

Meltdowns Grow More Likely at the Fukushima Reactors

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Japan's government and nuclear industry, with assistance from the U.S. military, is in a desperate race to stave off multiple nuclear reactor meltdowns as well as potential fires in pools of spent fuel.

As of Sunday afternoon, more than 170,000 people have been evacuated near the reactor sites as radioactive releases have increased. The number of military emergency responders has jumped from 51,000 to 100,000. Officials now report a partial meltdown at Fukushima's Unit 1. Japanese media outlets are reporting that there may be a second one underway at Unit 3. People living nearby have been exposed to unknown levels of radiation, with some requiring medical attention.

Meanwhile, Unit 2 of the Tokai nuclear complex, which is near Kyodo and just 75 miles north of Tokyo, is reported to have a coolant pump failure. And Japan's nuclear safety agency has declared a state of emergency at the Onagawa nuclear power plant in northeastern Japan because of high radiation levels. Authorities are saying its three reactors are "under control."

The damage from the massive earthquake and the tsunamis that followed have profoundly damaged the reactor sites' infrastructure, leaving them without power and their electrical and piping systems destroyed. A hydrogen explosion yesterday at Unit 1 severely damaged the reactor building, blowing apart its roof.

The results of desperate efforts to divert seawater into the Unit 1 reactor are uncertain. A Japanese official reported that gauges don't appear to show the water level rising in the reactor vessel.

There remain a number of major uncertainties about the situation's stability and many questions about what might happen next. Along with the struggle to cool the reactors is the potential danger from an inability to cool Fukushima's spent nuclear fuel pools. They contain very large

concentrations of radioactivity, can catch fire, and are in much more vulnerable buildings. The ponds, typically rectangular basins about 40 feet deep, are made of reinforced concrete walls four to five feet thick lined with stainless steel.

The boiling-water reactors at Fukushima 40 years old and designed by General Electric have spent fuel pools several stories above ground adjacent to the top of the reactor. The hydrogen explosion may have blown off the roof covering the pool, as it's not under containment. The pool requires water circulation to remove decay heat. If this doesn't happen, the water will evaporate and possibly boil off. If a pool wall or support is compromised, then drainage is a concern. Once the water drops to around 5-6 feet above the assemblies, dose rates could be life-threatening near the reactor building. If significant drainage occurs, after several hours the zirconium cladding around the irradiated uranium could ignite.

Then all bets are off.

On average, spent fuel ponds hold five-to-ten times more long-lived radioactivity than a reactor core. Particularly worrisome is the large amount of cesium-137 in fuel ponds, which contain anywhere from 20 to 50 million curies of this dangerous radioactive isotope. With a half-life of 30 years, cesium-137 gives off highly penetrating radiation and is absorbed in the food chain as if it were potassium.

In comparison, the 1986 Chernobyl accident released about 40 percent of the reactor core's 6 million curies. A 1997 report for the Nuclear Regulatory Commission (NRC) by Brookhaven National Laboratory also found that a severe pool fire could render about 188 square miles uninhabitable, cause as many as 28,000 cancer fatalities, and cost \$59 billion in damage. A single spent fuel pond holds more cesium-137 than was deposited by all atmospheric nuclear weapons tests in the Northern Hemisphere combined. Earthquakes and acts of malice are considered to be the primary events that can cause a major loss of pool water.

In 2003, my colleagues and I published a study that indicated if a spent fuel pool were drained in the United States, a major release of cesium-137 from a pool fire could render an area uninhabitable greater than created by the Chernobyl accident. We recommended that spent fuel older than five years, about 75 percent of what's in U.S. spent fuel pools, be placed in dry hardened casks something Germany did 25 years ago. The NRC challenged our recommendation, which prompted Congress to request a review of this controversy by the National Academy of Sciences. In 2004, the Academy reported that a "partially or completely drained a spent fuel pool could lead to a propagating zirconium cladding fire and release large quantities of radioactive materials to the environment."

Given what's happening at the Fukushima Daiichi nuclear complex, it's time for a serious review

of what our nuclear safety authorities consider to be improbable, especially when it comes to reactors operating in earthquake zones.