Notes on a Radiation Control Report regarding Pilgrim Nuclear Power Station

Ken Buesseler, Woods Hole Oceanographic Institution

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The Massachusetts Department of Public Health released a report this week with results from the analyses of tritium and a set of four radioactive isotopes known as gamma-emitters in the untreated water stored in three locations at the Pilgrim Nuclear Power Station (PNPS). Results from Holtec and Mass. state labs agreed and were reported "as anticipated", presumably referring to nuclear plants in general.

This is the first set of data on the contents of wastewater stored at PNPS and provides the scale of the problem at hand for the 1 million gallons Holtec proposes to release, noting that they claim that water actually released would have lower levels after clean up. How low is a question that remains to be answered, and the reasons why these issues are important is summarized below.

Levels in these untreated waters are very high, whether with respect to drinking water standards, what is already in Cape Cod Bay as a result of nuclear testing in the 1950s and 60s, or in comparison to the contents of waste tanks at Fukushima in Japan.More specifically, compared to US drinking water standards (these vary by country), tritium in the wastewater is 150 times higher than maximum allowed by US drinking water standards and cesium-137 is 40,000 times higher. Note: No one drinks seawater, this is only for comparison.

Compared to background levels of radiation found in Cape Cod Bay, tritium levels in the untreated wastewater are one million times higher and cesium-137 is 200 million times higher. This reinforces water should not be released prior to extensive clean up.

Removing 99% of cesium-137 would still result in water with 2 million times more of this isotope than is currently found in seawater and 400 times more than what is allowed by US drinking water standards. Removal, or clean-up will never be 100% effective.

Once in the ocean, each radionuclide follows its own path, driven by its particular chemistry. Cesium, for example is 100 times more likely to end up in fish than tritium, and Cobalt-60 is 700 times more likely.

Cesium is also 4,000 times more likely and cobalt 300,000 times more likely to accumulate in seafloor sediments than tritium.

Tritium, because it contains an isotope of hydrogen, is intrinsically a part of seawater and so is extremely difficult to remove but does generally move with the ocean currents. However, some of the tritium would be found as organically bound tritium (OBT)—about 10% of total tritium, according to some studies—and would be more likely to accumulate.

The bioaccumulation (K_{bio}) and sediment accumulation (K_d) factors described above are not exact numbers and vary according to fish species (age, type, etc) and type of seafloor (muddy, sandy, etc.).

In general terms, this means that to varying degrees, some fraction of the isotopes identified in this analysis would likely not move significantly beyond the outfall point, but would accumulate nearby in sediments and over time in fish and other marine biota.

The last line of the report is important and states that post clean-up, additional detailed analyses of "difficult to detect radionuclides" (e.g. carbon-14, strontium-89 and -90, and transuranic elements) would be required. Note: Plutonium is a transuranic of concern and an alpha-emitter. Strontium-90 is a beta-emitter and a bone-seeking isotope. This report, however, only looked for gamma-emitters and tritium.

The waste currently stored in 1,000 tanks at Fukushima is 350 times the volume of that stored at PNPS and has roughly the same concentration levels of tritium (about four times higher than at PNPS). The big difference is that cesium-137 and other radionuclides identified so far are many 1,000's to 100,000's times higher at PNPS than in the tanks at Fukushima, mainly because wastewater in Japan has been treated, sometimes repeatedly. It is possible to obtain lower concentrations (although not for tritium, and it is more difficult for some isotopes than others), but after 12 years, more than 70% of the tanks in Japan are still above their very strict regulatory limits.

Bottom line: This data shows us the extent of the problem presented by the waste stored at the PNPS. Extensive cleanup of this waste is still needed and I would hope after that has been completed, the wastewater would be re-analyzed, with independent labs, and using more sensitive methods to make a more complete analysis of additional radioactive elements of concern not covered in this report, particularly the alpha- and beta-emitters. At that point, a new plan could be evaluated based upon those results that would be part of a more complete radiological impact assessment (RIA). Such an RIA would need to consider not just doses, but the fate of those different radionuclides in the ocean, with their biological and sediment accumulation differences accounted for. Monitoring with appropriate methods for tritium and non-tritium radionuclides in the ocean seawater, seafloor and biota would be important before, during, and after releases to ensure the health and safety of the ocean and marine life and to address public concerns, even if levels of these isotopes are low.

The data generated by Irina Rypina and colleagues on ocean currents funded by WHOI Sea Grant is a critical first step to evaluate ocean currents and pathways, but these pathways do not represent the fate of the different radionuclides that we know are present and that depend on their individual chemistries.