another area of scrutiny is the proximity of the plant's six reactors to one another. Damage to one reactor contributed to damage to another, and their proximity hindered a recovery.

This arrangement can be found at other plants, because it can make it easier to move equipment around and helps to keep a smaller work force, said Mr. Ito. But now it looks like a "bad idea," he said. "We need to strike a better balance of operational efficiency and safety."

Terry Pickens, director of nuclear regulatory policy at Xcel Energy Inc. of the U.S., said there is no cookie-cutter reactor of the vintage of the Fukushima units because utilities in those days hired their own engineering firms and architects, and customized the plants' designs. At Xcel's Monticello plant in Minnesota, diesel generators are kept as far apart as possible so that "a natural phenomenon isn't likely to take both of them out," Mr. Pickens said.

The Japanese plant lost power during Friday's

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*I
wouldn't bet against the
Japanese, folks. They are
human and flawed like the
rest of us but if I had to pick
a group to tackle a knotty
problem like this one, it
would be them. They will
stabilize that plant.*

—Stephen Fitzgerald

however, was about 10 times as big as that theoretical maximum.

In the U.S., where there are 23 similar reactors operated by 11 different companies, backup generators typically are housed in bunker-like buildings at ground level. They are designed with watertight fittings that are intended to keep out water from floods or hurricanes.

General Electric Co. designed three of the six reactors for Tepco at the Daiichi complex but it didn't determine the layout of every piece of equipment, a company spokesman said. Some of that was done by architects and engineers hired by Tepco. He added that the main problem was the larger-than-expected tsunami, not the generator placement.

The Daiichi plant was central to a falsified-records scandal a decade ago that led Tepco to briefly shut down all its plants and led to the departure of a number of senior executives. Nuclear experts say that led to a number of disclosures of previously unreported problems at the plant.

—Yuka Hayashi, Miho Inada, Andrew Morse, Tennille Tracy and Nathan Hodge contributed to this article.

In a weekend briefing, Tepco Managing Director Akio Komori cited the elevation of the backup generators as one potential issue. A Tepco spokesman confirmed the remarks, adding that a full probe will have to wait while workers try to bring the reactors under control.

A spokesman for Japan's Nuclear and Industrial Safety Agency, the nation's nuclear-power regulator, said Fukushima Daiichi's emergency-generator design is "fairly prevalent" at other Japanese plants. The spokesman, Shigekatsu Ohmukai, disputed that the elevation of the generators was a problem. The agency, he said, had concluded that the plant could withstand a certain size of tsunami but "obviously the tsunami caused by Friday's earthquake exceeded our assumptions. That's the problem."

Tepco tested the Fukushima Daiichi plant to withstand an earthquake magnitude of 7.9—a level of seismic activity the power company thought wouldn't be surpassed in the area, according to company documents on its website from 2010. The quake that struck Friday,

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