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# FUKUSHIMA DAIICHI RADIOACTIVE WATER CRISIS: TEPCO'S DISCHARGE PLANS OF CONTAMINATED SUB-DRAIN WATER INTO THE PACIFIC OCEAN


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After several years of opposition, the Fukushima Prefectural Federation of Fisheries Cooperative Associations has recently given its consent to Tokyo Electric Power Company (TEPCO) to discharge radioactive water into the Pacific Ocean. The water to be discharged is removed from underground wells in the vicinity of the Fukushima Daiichi nuclear power plant and should not be confused with the highly contaminated water used in the cooling of the molten reactor cores. This short briefing summarizes some of the issues around the planned discharge of sub-drain water and its implications.

**Planned discharge of sub-drain water**

The contaminated water, for which the Fukushima Fisheries Cooperative gave consent for it to be discharged, is not the highly contaminated water used by TEPCO to cool the molten fuel in reactor units 1-3 of the Fukushima Daiichi nuclear power plant. Instead, it is less contaminated groundwater that has been removed from a series of sub-drains and wells located around the reactor and turbine buildings. This contaminated groundwater arises from accumulated wash-down rainwater as well as from inland water, which migrates onto the Fukushima Daiichi site. It is a major challenge to the planned decommissioning of the reactor site. At least 800 tons of groundwater a day enters the Fukushima site, of which 400 tons becomes highly contaminated, according to TEPCO.[1] The utility's aim with this current plan is to reduce the amount of groundwater entering the site and becoming highly contaminated. By reactivating the sub-drain system (damaged by the March 2011 earthquake and tsunami), TEPCO plans to eventually pump between 500-700 tons of water per day. This water will be temporarily stored before it is processed and subsequently retained it in a holding tank temporarily prior to the final discharge into the Pacific Ocean. Major constructions were completed in 2014, including a purification system.[2] The storage capacity of the tank is 1200 tons, and only test pumping and purification has been completed as of August 2015. The approval of the Fukushima Fisheries Cooperative thus gives TEPCO the go-ahead to begin the large-scale pumping of groundwater from the sub-drains, with a planned maximum processing of 1200 tons per day. In theory, this would allow TEPCO to discharge hundreds of tons of contaminated water each day.

TEPCO estimates that, with the implementation of its sub-drain pumping and discharge plan, the groundwater level around the reactors will be lowered, reducing the amount of groundwater entering the reactor buildings to 200 tons each day.[3]

1 For details on the groundwater sub-drain system see "Efforts to ensure ocean protection", Tokyo Electric Power Company, August 11 2014, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_03-e.pdf, accessed August 26 2015.

2 "Start of the verification test for purifying performance of the subdrain water treatment facilities at Fukushima Daiichi Nuclear Power Station", Tokyo Electric Power Company, August 11 2014, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_04-e.pdf, accessed August 26 2015.

3 "Efforts to ensure ocean protection", Tokyo Electric Power Company, August 11 2014, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_03-e.pdf, accessed August 26 2015.

On September 3 2015, TEPCO began the pumping of between 100-200 tons of sub drain water, from 20 of the 41 wells around the Fukushima Daiichi 1-4 reactors.[4] A total of 4000 tons of contaminated ground water, already pumped in 2014 during a test program, is to be discharged into the Pacific Ocean from mid September.[5]

**Radionuclide content of discharged water**

The first thing to be made clear is that for four years radioactively contaminated water has been entering the Pacific Ocean every day from the Fukushima Daiichi site. This has largely been uncontrolled releases.

In 2014, TEPCO estimated that more than 20 billion becquerels of Cesium-137 and nearly 25 billion becquerels of Tritium was released into the Pacific each day.[6] TEPCO's failure to disclose accidental releases in 2014[7] was one of the reasons an agreement with local fisheries associations was not secured until August 2015.[8]

The accumulated sub-drain groundwater stored in tanks will be processed to remove the majority of radioactive cesium, strontium and other radionuclides. However, the radioactive isotope tritium will not be removed. TEPCO estimates that the concentration in the processed water will be less than 1 becquerel per liter (Bq/l) for both Cesium-137 and Strontium-90.[9] The limit set for the planned tritium release is a maximum of 1500 Bq/l. However, the amount of water to be released is measured in hundreds of tons per day, potentially 500-600 tons, which would be around 1 billion bequerel of tritium released each day. Given the enormous uncertainties in the decommissioning schedule for the crippled Fukushima Daiichi nuclear power plant, this is potentially a process that will continue for decades.

The groundwater to be pumped, processed and discharged has become contaminated due to it coming into contact with water inside and around the Fukushima Daiichi reactor and turbine buildings. Many unknowns remain about the interaction of groundwater entering the site and existing highly contaminated water inside the reactor buildings. TEPCO has gone to considerable lengths to communicate that groundwater does not come into direct contact with water in the reactor buildings. In August 2014, TEPCO explained that:

> *Radioactive material concentration of the groundwater is much lower than that of the contaminated water accumulating in the reactor facilities. The water level of the contaminated water inside the buildings is kept lower than that of the outer groundwater, which prevents water inside from flowing out. Therefore, contaminated water in the buildings* ***theoretically does not*** *mix with the groundwater flowing around the buildings.*[10]

But this is not credible. In fact, TEPCO contradicts itself. For example, in March 2015, TEPCO admitted that it:

*"Continue[s] treatment of [the] groundwater accumulating in the reactor buildings - Groundwater and other water (approx. 300 tons/day of groundwater + 100 tons/day of water pumped up from well points)* ***accumulating in the reactor buildings,*** *will be put through the cesium adsorption device and the second cesium adsorption device (Kurion and Sarry) in order to remove Strontium, and then further decontaminated through ALPS*[11] *[emphasis added]"*

Clearly, the complexity of hydrology at the Fukushima Daiichi site means there are no certainties about the exact

4 "Subdrain & Groundwater Drain Operations Set To Begin At Fukushima Daiichi, Should Lead To Further Protection Of The Ocean", Fukushima Daiichi NPS Prompt Report, September 2, 2015, see at http://www.tepco.co.jp/en/press/corp-com/release/2015/1259088_6844.html, accessed September 3 2015; also see "TEPCO starts pumping up Fukushima groundwater", Jiji Press, September 03, 2015, see at http://the-japan-news.com/news/article/0002399819, accessed September 3 2015.

5 "TEPCO begins pumping up groundwater before dumping in ocean", Kyodo, September 3 2015, see at http://mainichi.jp/english/english/newsselect/news/20150903p2g00m0in042000c.html, accessed September 3 2015.

6 "Efforts to ensure ocean protection", Tokyo Electric Power Company, August 11 2014, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_03-e.pdf, accessed August 26 2015.

7 "Report on the Investigation and Examination into the Fukushima Daiichi NPS Drainage K Information Disclosure Issue", Dr. Dale Klein, Chairman Nuclear Reform Monitoring Committee, to Mr. Fumio Sudo, Chairman, The Tokyo Electric Power Company, July 29 2015, see at http://www.nrmc.jp/en/report/detail/__icsFiles/afieldfile/2015/08/24/E4.pdf, accessed August 25 2015.

8 "Fukushima fishermen give nod to TEPCO's plan to release treated water into sea, August 11 2015, see at http://ajw.asahi.com/article/0311disaster/fukushima/AJ201508110060, accessed August 26 2015.

9 "Start of the verification test for purifying performance of the subdrain water treatment facilities at Fukushima Daiichi Nuclear Power Station", Tokyo Electric Power Company, August 11 2014, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_04-e.pdf, accessed August 26 2015.

10 "Start of the verification test for purifying performance of the subdrain water treatment facilities at Fukushima Daiichi Nuclear Power Station", Tokyo Electric Power Company, August 11 2014, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_04-e.pdf, accessed August 26 2015.

11 "Regarding contaminated water purification", TEPCO, March 16 2015, see at http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2015/images/handouts_150316_02-e.pdf, accessed August 27 2015.

water migration.

And, while TEPCO has justified the planned sub-drain pumping and discharge plan on the basis that it will reduce the amount of groundwater entering the reactor buildings to 200 tons each day, this remains to be confirmed during the coming months.

**Justification for discharge**

The radioactive water crisis at the Fukushima Daiichi nuclear power plant continues to be one of the greatest challenges for TEPCO. The utility argues that the planned pumping and discharge of groundwater is justified on the grounds that it will significantly reduce the amount of water that becomes highly contaminated and therefore will reduce the amount of contaminated water flowing into the Pacific Ocean. This was the principle argument used to persuade the local fisheries association.[12] On one level it appears logical. Reducing the amount of water entering the site should lead to the reduction of newly contaminated water.

However, there are both risks and uncertainties in TEPCO's plans. There are no certainties in the amount of water entering the site. TEPCO's plans to reduce groundwater entering the site also includes the operation of an ice wall, which has been challenged as to its effectiveness.[13] Similarly, the effectiveness of the impermeable wall to prevent water entering the Pacific Ocean has also been questioned.[14]

**Tritium risks**

Radioactive tritium is not relatively harmless as communicated by the nuclear industry.[15] In fact, tritium is a relatively hazardous radionuclide.[16] For example, its beta particles inside the human body are more harmful than most X-rays and gamma rays. Organically bound tritium (i.e. attached to lipids, carbohydrates, and proteins), absorbed by marine life and humans, presents an additional risk. There are major uncertainties in the long-term effects posed by radioactive tritium,[17] and therefore the planned release of billions of becquerels by TEPCO cannot be considered an action without risk to the marine environment and human health. This is one principle reason why the proposals from TEPCO have been opposed by Fukushima citizens groups.[18]

**Highly contaminated water crisis at Fukushima Daiichi**

The challenges facing TEPCO in relation to the management of highly contaminated water are both enormous and unique. The approval to discharge contaminated water from the sub-drains and wells does not solve the much greater problem of the accumulation of hundreds of thousands of tons of highly contaminated water that is currently stored in over 950 steel tanks at the Fukushima Daiichi site.[19] Every day for more than four years, TEPCO has been pumping over 300 tons of water into the plant to cool the molten fuel that has deposited at the bottom and under the reactor pressure vessels of Fukushima Daiichi units 1-3. Without this cooling water, the molten fuel temperature would increase, potentially leading to additional chemical reactions.

As of August 20 2015, TEPCO reported that a total of 681,129 tons of highly contaminated water was in storage tanks at the Fukushima Daiichi site.[20] This does not include an estimated 65,900 tons of highly contaminated water that remains in the reactor and turbine buildings. Of this total, TEPCO has processed 515,706 tons by using a range

12 "Fukushima fishermen give nod to TEPCO's plan to release treated water into sea", Asahi, August 11 2015, see at http://ajw.asahi.com/article/0311disaster/fukushima/AJ201508110060, accessed August 26 2015.

13 "Experts Criticize Ice Wall Plan At Japan's Fukushima Nuclear Plant", Associated Press, February 5 2014, see at http://www.huffingtonpost.com/2014/05/02/fukushima-ice-wall_n_5252868.html, accessed January 29th 2015; see also "Japan's nuclear crisis: Fukushima Daiichi Status report", Greenpeace, February 2015, see at http://www.greenpeace.org/japan/Global/japan/pdf/Japan's_nuclear_crisis.pdf, accessed August 26 2015.

14 "Japan's nuclear crisis: Fukushima Daiichi Status report", Greenpeace, February 2015, see at http://www.greenpeace.org/japan/Global/japan/pdf/Japan's_nuclear_crisis.pdf, accessed August 26 2015.

15 "Canadian Cancer Study Finds No Adverse Health Effects From Tritium", Nuclear Energy Institute, October 23 2013, see at http://www.nei.org/News-Media/News/News-Archives/Canadian-Cancer-Study-Finds-No-Adverse-Health-Effe, accessed August 26 2015.

16 See for example the work of Dr Ian Fairlie, "Fukushima: Evaporating tank contents is not the solution", April 10 2015, see at http://www.ianfairlie.org/news/fukushima-evaporating-tank-contents-is-not-the-solution/, accessed August 26 2015.

17 "Is Radioactive Hydrogen in Drinking Water a Cancer Threat? The EPA plans to reevaluate standards for tritium in water," David Biello, Scientific American, February 7, 2014, see at http://www.scientificamerican.com/article/is-radioactive-hydrogen-in-drinking-water-a-cancer-threat/, accessed August 25 2015.

18 "Campaign to Stop Fukushima Radioactive Ocean Contamination", change.org, see at http://stoposensui15.blogspot.co.uk/p/english.html, accessed August 26 2015.

19 "Release of treated water into sea a step toward Fukushima...", Yomiuri Shimbun, August 13 2015, see at http://the-japan-news.com/news/article/0002353495, (subscription only).

20 "Situation of storing and treatment of accumulated water including highly concentrated radioactive materials at Fukushima Daiichi Nuclear Power Station (215th Release)", Tokyo Electric Power Company, August 21 2015, see at http://www.tepco.co.jp/en/press/corp-com/release/2015/1258274_6844.html, accessed August 26 2015.

of technologies. In this 'treated water', cesium, strontium and other radionuclides have been reduced by 90% plus. TEPCO processes around 7000 tons of this water each week. The radionuclides removed are contained in highly radioactive sludges; currently 597 tons are in storage.

The treated water has not had radioactive tritium removed; and the concentrations are significantly higher per liter than the previously-mentioned sub-drain water that is due to be released by TEPCO, with levels ranging to 97,000 Bq/l.[21]

There is no end in sight for the daily pumping of over 300 tons of cooling water into the Fukushima Daiichi reactors, which is directly linked to what options are finally deployed for managing the molten cores[22]. Plans for eventual core removal remain highly speculative. The result is that highly contaminated water will continue to accumulate at the site. The effectiveness of measures to reduce the inflow of groundwater into and under the site and its outflow to the Pacific Ocean will only become apparent over the coming months and years.

**Implications for future discharges**

The decision by the Fukushima Fisheries Cooperative to approve the discharge of contaminated sub-drain water is significant in radiological terms, but especially in terms of future options for TEPCO for the much larger challenge of the highly contaminated 'treated' cooling water. The highly contaminated water that remains in over 950 storage tanks is to be assessed for possible tritium removal, with three contractors planning test facilities to be demonstrated during the next 12-18 months. None of these technologies are guaranteed to be effective; and TEPCO has recently suggested the alternative of evaporation.[23] This latter option was used to treat the far smaller volume of contaminated water that arose from the Three Mile Island (TMI) nuclear reactor accident in 1979 – 8700 tons compared with the current 515,000 at Fukushima Daiichi.[24] The tritiated water at TMI was stored for ten years, with evaporation taking three years. Evaporation of the vast quantities of water at Fukushima Daiichi, even if feasible, would lead to radioactive fallout from air dispersal, both on land and into the Pacific Ocean.

It therefore remains most likely that the preferred option for TEPCO is eventual marine discharge into the Pacific Ocean. The Japanese Nuclear Regulation Authority, NRA[25], and the International Atomic Energy Agency, IAEA, have called for consideration of the discharge option.[26] NRA Chair Tanaka has expressed the view that, ***"I don't believe the technology is available for easy removal of tritium,"*** and that ***"The amount is not particularly mind-boggling from a global perspective. We can't help discharging water once it has cleared safety levels."***[27]

The IAEA has stated that, ***"further guidance on the application of international guidance for discharges in post-accident situations would be beneficial.***"[28]

All major parties – TEPCO, the NRA and the Japanese central and prefectural government – are aware that discharge of radioactive water into the Pacific Ocean remains one of the most controversial issues at the Fukushima Daiichi nuclear plant.

***To be clear, approval from the Fukushima Fisheries Cooperative for discharge of sub-drain water is explicitly NOT approval for the future release of highly contaminated water accumulated from the cooling of the Fukushima Daiichi reactors.***

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21 "Tritium levels reach new high at wrecked Fukushima nuclear plant," Reuters, September 12 2013, see at http://www.reuters.com/article/2013/09/12/us-japan-fukushima-radiation-idUSBRE98B0SH20130912, accessed August 25 2015.

22 For further information regarding the onsite water crisis and options for decommissioning, see "Japan's nuclear crisis: Fukushima Daiichi Status report", Greenpeace, February 2015, see at http://www.greenpeace.org/japan/Global/japan/pdf/Japan's_nuclear_crisis.pdf, accessed August 26 2015.

23 "Japan considers evaporation, storage of tritium-laced Fukushima water," Reuters, see at http://www.reuters.com/article/2015/04/08/us-japan-fukushima-water-idUSKBN0MZ0WC20150408, accessed August 26 2015.

24 "TMI-2 Tritiated Water Experience, Presented to the Tritiated Water Task Force of the Committee on Contaminated Water Countermeasures," Chuck Negin, 26 March 2014, see at http://www.meti.go.jp/earthquake/nuclear/pdf/140326/140326_01e.pdf, accessed August 25 2015.

25 "Fukushima Watch: Regulator Calls on Tepco to Discharge Tritium Water," January 21 2015, see at http://blogs.wsj.com/japanrealtime/2015/01/21/fukushima-watch-regulator-calls-on-tepco-to-discharge-tritium-water/, accessed August 25 2015.

26 "IAEA recommends discharging Fukushima radioactive water to the sea," Asahi, December 5,2013, see at http://ajw.asahi.com/article/0311disaster/fukushima/AJ201312050043, accessed August 25 2015.

27 "IAEA recommends discharging Fukushima radioactive water to the sea," Asahi, December 5 2013, see at http://ajw.asahi.com/article/0311disaster/fukushima/AJ201312050043, accessed August 25 2015.

28 See "The IAEA Fukushima Daiichi Accident Summary Report: A preliminary analysis", Jan Vande Putte, Kendra Ulrich, Shaun Burnie, Greenpeace Japan, May 28 2015, see at http://www.greenpeace.org/japan/Global/japan/pdf/IAEA%20analysis%20by%20GP%2020150528.pdf, accessed July 12 2015.

Future plans by TEPCO and the Japanese government to discharge radioactive water into the Pacific Ocean are a further example of their disregard for the public health of citizens in Japan and the protection of the marine environment. Together, with Fukushima citizens groups and the wider Japanese public, Greenpeace is opposed to the deliberate release of radioactive waste into the marine environment. The Fukushima Daiichi accident is already the single largest release of radioactivity into the marine environment in history, with routine 'accidental' releases continuing on a daily basis.[29] Further deliberate releases of radioactive contaminated water cannot be justified.

**FOR FURTHER INFORMATION**

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29 TEPCO estimated in 2013 that between 20 trillion and 40 trillion becquerels had been released into the Pacific, "Radioactive Water Leaks from Fukushima: What We Know", Livescience, August 13 2015, see at http://www.livescience.com/38844-fukushima-radioactive-water-leaks.html, accessed August 25 2015.