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# Japan Orders Evacuation Near 2nd Nuclear Plant

By **MATTHEW L. WALD**

WASHINGTON — Japanese officials issued broad evacuation orders on Saturday for people living near two nuclear power plants whose cooling systems broke down as a result of the earthquake. The officials warned that small amounts of radioactive material were likely to leak from the plants.

The power plants, known as Daiichi and Daini and operated by Tokyo Electric Power, experienced **critical failures of the cooling systems** after the plants were shut down, as they were during the quake.

About 45,000 people were affected by the evacuation order at the Daiichi plant, where those living within a six-mile radius were told to leave. The evacuation of the second plant was for a one-mile radius because “there is no sign that radiation has been emitted outside,” an official said.

Failure of the cooling systems allowed pressure to build up beyond the design capacity of the reactors. Small amounts of radioactive vapor were expected to be released into the atmosphere to prevent damage to the containment systems, safety officials said. They said that the levels of radiation were not large enough to threaten the health of people outside the plants, and that the evacuations had been ordered as a precaution.

Nuclear safety officials focused initially on the Daiichi plant. But by Saturday morning **Japan** had declared states of emergency for five reactors at the two plants, an escalation that added to worries about the safety of nuclear facilities in the quake-prone Japanese islands.

The Daiichi and Daini plants are 10 miles apart in Fukushima Prefecture, about 150 miles north of Tokyo and close to the quake’s epicenter off the coast.

The plants’ problems were described as serious but were far short of a catastrophic emergency like the partial core meltdown that occurred at the Three Mile Island plant near Harrisburg, Pa., in 1979.

A Japanese nuclear safety panel said the radiation levels were 1,000 times above normal in a reactor control room at the Daiichi plant. Some radioactive material had also seeped outside, with radiation levels near the main gate measured at eight times normal, NHK, Japan's public broadcaster, quoted nuclear safety officials as saying.

The safety officials said there was "no immediate health hazard" to residents from the leaks, which they described as "minute," and people were urged to stay calm.

The emergency at the Daiichi plant began shortly after the earthquake struck on Friday afternoon. Emergency diesel generators, which had kicked in to run the reactor's cooling system after the electrical power grid failed, shut down about an hour after the earthquake. There was speculation that the tsunami knocked the generators out of service.

Twenty hours later, the plant was operating in a battery-controlled cooling mode. Tokyo Electric said that by Saturday morning it had installed a mobile generator at Daiichi to ensure that the cooling system would continue operating even after reserve battery power was depleted. Even so, the company said it was considering a "controlled containment venting" in order to avoid an "uncontrolled rupture and damage" to the containment unit.

"With evacuation in place and the oceanbound wind, we can ensure the safety," a nuclear safety official, Yukio Edano, said at a news conference early Saturday.

It was not clear, however, how long the cooling systems could continue to function in emergency mode or when normal power supplies could be restored.

Two workers were reported missing at the Daiichi plant, but the company did not explain what might have happened to them.

A pump run by steam, designed to function in the absence of electricity, was adding water to the reactor vessel, and as that water boiled off, it was being released. Such water is usually only slightly radioactive, according to nuclear experts. As long as the fuel stays covered by water, it will remain intact, and the bulk of the radioactive material will stay inside. If the fuel is exposed, it can result in a meltdown.

The reactors at the two plants shut down when the earthquake began at 2:46 p.m. Friday. At the Daiichi plant's Reactor Unit 1, when the emergency generators shut down, pressure began to rise in the reactor, leading operators to vent it.

During much of the early morning on Saturday, safety officials focused on getting emergency power supplies to the Daiichi plant to restore the normal cooling function.

Secretary of State [Hillary Rodham Clinton](#), speaking in Washington, said that American military planes had already delivered “coolant.” But American military officials indicated that while they were prepared to help Japan grapple with any problems related to its nuclear facilities, they had not been asked to do so.

Japan relies heavily on nuclear power, which generates just over one-third of the country’s electricity. Its plants are designed to withstand earthquakes, which are common, but experts have long expressed concerns about safety standards, particularly if major quake hit close to a reactor.

One major concern is that while plant operators can quickly shut down a nuclear reactor, they cannot allow the cooling systems to stop working. Even after the plant’s chain reaction is stopped, its fuel rods produce about six percent as much heat as they do when the plant is running. The production of heat drops off sharply in the following hours, but continued cooling is needed or the water will boil away and the fuel will melt, releasing the uranium fragments inside.

Heat from the nuclear fuel rods must be removed by water in a cooling system, but that requires power to run the pumps, align the valves in the pipes and run the instruments. The plant requires a continuous supply of electricity even after the reactor stops generating power.

With the steam-driven pump in operation, pressure valves on the reactor vessel would open automatically as pressure rose too high, or could be opened by operators. “It’s not like they have a breach; there’s no broken pipe venting steam,” said Margaret E. Harding, a nuclear safety consultant who managed a team at [General Electric](#), the reactors’ designer, that analyzed pressure buildup in reactor containments. “You’re getting pops of release valves for minutes, not hours, that take pressure back down.”

Civilian power reactors are designed with emergency diesel generators to assure the ability to continue cooling even during a blackout. Many reactors have two, assuring redundancy; some have three, so that if one must be taken out of service for maintenance, the plant can still keep running.

It was not immediately clear how many diesel generators there are at Daiichi, but the operators reported earlier in the day that they were not working, prompting the evacuation.

Daiichi, which is formally known as Fukushima Daiichi Nuclear Power Station, was designed by General Electric and entered commercial service in 1971. It was probably equipped to

function for some hours without emergency diesel generators, said David Lochbaum, who worked at three American reactor complexes that use G.E. technology.

Mr. Lochbaum, who also worked as an instructor for the [Nuclear Regulatory Commission](#) on G.E. reactors, said that such reactors were equipped to ride out interruptions in electrical power by using pumps that could be powered by steam, which would still be available in case of electric power failure. Valves can be opened by motors that run off batteries, he said. Plants as old as Fukushima Daiichi 1 generally have batteries that are large enough to operate for four hours, he said.

After that, he said, the heat production in the core is still substantial but has been reduced. The heat would boil away the cooling water, raising pressure in the reactor vessel, until automatic relief valves opened to let out some of the steam. Then the valves would close and the pressure would start building again.

If the cooling system remains inoperative for many hours, the water will eventually boil away, he said, and the fuel will begin to melt. That is what happened at Three Mile Island. In that case, the causes were mechanical failure, operator error and poor design, according to government investigators.

*Ken Belson contributed reporting from New York.*