



Fukushima: One Year Later

The Fukushima Daiichi disaster raised fresh concerns about the safety of America's nuclear power plants and the wisdom of building new nuclear power plants in the United States. One year after the deadly earthquake and tsunami that spawned the meltdowns at Fukushima, new information continues to emerge about the events that took place at Fukushima and the implications for the people of Japan and the future of nuclear power.

This issue brief provides an update on the situation at Fukushima on the first anniversary of the disaster.

What happened at Fukushima Daiichi?

On March 11, 2011, an earthquake measuring 9.0 on the Richter scale struck off the eastern coast of Japan. The Fukushima Daiichi nuclear power plant, which consists of six nuclear reactors, was shaken, but it is unclear whether it was damaged by the earthquake. However, the ensuing tsunami – which was far larger than the plant was built to withstand, despite scientific warnings that larger tsunamis were possible in the area – wiped out electric power to the facility and damaged key equipment, including the diesel generators that were designed to provide backup power in an emergency.¹ A recent independent review of the accident found that the plant's owner, Tokyo Electric Power Company (TEPCO) was not required to – and did not – plan for the potential extended loss of electric power to the plant, an oversight that the review concluded “played a large and negative role in the events that transpired.”²

Without the ability to pump cooling water, fuel rods inside the plant's reactors began to heat up. Within hours or days, three reactors had experienced meltdowns, with molten fuel slumping to the bottom of the reactor pressure vessels and, in at least one case, melting through the vessel into the final layer of containment.³ As operators vented steam and gases from the reactors, a series of hydrogen explosions took place, causing further damage to equipment at the complex. Large amounts of radiation were dispersed into the air.

Over the past year, the plant's operator has apparently succeeded in cooling the reactor cores through large infusions of water. However, high levels of radiation make it impossible for the plant's operators to determine precisely where the melted reactor fuel may be located, or assess its condition. In addition, the cooling process has produced vast amounts of radioactive water that have occasionally leaked into the sea.

How much radiation was released and where did it go?

The meltdowns at Fukushima resulted in a massive release of radiation to both water and air.

- The Fukushima accident resulted in the **largest-ever accidental discharge of radiation to the sea**. Numerous species of marine life – including seaweed, clams, and some types of fish caught

off the coast of Fukushima – have been found to have levels of contamination above Japanese government limits for human consumption.⁴

- The accident **spread radiation over a wide swath of Japan**. Cesium 137 concentrations in soils in parts of Fukushima province exceed limits for agricultural production, and localized areas in other provinces may exceed those limits as well.⁵ Some areas beyond the 20 kilometer (12.2 mile) exclusion zone around Fukushima, particularly those located to the northwest, received levels of radiation above government safety standards.⁶ Radiation “hot spots” have been discovered in Tokyo and other cities more than 100 miles from Fukushima.⁷

What has been the impact on public health in Japan?

No one can predict the ultimate public health toll of the Fukushima accident. Radionuclides such as cesium 137 have half-lives of 30 years or more, meaning that they will persist in the environment for a long time. Key questions – such as the degree to which these long-lived radionuclides will accumulate up the food chain – remain unanswered by scientists.⁸ Moreover, because it can take years for radiation exposure to result in a specific health effect, the total impact on public health may never be known.

We do know the following, however:

- **Workers:** Approximately 167 workers at the plant were exposed to radiation exceeding 100 millisieverts, which was the safety standard in place for Japan’s nuclear workers prior to the Fukushima accident.⁹ Radiation doses at these levels have been associated with negative human health effects, including increased risk of cancer.¹⁰
- **Children:** Exposure to radiation can lead to thyroid cancer and other thyroid problems among children. Government tests conducted in March 2011 – but unreleased at the time – found elevated radiation doses to the thyroid glands of some children living near Fukushima.¹¹ Subsequent testing has found thyroid irregularities in some children living within and outside the exclusion zone at the time of the accident.¹²
- **Exposure through food and water:** Radiation has been found at unsafe levels in agricultural products such as rice, beef, milk, spinach and tea leaves.¹³ On March 22, radioactive iodine was detected at the Kanamachi water treatment plant, a facility 130 miles from Fukushima Daiichi that supplies water to Tokyo.¹⁴ The radioactive isotope was present at more than twice the level the Japanese government deems safe for infant consumption.¹⁵ The Japanese government has used warnings and bans on the sale of agricultural products to limit exposure to radiation, but it is not known whether these measures have succeeded in keeping all contaminated water and food away from people.

What have been the economic and societal costs?

- As of December 2011, roughly 90,000 people remain displaced as a result of the accident.¹⁶ Some areas contaminated by the disaster may remain uninhabitable for decades, if not forever.
- Cleanup and decommissioning of the Fukushima Daiichi power plant is expected to take 30 to 40 years.¹⁷ The cost of cleaning up the plant and compensating victims has been estimated to be as much as \$257 billion – about 5 percent of Japan’s annual gross domestic product.¹⁸

- Broader impacts of the disaster include potential long-term costs for medical care and monitoring, higher electricity costs (at least in the short term), and ripple effects throughout Japan's economy and society.

Is the threat over?

No. TEPCO and the Japanese government have reported that the reactors are “in a state of cold shutdown,” meaning that temperatures measured in the reactor are below those that would indicate ongoing damage to fuel. However, the threat posed by the Fukushima plants is far from under control:

- Leaks of radioactive water from the plant continue. In February, it was discovered that 8.5 tons of radioactive water had leaked from one reactor after a pipe had become detached.¹⁹ Smaller leaks caused by cold weather occurred elsewhere at the plant.
- There are continued questions about the location and status of the reactor fuel and the effectiveness of efforts to keep it cool. High levels of radiation prevent the plant's operator from conducting a detailed survey to locate the fuel.
- There are also continued questions about the stability of the plant's structures, especially in the event of another major earthquake. A team of Japanese and Chinese seismologists recently warned that the 2011 earthquake may have increased the chances of a significant earthquake taking place around the plant in the near future. They warned that “much attention should be paid to ... seismic safety in the near future.”²⁰

The Fukushima disaster illustrates the risks posed by nuclear power to our health and safety. The United States should take immediate steps to ensure that the lessons of Fukushima are applied at existing nuclear power plants, move quickly toward the closure of existing power plants at the end of their current licenses, and embrace a vision of a clean energy future built on a foundation of energy efficiency and the use of clean energy sources such as wind and solar.

This issue brief was prepared by Tony Dutzik and Travis Madsen of Frontier Group in March 2012 for Environment California Research & Policy Center, a member of Environment America Research & Policy Center. For more information go to www.environmentamericacenter.org.

References

- ¹ “Despite scientific warnings”: Eisuke Sasaki, “Tepco Procrastinated Even After Tsunami Threat Shown,” *Asahi Shimbun*, 9 November 2011, accessed at ajw.asahi.com/article/0311disaster/analysis/AJ2011110915073.
- ² Yoichi Funabashi and Kay Kitazawa, “Fukushima in Review: A Complex Disaster, A Disastrous Response,” *Bulletin of the Atomic Scientists*, 68(2): 9-21, March/April 2012, online version doi: 10.1177/00963402124403591.
- ³ Tokyo Electric Power Company, *The Evaluation Status of Reactor Core Damage at Fukushima Daiichi Nuclear Power Station Units 1 to 3*, 30 November 2011.
- ⁴ Institut de Radioprotection et de Sécurité Nucléaire, “Synthèse Actualisée des Connaissances Relatives à l’impact Sur le Milieu Marin des Rejets Radioactifs du site Nucléaire Accidenté de Fukushima Dai-ichi” 26 October 2011 (French); English translation accessed via Simply Info at www.simplyinfo.org/?p=3818, 5 March 2012.
- ⁵ Teppei J. Yasunari, et al., “Cesium-137 Deposition and Contamination of Japanese Soils Due to the Fukushima Nuclear Accident,” *Proceedings of the National Academy of Sciences*, 108(49): 19530-19534, 6 December 2011, doi: 10.1073/pnas.1112058108.
- ⁶ Edwin Cartlidge, “Fukushima Maps Identify Radiation Hot Spots,” *Nature News*, 14 November 2011, doi: 10.1038/nature.2011.9355.
- ⁷ Geoff Brumfiel, “Fukushima ‘Hot Spots’ Raise Radiation Fears,” *Nature News*, 11 October 2011, doi: 10.1038/news.2011.593.
- ⁸ Matt Smith, “Radiation Levels Higher But Safe Off Fukushima Daiichi, Scientists Say,” CNN.com, 27 February 2012, accessed at www.cnn.com/2012/02/22/world/asia/japan-fukushima-pacific/index.html.
- ⁹ Japan Atomic Industrial Forum, *Status of the Efforts Towards the Decommissioning of Fukushima Daiichi Unit 1 through 4 as of February 17th, 2012*, downloaded from www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1329457024P.pdf, 5 March 2012.
- ¹⁰ David J. Brenner, et al., “Cancer Risks Attributable to Low Doses of Ionizing Radiation: Assessing What We Really Know,” *Proceedings of the National Academy of Sciences*, 100(24): 13761-13766, 25 November 2003, doi: 10.1073/pnas.2235592100.
- ¹¹ *Asahi Shimbun*, “Government Sat on Survey of Radiation in Fukushima Children’s Thyroid Glands,” 22 February 2012.
- ¹² Justin McCurry, “International Nuclear Inspectors Arrive in Fukushima,” *The Guardian* (online), 9 October 2011, accessed at www.guardian.co.uk/world/2011/oct/09/iaea-fukushima-inspectors-arrive.
- ¹³ David Jolly, “Fukushima’s Contamination Produces Some Surprises at Sea,” *New York Times Green blog*, 28 September 2011, accessed at green.blogs.nytimes.com/2011/09/28/fukushimas-contamination-produces-some-surprises-at-sea/.
- ¹⁴ “Japan Finds More Vegetables, Water Affected by Radiation,” *Nikkei.com*, 24 March 2011.
- ¹⁵ Ibid.
- ¹⁶ Martin Fackler, “Japanese Split on Fukushima Radiation Cleanup,” *New York Times*, 6 December 2011.
- ¹⁷ See note 9.
- ¹⁸ Shinichi Saoshiro, “Japan Sees Atomic Power Cost Up by at Least 50 Percent by 2030 – Nikkei,” Reuters, 6 December 2011.
- ¹⁹ John Hutchinson, “Radioactive Leaks at Crippled Fukushima Nuclear Power Plant Increase Two Months After it Was Declared Safe,” *Daily Mail* (U.K.) 3 February 2012, accessed at www.dailymail.co.uk/news/article-2096160/Radioactive-leaks-crippled-Fukushima-nuclear-power-plant-increase-months-declared-safe.html.
- ²⁰ P. Tong, D. Zhao, and D. Yang, “Tomography of the 2011 Iwaki Earthquake (M 7.0) and Fukushima Nuclear Power Plant Area,” *Solid Earth* 3:43-51, 2012, doi: 10.5194/se-3-43-2012.