ClimateWire

2. NUCLEAR: Radiation dangers, engineering challenges confront technicians trying to regain control of Fukushima reactors *(03/24/2011)*

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Technicians at the Fukushima 1 nuclear complex are preparing for the second phase of their battle to regain control of three riven nuclear reactors -- a careful examination of pumps, instrument cables, piping and other systems that they will need to bring the four crippled reactors to a safe, cold shutdown.

With tons of corrosive seawater dumped into the reactors' specialized steel components, there is no hope that the aging reactors may be brought back to service, industry officials say.

The best-case outcome may be a repeat of the Three Mile Island accident in 1979, where the cleanup of the No. 2 reactor stretched on for more than a decade at a cost of $1 billion, according to some nuclear industry experts.

If most of the reactor systems can be restarted, the nuclear complex on Japan's northeast coast could avoid the fate of the Chernobyl reactor in Ukraine, where the molten core burned through to the bottom of the plant's foundation, forcing workers to entomb the intensely radioactive remains in a concrete sarcophagus.

One U.S. expert said a primary lesson from Three Mile Island is the need for patience and care in determining the extend of the damage.

Using a concrete pumping truck, normally used on construction projects, workers were able to spray water into the top of plant No. 4 at Fukushima 1. Photo courtesy of World-nuclear-news.org.

"The first order of business for me would be to get the cores and pools in stable, 'monitorable' condition -- cooled and not releasing unacceptable radiation -- and establish means to keep them there," said this engineer, who asked not to be quoted by name. Reliable electric power would be required. There would have to be standby measures to deal with unexpected emergencies at each step of the way. Only then would it be time to devise the long-term exit strategy, he said.

The need for caution was driven home yesterday when three workers laying electrical cable in the first floor and underground floor of the turbine building at the No. 3 reactor received high-level radiation exposures. Two of the workers, contract employees for plant owner Tokyo Electric Power Co., (TEPCO) were hospitalized with leg burns.

Japan's Nuclear and Industrial Safety Agency said the workers were working on a flooded basement floor trying to attach power lines in the turbine building adjacent to the reactor, and their feet were exposed to 170 to 180 millisieverts of radiation, NHK World reported. The maximum level of radiation exposure allowed for nuclear plant workers in Japan is normally 100 millisieverts, but Japanese authorities raised the limit to 250 millisieverts for emergency crews at the Fukushima plant.

TEPCO did not provide information on how radiation had reached the turbine building, but one expert speculated that efforts to move contaminated water within the No. 3 reactor unit may have been a factor.

Crews continued to work on re-establishing outside electric power to the plants and maintained cooling operations at damaged reactors and fuel pools. They succeeded in restoring lighting inside the No. 1 unit control room.

TEPCO intended to attempt restarting the flow of cooling water using external power to the No.3 reactor pump on Wednesday. But the work had to be halted when black smoke was seen rising from the reactor building Wednesday. Work was also suspended at the No.1, No.2 and No.4 reactors, NHK World reported. The company resumed injecting water into the No.3 reactor pool at 5:30 a.m. Thursday after black smoke was no longer visible.

However, a new concern centers on the risk of salt buildup on fuel rods within the reactors, from tons of seawater that have been injected to provide emergency cooling, *The New York Times* reported.

Richard T. Lahey Jr., who was General Electric's chief of safety research for boiling-water reactors when the company installed them at the Fukushima Daiichi plant, told the newspaper that if salt forms crusts on fuel rods, that could block needed circulation of water around the rods and impede cooling. The gravest risk would be a continuing buildup of heat and possible release of radioactivity from damaged fuel units.

Condition of reactor cores remains unknown

U.S. nuclear regulators, industry officials and expert observers agree that the condition of the reactor cores is not at all clear.

"I don't believe we have anywhere near a clear understanding of what the plant conditions are like within the reactor buildings," Nuclear Regulatory Commission Executive Director for Operations Bill Borchardt told commission members Monday. "What kind of electrical cables have been damaged, what kinds of pumps and valves remain operable is a significant unknown."

The commission yesterday voted to conduct two inquiries into the readiness of U.S. nuclear reactors to withstand natural disasters, as Borchardt had proposed this week. A "quick-look" assessment is designed to verify that reactors have added equipment and procedures called for after the Sept. 11, 2001, terrorist attacks. A longer review, to be completed in six months, is to examine lessons from the Japanese crisis and determine whether changes in NRC policies and regulations are required, the commission said.

David Lochbaum, director of nuclear safety for the Union of Concerned Scientists, noted that TEPCO crews, which have restored some outside electric power to the site, have already encountered problems with pumps and other equipment at the reactors damaged in the series of hydrogen explosions there last week. "They are having to go to either redundant components or bring in replacement parts to replace the pumps and motors that aren't working. So that's slowing down their efforts to retain control of the cooling systems on all the units."

Lochbaum said the injections of boric acid into reactor cores suggest there is concern about parts of fuel assemblies that may have broken loose and fallen to the bottom of the reactors. Boron would help absorb neutrons as a defense against the exposed nuclear material going critical again, he said. "The extent of that damage has not yet been reported."

Lochbaum also said some of the instrument readings being reported from the plant by TEPCO aren't consistent, indicating that some of measurements of conditions inside the reactor are faulty. One temperature reading for reactor No. 1 registered about 400 degrees Celsius, which would not be consistent with pressure readings at the same reactor. "So there's a disconnect there."

"On the best side, it would be an instrumentation problem," and the high temperature would be the outlier, he said. On the downside, the readings could indicate that the temperature of the reactor core is increasing because fuel rods no longer are covered with water. "I think there's more data supporting the best case than the worst case, but at the moment, the worst case can't be ruled out."

Likewise, pressure readings on units No. 2 and 3 that would appear to indicate there is a vacuum inside those reactor containments certainly seem spurious, he said.

Long, difficult and perhaps dangerous cleanup ahead

Reflooding the core poses other risks, he said. If some zirconium alloy cladding or casings of the reactor fuel have become damaged, they could crack on contact with water, sending more radioactive debris to the floor of the reactor. "It might then begin an attack on the steel of the reactor vessel," he said.

That was part of the damage equation at Three Mile Island, although during and after the accident, operators and regulators had no idea of the extent of core melting that had occurred.

Not until 1982 could technicians send camera probes into the core, revealing shocking images of rubble from fuel components destroyed by the core melting, as J. Samuel Walker, the NRC's historian, records in his history of the accident.

"When we first put a TV camera in, it looked like a moonscape," said a veteran of the operation.

The cleanup required a fiercely disputed release of "noble" radioactive gases from the containment and the removal and treatment of several hundred thousand gallons of contaminated water at the bottom of the unit, not completed until 1985.

Finally, workers in respirators and two layers of protective suits stood above an opening in the reactor, using long-handled tools to chop and extract tons of radioactive debris from the bottom. The cleanup was completed in 1990.

Technicians at the Fukushima plant will hope that the damage to the fuel rod bundles was contained by seawater injections in the days immediately following the start of the crisis, so that cooling water can circulate between the bundles to bring down the remaining high temperatures of the fuel units.

"The hard work is getting it into a stable controllable state, so you know where you are" and are sure what systems are still working and which one must be replaced, one expert said. Only then would it be time to plan strategy for opening the core and dealing with the fuel rods, damaged or whole, he said.

A normal cold shutdown of a reactor can be accomplished in days, once the reactor's remaining heat drops low enough so the cooling systems can stay ahead of it. How long that will take for the Fukushima reactors -- if that is even possible -- is still a mystery.