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In Stricken Fuel-Cooling Pools, a Danger for the Longer Term

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Even as workers race to prevent the radioactive cores of the damaged nuclear reactors in Japan from melting down, concerns are growing that nearby pools holding spent fuel rods could pose an even greater danger.

The pools, which sit on the top level of the reactor buildings and keep spent fuel submerged in water, have lost their cooling systems and the Japanese have been unable to take emergency steps because of the multiplying crises.

Experts now fear that the pool containing those rods from the fourth reactor has run dry, allowing the rods to overheat and catch fire. That could spread radioactive materials far and wide in dangerous clouds.

The pools are a worry at the stricken reactors at the Fukushima Daiichi plant because at least two of the three have lost their roofs in explosions, exposing the spent fuel pools to the atmosphere. By contrast, reactors have strong containment vessels that stand a better chance of bottling up radiation from a meltdown of the fuel in the reactor core.

If any of the spent fuel rods in the pools did indeed catch fire, nuclear experts say, the high heat would loft the radiation in clouds that would spread the radioactivity.

“It’s worse than a meltdown,” said David A. Lochbaum, a nuclear engineer at the Union of Concerned Scientists who worked as an instructor on the kinds of General Electric reactors used in Japan. “The reactor is inside thick walls, and the spent fuel of Reactors 1 and 3 is out in the open.”

A spokesman for the Japanese company that runs the stricken reactors said in an interview on Monday that the spent fuel at the Fukushima Daiichi and Daini plants had been left uncooled since shortly after the quake.

The company, Tokyo Electric, has not been able to cool the spent fuel pools because power has been knocked out, said Johei Shiomi, the spokesman. “There may be some heating up,” he said.

Before Tuesday's fire, some scientists said that a worst-case outcome was unlikely and that the Japanese would probably have enough time to act before too much water boiled away. Firefighters with hoses can pour in water, they said, or helicopters could drop tons of water.

“I’m still hopeful that they can contain all this,” Thomas B. Cochran, a senior scientist in the nuclear program of the Natural Resources Defense Council, a private group in Washington, said in an interview. “You’ve got time to put fire hoses up there and get it filled if it’s not leaking,” he said of the pool.

A 1997 study by the Brookhaven National Laboratory on Long Island described a worst-case disaster from uncovered spent fuel in a reactor cooling pool. It estimated 100 quick deaths would occur within a range of 500 miles and 138,000 eventual deaths.

The study also found that land over 2,170 miles would be contaminated and damages would hit $546 billion.

That section of the Brookhaven study focused on boiling water reactors — the kind at the heart of the Japanese crisis.

The threat is considered so severe that at the start of the crisis Friday, immediately after the shattering earthquake, Fukushima plant officials focused their attention on a damaged storage pool for spent nuclear fuel at the No. 2 reactor at Daiichi, said a nuclear executive who requested anonymity because his company is not involved in the emergency response at the reactors and is wary of antagonizing other companies in the industry.

The damage prompted the plant’s management to divert much of the attention and pumping capacity to that pool, the executive added. The shutdown of the other reactors then proceeded badly, and problems began to cascade.

Mr. Shiomi of Tokyo Electric said that in addition to the power and cooling failures, some water had spilled from the pools.

But he said that the company thought there “was relatively little danger that temperatures would rise.”

“If you compare this to everything that’s been going on,” Mr. Shiomi said, “it’s not serious.”

Each of the crippled reactors in Japan has one cooling pool sitting atop the main concrete structure. Thin roofs and metal walls usually surround the pools.

In a reactor pool, the time it takes uncooled fuel to begin boiling the surrounding water depends on how much fuel is present and how old it is. Fresh fuel is hotter in terms of radiation than old fuel is.

Mr. Lochbaum, who formerly taught reactor operation for the Nuclear Regulatory Commission, said the pools measured about 40 feet long, 40 feet wide and 45 feet deep. The spent fuel, he added, rested at the pool's bottom and rose no higher than 15 feet from the bottom.

That means that in normal operations, the spent fuel is covered by about 30 feet of cooling water.

Depending on the freshness of the spent fuel, Mr. Lochbaum said, the water in an uncooled pool would start to boil in anywhere from days to a week. The water would boil off to a dangerous level in another week or two.

Once most of the fuel is exposed, he said, it can catch fire.

If the spent fuel is a few months old, most of the iodine 131 — one of the most dangerous radioactive byproducts in spent fuel — will have decayed into harmless forms.

But the cesium 137 in the spent fuel has a half-life of 30 years, meaning it would take about two centuries to diminish its levels of radioactivity down to 1 percent.

It is cesium 137 that still contaminates much land in Ukraine around the Chernobyl reactor, which suffered a meltdown in 1986.

"I assume they are doing triage," Mr. Lochbaum said of the Japanese, with emergency personnel first trying to avoid core meltdowns and then turning their attention to the cooling pools.

He added that the explosions at the reactors at Daiichi could complicate efforts to try to reach the cooling pools and keep them filled with water.

"There's no telling what's up there," he said.

William J. Broad reported from New York, and Hiroko Tabuchi from Tokyo. Keith Bradsher contributed reporting from Hong Kong.