Opening the Floodgates at Fukushima Dai-ichi

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1. Introduction

Nearly 10 years after the Tohoku-oki earthquake and tsunami devastated Japan's Fukushima Dai-ichi Nuclear Power Plant (FDNPP), radioactivity levels in the ocean off FDNPP are 100,000s of times lower than at their peak in April 2011. Since mid-2015, none of the fish caught nearby exceed Japan's strict limit of 100 Bq/kg. However, enormous challenges remain in the decommissioning of the reactors and clean up on land. A future concern is the release of water from more than 1,000 tanks on the grounds of the power plant that are filling with ground water and cooling water that have become contaminated through contact with the reactors and their containment buildings.

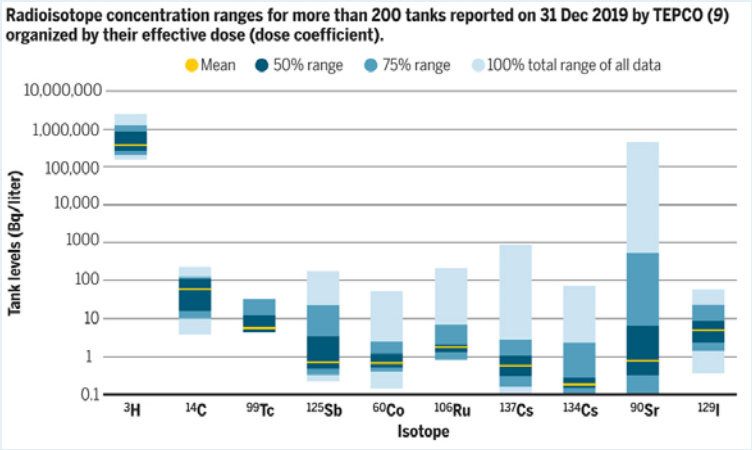
2. Current status of tanks

Large volume and increasing
- Over 1.2 million tons of contaminated water stored on site in tanks

Tritium is difficult to remove from tanks
- All nuclear power plants release tritium
- Relatively low health risk
- Ocean contains thousands of times more tritium from nuclear weapons testing, other NPPs and natural sources

Cleanup is not 100% effective for all radionuclides
- In 2018, ruthenium-106, strontium-90, technicium-99 and other radionuclides reported to be at levels of concern

3. What is in the tanks?

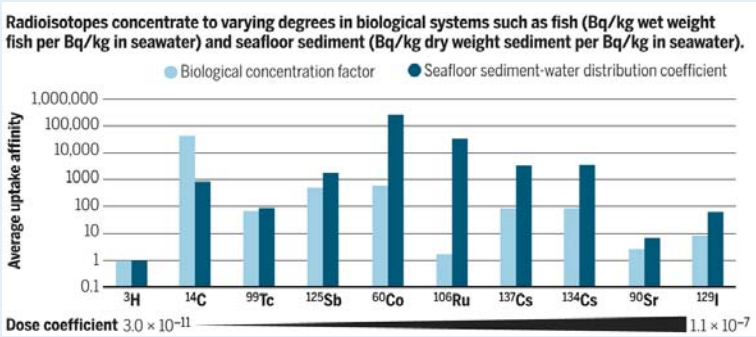


Results from TEPCO "Treated Water Portal Site"
https://www4.tepco.co.jp/en/decommission/progress/watertreatment/index-e.html

Radioactivity levels of tritium (^{3}H) in the tanks are the highest

Levels of non tritium isotopes are quite variable, and in some cases are above allowable limits

4. Different behavior in ocean



Behavior of other radionuclides differ from tritium in the ocean

Higher biological concentration factors than tritium
- potential fisheries concern

Higher sediment partitioning than tritium
- impacts fate off Japan coast

Higher biological health risks from non-tritium isotopes
- dose coefficients higher by more than 3 orders-of-magnitude

5. Conclusions

- Need additional clean up and independent tank by tank reporting before any releases
- Consider other possible radionuclides in cooling waters
- Clean up will take decades
  - reconsider storage as 97% tritium gone in 60 years
  - where and what are safe storage options?
- Any release would require pre/during/post release monitoring
  - would need to independently monitor seawater, seafloor sediments and marine biota not just for tritium, but wide suite of possible contaminants

Different isotopes pose different environmental and health risks

ISOTOPE	MAX RELEASE (BQ/LITER)[1]	FOOD LIMIT (BQ/KG)[2]	HALF-LIFE (YEARS)[3]
^{3}H	60,000	10,000	12.35
^{14}C	2000	10,000	5730
^{99}Tc	1000	10,000	211,000
^{125}Sb	800	1000	2.77
^{60}Co	200	1000	5.27
^{106}Ru	100	100	1.01
^{137}Cs	90	100	30.0
^{134}Cs	60	100	2.06
^{90}Sr	30	100	29.1
^{129}I	9	100	16,000,000

1. Maximum levels allowed in Japan for waters released from NPPs
2. Limits allowed for food safety (CODEX, adult)
3. Half-live is time for 50% of an isotope to decay

More details and references can be found in:

Science
Opening the floodgates at Fukushima
Tritium is not the only radioisotope of concern for stored contaminated water
Ken O. Buesseler Science August 2020;369:621-622

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