Fukushima Radiation Continues to Spread

By John LaForge

March 11 marked the fifth anniversary of the worst earthquake in Japanese history and the devastating tsunami that followed, smashing Japan's northeastern coast, killing as many as 19,000 people and sparking the worst radiation catastrophe since Chernobyl. Crashing over a 30-foot seawall, tsunami waters flooded the Fukushima Daiichi nuclear complex, knocking out emergency cooling pumps and causing three reactors to overheat, melt, and burn their way through their steel containers. A series of hydrogen explosions blew apart the containment buildings surrounding the reactors resulting in the widespread dispersal of iodine-131, cesium-134, cesium-137 and other radioactive materials.

Fukushima cesium concentrating in zooplankton, anchor of the oceans' food web

Scientists tracking radioactive materials leaked to the Pacific by the Fukushima disaster have given oceanographers surprising new information, notably that most of the contaminated surface water pushed by ocean currents east toward the United States from Japan, is "submerged to a depth of [1,312 feet] near to the International Date Line and then turns toward southwest." This pattern of ocean currents was completely unknown prior to the new study, published in the journal *Applied Radiation and Isotopes*.

Japanese scientists, in collaboration with the European Commission's Joint Research Centre traced the movement of cesium-134, and cesium-137 (known as radio-cesium) and collected samples of both zooplankton and suspended particles. Their study has found that "zooplankton contained higher amounts of radio-cesium than particulate matter as [zooplankton] consumes organic matter and thereby accumulates cesium."

That the animals have more radio-cesium than the suspended particles is related to the process called bio-accumulation in which the plankton absorbs the isotope faster than it is excreted. The concentration of cesium is multiplied, increasing the ratio of the toxin in living tissue, as larger species eat smaller ones on up the food chain—something biologists have warned of since the spill began in March 2011.

Zooplankton are at the very bottom of the ocean food chain, and are eaten by everything from small animals and fish to huge whales. Many small animals and fish depend on zooplankton as their main source of food. The new study's results are useful, the authors said, in order "to understand the uptake in the food chain and estimate impact on biosystems of future releases."

While the Fukushima catastrophe is always called "second" in overall radiation release behind the 1986 Chernobyl disaster, the total amount of cesium-137 spewed by the Fukushima meltdowns may be two to four times greater than Chernobyl, according to a 2014 report by the Korea Atomic Energy Research Institute.

—Sciencedaily.com, June 6, 2016

Unprecedented oceanic radiation release

This past March, Ken Buesseler, a marine radiochemist with the Woods Hole Oceanographic Institution reported: "More than 80 percent of the radioactivity from the damaged reactors ended up in the Pacific—far more than reached the ocean from Chernobyl… this event is unprecedented in its total release of radioactive contamination into the ocean."

"The continued release of radionuclides from groundwater and leaking tanks at Fukushima… needs to be watched closely, as the character or mix of radionuclides is changing. One example is the higher levels of strontium-90 contained in groundwater and in storage tanks that are leaking into the ocean." —www.WHOI.edu

Japan to use radioactive waste in building roads—lessons unlearned from US desert Southwest

The Environment Ministry on June 7 drew up a basic plan to use soil contaminated with radioactive substances in fallout from the Fukushima Daiichi triple meltdown releases to build roads.

Under the plan, soil tainted with relatively low radioactive cesium concentrations of up to 5,000 to 8,000 becquerels per kilogram will be used to form the base layer of roads.

This layer will then be covered with uncontaminated soil, asphalt and other material at a thickness of between 19 and 39 inches.

According to the ministry, covering radioactive soil with untainted material will minimize the health risk for residents living in nearby areas, as their annual radiation dose will be kept to 0.01 millisievert or less.

The ministry plans to launch a verification project in Minamisoma, Fukushima Prefecture, as early as this summer to test the use of contaminated soil as the base material for road construction.

Tainted soil in the prefecture, generated from decontamination work following the March 2011 accident …, will be kept in an interim storage facility near the nuclear reactor complex for final disposal at a site outside the prefecture within 30 years.

The interim facility, located in an area that straddles the towns of Okuma and Futaba, is believed to store up to 22 million cubic meters of contaminated soil. The latest plan will help the ministry facilitate the reuse of contaminated soil within and outside the prefecture to reduce the amount to be transferred to the final disposal site. —JIJI, *The Japan Times*, June 7, 2016

Zooplankton are the main food source for millions of small sea animals and fish. The one in the photo has been magnified many times.

600-Ton Mass of melted fuel still not located in wreckage of three Fukushima reactors

Even 63 months since the triple melt-throughs, 600 tons of this molten uranium fuel—200 tons in each devastated reactor—is unaccounted for. Neither emergency response teams nor decommissioning authorities have been able to locate the mass of ferociously hot (radioactively and thermally) molten uranium fuel—which has to be constantly flooded with cooling water to prevent further melting.

As Energy Biz reported March 31, "The cooling water becomes radioactive and leaks out through damaged areas into the building basements, where it mixes with groundwater, increasing the volume of contaminated water." *Scientific American* put it this way on March 1, "Groundwater flowing from a hill behind the crippled plant now mingles with radioactive materials before heading into the sea."

"There is no end in sight for communities in Fukushima," said Junichi Sato, Executive Director of Greenpeace Japan. "What started as a natural disaster turned into one of the worst industrial accidents in human history and a reminder that humanity must urgently turn its efforts toward safe, clean renewables," Sato said.

One temporary fix—a $312 million refrigeration or "ice wall" dug into the ground uphill from the destroyed reactor complex—was switched on March 31 for the first time. The wall is supposed to divert groundwater to keep it from continually seeping through quake-damaged foundations under the reactor buildings. Flowing through the wreckage, the groundwater becomes highly radioactive by mixing with cooling water that is continually being poured onto the three masses of melted fuel.

—Australian Broadcasting Corporation, May 24, 2016

Waste Fuel Fire at Fukushima Avoided by Luck; US Waste Vulnerable, Panel Says

By Richard Stone

Two weeks after the March 11, 2011 earthquake and tsunami devastated the Fukushima Daiichi Nuclear Power [complex], causing three nuclear reactors to melt down and release radioactive plumes, officials were bracing for even worse. They feared that [waste] fuel ... would catch fire and send radioactive smoke across a much wider swath of eastern Japan, including Tokyo.

Thanks to a lucky break detailed in a report released May 27 by the US National Academies, Japan dodged that bullet. The near calamity "should serve as a wake-up call for the industry," says Joseph Shepherd … who chaired the academy committee that produced the report. ... A major [waste] fuel fire at a US nuclear [reactor] "could dwarf the horrific consequences of the Fukushima accident," says Edwin Lyman, a physicist at the Union of Concerned Scientists, a nonprofit in Washington, D.C., who was not on the panel....

[At Fukushima] Unit 4 … the entire reactor core—all 548 assemblies—was in the spent fuel pool, and was hotter than fuel in the other pools. When an explosion blew off Unit 4's roof on March 15, plant operators … feared it had come from fuel in the pool that had been exposed to air.…The blast had destroyed instrumentation for monitoring the pool. ... [and] the possibility that the fuel had been exposed was plausible and alarming enough for then-NRC (Nuclear Regulatory Commission) Chair Gregory Jaczko on March 16 to urge more extensive evacuations than the Japanese government had advised…

The pool's water was boiling away because of the hot fuel. As the level fell perilously close to the top of the fuel assemblies, something "fortuitous" happened, [chairperson] Shepherd says. As part of routine maintenance, workers …allowed water from the reactor well to leak into the spent fuel pool, partially refilling it. ... Only good fortune … averted that disaster, the academy panel notes.

At US nuclear plants, [waste] fuel is equally vulnerable. ... The panel recommends that NRC take another look at the benefits of moving spent fuel to other storage …"

—Richard Stone oversees Science *magazine's international coverage. This is a heavily edited version of his May 27, 2016 article in* Science Online.

—Take Action! Hundreds of environmental and public interest groups have called for Hardened On-Site Storage (HOSS) of highly radioactive irradiated waste fuel at reactor sites, as an interim measure to improve safety and security. The first step in HOSS is to empty the densely packed vulnerable cooling pools, which are at risk of catastrophic fires. The waste must then be placed in hardened on-site dry casks (current dry cask models are not good enough). Tell Congress that HOSS must be required at all power reactors. See BeyondNuclear.org for details.

Regulatory Insiders Warn of Generic Reactor Flaw, Call for Shutting Nearly All US Reactors

On March 1, seven inside experts currently at the Nuclear Regulatory Commission (NRC) went public with a warning that nearly every US nuclear power reactor has a flawed emergency cooling electrical system that could potentially spark radiation disasters.

In an extraordinary action, the seven current NRC engineers filed a formal petition with the NRC's Office of Nuclear Reactor Regulations (ONRR) February 19. The engineers warned that 98 out of 99 operating reactors in the United States have a cooling system defect that make them vulnerable to loss-of-coolant accidents the likes of which have in the past, led to reactor meltdowns and major radiation releases.

Loss-of-coolant accidents caused over-heating, fuel melting, and large releases of radiation at Windscale in England (1957), Santa Suzanna in Calif. (1959), Three Mile Island in Penn. (1979), Chernobyl in Ukraine (1986), and at Fukushima-Daiichi in Japan (2011).

The whistleblowers wrote that the design flaw makes nearly all US reactors "vulnerable to so-called open-phase events in which an unbalanced voltage, such as an electrical short, could cause motors to burn out and reduce the ability of a reactor's emergency cooling system to function. If the motors are burned out, backup electricity systems would be of little help."

The extremely rare petition by the NRC staff engineers (five from Maryland, one from Louisiana, one from W. Virginia) has raised alarms across the regulatory and watchdog communities. Dave Lochbaum, of the Union of Concerned Scientists, wrote, "Thus, the open phase condition was about 100 times riskier than risks routinely experienced at nuclear power plants. ... The bottom line is that an open-phase condition could prevent electrical equipment from performing the safety roles needed to prevent or mitigate nuclear plant accidents."

The engineers' petition says 13 such events have struck at nuclear reactors worldwide in the past 14 years.

NRC authorities formally responded March 21 with a letter saying the commission would accept the petition and take the experts' warning under advisement. However, the NRC said, no immediate action would be taken.

The engineers had demanded that short of immediately resolving the electrical distribution problem, the NRC should shut down all US reactors pending repairs. The NRC's reply notes that reactor operators are currently working to implement a fix to the "open-phase" electrical glitch and must be in compliance by February 2019, three years from now.

However, the commissioners denied the petitioners' "request for immediate action," and the ONRR said it would decide "within a reasonable amount of time" whether reactors were out of compliance with emergency cooling requirements. No timeline was presented by the ONRR.

A total loss of emergency back-up cooling at Fukushima-Daiichi in Japan caused the first-ever and only triple reactor meltdown in history March 11, 2011. It has become the world's worst radiation catastrophe in terms of population density and total cesium-137 released. (In July 2014, the Korea Atomic Energy Research Institute reported that Fukushima's meltdowns had dispersed between two to four times as much cesium-137 as the 1986 Chernobyl catastrophe.) Japanese officials have said it will take at least 40 years to recover from the triple meltdown at Fukushima.

The Reuters article, titled "US NRC engineers urge fix for nuclear power stations," notes that the NRC engineers' petition is a method of formal warning "usually used by public interest groups to raise safety and other concerns with the commission."

As author and nuclear power analyst Harvey Wasserman reported this month, the veteran NRC resident inspector Michael Peck was transferred from California's Diablo Canyon reactor complex after he officially warned the NRC that the two huge Diablo reactors could not withstand shocks that could be delivered by any of the 12 nearby earthquake faults. "Peck's report was ignored," Wasserman reported. "It only became public after an intense independent investigation by Friends of the Earth and other green groups."

In the case of the seven NRC engineers' public alarm, the NRC has again chosen risk-taking, rolling the dice with its fingers crossed.

—Sources: *US News & World Report*, March 15; Syracuse *Post Standard*, March 5; and Reuters, March 1, 2016. ***—JL***