NUCLEAR CRISIS
JAPAN & THE FUTURE OF ENERGY POLICY

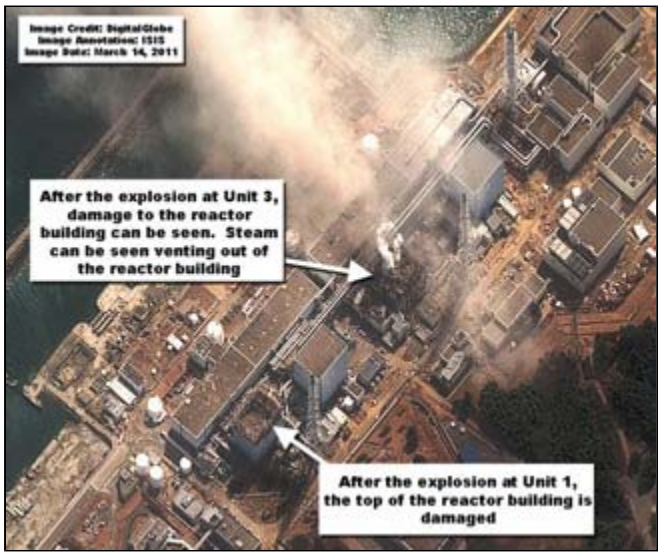
1. JAPAN EARTHQUAKE: New explosion rocks Fukushima nuclear plant *(ClimateWire, 03/15/2011)*

Peter Behr, E&E reporter

Japan's nuclear crisis escalated ominously following a third and more dangerous hydrogen explosion early Tuesday local time that may have damaged part of the reactor's primary containment shell, and a fire at a fourth reactor building.

The explosion at the Fukushima Daiichi unit 2 reactor followed a frantic battle by engineers to re-cover the reactor's fuel core with seawater, a critical action needed to halt a meltdown of the tops of fuel rods that could spin out of control if unchecked, experts said. Some reports said a crucial, doughnut-shaped "suppression chamber" or reservoir beneath the reactor that receives steam and gases from the reactor core had been damaged, increasing the risk of radiation release from that unit.

Japan's Nuclear and Industrial Safety Agency (NISA) reported Tuesday that "the suppression chamber may be damaged," according to World Nuclear News, an industry information service.



Satellite photo showing some of the destruction at Japan's Fukushima Daiichi nuclear complex. Photo courtesy of ISIS.

The fire and radiation release occurred at unit 4, which was in a stable, cold-shutdown mode before Friday's earthquake tidal wave struck the nuclear facility, 150 miles north of Tokyo on Japan's northeast seacoast.

Prime Minister Naoto Kan, in a nationwide address to the Japanese people, confirmed the radiation peril and called for calm, pledging that the emergency crews and authorities were doing "everything we can" to contain the spread of contamination. Slightly elevated radiation was detected in Tokyo, but officials said it not at health-affecting levels, according to press reports. News organizations reported that most of the 800 workers at the plant had been withdrawn, leaving firefighters and crews dealing with the seawater insertion to continue the struggle.

Cabinet Secretary Yukio Edano, speaking after the prime minister, said radiation levels around the plant's six reactors reached a level that would "without a doubt would affect a person's health." But he said that outside the existing 12-mile evacuation zone, there was little or no health danger, according to news reports.

Danger to spent fuel rods feared

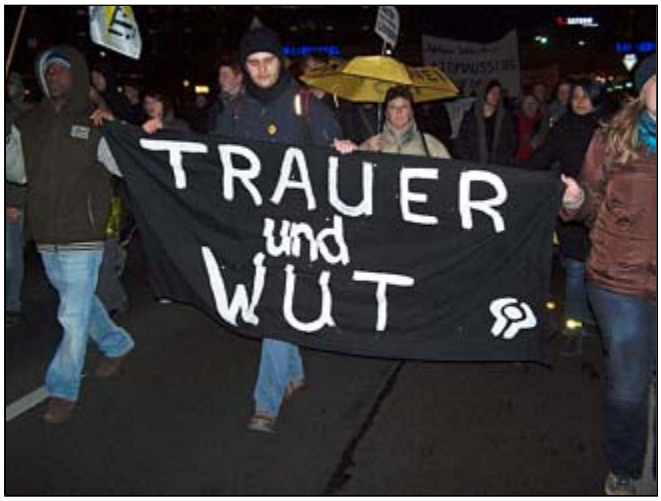
The three explosions at the Tokyo Electric Power Co. (TEPCO) reactor buildings, caused by hydrogen gas that vented from the reactor's primary containment, raised fears among some U.S. experts about possible damage to the tanks in those units that store spent reactor fuel assemblies.

Although the energy of the spent fuel rods is depleted, they are still "hot" and if left uncovered, could overheat, causing the casings to ignite and release radioactivity directly into the air -- the catastrophic sequence that followed the Chernobyl reactor in 1986.

In the General Electric Mark 1 boiling water reactors at the Fukushima Daiichi plant, the spent fuel pools are located at the top of the secondary containment building, a large concrete and steel structure that contains the reactor and its primary containment shell.

One expert said that an aerial photo of unit 1 appeared to show that a large crane used to move fuel assemblies in and out of the pool was missing.

Anthony R. Pietrangelo, senior vice president and chief nuclear officer of the Nuclear Energy Institute in Washington said that NEI had been told that the three pools survived the explosions without serious damage.



Anti-nuclear demonstrators marched in Berlin over the weekend carrying a sign showing their "grief and anger" over the disaster at Fukushima. Photo courtesy of Flickr.

"Our understanding is that there were no leaks at this point identified with the pools," he said.

"From a structural standpoint the pools are intact. They were not damaged by the hydrogen explosion. ... The real challenge there is to make sure the inventory above the fuel -- the water -- is maintained, and that can be as simple as putting a fire hose over the side of that pool. We don't have more additional information on the pools beyond that."

'Heroic' workers praised

A National Research Council report in 2006 studied the risks and consequences of an accident or terrorist attack involving spent fuel pools. The report, "Safety and Security of Commercial Spent Nuclear Fuel Storage," concluded that if water were drained or expelled from a pool, uncovering the spent fuel rods, the heat build-up could ignite the casing leading to a self-sustaining fire and radioactivity release. "[O]nce the fuel was uncovered, it might take only a few hours for the most recently discharged spent fuel rods to ignite," the report concluded.

As of yesterday, TEPCO had still been unable to restore normal electric power at the reactor site. Friday's earthquake knocked down power lines and an hour later, the tsunami swept through the site, carrying away diesel fuel tanks for backup generators and damaging generator controls. Backup batteries eventually ran out, creating a "station blackout" condition. Then the station's pumping system was helpless to keep reactor fuel rods from a overheating. If unchecked, that could cause a core meltdown.

"They only had one option left, and that was seawater," said David Lochbaum, director of the nuclear safety program for the Union of Concerned Scientists.

Pietrangelo said NEI had not been informed about the extent of damage to the reactor cores. As long as the reactor core interiors remain essentially intact, it is possible to circulate cooling water through the assembly. The greater the damage, the less effective the cooling operation becomes, he said.

Some reports yesterday said water hoses pumping seawater to reactor unit 2 had been damaged by the explosion.

The seawater injections are the best option for stabilizing the reactors, but the crisis won't end until outside electric power is restored and the reactors' main pumping systems can be restarted to complete a cold shutdown of the reactor cores. He said he had not heard when that power restoration might occur. "I'll be a lot more comfortable when they get AC power," he said.

The few details of the crises at Fukushima Daiichi underscore the courage of TEPCO crews and other workers to overcome the fearsome threat to the reactors and ultimately the public and themselves. "I think the Japanese workers at that plant are heroic in what they've been able to accomplish thus far given those conditions," Pietrangelo said.

Other details describe how security features crucial to the plant's survival failed or were negated by the volatile, unanticipated course of the crisis.

Unit 2 resisted flood efforts

The early efforts to flood the unit 2 reactor core were initially thwarted by pressure inside the reactor caused by steam and gases created by exposed, super-heated fuel rods.

Lochbaum said he understood that the pressure inside the unit 2 reactor vessel exceeded the pressure from the fire hose pumps that crews used to deliver seawater into the unit. "So the water just doesn't move," Lochbaum said.

The reactor has pressure relief valves that automatically open when overpressure is so severe that it threatens a catastrophic rupture of the reactor vessel, he said.

The valves are also designed to be operated manually from the control room. The operator throws a switch that activates a pneumatic drive containing nitrogen gas that is strong enough to overcome the restraining spring that keeps the valve closed, he said.

"The nitrogen gas accumulator for the valves allows the valves to be opened and closed a small handful of times. ... It seems most likely that they are just out of nitrogen gas and can't overcome the spring pressure to open the valve manually," he said. How this problem was overcome wasn't clear.

But steam and hydrogen gas have been vented out of the reactor and primary containment shell periodically to relieve potentially dangerous pressure in what Pietrangelo called a "feed and vent" process. The steel reactor vessel contains the fuel rods. It is surrounded by a bell-shaped, steel-lined concrete primary containment shell. The third line of defense is the large secondary containment building.

Hydrogen forms when overheated zirconium alloy casings of the fuel rods react with steam. The vented hydrogen gas collects at the top of the secondary containment building.

Japan crisis could lead to tougher U.S. regulations

Yesterday, workers drilled holes in the secondary building's roof to allow the gas to escape. Even so, crews could be forced to operate the building's ventilation system, Pietrangelo said yesterday, and that would risk a new explosion.

One expert noted that after the Three Mile Island reactor accident in 1979, the Nuclear Regulatory Commission ordered the installation of igniters, similar to glow plugs in diesel engines, which could burn small amounts of vented hydrogen harmlessly, thus preventing a dangerous build-up. They apparently are without power and failed their task, this expert said.

Lochbaum and UCS colleagues Ellen Vancko and Edwin Lyman called on the NRC to use the crisis as leverage to toughen regulation of U.S. reactors.

The regulation of spent fuel pools is one example, Lochbaum said. Reactor owners should be required to accelerate the transfer of fuel assemblies from the pools to storage in large ground-level containers -- dry cask storage, as it is called, Lochbaum said.

There are 23 U.S. reactors like the Fukushima Daiichi units that store spent fuel at the top of container buildings -- "up in the attic," Lochbaum said. And these are the most vulnerable and most obvious candidates for faster transfers to dry cask storage, he added. "The risk reduction is so great. There is no excuse for not doing it," he said.