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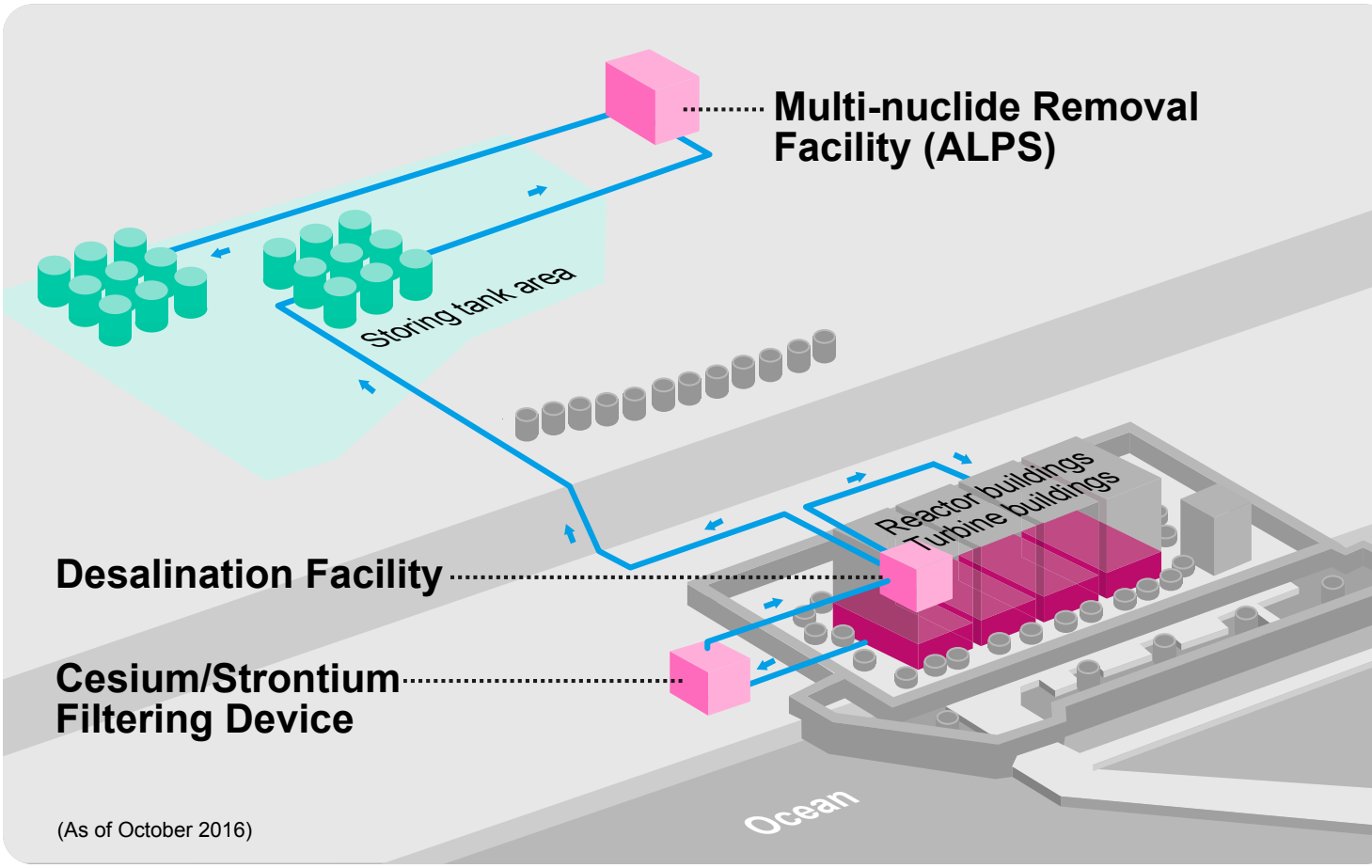
Advanced liquid waste processing systems

Safely processing Fukushima's wastewater

By John Fabian

The Tokyo Electric Power Company (TEPCO) became a household name a decade ago as the operator of the Fukushima Daiichi nuclear power plant, center of the largest nuclear accident in a generation. Now in 2021, as a result of the continuous mitigation efforts, TEPCO is currently storing 1.2 million cubic meters of treated wastewater—and counting—in more than 1,000 large storage tanks on site. This wastewater has been in the spotlight for the past few years since current projections show that storage capacity will run out by 2022. That spotlight intensified last year when a panel of experts from Japan named the Subcommittee on Handling of the ALPS-Treated Water (ALPS Subcommittee) recommended to the Japanese government that the treated wastewater should be released into the ocean. The ALPS Subcommittee's report states, "The topic of how to handle the treated water is one of the most important decommissioning tasks, which has been discussed since 2013." This issue has plagued the decommissioning and decontamination efforts for the past decade for one simple reason: a failure to effectively communicate about the low risk involved with processing, diluting, and discharging the water over a period of several years.



A depiction of the multiple water treatment facilities on the Fukushima Daiichi site. Image: TEPCO

Background on water treatment at Fukushima

Over the years since the Fukushima accident, TEPCO has had to manage millions of tons of water either from groundwater accumulating in buildings or from the coolant water continuously injected into the three damaged cores. The water requires constant processing to remove contaminants like cesium and strontium, along with other radioactive nuclides. To complete this process, TEPCO uses several water treatment systems: initial cesium removal systems named Kurion and SARRY, which remove 99.99 percent of cesium, followed by a desalination system that purifies the water to be reused as coolant. The waste from the desalination process is then moved to storage tanks to be processed by the advanced liquid waste processing system (ALPS).

These advanced systems remove 62 radionuclides such as cesium-134, cesium-137, strontium-90, and iodine-129 from the highly radioactive water. The process is so effective that the levels of these radionuclides in the water are well below the current international regulatory standards.

Although the ALPS process removes most of the dangerous isotopes, it cannot remove one: tritium. However, tritium is "considered one the of the least harmful radionuclides," according to the Health Physics Society (HPS). Tritium does produce ionizing radiation as it decays, but the beta particle that is emitted has a very low energy. The HPS fact sheet on tritium states that the beta particles from the hydrogen isotope "can only travel about 6 millimeters (mm) in air. . . . In human tissue, tritium's beta particle cannot penetrate the typical thickness of the dead layer of skin."

Tritium levels in the treated storage tank water, according to TEPCO, are at levels higher than regulatory limits allow. However, it is common practice by nuclear power plants all over the world to sufficiently dilute and discharge tritiated water into the environment over a period of time under the strict supervision of regulatory bodies.

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Construction of the ALPS processing facility on the Fukushima Daiichi site in 2013. Photo: TEPCO

ANS member and study director of the ANS Special Committee on the Fukushima Daiichi accident Paul Dickman said that the level of radioactivity is a lot, but "the United States discharges almost double that amount from our nuclear reactor fleet every year, and South Korea annually discharges an amount equal to about 40 percent of the stored tritium at Fukushima."

James Conca, an ANS member with a background in geology and radionuclide chemistry and a contributor to *Forbes* and *Nuclear News*, wrote in an article following the issuance of the subcommittee report that "putting this water into the ocean is without doubt the best way to get rid of it. Concentrating it and [storing] it actually causes more of a potential hazard to people and the environment."

What's the holdup?

If the water treatment processes lower to well below international regulatory standards the levels of the very dangerous and long-lived radionuclides, leaving only tritium behind (which has been effectively managed since the beginning of nuclear power generation), then why is this still an issue? According to Dickman, the issue stems from a failure to communicate to the general public in understandable language during the early stages of the Fukushima accident. He says, "The legacy of that communications failure remains today and hampers decommissioning operations at the Fukushima site." The problem was exacerbated by the torrent of misinformation that was propagated by social media and the insatiable demand for immediate and constant updates by the mainstream media.

Since the early days of the accident, TEPCO and the Japanese government have tried to reassure the public that release of tritiated water will not increase the risk of radiation exposure to the public. TEPCO has since set up an online water management portal to update and inform members of the public, and the Japanese government convened the ALPS Subcommittee to review the best ways to dispose of the treated wastewater in a safe manner and how to restore the faith of the public by dealing with "the problem of reputational damage."

The ALPS Subcommittee report recommends to the Japanese government first to re-treat the water as an extra safety step and then to gradually dilute and release it into the ocean over a period of several years. The report states that this is consistent with international law and current regulatory standards in Japan set prior to the March 2011 accident. The report also notes that if the current recommendations are followed, the release of re-treated water into the ocean will be no more than one one-thousandth of a percent of the exposure to natural radiation per year for a member of the public.

These steps taken by TEPCO and the Japanese government have not held back the antinuclear media frenzy. A steady stream of stories quote mainly from antinuclear groups and state that discharging water will "alter human DNA." These stories have latched on to the idea that carbon-14, a long-lived but low-energy beta emitter, would be released into the oceans. TEPCO has shown in its testing, however, that the levels of C-14 are far lower than current regulatory limits. According to the TEPCO water treatment portal, "The average concentration of C-14 in storage tanks for treated water (tanks analyzed as of the end of June 2020) is 42.4 Bq/liter, which falls below the government's regulatory standard of 2,000 Bq/liter." The range of values in samples was 2.53 Bq/liter to 215 Bq/liter—that is, even the highest concentration in a sample was barely one-tenth of the regulatory limit.

On top of this, adding that TEPCO plans to re-treat and then dilute the wastewater prior to discharging it over a period of several years ensures that levels of any radionuclides will be well below background radiation levels already present in the ocean. The safest option for dealing with Fukushima's wastewater problem is clear: continue with the recommendations from the ALPS Subcommittee (and many other professionals and nongovernmental organizations) to re-treat, dilute, and discharge the treated wastewater.

John Fabian (jfabian@ans.org) is publications director for the American Nuclear Society.

Further reading

This article was written using the following sources, which contain a wealth of additional information related to the Fukushima wastewater situation and its solution. All URLs are current as of the time of writing.

- "Treated Water Portal Site," Tokyo Electric Power Company; https://www4.tepco.co.jp/en/decommission/progress/watertreatment/index-e.html.
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- "Radiation Concentration Estimates for Each Tank Area (as of September 30, 2020)," Tokyo Electric Power Company; https://www4.tepco.co.jp/en/decommission/progress/watertreatment/images/tankarea_en.pdf.
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- T. Y. Kong et al., "Radioactive Effluents Released from Korean Nuclear Power Plants and the Resulting Radiation Doses to Members of the Public," *Nucl. Eng. Technol.*, Vol. 49, Issue 8, p. 1772 (December 2017); doi.org/10.1016/j.net.2017.07.021.
- J. Conca, "Japan's Expert Panel Agrees that Dumping Radioactive Water Into the Ocean is Best," *Forbes* (Feb. 1, 2020), forbes.com/sites/jamesconca/2020/02/01/japans-expert-panel-agrees-that-dumping-radioactive-water-into-the-ocean-is-best/?sh=1b86fcb9200c.
- "Health Physics Society Fact Sheet: Tritium," adopted March 2011, revised January 2020; hps.org/documents/tritium_fact_sheet.pdf.
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