NEW YORK STATE Department of Public Service

Three Empire State Plaza, Albany, NY 12223-1350
www.dps.ny.gov

June 15, 2023

VIA EMAIL

Hon. Michelle L. Phillips
Secretary to the Commission
3 Empire State Plaza
Albany, NY 12223-1350

Re: Matter No. 21-01188 – In the Matter of the Indian Point Closure Task Force and Indian Point Decommissioning Oversight Board.

Dear Secretary Phillips:

Please accept for filing in the above-captioned matter, independent technical expert Dave Lochbaum's June 15, 2023 Indian Point Decommissioning Oversight Board meeting presentation regarding a water removal options analysis. Should you have any questions regarding this filing, please contact me. Thank you.

Respectfully submitted,

Tom Kaczmarek
Executive Director
Indian Point Closure Task Force
Indian Point Decommissioning Oversight Board

Handling of Tritiated Water

Dave Lochbaum

June 15, 2023

Purpose

This report documents research evaluating the longstanding practice for disposing of radioactively contaminated water from Indian Point and one alternative.

The approach identified risk factors for the options and assessed the methods used to manage the risks to determine which option yields the lowest risk to the public.

Peer Reviews

This report was peer reviewed by the following individuals:

Anonymous Person: Retired from the NRC after nearly 15 years as an inspector and operator license examiner. 22 years of experience in private nuclear industry following service in the U.S. Navy before joining the NRC.

Paul M. Blanch: Energy Consultant (1993 to date) advising managers at Millstone, Maine Yankee, and Indian Point on employee concerns programs and safety conscious work environment issues. Northeast Utilities (1972-1993) as Supervisor of Electrical Engineering during construction and operation of Millstone Units 2 and 3. U.S. Navy (1963-1971) aboard the nuclear submarine Patrick Henry.

Jeff Mitman: Retired from the NRC in 2021 as a Senior Reliability and Risk Analyst. Project Manager for the Electric Power Research Institute (1992-2003) responsible for outage risk management in-service inspection, and spent fuel cask risk analysis. Startup test engineer for General Electric Nuclear Power (1980-1990) in construction, startup testing, and operations. Bachelor of Science in Nuclear Engineering from the University of Michigan.

Peer Reviews

The following individuals were also invited to peer review the presentation but did not do so:

Arnold Gundersen: Chief Engineer for Fairewinds Associates and author/advocate on many nuclear safety issues, including the leakage of tritium and other radionuclides from the then-operating Vermont Yankee nuclear plant.

Lucas Hixson: Researcher who has collected and analyzed samples from radioactively contaminated sites such as outside St. Louis, near Chernobyl, and near Fukushima.

Marvin Resnikoff: Senior Associate at Radioactive Waste Management Associates working on nuclear waste issues since involvement in the West Valley, New York proceeding in 1974.

This presentation benefited from the peer reviews and appreciate the time devoted pro bono to the reviews. The peer reviewers written comments are attached to this presentation.

The alternative assessed for this report is storage of the treated water in onsite tanks because it is the option most often proposed.

Other alternatives previously assessed:

Evaporation: Water contaminated by the TMI accident was treated and evaporated; NCRP estimated the public dose was 300 times higher than had the water been treated and discharged into the Susquehanna River.

Transport offsite: Contaminated water from Vermont Yankee is slated for transport, via exemptions from safety regulations, to Idaho for burial.

Removing tritium from water: Various methods are used to removed tritium from heavy water; methods for light water removal are more complex and costly

Vitrification: France buries vitrifies tritium and buries the glass-like product, experiencing tritium leaching from the buried material.

Ocean dumping: International treaties and federal law prohibits dumping.

Onsite injection well(s): EPA banned injection of radioactively contaminated water in 1984 due to various problems.

Peer reviewer Paul Blanch proposed another alternative – the retention of a spent fuel pool to comply with 10 CFR 72.122(l) regarding retrievability of spent fuel in dry casks.

I disagree with Paul for reasons including:

- **NRC clarified in writing that "retrievability" meant a canister loaded with spent fuel assemblies, not individual spent fuel assemblies in a canister.**
- **There's more water than can be stored in the Unit 2 and 3 spent fuel pools, even if both retained. So, other means are needed to handle the additional water, so those means can handle all the water, too.**
- **Indian Point is being decommissioned. Keeping one or two spent fuel pools available lengthens the decommissioning schedule and lessens the funds available to complete the cleanup.**
- **Most importantly, the primary reason for returning a loaded canister to a spent fuel pool would be degradation of the canister requiring re-packaging. The transfer of a loaded canister from pool to ISFSI pad is backed by safety studies showing that even if a loaded canister is dropped en route, it will not be breached. But zero studies have been performed, yet alone showing, that a degraded loaded canister if dropped on its way back to a pool won't crack open and release large amounts of radioactivity to the environment.**

Sources of radioactively contaminated water:

Unit 2 Spent Fuel Pool	**310,000 gallons***
Unit 2 Refueling Water Storage Tank	**360,000 gallons***
Unit 3 Spent Fuel Pool	**310,000 gallons***
Unit 3 Reactor Cavity	**360,000 gallons***
Total:	**1,340,000 gallons***

All of this water will be processed by the Unit 1/Unit 2 Integrated Liquid Waste Processing System. The Unit 3 Liquid Radwaste Processing System skid was removed for installation of the Hi-Lift Device. Water will be transferred between the units in tanker trucks.#

Sources:
*** Holtec International, "Decommissioning Oversight Board," April 27, 2023, slide 15.**
 # Holtec Decommissioning International, "2022 Annual Radioactive Effluent Release Report," April 28, 2023, page 9. (ADAMS ML23118A070)

Tentative contaminated water release dates:

Unit 2 Spent Fuel Pool	**September 2023**
Unit 2 Reactor Cavity	**August 2025**
Unit 3 Spent Fuel Pool	**June 2024**
Unit 3 Reactor Cavity	**April 2024**

NOTE: The water from the Unit 2 Refueling Water Storage Tank will be used to flood the Unit 2 reactor cavity to support segmentation of the Unit 2 reactor vessel. The water serves multiple functions including shielding workers from radiation emitted from the irradiated reactor vessel and suppression of radioactive particles created by the underwater segmentation process. After performing this role, the reactor cavity water, like the spent fuel pool water, will be processed by the liquid waste system for either discharge or storage.

Source: Holtec International, "Decommissioning Oversight Board," April 27, 2023, slide 15.

The water will be processed through filters and demineralizers to lessen its radioactivity:

Radionuclide	Before Microcuries/ml	After Microcuries/ml	Percent Removed
Cobalt-60	4.50E-07	0.00	100.0%
Cesium-137	2.18E-03	1.74E-06	99.9%
Krypton-85	9.85E-05	2.06E-05	79.1%
Tritium	4.47E-04	4.47E-04	0.0%
Strontium-90	1.53E-06	0.00	100.0%
Nickel-63	2.77E-06	0.00	100.0%

This data from the Unit 1 spent fuel pool disposal campaign shows that processing does not remove tritium from the water.

In the Unit 1 case, over 80% of the radioactivity was removed from the water by the processing.

There are less than 400 curies of tritium in the water to be processed from Units 2 and 3.*

Source: * Holtec International, "Decommissioning Oversight Board," April 27, 2023, slide 15.

Year	Fission and Activation Products	Tritium	Dissolved and Entrained Gases	Gross Alpha	Total Curies	Tritium Percentage of Release
Year	Curies	Curies	Curies	Curies	Curies	%
2005	0.075	1272.000	0.075	0.000	1272.150	**99.99%**
2006	0.059	1558.000	0.382	0.000	1558.441	**99.97%**
2007	0.054	1468.000	0.040	0.000	1468.094	**99.99%**
2008	0.069	667.021	0.038	0.000	667.127	**99.98%**
2009	0.063	1859.000	0.009	0.000	1859.071	**100.00%**
2010	0.067	1390.000	0.001	0.000	1390.067	**100.00%**
2011	0.056	1907.000	0.025	0.000	1907.081	**100.00%**
2012	0.047	1989.000	0.002	0.000	1989.050	**100.00%**
2013	0.076	2045.000	0.003	0.000	2045.079	**100.00%**
2014	0.040	640.000	0.000	0.000	640.041	**99.99%**
2015	0.077	1972.000	0.012	0.000	1972.089	**100.00%**
2016	0.138	1083.000	0.000	0.000	1083.138	**99.99%**
2017	0.080	1422.000	0.004	0.000	1422.084	**99.99%**
2018	0.090	1358.000	0.001	0.000	1358.090	**99.99%**
2019	0.039	832.000	0.001	0.000	832.040	**100.00%**
2020	0.042	1389.000	0.000	0.000	1389.042	**100.00%**
2021	0.105	867.550	0.005	0.000	867.660	**99.99%**
2005-2021 Average	**0.069**	**1395.210**	**0.035**	**0.000**	**1395.314**	**99.99%**

The Unit 1 spent fuel pool discharge case was the rule rather than its exception. Processing consistently proved effective in removing nearly all of the radioactivity, except tritium, from water discharged to the river.

Any leaks or spills of tritiated water during processing would be retained within the building housing the equipment as happened in the May 2022 holdup tank overflow event.* If any water managed to get out of the building, it would be detected by one or more of the many monitoring wells circling the buildings.

Any evaporated water would be exhausted via pathways monitored for radioactivity. #

Source: * U.S. Nuclear Regulatory Commission, Inspection Report, March 13, 2023, enclosure page 3. (ADAMS ML23047A154)
Note: # Tritium emits a low-energy beta particle "invisible" to detectors like the Reuter-Stokes monitors deployed around the site. Until the processing is completed and most radionuclides removed, the evaporated water will likely contain gamma emitters which are detectable.

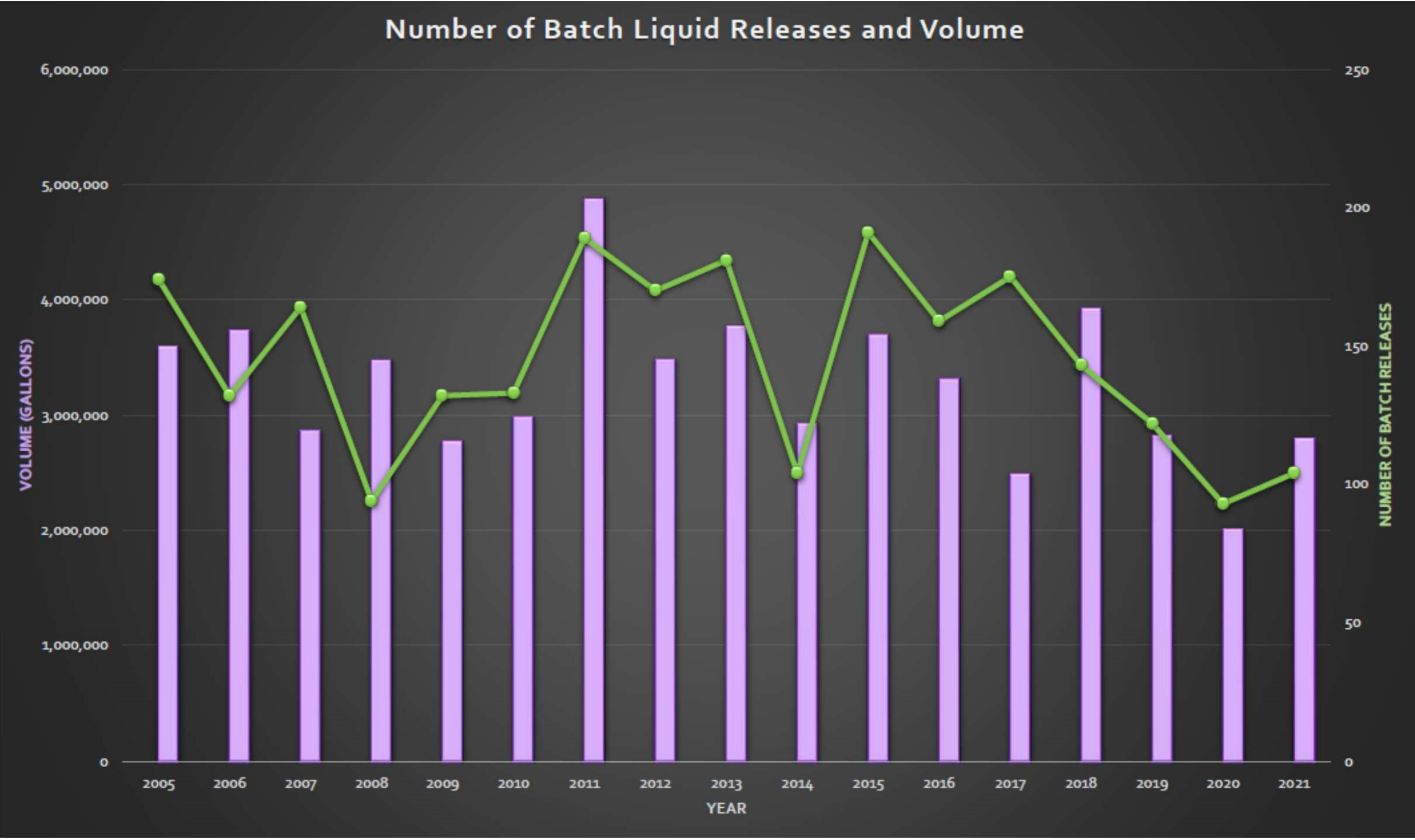
After processing, the water is collected in a tank holding about 18,000 gallons. Water is recirculated through the tank to achieve uniform mixing, and then sampled to determine if its isotopic contents are suitable for discharge to the river.

Water from the tank is pumped at a rate of 150 gallons per minute into the discharge canal where it mixes with dilution flow of at least 80,000 gallons per minute before entering the Hudson River.

It takes about 120 minutes for nearly 18,000 gallons to be discharged. In that time, the dilution flow will be approximately 9,600,000 gallons.

An average of over 100 batches were discharged annually between 2005 and 2021.

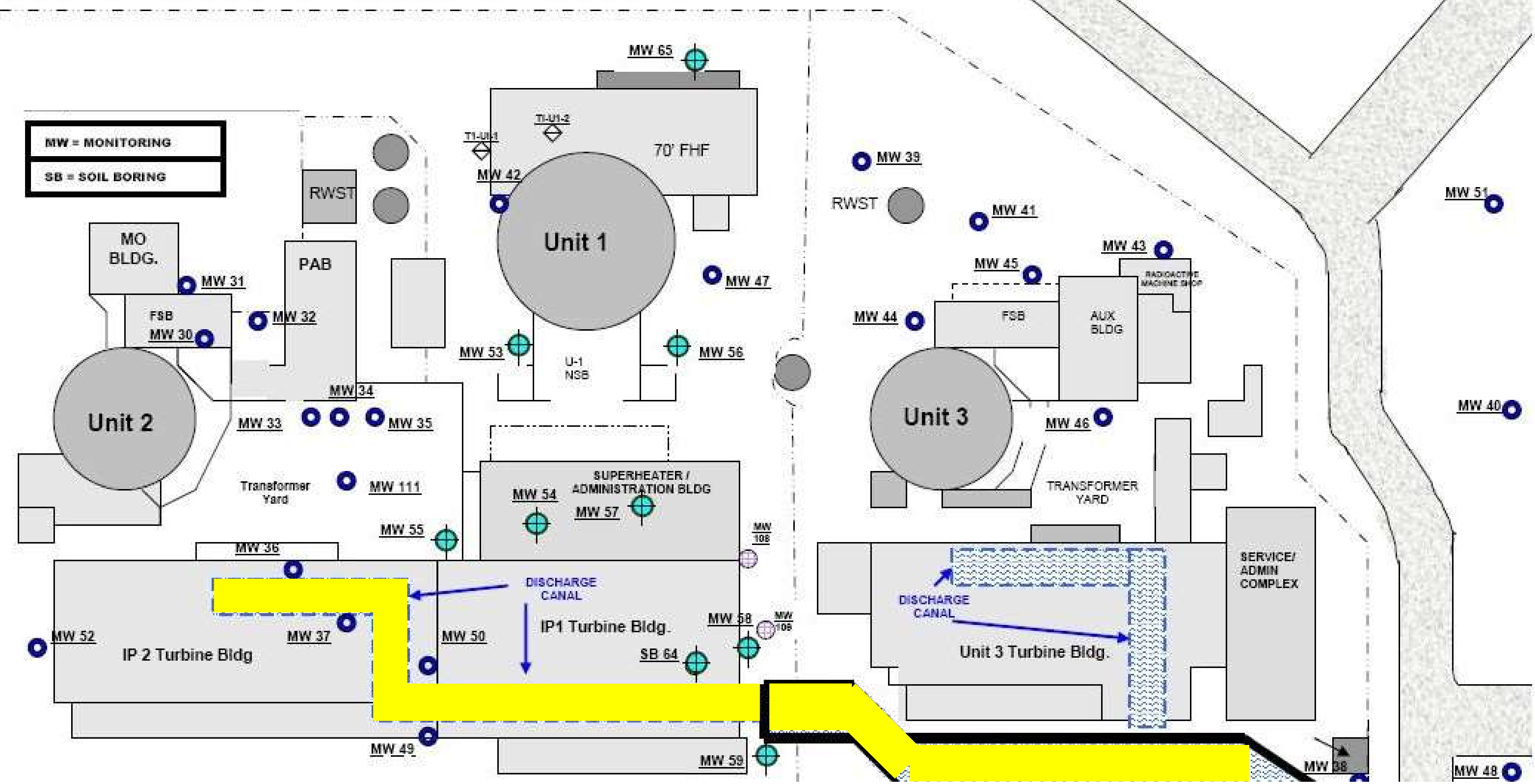
Source: * Holtec International, "Decommissioning Oversight Board," April 27, 2023, slide 15.



1,340,000 gallons / 18,000 gallons per batch = 74.44 batches, less than the number of batches discharged annually between 2005 and 2021.

Source: U.S. Nuclear Regulatory Commission, "NRC Oversight of Nuclear Plant Effluent Releases," April 27, 2023, slide 8.

The dilution flow is provided by one of the Circulating Water pumps, each capable of supplying at least 80,000 gallons per minute to the discharge canal.



Sampling of the tank to be discharged is used to establish the setpoint of a radiation monitor in the release pathway. If radioactivity above that setpoint is detected, the release is stopped.

	Tritium	Volume of Dilution Water	Tritium Concentration
	Curies	Liters	Picocuries/liter
2005	1,272	2,780,074,982,160	457.6
2006	1,558	2,790,075,251,880	558.6
2007	1,468	2,790,075,251,880	526.2
2008	667	2,840,076,600,480	234.9
2009	1,859	2,750,074,173,000	676.0
2010	1,390	2,710,073,094,120	512.9
2011	1,907	2,800,075,521,600	681.1
2012	1,989	2,840,076,600,480	700.4
2013	2,045	2,810,075,791,320	727.8
2014	640	2,800,075,521,600	228.6
2015	1,972	2,850,076,870,200	691.9
2016	1,083	2,690,072,554,680	402.6
2017	1,422	2,940,079,297,680	483.7
2018	1,358	3,020,081,455,440	449.7
2019	832	3,050,082,264,600	272.8
2020	1,389	2,000,000,000,000	694.5

Average - 518.7

By diluting the tritiated water with dilution flow (lots of dilution flow), the average tritium concentration of water discharged to the Hudson River from Indian Point between 2005 and 2020 inclusive was 518.7 picocuries per liter.

These concentrations are based on the contents of the tank and the dilution flow and do not take credit for additional dilution by mixing with the Hudson River, which has a flow rate of up to 80,000,000 gallons per minute.*

Source: * Entergy, "Indian Point Unit 3 Updated Final Safety Analysis Report," Rev. 7, 2017, Chapter 2, page 1 (ADAMS ML17299A164).

Onsite Storage Option

Some advocate that the processed water should be stored onsite to allow decay of tritium before being discharged.

How Many Tanks?

Assume 1,340,000 gallons to store

Size of Tank, gallons	Number of Tanks Required
1,340,000	1
670,000	2
268,000	5
134,000	10
67,000	20
53,600	25
33,500	40
26,800	50
22,333	60

Indian Point Energy Center

Units 1, 2, and 3

OFFSITE DOSE CALCULATION MANUAL

(ODCM)

Rev. 6

WRITTEN BY:	John Doroski	04/12/2021 (date)
REVIEWED BY:		4/20/2021 (date)
OSRC REVIEW:	OSRC 21-06	4/14/21 (date)
APPROVED BY:		4/21/2021 (date)
EFFECTIVE DATE:	04/29/2021	

D 3.1.4 Liquid Holdup Tanks

DLCO 3.1.4 Radioactive liquid contained in unprotected outdoor liquid storage tanks shall be limited to ≤ 10 Curies, excluding tritium and dissolved or entrained gases.

APPLICABILITY: At all times.

Safety requirements do not allow more than 10 curies of water to be stored in "unprotected outdoor liquid storage tanks" *unless* those curies are tritium.

So, all 400 curies of tritiated water could be stored in a single very large tank or in several smaller tanks.

Source: Indian Point Energy Center Units 1, 2 and 3, "Offsite Dose Calculation Manual (ODCM) Rev. 6," enclosure 2 to Holtec letter dated July 1, 2022. (ADAMS ML22182A076)

D 3.1.4 Liquid Holdup Tanks

BASES

The tanks listed in this Specification include outdoor tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. These tanks include the following:

a. Refueling Water Storage Tanks
b. Primary Water Storage Tanks
c. 13 Waste Distillate Storage Tank
d. 14 Waste Distillate Storage Tank
e. 31 Monitor Tank
f. 32 Monitor Tank
g. Unit 3 CPF High Total Dissolved Solids Tank
h. Unit 3 CPF Low Total Dissolved Solids Tank
i. Any Outside Temporary Tank

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that, in the event of an uncontrolled release of any such tank's contents, the resulting concentration would be less than the limits of 10 CFR 20 at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

Limiting a tank without a surrounding liner, dike, or wall and without drains to the liquid radwaste treatment system to 10 curies is intended to satisfy federal limits if water leaks or spills from unprotected tanks.

Since the limit does *not* apply to tritiated water, protection against leaked or spilled water reverts to *not* having leaks or spills.

Source: Indian Point Energy Center Units 1, 2 and 3, "Offsite Dose Calculation Manual (ODCM) Rev. 6," enclosure 2 to Holtec letter dated July 1, 2022. (ADAMS ML22182A076)

What are the Tank Risks?

Assume 99% chance of a tank NOT failing

Number of Tanks	Probability of Failure
1	1.0%
2	2.0%
5	4.9%
10	9.6%
20	18.2%
40	33.1%
50	39.5%

The odds that at least one of ten storage tanks fails is about ten percent.

If treating and discharging water to the river cannot be trusted, can tritium tanks be trusted NOT to leak?

What are the Tank Risks?

Risk = Probability x Consequences*

Tanks	Failure Probability	Tank Size, gallons	Risk, gallons
1	1.0%	1,340,000	13,400
2	2.0%	670,000	13,333
5	4.9%	268,000	13,135
10	9.6%	134,000	12,813
20	18.2%	67,000	12,200
40	33.1%	33,500	11,089
50	39.5%	26,800	10,586

*** Consequences are worst-case release of entire contents.**

The worst-case risks are nearly the same; fewer tanks have less chance of catastrophic failure, but larger releases when failure happens.

What are the Tank Risks?

Worst-case is least likely probability.
What's the history of storage tanks leaking?

Site	No. of Tanks	No. of Leaks	% Leakers
Hanford[1]	149	57	38.26%
Hanford[2]	28	1	3.57%
Fukushima[3]	305	6	1.97%

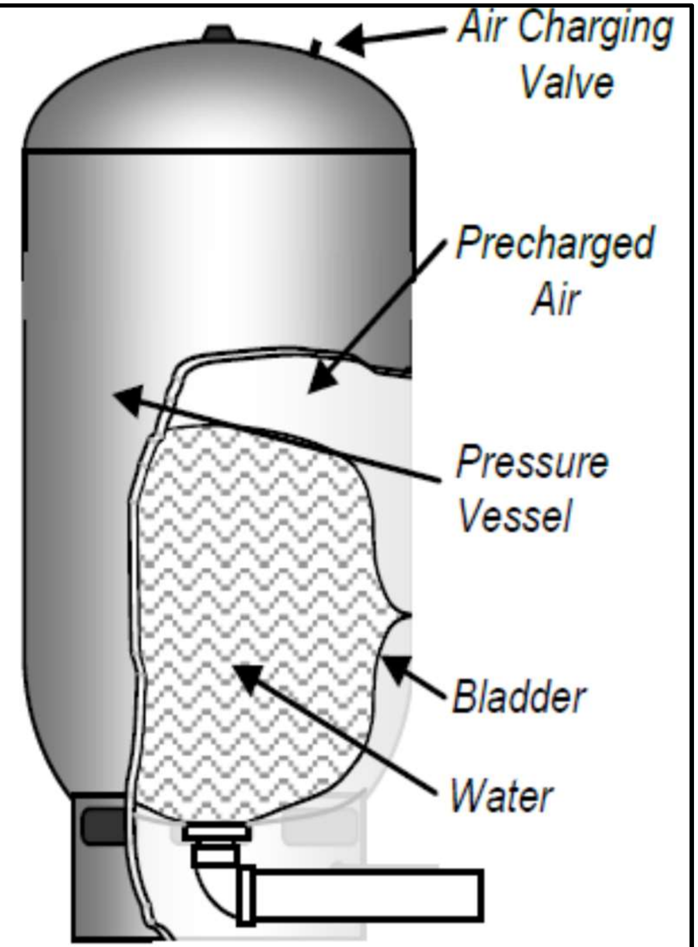
NOTE: Six tanks leaked at Fukushima after only 30 months of storage, at most.
NOTE: "Initiating event frequencies" are available in the nuclear industry for fires, pipe breaks, etc., but NOT for storage tank leaks.

[1] Pacific Northwest Nuclear Laboratory, Single-shell Tank Dashboard, January 31, 2023. https://phoenix.pnnl.gov/phoenix/apps/tankfarm/index.html
[2] Pacific Northwest Nuclear Laboratory, Double-shell Tank Dashboard, January 31, 2023. https://phoenix.pnnl.gov/phoenix/apps/tankfarm/index.html
[3] Nuclear Regulation Authority, September 5, 2013. (ADAMS ML14083A201)

Date	Reactor (State)	Description of Leak
07/20/1976	Vermont Yankee (VT)	Approximately 83,000 gallons of radioactively contaminated water overflowed the condensate storage tank into the storm drain system to the Connecticut River over a two-day period.
09/28/1979	Turkey Point (FL)	Approximately 3,000 gallons of radioactively contaminated water overflowed the refueling water storage tank and spilled onto the ground.
06/25/1987	Haddam Neck (CT)	An estimated 140,000 gallons of radioactively contaminated water leaked into the discharge canal after a truck struck the Primary Water Storage Tank.
08/19/1995	St. Lucie (FL)	Approximately 11,250 gallons of radioactively contaminated water overflowed the primary water tank onto the ground and into storm drains.
12/26/2007	Edwin I. Hatch (GA)	An estimated 5,700 gallons of radioactively contaminated water leaked into the ground when recently installed piping to underground collection tank 1Y22N008A became separated. A sample of water from the leak had tritium concentrations of 24,900 picocuries per liter.
01/05/2008	Browns Ferry (AL)	The condensate storage tank overflowed due to failed tank level instrumentation.

This is a *very* abridged list of problems at U.S. nuclear plants getting contaminated water into outside storage tanks and then keeping it there. Real leaks really happen.

What About Leak Prevention?



Bladder Pressure Tank

What about bladders within water storage tanks to protect against leakage? A bladder is like a balloon that expands as water fills it. The bladder <u>and</u> the tank must both fail for water to leak out.

What About Leak Prevention?

Washington State Department of
Health
Environmental Public Health
Office of Drinking Water

DOH 331-342
Sept. 2017
Revised

Drinking Water Tech Tips

Troubleshooting Bladder Pressure Tanks

What is a bladder pressure tank?

It is a type of tank containing pressurized air and water separated by a membrane (bladder) and pre-charged with air at the factory. On average, a bladder pressure tank lasts 5–7 years.

Bladders are not immortal. They fail in a relatively short period of time.

Source: Washington State Department of Health, DOH-331-342, "Troubleshooting Bladder Pressure Tanks," September 2017.

What About Leak Prevention?

"*The [Unit 2] primary water storage tank (PWST) was originally equipped with a rubberized bladder to separate the surface of the stored water from the atmosphere. … As reported previously, the bladder was found to be torn beyond repair and removed. Operation of the PWST without the bladder has been found to be acceptable.*" #

"*This change involved the removal of the bladder in the [Unit 2 Condensate Storage Tank] CST and … replacing the tank vent with redundant breather valves which were designed and tested to preclude explosion and implosion of the CST.*" *

Some water storage tanks at Indian Point had – repeat had – bladders installed within them. The bladders were removed after they failed.

Sources:
 # Consolidated Edison Company, "1992 10 CFR §50.59(b) Report for Indian Point Unit No. 2," June 30, 1993. (ADAMS ML100430414)
*** Consolidated Edison Company, "1993 10 CFR §50.59(b) Report for Indian Point Unit No. 2," June 28, 1994. (ADAMS ML100430493)**

Where Would the Tank(s) be Located?

If installing the storage tank(s) within the potential impact radius of the natural gas pipelines is not feasible, the storage tank(s) would seem to have to be installed at the northern end of the property beside the Independent Spent Fuel Storage Installation or far south of the pipelines and plant structures.

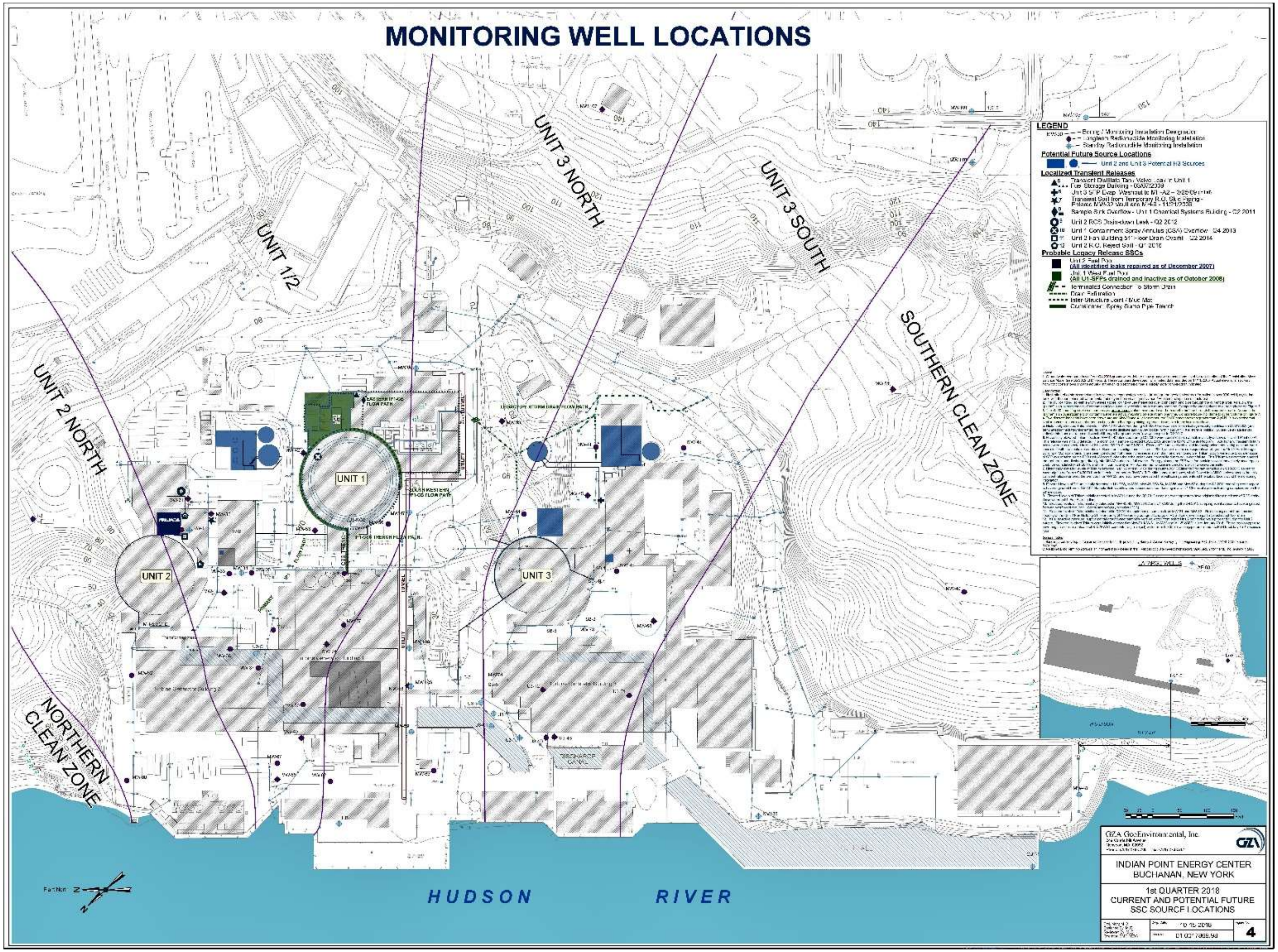
If five tanks were built and each was 20 feet tall, they would need diameters of nearly 24 feet in order to hold 268,000 gallons (35,827 cubic feet) of water.

The potential impact radius shaded in blue indicates an area where rupture of the natural gas pipeline could damage structures in the zone.

Source: Oak Ridge National Laboratory, [ORNL/SR-2022/2558](), "Updated Safety Review and Assessment of Natural Gas Transmission Pipelines Adjacent to the Indian Point Site," August 12, 2022.

Between the potential impact radius for the old pipelines and for the new pipelines, little space on the north end of the site property is available for installing water storage tanks.

Source: Oak Ridge National Laboratory, ORNL/SR-2022/2558, "Updated Safety Review and Assessment of Natural Gas Transmission Pipelines Adjacent to the Indian Point Site," August 12, 2022.



The south end of the site (on the right side of this drawing) may accommodate storage tank(s), but they are not close to the majority of the monitoring wells (MW-xx) installed to detect leakage of radioactive water.

Source: Matthew Barvenik, GZA, "Memorandum – Synopsis of Long Term Monitoring Plan Bases," January 25, 2008. (ADAMS ML080290204)

Discharge vs. Delay

Discharge means that about 400 curies of tritium will be released into the Hudson River, albeit diluted to a tiny fraction of the EPA Drinking Water Standard of 20,000 picocuries per liter.

Delay, for 12.3 years, means that about 200 curies of the tritium in the stored water will have decayed and no longer represents a hazard.

If (and it's a big if) none of the tritiated water evaporates or leaks from the tank(s) during those 12.3 years and adequate dilution flow remains available to then release the tritiated water to the Hudson River, delay yields a lower - not zero - hazard to public health.

Discharge vs. Delay

The tritium concentration of a gallon of water today:

Concentration = 400 curies / 1,340,000 gallons
= 0.0002985 curies per gallon

If stored for 12.3 (one half-life of tritium), the tritium concentration will decrease to half its initial value (i.e., 0.0001493 curies per gallon).

Discharge vs. Delay

The tritium concentration of a gallon of water if discharged to the Hudson River:

Number of batches = 1,340,000 gallons / 18,000 gallons per batch
= 74.4

Tritium content per batch = 400 curies / 74.4 batches
= 5.37 curies

Release time = 18,000 gallons per batch / 150 gallons per minute
= 120 minutes

Dilution flow = 80,000 gallons per minute x 120 minutes per release
= 9,600,000 gallons

Tritium Concentration = 5.37 curies / (18,000 gallons + 9,600,000 gallons)
= 0.000000559 curies per gallon

Discharge vs. Delay

The tritium concentration of a gallon of water being stored is initially 0.0002985 curies per gallon, decreasing to 0.0001493 curies per gallon over 12.3 years.

The tritium concentration of a gallon of water if discharged to the Hudson River is 0.000000559 curies per gallon assuming no radioactive decay.

The ratios of stored to discharged tritium concentration:

Initially = 0.0002985 curies per gallon / 0.000000559 curies per gallon = 534

After 12.3 years = 0.0001493 curies per gallon / 0.000000559 curies per gallon = 267

Thus, a gallon of stored water leaked or evaporated has a concentration 267 to 534 times greater than from a gallon discharged to the river via the tried and proven method.

Discharge vs. Delay

The topography of the Indian Point site is such that any water leaked/spilled into the ground tends to migrate into the river.

The underground plume entering the river would be diluted only by rainfall, which is probably less than the 80,000 gallons per minute dilution flow provided for controlled releases to the river.

With zero leaks or spills, 12.3 years of decay means that the delayed discharge of a gallon into the river has one-half the tritium concentration of a gallon treated and discharged now.

But if a gallon leaks or spills during that time, it'll have 267 to 534 times greater tritium concentration than a gallon discharged now.

Peer Review Comments - Anonymous individual

Gmail

David Lochbaum <davelochbaum@gmail.com>

Re: Draft slides plus background - my thoughts…

1 message

Fri, May 12, 2023 at 2:19 PM

To: David Lochbaum <davelochbaum@gmail.com>

Dave,

There have been many leaks from buried pipes. I expect there may even have been some small tank leaks (although I don't specifically recall any). There have been no tank failures (catastrophic collapses) at Indian Point.

I still believe the best option for all is to discharge the water to the Hudson.

As you obviously know, you will have a very difficult time convincing the anti-nuke activists that storing the water on site is not a viable solution. If many of the old tanks have now been removed, the only option would be to build new tanks as you have said if the pressure to store the water on site becomes politically overwhelming. Nobody wants to litigate but it may make more sense to litigate on this issue. My guess is that HOLTEC would ultimately win but it only adds costs to the decommissioning budget. I also suspect the 400 curie limit on tank contents could be amended if HOLTEC shows that the tank would be built to high standards - similar to an RWST or CST.

You may want to include a few more slides that addresses estuarial flow and explain why the tritiated water cannot possibly migrate/diffuse up river to the water intakes of public water supplies. This is not my area of expertise so it may be appropriate to reach out to a hydrologist. The activists like to say that the river flows in both directions. It does not. The surface layer flow is always toward the ocean. There is a brackish water layer below the surface that remains entrapped because of hydraulic and gravitational forces and may indeed become very slightly contaminated with T2O.

No public water system draws potable water from brackish sources for obvious reasons, especially in the Indian Point / Peekskill area because they have many clean sources of surface water from the NYC reservoir system. All public water system intakes will most certainly be above the brackish water layer in a tributary feeder or above the brackish water / fresh water interface line (near Poughkeepsie) and cannot possibly draw from brackish water. The vast majority of Tritium that is discharged will be swept out to sea. Some small amount may become entrapped in the brackish water layer due to diffusion. Either way, there is no way that any Tritium will enter a source of public drinking water. This should be easy to show in slides. If you don't drink it, you can't be exposed to Tritium. The amount of Tritium that evaporates from the Hudson into the air is inconsequential and the concerns about contaminating fish and biologics can easily be refuted by the REMP sample results (i.e. - no measurable contamination).

The combination of low energy betas, low activity levels (long half life), dilution of the activity after discharge and no sources of public drinking water would seem to make the case that radiation exposure from Tritium is far below any public health concerns. The anti-nuke activists will continue to object but the state and local officials (who actually make the decisions) should be able to separate the noise from the signal, especially if they are briefed well.

The anti-nuke activists have been running the same political plays for years. Object to everything and try to raise costs until the nuclear activity becomes uneconomical to drive the licensee out of business. The licensees seem to be reluctant to say that they can't afford the increased costs and higher costs could harm or stall the project execution. Perhaps HOLTEC should threaten to just stop all decommissioning activities until the DTF increases to a level that they can afford to build the storage tanks - 20 years would do it. This would get the state and local officials attention and they might push through the local anti-nuke political resistance to direct discharges.

You presentation makes the best case that can be made under the constraints imposed on you. Perhaps you could present the slides as stated and see how the anti-nuclear stakeholders respond. I did not see any problems in your presentation besides the ones that I originally raised.

Best,

PS. My wife just showed me a quote that seems relevant. “We live in a time where smart people have to be quiet so that stupid people will not be offended.”

Sent from my iPad

On May 12, 2023, at 1:13 PM, David Lochbaum <davelochbaum@gmail.com> wrote:

Hello

Solid comments.I'll certainly try to better justify what risk of failure values I use.

Attached are records about a February 2009 leak from an 8-inch pipe connected to the Unit 2 CST.

It cannot leak again --- the Unit 2 CST has been removed as have many of the other outside tanks you mentioned.

My understanding is that the Unit 3 reactor cavity is filled to provide shielding for vessel segmentation and other work. When this work moves to Unit 2, their plan is to transfer the RWST to the reactor cavity for the same purpose.

Thanks,
Dave

On Thu, May 11, 2023 at 1:17 PM wrote:

> Dave,
>
> After review and cogitation, the biggest weakness (IMHO) is the failure statistics of storage tanks. You cite prior failures of storage tanks at several places and conclude that a failure rate of 1-2% is appropriate. The problem with this approach is that the examples don’t include the time in service (did they fail after 12 years or 50 years) the contents (Hanford tanks contained acidic and caustic liquids extracted from the PUREX process) or tank operations (a tank that is drained and refilled frequently will have a higher likelihood of failure due to cyclic stress and oxidation when drained). T2O is relatively chemically inert and the tanks need not to be cycled (filled and refilled) if they are provided with breather valves. All these factors have a significant impact on the probability of tank failure (as well as cost). There have been relatively few failures of safety related tanks in the nuclear industry over the years. A proper Bayesian update of the failure (or leakage) likelihood of storage tanks should be much less that 1-2%.
>
> There are (or were) many existing storage tanks at Indian Point that could be repurposed to store tritiated water (T2O). Both units had RWSTs and CSTs that were seismically qualified, safety grade (important to safety), protected from missiles, and properly maintained. I don’t recall any leaks from these tanks over the many years I was working at Indian Point. In addition, they had PWSTs, fire water protection tanks, the Unit 1 condensate storage tanks, a large city water tank and two huge unit 1 fuel oil tanks (1,000,000 gallons each - used to fire the unit 1 superheater) that still remained standing after the units were shutdown. All of these tanks could potentially be used to store T2O for some period of time assuming they are still standing in reasonable shape.
>
> Building new tanks is also an option. Tanks can be constructed with double bottoms and leak detection systems that will easily last for 60 years. They will be highly reliable. It is just a question of cost.
>
> Assuming a failure rate of 1-2% for 12.5 years is simply not representative of tanks failures or leaks at Indian Point since 1962. Projecting one new tank failure (55%) in 12.5 years is far too high based on actual tank failure rates at Indian Point. Failure rates depend entirely on tank construction, maintenance, and support.
>
> I don’t know if the stakeholders are aware of these facts or if they would challenge your presentation, but based on my reading of some of their internal emails, I expect they might raise these questions in public. The problem is that if they do successfully challenge one part of your presentation, the entire presentation becomes suspect.
>
> You also contend that exposure from breathing atmospheric T2O may be relatively more harmful than drinking liquid T2O. This is not an apples to apples comparison. While Tritium water vapor is may be hazardous in high concentrations, the atmosphere is vast - the air contains a much greater volume than

the Hudson River so the dilution effects would be far greater in air. Breathing air at the same activity level does not automatically result in higher dose rates because you breath out most of what you breathed in. A smaller fraction of atmospheric T20 is absorbed by the lungs in comparison to drinking the same activity, where almost all activity is retained in your body (with a biological half life of 10 days).

In short, I worry that any good health physicist could punch holes in your presentation. The overall message is good - Tritium is not a health hazard when discharged into the River. But I don't think you can make a strong case that storing Tritium in tanks results in greater health hazards than discharging it into the River from an HP perspective.

I recommend focusing more on the dilution effects during discharge in addition to the other low impact factors to show that the combination of low activity (long half life), low energy and high dilution in the River quickly portends very little dose impact to the public. Of course…the activist stakeholders will still object.

Obviously, HOLTEC wants to discharge the T2O into the River so they can complete decommissioning expeditiously. If decommissioning gets delayed, they lose money. The decommissioning project is essentially a fixed cost deal (except for DOE funds for the SNF management). They can always stop the decommissioning project to allow the DTF to grow but I doubt they see this as a success path (although it could be a good threat). If the stakeholders put too many road blocks in their path, they can fold HDI, give up the license and let the state and federal partners sort it out. We have many examples of companies (on the nuclear materials side of the house) that went out of business, vacated their license, and walked away from highly contaminated radioactive waste sites without satisfactory remediation. They become superfund sites and the state usually winds up having to organize the clean up with help from the feds. It takes many years and the sites are unavailable for repurposing during that time.

So rather than trying to project tank failure rates and arguing that storage tanks are more dangerous than discharges, I recommend enhancing your presentation to show the potential impact of the cost of storing the T2O on site, rather than trying to build a safety case comparison between discharging the T2O vs. storing it. The antinuclear activist true believers will not be persuaded - they are still running the old playbook from the 1970s - trying to increase the costs of any nuclear activity until the utility cries "uncle". What they apparently don't seem to realize is that there is nobody backstopping the decommissioning costs anymore. ConEd and PASNY/NYPA are all gone. They really need to let HOLTEC decommission the plant as budgeted/envisioned when they took over the license for everyone to win.

Feel free to call me at your convenience to talk about this. I have probably not explained it well.

If you want to continue to present the safety case comparison between discharging to the Hudson vs. storage in new tanks, I think your presentation probably makes the best case available. I just expect the stakeholders will punch holes in parts of your comparison and you may lose some credibility.

Best,

PS. I suspect I know the answer but why did they leave the Unit 3 refueling cavity filled instead of pumping the T2O water back to the RWST? The evaporation rate of T2O from unit 3 will be very high if the cavity and pool are filled.

Sent from my iPad

> On May 9, 2023, at 8:43 AM, David Lochbaum <davelochbaum@gmail.com> wrote:
>
>
> Hello
>
> Thanks for agreeing to anonymously reviewing my draft. It's attached as the PDF beginning with 20230615.
>
>

>
> So, this iteration seeks to explain that the "preferred" option of storing the water onsite until either a

miracle occurs or half of the tritium content decays has some risks, too.
>
>

>
> Any comments/suggestions will be appreciated. Thanks for taking the time to do this,
> Dave

---

2 attachments

20090910-ip2-nrc-slides-acrs-cst-pipe-leak-ML110040408.pdf
487K

20090215-ip-condition-report-8-inch-cst-pipe-leak-ML12334A685.pdf
8337K

Tuesday, June 6, 2023

Dear Dave,

I appreciate the opportunity to review your draft presentation on the "Handling of Tritiated Water," which is scheduled to be presented before the Indian Point Decommissioning Board (DOB) on June 15, 2023.

On Page #2, you discuss the "Purpose" of this study and provide an outline of four previously assessed methods, but there is no summary of these discounted assessment results. It is important to clarify why you have chosen to focus solely on the two options of on-site storage or discharge to the river and why the alternatives were discounted. Additionally, it is necessary to include a definition of NCRP.

In my professional opinion, there is one additional viable alternative, which involves retaining the spent fuel pool(s) for the short-term retention of tritiated water. This alternative would assure compliance with the regulation stated in 10 CFR 72.122(l) regarding retrievability. According to this regulation,

> “10 CFR 72.122(l) storage systems must be designed to allow easy retrieval of spent fuel, high-level radioactive waste, and reactor-related GTCC waste for further processing or disposal.”

While your discussions effectively address the short-term issues, there is no mention of the long-term retrievability issue that must be addressed in the now for fuel inspection, and repair prior to transportation from the Indian Point site. This decision must be made now and not after the discovery of a degraded canister. For the long term a "Hot Cell” will be required, and until that time, the fuel will remain unrepairable, uninspecable, and non-transportable. Moreover, removing the spent fuel pools and the ability to decommission the spent fuel would constitute a clear violation of this regulation unless a "Hot Cell" is constructed for the future.

The NRC does not have the authority to change this very succinct and clear rule. Therefore, it is crucial to evaluate this option for both long-term (25-50 years) and short-term (5-25 years) considerations. Retaining the spent fuel pool(s) would effectively resolve both the tritium discharge issue and the retrievability concerns in the short term, and it should not be overlooked. The probability of a degraded and leaking canister is relatively high over the expected fuel storage life of the canisters, which may be measured in decades. There will be no possibility of “repurposing” the site as long as the spent fuel remains at Indian Point.

Should it be determined the retention of the spent fuel pool option is not viable, it is my strongest belief that the lowest risk to the public at this time is the diluted discharge of the tritiated water to the river as described in your draft presentation.

This discharge has been the practice for more than 40 years with no observable impact on the environment or the public with significantly greater concentrations of tritium than proposed for the discharges during decommissioning.

At the conclusion of your draft presentation, I strongly recommend you provide both a SUMMARY and RECOMMENDATIONS section to ensure a comprehensive and conclusive overview of the topic.

Sincerely,

Paul M. Blanch
135 Hyde Rd.
West Hartford, CT 06117
pmblanch@comcast.net
860-9223119

Independent Peer Review of

Lochbaum presentation

“Handling of Tritiated Water” dated June 15, 2023

By Jeff Mitman

I have reviewed this presentation from two perspectives. First, did it miss any important issues? Second, are the positions advocated reasonable?

The presentation evaluates the water found in the Unit 2 and 3 spent fuel pools, the Unit 2 refueling water storage tank (RWST) and the Unit 3 reactor cavity (see Slide 3). It is my understanding that the Unit 1 spent fuel pool, the Unit 1 and 2 reactor cavities and as well as the Unit 1 and 3 RWSTs have already been processed otherwise the water inventory would be significantly larger. Additional water is typically found in the each unit’s hotwell. However, in pressurized water reactors (PWRs) this water is usually not radioactive and thus would not contain any tritium. Presumably, this is true for the Indian Point site.

Regarding the adequacies of the suggested positions: I have reviewed most of the calculated values in the presentation and all of those that I reviewed I have replicated, meaning I’ve verified the calculations. The entire evaluation rests on the input assumption that the quantity of Tritium that needs to be discharged is 400 Curies. While I have no basis or reason to question this value and I am not questioning this value, the entire issue is based on it this critical input assumption.

An additional point of consideration: If the tritiated water is release, the risk to the site and the surrounding community from it is gone. As long as the tritiated water remains at the site, there remains some very small residual risk to the local community.

According to Slide 15 of the April 27th, 2023 Holtec presentation the amount of tritiated water to be stored or released is previously discussed 400 Curies. According to Slide 15 of the April 10, 2023 Lochbaum presentation the average annual release of tritium release between 2005 and 2021 was 1395 Curies. The 400 Curies to be stored or released is therefore, less than 1/3 of the average amount released each year and less than the smallest amount released in any given year (640 Curies in 2014). Thus, releasing the 400 Curies would have a smaller impact on the river and the surrounding environment than the releases that have occurred between 2005 and 2021.

Additional considerations for the storage option: Slide 6 of the June 15, 2023 Lochbaum presentation say: “Any leaks … would be retained within the housing …” While retention within the buildings may be likely, past experience at Indian Point and elsewhere, shows that leaks often migrate out of the buildings. A recent example occurred at the Monticello Nuclear Plant in Minnesota late in 2022 when 400,000 gallons of tritiated water was released to the environment (https://www.pca.state.mn.us/news-and-stories/statement-on-xcel-energy-shutdown-of-monticello-nuclear-plant). This possibility should not be overlooked.

In my opinion both the storage and release options are safe. However, the release option is slightly safer for the following reasons:

- The storage option incurs a small risk to the workers (and others) constructing, monitoring and demolishing the tanks once they are no longer needed.
- As the Lochbaum presentation discusses, tanks do fail and release their contents. In my opinion, it is always better to control the time and means of any release in contrast to planning to store with the possibility of uncontrolled and unmonitored leak occurring.

While costs have not been discussed, if they are a consideration, I suspect that the treat and release option would cost less.

Jeffrey T. Mitman - Bio

Currently consulting with Beyond Nuclear on the US Nuclear Regulatory Commission's (NRC) subsequent license renewals.

Retired from the NRC in 2021 as a Senior Reliability and Risk Analyst. BSE Nuclear Engineering, University of Michigan. At the NRC I conducted risk evaluations of at-power and shutdown events; flooding and spent fuel pool risk issues. I've also contributed to the development of human reliability analysis and common cause failure methods, implementing procedures and PRA standards.

Previous positions included: Project Manager Electric Power Research Institute (1992-2003) with responsibility for outage risk management, risk informed in-service inspection, fire risk, spent fuel cask probabilistic risk assessment and software development. Startup Engineer with General Electric Nuclear Power (1980-1990) working in in construction, operations (shift technical advisor), startup testing (Senior Reactor Operator certified) and outage management.

American Nuclear Society member since 1978.