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

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Updated January 2015 – Robert Bernardo
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The NRC continues to see public interest in low concentrations of radioactive material detected off the U.S. West Coast. The material comes from the Fukushima Daiichi Nuclear Power Station's catastrophic and unprecedented accident following the Great Japan Earthquake and Tsunami of March 2011.

While the NRC has created this background discussion, more up to date information is available through the links (such as to Japan's Nuclear Regulatory Authority (JNRA)) at the end of this report. While the NRC continues to examine information on this situation, many other Federal and State agencies carry out the environmental monitoring needed to determine any health and safety effects from the Fukushima-based contamination.

## THE FACTS: BOTTOM LINE

The available evidence continues to lead the NRC and other Federal, State and local governments to conclude the low levels of radiation leaking into the ocean from Fukushima Daiichi fall well short of posing any U.S. health or environmental risk.

## THE FACTS: FUKUSHIMA DAIICHI CONTAIMINATED GROUND WATER

On June 19, 2013, contaminated groundwater was discovered between some of Fukushima Daiichi's turbine buildings and the seaport where clean water should be expelled from the facility . Tokyo Electric Power Company (TEPCO), the utility company that owns and operates the plant, analyzed the water and reported the main contamination source was leaks from cable trenches which connect with circulation pumps. TEPCO reported in February of 2013 that the contaminated water reached these trenches during the March 2011 tsunami; the International Atomic Energy Agency (IAEA) confirmed this finding later in 2013 [1]. In August of 2013, TEPCO announced another source of contaminated water -- leaks from aboveground tanks that store water used to cool the damaged reactors. Officials later determined the reactor cooling system itself was contributing to the leaks. Groundwater flowing into the basements of the damaged reactor and turbine buildings also fed the leaks. [2]

These leaks introduced radioactive material into the Pacific Ocean. The material has been observed within the sea port directly offshore from Fukushima Daiichi[3] [4]. Apart from a few isolated locations directly outside the plant's outlet, the contamination levels remain safely below World Health Organizations (WHO) guidelines for drinking water [5]. Japan's government responded to the situation in September 2013, developing and implementing a "preventative and multi-layer" [2] approach to containing and halting contamination, and isolating what had already been released. [1] [2]

Links at the end of this document to the IAEA, JNRA and TEPCO provide more information on current contamination levels near Fukushima Daiichi.

## THE FACTS: WHAT IS BEING DONE

The current Fukushima groundwater plan, which includes actions started when the leaks were discovered, intends to meet three main goals by April 2016. TEPCO is carrying out this plan with financial assistance from the government of Japan [1]. The first goal is eliminating sources of contamination by removing and filtering water from the trenches, along with cleaning up the sea harbor. The second goal is isolating the leaks through such measures as installing an

impermeable “frozen” [2] soil wall on the land side of the plant to divert ground water away from the damaged buildings. 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. This goal includes pumping groundwater from the mountainside area of the plant to further reduce groundwater flowing into the contaminated area. The final goal is preventing further leakage. This involves treating the soil with sodium silicate (i.e., liquid glass) to make it less permeable, as well as accelerating the installation of weld joints to stop leaks in the contaminated water storage tanks. In April 2014 TEPCO started pumping upstream groundwater at the site into storage tanks to begin routing clean groundwater around the contaminated area and into ocean. [1] [2] [4]

In January 2015, TEPCO added a “Major Initiative for Water Management” section to the “Decommissioning Plan of Fukushima Daiichi Nuclear Power” information on their English language homepage. The section includes displays of how each water treatment and management structure works at Fukushima Daiichi. Clicking on the graphics provide more details about each strategy, including the seaside impermeable wall, the frozen soil wall, groundwater bypass, subdrain system, and water processing systems. TEPCO’s website has the latest information on these efforts.

In a February 2014 Mission Report on cleanup and decommissioning planning at the site, the IAEA agreed “with TEPCO’s apparent cause findings and countermeasures taken for correctable causes” [1]. The NRC also holds regular discussions with JNRA and TEPCO.

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

Trace amounts of contamination traveling across the Pacific are monitored by U.S. and Canadian agencies, as well as by private groups. These agencies analyze the monitoring results to determine possible impacts on the environment, drinking water and food safety. While the analysis is done outside the NRC, we closely consider the results and discuss them 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 indicating 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 contaminates from the Fukushima Daiichi Nuclear Power Station (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, 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, and Canadian researchers are conducting a systematic study of the Fukushima radioactivity in North American continental waters.

In November 2014, WHOI scientists found trace amounts of Fukushima contamination about 100 miles (150 km) due west of Eureka, California [11]. The amount of radioactivity reported in this offshore data is 1,000 times lower than EPA drinking water standards. In December 2014, Canadian scientists published a paper in the Proceedings of the National Academy of Sciences [12] discussing Fukushima contamination. The paper concludes that radioactive Cesium from the Fukushima accident reached the continental shelf of Canada in June 2013, and by February 2014 had reached a level equal to that found by WHOI. Using the latest ocean circulation models, the Canadian paper estimates that future contamination levels could double in the 2015 to 2016 timeframe and then decline to background levels by 2021. The reports from both groups stated that these levels do not represent a threat to human health or the environment. Links to each of these reports are provided in the “For More Information” section.

## TECHNICAL BACKGROUND: WATER SAFETY AND RADIATION

Available evidence leads the NRC to conclude the Pacific contamination 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 cancer risks increase only if a person ingests radionuclides over an extended period of time at doses more than five thousand times greater than what has been detected in the Pacific [5]. The EPA’s drinking water limit is lower than the WHO estimate. As contaminated water exits the harbor in Japan, the contamination will dilute significantly as it travels towards the U.S., and will also become weaker through the natural process of radioactive decay [13].

Because of its long half-life, radioactive Cesium (Cs-137) is the primary isotope of concern from a health perspective for the U.S. West Coast. Cs-137 levels right near the Fukushima Daiichi NPS have generally been below the WHO guidelines 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 only trace amounts of this isotope, in levels far below drinking water limits, will reach the U.S. In fact, seawater sampling at Fukushima Daiichi at points 30 to 200 km out to sea shows Cs-137 concentrations almost identical to pre-accident concentrations. [14]

## 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:* Water is 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 Stronium-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 tsunami and the subsequent nuclear accident. 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 into the buildings 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 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 Implementation Plan includes a system to remove the Strontium from the stored water [1] [2]. TEPCO has taken steps (such as replacing flanged tanks with all welded tanks) to reduce or eliminate tank leakage. Other measures (such as sealing the ground around the tanks and treating the ground with Apatite, which absorbs Strontium) have been taken to insure that any leakage is detected quickly and to prevent any leakage from reaching either groundwater or the harbor.

**Figure: Fukushima Daiichi NPS today.**

- *Accident water left in trenches:* Each unit has U-shaped, concrete tunnels (trenches) 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 contamination. However, the unit 2, 3, and 4 trenches were flooded with highly-contaminated accident water. The contaminated water can leak from the trenches into the port. TEPCO has attempted to isolate the unit 2 trench from the unit 2 turbine building by

freezing the water in the connection areas between the buildings and the trench, but this was not successful. Currently, TEPCO is using special cement and grout to fill the trenches completely and simultaneously pumping out the contaminated water, while monitoring the water level in the trench to insure no water leaks out. Once the operations are complete on the unit 2 trench, a similar approach will be used to remove the contaminated water from the unit 3 and 4 trenches. TEPCO estimates completing this work by the end of March 2015.

**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
  - TEPCO results of Radioactive Analysis around Fukushima Daiichi Nuclear Power Station
- Examples of Research Efforts
  - WHOI Fukushima Daiichi information.
  - Citizen scientists sample water
  - WHOI News Release: Fukushima Radioactivity Detected Off West Coast
  - Arrival of the Fukushima radioactivity plume in North American continental waters

# 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.

[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.

[9] National Oceanic and Atmospheric Administration, "Japan Tsunami Marine Debris," 08 04 2014. [Online]. Available: http://marinedebris.noaa.gov/tsunamidebris/.

[10] Oregon Health Authority, "Oregon Health Authority: Radiation Protection," [Online]. Available: http://public.health.oregon.gov/HealthyEnvironments/RadiationProtection/Pages/index.aspx.

[11] K. Buesseler, "Woods Hole Oceanographic Institution," 10 November 2104. [Online]. Available: http://www.whoi.edu/news-release/Fukushima-detection.

[12] J. N. Smith, R. M. Brown, W. J. Williams, M. Roberts, R. Nelson and S. B. Moran, "Arrival of the Fukushima radioactivity plume in North American continental waters," *Proceedings of the National Academy of Sciences of the United States of America,* vol. 112, no. 1, 29 December 2014.

[13] Nuclear Regulatory Commission, "NRC Glossary: Radioactive Decay," 02 04 2014. [Online].

Available: http://www.nrc.gov/reading-rm/basic-ref/glossary/radioactive-decay.html.

[14] Japan Nuclear Regulation Authority, "Monitoring Information of Environmental Radioactivity Level," 2014. [Online]. Available: http://radioactivity.nsr.go.jp/en/list/205/list-1.html.

[15] 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].