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Japan Says 2nd Reactor May Have Ruptured With Radioactive Release

By **HIROKO TABUCHI** and **KEITH BRADSHER**

TOKYO — Japan's nuclear crisis intensified again Wednesday, with Japanese authorities announcing that a containment vessel in a second reactor unit at the stricken Fukushima Daiichi plant in northeastern Japan may have ruptured and appeared to be releasing radioactive steam. That would be the second vessel to be compromised in two days.

The vessel had appeared to be the last fully intact line of defense against large-scale releases of radioactive materials from that reactor, but it was not clear how serious the possible breach might be.

The announcement came after Japanese broadcasters showed live footage of thick plumes of steam rising above the plant.

Yukio Edano, the chief cabinet secretary, said the government believed the steam was coming from the No. 3 reactor, where an explosion on Monday blew out part of the building surrounding the containment vessel.

The reactor has three layers of protection: that building; the containment vessel, and the metal cladding around fuel rods, which are inside the reactor. The government has said that those rods at the No. 3 reactor were likely already damaged.

A spike in radiation levels at the plant as the steam was rising forced some of the relatively few workers left at the plant to retreat indoors, suspending some critical efforts to pump water into several reactors to keep them cool.

Earlier in the morning, the company that runs the plant reported that a fire was burning at a different reactor, just hours after officials said flames that erupted Tuesday had been doused.

A government official at Japan's nuclear regulatory agency soon after said that flames and smoke were no longer visible, but he cautioned that it was unclear if the fire, at the Reactor

No. 4 building, had died out. He also was not clear if it was a new fire or if the fire Tuesday had never gone out.

There are a total of six reactors at the plant.

The developments are troubling reminders of the difficulties the company is having in bringing the plant, which has suffered multiple explosions since Saturday, under control. And the confusion is emblematic of days of often contradictory reports about what is happening at the plant.

The company, Tokyo Electric Power, says it cannot know for sure what is happening in many cases because it is too dangerous for workers to get close to some reactors.

The situation became especially dire on Tuesday, when releases of radiation led the company to pull most of its workers from the plant.

Among the authorities' main concerns are pools for spent fuel rods at several reactors at the plant, including Reactor No. 4, where the pool has lost some of the water needed to keep the fuel rods stable. The rods are still radioactive and potentially as hot and dangerous as the fuel rods inside the reactors.

Minoru Ogoda, the official with Japan's nuclear regulatory agency, said a proposed plan to use helicopters to put more cold water into the pool was looking unlikely.

The hole or holes in the roof caused by an earlier blast did not appear big enough to allow sufficient amounts of water in, he said.

He said Tokyo Electric would probably try to spray water into the reactor building through a gaping hole in the wall blasted open by the explosion.

That explosion on Tuesday was caused by hydrogen gas bubbling up from chemical reactions set off by the fuel rods in the pool, Japanese officials said. Inspectors from the United States [Nuclear Regulatory Commission](#) said they had been told by Japanese authorities that what was burning was lubricating oil from machinery near the pool.

Concern remained high about the storage pools at two other reactors, Nos. 5 and 6. None of those three reactors at the plant, 140 miles northeast of Tokyo, were operating on Friday afternoon when an offshore earthquake with a magnitude now estimated at 9.0 shook the site. A tsunami rolled into the northeast Japanese coastline minutes later, swamping the plant.

At least 750 workers were evacuated on Tuesday morning after a separate explosion ruptured the inner containment building at Reactor No. 2 at the Daiichi plant, which was crippled by Friday's earthquake and tsunami. The closely spaced but apparently coincidental explosions at Reactors Nos. 2 and 4 together released a surge of radiation 800 times as intense as the recommended hourly exposure limit in Japan.

But 50 workers stayed behind, a crew no larger than would be stationed at the plant on a quiet spring day. Taking shelter when possible in the reactor's control room, which is heavily shielded from radiation, they struggled through the morning and afternoon to keep hundreds of gallons of seawater a minute flowing through temporary fire pumps into the three stricken reactors, Nos. 1, 2 and 3, where overheated fuel rods continued to boil away the water at a brisk pace.

By early afternoon radiation levels had plunged, according to the [International Atomic Energy Agency](#). Workers have released surges of radiation each time they bleed radioactive steam from the troubled reactors in an attempt to manage the pressure inside them, but the reactors are not yet releasing high levels of radiation on a sustained basis, Japanese officials said.

The United States military revised its plans as radiation from the plant worsened. Some American warships that had been expected to arrive at the tsunami-shattered northeast coast of Honshu Island were diverted to the west coast instead because of concerns about radiation, the Navy said.

The Navy also promised to continue relief missions even though several more helicopter crews were testing positive for low-level exposure to radiation, and even as American military personnel and their families at the Yokosuka and Atsugi bases were encouraged to take precautions against radiation exposure.

Late Tuesday morning, Prime Minister [Naoto Kan](#) warned in a nationally televised address of rising radiation.

Mr. Edano, the chief cabinet secretary, urged people who live within about 18 miles of the plant to take precautions. "Please do not go outside, please stay indoors, please close windows and make your homes airtight," he said. [Yukiya Amano](#), the director general of the International Atomic Energy Agency, said at the organization's Vienna headquarters that there was a "possibility of core damage" at reactor No. 2, but that the damage "is estimated to be less than 5 percent of the fuel."

The sudden turn of events, after an explosion on Monday at one reactor and then an early-morning explosion on Tuesday at yet another — the third in four days at the plant — had already made the crisis at the plant the worst nuclear accident since the Chernobyl reactor disaster a quarter-century ago. It had become impossible for workers to remain at many areas within the plant for extended periods, the agency said. In Tokyo, the metropolitan government said Tuesday that it had detected radiation levels 20 times above normal over the city, though it stressed that such levels posed no immediate health threat and that readings had dropped since then. The explosion in Reactor No. 2, a little after 6 a.m. on Tuesday, particularly alarmed Japanese officials and nuclear power experts around the world because it was the first detonation at the plant that appeared to occur inside one of the primary containment vessels.

Those buildings are fortresslike structures of steel and reinforced concrete, designed to absorb the impact of a plane crash and minimize radiation leaks. After a series of conflicting reports about how much damage the reactor had sustained after that blast, Mr. Edano said, “There is a very high probability that a portion of the containment vessel was damaged.”

Japanese officials subsequently said that the explosion had damaged a doughnut-shaped steel container of water, known as a torus, that surrounds the base of the reactor vessel inside the primary containment building.

Ruptures in the torus are serious, said Michael Friedlander, a senior nuclear power plant operator for 13 years at three plants in the United States, including three years at a **General Electric** boiling water reactor very similar to the ones in trouble in Japan. But the torus is not as important as the reactor vessel itself, which has 6.7-inch-thick steel walls and 8.4-inch-thick steel for its roof and floor. The vessel is designed to hold very high-pressure steam as well as the uranium fuel rods.

The reactor vessel has 20 safety valves that during a shutdown of the reactor inject steam into a million-gallon “suppression pool” of water in a steel torus immediately underneath it.

“Imagine if you had a big pressure cooker and you had a tube off the pressure cooker into a big tub of water — the suppression pool is the tub of water,” said Mr. Friedlander, a defender of nuclear power who is now a money manager in Hong Kong.

Steam vented into the suppression pool from the reactor vessel is not supposed to be radioactive. But it becomes radioactive, and potentially very radioactive, if the fuel rods in the reactor vessel above have begun to melt.

The atmosphere in the primary containment building, around the reactor vessel and above the suppression pool, is supposed to consist of inert nitrogen, with no oxygen at all. An inert atmosphere is used in the primary containment building to avoid the risk of oxygen explosions with hydrogen if the reactor starts producing much larger quantities of hydrogen gas than usual. Hydrogen gas is highly combustible with oxygen.

Hiroko Tabuchi reported from Tokyo, and Keith Bradsher from Hong Kong. David E. Sanger and Matthew L. Wald contributed reporting from Washington.