ClimateWire

2. NUCLEAR: Desperate attempts to save 3 Fukushima reactors from meltdown *(03/14/2011)*

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Tokyo Electric Co. crews prepared Monday to pump seawater into a third reactor at the stricken Fukushima Daiichi nuclear plant in order to prevent or halt a meltdown of its fuel assemblies, hours after a second explosion of leaked hydrogen gas rocked another reactor building at the site on Japan's northeast coast.

Experts called the injection of seawater and neutron-absorbing boron into the site's three crippled reactors units a desperation move never attempted before in the industry. It amounted to sacrificing the reactors in an attempt to maintain the structural integrity of the reactor and its encasing concrete containment structure and prevent a potential uncontrolled major radiological release. Three other Fukushima Daiichi reactors had been shut down for planned work before Friday's 8.9 earthquake and were not part of the crisis.

"I would describe this measure as a Hail Mary Pass but if they succeed, there is plenty of water in the ocean and if they have the capability to pump this water in the necessary volume and at the necessary rates ... then they can stabilize the reactor," said former Energy Department official Robert Alvarez, according to press accounts of his press conference Saturday.

However, it was not clear how long the stabilization would take, or whether periodic releases of gases from the reactor vessels to relieve pressure could pose long-term radiation contamination threats to the area around the plant.

A buildup of hydrogen gas, formed by damage to the reactor core when cooling systems failed, was blamed for the explosion Monday at the plant's No. 3 unit building, a steel and concrete structure that forms the outer containment of the reactor. Authorities said the blast injured 11 people but apparently did not damage the reactor and main concrete containment shell.

"There is no massive radioactive leakage," Cabinet Chief Cabinet Secretary Yukio Edano said.

Over the three days, radioactive releases described as minor in scale were deliberately made from the plant's units to relieve gas pressures within the reactor structures. Japanese officials carried out a steadily advancing evacuation of areas surrounding the site, with nearly 200,000 people reported to have left the area as of Sunday, adding to an immense personal trauma of tens of thousands forced to flee the tsunami's destruction.

Seawater injection at Unit 1 was ordered on Saturday after a series of systems failures left the top part of the reactor fuel assemblies unprotected by cooling water, authorities said. Although the three working reactors had been shut down because of the earthquake, the fuel rods continued to give off heat.

Started by a failure of backup power generators

In normal operation, the heat is removed by pumping water through the vessel, creating steam that drives electricity-generating turbines. The loss of outside power and then backup power at the site prevented the cooling system from operating normally.

The same emergency water injection was planned Monday for Unit 2, after crews detected a buildup of pressure inside its reactor, evidence that its fuel assemblies also had become uncovered.

The power plant lost outside power after the earthquake, and the tsunami left large backup diesel generators out of service, Japanese officials said. Battery power, the third line of defense, apparently could not maintain the cooling water flow.

"Defense in depth" is the watchword of the nuclear industry, a strategy of backups for critical components, and backups to backup when needed. But defenses had failed to account for the impact of a tsunami's massive flooding

Reports from government and industry officials in Japan initially minimized the threat. The U.S. Nuclear Energy Institute distributed an assessment from the Federation of Electric Power Companies of Japan saying that the

Unit 1 reactor core still had a sufficient amount of water for cooling, "with no danger of the nuclear fuel being exposed."

In fact, the top portion of the fuel units became exposed and overheated, leading to the formation of hydrogen gas in a reaction of steam with the zirconium fuel rod casing. Surrounding the reactor is a bell-shaped concrete structure, the primary containment, built to prevent radiation that escapes the reactor from reaching the atmosphere outside the plant.

As hydrogen continued to form, relief valves in the primary containment structure may have opened allowing the gas to exit the primary containment and concentrate in the secondary containment building that surrounds the primary containment, according to U.S. experts familiar with the Japanese reactors.

Compounded by hydrogen explosions

In the General Electric Mark 1 reactor design, the secondary containment structure --a large factory-like outer building --is designed to hold small amounts of gas escaping from the reactor and its primary containment, said David Lochbaum of the Union of Concerned Scientists. But the hydrogen gas concentrated at the top of Unit 1 on Saturday. Something ignited it and the explosion blew off the metal roof over unit 1 at 3:36 pm local time, in a scene viewed worldwide on news reports and social media. The same reaction is believed to have caused the second explosion, at Unit 3, on Monday.

In both cases, the concrete primary containment shell was not damaged, officials reported. However there have been no reports of what happened to metal tanks at the top of the secondary containment building that contains the spent fuel rods, which continue to give off heat and must be cooled by circulating water, Lochbaum said.

"One of the challenges is that the explosion took the roof away. If any of it fell into the [spent fuel] pool, it could either have damaged the fuel," or impaired the water circulation in the pool. "That's the concern that's in play," Lochbaum said Sunday.

Around 8 p.m. Saturday in Japan, Cabinet Secretary Edano announced a high-level decision had been made to inject seawatater into Unit 1. "We've decided to fill the reactor container with sea water. Trade Minister Kaieda has instructed us to do so. By doing this, we will use boric acid to prevent criticality," he said, according to Reuters.

Edano said it the operation would take five to 10 hours initially, and around 10 days to complete the process. Precise details of how the sea water was being piped into the reactor facility were not available Sunday, and it wasn't clear whether crews had succeeded in putting it into the reactor vessel as well as the surrounding primary containment shell.

On Sunday, the same emergency measures were required at the Fukushima Daiichi Unit 3. Toyko Electric (Tepco) said it was unable to restart the reactor's high-pressure water injection system that supplies the reactor core with coolant after it shut down. Tepco then notified the Japanese government of the second emergency at the plant, according to World Nuclear News.

Japan's Nuclear and Industrial Safety Agency (NISA) reported late on Saturday that a gauge measuring water levels inside the No. 3 reactor appeared to be malfunctioning. It was reporting that the tops of the fuel assemblies were uncovered by water and thus vulnerable to failing.

"It is unknown whether [the reading] is real or not," the Japan Atomic Industry Forum (JAIF) said, according to press reports. Other readings contradicted the gauge information, indicating that the threat to the fuel rods was not acute. The order to introduce sea water followed.

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