

# NUCLEAR INFORMATION AND RESOURCE SERVICE

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## CHRONOLOGICAL FACT SHEET ON 2011 CRISIS AT FUKUSHIMA NUCLEAR POWER PLANT

**UPDATE, December 7, 2011.** On November 30, Tepco released a document that acknowledged, for the first time, that fuel in Unit 1 of Fukushima Daiichi had likely melted through the reactor vessel onto the concrete basemat below.

This appears to have set off considerable speculation across the internet that a “China Syndrome” event is inevitable—i.e., that it is impossible to now stop this fuel (or “corium”) from melting through the concrete and reaching groundwater, which would set off an enormous steam explosion—or some such disaster.

This is not the case. While there are some problems and unanswered questions with Tepco’s document, and as has been the case since the onset of this accident it appears to present a rosier picture of what has happened and continues to happen at Fukushima than is actually the case, the prospects of a new far-reaching disaster appear remote absent something that would cause a new disruption to the cooling water system now in place, such as another major earthquake/tsunami, which certainly can’t be discounted. In October, Tepco estimated it would take only 38 hours for fuel to reach the melting point if the cooling system were to fail. <http://www.japantimes.co.jp/text/nn20111114x3.html>

The Tepco document is available here: [http://www.tepco.co.jp/en/nu/fukushima-np/images/handouts\\_111130\\_04-e.pdf](http://www.tepco.co.jp/en/nu/fukushima-np/images/handouts_111130_04-e.pdf)

On page 18, Tepco estimates that fuel from Unit 1 has melted approximately 70 centimeters into the concrete below the reactor pressure vessel. That’s just a guess by Tepco, they really don’t know since they can’t get down there to find out. But it’s probably an educated guess.

The important point is whether there is continued melting of fuel going on, and if the fuel is thus continuing to make its way through the concrete. Concrete doesn’t really melt, but it crumbles at about 1000 degrees Centigrade (nuclear fuel melts around 2200 degrees Centigrade, the components of concrete--sand and stone--melt at about 2600 degrees Centigrade). Crumbling concrete would provide a pathway for melting fuel to continue through it.

But there is simply no evidence temperatures are anywhere near that high at any of the Fukushima reactors. As we reported in September (see below), even then temperatures were

around the 100 degree Centigrade mark, not 1000 degrees (even accounting for the likelihood that temperatures were somewhat higher than Tepco was measuring—since it doesn't know precisely where the hottest spots are--and/or admitting). There is nothing to indicate temperatures inside the reactors have gone up since then, and indeed Tepco claims they've gone down. If temperatures were much above 100 degrees, then we would be continuing to see the kind of steam releases that were clearly visible on the various webcams set up around Fukushima (Tepco's is here: <http://www.tepco.co.jp/nu/f1-np/camera/index-j.html>) a few months ago. But there is rarely visible steam anymore. And, even then, there is an enormous difference between the temperature required to create steam and the temperature required for nuclear fuel to move through concrete. And there is an even larger difference between the temperature required to create steam and that required to maintain melting of nuclear fuel.

A more likely scenario than melt-through of the concrete would be if the fuel pooled and moved sideways (rather than down) and melted through the containment walls, which are not nearly as thick as the concrete basemat. But again, temperatures are not high enough for this to be occurring at present.

So the fears of a “China Syndrome” or further fuel melting appear unfounded absent some new major component failure or natural disaster. The temperatures are not that high, and it would be impossible to hide temperatures that high. But it doesn't require a further accident to recognize Fukushima for what it already is—a disaster of the highest proportions, one that has made 3% of Japan's land mass uninhabitable and will sicken and kill many people over the years through direct exposures that already have occurred and continued exposures from the environment, from food and the like.

Tepco's document argues that only about 3% of Unit 2 and Unit 3's fuel melted to the bottom of the reactor pressure vessel (page 9, 17-18). This is where we really question the document. This is again based on calculation and estimate, since Tepco can't actually get there and see. Given that it has been believed for many months that there were breaches of the containment at both Units 2 and 3 (as well as Unit 1, which Tepco now admits), we think it likely that far more fuel than that has accumulated at the bottom of the vessels, and it wouldn't surprise us at all if in a few years we learn that molten fuel had penetrated the concrete of both of these reactors as well (remember that, in the case of the 1979 Three Mile Island accident, the utility argued for years that there had been no actual fuel melt, until they were actually able to look into the pressure vessel and find out that, oops, a whole lot of it had melted....).

In other relatively recent news, Tepco in November (<http://mdn.mainichi.jp/mdnnews/news/20111112p2a00m0na012000c.html>) confirmed that the explosion at the Unit 4 reactor, which had no fuel in its core, was caused by a backflow of hydrogen gas from shared pipes with the Unit 3 reactor. This has profound implications for multi-unit reactor sites with shared components.

That Fukushima, even without further meltdown, was and is an unmitigated disaster is evident by a study from the French government-funded Institute for Radiological Protection and Nuclear Safety, which found that Tepco had greatly understated the amount of radioactive Cesium that had been released into the Pacific Ocean. According to the study,

27,000 terabecquerels (27,000 trillion becquerels) of Cesium were released into the ocean; Tepco had estimated 15,000 terabecquerels. <http://www.bloomberg.com/news/2011-10-31/fukushima-plant-released-record-amount-of-radiation-into-ocean.html#> A different study, published in the Atmospheric Chemistry and Physics journal estimated Cesium releases to the air at 35,800 terabecquerels. Fortunately for Japan, most of that—probably 80%--was blown over the Pacific Ocean rather than land. The worst of the contamination in Japan was caused by a two-day shift in the wind in mid-March accompanied by rains which brought radiation to the ground, especially to the northwest of the Fukushima Daiichi site. It is almost unimaginable what the effect would have been on Japan had the wind been blowing inland (especially south toward Tokyo) during the worst of the accident and that 80% of the radiation had fallen on land.

Meanwhile, while the worst is over absent another disaster man-made or natural, the accident does seem to continue without end. Earlier this week, between 45 and 200+ tons of radioactive water was released into the ocean from Fukushima. And Japan still refuses to evacuate people living in many contaminated areas. Some in the government want to try to clean up those areas instead—a job likely to prove fruitless (and initial attempts at cleanup bear that out <http://nyti.ms/w183dX>) and, worse, will cause tens of thousands of people to continue to be unnecessarily exposed to toxic radiation.

**UPDATE, September 29, 2011.** Yesterday marked a milestone of sorts for the Fukushima Daiichi reactors: some six-and-a-half months after the onset of the accident, temperature levels at all of the reactors and fuel pools fell below the boiling point (100 degrees Celsius) for the first time since March 11.

But there are some caveats to that statement. The temperature at Unit 2 fell only to 99.4 degrees Celsius, and has been going up and down in recent days, so could quickly return to the boiling point. Moreover, while the reactor temperatures are measured at the bottom of the pressure vessel, it's not clear that is where the hottest temperatures are. Since fuel melted and containments failed, allowing fuel to go below the pressure vessel, temperatures below the vessel where the molten fuel has collected may remain higher than the boiling point.

Meanwhile, the cooling system that has brought down temperatures is a jerry-rigged system nothing akin to the normal cooling systems found in reactors, and its long-term reliability is in serious question. This is especially so because the region continues to suffer earthquakes (a 5.6 earthquake struck the region this morning), not to mention typhoons and other problems.

In other words, there remains some time before cold shutdown of the reactors can be proclaimed. And in the meantime, radiation releases continue, although they are reported to be a small fraction of earlier releases. They're now on the order of one million becquerels/hour (as opposed to a trillion/hour a few months ago and thousands of times more than that in March). Although, a caveat to that too: as noted below, Tepco has admitted that it doesn't really know how much radiation is being emitted--it's estimating.

A couple of reports have struck us recently. One widely reported (here from ABC news in Australia: <http://www.abc.net.au/news/2011-09-28/fukushima-residents-unable-to-return->

[home/3026496/?site=sydney](http://home/3026496/?site=sydney)) is that Tepco seriously considering abandoning the Fukushima facility in mid-March when it reduced its on-site workforce to 50 people (we warned about that on the Don Imus show at the time, although we were concerned we might be a little sensationalistic; as it turns out, that's exactly what Tepco was thinking).

Another, also widely reported, is that then-Prime Minister Kan was actively considering ordering an evacuation of Tokyo in mid-March as conditions deteriorated and foresaw a potential end to Japan as a functioning nation. It may go without saying that if Tepco actually had abandoned its efforts at the time, that's exactly what would have happened.

Meanwhile, for the people of Japan, the concerns are the same they have had for months: people remain living in areas with radiation levels that would have required evacuation before Japan increased its allowable radiation levels 20 times; contaminated food—the rice harvest, which is going on now, is especially key. So far we have seen only one report of highly contaminated rice (<http://www.commondreams.org/headline/2011/09/24>), although many might find “allowable” contamination levels of rice to be rather unsettling.

The other major concern of people in Japan is whether the remaining existing reactors will be allowed to restart, and the movement to prevent that is growing rapidly, as this report from *Time* yesterday indicates: <http://www.time.com/time/world/article/0,8599,2095296,00.html>.

Media coverage of Fukushima, especially in the U.S., is nearly non-existent, but some coverage, especially in Asia, is fairly good. Of particular note is a report from *Bloomberg* this week that brings the human dimension to the fore: [http://news.businessweek.com/article.asp?documentKey=1377-aY4w9SrlkwSE-4MDTNC657IKE0HPAVBDKP5UGS6&utm\\_source=twitterfeed&utm\\_medium=twitter](http://news.businessweek.com/article.asp?documentKey=1377-aY4w9SrlkwSE-4MDTNC657IKE0HPAVBDKP5UGS6&utm_source=twitterfeed&utm_medium=twitter)

Finally, a group of Japanese farmers and activists were in the U.S. last week to talk about the continuing effects of Fukushima. We were proud to host a dinner for them in Washington; of more general interest, however, is this video of one of their New York presentations. It's long, but worth watching: <http://politube.org/show/3285>

**UPDATE, August 22, 2011.** The *New York Times* reports that Japan is finally getting ready to acknowledge what we have been saying in this space for months: that the Fukushima evacuation zone is an uninhabitable Dead Zone, and no one will live there again for at least many decades. An official government announcement is expected later this week.

The news follows release of a new radiation survey conducted by the government, which shows contamination levels throughout the evacuation zone to be much higher than previously admitted—up to 500+ MilliSieverts/year (50 Rems/Year) in Okuma, two miles southwest of the reactor site. This is actually about twice as high as radiation levels NIRS measured in Pripjat, Ukraine—about two miles from Chernobyl—in 1996.

But high radiation levels also were measured outside the 20 kilometer (12-mile) exclusion zone. Levels in the town of Namie, for example, 22 kilometers to the northwest of Fukushima Daiichi,

were reported at 229 MilliSieverts/year—far above inhabitable levels. It is our (unconfirmed) understanding that most, if not all, of Namie previously had been evacuated, as well as some other towns even further from the reactor site. Thus, the actual Dead Zone is expected to be larger than the 20 kilometer radius.

Contamination of food in Japan continues to be a concern, and a concern that only has grown with the first report of Cesium contamination of rice, some 100 miles from Fukushima Daiichi. The rice harvest—critical to Japan—is just beginning. While the contamination levels were below “allowable” amounts, to find any contamination in rice, especially that far from the reactor site, is foreboding.

**UPDATE, August 1, 2011.** Tepco reported today the highest radiation levels yet measured at Fukushima Daiichi—1,000 Rems/hour (10 Sieverts/hour)—a lethal dose. The measurements were taken at the base of the ventilation stack for Units 1 and 2 (the stack that did not work during the accident). The actual levels may have been more than measured, since the monitoring equipment could not measure more than 10 Sieverts/hour. Workers sent to the area to confirm the measurements, which were first picked up by a gamma measuring camera, received doses of about 400 millirems in just a few minutes.

All of this brings up a lot of questions Tepco and the Japanese government must be held to account for. It has been more than four months since the accident began. The belief is that these readings are a result of the failed attempt at ventilation in the early hours of the accident. How is it possible that Tepco is noticing this extraordinarily high reading only now? How many workers have walked by this area in the past four and a half months without realizing the kind of dose they were getting? What does this say about Tepco’s, and the government’s, overall radiation measurements both onsite and offsite?

Indeed, even while Tepco last week said the continuing releases from Fukushima are only a fraction of what they were in April (one billion becquerels/hour versus one trillion becquerels/hour in April) and far lower than mid-March, Tepco also had to admit that it doesn’t actually know how much radiation is being emitted. The utility said it planned to begin tests at Unit 1 over the past weekend to try to find out what is actually being emitted from there, and will begin similar tests at Unit 2 during August. But it doesn’t even plan to try tests at Unit 3 because the radiation levels are so high in that reactor.

Given Tepco’s and the government’s inability to detect lethal levels of radiation onsite—where there are presumably many radiation monitors available—what confidence can anyone have about offsite measurements in Japan? The role of citizen radiation monitoring has never been more crucial. The *New York Times* today has an article demonstrating this fact. It is the citizen monitors who are finding radioactive hotspots throughout north central Japan, who are demanding evacuations, who are documenting this contamination without end.

**UPDATE, Tuesday, July 19, 2011.** It has now been more than four months since the accident began at Fukushima Daiichi and unfortunately no end is yet in sight. Much like last year’s BP oil spill, which spewed oil into the Gulf of Mexico for months yet vanished from the major media

within weeks, so has much of the major media moved on from Fukushima. But the accident continues, radiation continues to be released (though much lower amounts, of course, than initially), and the risk of new problems remains.

One immediate problem is Typhoon Ma-On, which is expected to hit Japan this week. This is a major storm that, depending on its strength and position, could cause serious problems at Fukushima, especially in terms of flooding areas already holding vast amounts of contaminated water. Tepco has put a new structure over the Unit 3 turbine building, damaged by explosion in March, to try to keep rainwater out, since the basement of the building is already holding about as much contaminated water as it can—several inches of rain could cause additional leakage into the Pacific Ocean. However, Tepco apparently will not be able to put covers over the damaged Units 1, 3 and 4 reactors themselves. Unit 3 will be particularly vulnerable to the effects of the typhoon.

Meanwhile, Tepco says it has achieved “stable cooling” of all of the reactors at the site. This might sound like good news until it is realized that Tepco does not mean the reactors are at cold shutdown. In fact, all 3 reactors with fuel in them remain above the boiling point of 100 degrees Centigrade, meaning that water continues to boil off and radiation continues to be released. Cold shutdown—bringing the temperatures below 100 degrees—is still not expected before January 2012. What Tepco really means is that it has more or less successfully set up a system for water to be recirculated through the reactors, so that constant water from outside is no longer needed. However, the recirculation system has been plagued with problems from the beginning and continues to not work at desired capacity.

That is not the case for the Unit 4 fuel pool, which continues to receive water from outside. Temperature in the pool is said to be below boiling, at 80 degrees Centigrade.

Radiation levels across north-central Japan continue to be an issue. Most recently (i.e. today), Japan has stopped the sale of beef from Fukushima Prefecture (why they ever allowed the sale is the real mystery...) and may stop the sale from other Prefectures too. At least 578 contaminated steer have been sold in recent weeks, and apparently all or almost all of it already has been consumed. The steer became contaminated by eating straw contaminated by high amounts of Cesium-137. The presence of high levels of Cesium-137, which has a 300-year hazardous life, indicates that the contamination problems in Japan will continue to plague the country for generations.

But it's not just beef and straw. Very high levels of Cesium-137 and other radioactive elements have been detected in all manners of agricultural products and soils across the region. Our friends at Green Action Japan have posted this chart of measurements taken last week: [http://www.acro.eu.org/OCJ\\_en.html#12](http://www.acro.eu.org/OCJ_en.html#12) Of particular note are both the Cesium-137 levels far higher than allowable limits, but also the continued presence of high levels of Iodine-131. Because of its 8-day half-life, Iodine-131 released during the initial week of the accident, when extremely large amounts of radioactive materials were ejected from all the Fukushima reactors, already has decayed to background. The continued presence of high levels of Iodine-131 is a certain indicator of the radiation releases that continue at Fukushima and will continue for months to come.

**UPDATE, Tuesday, June 21, 2011.** A new version of the map we posted Friday of radiation readings in Japan sheds more light on the vast contamination of the northern part of the country and



new evidence that the government's response has been woefully inadequate. The map is here: <http://gunma.zamurai.jp/pub/2011/18June.pdf> (Warning, this is a very large—15mb—pdf file; not recommended for slow connections).

For perspective, a radiation level of about 0.19 MicroSieverts/hour is roughly equivalent to the maximum allowable radiation exposure level (1 MilliSievert/year or 100 Millirems/year) for the United States. Until March 2011, that was also the allowable exposure level in Japan.

All of the shaded spots in this map exceed that level. These include areas more than 200 kilometers (120 miles) from Fukushima Daiichi.

People in the areas in darker orange and red (above 4 MicroSieverts/hour), extending more than 50 kilometers (30 miles) from the site, would exceed even Japan's revised allowable dose of 20 MilliSieverts/year (200 Millirems/year). As another perspective, people in the red area would exceed the previous annual allowable dose within a week.

Why isn't everyone in these areas being relocated?

One note of caution, however. These measurements have been taken by local governments in 18 Prefectures across northern Japan. Because these measurements have been taken by different people with varying levels of expertise, using different equipment, they may not correlate exactly and there may be some overstatement—and understatement—of the real situation. Taken together, however, they provide probably the clearest picture yet of the growing threat to public health and safety in Japan. Thanks to Greenpeace Japan for pointing us to this map.

By the way, the contamination map we posted here Friday (on which the contour map cited above is based) is available in an updated interactive version here: <http://www.nnistar.com/gmap/fukushima.html>. You can zoom in on specific areas, compare the map to a satellite image, and more. Very useful.

In other news, the Ministry of Economy and International Trade, which both promotes and regulates nuclear power in Japan, is considering permanent shutdown of all 10 of Japan's GE Mark I reactors (4 of which, of course, are already permanently shutdown at Fukushima Daiichi). The U.S. should do the same.

**UPDATE, Friday, June 17, 2011.** There have been increasing reports of radioactive "hotspots" being found around Japan—especially in the area outside but near the evacuation zone of course, but also quite far away. For example, the Wall Street Journal reported today on a hotspot found in Chiba Prefecture 120 miles from Fukushima Daiichi and not too far from Tokyo. There have been reports of elevated readings in Tokyo itself, and across northern Japan.

We found the map below today on DailyKos which gives some indication of the extent of contamination. The areas in blue indicate slightly elevated radiation levels—high enough that a person exposed to these levels likely would receive an annual radiation dose in excess of 1 MilliSievert/year (100 millirems/year), which, until Fukushima was the maximum annual exposure level for the general public in Japan—as it remains the maximum level in the U.S.

As the colors move more toward red, the levels go higher. As has been well-understood, the areas to the northwest of Fukushima Daiichi have been hardest hit—but not all those areas in red and orange have yet been evacuated—and they should be. Indeed a good argument could be made that the areas in any color other than blue should be evacuated. Of course, no one will ever return to those areas that have been evacuated.

Areas not marked with a color are not necessarily uncontaminated—they may have just not been measured yet.

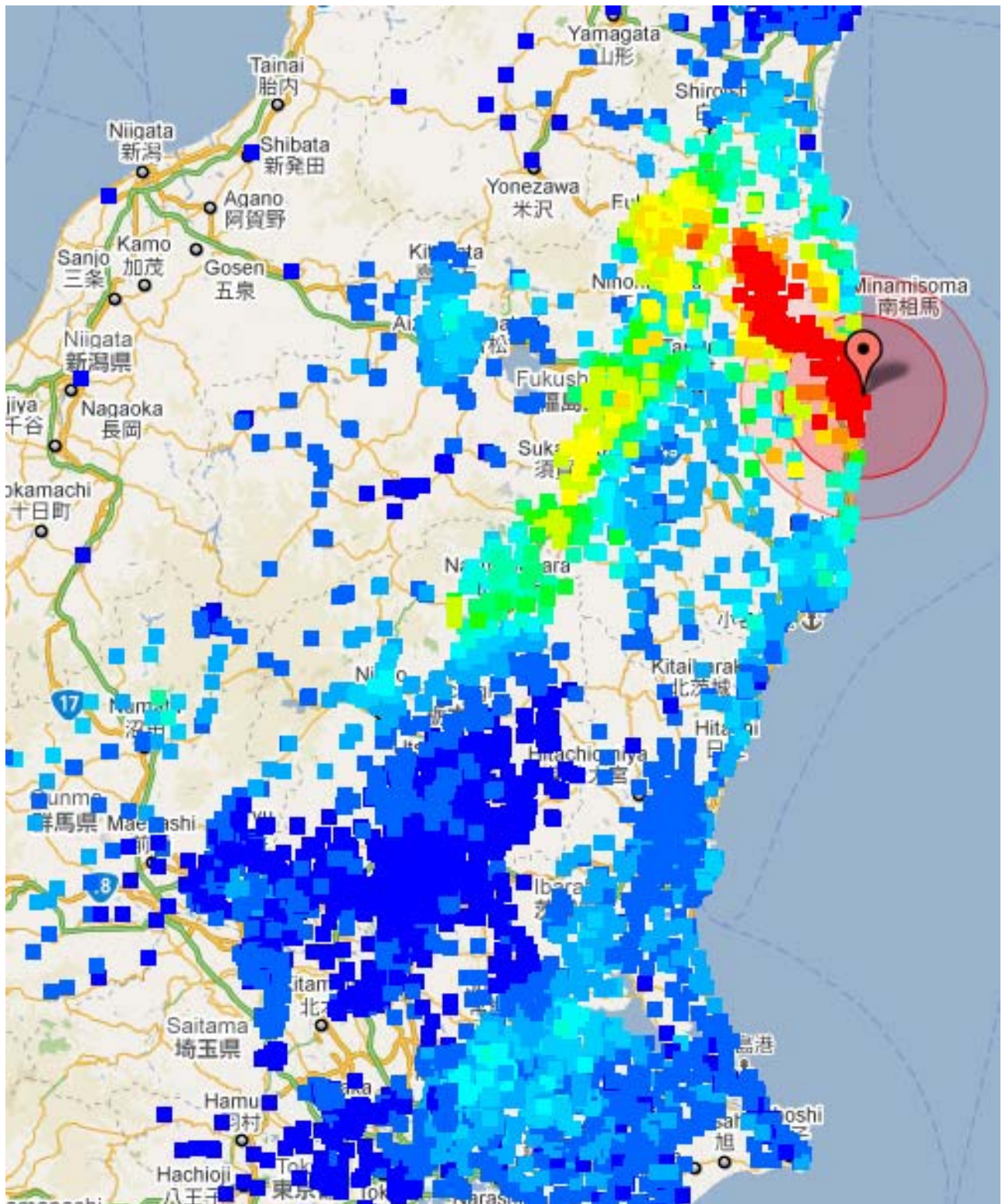
And that brings us to two points about radioactive “hotspots.” First, while the ongoing daily radiation releases from Fukushima certainly aren’t helping things, we believe that most of the hotspots are being discovered now simply because they are finally being measured now. The high levels of radiation most likely were generated during the first week of the accident. In other words, people have been living with these hotspots for the past three months—and are only in recent days learning about them. And we believe many more hotspots will be discovered as measuring continues and expands. This means that the exposures to the general unevacuated population—especially internal exposures—are most likely higher than has been presumed.

The second point is, as is obvious from the map, radiation does not deposit uniformly. Indeed, there can be, and likely are, hotspots even in those areas showing relatively low contamination levels. It is not uncommon to take a radiation measurement in one location, and find a much higher hotspot just yards, and even feet, away. That is usually due to the presence of a highly radioactive particle, and short of measuring every square foot of land, it is impossible to fully measure all of the hotspots.

That’s why governments must err on the side of caution, and where general radiation levels indicate that allowable limits may be exceeded, it should be presumed that those limits will be exceeded and appropriate measures—including relocation—should be implemented. That’s why villages dozens and even hundreds of miles from Chernobyl, well outside the Dead Zone, no longer exist.

Instead, Japan has chosen the opposite course. Instead of taking steps to prevent unnecessary exposures, it increased the allowable limit from 1 MilliSievert/year to 20 MilliSieverts/year (2 rems/year)—an “allowable” level more commonly associated with German nuclear workers (U.S. nuclear workers are allowed to receive 5 rems/year). Even so, many people in northern Japan are likely to receive doses above 20 MilliSieverts/year because of the government’s fear and failure to take necessary protective steps. And that is likely to turn out to be the real tragedy of Fukushima.





■ 0.0-0.1未満 ■ 0.1-0.2未満 ■ 0.2-0.3未満 ■ 0.3-0.4未満 ■ 0.4-0.5未満 ■ 0.5-0.6未満 ■ 0.6-0.7未満 ■ 0.7-0.8未満 ■ 0.8-0.9未満 ■ 0.9-1.0未満  
 ■ 1.0-1.5未満 ■ 1.5-2.0未満 ■ 2.0-2.5未満 ■ 2.5-3.0未満 ■ 3.0-3.5未満 ■ 3.5-4.0未満 ■ 4.0-4.5未満 ■ 4.5-5.0未満 ■ 5.0以上 (単位  $\mu\text{Sv/h}$ )

**UPDATE, Tuesday, June 14, 2011.** In what can only be described as the most pathetic response to growing concern over radioactive contamination in Japan yet, 34,000 school children in the Fukushima City area will be given personal radiation dosimeters to wear constantly. But the dosimeters won't be handed out until September, will be read by authorities only once per month and will only be used for three months. And, of course, the dosimeters won't measure internal contamination.

Japanese officials hope the readings will show relatively low contamination. That may or may not turn out to be true. Given that Japan already has raised its allowable exposure levels twenty-fold—from 1 to 20 MilliSieverts/year, “relatively low” has a different connotation, especially where children are concerned. This report from Russian TV, reporting from the Fukushima City area, isn't reassuring. The reporter found hotspots registering 1,000 times above background levels, and the many radiation-suit clad workers around are a lot more protected than school children...  
[http://www.youtube.com/watch?v=z49\\_1YkPgPE](http://www.youtube.com/watch?v=z49_1YkPgPE)

Hotspots also have been found far from the Fukushima area—in fact, as far as 180 miles south of the reactor site. More hotspots are likely to be found in areas that have not even been measured yet, especially to the north and northwest. This follows the same trend as Chernobyl, where the initial 30 kilometer evacuation zone has become known as the Dead Zone, but evacuations and other protective measures occurred at many locations as far as 200 miles away as the full extent of the accident became clearer.

Meanwhile, Tepco is screening workers for radiation exposure and it has found two exposed to more than 600 MilliSieverts, six to about 500 MilliSieverts, and at least 93 to more than 100 MilliSieverts. Before March 11, the Japanese limit for nuclear workers was 100 MilliSieverts/year. That was quickly raised to 250 MilliSieverts after the accident. According to NHK TV, Tepco is screening about 3,700 workers. But other reports indicate that nearly 8,000 people have worked at the site since the accident began.

Tepco's plans to install a working cooling system for the Unit 4 fuel pool, similar to that apparently successfully installed at Unit 2, have hit a substantial roadblock. Workers were finally able to enter Unit 4 this week and discovered that the water pipe it had been counting on using is heavily damaged (as is the rest of the unit, see photo). This means that water will continue to have to be pumped into the pool from outside.



Efforts to continue work at Unit 2 have also run into trouble because of extremely high humidity (99.9%) inside the reactor building that makes working in the building virtually impossible. Tepco had thought the source was the heat from the fuel pool, but now that the pool is cooling, it has realized the source is heat from the molten reactor core in the suppression pool under the building—and that will be a lot harder to address.

Finally, if you missed the news: Italy is the latest country to chart a new path to a non-nuclear future. A referendum held June 12-13 resulted in an almost-astonishing 94% vote against more nuclear reactors in the country. 57% of eligible voters actually voted, despite government efforts to discourage turnout.

**UPDATE, Thursday, June 9, 2011.** Japan admitted this week that not only did three reactors melt down (Unit 4 had no fuel in its core, otherwise it would have melted too), but that the fuel melted through the containments. Not really news: the U.S. NRC had made that assessment in the first week of April (see April 6 and 7 below).

Japan also admitted that radiation released from the initial meltdowns was at least twice what government and utility officials previously had acknowledged. Also not really news: the Austrian government had made that assessment, based on actual radiation readings rather than official pronouncements, back on March 23 (again, see below, March 23).

But the reluctance of Japan's government and Tepco to face up to the consequences of Fukushima in real time unfortunately casts doubt on everything they say even now after all their apologies have been made. Should we believe current radiation release figures, for example? Or believe that Tepco is even capable of developing and implementing a plan to finally stabilize the situation?

A good first step would be for Japan to finally publicly admit that there is a large permanent dead zone around Fukushima, which will not be habitable for centuries. In other words, evacuees will not be returning to their homes and former livelihoods. Moreover, as was the case at Chernobyl, the dead zone is likely to grow rather than shrink as more detailed radiation readings are taken and radiation continues to spew from the Fukushima Daiichi site.

Already, there are indications that Japan will soon be evacuating a couple more towns where hot spots have been found--30 miles (50 kilometers) from Fukushima Daiichi—far outside the current evacuation zone. The towns are Minamisoma City and Date City in the hardest-hit area northwest of the site.

Meanwhile, as Tepco continues to send robots into areas of the reactors they haven't previously entered, radiation measurements have soared, with up to 400 rems/hour (4,000 MilliSieverts/hour) reported inside Unit 1. We note that we have seen no reports of robots even entering similar areas inside Units 2 or 3, but we would expect similar or higher measurements in those much larger reactors.

Temperatures inside all three reactors remain above the boiling point (100 degrees Centigrade, 212 degrees Fahrenheit), which means that the water pooled underneath the reactors in which the molten fuel apparently sits continues to both boil off and be released to the air in the form of radioactive steam, and, because the containments have been breached, continues to leak out into groundwater, trenches, nearby buildings, and eventually the Pacific Ocean. And water must continue to be poured into the reactors lest water levels fall too greatly which would cause temperatures to rise and meltdowns to resume.



The idea of installing functioning cooling systems under these conditions (400 rems/hour is far too high to allow for the presence of workers—even with protective gear they could stay in the area only for minutes) seems far-fetched. As does the notion that this accident will be stabilized by the new year....

**UPDATE, Thursday, June 2, 2011.** Concern is growing that radioactive water in the reactor buildings and other facilities at Fukushima Daiichi may again be released into the ocean. Water levels have been rising, partly as a result of continued pumping of water for cooling and partly as a result of heavy rains last weekend from Typhoon Songda, which fortunately only grazed the Fukushima site. A Tepco spokesman said today that radioactive water could begin to overflow trenches within 5-7 days.

Nagasaki University Hospital says that 40% of the people it sent to Fukushima Prefecture in March to assist with the aftermath of the earthquake/tsunami received measurable internal exposure to radiation, including Iodine-131 and Cesium-137.

In a new indication of just how far significant levels of radiation spread from Fukushima, Japan today banned distribution of green tea grown in four prefectures ~~southwest of Tokyo~~ south and southwest of Fukushima and north of Tokyo—~~more than~~ as far as 150 miles from the Daiichi site—because of elevated levels of Cesium-137. (corrected, June 6, 2011)

Tepco has set up its own live webcam of the Daiichi site here: <http://www.tepco.co.jp/nu/f1-np/camera/index-j.html>. Occasional (and occasionally large) radioactive steam releases are ongoing....

Meanwhile, a top Tepco official admitted recently that it is unlikely that the situation at Fukushima will be stabilized by January, as the utility's plan, revised just two weeks ago, predicts. One positive sign however, a functioning cooling system has been installed for the Unit 2 fuel pool, and water temperature has been brought down substantially.

**UPDATE, 11:30 am, Thursday, May 26, 2011.** Evidence is growing that the March 11 earthquake itself caused major damage to the Fukushima Daiichi reactors even before the accompanying tsunami knocked out offsite power and ensured the subsequent meltdowns.

According to Keiji Miyazaki, professor emeritus of nuclear reactor engineering at Osaka University, the earthquake likely damaged the high pressure coolant injection system, part of the emergency core cooling system at Unit 3 (as we reported below, it already has been believed that Unit 1 suffered severe damage from the earthquake). This system is supposed to work to cool the reactor even if power is lost, but at Unit 3, it didn't. A review of pressure readings at Unit 3 indicate that there likely was a major steam leak that ultimately led to the speedy meltdown there. Article from Asahi.com here: <http://www.asahi.com/english/TKY201105250150.html>

A rough translation of remarks by seismologist Katsuhiko Ishibashi (Emeritus Professor, Kobe University, which also suggest the earthquake itself heavily damaged the reactors, is available here: <http://abolition-of-nuclear.blogspot.com/>

Tomio Kawata, a research fellow of the Nuclear Waste Management Organization of Japan, said this week that the soil of a large area of northwest Japan—about 600 square kilometers—is contaminated with Cesium-137 at levels higher than prompted compulsory evacuation orders in the Soviet Union after Chernobyl (1.48 million becquerels per square meter). 700 square kilometers is contaminated with levels from 555,000-1.48 million becquerels per square meter.  
<http://mdn.mainichi.jp/mdnnews/news/20110525p2g00m0dm108000c.html>

Today, Tepco said that some 60 tons of radioactive water in one of its makeshift storage tanks—where it has been putting radioactive water gathered from the reactors and turbine buildings—has leaked out. The leak is apparently continuing.

Greenpeace is continuing its testing of marine life 12 miles and more from the Daiichi site, this week finding seaweed with contamination levels as high as 60 times legal limits.

**UPDATE, 2:30 pm, Friday, May 20, 2011.** The world's media are shocked (shocked, we tell you...) that three Fukushima reactors melted down. Where have they been the past 10 weeks? Where did they think all that radiation was coming from? You know, that radiation that caused the evacuation/relocation of people as far as 25 miles from the reactor site? Not to mention contamination of food, seawater, etc.....

Even Tepco admitted weeks ago that 35-50% of the fuel had melted at the three reactors (U.S. Energy Secretary Steven Chu had estimated 70% melt at Unit 1); the big difference now is that it seems as if all the fuel has melted and is now a large glop at the bottom of each reactor building.

We expect the media to be equally shocked when they finally realize that the evacuees will never be returning home and that the world now has another piece of itself rendered uninhabitable by nuclear power.

In actual news, evidence is growing that Unit 1's meltdown was initiated by the earthquake and only exacerbated by the ensuing tsunami. Bloomberg reports that a radiation alarm inside Unit 1 went off before the tsunami even arrived, indicating coolant already had been lost and fuel melting had begun. If true, this could also require a re-assessment of how quickly reactors can melt down—that would mean meltdown had begun less than an hour after loss-of-coolant.

Masataka Shimizu, President of Tepco, resigned today after leading the company into the largest financial loss in Japanese history—about \$15 Billion, and that's before any compensation has been paid to the tens of thousands of people who have lost their homes and livelihoods.

Woods Hole Oceanographic Institution says that the impact on the world's oceans by Fukushima exceeds the impact of Chernobyl—in fact, the impact is 10 times higher. Woods Hole has received an emergency grant from the National Science Foundation to set baseline radionuclide levels in both the Atlantic and Pacific Oceans and to monitor the impact of Fukushima fallout.

Recently released photos of the tsunami hitting Fukushima Daiichi are here: <http://bit.ly/mG5WzY>

**UPDATE, 12:30 pm, Monday, May 16, 2011.** On March 27, we reported on a press conference by a Japanese nuclear engineer who believed that the meltdown at Unit 1 was caused by a loss-of-coolant accident initiated by the earthquake itself, which was exacerbated by the ensuing tsunami and loss of power. It now appears that assessment was correct. Tepco said today that radiation levels inside Unit 1 were measured at 300 MilliSieverts/hour within hours of the earthquake—meaning that fuel melting already had begun. For melting to have begun that early, coolant must have been lost almost immediately. It's now believed that fuel melted and dropped to the bottom of the containment—melting a hole into it, within 16 hours. Most likely, a major pipe carrying cooling water to the core was damaged by the earthquake, which should lead to a new evaluation of the ability of key reactor components to withstand seismic events.

Tepco also said today that an Olympic pool sized pond of highly radioactive water—some 3,000 tons of water--was discovered in the basement of Unit 1 over the weekend. This at least answers some of the question about where all the water that has been pumped into the Unit has been going...

Meanwhile, a robot placed on the second floor of Unit 1 measured radiation levels up to 2,000 MilliSieverts/hour—or 200 rems/hour—far too high for people to work in. And Tepco now acknowledges that the containments of Units 2 and 3 also almost certainly have been breached by molten fuel, which indicates a similar scenario to Unit 1—thousands of tons of water that have been pumped in to keep the reactors cool has become highly radioactive water leaking back out. There is likely far less water in the pressure vessels than Tepco previously believed.

All of this means that Tepco's 6-9 month plan to bring the reactors to "stability" will undergo major changes, and likely will be extended much into the future. Their plan has been scheduled for a public revision tomorrow.

Relocation of people in Iitate and other highly contaminated villages to the northwest of the Fukushima Daiichi but outside the original 20 kilometer exclusion zone finally began over the weekend, although it has now been more than a month since the intent of their relocation was announced. Why this necessary step wasn't taken sooner is beyond us....

For people looking for some more positive news, today's Climate Progress blog contains an excellent piece on Germany's accelerating transition away from nuclear power and toward a sustainable energy future. <http://climateprogress.org/2011/05/16/nukes-germany-transition-renewable-energy/>

**UPDATE, 11:30 am, Thursday, May 12, 2011.** At a Tokyo press briefing today, Tepco officials said that there is likely a hole inside the Unit 1 containment which is allowing highly radioactive water to leak—where the water is leaking to isn't known at this point. Tepco has flooded Unit 1 with some 11 million liters of water so far, and the unit can only physically hold less than 8 million liters—although much of that loss could have been by evaporation and release of radioactive steam. But now Tepco admits that the fuel rods inside Unit 1 are essentially uncovered—meaning that much of the water poured into the reactor has leaked back out. Much of the fuel—exactly how much isn't known--is now a molten mass on the bottom of the reactor vessel.

Tepco says this molten mass is currently covered by water and is thus being cooled, although temperatures inside the reactor remain above the boiling point (as they do at Units 2 and 3 as well).

This new development likely will set back Tepco's 6-9 month plan to bring the situation at Fukushima to stability. Tepco had hoped to reach a cold shutdown (with temperatures under the boiling point) of Unit 1 within weeks and for Units 2 and 3 in July. But first the hole inside Unit 1 allowing the radioactive water to leak out must be found and somehow fixed—a job that would entail very high worker exposures. Stability is a concept that seems still to be a very long ways from reality at Fukushima.

Meanwhile, Tepco says it has fixed a leak at Unit 3 found yesterday that was allowing highly radioactive water to flow into the ocean.

The Japanese government is expected tomorrow to approve some sort of bailout bill for Tepco, to help it pay the enormous compensation claims and cleanup costs that already have occurred and will continue mounting for many years. Other nuclear utilities may be required to pitch in and help, and some sort of increased government oversight of Tepco is likely. The ability of Tepco to offer dividends to shareholders is likely to be prohibited for at least a decade. Utilities thinking about building nuclear reactors in other parts of the world may want to take heed....

The live webcam at Fukushima yesterday showed larger amounts of radioactive steam being released from all the reactors than has typically been the case in recent days. No explanation so far.

Greenpeace, whose Rainbow Warrior ship has been prohibited by the Japanese government from coming closer than 12 miles to Fukushima, has been testing seaweed further away from the site, and found several samples measuring 20 times legal limits of Cesium-137 in the ocean as far as 40 miles from the Fukushima site. Seaweed is a staple part of the Japanese diet, with the average household consuming seven pounds per year.

**UPDATE, 2:30 pm, Tuesday, May 10, 2011.** Japanese Prime Minister Naoto Kan announced today that Japan is scrapping plans to build 14 new nuclear reactors and instead will rethink its energy policy with a focus toward renewable energy sources and efficiency.

Separately, Chubu Electric Co. yesterday agreed to Kan's request that the three operational reactors at the Hamaoka nuclear complex be closed, at least until seismic upgrades can be performed and a new seawall to protect against tsunamis be built. The betting here is that these reactors, which sit atop probably Japan's most dangerous earthquake fault, will not reopen. And Tokyo Electric Power, perhaps bowing to reality, said that it may never restart its four Fukushima Daini reactors. Like the Fukushima Daiichi reactors, they also lost cooling shortly after the March 11 earthquake and tsunami, but cooling was restored before the accident became too severe.

92 former residents of the evacuation zone entered the zone yesterday on buses provided by the government—the first people to legally enter the zone since it was declared an exclusion zone April 22. They were required to wear radiation suits and were in the area for two hours and allowed to pick up some household belongings. Government officials conducting a test run of the operation a



day earlier received doses of 25 microsieverts in their brief visit, indicating that radiation levels inside the zone remain quite high.

New joint U.S.-Japanese aerial monitoring results of the area have been posted and show significant Cesium contamination well beyond the government's evacuation zone. Cesium levels above 600,000 becquerels per square meter are indicated more than 60 kilometers (30 miles) northwest of the Fukushima Daiichi site. After Chernobyl, the Soviet Union evacuated areas above 550,000 becquerels per square meter. Maps are posted on the DOE website here: <http://blog.energy.gov/content/situation-japan/> Note: the maps are easier to see if you download them and view them in Powerpoint.

Work to put in a new cooling system has been set back at Unit 1 as radiation levels as high as 700 MilliSieverts/hour (70 rems/hour) were encountered. Some 500 million becquerels of radiation were released to the environment as access points to the reactor were opened up.

Meanwhile, there are some reports that the Unit 3 reactor has been heating up again. A remarkable new video of the fuel pool at Unit 3 has been released. While on the positive side it does show that the pool is now underwater, the pool is a picture of complete devastation. Perhaps most tellingly, there is no actual visual evidence any fuel remains in the pool—certainly not in racks as designed. However, some fuel must remain, as NHK TV reports radiation readings taken Sunday inside the pool of “140,000 becquerels of radioactive cesium-134 per cubic centimeter, 150,000 becquerels of cesium-137, and 11,000 becquerels of iodine-131.” The presence of short-lived Iodine-131 indicates that either the pool has become contaminated from melting fuel in the Unit 3 reactor or there has been inadvertent fissioning inside the fuel pool itself. An inadvertent criticality is believed by many to have caused the enormous explosion at Unit 3.

**UPDATE, 12:30 pm, Friday, May 6, 2011.** Speculation in some media reports that Unit 1 will reach a cold shutdown within a week appears unwarranted; at best it will take about a month to achieve that goal—and that's if all goes well. Of course, Units 2 and 3 need to reach cold shutdown (and fuel pools, esp. for Units 3 and 4 need to be brought fully under control) before this can move from an “ongoing accident” situation to a clean-up situation. Temperatures in all three units with fuel in the core (Units 1, 2 & 3) remain above the boiling point, meaning water continues to boil off and fuel rods remain exposed.

In the meantime, radiation releases continue. The IAEA reports that Cesium-137 deposition continued in 13 prefectures from April 22-May 3, with levels ranging from 1.3 Bq/m<sup>2</sup> to 92 Bq/m<sup>2</sup>. Gamma radiation above background was measured in only two nearby prefectures—Fukushima and Ibaraki. Levels in northeast Fukushima, more than 30 kilometers from the Daiichi site, were measured as high as 19.7 MicroSieverts/hour. Radiation levels closer to the reactor site are much higher.

Contamination of food from Fukushima Prefecture was found in 16% of samples tested. In six prefectures (Chiba, Fukushima, Gunma, Ibaraki, Tochigi, and even Tokyo), 222 (9%) samples were found to have radioactivity above Japanese regulatory standards.

As we reported yesterday, pressure is growing for the shutdown of the Hamaoka reactors. Today Prime Minister Kan asked for the reactors to close at least until new earthquake/tsunami-resistant measures can be installed. Kan claims he cannot force them to shutdown however.

Sewage sludge made radioactive from the accident was turned into concrete and distributed to at least three prefectures in Japan by Sumitomo Osaka Cement. Its facility was located outside Fukushima, in Tochigi Prefecture. There are reportedly 22 facilities inside Fukushima Prefecture that use sewage sludge in the manufacture of concrete. It is unknown whether these facilities have continued operating or have been sending radioactive concrete across Japan.

Meanwhile, the lessons of Fukushima continue to be ignored by the nuclear industry and its political backers around the world. Jacques Besnainov, chief executive of Areva North America, told a writer covering an industry conference in North Carolina, “Nothing has changed” as a result of Fukushima. “We bet on the U.S. 10 years ago and we think it is still a good bet. Fukushima will not delay the renaissance, he said.” And in Japan, members of the Liberal Democratic Party—which has been strongly backed by the nuclear industry—have set up a new task force to promote nuclear power in Japan....

**UPDATE, 12:30 pm, Thursday, May 5, 2011.** Radiation levels in the seabed near Fukushima are reported at 100 to 1,000 times above normal. Japanese officials reportedly are agreeing to help from Britain in measuring radiation in the sea, but continue to bar the Greenpeace ship Rainbow Warrior from coming closer to the site than the 12-mile international water zone. Greenpeace wants to conduct independent radiation monitoring of the water in the area.

A 6.1 magnitude earthquake struck eastern Japan today; no reports of damage so far.

The U.S. Environmental Protection Agency apparently has decided everything is hunky-dory in the USA, so it has stopped the more frequent radiation monitoring it undertook after Fukushima. That means milk, for example, will only be tested once every three months, despite the fact that the Chairman of the NRC testified in Congress yesterday that while the situation at Fukushima is “static,” it is not necessarily improving and serious problems remain. And the International Atomic Energy Agency reports that steam continues to be emitted from Units 2 and 3, which in this case means radioactive steam.

Meanwhile, “nuclear engineers” at UC Berkeley testing food products from Japan found Cesium-134 and -137 in strawberries from Japan and, according to a report at forbes.com immediately and incorrectly compared it to radiation received from an airplane flight. Ingestion of radioactive cesium is simply not the same as gamma rays received during flight.

Turning to good news, it appears that at least some of Japan’s most dangerous reactors, at Hamaoka, may be forced to close permanently as a result of new seismic standards. The Japanese government says there is an 87% chance of a 8.0 or larger earthquake striking a fault under these reactors within the next 30 years.

**UPDATE, Noon, Wednesday, May 4, 2011.** Tokyo Broadcasting System has set up a live webcam at Fukushima Daiichi. Radioactive steam can be seen constantly emitted from Units 3 and 4.  
<http://www.youtube.com/user/tbsnews1?feature=feedrss#p/1/-ZPYlazljME>

Workers are preparing to enter Unit 1 for the first time since the earthquake, in order to install air filters, powered by diesel generators, in an effort to lower radiation levels inside the building. This is the first step toward attempting to install a circulating cooling system for the reactor. But Tepco is not even sure of the water level inside the reactor—except it seems to be sure the water is not above the fuel, indicating some continued melting—and has had to reduce the amount of water it is pumping in to the reactor from 14 tons/hour to 6 tons/hour. This is because pressure inside the reactor vessel has been falling, leading to fears that outside air could enter and cause a new hydrogen explosion.

Meanwhile, Tepco also continues to pump nitrogen into Unit 1 in an attempt to inert the containment to prevent a hydrogen explosion. The utility admits a similar step needs to be taken at Units 2 and 3, but at Unit 2 in particular, it fears that there is a breach of containment which means the nitrogen would leak back out. More info available here: <http://spectrum.ieee.org/tech-talk/energy/nuclear/workers-plan-to-enter-fukushima-reactor-no-1>

**UPDATE, 12:30 pm, Friday, April 29, 2011.** Toshiso Kosako, a University of Tokyo professor and radiation expert, resigned as a special nuclear advisor to Japan's Prime Minister Naoto Kan today, in protest over the government's handling of the Fukushima crisis. Kosako was appointed as an advisor on March 16. He told a news conference—apparently holding back tears-- that "The prime minister's office and administrative organizations have made impromptu policy decisions, like playing a whack-a-mole game, ignoring proper procedures." Kosako specifically pointed to the government's decision to increase allowable exposures to workers from 100 to 250 MilliSieverts/year (from 10 to 25 rems/year; U.S. allowable level for workers is 5 rems/year) and to the decision to allow schoolchildren in Fukushima Prefecture to be exposed to 20 MilliSieverts/year (2 rems/year; 20 times higher than international standards).

Today is the deadline to sign the petition to Japan's government to object to the 20 MilliSieverts/year level for Japan's children. Please sign this petition here:  
<http://fukushima.greenaction-japan.com/>

The International Atomic Energy Agency reports that temperatures in all three reactors (Units 1-3) with fuel in their cores remains above 100 degrees Centigrade, or above the boiling point. Thus, water continues to be boiled off and released as radioactive steam, and must be replenished. However, Tepco has called off efforts to inject massive amounts of water into the reactors to turn them into the "water coffins" described below. Tepco had begun doing that in Unit 1 but has stopped over concerns that increasing water pressure could produce leaks in the pressure vessel that could lead to outside air coming in that might result in a new hydrogen explosion.

**UPDATE, 11 am, Wednesday, April 27, 2011.** Bloomberg News reports today that 2 robots entered the Unit 1 reactor building and took radiation readings inside of 1120 MilliSieverts/hour (about 112 rems/hour)—among the highest readings measured since the onset of the accident. A worker would receive a maximum annual dose (by Japanese standards) in less than 15 minutes; in

the U.S. a worker could stay less than three minutes before receiving the maximum allowable dose (a member of the public could be exposed to that level for only about a second...).

A new video from nuclear engineer Arnie Gunderson of Fairewinds Associates postulates that the Unit 3 explosion was sparked by a criticality in its fuel pool. The video includes excellent footage and a clear explanation. Worth seeing.

The New York Times today reports on a “culture of complicity” between Tepco and the Japanese government that led to unresolved safety issues at Fukushima—and Japan’s other nuclear facilities.

**UPDATE, 4 pm, Monday, April 25, 2011.** Japanese activists are alarmed about a government decision to allow children in Fukushima Prefecture to attend schools where radiation readings indicate they could be exposed to 20 MilliSieverts/year (2 rems/year)—20 times the U.S. allowable standard for the public. This decision appears not to be based on risk (and children are more susceptible to radiation than adults), since the government also is relocating people in five villages outside the previous evacuation zone because people in them could be exposed to 20 MilliSieverts/year. Rather, the decision appears to be based on the reality that many schools in Fukushima Prefecture are experiencing high levels of contamination, and the government apparently does not want to require children to go to schools further away, nor further expand the exclusion zone.

Activists are asking people to sign a petition against this unconscionable government policy. You can do so here: <http://fukushima.greenaction-japan.com/>

The Unit 4 fuel pool heated up over the weekend—why is not clear—but temperatures were reported above 90 degrees Celsius—just short of boiling. Tepco responded by pouring even more water on the pool: 200 tons on Friday and 140 tons on Saturday with another 210 tons planned for today, when temperature levels began rising again after dropping briefly yesterday. But now there are growing concerns that the weight of all the water that has been added—not only to this pool but to all four units—are compromising the structural integrity of what’s left of the containment buildings. The U.S. NRC pointed out this conundrum nearly a month ago, but Tepco so far has had little choice but to continue to add water to the facilities to prevent further melting and overheating. Eventually, some sort of closed-loop cooling system needs to be installed, but installing such a system in a high-radiation area like Fukushima, to a complex in ruins, is a task few if any engineers ever have contemplated.

While some of the water is evaporating into radioactive steam, most of the radioactive water continues leaking into the buildings, the turbine buildings, into groundwater, etc.

Meanwhile, Tepco also reportedly is trying to turn Units 1, 2 and 3 into “water coffins.” The idea is to flood the pressure suppression tubes and reactor pressure vessels with water. These components can hold about 7,000 tons of water, and Tepco says it has poured that much into Unit 1, and that it believes most of that water is still there (although the pressure vessel itself is said to be only half-full). But Tepco already has poured 14,000 tons into Unit 2 and 9,600 tons into Unit 3—indicating the presence of substantial leaks and an idea that doesn’t seem to be working.

The Yomiuri Shimbun newspaper reports that revised radiation release statistics for April 5 indicate that instead of the approximately 1 terabequerel/hour releases originally reported by Tepco, actual releases that day were about 6.4 terabequerels/hour. It is not known what caused the higher releases. The newspaper notes that the continued release rate of about 1 terabequerel/hour—if continued over the next several months as is expected—would itself merit an accident of Level 6 on the international rating system, not counting the much higher releases experienced during March.

**UPDATE, Noon, Thursday, April 21, 2011.** As expected, the Japanese government has now turned the 20 kilometer “evacuation” zone into an exclusion zone. People entering the zone can be fined up to \$1200 or jailed up to 30 days for entering the zone. Streams of people entered the zone earlier today before the new law went into effect to gather their possessions and check on their homes. The government will now allow a single visit per household, lasting no more than two hours, for people to gather their possessions. People returning from these visits will have to be screened for radiation. It is not clear what will happen to possessions found to be radioactive.

It is highly unlikely people will be allowed to return to the area, although the Japanese government appears to be willing to accept higher annual radiation levels for the public than other nations. For example, the government has allowed schools in Fukushima Prefecture outside the evacuation zone to open in April, despite radiation readings at 75% of the schools monitored showing radiation levels above the legal standard for a “radiation controlled area” – defined as an area where unnecessary human entry and radioactive exposure are to be prevented and avoided.

NHK TV reports that radioactive groundwater has been seeping into Units 5 and 6 at Fukushima Daiichi. These units are set some distance apart from the crippled Units 1-4, which means the overall contamination of the area, and migration of radioactive water, is significant.

Several media outlets reported that a Tepco official said Wednesday that Unit 1 is “melting down,” although no clarification was included in these reports. Today, Tepco says that while there has been fuel damage at Units 1-4, it denies that there is ongoing melting of fuel.

A 6.3 earthquake struck Japan Thursday night; there are no reports of consequences at this time.

**UPDATE, 1:30 pm, Monday, April 18, 2011.** High radiation readings were again measured in seawater near Fukushima over the weekend. Of particular concern were high readings of Iodine-131. With its eight-day half-life, new spikes in Iodine-131 should not be found. This strongly suggests that melting of fuel and new radiation releases continue to occur.

Competing proposals from Japanese nuclear giants Hitachi and Toshiba for dealing with Fukushima over the long term have markedly different forecasts for the site. Toshiba believes the site can be cleaned and brought to essentially a greenfields status within 10 years; Hitachi thinks it will take 30 years and a Hitachi representative openly scorned the Toshiba proposal saying he had no idea what technology Toshiba could be talking about that could clean up this mess within 10 years. Meanwhile, Tepco says it will take six to nine more months before the reactors and fuel pools can be said to be stabilized and under control.

Residents of the town of Namie, outside the initial evacuation zone, were exposed to 17,000 microsieverts over the past month, or about 1.7 rems. That's about 17 times the annual allowable level for the public in the U.S. Residents are slated to be relocated from Namie and four other towns sometime this month.

A robot was sent inside the reactor buildings of Units 1 and 3 over the weekend, measuring radiation levels of 4.7-5.9 rems/hour—too high for people to work in for any period of time. The robot is not believed to have entered the containment area.

**UPDATE, 11:30 am, Thursday, April 14, 2011.** The fuel pool at Unit 4 apparently has experienced an inadvertent criticality at some point in the past month. Tokyo Electric Power (Tepco) has confirmed that some fuel rods in the pool are damaged. A 400 milliliter water sampling from the pool taken Tuesday found elevated levels (as much as 100,000 times above normal) of Iodine-131, Cesium-134 and Cesium-137. As nuclear engineer Arnie Gunderson of Fairewind Associates points out, there should be no Iodine-131 detected at all. All of the fuel from Unit 4 had been removed from the core and placed in the pool well before the March 11 accident. With a half-life of 8 days, the likely way Iodine-131 would be detected in this water would be if there had been a criticality—which given the severe damage to the pool is more than just conjecture. Tepco, however, suggests the readings may be caused by radioactive rubble in the pool or radioactive rainwater coming into the pool.

Tepco says it so far has pumped out 700 tons of highly radioactive water from a trench to a condenser; but with 60,000 tons of this water across three reactors, that's a proverbial drop in the bucket.

The Japanese Atomic Industrial Forum reports that the nitrogen injection into the containment of Unit 1, intended to reduce the possibility of another hydrogen explosion, appears not to be working. Pressure is not rising in the containment, indicating that the nitrogen is leaking back out.

Samples taken by ARCO, an independent French radiation laboratory, of soil and water in several communities outside the official evacuation zone, show very high levels of radioactive Iodine and Cesium as far away as Fukushima itself (about 60 km, or 36 miles, away).

Note to readers in Hawaii: U.S. EPA measurements from Hilo show elevated levels of Iodine-131 and Cesium-137 in milk samples taken earlier this week (19 picocuries/liter of Cesium-137 and 18 picocuries/liter of Iodine-131 vs “acceptable” level of 3 picocuries/liter). This is of concern for people who may drink local milk, or eat local cheeses and meat from local livestock.

**UPDATE, 12:30 pm, Tuesday, April 12, 2011.** As predicted, the Japanese government has officially upgraded the status of the Fukushima accident to Level 7. In doing so, however, the government appears to be downplaying the actual radiation releases, with several media reports this morning quoting government officials as saying releases have been about 10% of those from Chernobyl.

However, as we reported here on March 23, the Austrian weather service, which has been monitoring radiation across the world and advising the International Atomic Energy Agency, said

that releases of Cesium-137 at that time were already 20-60% those of Chernobyl and Iodine-131 releases were at 20%. Note: this updated release puts Cesium-137 releases at 50% those of Chernobyl.

Greenpeace, which issued a statement March 25 saying Fukushima was already a Level 7 accident at that time, referred both to the Austrian study and a study by French nuclear officials. We repost the Greenpeace statement, which includes links to both studies.

The world's media also appear to be missing another important story: the "evacuation" of five more villages to the northwest, that we reported yesterday, is not really an "evacuation." It is a permanent relocation. If people were being evacuated to avoid a potentially immediately threatening radiation dose, the evacuation would not take weeks or even a month; it would happen in hours. Rather, the Japanese government has acknowledged that radiation levels in those villages, although outside the established exclusion zone, are too high to allow long-term habitation. Thus, people will leave from those villages—and will not return.

**UPDATE, 4:00 pm, Monday, April 11, 2011.** Kyodo News Service is reporting that the Japanese government is finally considering upgrading the severity of the Fukushima accident to the highest level on the international scale—Level 7. This follows release of a calculation from the Nuclear Safety Commission of Japan that a staggering 10,000 terabecquerels of radiation were released from the site for at least several hours (one terabecquerel is a trillion becquerels and is roughly equivalent to 27 curies of radiation) at one unspecified point. Clearly, millions of curies have been released from Fukushima.

Current releases are said to be just under one terabecquerel per hour.

The Commission also reported that people as far as 60 km from the plant to the northwest, and 40 km or so to the south and southwest since the accident already have received their annual allowable dose of radiation.

**UPDATE, 3:00 pm, Monday, April 11, 2011.** One full month after the earthquake, tsunami and onset of the Fukushima nuclear disaster, the Japanese government is preparing for evacuation of five more villages about 25 miles or so northwest of Fukushima Daiichi, including Iitate and Namie, which we have noted numerous times below have been experiencing high radiation levels for a month now. Five other villages are being considered for evacuation. However, the planned evacuations are not immediate and may take weeks to happen.

According to the New York Times, government officials are concerned that people in these areas could received more than 20 milliSieverts by living there a year. That equals 2,000 millirems, or 2 rems—20 times the U.S. allowable standard of 100 millirems/year. According to a 1990 NRC policy document, exposure to 100 millirems/year provides a 1 in 267 lifetime risk of fatal cancer. Even the Soviet Union evacuated regions where people could be expected to receive 5 milliSieverts/year.

Meanwhile, in what is probably a bow to permanent reality, the government is setting up to make the current evacuation zone an exclusion zone, and will no longer let people into the zone.



Residents of the zone have sometimes been going back in temporarily to retrieve possessions—which of course are contaminated.

Today's new aftershock knocked out power to Fukushima Daiichi for about an hour, and workers were again forced to temporarily evacuate the site. Emergency pumping of cooling water into the reactors and fuel pools also was stopped—this likely means heat levels increased and additional fuel melting may have taken place.

Last Thursday night's aftershock shows the unreliability of emergency diesel generators at nuclear reactors. The Higashidori reactor site has three generators on hand; two were (and remain) out of service, and the third broke down and began leaking oil (fortunately, it waited to break down until after offsite power had been restored). Currently there are no operational generators at this site. At the three-unit Onagawa site, one of the two generators at the Unit 1 reactor was found to be not working when the power went out.

According to Japan Times, 17,500 people participated in two anti-nuclear protests in Tokyo yesterday.

**UPDATE, 6:00 pm, Friday, April 8, 2011.** Activists in Japan are putting out an urgent appeal to stop schools in contaminated zones from opening. In Japan, schools are scheduled to open for the year over the next two weeks. Radiation levels in many areas outside the evacuation zone remain high. For example, measurements taken April 5 in Iitate Village (40 km northwest of Fukushima Daiichi) range from 9.5 to 18.2 MicroSievert/hour, or nearly 1-2 millirems/hour. Allowable *annual* exposure level in the U.S. is 100 millirems/year, meaning people exposed to this level of radiation could receive their annual dose in 50 to 100 hours. But it's even worse in the town of Namie, also northwest of the site: levels there were measured April 5 at 18.8 to 23 MicroSievert/hour. Children are more susceptible to radiation exposure than adults.

Power, fortunately, has been restored to the nuclear sites that lost power in yesterday's earthquake. There were some reports of unspecified problems with some of the emergency diesel generators, that hopefully will be made clear soon. Some radioactive water leaked from fuel pools at the three-unit Onagawa site in northeast Japan, but it was said to be contained inside the reactor buildings.

**UPDATE, 3:15 pm, Thursday, April 7, 2011.** Today's earthquake (which we have seen variously reported as between 7.1 and 7.9 in magnitude) has knocked out power in some sections of northeast Japan. The single-unit Higashidori Boiling Water Reactor and the Rokkasho reprocessing plant have lost offsite power and are running on emergency diesel generators. Offsite power may also have been lost to the three unit Onagawa nuclear complex, although there is a report that power remains for the reactors themselves, but not for the fuel pools and that those are relying upon emergency diesel generators.

**UPDATE, 12:30 pm, Thursday, April 7, 2011.** A 7.1 earthquake struck northeast Japan about an hour ago (11:30 pm Japan time); workers were temporarily evacuated from the Fukushima Daiichi nuclear site. There are no immediate reports of additional damage at the site.

Fairewinds Associates has posted the NRC assessment referred to in yesterday's New York Times. Well worth reading: <http://www.fairewinds.com/content/nrc-report-official-use-only-fukushima-assessment-march-26th-2011> This assessment warned of possible new damage from further aftershocks.

A first glimpse inside the evacuation zone can be found in a video from Japanese journalists. They are approaching the Fukushima Daiichi site from the south (highest radiation readings have been to the northwest) and manage to get about one mile from the site, where their reading is more than 100 MicroSievert/hour (about 10 millirems/hour). Significant earthquake and tsunami damage is evident in the region. 12 minutes long and worth it.

<http://www.youtube.com/watch?v=mHWvbisFg0I&feature=share>

**UPDATE, 3:30 pm, Wednesday, April 6, 2011.** The New York Times has an important front-page story today on a still-unreleased U.S. Nuclear Regulatory Commission assessment that indicates the situation at Fukushima remains extremely serious, that some of the measures Tepco and the Japanese government have taken have caused unanticipated repercussions and new problems—in particular new stresses placed on the containments that places their ability to withstand earthquake aftershocks in doubt, and ongoing concerns about the possibility of more hydrogen explosions at the site.

The article also states, “The document also suggests that fragments or particles of nuclear fuel from spent fuel pools above the reactors were blown “up to one mile from the units,” and that pieces of highly radioactive material fell between two units and had to be “bulldozed over,” presumably to protect workers at the site. The ejection of nuclear material, which may have occurred during one of the earlier hydrogen explosions, may indicate more extensive damage to the extremely radioactive pools than previously disclosed.”

And the article adds that the NRC believes there was a hydrogen explosion at Unit 4's fuel pool, which caused major radiation releases. NIRS notes that we still have not seen a single radiation reading—official or unofficial—from inside the evacuation zone.

Although the assessment obtained by the Times was dated March 26, NIRS has strong reason to believe that the NRC continues to find the assessment accurate as of today, April 6. NIRS and other groups this morning asked for release of the assessment to the public and promised to file a Freedom of Information Act request if the document is not quickly forthcoming.

Tepco has begun inserting nitrogen into the containment of Unit 1 to try to force out accumulating hydrogen which threatens to explode. This was one recommendation made by U.S. NRC officials.

In one piece of improving news, Tepco says its latest efforts to plug a crack that has been allowing highly radioactive water to pour into the Pacific Ocean are showing signs of success.

Meanwhile, these water releases have led the National Japan Fisheries Union to demand the shutdown of all nuclear reactors in the country. Activists in Japan say this is very big news.

In other major news, Germany's Environment Minister said all nuclear reactors in that country will be permanently closed by 2020. He said that eight of Germany's 17 reactors will be closed permanently by the end of the year.

**UPDATE, 4:30 pm Tuesday, April 5, 2011.** Japan's NHK TV is reporting that a plant worker at Fukushima Daiichi says that radiation levels inside the reactors buildings of Units 1-3 are "immeasurable"—so high that their radiation monitors have been rendered useless. The report states that levels of 10 rems/hour have been measured even outside the buildings.

**UPDATE, 11:00 am, Tuesday, April 5, 2011.** The Los Angeles Times is reporting that radioactive Iodine-131 has been measured in seawater near Fukushima at 7.5 million times the legal limit. Perhaps even more worrisome is that radioactive Cesium-137 has been measured at more than 1 million times the limit. The Cesium is likely to lodge in sediment in the region and remain a factor for marine life and fishing for perhaps centuries.

Fish caught in the region already have been measured with excess cesium levels. In response, Japan has established its first standards for radiation levels in fish. Close tracking and monitoring of sea currents and radiation levels will be critical.

Japan's Atomic Industrial Forum reports that the cores of Units 1, 2 and 3 remain partially exposed, despite the non-stop efforts over the past three weeks to keep them covered with water. Thus, some fuel melt likely is continuing.

A new report from UBS, a major financial institution, predicts that Fukushima will have a greater negative impact on the world's nuclear industries than Chernobyl did.

**UPDATE, 10:30 am, Monday, April 04, 2011.** Japan's government has acknowledged the obvious: that it will be months before the Fukushima nuclear crisis can be considered under control, and likely there will continue to be radiation releases for an extended period.

Efforts over the weekend to seal an 8-inch crack in a concrete pit holding Unit 2 electrical cables so far have been unsuccessful. It's believed the crack is a source for highly radioactive water (about 100 rems/hour) leaking into the Pacific Ocean. However, Tepco officials also admit there may be other release points and are planning to inject dye (where is not entirely clear) in an effort to try to trace the leaks.

Tepco announced Monday evening that it has begun deliberately discharging 11,000 tons of radioactive water into the ocean. Tepco press release: <http://www.tepco.co.jp/en/press/corp-com/release/11040404-e.html>

Two workers were confirmed dead at the site over the weekend; they reportedly were killed in the initial tsunami but were in a high radiation area. It seems Tepco should have known—and reported—that workers were missing. Are there any other workers still missing?

This blog has some recent (March 31) high-resolution satellite photos of the site and surrounding area, along with some interesting commentary: <http://www.chrismartenson.com/blog/breaking->

[latest-satellite-imagery-fukushima/55711?utm\\_source=newsletter\\_2011-04-02&utm\\_medium=email\\_newsletter&utm\\_content=node\\_title\\_55711&utm\\_campaign=weekly\\_newsletter\\_12](http://www.llrc.org/latest-satellite-imagery-fukushima/55711?utm_source=newsletter_2011-04-02&utm_medium=email_newsletter&utm_content=node_title_55711&utm_campaign=weekly_newsletter_12)

The European Committee on Radiation Risk says its models predict some 400,000 cancers over the next 50 years from Fukushima fallout in the area within 200 kilometers (120 miles) from the site. Models used by the UN's ICRP predict a little over 6,000 cancers. <http://www.llrc.org/>

General Electric chair Jeffrey Immeldt said in Tokyo today that GE will donate \$10 million to victims of the earthquake, tsunami and nuclear accident. GE-designed reactors, with their well-known design flaws, contributed greatly to this accident. GE paid no U.S. taxes last year on profits of \$5.1 Billion. Actions like Immeldt's simply expose the incredible level of corporate greed and social irresponsibility that underlies the entire nuclear power industry. Seriously, how do people like that sleep at night?

**UPDATE, 11:30 am, Friday, April 1, 2011.** New video shows that Unit 4 fuel pool is exposed to the air and contains little or no water. Nuclear engineer Arnie Gunderson of Fairewinds Associates explains the video and its implications: <http://www.fairewinds.com/content/what-we-do>

Radioactive Iodine-131 has been measured in groundwater fifty feet below the Fukushima Daiichi site at 10,000 times above normal, raising some concerns about potential contamination of drinking water.

The U.S. is sending a large concrete pumping machine (one of only three in the world) from its MOX construction site at Savannah River, South Carolina to Japan, apparently to be refitted to pump water. It's expected to arrive in Japan in about a week or so. The machine will become highly radioactive and will not return to the U.S. The good news is that this is likely to set back construction of the dangerous, dirty and unnecessary MOX factory in the U.S.

Citizens Nuclear Information Center in Tokyo released a statement yesterday warning of continued earthquake dangers, calling for shutdown of the Hamaoka Nuclear Power Station, located near a fault line and long considered to be the most vulnerable nuclear site to earthquakes, and calling for the Japanese government to be honest about cancer risks from the radiation fallout.

Tokyo Electric Power admitted yesterday that it does not even have enough radiation dosimeters for all its workers at the Fukushima Daiichi site. Workers have thus been sharing dosimeters and going into high radiation areas without knowing what levels they may be receiving.

Today's Excel spreadsheet of radiation monitoring data (the first since Monday) shows basically continued and sustained higher than normal levels outside the evacuation zone, especially to the northwest of Fukushima Daiichi.

**UPDATE, 10:00 am, Thursday, March 31, 2011.** The International Atomic Energy Agency has reported that levels of Cesium-137 in areas outside the emergency evacuation zone (especially near Iitate Village, 40 kilometers—24 miles away) are more than twice as high than levels the Soviets established for relocation from the Chernobyl area. The IAEA said cesium levels are up to 3.7

megabecquerels per square meter (MBq/sq. m) in that area. Soviet guidelines required relocation when Cesium levels reached 1.48 MBq/sq. m. This is adding to pressure on the Japanese government to expand the evacuation zone.

Levels of radioactive Iodine-131 in seawater near the Fukushima Daiichi site continue to soar and were measured today at more than 4,300 times above normal.

Earth Track has published a handy guide to nuclear liability standards in Japan and the U.S.

There are reports this morning that up to 1,000 bodies of people killed by the earthquake and tsunami inside the evacuation zone have not been recovered due to radioactive contamination.

It is growing ever clearer that the Fukushima disaster will be a lengthy one. We do not believe people will be able to re-settle in the evacuation zone—indeed, as at Chernobyl, the permanent exclusion zone is likely to grow rather than become smaller. Andre-Claude Lacoste, president of the French nuclear society, hinted at this in a press conference yesterday saying:

On contaminated land:

"Depending on the level of contamination, the management of these territories will be extremely difficult for years to come, if not for decades."

On the stabilization of the reactor site and beyond:

"If there are orders of magnitude that I would like to share with you, they are the following: the return to a more or less acceptable level of safety on-site is a question of weeks, and, no doubt, of months. The management of the contamination outside the plant - the plant clearly is a lost site - beyond, around the plant, it is a question of years if not of decades."

Once again, the "safe and clean" nuclear power industry has left a portion of our planet permanently uninhabitable.

**UPDATE, 3:30 pm, Tuesday, March 29, 2011.** The Guardian (U.K.) is reporting that "Richard Lahey, who was head of safety research for boiling-water reactors at General Electric when the company installed the units at Fukushima, told the Guardian workers at the site appeared to have "lost the race" to save the reactor, but said there was no danger of a Chernobyl-style catastrophe." Lahey said he believes a full core meltdown, with breach of the steel liner containment, is in process at Unit 2. While his statement about no danger of a Chernobyl-style catastrophe appears meant to reassure, he admitted that, "it's not going to be good news for the environment."

However, there has been no confirmation yet of this hypothesis from other sources; the U.S. Nuclear Regulatory Commission told a Senate hearing this morning that it does not yet know the source of the leaks that have sparked extremely high radiation levels in water inside the reactor building at three units, as well as in nearby turbine buildings and in trenches outside.

Meanwhile, Japanese newspapers are reporting that the government is considering taking over TEPCO (Tokyo Electric Power Co.), the utility that owns Fukushima, either temporarily or permanently. TEPCO has lost 70% of its value since March 11 and its chief executive officer has

not been seen in public since March 13 and did not even attend crisis meetings at TEPCO's Tokyo headquarters from at least March 16-22.

**UPDATE, 3:00 pm, Monday, March 28, 2011** On this 32<sup>nd</sup> anniversary of the Three Mile Island accident, we want to point out that people were affected by that accident too. Here is a chronology from Three Mile Island Alert on health effects of the TMI accident:

<http://www.nirs.org/reactorwatch/accidents/tmihealthchronology.pdf>

Three isotopes of Plutonium (238, 239 & 240) have now been found in low levels in soil outside the Fukushima reactors. This is another confirmation that core meltdowns have occurred and may be continuing with releases of radiation to the environment from containment.

**UPDATE, 11:30 am, Monday, March 28, 2011.** TEPCO has confirmed that radiation levels in water inside the damaged reactors is about 100 rems (1 Sievert) per hour. Apparently that's only 100,000 times above normal, not 10 million times. Somehow doesn't make us feel better... There are several reports this morning that this highly-radioactive water, which so far has been limited to inside the reactor buildings, has begun to seep outside.

A striking video taken yesterday morning from a helicopter above Fukushima shows incredible damage and continuing radioactive steam leaks:

[http://www.youtube.com/user/modchannel#p/a/u/0/ZKFGavZ\\_rf4](http://www.youtube.com/user/modchannel#p/a/u/0/ZKFGavZ_rf4). According to this report from the Japan Atomic Industrial Forum, the video appears to show that a heavy crane fell onto the fuel pool at Unit 3 and may have damaged the pool:

[http://www.jaif.or.jp/english/news\\_images/pdf/ENGNEWS01\\_1301313213P.pdf](http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1301313213P.pdf)

A March 17 Japanese government memo has been released that states new ingestion limits for radionuclides, including plutonium. English version available here:

<http://www.mhlw.go.jp/stf/houdou/2r9852000001558e-img/2r98520000015av4.pdf>

NIRS, Friends of the Earth and Physicians for Social Responsibility have filed a Freedom of Information Act request for radiation levels at Fukushima collected by the U.S. government. Copy of request is here: <http://foe.org/sites/default/files/FOE-NIRS-PSR-RadiationFOIA-3-22-11.pdf>

Today's Excel spreadsheet shows basically stable, but high, radiation readings in nearby towns outside the evacuation zone. Readings at Iitate Village (25 miles to the northwest) continue much higher than elsewhere, leading Greenpeace to call for evacuation of the village.

**UPDATE, Noon, Sunday, March 27, 2011. There appears to be growing confusion and contradictory reports about radiation levels at the Fukushima site and in nearby communities.** For example, on Friday we reported (see below, 10 am update), that 3 contaminated workers were said to have experienced a dose rate of about 20 rems/hour, but that that level seemed low for the injuries reported. On Saturday, the New York Times confirmed that the actual levels encountered by the workers were 2-6 Sieverts, or 200-600 rems/hour. The Times noted that a whole body exposure of 400 rems would be expected to kill half the people exposed. It is unlikely that these workers received a whole body dose of that level. However, it is still a serious situation.

Today, workers reported a huge spike in radiation levels in water inside Unit 2, which has been reported variously at 10 million times normal and/or 100 rems/hour. Later, TEPCO said the reading was an error—but did not supply any new or contradictory information on radiation levels inside the building. This has been typical of TEPCO over the past two weeks: this utility simply has not been providing accurate, complete information. And 100 rems/hour would be consistent with the levels encountered by the injured workers. Clearly, when the immediate and continuing crisis has passed, there needs to be a thorough and complete housecleaning of TEPCO.

What is also clear is that there are extremely high radiation levels in water on the floors inside all of the Units 1 through 4 reactors. There are also high levels in seawater near the site. Reactor fuel has melted and fuel pools have been compromised—and the result is high radiation releases to the environment. Finally, it is also all too clear, more than two weeks into this accident—with power still not restored to the cooling systems of any of these four reactors—that this will continue indefinitely and could still become far worse.

**On Saturday night, Citizens Nuclear Information Center in Tokyo held a press conference with** Mitsuhiro Tanaka, a nuclear engineer who helped design the Unit 4 reactor pressure vessel. He conducted an analysis of the events at Unit 1 (the first reactor to experience an explosion, barely 24 hours after the earthquake) and concludes that Unit 1 suffered a Loss-of-Coolant Accident within hours of the earthquake. Indeed, it is likely the earthquake caused a key cooling pipe to rupture. Tanaka noted that an attempt was made to initiate the emergency core cooling system within two hours of the earthquake, which failed because of lack of power.

The implication of this analysis is that TEPCO knew within hours—probably less than two hours—of the earthquake that a nuclear meltdown was likely, and yet did not the public nor seek an immediate evacuation of the area. It also indicates that, contrary to nuclear industry statements, that the reactors did not even withstand the earthquake itself. If true, and Tanaka acknowledged some key data is still incomplete, this will likely have serious repercussions on TEPCO as well as government nuclear safety authorities if they were aware of the situation.

Today's Excel spread sheet shows basically constant radiation levels in nearby communities, with some showing slight increases over the past two days, others slight declines. All remain well above background levels, and all areas measured are outside the evacuation zone. Of particular concern in the village of Iitate, about 25 miles northwest of the plant site, which is outside the evacuation zone but has been showing very high readings for the past two weeks.

**UPDATE, 11:00 am, Friday, March 25, 2011.** Greenpeace Germany has released a statement stating that, according to an analysis of radiation releases by consultant Dr. Helmut Hirsch, Fukushima is now a Level 7 accident on the international scale (currently it is officially ranked as a Level 5, comparable to the Three Mile Island accident of 1979; Level 7 would make it comparable to Chernobyl).

**UPDATE, 10:00 am, Friday, March 25, 2011.** Three workers were treated yesterday for contamination after walking in highly radioactive water in Unit 3 that is said to have had a dose rate of 20 rems/hour—about 10,000 times above normal. However, even that rate wouldn't be high enough to cause the burns that were reported on the workers, so there is suspicion that the rates



were even higher. Radioactive elements were found in the water that are not normally found in reactor cooling water.

This has led to new open speculation among government and utility officials that the core of Unit 3 has been breached and primary containment has failed (most observers have suggested this for several days). The Japanese Prime Minister has called the situation “very grave and serious.” Radiation can be expected to be released from at least Unit-3 for some time. Steam is continuing to be released from multiple reactors at the site—steam releases at this point are certainly radioactive.

The Prime Minister suggested—but still has not required—that people evacuate in the zone 20 km to 30 km (12-18 miles) from the plant site.

Radioactive contamination of food has now been found in 11 different vegetables. High Iodine-131 levels have now been found in water supplies other than Tokyo’s; however we do not know which cities are affected.

Today’s Excel spreadsheet shows little change in radiation levels in nearby cities, with the exception of Koriyama City, 58 km to the west, which shows increased levels. Please note that all of these readings are taken outside the 30 km zone. Radiation levels closer to the site are surely higher.

**UPDATE, 3:30 pm, Thursday, March 24, 2011.** Japanese officials said today that infants—even outside the evacuation zone—could have received doses of 10 rems to their thyroids from Iodine-131 over the past two weeks. This would apply to infants who had stayed outdoors every day. Infants are much more susceptible to radiation than adults.

Steam was seen coming from Units 1 through 4 today, in some cases large amounts. This is positive in the sense that steam means there is some water; however there is also clearly considerable heat and the steam is carrying radiation into the air.

23 members of Japan’s Parliament have now signed a statement urging a larger evacuation zone.

Today’s Excel spreadsheet again shows very slight declines in radiation levels in the region surrounding Fukushima. Levels remain far above normal.

There are reports that Iodine-131 levels in Tokyo’s water supply have returned to allowable levels for infants. We have heard no reports about the water supplies for other cities (Tokyo is 150 miles away), especially in the area northwest of Fukushima which has received the highest levels of fallout.

**UPDATE, Noon, Wednesday, March 23, 2011.** The Austrian Central Institute for Meteorology and Geodynamics (ZAMG), which is advising the International Atomic Energy Agency, reports that releases of radioactive Cesium (hazardous life: 300-600 years) from Fukushima now are 20-60% those of Chernobyl; releases of Iodine-131 are at 20% Chernobyl releases.

**UPDATE, 11:00 am, Wednesday, March 23, 2011.** We have received no recent updates on the condition of the reactors and fuel pools at Fukushima Daiichi. In this case, hopefully no news is good news.

Radioactive Iodine-131 has been found in Tokyo's water supply at twice the allowable level for infants. The government is telling people not to let infants drink tap water or use it in formula. Since Tokyo is some 150 miles away, it is likely elevated levels of radiation are also being found in other cities' water, although this has not been confirmed.

The U.S. Food and Drug Administration has banned import of milk and vegetables from Japan to the United States.

Today's excel spreadsheet on radiation levels in surrounding communities shows a continued slight decline in these levels. However, we point out that all of the levels are far above background and above levels allowable for long-term human habitation. We also point out that all of the monitoring locations are outside the current evacuation zone, in most cases many miles outside.

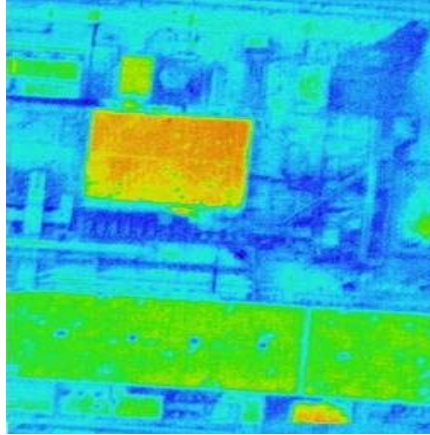
Agence France-Presse is reporting that France's Nuclear Safety Authority says that local contamination in the area is a problem that will remain for "decades and decades."

**UPDATE, Noon, Tuesday, March 22, 2011.** Reports on power lines and ability to supply offsite power to reactor and fuel pool safety systems have been contradictory for days. It appears now that power lines have indeed been brought to all 6 reactors, and it is likely power has been restored to Units 5 and 6 (we haven't seen confirmation of this yet). However, Units 1 through 4 have experienced substantial damage to their safety systems and while offsite power appears to be available, it is not operating the safety systems at these reactors. Repairs to the systems must be made first; that will take at least a day and probably considerably longer.

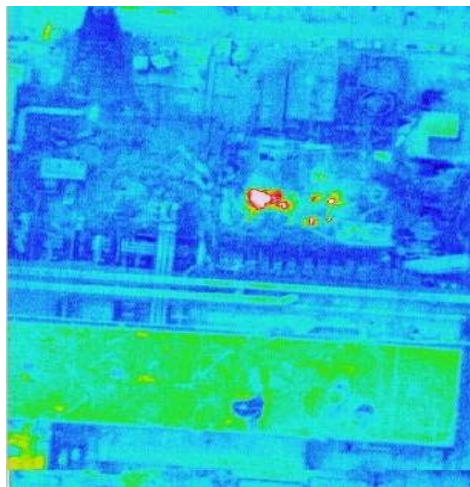
Contamination has been found in seawater near the Daiichi site; this could affect fishing in the region.

Official Japan website showing radiation readings in nearby towns as of March 22 ([http://www.mext.go.jp/component/english/\\_icsFiles/afieldfile/2011/03/21/1303997\\_2119.pdf](http://www.mext.go.jp/component/english/_icsFiles/afieldfile/2011/03/21/1303997_2119.pdf)). Highest reading is 111 Micro/Sievert/hour, or about 11 millirems/hour, 30 kilometers (18 miles) from reactor site. Maximum allowable dose to public would be received in about 9 hours.

12 members of the Japanese Parliament today called on the government to immediately expand the evacuation zone.



**Infrared image from Unit 2:**  
**Temperature is said to be 262 degrees F, which may indicate no water in the building.**



**Infrared image from Unit 3:**  
**Highest temperature said to be about 144 degrees F.**

**UPDATE, 7:45 pm, Monday, March 21, 2011.** The incident of smoke coming from Unit 3 appears perhaps more significant than TEPCO first stated. Video images showed substantial amounts of smoke from Unit 3 as well as smoke or steam emanating from Unit 4,

CNN is airing infrared images showing the heat levels at the site. Fairewinds Associates nuclear engineer Arnie Gunderson told CNN that his analysis of the images indicates there may be no water at all in Unit 2--the image shows a uniform high heat level throughout the containment building, which has not exploded, but does have a large hold in one side. At Units 1 and 3, irregular but extremely high heat levels appear--this could be of major concern.

Despite signs of stabilization at some of the reactors, the peril remains high.

**UPDATE, Noon, Monday, March 21, 2011** Radiation doses at Fukushima Daiichi and Fukushima Daini, March 18-21, 2011. Obtained by Dr. Chris Busby at European Committee on Radiation Risk (ECCR). ECCR risk model predicts 120,000 cancers worldwide from Fukushima accident based on current known releases.

Excel spreadsheet on offsite contamination levels through 3:00 am Tokyo time, Monday, March 21.

30-minute Interview with Michael Mariotte of NIRS on Voice of America, aired worldwide March 19-20, 2011. Available in mp3 and Windows Media. UPDATE, 10:30 am, Monday, March 21, 2011. Gray smoke began emitting from the area around the Unit 3 fuel pool today, and workers were temporarily evacuated. It is as yet unclear what caused the smoke. TEPCO says radiation levels did not increase at ground level because of the smoke. As has been the case since the beginning, air radiation levels are either not being taken or not being made public. Ground radiation levels at the Fukushima site are currently over 2,000 Micro/Sievert/hour, or approximately 200 millirems/hour. There are likely hot spots of far higher levels.

Radiation levels in nearby communities vary substantially, with highest readings early this morning at Iitate Village (40 km northwest) at about 13 Micro/Sievert/hour and Fukushima City (61 km northwest) at about 8 Micro/Sievert/hour. Both readings are down from a few days ago. Readings are provided by our colleagues at Greenpeace Japan; additional monitoring systems should arrive in Japan today or tomorrow for enhanced independent monitoring. We hope to have real-time monitoring information available on the web by the end of the week.

**UPDATE, 10:30 am, Saturday, March 19, 2011.** Officials believe they are having some success using a variety of methods to cool the damaged reactors at the Fukushima site, including fire trucks and a remotely-operated system that can spray water for seven hours at a time. A power cable has apparently finally been placed at the site (after several incorrect reports that this already had happened), and may be hooked up later on Saturday. If successful, this would provide power to the site. However, the condition of the safety systems inside the reactors is unknown, so it is also unknown whether offsite power will prove to be the savior it would have been a week ago.

The condition of the fuel pools, especially at Units 3 and 4, appears to remain more serious.

TEPCO has cut holes in the roofs of the Units 5 and 6 containment buildings in an effort to remove building pressure and prevent explosions such as those that severely damaged Units 1, 3 and 4. This means some radiation is certainly being released through these holes.

Contaminated milk and spinach has been found; the spinach was growing 60 miles from the site. More food contamination can be expected in the coming days and weeks.

Most alarming are reports from AccuWeather and CNN that wind directions—which through the week have been steadily west-east toward the Pacific Ocean—are shifting: first to the north and northwest, then on Monday south toward Tokyo.

**UPDATE, 5:00 pm, Thursday, March 17, 2011.** Efforts by TEPCO to cool reactors and fuel pools by using water cannons (in the past sometimes used to quell anti-nuclear demonstrators...) and water drops from helicopters appear to have had little effect.

NRC chairman Greg Jazcko today reiterated his statement that the Unit 4 fuel pool has no water and is releasing radiation levels that are lethal in a short period of time. Jazcko apparently is basing his

statements on reports from NRC people who have gone to the site rather than on TEPCO, which is coming under increasing criticism for lack of substantive information.

Germany has moved its embassy operations from Tokyo to Osaka, which is further south from Fukushima.

There are reports that air travelers from Tokyo have been found with radioactive contamination upon arrival at U.S. airports.

At this point, the wind is a huge factor. So far, it is continuing to blow east away from the land and toward the Pacific Ocean. A shift in the wind could have severe consequences.

One positive sign: TEPCO says they are closer to installing a power line to at least one reactor at the site, which might enable use of cooling systems again.

In the U.S., New York Governor Cuomo has called for the shutdown of the Indian Point reactors, while Illinois Governor Quinn has ordered a new safety review of the state's four General Electric Mark I reactors.

**UPDATE, 4:30 pm, Wednesday, March 16, 2011.** NRC Chairman Greg Jazcko told a Congressional committee this afternoon that the Unit 4 fuel pool has no water and is releasing massive amounts of radiation. The U.S. Nuclear Regulatory Commission is recommending that the current 30-kilometer (18 miles) evacuation zone be expanded to 50 miles.

**UPDATE, 10:00 am, Wednesday, March 16, 2011.** The situation at Fukushima Daiichi continues to deteriorate. All plant workers were evacuated for some hours due to extremely high radiation levels onsite, but a skeleton crew is said to have returned. Solid information is sketchy and even the Japanese government is publicly complaining about the quality and quantity of information coming from Tokyo Electric Power.

We hope to update radiation levels in the next two or three hours; we have seen some contradictory figures and need to clarify before we post. It is clear, however, that radiation is now elevated across northern Japan, and at least one report indicated elevated levels as far south as Tokyo.

Unit 2 primary containment is believed to be significantly breached.

NIRS believes there are now multiple meltdowns in progress along with significant releases from irradiated fuel pools.

**UPDATE, 6:15 pm** (note: all Update times are Eastern U.S. time), Tuesday, March 15, 2011. We have just learned that TEPCO has announced that at 5:45 am Tokyo time (4:45 pm eastern us time) flames have appeared again at the northwest side of Fukushima Daiichi (Unit 4). It is impossible to go near the fire since the radiation is so high.

**UPDATE 8:15 am, Tuesday, March 15, 2011.** The situation at Fukushima is going from bad to worse. There was briefly a fire in the irradiated fuel pool at Unit 4. The fire is said to be extinguished for now.

Most disturbingly, Tokyo Electric Power (Tepco) has evacuated all but 50 people from the reactor site. This skeleton crew (of heroic workers) is not likely to be enough to handle simultaneous crises at four reactors and four fuel pools. This may well be a sign that Tepco has given up hope that it can successfully contain this crisis and prevent full meltdowns.

Radiation levels at the site increased overnight (US time) but have dropped a little more recently. Reading in one location was about 4 Rems/Hour. At the site gate readings have dropped from slightly above 1 Rem/hour at 9:30 am (Tokyo time) to about 50 millirems/hour at 3:30 pm (Tokyo time).

Detectable (although still quite low) radiation levels have been recorded in Tokyo, nearly 200 miles to the south.

A 30 kilometer (18.6 miles) exclusion zone has been set up around the site. No one is being allowed inside this zone. However, only residents within 20 kilometers of the site so far have been evacuated; residents from 20-30 kilometers are being told to take shelter indoors.

There is no indication whatsoever that grid power will be available anytime soon. Without power to run safety systems and the clear inability to provide adequate backup power, there is unfortunately little likelihood this crisis can be contained.

**UPDATE 7:30 pm, Monday, March 14, 2011.** Tokyo Electric Power is holding a press conference at this hour. Video stream is at <http://www.ustream.tv/channel/nhk-gtv2>. NHK TV reports that there has been an explosion at Unit 2 at Fukushima Daiichi. There is speculation that this explosion has damaged the primary containment (inside the concrete containment building, which is the secondary containment. Tepco is evacuating some non-essential personnel from the reactor site. 2.5 meters of the core are currently uncovered by water—which means it is almost certainly melting. Winds from the site are currently blowing toward the North.

**UPDATE 12:30 pm, Monday, March 14, 2011.** According to our colleagues in Japan, Tokyo Electric Power states that Fukushima Daiichi-2 “has again lost its coolant (sea water was pumped in but is dropping). They cannot ease the reactor pressure because the relief valve is stuck closed. Air dose rate on site (outside the reactor building) was 3,130 at around 9:30pm.” We believe the 3,130 figure means 3130 MicroSievert/hour, which would be highest reading yet recorded—about 310 millirems/hour. For comparison, the U.S. EPA allowable dose to a member of the public from a single reactor is 25 millirems/year, the U.S. NRC’s allowable dose is 100 millirems/year from all nuclear sources.

**UPDATE 10:00 am, Monday, March 14, 2011.** An explosion has occurred at Fukushima Daiichi Unit 3. Video here: [http://www.youtube.com/embed/T\\_N-wNFSGyQ](http://www.youtube.com/embed/T_N-wNFSGyQ). This explosion appears to be even more violent and destructive than Saturday’s explosion at Unit 1.

Unit 2 at Fukushima Daiichi is reported to have lost coolant and may be experiencing melting of the core. In a press release, Tokyo Electric Power said: "Given the events at Units 1 and 3, procedures to release hydrogen gas through the walls of the reactor building in advance are now being considered for Unit 2." We are not clear what Tepco means by this statement.

There is growing concern about the status of irradiated fuel pools at all of the Fukushima reactors. At these reactors, the pools are located inside the outer containment building above the core and, like the reactor cores, require constant cooling. Given that at least the top third of two containment buildings have been blown off, the integrity of the fuel pools is unclear.

17 U.S. Navy members on an aircraft carrier offshore of Japan were discovered to be contaminated with radiation; the U.S. Navy is reportedly moving ships farther away from the Fukushima area.

More than 200,000 people have been evacuated from the Fukushima area.

UPDATE 2:30 pm, Sunday, March 13, 2011. Tokyo Electric Power is reporting that some six feet of the core of Unit-3 remains uncovered and has been for some time despite efforts to pump water into the core. Tepco speculates there may be leaking pipes and water is not remaining in the core. A translation of part of the statement from our Japanese colleagues: "The fuel's integrity has been considerably compromised. We are assessing a considerably serious situation."

UPDATE, 1 pm, Sunday, March 13, 2011. The International Atomic Energy Agency reports that a first-level (lowest-level) emergency has been declared at the three-unit Onagawa nuclear station north of Fukushima. Immediately after Friday's earthquake a fire broke out at this facility, but it was said to have been extinguished fairly quickly. However, on Saturday, elevated radiation levels were measured at the Onagawa site (about 10 microSievert/hour or about 1 millirem/hour) for a few hours. The emergency was declared due to these elevated levels, but utility officials say the reactors there are under control.

Venting of the Fukushima Daiichi Unit-3 containment took place on Sunday morning, according to the IAEA, to relieve pressure building up inside the containment. Venting of a containment releases radiation into the air. According to an IAEA statement, "Subsequently, following the failure of the high pressure injection system and other attempts of cooling the plant, injection of water first and sea water afterwards started. The authorities have informed the IAEA that accumulation of hydrogen is possible." IAEA statement at:

<http://www.iaea.org/newscenter/news/tsunamiupdate01.html>.

**An accumulation of hydrogen is believed to be the cause of Saturday's explosion at Fukushima Daiichi Unit 1. As noted below, Fukushima Daiichi Unit-3, unlike every other reactor at the site, uses plutonium-based MOX fuel.**

UPDATE, 5:30 pm, Saturday, March 12, 2011. Reuters is reporting that Fukushima Daiichi Unit 3 has lost cooling capability: <http://www.reuters.com/article/2011/03/12/us-japan-quake-nuclear-cooling-idUSTRE72B3GI20110312> This is of particular concern since, unlike all of the other reactors in trouble, Unit 3 has been using plutonium-based MOX (mixed oxide) fuel since



September 10, 2010. Consequences of an accident at a MOX-powered reactor would be even more severe than at a more typical uranium-powered reactor.

UPDATE, 3:25 pm, Saturday, March 12, 2011. The International Atomic Energy Agency reports that a total of 140,000 people have now been evacuated from zones 20 kilometers around Fukushima Daiichi and 10 kilometers around Fukushima Daini. The IAEA says that evacuation has not been completed.

At a Washington DC press event this afternoon, former NRC Commissioner Peter Bradford pointed out that no government would evacuate so many people in the midst of an ongoing natural disaster unless the situation were extremely serious.

UPDATE, 1:45 pm, Saturday, March 12, 2011. It is being reported that Japanese authorities are preparing to distribute potassium iodide to the public in the most affected zones. This helps protect against thyroid cancer caused by exposure to radioactive Iodine-131. The release of Iodine-131 to the environment indicates melting of reactor fuel.

UPDATE, 1 pm, Saturday, March 12, 2011. World Nuclear News is reporting that a worker who was apparently trapped in the exhaust stack of Unit 1 at Fukushima Daiichi has died.

Tokyo Electric Power Co. (Tepco) has announced that it will begin venting the containments of three of the four reactors at the Fukushima Daini site in an effort to reduce pressure inside those containments. This will cause additional radiation releases to the air. Evacuation of a three-kilometer zone around the Daini site has begun; people from 3 to 10 kilometers from the site are being told to take shelter indoors and have been notified that they may be asked to evacuate.

UPDATE 12:30 pm, Saturday, March 12, 2011. Japanese government officials state that radiation levels at the Fukushima Daiichi site have decreased from 1015 micro/Sieverts per hour to about 70 microSieverts/hour. There is no independent confirmation of these levels. Officials state that the primary containment remains intact.

However, there are indications that there has been some fuel melting, and there are reports that some radioactive cesium has been detected. Utility officials are reportedly now planning to pump in seawater directly, perhaps with boron added, in an effort to cool the reactor and avert further fuel melt. This may, if it works, also permanently disable the reactor (although at this point we believe this reactor could never operate again in any case).

UPDATE, 11:30 am, Saturday, March 12, 2011. Official reports are that radiation levels have decreased from those reported below; however radiation monitoring systems are either still down or not available to the public.

Some experts say the containment building at Unit 1 may not be completely destroyed; that the portion enclosing the steel liner (the primary containment) may still be intact. Available photos and videos are inconclusive. Clearly at least the top third of the building has been destroyed. In this reactor design, the irradiated fuel (sometimes incorrectly called “spent” fuel) pool sits inside

containment above the reactor core. It is not clear from the photographic evidence whether a roof remains over the fuel pool.

UPDATE, 9:30 am, Saturday, March 12, 2011. An explosion has occurred at Fukushima Daiichi Unit 1. Video of the aftermath of the explosion shows that the containment building has been destroyed. In a General Electric Mark I reactor, the containment building is fairly weak and is considered the secondary containment. The primary containment is a steel liner that surrounds the reactor core. So far, video and photos have not been clear enough for us to determine whether this steel liner is intact.

Radiation levels at the site are reported to be 1,015 micro/Sieverts per hour. This is roughly equivalent to 100 millirems/hour. The allowable annual dose for members of the public from nuclear facilities in the U.S. is 100 millirems/year. The allowable annual dose for nuclear workers is 5,000 millirems/year. The average annual background dose from all radiation sources in the U.S. is about 360 millirems/year.

The explosion in Unit 1 was almost surely a hydrogen explosion. Pressure has been building up in the containment since offsite power was lost to the reactor because of the earthquake/tsunami. The GE Mark I reactor design is called a “pressure suppression” design. Rather than be built to withstand large pressure increases, General Electric sought with this design to attempt to reduce such increases in an accident scenario. The design has been criticized by independent nuclear experts and even Nuclear Regulatory Commission staff for many years (see: <http://www.nirs.org/factsheets/bwrfact.htm>). In this case, the design clearly did not work. 24 U.S. reactors use the GE Mark I design.

The evacuation zone around the site has been expanded to 20 kilometers (about 12 miles).

Another reactor at Fukushima Daiichi, Unit 2, is reported to be without cooling capability at this time. Three reactors at the nearby Fukushima Daini site are reported to be without cooling capability. These are GE Mark II designs, which are considered a mild improvement over the Mark I design. Both sites are on the Pacific Ocean, about six miles apart.

Video of the site after the explosion from NHK TV in Japan:

<http://www.youtube.com/watch?v=ELR3hdlce2g>

Video of the explosion itself, from Japanese TV: <http://www.youtube.com/watch?v=jMEV-X5b 8>

UPDATE, 8 pm, Friday, March 11, 2011. Venting of the containment began at Fukushima Daiichi Unit 1 around 9:00 am Tokyo time. This will release some radiation into the air. Because radiation monitors at the site are inoperable (see below), it will be impossible to know how much radiation is being released.

UPDATE, 7:45 pm, Friday, March 11, 2011. An evacuation of a three kilometer zone has been ordered at a second reactor site in the Fukushima area. Apparently there are also problems cooling

three of the four reactors at the Fukushima Daini site. All of these reactors are later model General Electric Boiling Water Reactors.

UPDATE, 7:30 pm, Friday, March 11, 2011: Units 1, 2 and 3 at the Fukushima Daiichi site have lost offsite power. Pressure is building up inside Unit 1 (a General Electric Mark I reactor, see below). The normal procedure to release the pressure is to vent the containment (a procedure that releases radiation into the air), but the utility has been unable to do so because of the lack of power. Plant workers may need to enter the containment to do so manually.

UPDATE, 6: 45 pm, Friday March 11, 2011: Numerous sources are reporting radiation levels at Fukushima to be 1,000 times higher than normal inside Unit-2 (though some sources have also reported high radiation levels inside Unit 1) and at least eight times higher than normal at the plant gates outside. The evacuation zone has been expanded to 10 kilometers (about 6 miles) from the Fukushima reactor site.

**UPDATE, 4:45 pm, Friday March 11, 2011:** NHK News in Japan is reporting that some mobile “electric power source units” have arrived at the Fukushima reactor site and been connected, and that at least some power is being provided to the Unit-1 and Unit-2 reactors. We don’t yet know the nature or capability of these units.

**UPDATE, 3:30 pm, Friday, March 11, 2011:** A Japanese Cabinet Office report released at 12:30 am Saturday, March 12, 2011 (Japanese time) predicts that fuel damage will occur at the Fukushima Daiichi Unit-2 reactor late Saturday night (Japan time, early Saturday morning US time) if cooling is not restored before then.

Environmental activists in the area report that radiation monitoring stations in the Fukushima Daiichi area are not operating. Tepco's (Tokyo Electric Power Co.) monitoring website is at: <http://www.tepco.co.jp/nu/pamp/index-j.html>

At the top it says that "monitoring goes on around the clock year round". At the bottom it says in red: THIS SYSTEM IS CURRENTLY SHUTDOWN"

Activists believe this is indicative of an attempt to downplay potential radioactive releases, especially as Tepco says it plans to vent the containment to relieve pressure, which will cause release of radioactivity into the air.

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There are six nuclear reactors at the Fukushima Daiichi nuclear power site, located near the town of Okama in the Fukushima Prefecture. Another site in the same Prefecture, Fukushima Daini, contains four nuclear reactors. The sites are on the eastern Japanese coast about 200 miles north of Tokyo. All of these reactors are owned and operated by Tokyo Electric Power Co. (Tepco).

The earthquake of March 11, 2011 appears to be causing the greatest problems for the Fukushima Daiichi reactors, although several reactors at both sites were affected by the earthquake. Specifically, Fukushima I-2 has lost backup power and necessary cooling capability. As of 11:30 am Eastern time March 11, cooling capability has not been restored.

About 3,000 people within three kilometers of the reactor site are being evacuated. People living three to ten kilometers from the site are being told to stay indoors.

At 2:20 am Tokyo time (12:20 pm eastern US time); it was reported that pressure is rising inside the Unit 2 reactor and that radiation may be vented to the atmosphere. At 1:45 eastern US time, the Associated Press reported that venting of the reactor containment to reduce pressure building up inside the containment is about to begin. This venting will release some radioactivity into the air. Elevated radiation levels were also reported inside the control room of the Unit 1 reactor.

These reactors are:

### **Fukushima Daiichi 1**

<b>Reactor</b>	<b>Design</b>	<b>Size</b>	<b>Date of Commercial operation</b>
Fukushima I-1	General Electric Mark I BWR	439MW	March 1971
Fukushima I -2	General Electric Mark I BWR	760 MW	July 1974
Fukushima I - 3	General Electric Mark I BWR	760 MW	March 1976
Fukushima I - 4	General Electric Mark I BWR	760 MW	October 1978
Fukushima I - 5	General Electric Mark I BWR	760 MW	April 1978
Fukushima I - 6	General Electric Mark II BWR	1067 MW	October 1979

### **Fukushima Daini II**

Fukushima II-1	General Electric Mark II BWR	1067 MW	April 1982
Fukushima II-2	General Electric Mark II BWR	1067 MW	February 1984
Fukushima II-3	General Electric Mark II BWR	1067 MW	June 1985
Fukushima II-4	General Electric Mark II BWR	1067 MW	August 1987

In 1986, Harold Denton, then the NRC's top safety official, told an industry trade group that the "Mark I containment, especially being smaller with lower design pressure, in spite of the suppression pool, if you look at the WASH 1400 safety study, you'll find something like a 90% probability of that containment failing."

Some modifications have been made to U.S. Mark I reactors since 1986, although the fundamental design deficiencies remain.

For more information about the GE Boiling Water Reactor designs and some of their drawbacks:  
<http://www.nirs.org/factsheets/bwrfact.htm>

Citizens' Nuclear Information Center, a Japanese environmental group, has documented previous safety problems and cover-ups by Tepco at the Fukushima reactor complex:  
<http://cnic.jp/english/newsletter/nit92/nit92articles/nit92coverupdata.html>



Wikipedia photo of the Fukushima Daiichi complex

On June 17, 2010, the same Fukushima I-2 reactor experienced a loss-of-power accident. According to Citizens' Nuclear Information Center, "On June 17, Tokyo Electric Power Company's Fukushima I-2 (BWR, 784MW) scrambled due to a problem with the generator. Power was lost for a time, because the switchover to the offsite power supply was unsuccessful. As a result, the feedwater pump stopped and the water level in the reactor core fell about 2 meters. The emergency diesel generator started up just in time, so the Emergency Core Cooling System was not activated. The water level was restored by an alternative pump in the core isolation cooling system."

At least one reactor at the complex, Fukushima I-3, began using MOX (mixed plutonium-uranium) fuel in September 2010.

*This factsheet will be updated as new information becomes available. Michael Mariotte, March 11, 2011.*