



WATER CONTAMINATION- IMPACTS ON THE U.S. WEST COAST

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The NRC continues to note public interest regarding the U.S. West Coast and low concentrations of radioactive material detected in the Pacific Ocean. The source of these ongoing leaks is the Fukushima Daiichi Nuclear Power Station (NPS) in Japan, and is the result of that site's catastrophic and unprecedented accident following the Great Japan Earthquake and Tsunami of March 2011.

The NRC provides the following discussion as background. More up to date information, however, is available through the links provided at the end of this report. While the NRC continues to remain apprised of this situation, various other federal and state agencies are charged with environmental monitoring to determine the health and safety effects of the situation.

For more information from Japan, links to the Japanese Nuclear Regulatory Authority (JNRA) are provided at the end of this report.

THE FACTS: BOTTOM LINE

The NRC and responsible federal, state and local governments do not see any evidence that the low levels of radiation leaking into the ocean from the Fukushima Daiichi NPS pose any U.S. health or environmental risk.

THE FACTS: FUKUSHIMA DAIICHI CONTAMINATED GROUND WATER

On June 19, 2013, contaminated groundwater was discovered at the Fukushima Daiichi NPS between some of the facility's turbine buildings and the seaport where clean water should be expelled from the facility. Analysis by the Tokyo Electric Power Company (TEPCO), the utility company that owns and operates the NPS, reported that the main source of the contamination were leaks from cable trenches which connect with circulation pumps. TEPCO reported in February of 2013 that the contaminated water reached these trenches during the actual tsunami event in March of 2011; this finding was later confirmed by the International Atomic Energy Agency (IAEA) [1]. Next, on Aug. 19, 2013 TEPCO announced another source of contaminated water, citing that leaks from above ground tanks where the contaminated water is stored. Following these discoveries, officials determined that circulating water within the reactor that cools the system was contributing towards the leaks, as well as ground water which flows into the basements of the reactor and turbine buildings and was determined to be leaking. [2]

As a result, radioactivity has been observed within the sea port directly outside the Fukushima Daiichi NPS [3] [4]. However, except for a few isolated locations directly outside the plants outlet, the radionuclide concentrations remain within the World Health Organizations (WHO) guidelines for drinking water [5]. The government of Japan, in September of 2013, established policy to respond to this emergency situation. This response includes the development and implementation of a "preventative and multi-layer" [2] approach to containing and halting contamination, and isolating that which has already been released. [1] [2]

For more information on current levels of contamination near the Fukushima Daiichi NPS, links to the International Atomic Energy Agency (IAEA), JNRA and TEPCO are provided at the end of this report.

THE FACTS: WHAT IS BEING DONE

As of February 2014, the current Fukushima groundwater plan intends to meet three main goals, by April 2016. TEPCO is carrying out this plan with financial assistance from the government of Japan [1]. Many of these actions are ongoing and have been underway since the leaks were discovered.



The first goal of their cleanup approach is to eliminate the sources of contamination through removal of contaminated water from the trenches, and treating this water with multi-nuclide removal equipment, while cleaning up the sea harbor. The second goal is to isolate the source of the leaks through such measures as installing an impermeable “frozen” [2] wall on the land side of the plant to isolate the contaminated ground water. They will also remove contaminated soil to a storage facility onsite [4]; as well as install impermeable walls on the ocean side of the plant to stop any leakage to the sea and pump groundwater from the mountainside area of the plant to reduce groundwater flowing into the contaminated area. The final goal is to prevent further leakage. The implementation plan is to treat the soil with sodium silicate (i.e. liquid glass) to make it less permeable, and to accelerate the installation of weld-joints in the leaking storage tanks housing the contaminated water. Further, on April 9, 2014 it was announced that TEPCO started pumping upstream groundwater at the site into storage tanks. This is considered the start of routing clean groundwater around the contaminated area and into ocean. [1] [2] [4]

The International Atomic Energy Agency’s (IAEAs) Mission Report on the mid-and-long term roadmap for cleanup and decommissioning of the site, issued in February 2014, stated the agency agrees “with TEPCO’s apparent cause findings and countermeasures taken for correctable causes” [1].

THE FACTS: IMPACTS TO THE U.S. AND ONGOING MONITORING

As the trace amounts of the contaminated water travel towards the U.S. West Coast, many U.S. federal government agencies collect data as they determine environmental consequences including impacts on the environment, drinking water and food safety. While the NRC does not collect this data, we closely consider the environmental and public health impacts of the situation and provide technical expertise on the safe operations of nuclear power. The NRC also holds regular discussions with the Japanese Nuclear Regulation Agency (JNRA) and TEPCO. The NRC is ready to support the JNRA upon their request. In addition, the NRC is communicating routinely with other federal and State agencies.

As of March 2014, the Food and Drug Administration (FDA) has found “no evidence that radionuclides from the Fukushima incident are present in the U.S. food supply at levels that would pose a public health concern” [6]. Further, FDA states this is true for both regulated food products imported from Japan and our own domestic food products including seafood that is caught off the U.S. West Coast [6]. In fact, the FDA, the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Agency (NOAA) jointly issued a statement stating that they “have high confidence in the safety of seafood products in the U.S. marketplace or exported U.S. seafood products” [7].

The EPA utilizes a nationwide system called RadNet to monitor the nation’s air drinking water, precipitation and pasteurized milk to determine levels of environmental radiation the American public is exposed to. RadNet sample analyses and monitoring results are able to detect increased radiation in the environment. RadNet has “not found any radioactive elements associated with the damaged Japanese reactors since late 2011, and even then, the levels found were very low—always well below any level of public health concern” [8]. The National Oceanic and Atmospheric Administration (NOAA) is responsible for modeling and monitoring the movement of marine debris related to the tsunami in Japan [9]. The NOAA Marine Debris Program is working with federal, state, and local partners to collect data, assess the debris, and reduce possible impacts to our natural resources and coastal communities.

State and local governments play a major role in monitoring environmental conditions related to this event. For instance, the FDA is working cooperatively with the State of Alaska, undertaking a program to sample a wide variety of fish samples within the state for trace amounts of contaminants from the Fukushima Daiichi NPS leaks as they approach the U.S. West Coast. West Coast State



governments in particular are closely monitoring air, sand and soil for higher than normal levels of radiation, and they will continue to do so [10].

Also, U.S. researchers play a critical role in monitoring and learning from this event. For instance, the Woods Hole Oceanographic Institute (WHOI), in conjunction with the National Science Foundation, has established a [monitoring program](#) for the low levels of contamination as it reaches the U.S. West Coast.

TECHNICAL BACKGROUND: WATER SAFETY AND RADIATION

Available evidence leads the NRC to conclude the contaminated water will not affect U.S. public health. Radioactivity from both man-made and naturally occurring sources is present throughout the environment, including bodies of water. WHO estimates that increased cancer risks exist when ingesting radionuclides over an extended period of time at doses above 10 Bq/L [5]. The EPA's limit is set below that level at 7.41 Bq/L. As contaminated water exits the harbor in Japan the concentration of radioactive material will not only dilute significantly as it travels towards the U.S., but it will also go through a process called "radioactive decay" where it will experience a decrease in radioactivity [11].

Radioactive Cesium (Cs-137) is the primary isotope of concern and Cs-137 levels right near the Fukushima Daiichi NPS have generally been below 10 Bq/L since the contamination was detected last year [3]. Since this is considered safe for drinking water, and combined with U.S. monitoring efforts of our own drinking water and food sources, the NRC is confident that even trace amounts of contamination reaching the U.S. result in minute contamination. In fact, seawater sampling at Fukushima Daiichi at points 30 to 200 km out to sea shows very low Cs-137 concentrations; typically below 0.004 Bq/L (CITE). Further, pre-accident concentrations of the same areas were only around 0.003 Bq/L.

TECHNICAL BACKGROUND: THE FUKUSHIMA DAIICHI NPS

The following discussion provides more details on how the leaks are occurring.

- *Circulating water within the reactor that cools the system:* seawater is currently being circulated through the reactor to cool the system; some of this water is leaking out of the reactor coolant system and into the buildings that house the reactor and turbine. TEPCO pumps approximately 800 tons/day of this contaminated waste water out of the reactor building/turbine building basements to avoid it flowing out and into the groundwater. Once this water is pumped out, it is desalinated and then filtered to remove radioactive cesium. About 400 tons/day is pumped back to cool the reactors, becoming contaminated again as it flows through reactor core; it then flows back to the reactor /turbine building basements where it is again pumped out; this cycle is continued. The rest of the water, 400 tons/day, containing high concentrations of Strontium-90 and tritium, is pumped to an ever growing storage tank farm. [1] [2]
- *Groundwater flowing into and out of the basements of the reactor and turbine buildings:* The reactor and turbine buildings were damaged in the earthquake and the subsequent nuclear event. As a result, groundwater is able to enter the basements of those buildings. TEPCO intentionally keeps the water level in the basements, including both the water pumped in to cool the reactors and the groundwater leaking into the buildings, at a lower level than the water table on the outside of the basements. This is done so that it is easier for the groundwater to flow in than for the contaminated water to flow out. However, despite the water table being higher, some of the contaminated water still leaks out of the basements and into the soil and the groundwater.

The ground water that flows into the buildings becomes contaminated because, once it enters the basements, it mixes with the contaminated cooling water that leaked out of the reactor coolant system. The groundwater that enters into the basement accounts for approximately 400 tons/day



of water that TEPCO pumps out of these facilities. This contaminated water includes radioactive cesium, strontium, and tritium. Cesium moves very slowly in groundwater. Strontium is adsorbed less than cesium and moves faster, while tritium remains with the groundwater as it flows toward the harbor. As discussed, TEPCO plans to impede the flow of groundwater through a series of engineered solutions such as impermeable walls.

[1] [2]

- *Leaking storage tanks containing highly contaminated water:* The storage tanks holding the excess contaminated water that is pumped out of the reactor/ turbine buildings are also of concern. As discussed earlier, leakage from these tanks was discovered shortly after the contaminated water was identified in 2013. The tank farm's radioactive strontium level represents a very significant potential contamination source, which is why the Japanese officials' Implementation Plan includes a system to remove the strontium from the stored water. [1] [2]



Figure: Fukushima Daiichi NPS today.

- *Accident water left in trenches:* A second source of ocean contamination is the trenches. These are u-shaped, concrete tunnels where pipes and electrical cables run between seawater pumps and the turbine buildings. These trenches flooded during the 2011 tsunami. The Unit 1 trench was flooded with tsunami water and contains very little radioactivity. However, the Unit 2 trench was flooded with highly contaminated accident water. As of February 2014, TEPCO reports that these trenches are still leaking. [1]

TECHNICAL BACKGROUND: FOR MORE INFORMATION

Many organizations, both national and international, provide information about the current state of the water contamination issue, both at the source from the Fukushima Daiichi NPS and as the trace amounts reach the U.S. For more information follow the links below:

- U.S. Federal Government:
 - [FDA food safety efforts](#)
 - [NOAA Fukushima Daiichi and marine debris](#)
 - [EPA RadNet and Fukushima Resources](#)
 - [Joint Statement by EPA, FDA and NOAA about seafood safety](#)
- U.S. State governments
 - [Hawaii Dept. of Health- health concerns related to Fukushima](#)
 - [EPA's RadNet for Alaska Drinking Water](#)
 - [Alaska Department of Conservation- radiation concerns](#)
 - [Washington State Department of Health Fukushima 2013 Update](#)
 - [California Dept. of Public Health-Radiologic Health Branch](#)



- [Oregon Health Authority Radiation Protection](#)
- International:
 - [Japan NRA: Fukushima Daiichi NPS Issues](#)
 - [Japan's Ministry of Economy, Trade, and Industry](#)
 - [Health Canada: Radiation Dose Data from the Fixed Point Surveillance Network](#)
 - [IAEA reports on conditions at Fukushima Daiichi](#)
 - [TEPCO current reports on Fukushima Daiichi NPS](#)
- Examples of research efforts
 - [WHOI Fukushima Daiichi information.](#)
 - [Citizen scientists sample water](#)



Bibliography

- [1] International Atomic Energy Agency, "Mission Report: IAEA International Peer Review Mission on Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi NPS Units 1-4," IAEA, Vienna, Austria, 2013.
- [2] Tokyo Electric Power Company, "Contaminated Water at Fukushima Daiichi NPS," TEPCO, Tokyo, Japan, 2014.
- [3] International Atomic Energy Agency, "Japan's Reports on Conditions at TEPCO's Fukushima Daiichi Nuclear Power Station," 14 04 2014. [Online]. Available: <http://www.iaea.org/newscenter/news/2013/japan-basic-policy-full.html>.
- [4] Japan Nuclear Regulation Authority, "News Release: 20 February 2014," JNRA, Tokyo, Japan, 2014.
- [5] World Health Organization, "Guidelines for Drink-water Quality," WHO, Geneva, Switzerland, 2011.
- [6] Food and Drug Administration, "FDA Response to the Fukushima Dai-ichi Nuclear Power Facility Incident," 10 03 2014. [Online]. Available: <http://www.fda.gov/newsevents/publichealthfocus/ucm247403.htm>. [Accessed 14 04 2014].
- [7] FDA, EPA, NOAA, U.S. Seafood Safe and Unaffected by Radiation Contamination from Japanese Nuclear Power Plant Incident; U.S. Monitoring Control Strategy Explained, Washington, D.C., 2014.
- [8] Environmental Protection Agency, "What is EPA doing about tracking radiation in our environment from Fukushima?," 9 01 2014. [Online]. Available: <http://radiation.supportportal.com/link/portal/23002/23013/Article/35333/What-is-EPA-doing-about-tracking-radiation-in-our-environment-from-Fukushima>. [Accessed 14 04 2014].
- [9] National Oceanic and Atmospheric Administration, "Japan Tsunami Marine Debris," 08 04 2014. [Online]. Available: <http://marinedebris.noaa.gov/tsunamidebris/>. [Accessed 14 04 2014].
- [10] Oregon Health Authority, "Oregon Health Authority: Radiation Protection," [Online]. Available: <http://public.health.oregon.gov/HealthyEnvironments/RadiationProtection/Pages/index.aspx>. [Accessed 14 04 2014].
- [11] Nuclear Regulatory Commission, "NRC Glossary: Radioactive Decay," 02 04 2014. [Online]. Available: <http://www.nrc.gov/reading-rm/basic-ref/glossary/radioactive-decay.html>. [Accessed 14 04 2014].
- [12] International Atomic Energy Agency, "IAEA: Top Stories and Features- Level 3 Event, which is termed a Serious Incident on the International Nuclear and Radiological Event Scale," [Online]. Available: <http://www.iaea.org/newscenter/news/2013/ines3.html>. [Accessed 14 04 2014].