



THE FUKUSHIMA DISASTER

INTRODUCTION

On March 11, 2011, at 14:46 Japan Standard Time, a magnitude 9 earthquake struck off the Pacific coast of Japan with the hypocenter 80 miles east of Sendai. Twenty minutes later, the first in a series of tsunami waves inundated a 1,200-mile swath of Japan's northeastern coast, creating a humanitarian and material disaster. Five of Japan's nuclear power plants (a total of 15 reactor units, 11 operating at the time)

were directly impacted by the earthquake and tsunami.

At the Fukushima Daiichi nuclear site, the initial earthquake toppled the offsite electrical grid system knocking out the supply of offsite AC power to all six reactor safety systems.

Forty-two minutes after the quake, the first tsunami wave struck the Fukushima nuclear power site, flooding the area around Units

1 through 4 in 15 feet of seawater with the highest wave watermark measuring 45 feet.

These events were to set in motion what we now know as "Fukushima;" like Chernobyl, no longer a place name but synonymous with disaster.

In this edition of *The Thunderbird* we explore the events, consequences, lessons and implications of Fukushima on the present and future of nuclear power in the U.S.

FUKUSHIMA: WHAT HAPPENED?

When the March 11 earthquake and tsunami struck at the Fukushima Daiichi nuclear power plant complex, reactor Units 1, 2 and 3 automatically shut down successfully. Unit 4 had recently moved all of the reactor fuel into the elevated storage pond. Units 5 and 6 were shut down but still actively cooling their reactor cores.

Nuclear power plants are designed with multiple power systems to run pumps and operate safety systems to keep the still super-hot reactor cores from overheating. However, the tsunami simultaneously destroyed the nuclear station's harborside seawater-cooling pumps and flooded the onsite Units 1 through 4 emergency diesel generators, disabling the bulk of emergency onsite backup AC power to critical safety systems.

While the timeline varies from one unit to the next, within hours, the emergency power from the large onsite battery banks was depleted, plunging much of the atomic power complex into a complete loss of electrical power known as "prolonged station blackout."

Only one air-cooled emergency diesel generator for Units 5 and 6 remained operational, providing power to cool the two shut down reactors. The control rooms for Units 1 through 4 lost the ability to monitor and control the reactors.

Continued on next page

INSIDE THIS ISSUE

- No one died: The perpetual lie
- Life after evacuation
- Fuel pool risks: status update
- A "man-made" disaster
- Will EPA weaken U.S. radiation rules?
- The radioactive water problem

Fukushima: What Happened?

Continued from front page



Without the flow of cooling water, the tremendous amount of residual heat left in the shut down reactors' cores began to overheat, swell and burst from fuel rod casings, then burn like super-hot flares.

Reactor operators scrambled in darkened control rooms by flashlight to try to regain control, even pulling batteries from their cars in the parking lot in an attempt to hotwire the reactors' control and monitoring systems for cooling Units 1, 2 and 3. The fuel in the overheated reactor cores began to melt.

With core temperatures rising and the reactor vessels over-pressurizing with steam, radioactivity was being released from the damaged reactor cores inside the reactor vessels and containment.

The zirconium alloy in the fuel rod cladding chemically reacted at high temperature with the steam to generate non-

condensable and highly explosive hydrogen gas. Because of the loss of electrical power and high radiation fields, operator efforts to vent the extreme heat, the increasing steam pressure and the explosive gas, failed. The accumulation of hydrogen gas throughout the complex needed only a tiny spark to ignite the three explosions. These destroyed the Unit 1 reactor building on March 12, and Units 3 and 4 -- linked by common containment venting systems -- on March 14th. Within 72 hours of the earthquake, the reactor cores at Units 1, 2 and 3 had catastrophically melted down.

The lava flow of uranium and steel, known as corium, burned through the thick-walled reactor pressure vessels and then attacked the concrete and steel containment structures below, sending an aerosol release of radioactive iodine and radioactive cesium into the atmosphere.

Heroic last-ditch efforts to cool the molten cores with fire trucks pumping seawater into the nuclear wreckage resulted in the first wave of massive amounts of highly radioactive water flowing uncontrolled back into the Pacific Ocean.

Though efforts to restore offsite electrical power to the destroyed reactor complex began immediately after the earthquake, the first live electric power cable to the destroyed site would not be completed until a week later on March 18.

“NO ONE DIED”: FROM TMI TO CHERNOBYL TO FUKUSHIMA, THE PERPETUAL LIE



As with the bogus claim that “no one died at Three Mile Island” or “so much as sprained an ankle,” the same lie, that no one has perished or even suffered health damage, has been callously trotted out in the aftermath of the Fukushima nuclear catastrophe.

Beyond Nuclear examined the truth about the TMI disaster in its Spring 2014 *Thunderbird*.

As Dr. John Gofman warned in his foreword to Alla Yaroshinskaya's 1995 book *Chernobyl: The Forbidden Truth* (U. of NE Press), efforts to set the record straight must include scientific watchdogging and data protection/preservation, amidst shameless nuclear establishment efforts to bury the truth.

Here are some well-established facts that rebut the perpetual “no one died” lie:

1. The Union of Concerned Scientists' 2014 book *Fukushima: The Story of a Nuclear Disaster* (New Press, p.118), by David Lochbaum, Edwin Lyman,

and Susan Q. Stranahan, documents that by the end of March, 2011, 40 hospital patients and 10 nursing home residents had died due to “a series of bureaucratic errors and communication mix-ups” during the evacuation of Futaba, one of the two host towns of Fukushima Daiichi.

A total of 228 patients were initially abandoned, completely alone in their beds for two days, in unlit, unheated facilities, subject to worsening radioactivity levels. Not all who endured abandonment also survived the subsequent hours-long, “grueling odyssey” in search of a shelter. Incredibly, 35 patients were “accidentally forgotten” in Futaba a second time, abandoned for another two days!

Continued on next page

“No One Died”: The Perpetual Lie

Continued from previous page

2. As reported March 1, 2014 in a *Japan Times* editorial, “more people have died from stress-related illnesses and other maladies after the disaster than from injuries directly linked to the disaster...1,656 people in Fukushima Prefecture...surpass[ing] the 1,607 people who died from disaster-related injuries. Another 434 people have died since 3/11 in Iwate Prefecture and 879 in Miyagi Prefecture. These indirect causes are just as deadly as the direct causes, and are likely to last much longer unless the central government takes action.” The editorial cited “Tepco’s continuing inept handling of the cleanup at the Fukushima No. 1 nuclear plant,” as a lead culprit, and called on national resources to fund needed healthcare and livable compensation for those 136,000 evacuees still languishing in temporary shelters far from their radioactive homes. “[A]bout 90 percent of those who have

died since the initial 3/11 toll were at least 66 years old,” the *Japan Times* emphasized. This accounting of indirect deaths attributable to the nuclear catastrophe was up from 1,539 reported in September 2013 by the *Mainichi Shimbun*.

3. As reported by the *Asahi Shimbun*, Jotaro Wakamatsu, a 79-year-old Fukushima Prefecture poet, 40-year anti-nuclear activist, and himself a nuclear evacuee, wrote that the radiological evacuation “hampered search efforts for people missing due to the tsunami.” His post-Fukushima poem “Visible Disaster and Invisible Disaster” includes the line: “Many of them may have died/ and are likely left under dirt and debris .../ without being laid to rest.”

4. Among the indirect causes of death attributable to the nuclear catastrophe are suicides. In August 2014, a Japanese court ordered TEPCO to pay nearly \$500,000

in compensation to Mikio Watanabe, a nuclear evacuee, in the aftermath of his wife Hamako’s suicide. This could serve as a precedent for a growing number of bereaved families who have lost loved ones to suicide in the aftermath of Fukushima. This includes a number of dairy farmers whose livelihoods were ruined overnight on 3/11/11.

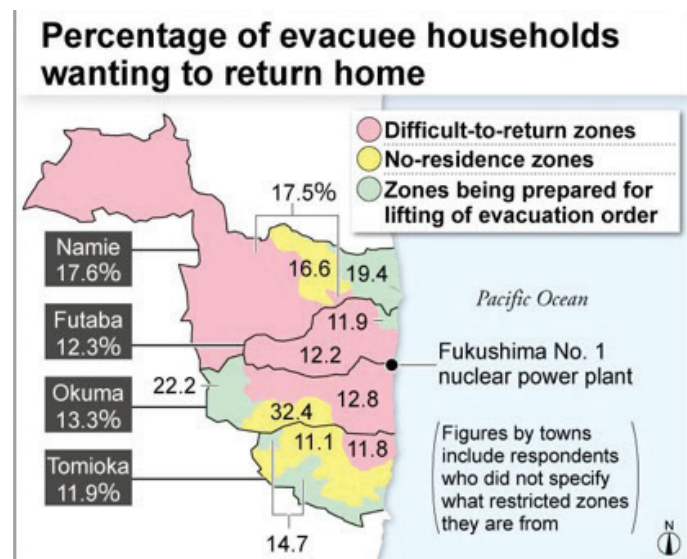
5. The workers at the Fukushima nuclear plant remain very much in harm’s way. As reported by the *Asahi Shimbun* on January 21, 2015, two workers died on the same day from industrial accidents at TEPCO’s adjacent Fukushima Daiichi and Daini nuclear power plants. One died after falling into a rainwater storage tank, due to an improperly secured safety harness. Another died after his head was caught in radioactive waste disposal machinery. The chaotic recovery efforts have employed ever greater numbers of untrained workers.

Back, but not home: Life after evacuation

Before the Fukushima nuclear catastrophe began in Japan, the allowable—though not safe—dose to members of the public from nuclear operations was 1 millisievert (100 mrem)/year. After the catastrophe, and under much public and international derision, the government of Japan announced 20 millisieverts per year would be protective enough, even for children. What changed? Surely not human biology.

Four towns were analyzed (see graphic at right), situated near the ruined Fukushima nuclear power facility, divided into three zones based on annual radiation dosage levels. The areas giving the lowest dose “Zones being prepared for lifting of evacuation order,” can expose people to as high as 20 millisieverts per year, with the eventual goal [not promised] being 1 millisievert or less. Twenty millisieverts is the annual maximum allowable dose for German nuclear workers. Decontamination is being attempted in some areas, but even “cleaned” means the radiation level is still higher than pre-accident levels, demonstrating that once a nuclear accident occurs, there is no recapturing the old environment.

Evacuees seem to know this. According to surveys taken at the end of 2014, less than one-fifth of evacuees want to return to their homes, and wish to relocate instead, particularly those with children. But TEPCO, the nuclear utility responsible, desperate to save face and money, is pressuring people to



resettle by offering a one-time lump sum if people return, rather than granting full compensation for the loss of evacuees’ homes. Many evacuee stipends are set to end in March 2015.

For those who do return, the community they knew no longer exists since many businesses remain shut and only a fraction of former residents are returning. The intricate social structure has been damaged and is not easily recreated.

STATUS OF HIGH-LEVEL RADIOACTIVE WASTE STORAGE POOL RISKS

First, some good news. All irradiated, and even fresh, nuclear fuel has been removed from the precarious Fukushima Daiichi Unit 4 storage pool. The final irradiated nuclear fuel was removed in November and fresh fuel in December and transferred to the ground-level common pool, adjacent to Unit 4.

This concluded a nearly four-year-long process. The mid-March 2011 hydrogen explosion so damaged the reactor building, there was global concern it would simply collapse -- potentially due to another strong earthquake at the site -- drain the storage pool cooling water, and set the 1,331 irradiated nuclear fuel assemblies -- 219 metric tons of heavy metal -- on fire.

There was no radiological containment around the pool to begin with, but the explosion had made it open air. The hazardous radioactivity releases from such a Unit 4 pool fire would have dwarfed the rest of the Fukushima nuclear catastrophe by an order of magnitude.

What took so long? First, steel braces were built to bolster the pool floor, so it wouldn't simply drop out. Then, an exoskeleton had to be built, to stabilize the reactor building, so it could support the necessary crane. A new roof had to be added as well. Finally, in November 2013, fuel removal began. That job took a year to complete.



IAEA experts depart Unit 4 of TEPCO's Fukushima Daiichi Nuclear Power Station on 17 April 2013 as part of a mission to review Japan's plans to decommission the facility. (Photo Credit: Greg Webb / IAEA.)

The bad news? There are three additional high-level radioactive waste storage pools, of very uncertain status, yet to go! Reportedly, the Unit 1 pool held 40 tons of irradiated nuclear fuel, Unit 2, 97 tons, and Unit 3, 63 tons when the catastrophe began. The resulting high radioactivity levels due to the meltdowns at all three units further complicate fuel removal.

Removal of debris and of the Unit 1 temporary canopy (installed after the 3/11 explosion blew the roof and walls off) have delayed the start of irradiated nuclear fuel removal from 2017 to 2019. Other problems could delay the Unit 2 pool transfer from 2017 to 2023.

Although TEPCO still claims fuel removal could begin in the next few months, the Unit 3 situation may be the worst of all. Arnie Gundersen of Fairewinds Energy Education

summarized what is known as of 2/13/14 in a podcast posted on his website, "New TEPCO Report Shows Damage to Unit 3 Fuel Pool MUCH Worse Than That at Unit 4."

Analyzing TEPCO documents, Gundersen was able to conclude that a remarkable 50 tons of debris had fallen on top of, and into, the irradiated fuel below, undoubtedly doing damage.

Gundersen fears some amount of the fuel could have been hurled from the pool by the force of the mid-March 2011 explosion, just before the debris came crashing down. Irradiated fuel fragments were found a mile or more from the reactor units.

Gundersen warned fuel may need to be robotically cut from its mangled storage racks, an unprecedented operation.

Fukushima post-mortem: A "man-made" disaster

Following the March 11, 2011 disaster, a six-month investigation by Japan's parliament, The National Diet, determined that the nuclear catastrophe was "man-made." The official report states, "The TEPCO Fukushima Nuclear Power Plant accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by said parties. They effectively betrayed the nation's right to be safe from nuclear accidents. Therefore, we conclude that the accident was clearly 'man-made.'" The official investigative committee determined that the direct causes of the catastrophe were foreseeable prior to March 11, 2011, but no one took

action. There are many deep roots to the man-made cause of the Fukushima catastrophe. However, the Japanese report finds that the primary root cause lay in the "regulatory capture" of the government's nuclear oversight and enforcement agencies in Japan.

"Regulatory capture" is evident when a regulator becomes a caretaker of the supposedly regulated industry's financial and production agenda rather than the defender of the public health, safety and environmental interests. This precisely mirrors Beyond Nuclear's own conclusions about the U.S. nuclear regulator (see *U.S. ignores known technical flaws*, page 5).

Will EPA weaken radiation exposure standards during a U.S. Fukushima?

In the wake of Fukushima, the U.S. Environmental Protection Agency (EPA) has issued extremely unprotective guidelines for radiation exposures under nuclear disaster circumstances. Known as “Protective Action Guides” (PAGs), they are rather exposure *standards*, designed to soothe a wounded nuclear industry should a Fukushima-like catastrophe occur in the U.S.

These PAGs allow 20 millisieverts (mSv) of exposure from an environment contaminated by a nuclear disaster. This dose would shockingly allow as acceptable 1 in 6 people exposed contracting cancer. Although the PAGs recommend 5mSv per year after the first year, there is no guarantee that anyone will

be relocated, or that the environment will be cleaned to this lower level. In Japan, officials are attempting to resettle people into areas of 20 mSv/yr even four years after the catastrophe.

In recommending the 20 mSv annual limit, the EPA is abandoning its goal of protecting the public to between 1 in 10,000 to 1 in 1 million lifetime cancers, in favor of less protective standards. The EPA guidelines could mean that the internationally recommended limit of 1 mSv per year exposure (still not protective, particularly of developing children) will not be honored if a Fukushima-style disaster occurred in the U.S.

In fact, one EPA employee suggested that in the event of a nuclear disaster,

“People are going to have to put their big boy pants on and suck it up.” “It” being “radiation”.

The EPA is admitting what Chernobyl and Fukushima are already demonstrating: there is no full recovery from a nuclear catastrophe.

What Fukushima has taught us is that once a nuclear catastrophe like this happens, the government will likely choose to protect the nuclear industry and its finances over the health and safety of the public.



U.S. ignores known technical flaws to keep “Fukushima-style” reactors running

The Japanese nuclear industry announced in January 2015 that, rather than invest in safety upgrades, they are permanently closing and decommissioning five more of their oldest atomic power plants. These permanent closures are in addition to all six units at Fukushima Daiichi. Two of the announced closures are Shimane Unit 1 and Tsuruga Unit 1, both GE Mark I boiling water reactors identical to Fukushima Daiichi Units 1-5.

In the U.S., however, Fukushima has magnified the “regulatory capture” of the Nuclear Regulatory Commission’s tug-of-war between its Congressional mandate to protect public safety and its bias to protect the nuclear industry’s financial interests.

The Fukushima disaster demonstrated what conscientious U.S. nuclear engineers and federal regulators have been saying for more than four decades: if any of these significantly undersized and vulnerable GE Mark I and Mark II containment systems are challenged by a severe accident, there is a very high probability that the structures will catastrophically fail, resulting in widespread radiological contamination.

By 1986, Harold Denton, then the top NRC safety officer, had confirmed there was a 90% chance of containment failure for the GE Mark I during an accident. A 100% containment failure was precisely what occurred at the three Fukushima reactors that melted down.

In November 2012, the NRC’s *Japan Lessons Learned Task Force* strongly recommended that the NRC order all GE Mark I and Mark II operators to install external, engineered, high-capacity radiation filters on upgraded hardened containment vents. The *Task Force* viewed the retrofit as a cost-benefited substantial safety improvement.

The nuclear industry disagreed and strongly opposed the radiation filter retrofit largely on the basis of cost versus the remote risk they assessed another catastrophe presented.

By a majority vote in March 2013, the NRC Commission ordered operators to upgrade containment vents but rejected the *Task Force* recommendation for radiation filters.

Of further concern, the agency is shutting out any further public debate or input by independent experts by closing down a Commission-proposed rulemaking and process.

This deprives impacted communities of any further chance to push for the mandatory installation of filtered vents on the GE reactor containment structures.

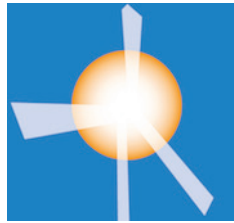
The fact that the NRC is neither willing to shut down vulnerable reactors, nor require the industry to backfit them in the interest of public health and safety, suggests NRC really stands for “Nuclear Regulatory Capture.”

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*The Thunderbird, in Lakota tradition, is the Guardian of the Truth.
Thunderbird design courtesy of Glenn Carroll of Nuclear Watch South.*



ABOUT BEYOND NUCLEAR

Beyond Nuclear aims to educate and activate the public about the connections between nuclear power and nuclear weapons and the need to abandon both to safeguard our future. Beyond Nuclear advocates for an energy future that is sustainable, benign and democratic.

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Fukushima's radioactive water: stored, leaking and flowing into the ocean



Radioactive water storage tanks are at capacity and some are leaking. (Photo: IAEA).

The Fukushima catastrophe has resulted in the release of radioactive fallout into the atmosphere and the discharge of radioactive liquid effluent into the Pacific Ocean. Radionuclides released include cesium 134, cesium 137, strontium 90, plutonium 239, iodine 131 and tritium.

Prevailing winds meant that most of the atmospheric radioactive releases went out to sea, with just 20% falling on land. Thus, the nuclear disaster added to the existing man-made radioactive contamination of the oceans from atmospheric weapons testing; previous nuclear accidents such as Chernobyl and Sellafield; nuclear fuel reprocessing; nuclear power plant discharges; the dumping of nuclear waste; and nuclear powered military naval vessels.

On the Fukushima site, TEPCO's ongoing effort to cool the uncontained and melted reactor cores is generating

more and more radioactive water. Water is reportedly being circulated through the three reactors and some of this now highly radioactive water is then leaking out into buildings that house the reactors and the turbines.

TEPCO is pumping 800 tons/day of radioactive water out of the reactor buildings to be desalinated and filtered of radioactive cesium, although intense radiation is degrading the filtration system, resulting in breakdowns and leaks. About 400 tons/day is pumped back into the reactors and leaks back out into the buildings. The other 400 tons/day is pumped into hastily constructed 1,000-ton tanks. This water contains high concentrations of unfiltered strontium-90 and tritium.

Some tanks have already leaked lethal radioactive water onto the site. In addition, there is a daily flow of groundwater runoff from the nearby mountainside into and out of the reactor complex's basements. This radioactive water is pumped out and partially treated. Some of the water is redirected into the storage tanks from its path toward the ocean harbor.

TEPCO is building one new tank each day for the radioactive water, but is running out of available space for the expanding tank farm. Government and industry officials are planning to dump the tanks' contaminated contents into the ocean by 2017. This massive release of contaminated water along with TEPCO's repeated failure to accurately report radiation levels and to disclose radioactive leaks into the harbor, has prompted protests from area fishermen.