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Three Empire State Plaza, Albany, NY 12223-1350
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February 3, 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, the February 2, 2023 presentation from independent technical expert David Lochbaum regarding spent fuel pool water removal options at Indian Point. 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

Spent Fuel Pool Water Disposal Options

Dave Lochbaum*
February 2, 2023

* Appendix A summarizes the author's qualifications for this topic

Concerns/questions have been raised regarding what to do with the water in spent fuel pools after all the spent fuel has been transferred into onsite dry storage.

A primary concern involves tritium in the spent fuel pool water because while other radionuclides in water can be removed or reduced by filtering, tritium cannot be easily filtered out. As shown in the next slide, tritium constitutes the majority of the radioactivity released to the river in the past.

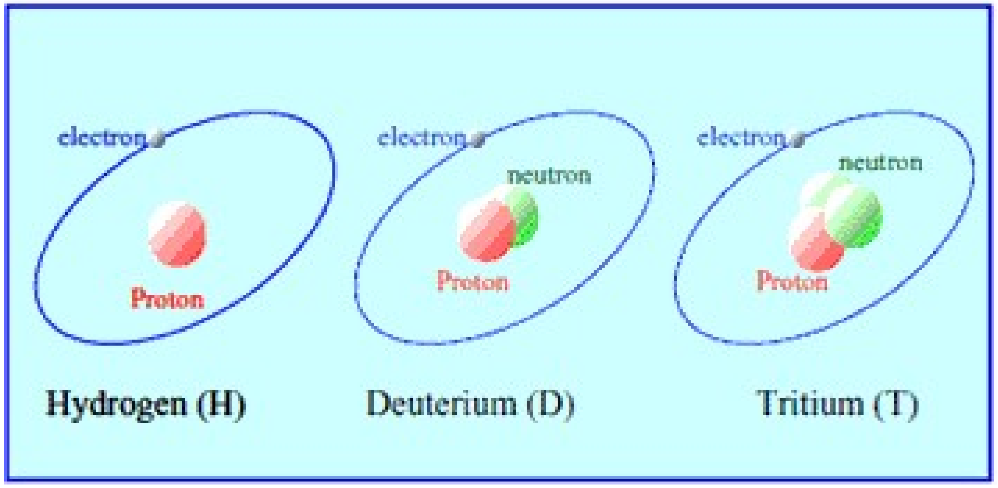
Radioactivity in Water Discharged from Indian Point (from annual radiation effluent submittals to NRC)

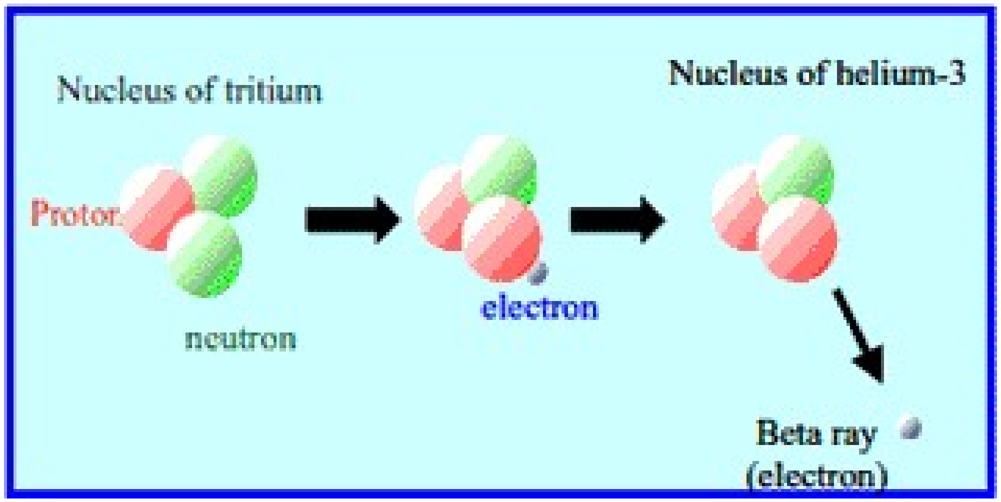
	Fission and Activation Products	Tritium	Dissolved and Entrained Gases	Gross Alpha	Total Curies	Tritium Percentage of Release
Year	Curies	Curies	Curies	Curies	Curies	%
2005	0.075	1272.000	0.075	0.000	1272.150	99.99%
2006	0.059	1558.000	0.382	0.000	1558.441	99.97%
2007	0.054	1468.000	0.040	0.000	1468.094	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%

Tritium constituted 99.99% of the radioactivity discharged to the river from Indian Point.

Tritium Background Info

Tritium is an isotope of hydrogen. Hydrogen has one proton and one electron. Deuterium has one proton, one electron and one neutron. Tritium has a second neutron.

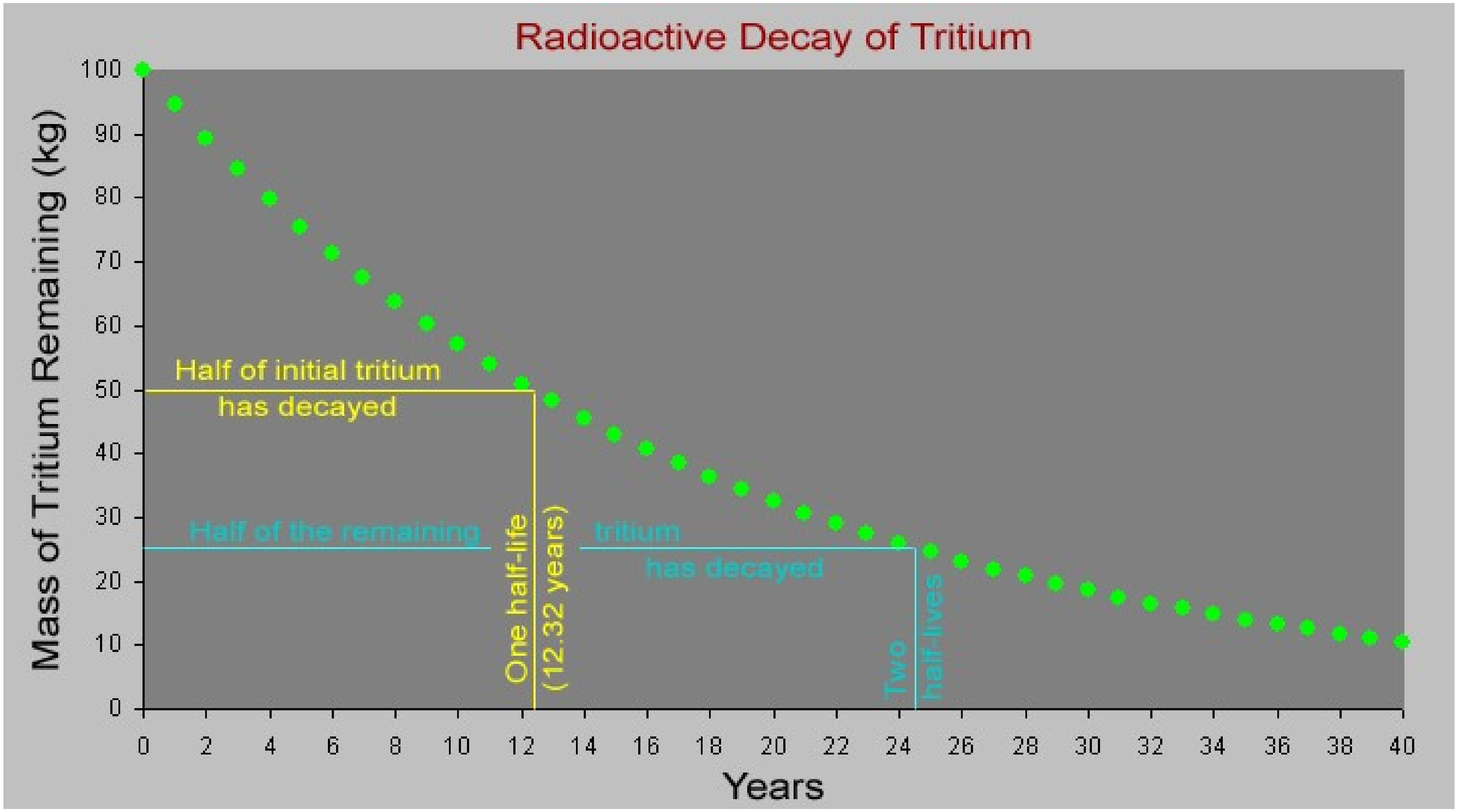




Deuterium is a stable isotope, but tritium is unstable. It seeks stability by emitting a beta particle (an electron).

Each water molecule (H_2O) has two hydrogen atoms and one oxygen atom. Either or both of the hydrogen atoms in a water molecule could be tritium.

Tritium Background Info



Tritium has a half-life of about 12.3 years. Thus, if there are 1,000 tritium isotopes today, there will be 500 tritium isotopes 12.3 years later and 250 tritium isotopes 24.6 years later.

Tritium Background Info

Derived Concentrations (pCi/l) of Beta and Photon Emitters in Drinking Water

Yielding a Dose of 4 mrem/yr to the Total Body or to any Critical Organ as defined in NBS Handbook 69

Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l
H-3	20,000	Ni-65	300	Nb-95	300	Sb-124	60	Nd-147	200	Os-191	600
Be-7	6,000	Cu-64	900	Nb-97	3,000	Sb-125	300	Nd-149	900	Os-191m	9,000
C-14	2,000	Zn-65	300	Mo-99	600	Te-125m	600	Pm-147	600	Os-193	200
F-18	2,000	Zn-69	6,000	Tc-96	300	Te-127	900	Pm-149	100	Ir-190	600
Na-22	400	Zn-69m	200	Tc-96m	30,000	Te-127m	200	Sm-151	1,000	Ir-192	100
Na-24	600	Ga-72	100	Tc-97	6,000	Te-129	2,000	Sm-153	200	Ir-194	90
Si-31	3,000	Ge-71	6,000	Tc-97m	1,000	Te-129m	90	Eu-152	200	Pt-191	300
P-32	30	As-73	1,000	Tc-99	900	Te-131m	200	Eu-154	60	Pt-193	3,000
S-35 inorg	500	As-74	100	Tc-99m	20,000	Te-132	90	Eu-155	600	Pt-193m	3,000
Cl-36	700	As-76	60	Ru-97	1,000	I-126	3	Gd-153	600	Pt-197	300
Cl-38	1,000	As-77	200	Ru-103	200	I-129	1	Gd-159	200	Pt-197m	3,000
K-42	900	Se-75	900	Ru-105	200	I-131	3	Tb-160	100	Au-196	600
Ca-45	10	Br-82	100	Ru-106	30	I-132	90	Dy-165	1,000	Au-198	100
Ca-47	80	Rb-86	600	Rh-103m	30,000	I-133	10	Dy-166	100	Au-199	600
Sc-46	100	Rb-87	300	Rh-105	300	I-134	100	Ho-166	90	Hg-197	900
Sc-47	300	Sr-85 m	20,000	Pd-103	900	I-135	30	Er-169	300	Hg-197m	600
Sc-48	80	Sr-85	900	Pd-109	300	Cs-131	20,000	Er-171	300	Hg-203	60
V-48	90	Sr-89	20	Ag-105	300	Cs-134	80	Tm-170	100	Tl-200	1,000
Cr-51	6,000	Sr-90	8	Ag-110m	90	Cs-134m	20,000	Tm-171	1,000	Tl-201	900
Mn-52	90	Sr-91	200	Ag-111	100	Cs-135	900	Yb-175	300	Tl-202	300
Mn-54	300	Sr-92	200	Cd-109	600	Cs-136	800	Lu-177	300	Tl-204	300
Mn-56	300	Y-90	60	Cd-115	90	Cs-137	200	Hf-181	200	Pb-203	1,000
Fe-55	2,000	Y-91	90	Cd-115m	90	Ba-131	600	Ta-182	100	Bi-206	100
Fe-59	200	Y-91m	9,000	In-113m	3,000	Ba-140	90	W-181	1,000	Bi-207	200
Co-57	1,000	Y-92	200	In-114m	60	La-140	60				
Co-58	300	Y-93	90	In-115	300	Ce-141	300				
Co-58m	9000	Zr-93	2,000	In-115m	1,000	Ce-143	100				
Co-60	100	Zr-95	200	Sn-113	300	Ce-144	30				
Ni-59	300	Zr-97	60	Sn-125	60	Pr-142	90				
Ni-63	50	Nb-93m	1,000	Sb-122	90	Pr-143	100				

The higher the hazard, the lower the limit. Why is the limit for tritium so much higher than for Strontium-90 and Iodine-131?

Source: U.S. Environmental Protection Agency, https://www.epa.gov/sites/default/files/2015-06/documents/compliance-radionuclidesindw.pdf

Tritium Background Info

"Tritium is almost always found as water, or 'tritiated' water. Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted through the urine within a month or so after ingestion."

"As with all ionizing radiation, exposure to tritium increases the risk of developing cancer. However, tritium is one of the least dangerous radionuclides because it emits very weak radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues are generally uniform and dependent on the tissues' water content."

Source: U.S. Environmental Protection Agency, "Tritium," November 30, 2004 (ML060970190).

Because tritium remains in the body a relatively short time (Sr-90 gets absorbed into teeth and bones, I-131 gets absorbed by the thyroid), has a long half-life, and emits a low-energy beta particle, it is a lesser hazard than longer lasting radionuclides with higher energy emissions.

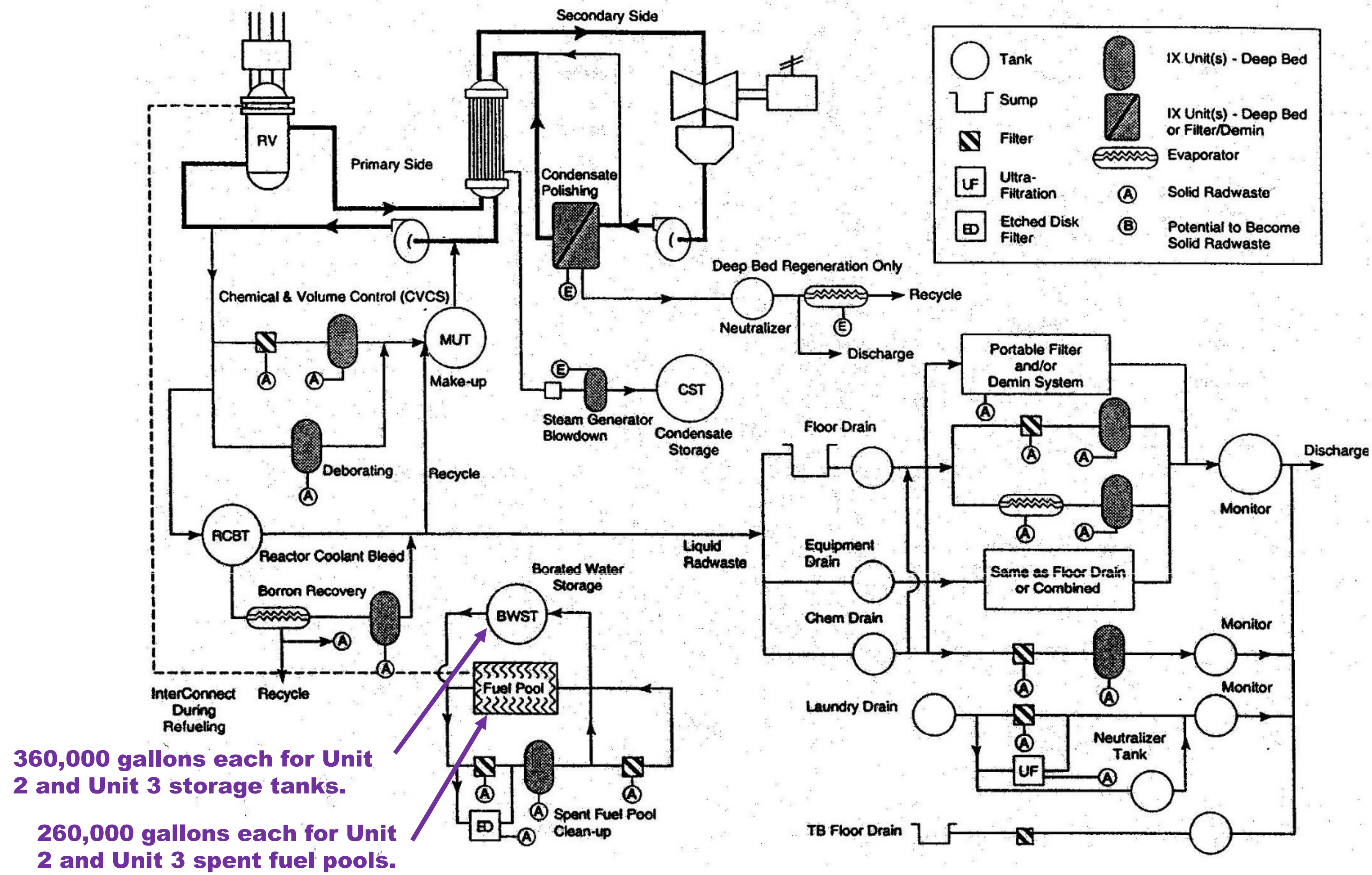
Spent fuel pool water can be:

- discharged to the river
- evaporated to the air
- shipped offsite for burial
- stored onsite until decayed

The spent fuel pool is the source of the radioactively contaminated water for all four options.

All four options implicate more than the source (spent fuel pool) and the destination (river, air, soil, storage tanks). Each involves intermediate processing steps.

In other words, spent fuel pool water is not directly dumped to the river, boiled to the air, buried in dirt or stored in a different container.



A pressurized water reactor (PWR) schematic showing the liquid waste system on the lower right that collects, treats, and re-uses or discharges water.

Source: NRC Lesson Plan on Liquid Waste Systems (ML12151A437).

Option:

Discharged to the river

Tritium Liquid Effluents 2009-2019			
Year	Average PWR	Indian Point Unit 2	Indian Point Unit 3
2009	505.0	885.0	974.0
2010	493.0	732.0	658.0
2011	579.0	927.0	980.0
2012	564.0	849.0	1,140.0
2013	499.0	1,310.0	735.0
2014	533.0	472.0	168.0
2015	591.0	682.0	1,290.0
2016	542.0	632.0	451.0
2017	671.0	654.0	768.0
2018	644.0	494.0	864.0
2019	607.0	454.0	378.0
Annual Average	566.2	735.5	764.2

The average pressurized water reactor (PWR) discharged 566.2 curies of tritium annually to the nearby lake, river or ocean between 2009 and 2019. Appendix B charts effluents each year for all PWRs.

(NRC's data for Indian Point for 2014-2018 is wrong; the table above provides the right data)

HOLTEC DECOMMISSIONING INTERNATIONAL

Krishna P. Singh Technology Campus, 1 Holtec Blvd., Camden, NJ 08104
Telephone (856) 797-0900
Fax (856) 797-0909

HDI-IPEC-22-052

10 CFR 50.36a (a)(2)
10 CFR 72.44 (d)(3)

July 1, 2022

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Indian Point Energy Center
Facility License No. DPR-05, DPR-26 and DPR-64
NRC Docket Nos. 50-03, 50-247, and 50-286

Subject: Resubmittal of the 2021 Annual Radioactive Effluent Release Report

Reference 1: Holtec Decommissioning International, LLC (HDI) Letter to US NRC, "2021 Annual Radioactive Effluent Release Report," (HDI-IPEC-22-034) (ADAMS Accession Number ML22118A493), dated April 28, 2022

Enclosed is a resubmittal of the Indian Point Units 1, 2, and 3 Annual Radioactive Effluent Release Report for 2021 and the updated Offsite Dose Calculation Manual (ODCM). Reference 1 inadvertently included a copy of the Annual Radiological Environmental Operating Report rather than the Annual Radioactive Effluent Release Report as Enclosure 1 in the submittal.

This letter contains no new regulatory commitments.

If you have any questions or need further information, please contact Mr. Walter Wittich, IPEC Licensing at 914-254-7212, or me at (856) 797-0900, ext. 3578.

Sincerely,

Jean A. Fleming — Digitally signed by Jean A. Fleming Date: 2022.07.01 07:20:26 -04'00'

Jean A. Fleming
Vice President, Licensing, Regulatory Affairs and PSA
Holtec Decommissioning International, LLC

Liquid Effluents Dose

The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to unrestricted areas shall be limited to the following:

- Quarterly: Less than or equal to 1.5 mrem total body
  Less than or equal to 5 mrem critical organ
- Yearly: Less than or equal to 3 mrem total body
  Less than or equal to 10 mrem critical organ

Total Dose (40CFR190)

The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to the following:

- Less than or equal to 25 mrem, Total Body or any Organ except Thyroid.
- Less than or equal to 75 mrem, Thyroid

Federal regulations permit the monitored and controlled releases of radioactively contaminated liquids from nuclear plants.

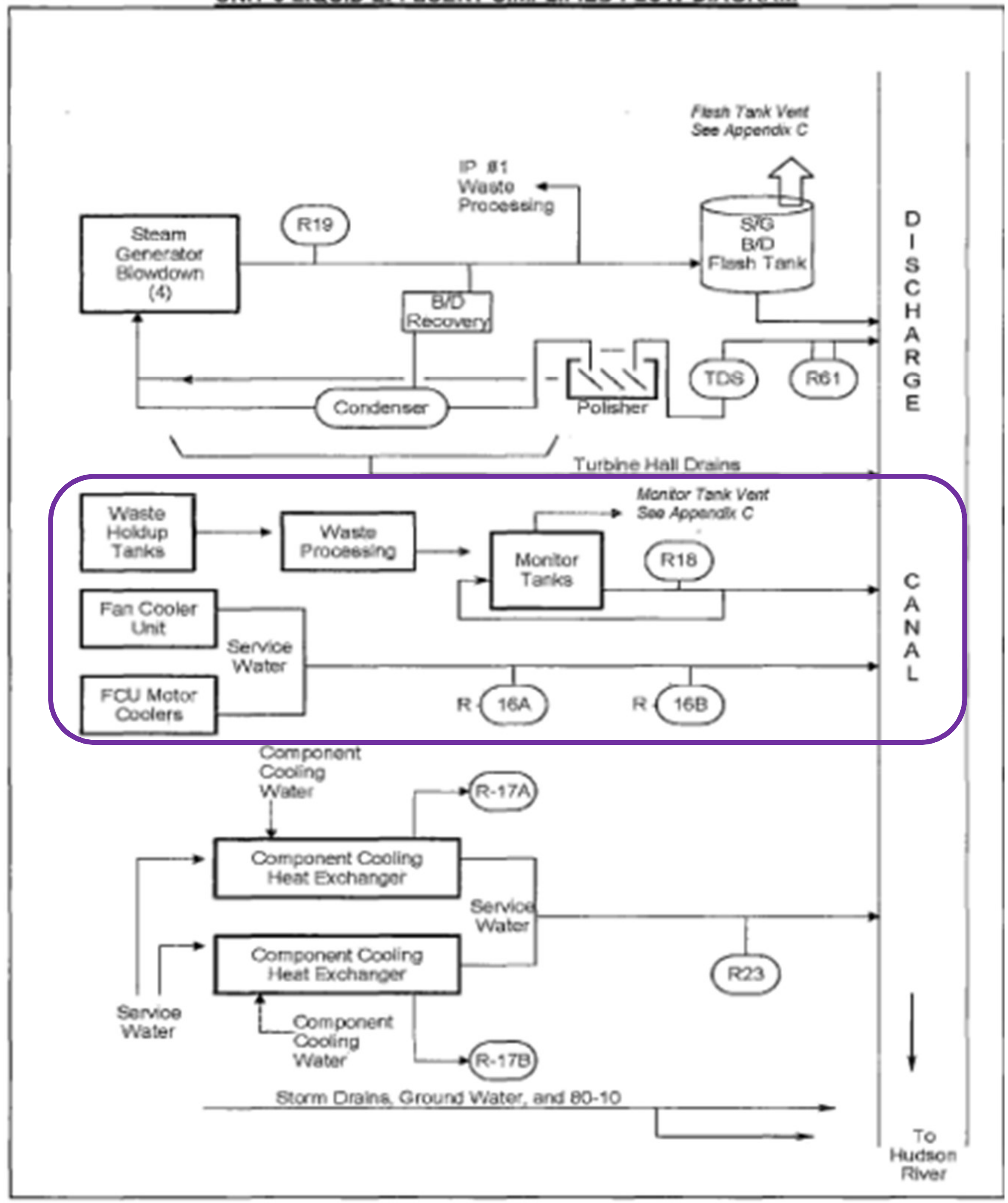
The limit on liquid releases is 3 millirem per year while the limit from all releases is 25 millirem per year.

Owners must submit annual reports to the NRC on the accounting they perform to verify compliance with the limits.

Source: HOLTEC, "Resubmittal of the 2021 Annual Radioactive Effluent Release Report," July 1, 2022 (ML22182A076).

Radioactively contaminated water is collected and processed. Before being released, the water in the Monitor Tanks is sampled to ensure the contents are below discharge limits, and to establish the proper setpoint for the radiation monitor (R18) in the discharge line that will stop the flow if the radioactivity rises too high. Spent fuel pool water would be routed through this Waste Disposal System before being discharged.

UNIT 3 LIQUID EFFLUENT SIMPLIFIED FLOW DIAGRAM



Source: Entergy, "Offsite Dose Calculation Manual," Rev. 5, April 30, 2021 (ML21168A060).

Table D 3.1.1-1 (Page 1 of 2)
Radioactive Liquid Waste Sampling and Analysis

LIQUID RELEASE TYPE	SAMPLE TYPE	SAMPLE FREQUENCY	MINIMUM ANALYSIS FREQUENCY	SAMPLE ANALYSIS	LOWER LIMIT OF DETECTION (LLD) in uCi/ml, (a),(g),(c)
1. Batch Waste Release Tanks (b) eg. *Waste Tanks,* *SG Draindowns, etc*	Grab Sample	Each Batch (h)	Each Batch (h)	Principal Gamma Emitters	5E-7
				Mo-99, Ce-144	5E-6
				I-131	1E-6
	Grab Sample	One batch per 31 days (h)	31 days	Dissolved and Entrained Gases (gamma emitters)	1E-5
	Composite (d)	Each batch (h)	31 days	H-3	1E-5
				Gross Alpha	1E-7
	Composite (d)	Each batch (h)	92 days	Sr-89, Sr-90	5E-8
				Fe-55	1E-6
2. Continuous Releases (e) eg. *SG Blowdown,* *U1 NCD,* *U1 SFDS,* *Foundation Drain Line (k)* *etc*	Composite (d)	Composite	7 days	Principal Gamma Emitters (c)	5E-7
				Mo-99, Ce-144	5E-6
				I-131	1E-6
	Grab Sample	31 days	31 days	Dissolved and Entrained Gases (gamma emitters)	1E-5
	Composite (d)	Composite	31 days	H-3	1E-5
				Gross Alpha	1E-7
			92 days	Sr-89, Sr-90	5E-8
				Fe-55	1E-6
3. Service Water (in Radiologically Controlled Areas)	Grab Sample	31 days	31 days	Gamma and Beta emitters (j)	Per liquid batch releases, above.
4. Turbine Hall Drains, SG Feedwater (i)	Composite (d)	Composite	7 days	Gamma and Beta emitters (j)	Per liquid batch releases, above.

10/20

(a) The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD shall be determined in accordance with the methodology and parameters in the ODCM. It should be recognized that the LLD is defined as an <u>a priori</u> (before-the-fact) limit representing the capability of a measurement system and not as an <u>a posterior</u> (after-the-fact) limit for a particular measurement.

(b) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed by the method described in Part II, Section 2.1.4 to assure representative sampling.

(c) The principal gamma emitters for which the LLD (of 5E-7 uCi/ml) applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, Cs-137, and Ce-141. Mo-99 and Ce-144 shall also be measured, but with an LLD of 5E-6 uCi/ml, per Reference 49. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identified, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Specification D 5.2.

(d) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(e) A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

(f) When operational or other limitations preclude specific gamma radionuclide analysis in batch releases, the provisions of Regulatory Guide 1.21 (Revision 1), Appendix A Section C.4 and Appendix A, Section B shall be followed.

(g) For certain radionuclides with low gamma yield or low energies, or for certain radionuclide mixtures, it may not be possible to measure radionuclides in concentration near the LLD. Under these circumstances, the LLD may be increased in inverse proportion to the magnitude of the gamma yield (i.e., $5 \times 10^{-7}/I$ where I is the photon abundance expressed as a decimal fraction).

(h) Complete prior to each release.

(i) Steam Generator Feedwater and Turbine Hall Drains are adequately monitored from Steam Generator Blowdown Composites. Increased monitoring need only be performed when a Primary to Secondary leak exists, as defined in RECS Section D.1.1.

(j) Beta emitters need only be analyzed if gamma emitters have been positively identified.

(k) Foundation Drain Line samples are grab samples (at least once per month).

The processing, sampling, monitoring and control measures of the waste disposal system are regulatory requirements.

Source: Entergy, "Offsite Dose Calculation Manual," Rev. 5, April 30, 2021 (<u>ML21168A060</u>).

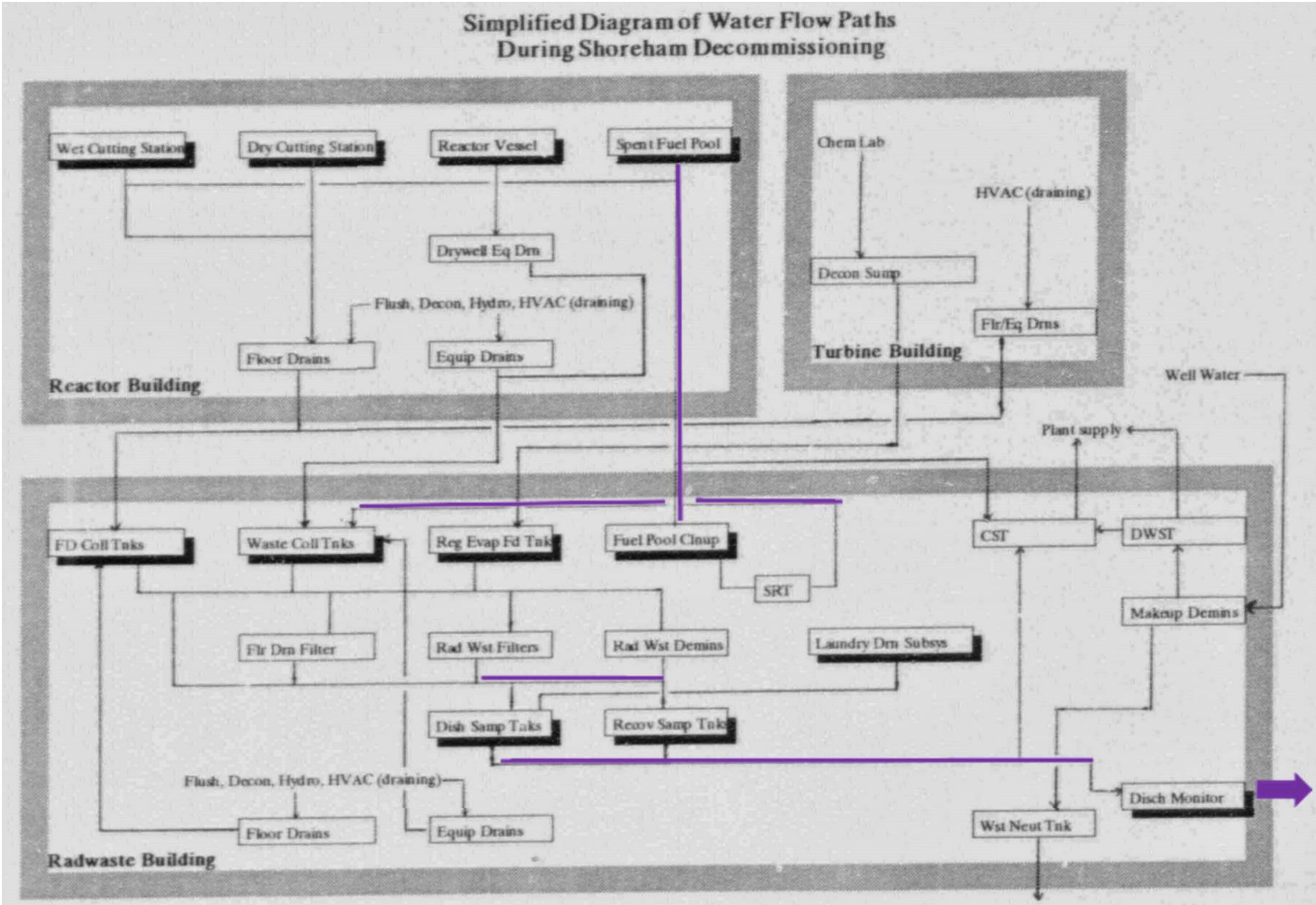
Lesson from Shoreham

The Shoreham nuclear plant on Long Island did not operate much before being permanently shut down. It did operate long enough, however, to create over 150,000 gallons of radioactively contaminated water:

> ***"… an estimated 87,000 gallons and another 72,000 gallons of waste water will be discharged from the Wet Cutting Station and the Reactor Pressure Vessel, respectively. The dose estimate assumes a uniform radioactive contamination concentration in these waters equal to 4.44E-2 uCi/ml."***

Source: Long Island Power Authority, "Technical Report on Water Processing and Water Management Activities," June 25, 1992 (ML20101K579).

Lesson from Shoreham



The radioactively contaminated water was processed, sampled and discharged via a monitored, controlled pathway to Long Island Sound.

Source: Long Island Power Authority, "Technical Report on Water Processing and Water Management Activities," June 25, 1992 (ML20101K579).

Lesson from Indian Point

Water from the Indian Point Unit 1 spent fuel pool was treated and released to the Hudson River:

> ***"This letter is to notify the NRC that Entergy has transferred all 160 spent fuel assemblies stored in the IP1 SFP*** **[spent fuel pool]** ***into dry cask storage and placed these stored assemblies on the existing ISFSI*** **[independent spent fuel storage installation]*****, located on the Indian Point site. The ISFSI is licensed under the general license provisions of 10 CFR 72 Sub Part K. Entergy has also drained down the IP1*** **[Indian Point Unit 1]** ***SFP."***

Source: Entergy to NRC, December 11, 2008 (ML083510667).

Lesson from Indian Point

Water from the Indian Point Unit 1 spent fuel pool was treated and released to the Hudson River:

> ***"The Unit 1 Spent Fuel, which has been considered the source of most of the groundwater contamination, was removed in 2008, to integrated spent fuel storage. This process demanded pool levels to be increased in April, 2008, for the defueling operation. During this evolution, the pool water was continuously demineralized and carefully monitored. … For dewatering, two sets of composite samplers were installed, and the slow, permitted release was carefully integrated. Resin-specific cleanup systems were added during the pump down to the routine liquid effluent release line. The empty pools were then cleaned, closed, and covered."***

Source: Entergy, "Annual Radioactive Effluent Release Report, April 17, 2009 (ML091260203).

Lesson from Indian Point

Water from the Indian Point Unit 1 spent fuel pool was treated and released to the Hudson River:

"As a result of aggressive processing before, during, and after the defueling operation, the effluent release from draining the pools (Sep, 2008) resulted in curies and mrem consistent with or slightly lower than routine monthly effluent. Strontium-90 releases, in particular, were essentially nonexistent, because the pool water had been cleaned up for months prior draining."

Source: Entergy, "Annual Radioactive Effluent Release Report, April 17, 2009 (ML091260203).

Lesson from Indian Point

On November 14, 2022, the NRC responded to an inquiry from the Ulster County Legislature of the State of New York by stating:

"The release of effluent discharges at nuclear power plants are regulated by the U.S. Environmental Protection Agency (EPA) and the NRC. The NRC's regulations and licensing reviews for nuclear power plants, like Indian Point, consider the controlled release of effluent discharges as part of the agency's safety and environmental assessments, protecting the public health and safety and the environment. The same NRC limits that apply to effluent discharges at operating plants also apply during the decommissioning of those plants. Therefore, any liquid discharges from Indian Point during previous operation and now continuing through decommissioning are required to remain within the prescribed limits, be processed through filters, and be sampled prior to being released. The NRC inspects the actions and the records of its licensees to ensure that compliance with environmental radiation standards is maintained." **[underlining added for emphasis]**

Source: Nuclear Regulatory Commission, November 14, 2022 (ML22304A147).

Lesson from Pilgrim

The Pilgrim nuclear plant in Massachusetts was owned by Entergy and is now being decommissioned by Holtec, like Indian Point.

On January 30, 2020, the EPA and the Massachusetts Department of Environmental Protection (MassDEP) signed the National Pollutant Discharge Elimination System (NPDES) permit controlling discharges to Cape Cod Bay. A section titled Unauthorized Discharges contained this provision:

> ***"The discharge of pollutants in spent fuel pool water (including, but not limited to, boron) is not authorized by this permit."***

A footnote explained:

> ***"MassDEP takes this action in an abundance of caution to ensure protection of Massachusetts' waters."***

Source: NPDES Permit No. MA000357, January 30, 2020.

Indian Point Agreement

"In accordance with the Stipulation, NYSDEC Staff is renewing Indian Point's Units 2 and 3 existing SPDES permit without material change, based on terms and conditions that have had the benefit of full public comment and/or adjudication." **[Exhibit H]**

Unlike at Pilgrim, the permit issued for discharges from Indian Point into the Hudson River does not prohibit the release of spent fuel pool water (as long as long as EPA and NRC regulatory requirements are met.)

Source: New York State, Riverkeeper, and Entergy, "Agreement," January 9, 2017. [ML17068A245]

Sidebar: Nuclear Radiation Limits

EPA's drinking water limits are 20,000 picocuries per liter for tritium, 8 picocuries per limits for Strontium-90, and so on based on limiting radiation dose to the body at 4 millirem. Indian Point's limit on liquid releases is 3 millirem per year to the total body.

How does one translate picocuries per liter into millirem per year?

NRC's regulations require owners to calculate the maximum potential exposure to an individual from airborne and liquid releases considering all the radionuclides in the releases, various means of exposure (e.g., inhalation, consuming fish, drinking water, etc.) and how radionuclides affect the body.

The analysis is performed using the equation on the next slide.

Sidebar: Nuclear Radiation Limits

$$D(T) = \sum_{i=1}^{m} [A_{iT} * \sum_{k=1}^{n} (dt_k)(C_{ik})(F_k)]$$

Where:

m = The total number of isotopes released.

D(T) = The liquid effluent cumulative dose commitment from nuclides to the total body or any organ, T, for the time period k, in mrem.

dt_k = The length of the time period, k over which C_{ik} and F_k are averaged for all liquid releases, in hours. (This can be individual release durations summed, or an entire period duration, defined with each application of this equation.)

C_{ik} = The undiluted liquid effluent average concentration of nuclide, i, in uCi/ml, during time period dt_k from any liquid release.

n = The total number of releases considered.

A_{iT} = The site related ingestion dose commitment factor to the total body or any organ for each identified principal gamma and beta emitter listed in Table 2-1, 2-2, and 2-3, in mrem-ml per hr-uCi.

F_k = The total dilution factor for C_{ik} during any liquid effluent releases; defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted receiving waters, times an applicable factor.

Source: Entergy, "Offsite Dose Calculation Manual," Rev. 5, April 30, 2021 (ML21168A060).

Question About Tritium Limit

Tritiated water may pose a relatively low hazard by itself, but what if tritium bioaccumulates (i.e., gets absorbed by plants and consumed by marine life to concentrate the amount and increases the harm?

"To date, no phenomenon of tritium bioaccumulation has been observed in marine organisms on the French Channel coast."

Source: Institut de Radioprotection et de Surete Nucleaire (IRSN), "Tritium and the Environment," December 18, 2010. (https://www.irsn.fr/EN/Research/publications-documentation/radionuclides-sheets/environment/Documents/Tritium_UK.pdf)

Several French nuclear power plants discharge radioactively contaminated water into the French Channel (or English Channel when viewed from the other side of it), so the lack of tritium bioaccumulation is encouraging, but not the whole story.

Question About Tritium Limit

A tritium atom (H^3) can join another hydrogen atom and a oxygen atom to form tritiated water, or it can bind with other atoms to form other molecules. It may make a difference:

> ***"OBT*** **[organically bound tritium]** ***is produced through photosynthesis in plants and metabolic processes in animals and can be detected in most compartments of organic materials such as plants, animal products and soils. … Unlike for HTO*** **[tritiated water]*****, OBT behaviour is not well understood in the environment. Tritium as HTO can't bio-accumulate in the environment. However, it is not well known whether or not OBT can accumulate in the environment."***
> **[underlining added for emphasis]**

AECL Canada, Chalk River Laboratories, "Current Understanding of organically bound tritium (OBT) in the environment," 2013.

Question About Tritium Limit

"Tritium was bioaccumulated into organic tritium in phytoplankton cells. Green algae incorporated more tritium than the cyanobacteria. Organic tritium was transferred from phytoplankton to blue mussels when ingested. Linear uptake of tritium into mussels indicates a potential for biomagnification. <u>Current legislation may underestimate accumulation of tritium in the environment.</u>" **[underlining added]**

Benedict C. Hasechke & Clare Bradshaw, *Journal of Environmental Radioactivity,* Vol.115, January 2013, pp. 28-33.

"OBT has a longer retention time than tritiated water in animals. OBT is lost slowly from animals as a result of metabolic oxidation to HTO, which is then excreted."

AECL Canada, Chalk River Laboratories, "Current Understanding of organically bound tritium (OBT) in the environment," 2013.

Legislation setting the limits assumed tritium is retained in the body shorter than if it is in organically bound form. The limits may be non-conservative.

Answer About Tritium Limit

"Using the current ICRP dose conversion factors of HTO and OBT, the OBT dose contributes only about 1% to the total tritium dose for most aquatic releases. This contribution increases if the contaminated water is used to irrigate agricultural crops, but even in this case, it reaches only about 10%."

AECL Canada, Chalk River Laboratories, "Current Understanding of organically bound tritium (OBT) in the environment," 2013.

Even if the current limits non-conservatively account for organically bound tritium, there is considerable margin between the radiation dose from actual releases to the current limit. In other words, even if the limit was lowered to fully account for organically bound tritium, the radiation doses from past discharges of radioactively contaminated water would remain on the good side of the limit.

	Total Whole Body Dose From Liquid Effluents	Total Body Dose Limit (40 CFR 190)	Percentage of 40 CFR 190 Limit
	millrem	millrem	
2005	0.001256	3	0.0419%
2006	0.001007	3	0.0336%
2007	0.000855	3	0.0285%
2008	0.000767	3	0.0256%
2009	0.001149	3	0.0383%
2010	0.000688	3	0.0229%
2011	0.000748	3	0.0249%
2012	0.000576	3	0.0192%
2013	0.001375	3	0.0458%
2014	0.0004589	3	0.0153%
2015	0.001247	3	0.0416%
2016	0.001091	3	0.0364%
2017	0.000784	3	0.0261%
2018	0.001947	3	0.0649%
2019	0.0005892	3	0.0196%
2020	0.000709	3	0.0236%
2021	**0.011966**	3	**0.3989%**

x 10 = 3.989%

If bioaccumulation of organically bound tritium meant that the actual dose was 10 times higher than the calculated dose, that increased dose would still be less than 4 percent of the 40 CFR 190 limit.

Source: Indian Point owner's annual effluent reports to the NRC (e.g. ML061240373).

Discharge to the river

Cons:

Tritiated water is discharged into the river with the potential it may be consumed by humans/wildlife.

Pros:

Discharge will be conducted with equipment and procedures that have been used for many years at Indian Point.

Minimal impact on decommissioning schedule and cost.

Experience shows that past discharges resulted in radiation exposures to humans significantly below allowable federal limits.

Option:

Evaporated to the air

Lesson from Three Mile Island

The City of Lancaster, Pennsylvania initiated Civil Action No. 79-1368 (City of Lancaster v. United States Nuclear Regulatory Commission) in U.S. District Court of Columbia seeking to prevent the release of contaminated water generated during the March 1979 accident at Three Mile Island Unit 2 into the Susquehanna River.

On February 27, 1980, a settlement agreement was reached by the parties that "*no accident-generated wastewater will be discharged into the Susquehanna River from the date of this Settlement Agreement through December 31, 1981, or until the NRC completes its Programmatic Environmental Impact Statement.*"

Source: Settlement Agreement, February 27, 1980 (ML20054E125).

Lesson from Three Mile Island

Table 7.1 Summary of Estimated TMI-2 Liquid Waste

Source of Liquid Waste	Volume (gallons)	Curie Inventory in Untreated Liquid: Minimum	Maximum
1. AFHB Chemical Decon Solutions	7,000	60	60
2. RB Sump Water	700,000	500,000	500,000
3. RCS Water	96,000	20,000	20,000
4. RCS Flush and Drain	250,000[a]	20,000	100,000
5. RB Decon Solutions			
(a) Water Based	150,000[a]	90	90
(b) Chemical	40,000	10	10
6. RCS Decon Solutions[b]			
(a) Water based	100,000[a]	2,000	20,000
(b) Chemical	500,000[a]	2,000	20,000

[a]Processed water could be used for the cleanup activities resulting in the generation of this liquid waste.

[b]The RCS water-based and chemical decontamination processes are mutually exclusive. Either the water-based or chemical process will be used in the decontamination of the RCS.

The accident flooded the reactor building (RB) with lots of water containing lots of radioactivity.

Source: U.S. Nuclear Regulatory Commission, "Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident Three Mile Island Nuclear Station, Unit 2," NUREG-0683 Vol. 1, March 1981 (ML19343C359).

Lesson from Three Mile Island

Table 7.4. Radioactivity in TMI-2 Untreated Liquid Waste

Source of Liquid Waste	Average Radionuclide Concentrations (µCi/mL[a])	Isotope Inventory (Ci)[a] H-3	Cs-137	Cs-134	Sr-90	Sr-89	Others[d]
1. AFHB Chemical Decon Solutions	2	-[e]	51	8	1	-	-
2. RB Sump Water	190	2,500	430,000	66,000	7,000	190	75
3. RCS Water	60	30	9,000	1,500	7,800	20	110
4. RCS Flush & Drain[b]	100	-	49,000	7,500	39,000	4,100	550
5. RB Decon Solutions							
(a) Water based	0.2	-	77	12	1		-
(b) Chemical	0.1	-	8	2			-
6. RCS Decon Solutions[b]							
(a) Water Based[c]	50	-	9,900	1,500	7,800	820	110
(b) Chemical[c]	10	-	9,900	1,500	7,800	820	110

[a]Rounded.

[b]The curie content corresponds to the maximum estimated values in Table 7.1.

[c]These two solutions are mutually exclusive. Either the water-based or chemical decon solution will be generated during decontamination of the RCS.

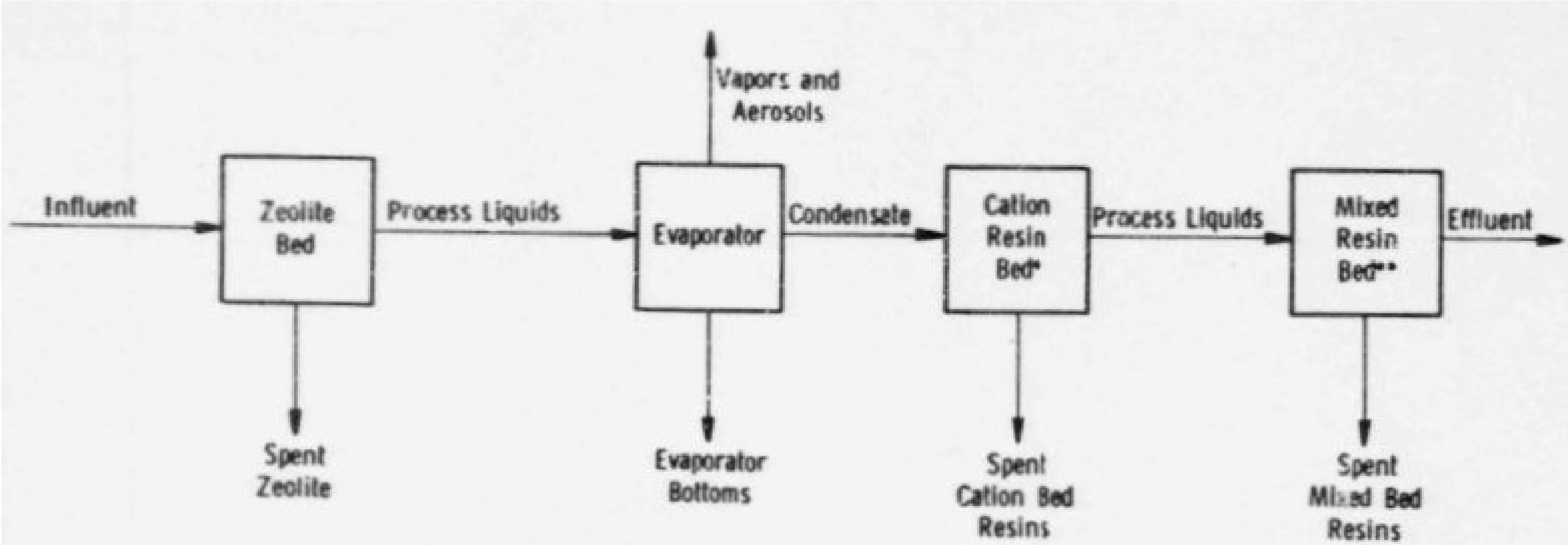
[d]See Table G.8 for detailed distribution of other radionuclides.

[e]"-" denotes less than one curie.

The reactor building flood water had 2,500 curies of tritium and 430,000 curies of Cesium-137.

Source: U.S. Nuclear Regulatory Commission, "Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident Three Mile Island Nuclear Station, Unit 2," NUREG-0683 Vol. 1, March 1981 (ML19343C359).

Lesson from Three Mile Island



With the "treat and release" option eliminated by the settlement agreement, the alternative option featured filtering the accident generated water to remove as much of the radioactivity as possible and then evaporating the processed water. Residue left after boiling off the water (evaporator bottoms) was disposed of as solid radioactive waste.

Source: U.S. Nuclear Regulatory Commission, "Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident Three Mile Island Nuclear Station, Unit 2," NUREG-0683 Vol. 2, March 1981 (ML20149L830).

Lesson from Three Mile Island

Approximately 2,300,000 gallons of water containing an estimated 1,020 curies of tritium were radioactively contaminated during the March 28, 1979, partial meltdown of Three Mile Island Unit 2 reactor core.

The system for disposing over two million gallons of accident generated waste featured an electric powered vaporizer to boil water at a rate of about 5 gallons per minute. The vapor was vented to the atmosphere through a 100-foot tall stack. The residue (i.e., any solid material remaining after the water boiled away) was packaged for disposal as solid radioactive waste.

The company notified the NRC that disposal of 2,230,000 gallons of accident generated water was completed on August 12, 1993.

Source: General Public Utilities, "Preliminary System Description for Accident Generated Water Disposal," February 16, 1988 (ML20149J557).

Lesson from Three Mile Island

Tritiated water evaporated into the air does not eliminate its potential contact with humans. Individuals could inhale the gaseous tritium. Or along the lines of "what goes up must come down," rainfall could deposit tritium in city water reservoirs, ponds, schoolyards, etc. where individuals could be exposed to it.

Lesson from Three Mile Island

In 1987, the National Council on Radiation Protection and Measurements assessed the potential radiation dose to the public from discharge of the radioactively contaminated water to the river and its evaporation to the air. The NCRP concluded that evaporation could result in doses 300 times higher than water discharge:

Table 8.2 – Summary of the total effective dose equivalents resulting from two modes of release

	Release to Atmosphere		Release to Surface Water
Total	6.0 μSv (0.6 mrem)		0.02 μSv (2 μrem)
Pathway			
Food (67%)	4 μSv (0.4 mrem)	Food (36%)	0.007 μSv (0.7 μrem)
Milk (18%)	1 μSv (0.1 mrem)	Milk (10%)	0.002 μSv (0.2 μrem)
Inhalation (13%)	0.8 μSv (0.08 mrem)	Inhalation (0%)	0 μSv (0 μrem)
Drinking Water (1%)	0.06 μSv (0.006 mrem)	Drinking Water (54%)	0.011 μSv (1.1 μrem)

Source: National Council on Radiation Protection and Measurements, "Guidelines for the Release of Waste Water from Nuclear Facilities with Special Reference to the Public Health Significance of the Proposed Release of Treated Waste Waters at Three Mile Island," May 1, 1987.

Lesson from Three Mile Island

Some of the accident generated water may have leaked into the ground before it could be boiled into the sky.

A sample from an onsite monitoring well collected on August 3, 1990, had a tritium concentration of 29,000 picocuries per liter, above the EPA drinking water standard of 20,000 picocuries per liter (although no one was drinking the monitoring well's water.)

This monitoring well was located between the Borated Water Storage Tank and Processed Water Storage Tank No. 1. The sampling point was about 40 feet below ground.

Source: U.S. Nuclear Regulatory Commission, "Preliminary Notification of Event or Unusual Occurrence PNO-I-90-71, "Potential Leakage of Accident Generated Water," August 30, 1990 (ML20059E797).

Evaporated to the air

Cons:

Tritiated water is released into the air with the potential it will be inhaled/ingested by humans.

Release will be conducted with equipment and procedures never before used at Indian Point.

Increases length and cost of decommissioning.

Pros:

Process has been used elsewhere and is governed by existing federal regulations.

If the solution to pollution is dilution, mixing tritium with air rather than water might yield greater dilution and thus a better solution.

Option:

Shipped offsite for burial

Lesson from Vermont Yankee

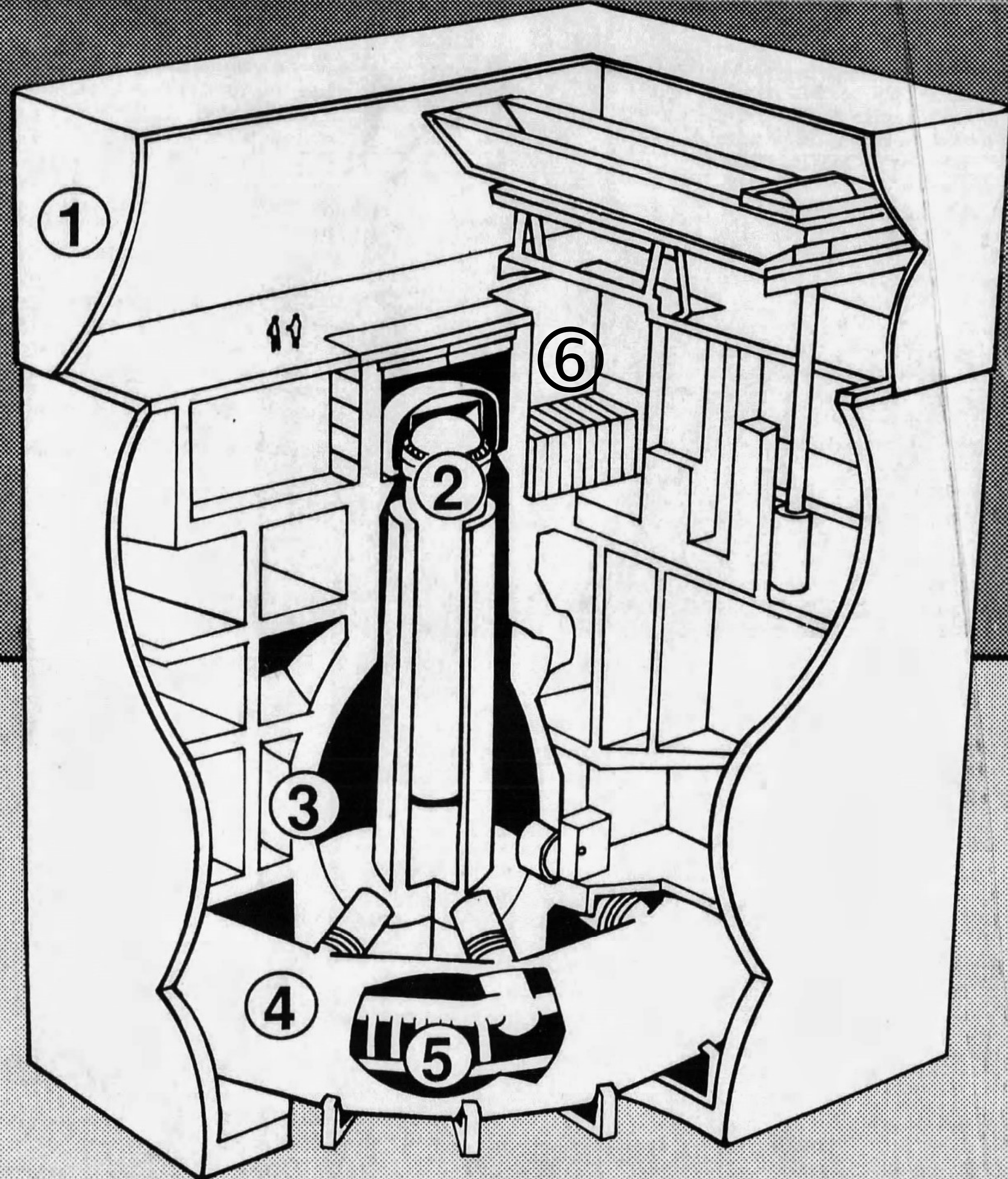
The Vermont Yankee nuclear plant disposed of spent fuel pool water without discharging it into the nearby lake, river or ocean or venting it to the atmosphere.

It was transported out west and buried.

Vermont Yankee's radioactively contaminated water was transported to a site about 10.5 miles northwest of Grand View, Idaho and buried.

1. Reactor Building (Secondary Containment)
2. Reactor Vessel
3. Containment (Drywell)
4. Containment (Wetwell or Torus)
5. Pressure Suppression Pool
6. Spent Fuel Pool

Nearly 2,000,00 gallons of radioactively contaminated water was shipped to Idaho. About 200,000 gallons of spent fuel pool water and about 9 times as much suppression pool (torus) water went to Idaho.



SOURCE: General Electric

"In accordance with 10 CFR 20.2002, "Method for obtaining approval of proposed disposal procedures" NorthStar Nuclear Decommissioning Co., LLC requests NRC approval of alternate waste disposal at the US Ecology, Inc (USEI) Resource Conservation and Recovery Act (RCRA), Subtitle C hazardous waste disposal facility located near Grand View, Idaho. The waste will consist of approximately 2,000,000 gallons of low-activity radioactive wastewater containing byproduct material from activities associated with the decommissioning process at Vermont Yankee Nuclear Power Station (VY). ... Since the USEI facility is not an NRC-licensed disposal facility, USEI will submit under separate letter a request for an exemption pursuant to 1O CFR 30.11 to allow for the disposal of the byproduct material at the USEI facility."

An exemption from NRC's safety regulations was needed to allow the radioactively contaminated water from Vermont to be buried in Idaho.

Source: NorthStar Nuclear Decommissioning Co. LLC, "*10 CFR 20.2002 Request for Alternate Waste Disposal at US Ecology, Idaho,*" May 20, 2020 (ML20157A123).

"The wastewater will be solidified with clay at USEI and disposed as a soil-like waste upon receipt. The liquid solidification process at USEI is routinely used for applicable shipments. A limit of 1,000,000 gallons is conservatively assumed to be transported in a single year, since actual shipments will indeed be lower. To account for the solidification process at USEI, a total waste mass for the entire project of 4.25E+07 pounds (lb) was entered into the SSDA workbook to account for the 'bulking' that will occur from the clay used to solidify the water."

The 2,000,000 gallons of radioactively contaminated water would be mixed with clay to form 42,500,000 pounds of soil-like waste (a.k.a. "nuke mud") for burial.

Source: NorthStar Nuclear Decommissioning Co. LLC, "*10 CFR 20.2002 Request for Alternate Waste Disposal at US Ecology, Idaho,*" May 20, 2020 (ML20157A123).

"In an email dated March 15, 2021 (ADAMS Accession No. ML21075A144), VY stated that their initial submittal had a typo in the volume of water that each railcar could hold, and they provided an updated dose analysis for the railcar surveyor. Using the correct volume of 20,000 gallons per railcar (75,700 L per railcar) results in there being 101 shipments of water for the project (versus the previous estimate of 67 shipments)."

Originally, the plan was to transport the 200,000 gallons of spent fuel pool water to Idaho for burial. That plan was revised to include about 1,800,000 gallons of torus water – all to be transported in 67 railcars to Idaho for burial. The revised plan was then updated to correct a "typo" in that 101 railcars would be needed.

Source: Nuclear Regulatory Commission, *Vermont Yankee Nuclear Power Station – Request for 10 CFR 20.2002 Alternate Disposal at US Ecology Idaho,* May 7, 2021 (ML21082A115).

"The NRC staff reviewed the exposure scenarios evaluated in this 20.2002 request and concludes that they are consistent with NRC guidance on 20.2002 requests. The NRC staff notes that the evaluation of the transport dose to the public is not required per the most recent revision to the "Guidance for the Reviews of Proposed Disposal Procedures and Transfers of Radioactive Material under 10 CFR 20.2002 and 10 CFR 40.13(a)" (ADAMS Accession No. ML18296A068) and the NRC staff does not evaluate doses from the disposal of radioactive material while it is in transit for disposal therefore did not review the transport dose during their review of this 20.2002 request."
[underlining added for emphasis]

Actually, whether the 2 million gallons went in one very large railcar or 2,000 tiny railcars was immaterial in the NRC's eyes. They "*did not review the transport dose*."

Source: Nuclear Regulatory Commission, ***Vermont Yankee Nuclear Power Station – Request for 10 CFR 20.2002 Alternate Disposal at US Ecology Idaho,*** **May 7, 2021 (ML21082A115).**

Table 5 Projected Post-Closure and Inadvertent Intruder Doses Calculated using SSDA Revision 3 and SSDA Revision 3b

Scenario	Revision 3 Annual Dose mrem/yr (mSv/yr)	Revision 3b Annual Dose mrem/yr (mSv/yr)
Post-Closure	0.941 (0.00941)	1.50 (0.0150)
Inadvertent Intruder – Construction	7.67 (0.0767)	1.07 (0.0107)
Inadvertent Intruder – Well Driller	7.20 (0.0720)	0.504 (0.00504)
Inadvertent Intruder – Driller Occupancy	0.498 (0.00498)	0.0336 (0.000336)

Assuming no more typos and no Revision 3c, 3d, etc., the annual radiation post-closure dose to the people of Idaho from the burial of soil-like waste from Vermont Yankee is projected to be 0.941 to 1.50 mrem/year – considerably below the 25 mrem/year limit in federal regulation 40 CR 190.

Source: Nuclear Regulatory Commission, *Vermont Yankee Nuclear Power Station – Request for 10 CFR 20.2002 Alternate Disposal at US Ecology Idaho,* May 7, 2021 (ML21082A115).

	Total Whole Body Dose millrem
2005	0.001256
2006	0.001007
2007	0.000855
2008	0.000767
2009	0.001149
2010	0.000688
2011	0.000748
2012	0.000576
2013	0.001375
2014	0.0004589
2015	0.001247
2016	0.001091
2017	0.000784
2018	0.001947
2019	0.0005892

The calculated annual radiation dose to the public from releases of radioactively contaminated water from Indian Point ranged from a low of 0.000576 mrem in 2012 to a high of 0.001947 mrem in 2018.

The projected annual radiation dose to the public from the burial site in Idaho of 0.94 mrem/year to 1.50 mrem/year is 483 to 770 times greater than the highest radiation dose from liquid releases from Indian Point between 2005 and 2019.

Environmental Justice?

If burying radioactively contaminated water in Idaho poses no undue risk to the people of Idaho, why not just bury it in Buchanan?

How can it be safe there yet unsafe here?

Shipped offsite for burial

Cons:

Tritiated water is placed into the ground with the potential it will be inhaled/ingested by humans.

Leaks and spills while filling the shipping containers at Indian Point or emptying them in Idaho or an accident during transportation could result in untreated, undiluted tritiated water flowing places it should not be.

Process requires exemptions/waivers from federal safety regulations.

Environmental injustice?

Pros:

If there are no leaks, spills, or accidents en route, any problem becomes Idaho's and not New York's.

Option:

Stored onsite until decayed

Lesson from Fukushima

On March 11, 2011, the reactor cores of the three operating reactors at Fukushima Daiichi melted down. (That's the plant between the Pacific Ocean and the water storage tanks.)

Lesson from Fukushima

As this picture taken before March 11, 2011, shows, the water storage tanks were not "original equipment."

Lesson from Fukushima

As this picture taken after March 11, 2011, shows, water storage tanks were installed to contain radioactively contaminated water created by the accident.

Lesson from Fukushima

The water storage tanks proliferated because lots of radioactively contaminated water was being produced and discharge to the ocean was not an option.

Less than 30 months after the accident, the water storage tanks were found to be leaking radioactively contaminated water, with a drain path to the ocean.

Countermeasures to mitigate risks regarding the water leak from the tank

August 26, 2013

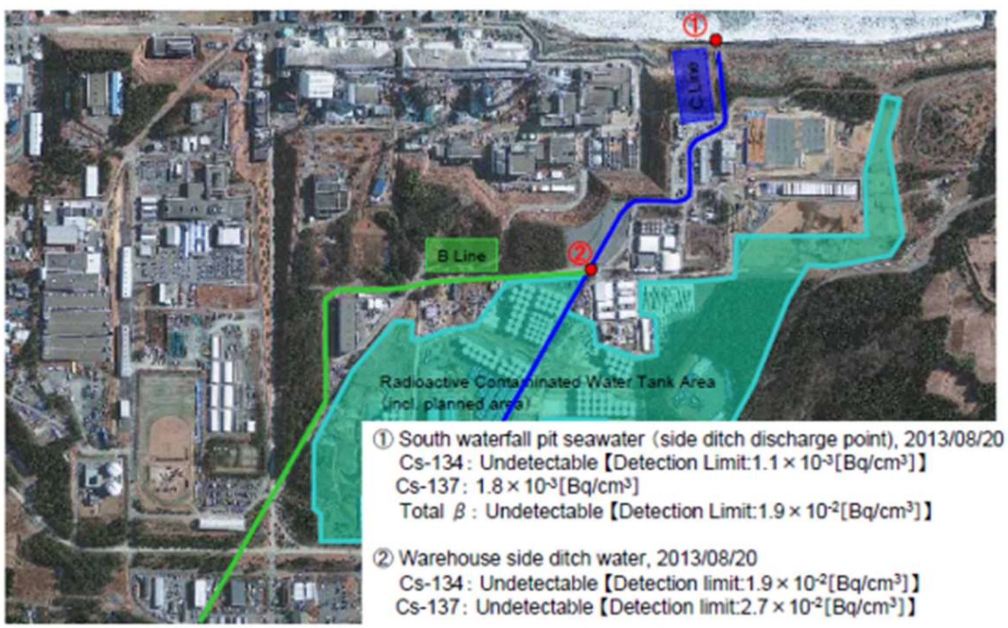
Tokyo Electric Power Company, Inc

東京電力

TEPCO

1

【Measure 1 –⑤】 Investigation of water outflow into the ocean



① South waterfall pit seawater (side ditch discharge point), 2013/08/20
Cs-134: Undetectable【Detection Limit:1.1 × 10^{-3}[Bq/cm³]】
Cs-137: 1.8 × 10^{-3}[Bq/cm³]
Total β: Undetectable【Detection Limit:1.9 × 10^{-2}[Bq/cm³]】

② Warehouse side ditch water, 2013/08/20
Cs-134: Undetectable【Detection limit:1.9 × 10^{-2}[Bq/cm³]】
Cs-137: Undetectable【Detection limit:2.7 × 10^{-2}[Bq/cm³]】
Total β :9.3 × 10^{-2}[Bq/cm³] (Note) β ray:70 μm radiation dose rate

東京電力

7

If the solution to pollution is dilution, then non-dilution of the leaked water constitutes a pollution problem.

Appendix C is an abridged – very abridged – listing of leaks and spills of radioactively contaminated water from water storage tanks and connected piping at U.S. nuclear power reactors.

Water storage tanks never, ever leak water.

Unless water is stored in the tanks.

The question is not if water storage tanks leak.

The question is when water storage tanks leak.

Lesson from (too) Many Places

Water storage tanks are equipped with vents to allow air to leave or enter, as needed. Appendix C lists several spills of radioactively contaminated water when tanks overflowed through the vents. Among the many examples:

- **Vermont Yankee: 83,000 gallons overflowed a tank and drained into the Connecticut River**
- **Turkey Point (FL): 3,000 gallons containing 1,091 curies overflowed the Refueling Water Storage Tank**
- **St. Lucie (FL): 11,250 gallons containing 3.91 curies of tritium overflowed the primary water tank**
- **Browns Ferry (AL): The Condensate Storage Tank overflowed due to failed level instrumentation – the spill was detected when leaked water flooded a nearby building**

Lesson from (too) Many Places

Source: https://www.dultmeier.com/blog/petro/tank-vent-proper-venting/

As these pictures illustrate, improperly vented water storage tanks have imploded and collapsed when a vacuum formed inside the tanks and the differential pressure caused the tank's walls to bend.

Fatal Lesson from Calvert Cliffs

On September 15, 1988, a diver descending a ladder into the Condensate Storage Tank at the Calvert Cliffs nuclear plant in Maryland fell off the ladder into the tank's water.

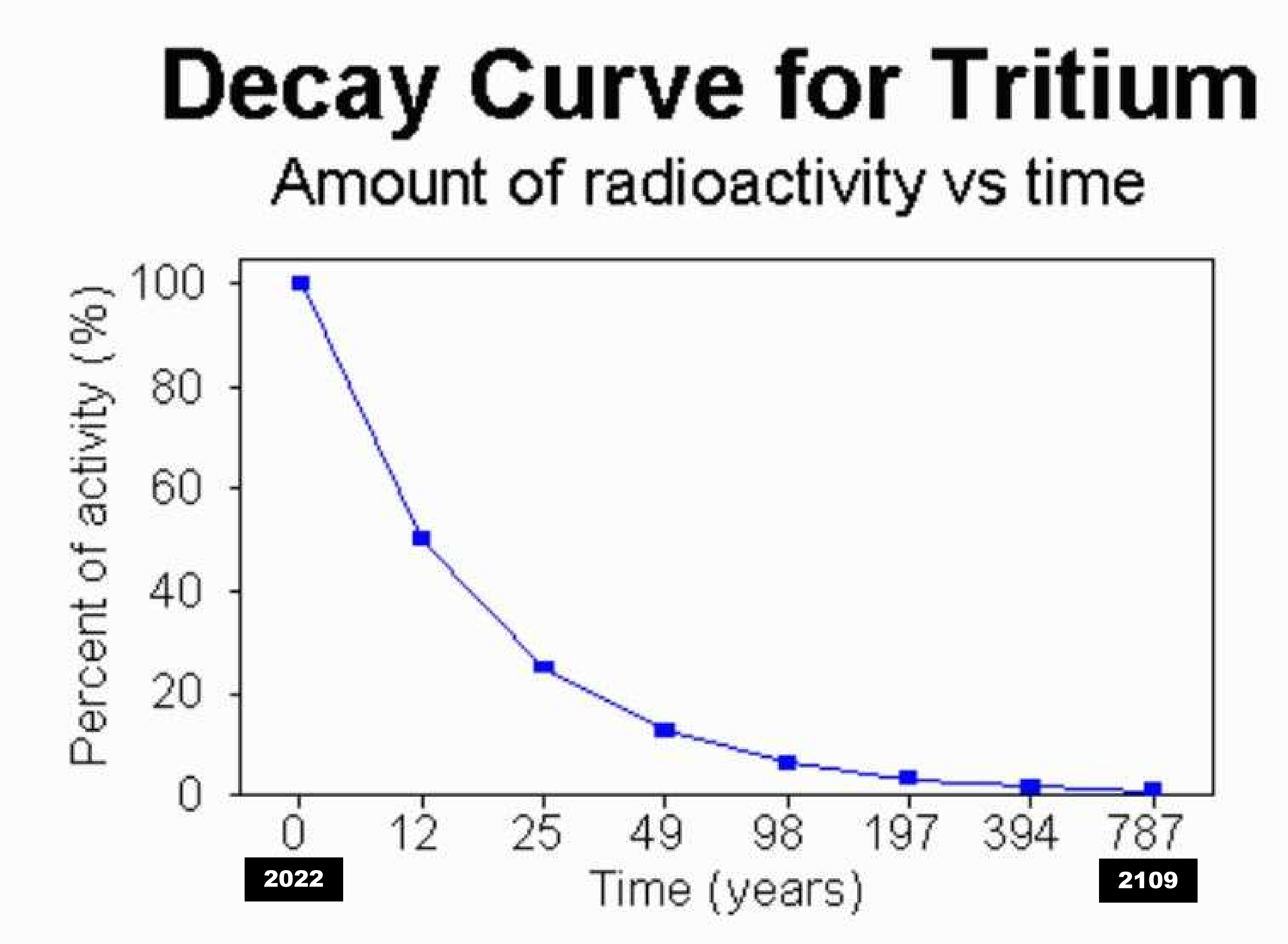
A worker jumped into the tank to assist the diver.

A third worker pulled the diver from the tank using the diver's safety line. The diver was given first aid and transported to a hospital where he recovered.

Police divers recovered the body of the worker who attempted to aid the fallen diver about three hours later. The worker had either drowned or suffocated in the attempted rescue of the diver.

NOTE: Tugging on the diver's safety line had lower risk than jumping into the tank. A rushed effort to save one life cost another life.

Source: Nuclear Regulatory Commission, PNO-I-88-95, "Industrial Accident Resulting in Death," September 15, 1988 (ML20154E833).



The water storage tanks would only need to be leak-proof, spill-free and vent-free for merely 787 years for the tritium to decay away.

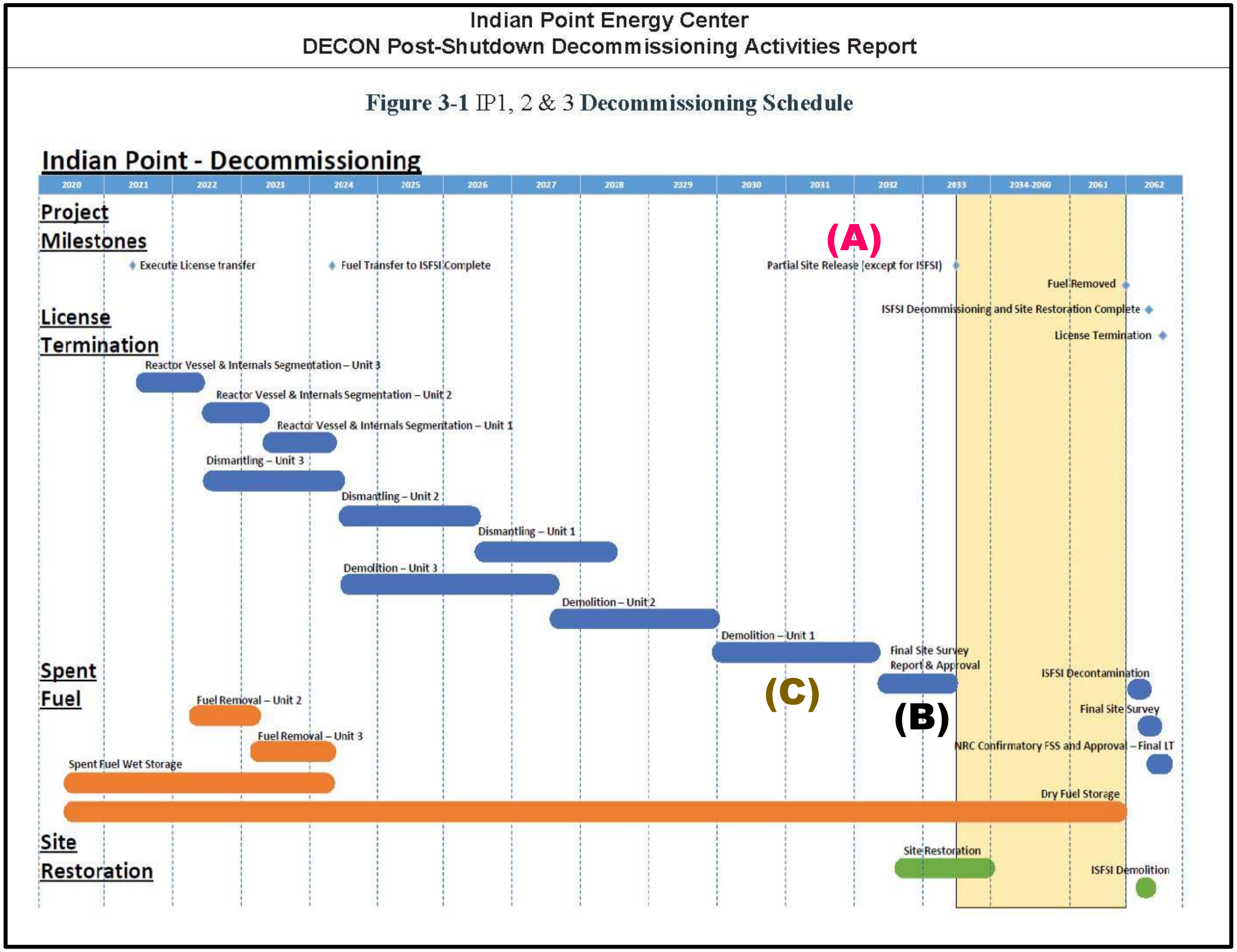
Contrary to Closure Agreement and Public Service Commission Order

As detailed in Appendix D, the Closure Agreement for the permanent closure of Indian Point Units 2 and 3 explicitly authorized treat and release of radioactively contaminated water to the Hudson River and the PSC Order approving ownership transfer from Entergy to Holtec found thorough and timely decommissioning and site restoration to be "unquestionably in the public interest."

Onsite storage of spent fuel pool water is therefore inconsistent with the terms and conditions of the agreement and order.

Furthermore, onsite storage involves the risk of leakage requiring remediation – a cost factor explicitly identified as being an attractive reason for Holtec's expeditious decommissioning instead of Entergy's long term, get around to it decommissioning plan.

Delay is Not Risk-Free



The NRC issues a Partial Site Release (A) only after approving the Final Site Survey Report (B).

The Final Site Survey Report is prepared after demolition and dismantling of Units 1, 2, and 3 is completed (C).

Sustaining onsite storage of radioactively contaminated water postpones the Final Site Survey from 2032 to ???.

Contamination problems at Zion were literally uncovered during the Final Site Survey.

Source: Entergy, "Indian Point Unit No. 2 10 CFR 50.71(e) Submittal," September 14, 2020 (ML20259A199).

Lesson from Zion

On April 15, 2019, NRC and Oak Ridge Institute for Science and Education representatives began a survey of the site after being notified by the owner that it was clean per the License Termination Plan.

On April 16, 2019, ORISE discovered radioactive particles. The NRC granted the owner's request to suspend its confirmatory survey and departed the site on April 18, 2019.

The owner's re-surveys found additional radioactive particles "*primarily on the soil footprint where the Containment Tents were constructed and from the areas where radioactive waste was stockpiled prior to packaging.*"

Had the survey been delayed, identification and remediation of the loose radioactive particles would also have been delayed.

Source: Zion Memo, "Results of Re-Survey of Power Block Area and Readiness for ORISE Confirmatory Surveys," May 30, 2019 (ML21067A215).

Stored onsite until decayed

Cons:

Retains the radioactively contaminated water onsite for a few centuries.

May require storage tanks to be installed to accommodate the volume of water.

Involves evaporation of tritium to the air.

Contrary to terms and conditions of the closure agreement, joint proposal, and PSC order.

Postpones surveys to ensure no excessive residual radioactivity remains at the site.

Pros:

Assuming no leakage, no radioactively is released to the water. It decays away over time.

Summary

Spent fuel pool water can be:

- **discharged to the river**
- **evaporated to the air**
- **shipped offsite for burial**
- **stored onsite until decayed**

In my opinion, discharging the spent fuel pool water via the waste disposal system poses the least public risk.

Appendix A

Georgia Power Company
270 Peachtree Street
Post Office Box 4545
Atlanta, Georgia 30302
Telephone 404 522-6060

Employee Relations Department

Georgia Power
the southern electric system

May 14, 1979

Mr. David A. Lochbaum

Dear Mr. Lochbaum:

We were very pleased to hear of your acceptance of the position of Junior Engineer in the Power Generation Department at Plant Hatch at the beginning monthly salary of

The date agreed upon for your reporting is June 18, 1979. You should report to Mr. W. Manry at Plant Hatch. Please take a copy of your birth certificate with you, as it will be needed in your initial employment process. Also, please bring a certified final college transcript showing that you have completed all requirements for graduation.

If you live 35 miles or more from your assigned work location, the Company will assist you in paying the expenses associated with your relocation. Contact Mr. W. W. Ivie, Manager of Traffic and Purchasing Services collect at area code (404) 522-6060, extension 2841, and he will make the necessary arrangements to have your household goods moved to your new residence. Relocation must be completed within 30 days from the date you report to work. If unusual circumstances occur where an extension may be justified, you should contact your supervisor. He will request authorization from the Manager of Compensation and Benefits.

We look forward to having you as an employee of the Company, and we feel that you will find many satisfying and rewarding experiences as you begin your career with us. Please let us know if we can be of any assistance to you in the future.

Very truly yours,

Wm. V. Morris

William V. Morris
Coordinator Professional Employment

WVM/sel

cc: W. Manry
B. Ragsdale

Lochbaum graduated in June 1979 with a Bachelor of Science degree in Nuclear Engineering from the University of Tennessee.

His first job out of college was as Radwaste System Engineer for the two boiling water reactor units at the Edwin I. Hatch nuclear plant in Georgia.

Each unit had its own radwaste system that collected contaminated water and processed it for either re-use in the plant or discharge to the Altamaha River.

Appendix A

Lochbaum co-authored a report to the NRC in November 1992 that included this concern:

> ***"The instrumentation available to the operator post-LOCA may not provide adequate indication of spent fuel pool temperature and level to allow proper response to a loss of fuel pool cooling event."***

The NRC took no action to address this, and other concerns. At least not until…

November 27, 1992

Mr. Thomas T. Martin
Regional Administrator, Region I
United States Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406-1415

SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION
DOCKET NO. 50-387
LICENSE NO. NPF-14
10CFR21 REPORT OF SUBSTANTIAL SAFETY HAZARD

Dear Mr. Martin:

Pursuant to the requirements of 10CFR21, Reporting of Defects and Noncompliance, this letter is submitted to report a "substantial safety hazard" that exists in the design of the Susquehanna Steam Electric Station (SSES) located near Berwick, Pennsylvania. This report is being made by Mr. David A. Lochbaum who, through July of this year, worked as a contract engineer in Pennsylvania Power & Light Company's (the licensee) Nuclear Plant Engineering Section, and Mr. Donald C. Prevatte who is currently, and until the end of this year, working as a contract engineer in PP&L's Nuclear Plant Engineering Section.

The substantial safety hazard is as follows: The SSES design for a loss of normal spent fuel pool cooling fails to meet numerous regulatory requirements. As a result, for a design basis accident, there is the potential for meltdown of irradiated fuel outside primary containment and the failure of all safety-related systems in the reactor building.

For an operating plant, 10CFR50.72 requires licensees to report in one hour any instance of the plant (a) being in an unanalyzed condition that significantly compromises plant safety, (b) in a condition that is outside the design basis of the plant, or (c) in a condition not covered by the plant's operating and emergency procedures. It also requires that reports shall be made within four hours of any condition that alone could have prevented the fulfillment of the safety function of structures or systems needed to (a) shut down the reactor and maintain safe shutdown, (b) remove residual heat, (c) control radioactive release, or (d) mitigate the accident. All of these conditions exist at SSES for the design basis accident (DBA) loss-of-coolant accident (LOCA) or LOCA with a loss-of-offsite-power (LOOP) as a result of the heatup of the spent fuel pool which mechanistically follows these accidents.

Source: David Lochbaum and Donald Prevatte, "10CDR21 Report of Substantial Safety Hazard," November 27, 1992 (ML18026A248).

Appendix A

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 12, 2012

EA-12-051

All Power Reactor Licensees and
Holders of Construction Permits in
Active or Deferred Status

SUBJECT: ISSUANCE OF ORDER TO MODIFY LICENSES WITH REGARD TO RELIABLE SPENT FUEL POOL INSTRUMENTATION

The U.S. Nuclear Regulatory Commission (NRC) has issued the enclosed Order that modifies the current license for your facility. The Order requires provisions for reliable spent fuel pool indications and applies to all addressees listed in Attachment 1 to the enclosed Order.

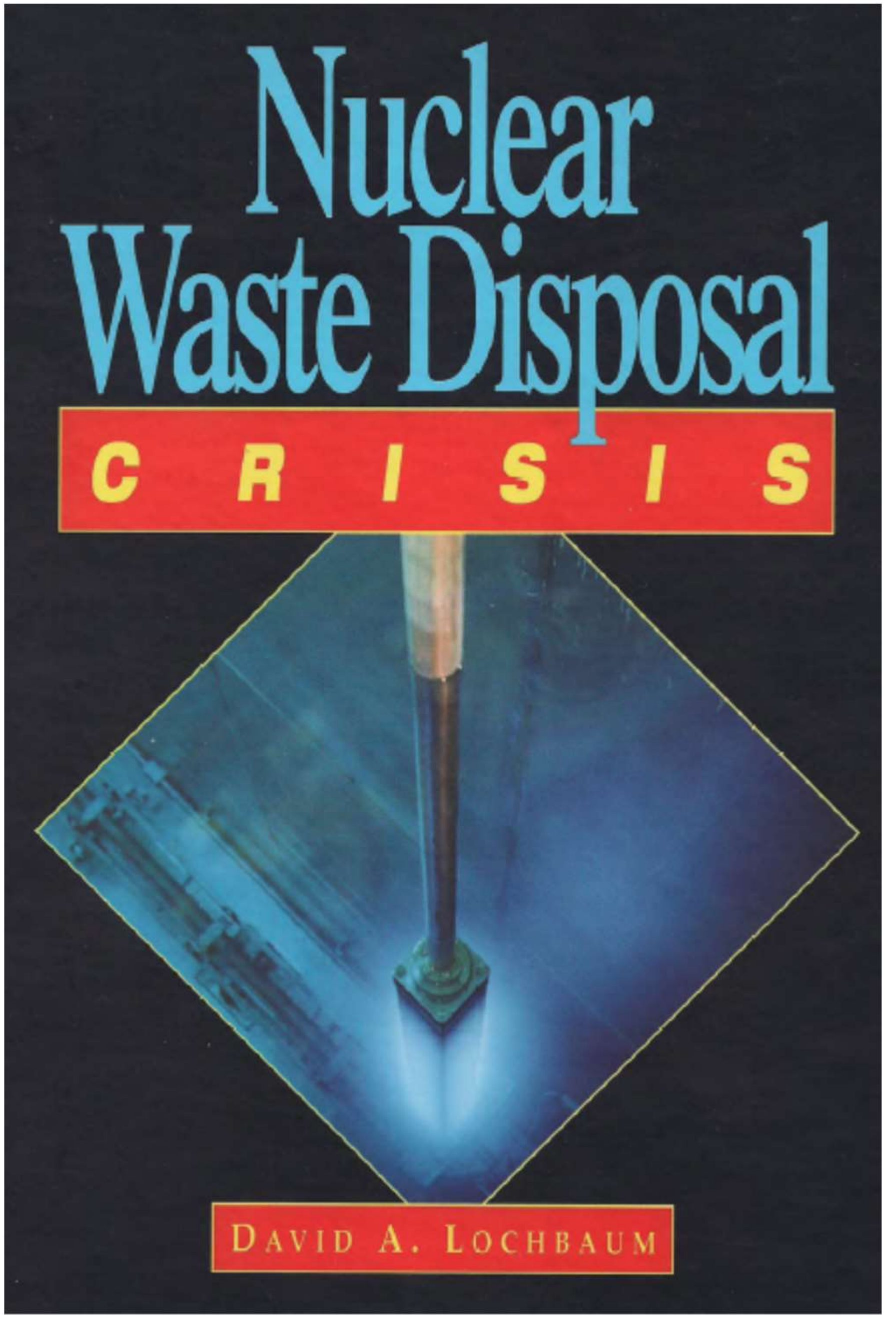
Following the earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011, the NRC established a senior-level task force referred to as the Near-Term Task Force (NTTF). The NTTF conducted a systematic and methodical review of the NRC regulations and processes to determine if the agency should make safety improvements in light of the events in Japan. As a result of this review, the NTTF issued SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan" (Agencywide Document Access and Management System (ADAMS) Accession No. ML11186A950). SECY 11-0124, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," (ADAMS Accession No. ML112911571) and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," (ADAMS Accession No. ML11272A111) were issued to establish the NRC staff's prioritization of the recommendations. Recommendation 7.1, concerning reliable spent fuel pool instrumentation, was determined to be a high-priority action. This Order is based upon the NTTF recommendation.

During the events in Fukushima, responders were without reliable instrumentation to determine water level in the spent fuel pool. This caused concerns that the pool may have boiled dry, resulting in fuel damage. Numerous attempts were made to refill the spent fuel pools, which diverted resources and attention from other efforts. The events at Fukushima demonstrated the confusion and misapplication of resources that can result from beyond-design-basis external events when adequate instrumentation is not available.

… a mere 19 ½ years later when the NRC ordered all owners of operating nuclear power reactors in the United States to belatedly provide reliable instrumentation for spent fuel pool water levels as "*a high priority action*."

Source: NRC, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," March 12, 2012 (ML12054A679).

Appendix A



Lochbaum authored a book on spent fuel storage problems that was published in 1996.

Appendix A

Contents

His book covered fuel pool and dry cask storage of spent fuel as well as spent fuel storage risks.

Appendix A

IN THE UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF PENNSYLVANIA

IN RE TMI LITIGATION : CIVIL ACTION NO. 1:CV-88-1452
CASES CONSOLIDATED II :
:
This Document Relates to: :
All Plaintiffs :

O R D E R

In accordance with the accompanying memorandum of law, IT IS HEREBY ORDERED THAT:

1) Defendants' motion in limine to exclude Plaintiffs' medical causation experts is GRANTED as to the proffered testimony of Dr. Theodor Sterling and Dr. Sigmund Zackrzewski;

2) Defendants' motion in limine to exclude Plaintiffs' medical causation experts is DENIED as to the proffered testimony of Dr. Winters, Dr. Cardinale, Dr. Galindo, and David Lochbaum, to the extent that each of their testimony is eventually connected with appropriate dose testimony pursuant to Rule 104(b) of the Federal Rules of Evidence.

SYLVIA H. RAMBO, Chief Judge
Middle District of Pennsylvania

Dated: April 5, 1996.

In April 1996, Judge Sylvia Rambo admitted Lochbaum's testimony about pathways for radiation releases in a case stemming from the 1979 accident at Three Mile Island. Judge Rambo wrote:

"Mr. Lochbaum has demonstrated that his opinion has little potential for error. His testimony reveals that he did not produce a result-oriented opinion, but rather carefully went through engineering and analytical steps in order to make an analysis. He applied a methodology that examined the potential for a blowout and carefully defined the narrow windows of time when there was potential for a blowout. As for his opinion on releases, he has carefully stated the basis for his opinions that the releases were significantly more than 10 million curies."

Appendix A

Spent Fuel Pool
Accident Risk at
Decommissioning Plants

David Lochbaum
Nuclear Safety Engineer
February 20, 2001

Lochbaum presented his views on spent fuel storage to the NRC Commissioners, the American Physical Society, the President's Blue Ribbon Commission and many others.

Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

Presentation to the American Physical Society

Interim Storage of Power Reactor Spent Fuel

David Lochbaum
Director, Nuclear Safety Project

August 8, 2006

Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

Interim Storage of Power Reactor Spent Fuel

David Lochbaum
Director, Nuclear Safety Project

August 2010

Appendix A

UNITED STATES NUCLEAR REGULATORY COMMISSION

Instructor Certification for

General Electric Technology

This certifies that

David A. Lochbaum

has completed the qualification requirements and has demonstrated competence, superior knowledge and operational expertise needed for instruction of NRC personnel.

January 25, 2010
Date

Chief Learning Officer, HR

Lochbaum was certified in January 2010 to teach NRC inspectors and reviewers in reactor technology.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG/CR-2907
Volume 25

Radioactive Effluents from Nuclear Power Plants

Annual Report 2019

Manuscript Completed: August 2021
Date Published: September 2021

Prepared by:
J. Davis

Oak Ridge Associated Universities
1299 Bethel Valley Road, SC-200, MS-21
Oak Ridge, TN 37830

Steven Garry, NRC Project Manager
Micheal Smith, NRC Project Manager

Office of Nuclear Reactor Regulation

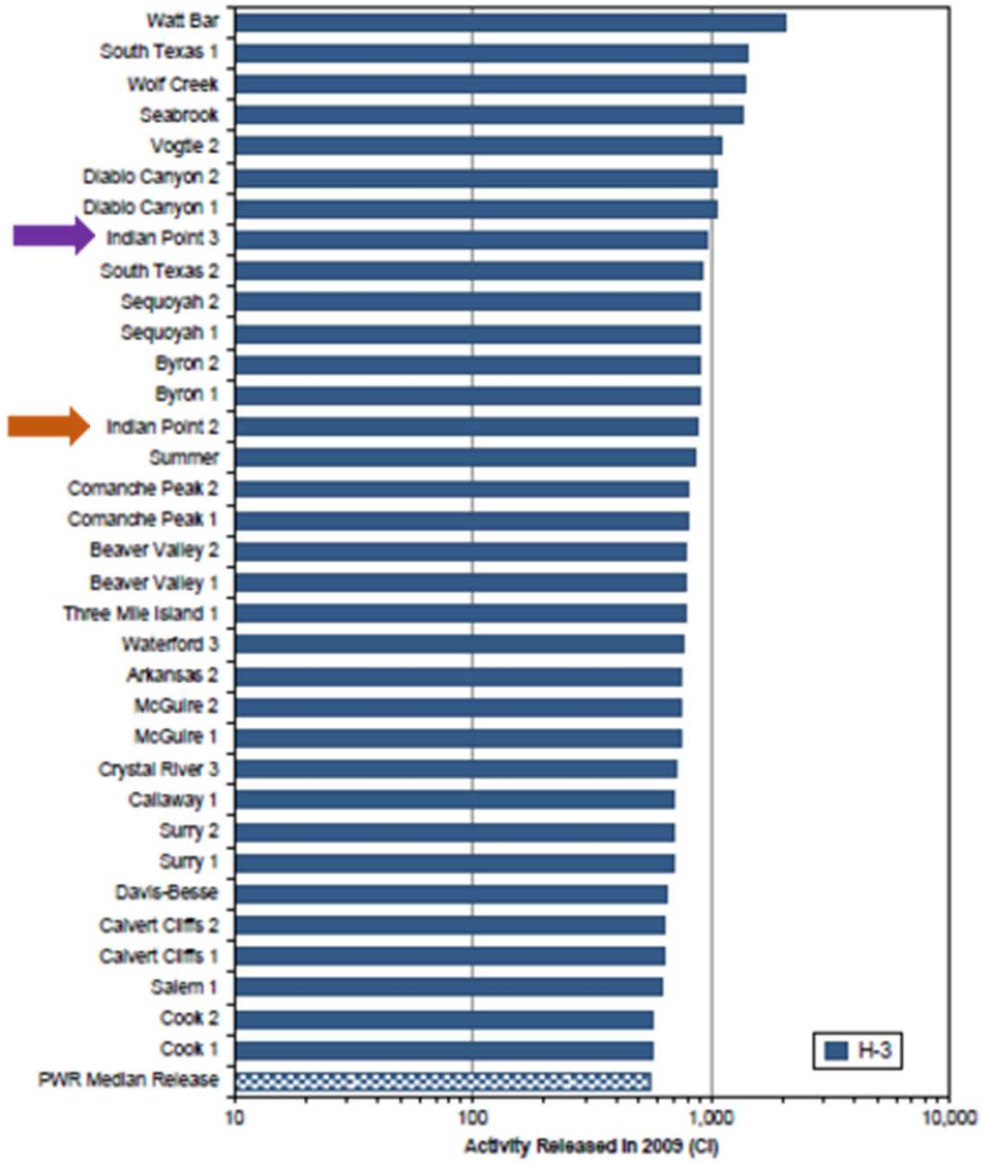
Appendix B: Tritiated Water Releases 2009-2019

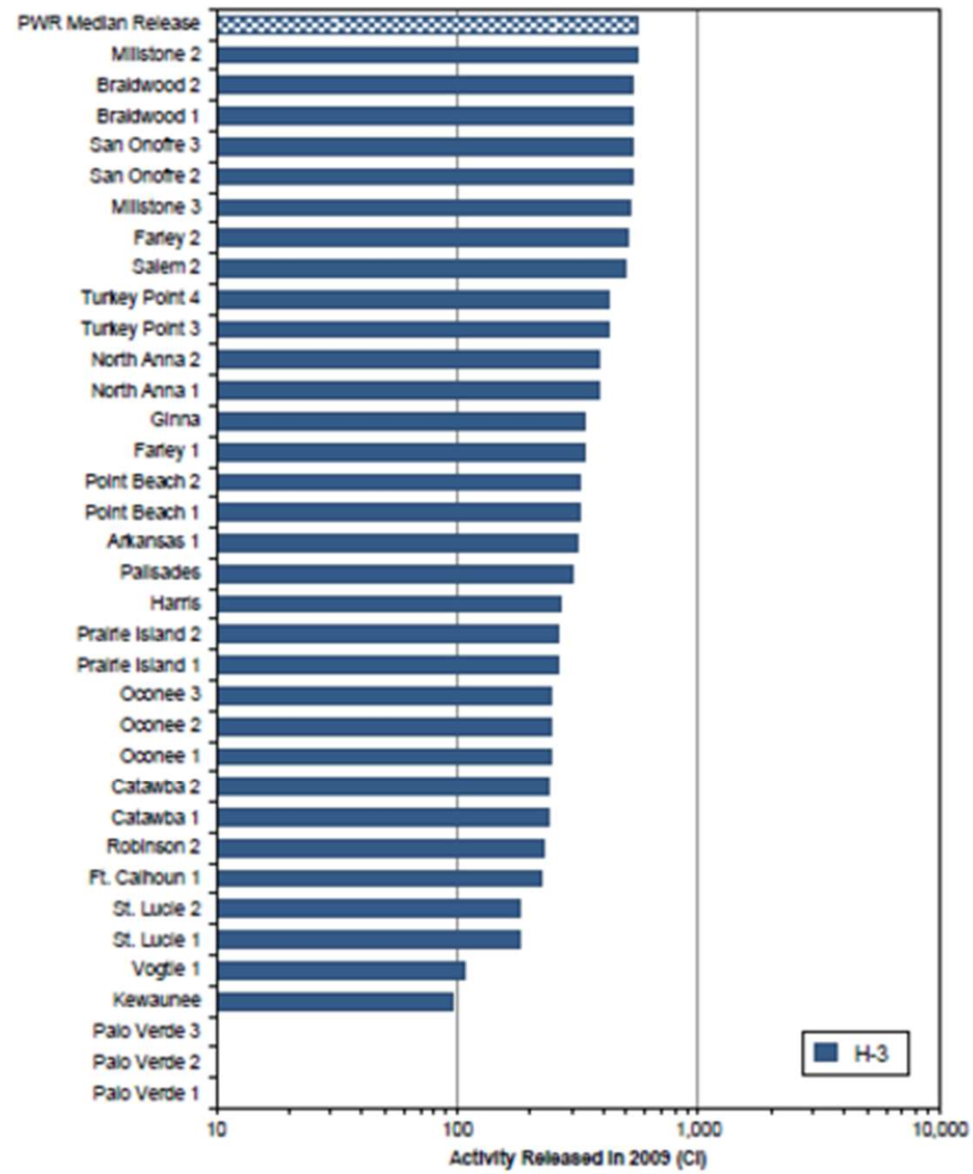
A series of reports issued by the NRC compiles the annual submittals from owners on radioactive effluents from their plants.

A table in these reports charts the amount of tritium released in liquid form from each reactor.

(The three reactors at Palo Verde report zero releases of tritium in liquid form. This plant in located in the desert west of Phoenix, Arizona with no nearby lake, river, or ocean to discharge into.)

Appendix B

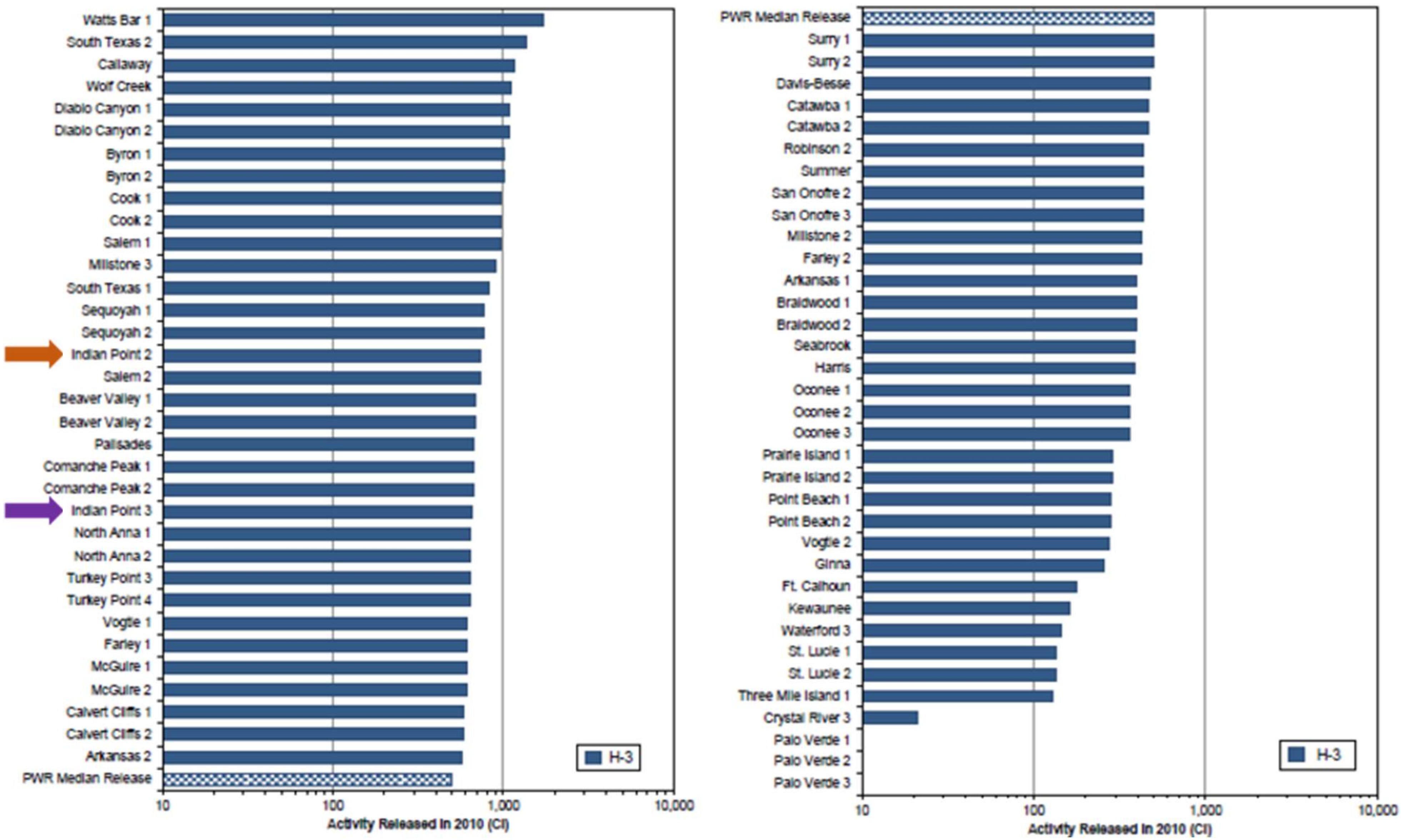




Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2009.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

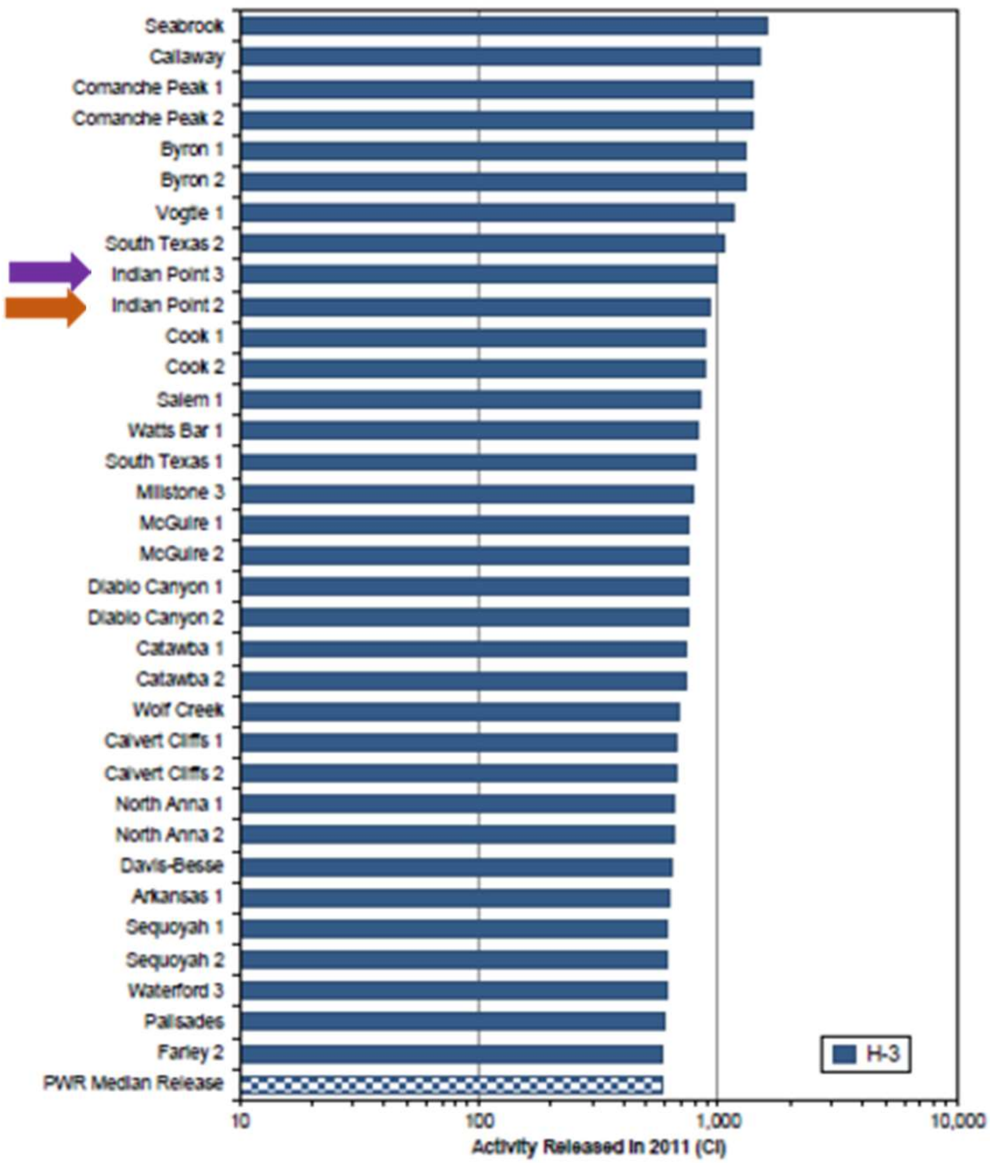
Appendix B

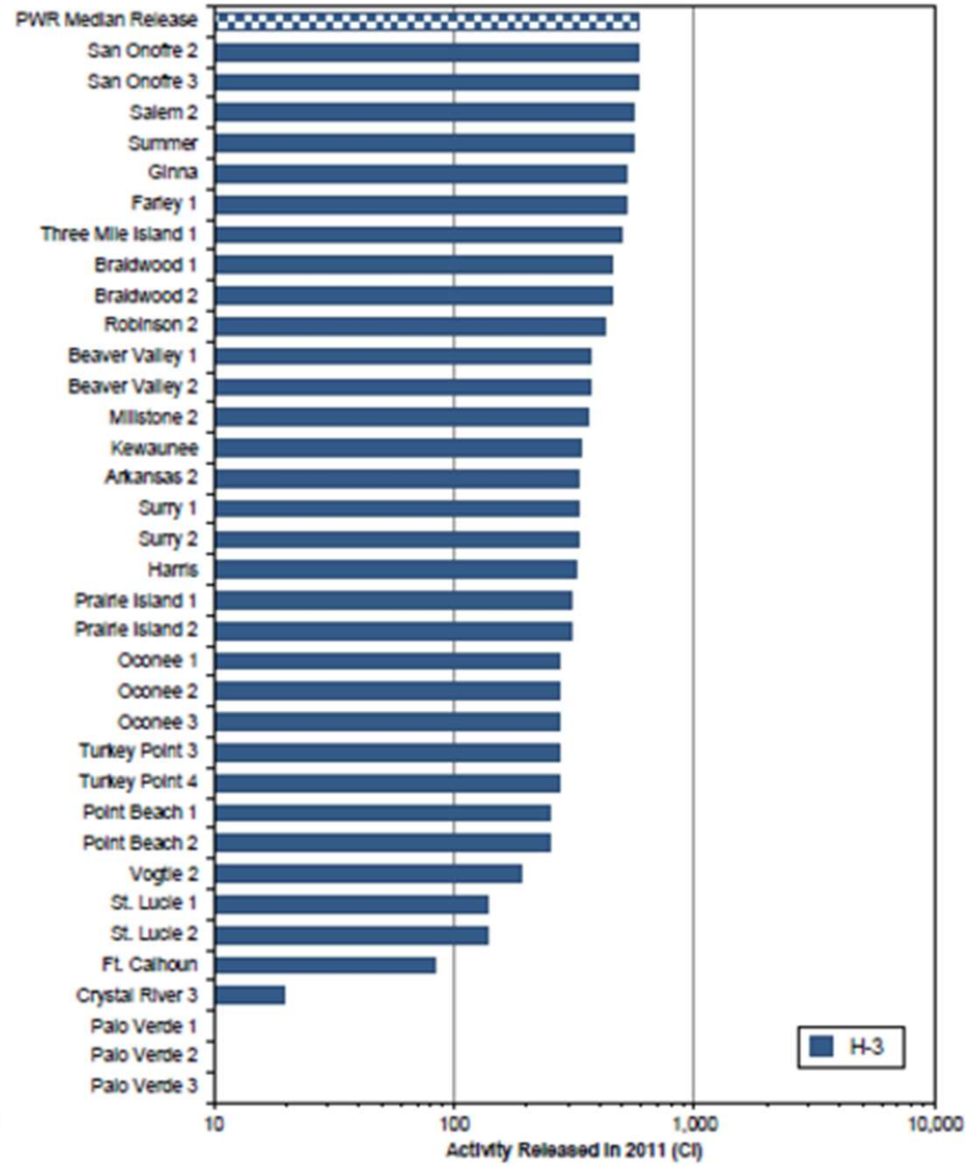


Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2010.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

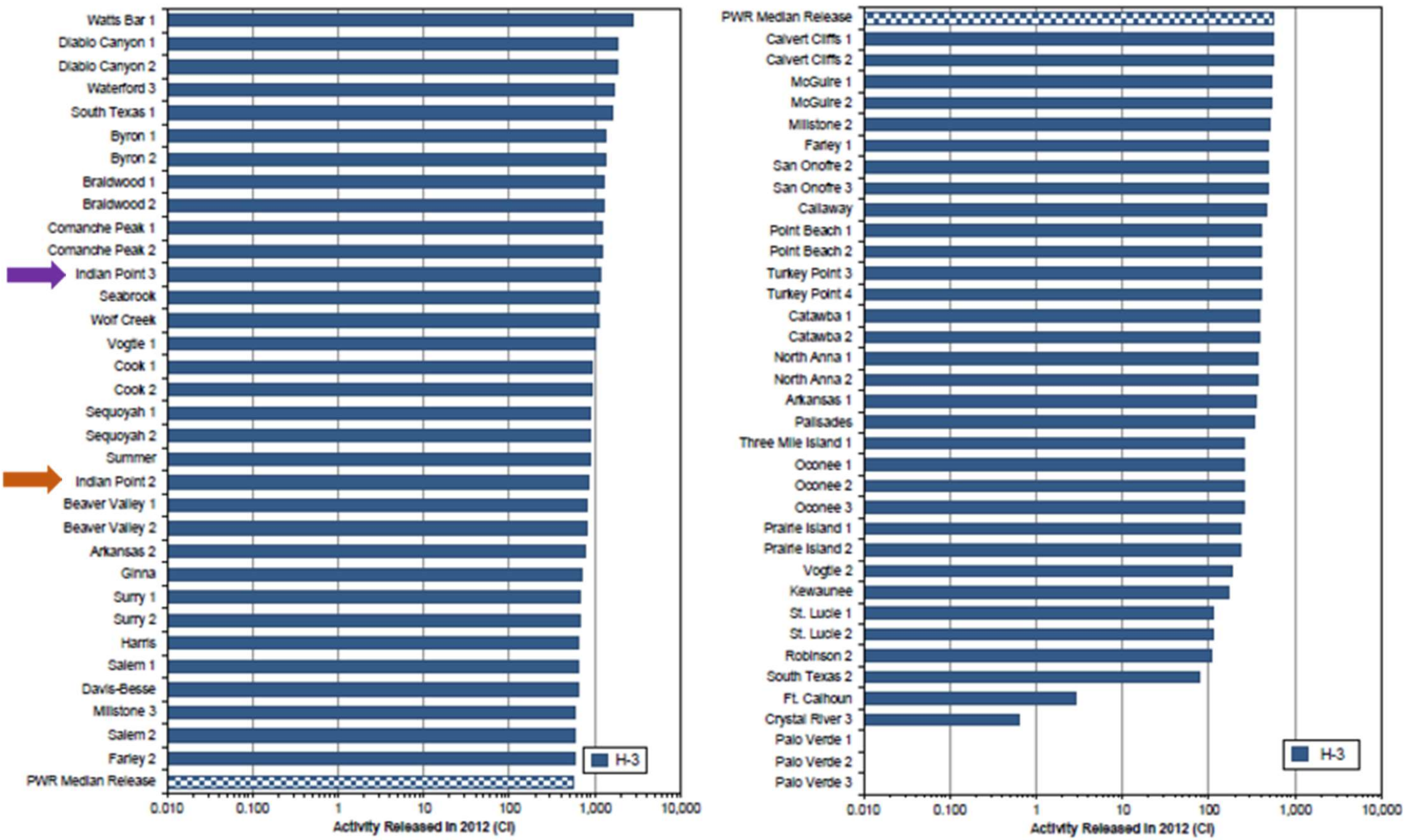




Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2011.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

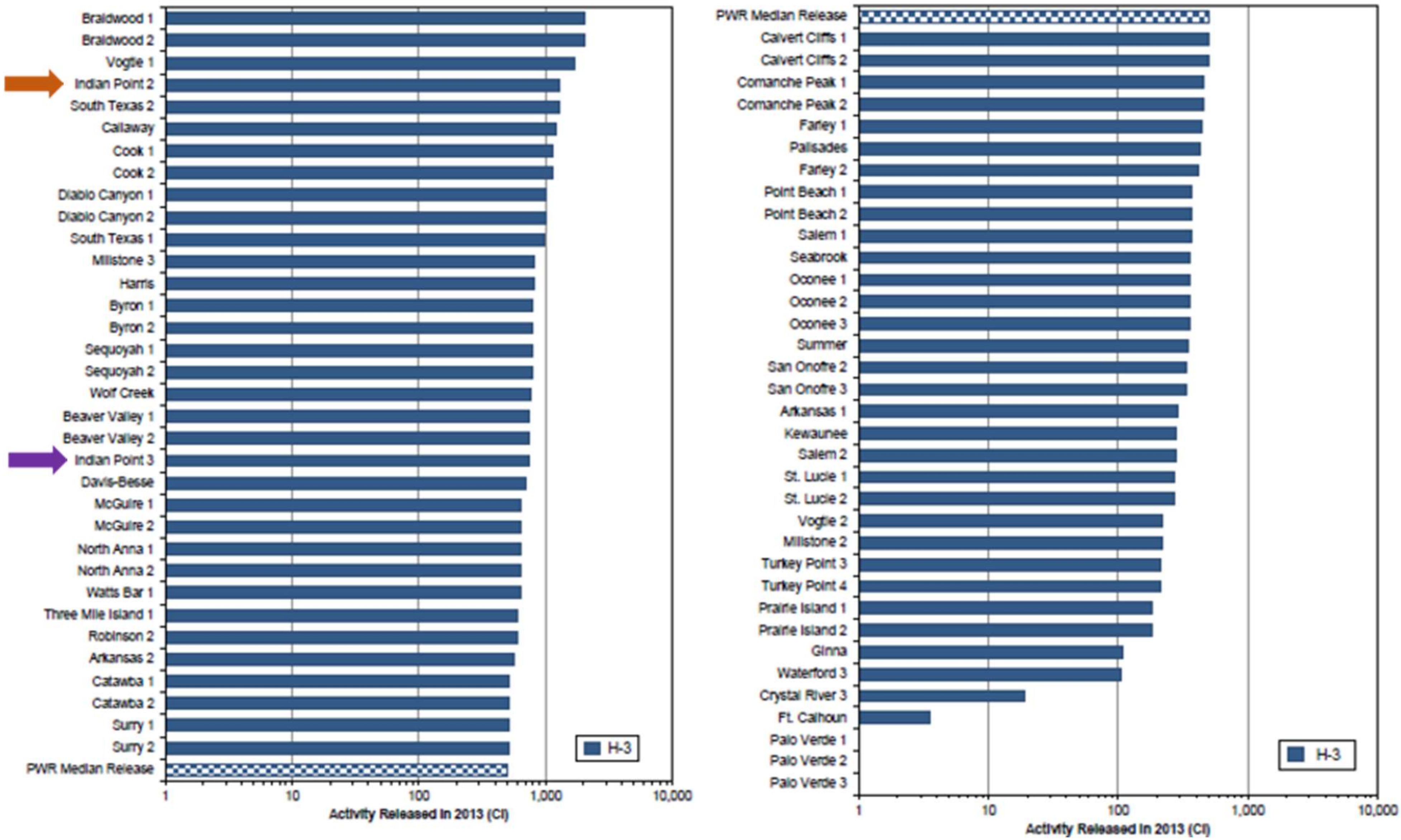
Appendix B



Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2012.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

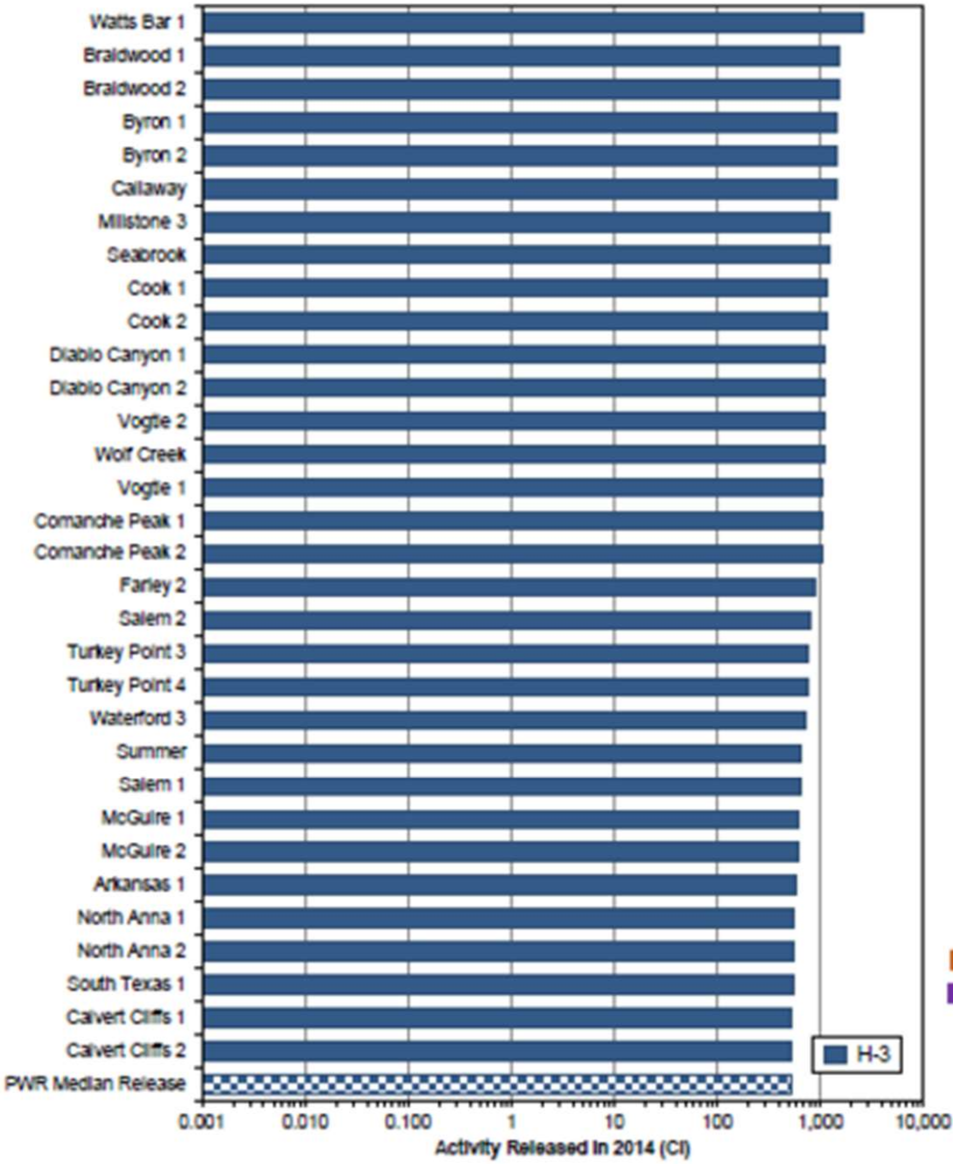


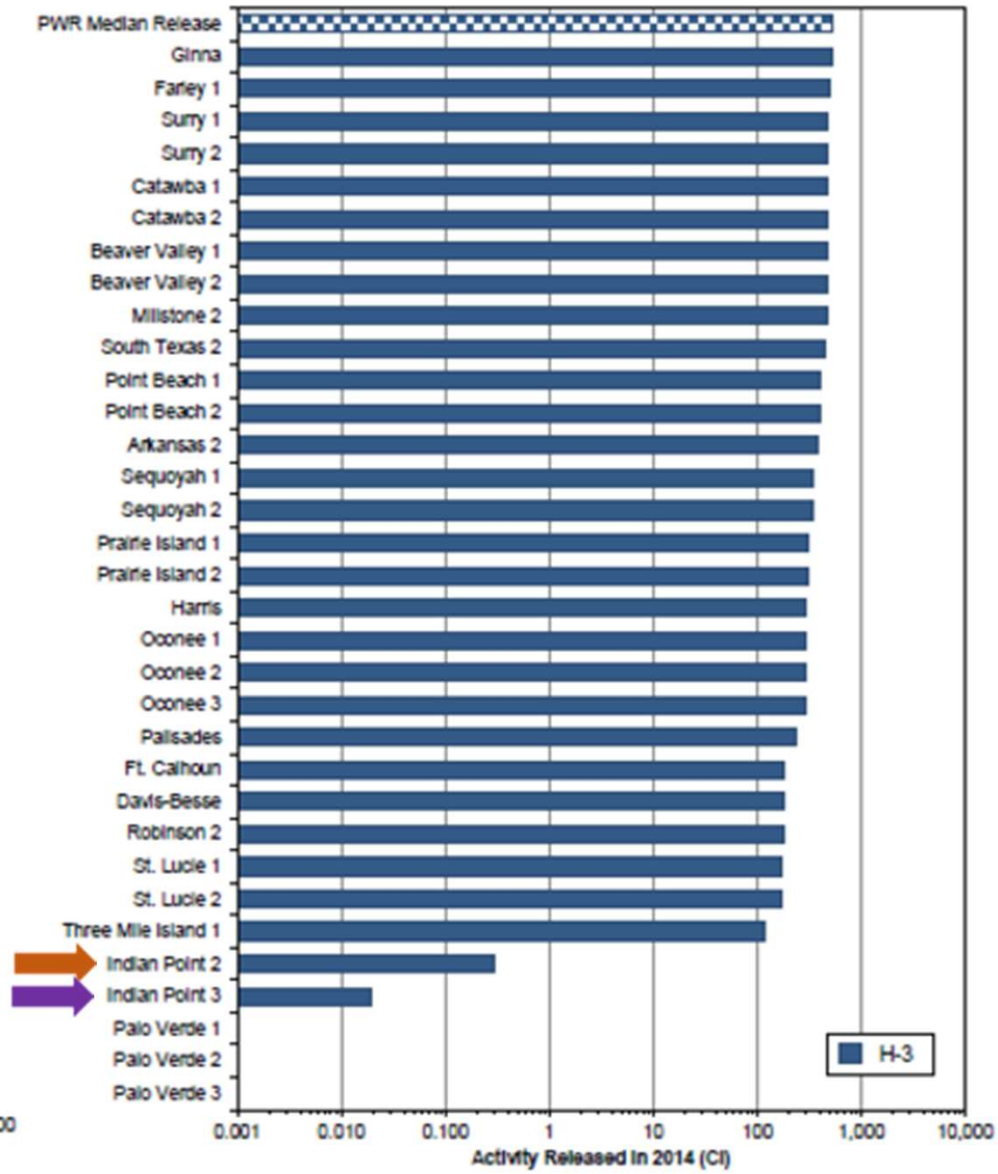
Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2013.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

The NRC's data for Indian Point is much lower than the data reported by it's owner (for unknown reasons).



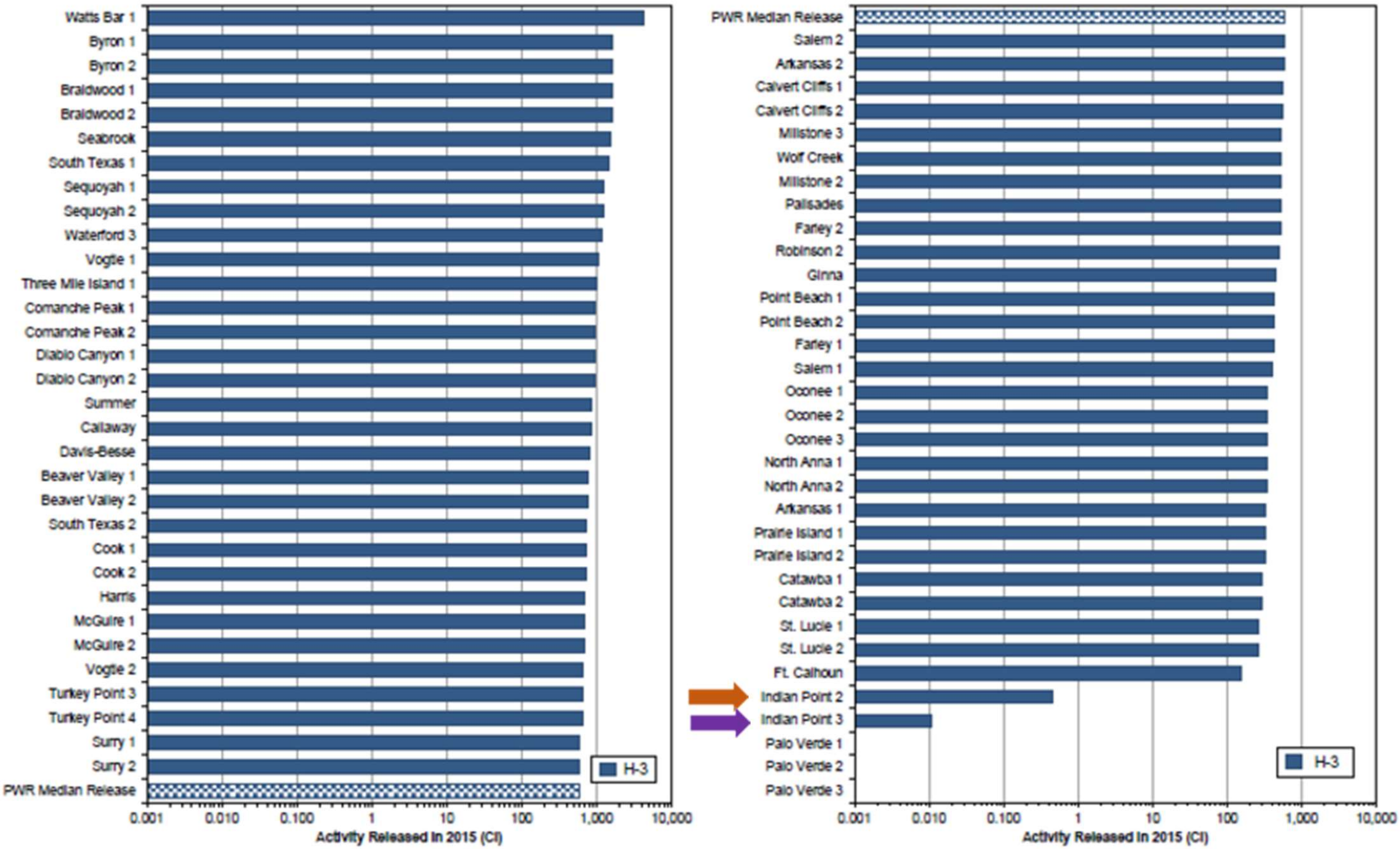


Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2014.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

The NRC's data for Indian Point is much lower than the data reported by it's owner (for unknown reasons).

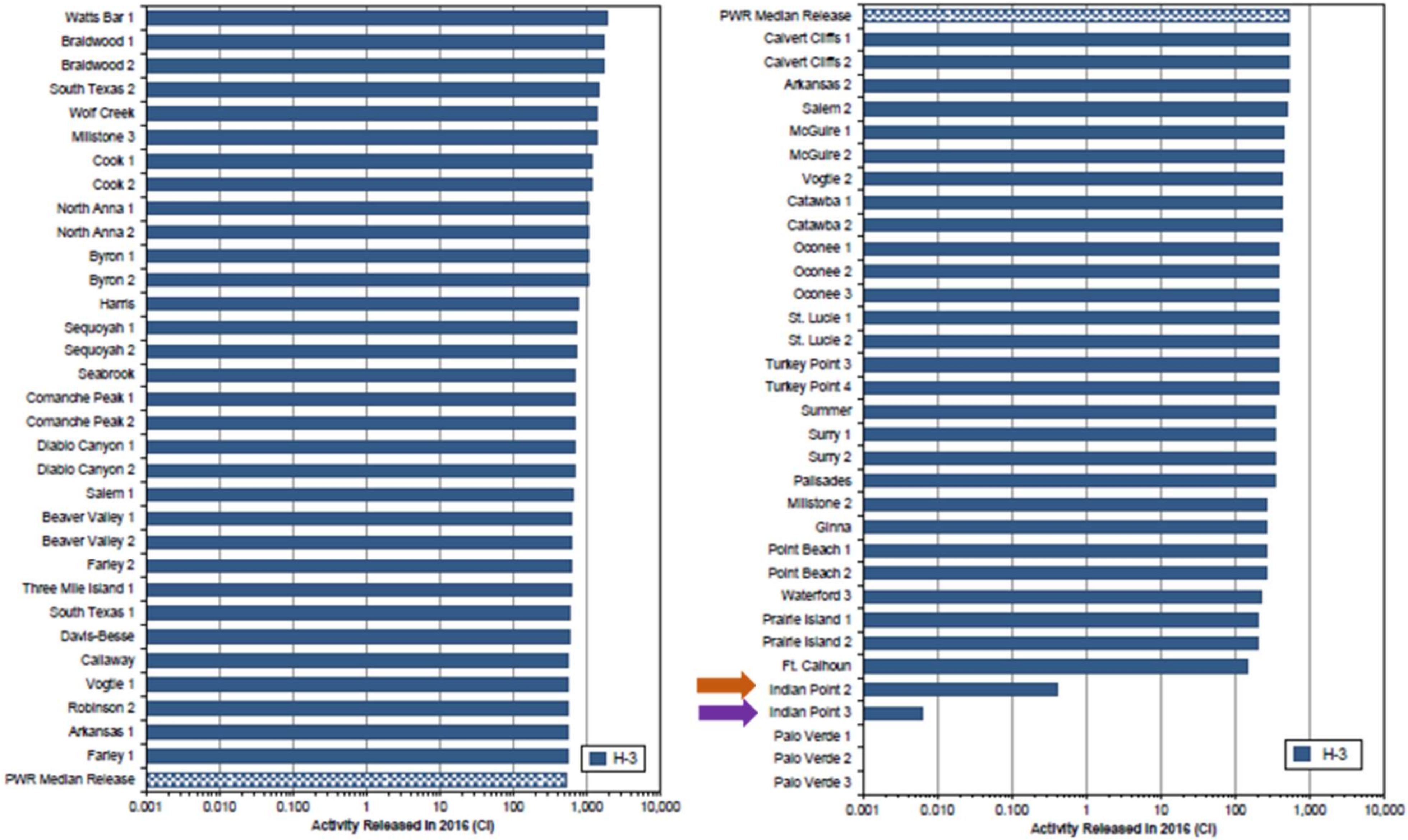


Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2015.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

The NRC's data for Indian Point is much lower than the data reported by it's owner (for unknown reasons).

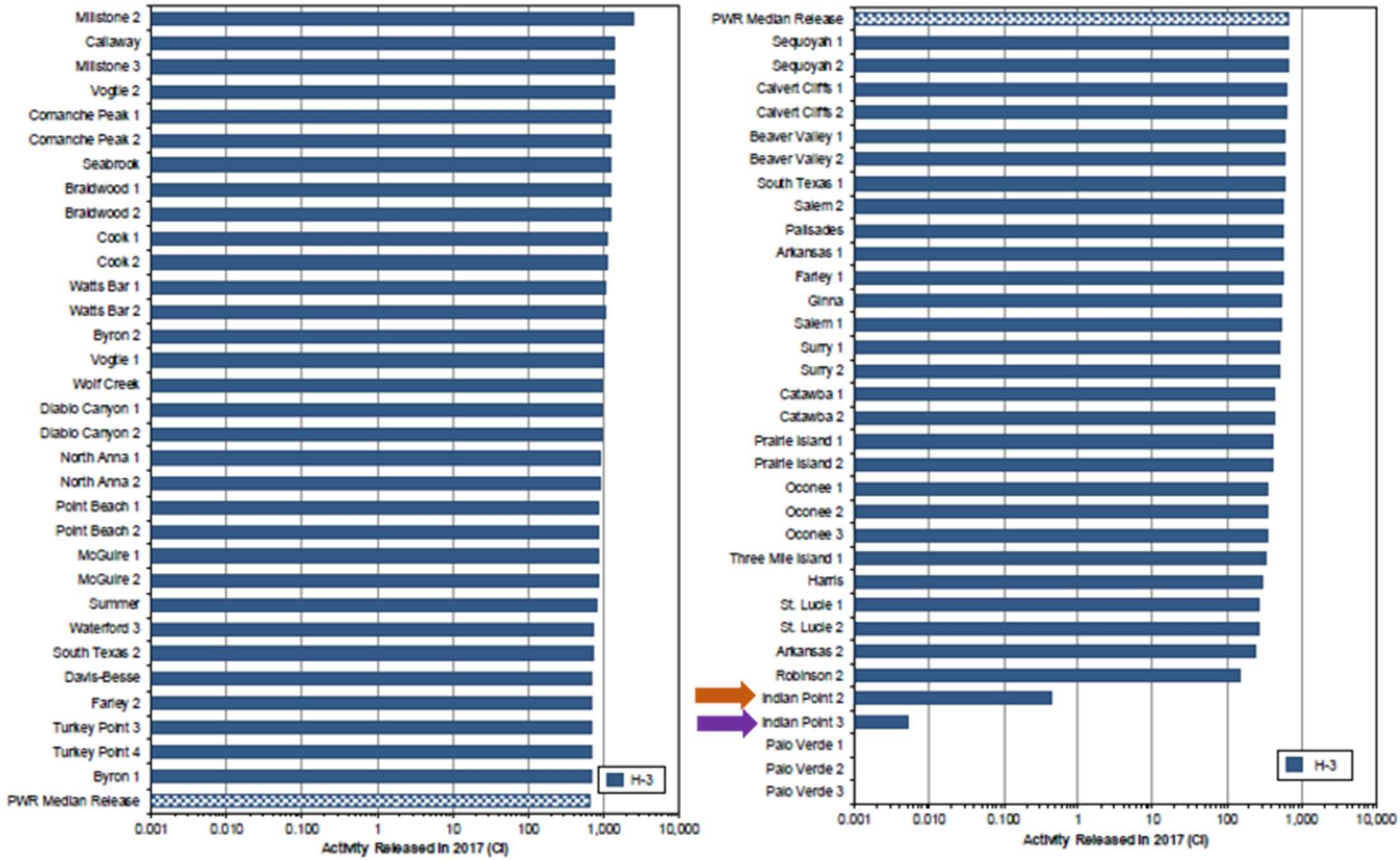


Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2016.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

The NRC's data for Indian Point is much lower than the data reported by it's owner (for unknown reasons).

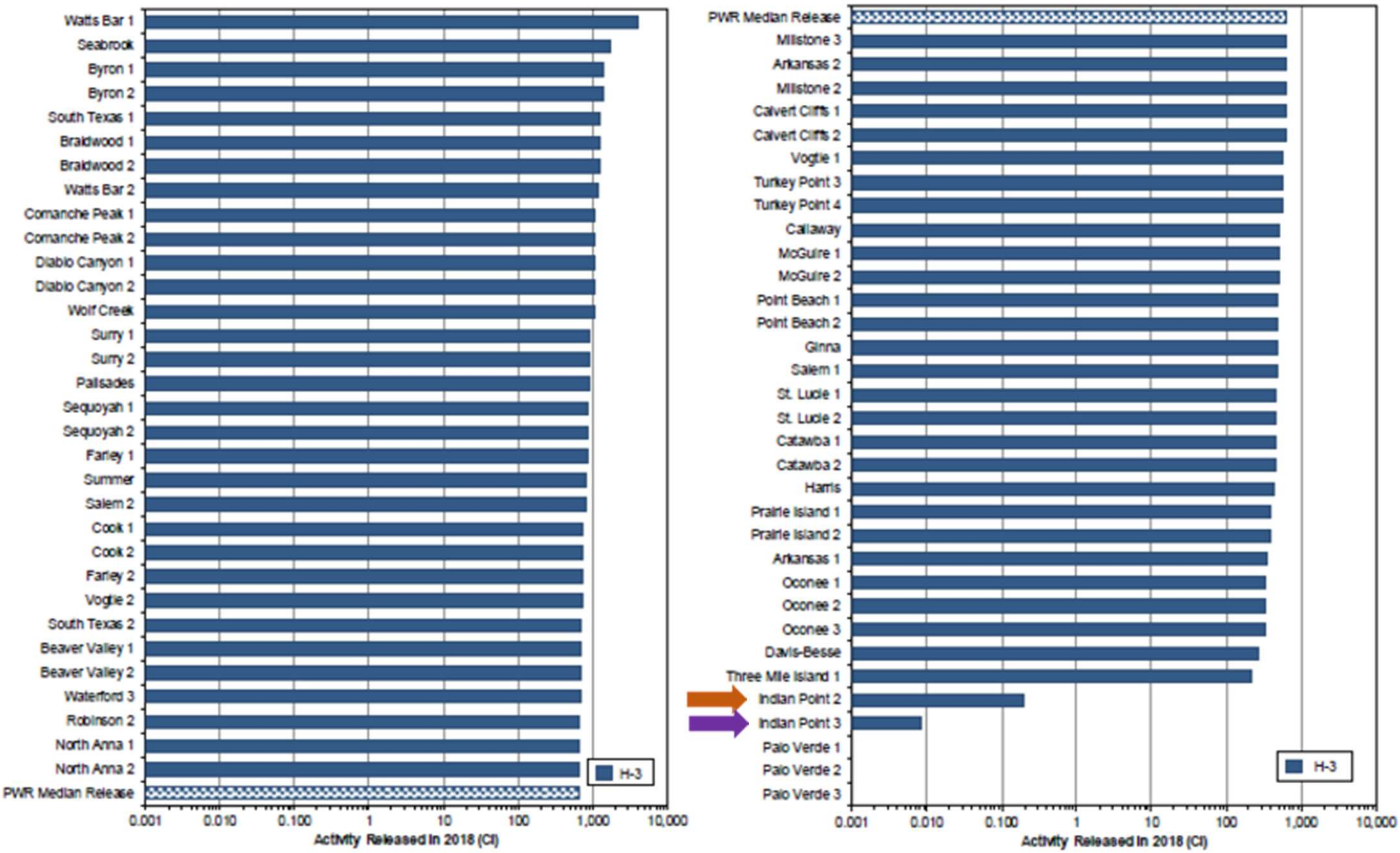


Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2017.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B

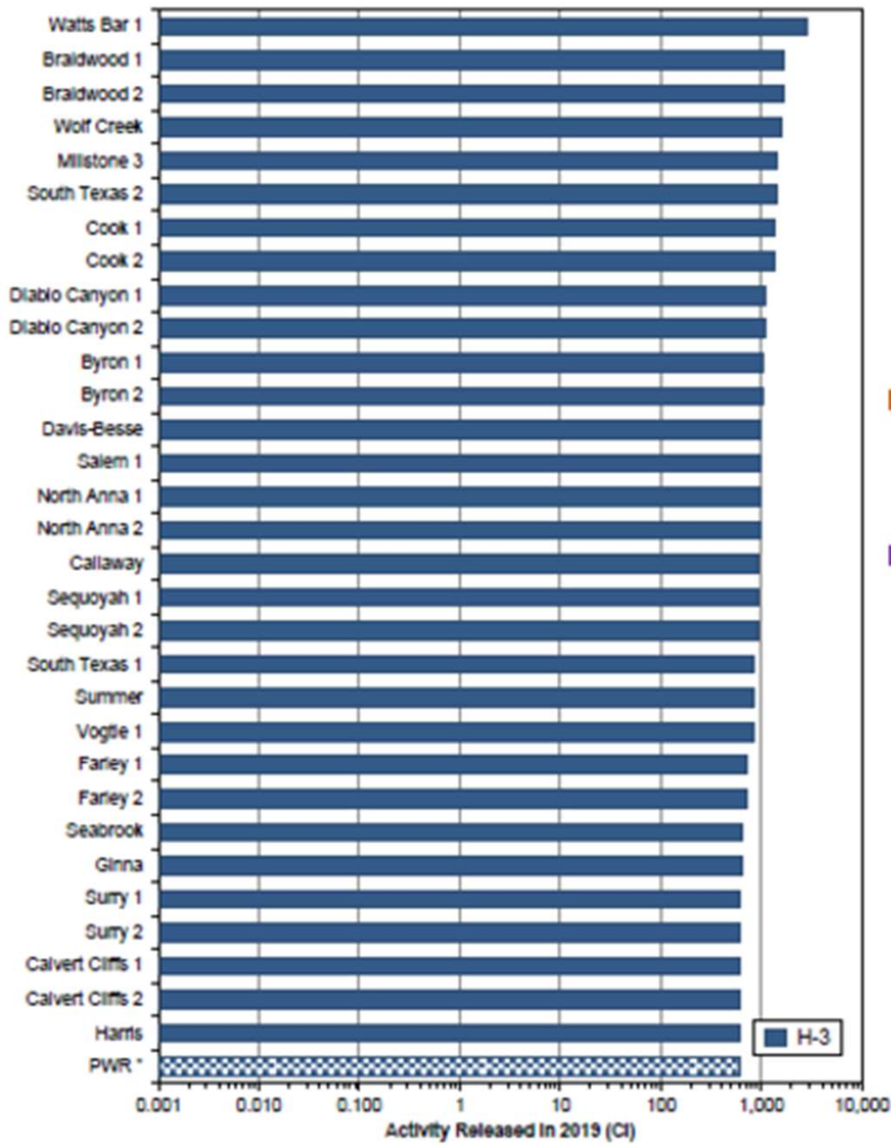
The NRC's data for Indian Point is much lower than the data reported by it's owner (for unknown reasons).

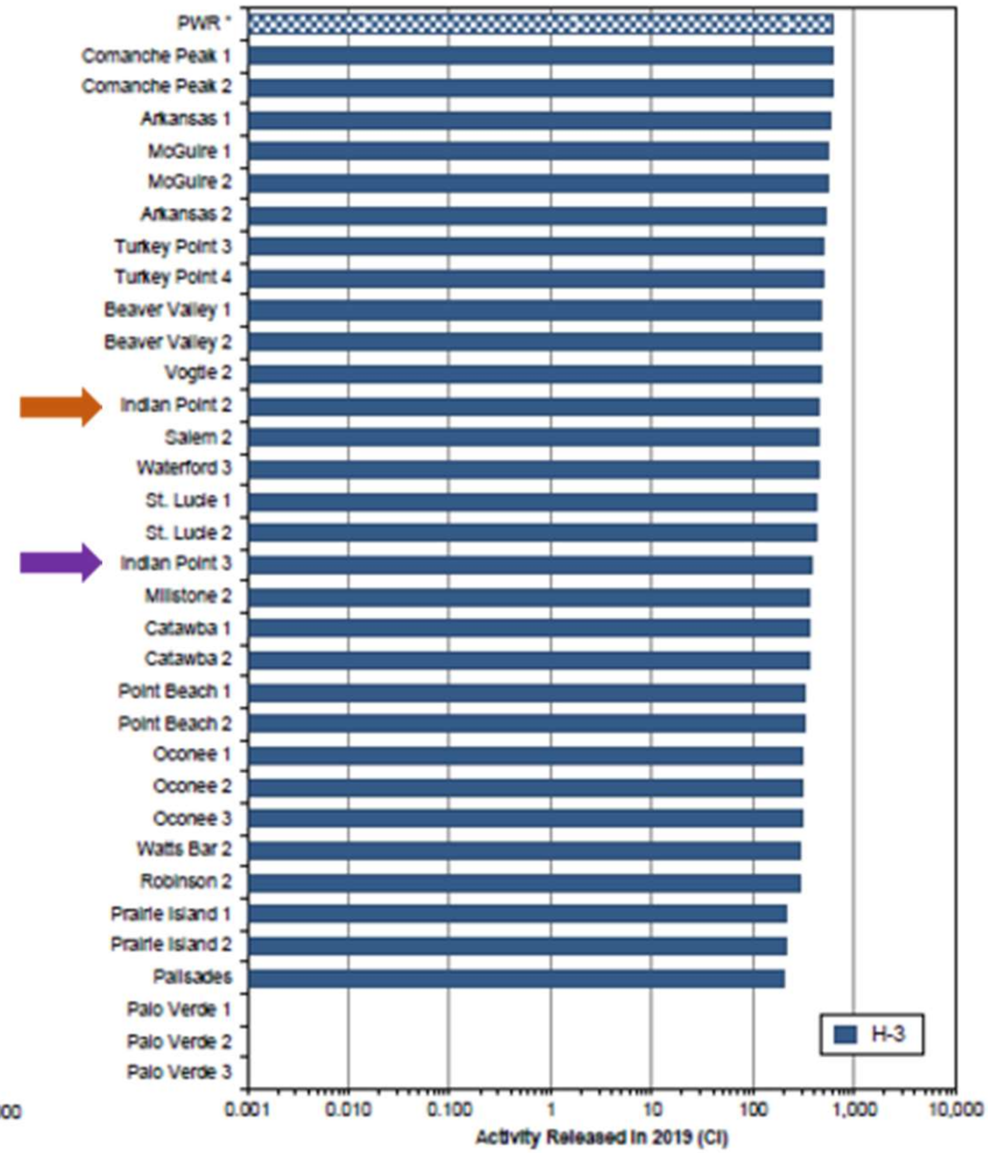


Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2018.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix B





Amount of tritium (in curies) in liquid releases from U.S. pressurized water reactors during 2019.

Source: U.S. Nuclear Regulatory Commission, "Radioactive Effluents from Nuclear Power Plants," NUREG/CR-2907.

Appendix C

Event Date	Site Name	City	State	Event Description
19630808	Big Rock Point	Charlevoix	MI	Radioactively contaminated water leaked from a flange on the outdoor waste hold tank located to the west of the turbine building. It is likely that the contaminated water entered the ground below the tanks.
19630918	Yankee Rowe	Rowe	MA	Approximately 10 gallons of radioactively contaminated water spilled onto the ground when a one-half inch sampling valve was inadvertently left open while filling the shield tank cavity from the safety injection tank. After cleanup, the residual contamination level was measured to be 70 to 100 millirem per hour at one inch off the pavement.
19730424	Oyster Creek	Forked River	NJ	About 100 gallons of radioactively contaminated water leaked into the ground from a storage tank truck.
19730910	Oconee	Seneca	SC	Approximately 20 gallons of radioactively contaminated water spilled onto the ground when a Chem-Nuclear tank truck overflowed as waste from the B miscellaneous waste hold-up tank was being transferrred.
19731220	Oyster Creek	Forked River	NJ	About 3,400 gallons of radioactively contaminated water leaked into the ground after the drain line from a temporary storage tank froze and cracked. **3,400 gallons**
19740317	Dresden	Morris	IL	Radioactively contaminated water was spilled when a valve that was supposed to divert flow to an empty tank when the aligned tank was filled to capacity failed. As a result, the tank was overfilled.
19741218	Oconee	Seneca	SC	Approximately 50 gallons of radioactively contaminated water spilled onto the ground when a Chem-Nuclear tank truck overflowed.
19750611	Pilgrim	Plymouth	MA	About 150 gallons of radioactively contaminated water overflowed a disposable resin cask in a truch and spilled onto the ground outside the radwaste building.
19760610	Pilgrim	Plymouth	MA	Approximately 150 gallons of radioactively contaminated water overflowed a disposable resin cask on a truck and spilled onto the ground outside the radwaste building. About 400 square feet were contaminated. Workers confined the spill with vermiculite and commenced cleanup.
19760720	Vermont Yankee	Vernon	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. **83,000 gallons**
19770802	Pilgrim	Plymouth	MA	While spent fuel pool resin was being transferred to the spent resin storage tank, radioactively contaminated water flowed through an open vent valve onto the pavement outside the radwaste truck lock door. The spilled water was mopped up and the contaminated asphalt paved over.
19771009	Salem	Salem	NJ	Approximately 600 gallons of radioactively contaminated water were inadvertently pumped from a liquid waste tank into a circulating water discharge pipe instead of to a tanker truck.

Appendix C

19780430	Crystal River	Red Level	FL	The NRC reported about a spill of radioactively contaminated resin. Workers were transferring the resin from a holdup tank inside the auxiliary building to a shielded shipping cask outside. All of the hoses were metal-braided and all of the piping was steel except for a polyvinylchloride tee inside the trailer. When level in the cask was sensed high, an automatic shut-off valve closed. The ensuing pressure surge caused the PVC tee to break. Resin spilled from the broken tee into the trailer's sump. Bolted seams in the sump leaked resin onto the asphalt pavement under the trailer. The resin slurry flowed into a nearby storm drain.
19790201	Zion	Zion	IL	During the transfer of the 2A mixed bed to an HN-200 cask, the cask was overfilled and approximately 25 gallons of water and resin flowed into the ground.
19790330	Zion	Zion	IL	During the transfer of resin to a cask, the cask was overfilled and approximately 25 gallons of water and resin flowed into the ground. A failed high liquid level alarm and a frozen overflow vent line factored into the event.
19790611	Turkey Point	Florida City	FL	Approximately 900 gallons of radioactively contaminated water overflowed a waste processing tank due to an operator error in aligning valves. The auxiliary building floor drain backed up to the onsite storm drain. The drain system discharged the radioactively contaminated water to an onsite underground tile bed.
19790612	Indian Point	Buchanan	NY	About 10 gallons of radioactively contaminated water was spilled when a hose failed during backflushing of a shipping cask for spent resin.
19790828	Turkey Point	Florida City	FL	Approximately 3,000 gallons of radioactively contaminated water overflowed the refueling water storage tank and spilled onto the ground. It was estimated the spilled water contained 1.091 curies. **3,000 gallons**
19791215	Zion	Zion	IL	During the transfer of resin to a cask, the cask was overfilled and approximately 25 gallons of water and resin flowed into the ground. A failed high liquid level alarm and a frozen overflow vent line factored into the event. The outside air temperature a
19800716	Oconee	Seneca	SC	Approximately 5 gallons of radioactively contaminated water spilled onto the ground from a liner in the mobile solidification area south of the interim radwaste building as the liner was being filled. The leak was through an inspection hole in the cask holding the liner.
19800806	Yankee Rowe	Rowe	MA	As workers were pumping resin into a disposal cask, radioactively contaminated water leaked from the transfer hose. A 15-foot by 20-foot area in the yard was contaminated. Some of the contaminated asphalt was removed and shipped to a licensed low-level radwaste dump.
19800913	Palisades	South Haven	MI	A fork lift transporting a canister of radioactive waste hit a pot hole. About two gallons of radioactively containment liquid spilled from the canister when it slipped from the forks. Workers removed the contaminated soil and placed it it waste barrels for disposal.
19810628	Indian Point	Buchanan	NY	About 45 gallons of radioactively contaminated water spilled when a resin cask was overfilled.

Appendix C

3,600 gallons

19811027	H. B. Robinson	Hartsville	SC	Approximately 3,600 gallons of radiaoctively contaminated water leaked from a temporary tank holding chemical decontamination waste water and flowed into the site storm drain where it flowed on to the west settling pond.
19820119	Beaver Valley	Shippingport	PA	Approximately 500 gallons of radioactively contaminated water being transferred between waste tanks spilled onto the ground when the transfer pipe froze and cracked. A security guard on rounds noticed the leakage and notifed operators who took steps to stop the leaking.
19820317	Turkey Point	Florida City	FL	A valve lineup durign the transfer of radioactively contaminated water from the Unit 3 reactor cavity to the Unit 3 refueling water storage tank allowed ater to overfill the Unit 4 refueling water storage tank. About 11,000 gallons spilled onto the ground, flowed through storm drains into the intake canal.
19820709	Oconee	Seneca	SC	Radioactively contaminated water spilled into the ground near the Unit 3 solidificaiton area while a portable demineralizer was being filled.
19840913	Haddam Neck	Haddam Neck	CT	Radioactively contaminated water spilled when a resin liner was overfilled.
19870625	Haddam Neck	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. **140,000 gallons**
19881116	Pilgrim	Plymouth	MA	Due to a valve inadvertently left open, 2,300 gallons of radioactively contaminated water spilled form a container of used filters on the process building floor. The water flowed outside the building towards the inner site boundary fence. About 1,000 cubic feet of gravel and earth were removed during the remediation effort. **2,300 gallons**
19900822	Zion	Zion	IL	Approximately 200 gallons of radioactively contaminated water spilled from a vendor laundry trailer, contaminating an area of about 80-feet by 80-feet.
19910328	Palisades	South Haven	MI	As resin was being sluiced from tank T-104B to a resin storage cask, a clog pressurized and broke the transfer hose. About 20 cubic feet of resin spilled into the turbine building and onto the pavement outside. Workers decontaminated the pavement and turbine building floor.
19940507	Palisades	South Haven	MI	A truck transporting a box of contaminated soil hit a bump, causing the box to fall from the truck. The box broke open and deposited about half its contents onto the road near the south radwaste building.
19950819	St. Lucie	Hutchinson Island	FL	Approximately 11,250 gallons of radioactively contaminated water overflowed the primary water tank onto the ground and into storm drains. It was estimated that the leaked water contained 3.94 curies of tritium. **11,250 gallons**
19970430	Sequoyah	Soddy-Daisy	TN	Approximately 3,000 gallons of radioactively contaminated water spilled from the modularized transfer demineralization system when a conductivity probe failed. An estimated 600 to 1,000 gallons flowed through the railroad bay door to the ground outside. **3,000 gallons**
20001129	Oconee	Seneca	SC	Radioactively contaminated water spilled at the treatment storage disposal facility and contaminated some soil.

Appendix C

20010831	LaSalle County	Seneca	IL	Radioactively contaminated water entered the ground when the Unit 2 cycled condensate storage tank overflowed.
20010920	St. Lucie	Hutchinson Island	FL	Approximately 83 gallons of radioactively contaminated water leaked onto the ground from a hose connected to waste monitor tank 1A.
20020208	St. Lucie	Hutchinson Island	FL	Approximately 15 gallons of radioactively contaminated water leaked onto the ground when a resin dewatering hose became disconnected from a floor drain. About five gallons reached the storm drains.
20040413	St. Lucie	Hutchinson Island	FL	Approximately 2,400 gallons of radioactively contaminated water overflowed the refueling water tank onto the ground and into the storm drain system. **2,400 gallons**
20070621	Brunswick	Southport	NC	During the transfer of radioactively contaminated water from the Unit 1 suppression pool to the waste surge tank, about 2,500 to 3,000 gallons of water leaked onto the ground from a disassembled check valve on the drain line from the Unit 2 condensate storage tank to the waste storage tank. Some of the leaked water entered the storm drain system. **2,500 to 3,000 gallons**
20071226	Edwin I. Hatch	Baxley	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. **5,700 gallons**
20080105	Browns Ferry	Decatur	AL	The condensate storage tank overflowed due to failed tank level instrumentation. The spilled water flowed into the sump in the condensate piping tunnel, triggering a high level alarm that prompted workers to initiate the search that discovered the overflow condition. Some of the spilled water may have permeated through the pipe tunnel into the ground.
20080204	McGuire	Cornelius	NC	The company reported that a leak in the final holdup pond allowed approximately 100,000 gallons of radioactively contaminated water to leak into the groundwater. **100,000 gallons**
20100407	Browns Ferry	Decatur	AL	Approximately 1,000 gallons of radioactively contaminated water leaked from Condensate Storage Tank No. 5 as workers were transferring water between condensate storage tanks. A worker conducting routine rounds observed water leaking from an open test valve near the top of CST No. 5. **1,000 gallons**

Appendix D
Indian Point Agreement

"Entergy will implement in 2017 targeted plant and hardware modifications at Indian Point to minimize potential releases of radiologically-contaminated fluids to groundwater from normal and temporary plant systems and operations." **[Tritium Mitigation paragraph]**

"In accordance with the Stipulation, NYSDEC Staff is renewing Indian Point's Units 2 and 3 existing SPDES permit without material change, based on terms and conditions that have had the benefit of full public comment and/or adjudication." **[Exhibit H]**

Source: New York State, Riverkeeper, and Entergy, "Agreement," January 9, 2017. [ML17068A245]

Appendix D
Defueled Safety Analysis Report

"Liquid, gaseous, and solid waste processing and handling facilities are designed so that the discharge of effluents and offsite disposal shipments are in accordance with applicable government regulations."

"Radioactive fluids entering the waste disposal system are collected in sumps and tanks until determination of subsequent treatment can be made. They are sampled and analyzed to determine the concentration of radioactivity, with an isotopic breakdown if necessary. Before any attempt is made to discharge radioactive waste, it is processed as required. The processed water from waste disposal, from which most of the radioactive material has been removed, is discharged through a monitored line into the circulating water discharge."
[page 4-1]

Source: Entergy, "Indian Point Unit No. 2 10 CFR 50.71(e) Submittal," September 14, 2020 (ML20259A199).

Appendix D
Indian Point Joint Proposal

"Thereafter, on December 20,2019, HDI submitted its PSDAR and DCE to the NRC. In its PSDAR and DCE, HDI detailed the efforts to be undertaken, estimated costs and projected timeline to implement its DECON Plan to complete radiological decommissioning of Indian Point (except for the ISFSI) and to secure Partial Site Release by the end of 2036 and potentially as early as 2033, which was consistent with the time frame set forth in the Joint petition." **[page 8]**

"The Signatory parties submit that this Joint Proposal gives fair and reasonable consideration to the interests of all parties and that its approval by the Commission is in the public interest." **[page 11]**

Source: Fifteen parties Joint Proposal to the State of New York Public Service Commission, April 14, 2021.

Appendix D
Indian Point Joint Proposal

"Holtec has proposed to cost effectively, safely, and expeditiously decommission Indian Point utilizing HDI's DECON Plan which the Signatory Parties agree will allow the Site to be decommissioned decades sooner than if it remained under Entergy ownership. In contrast, Entergy is not engaged in the decommissioning business and under continued Entergy ownership, a 60-year SAFSTOR approach would be pursued, and Indian Point would remain in a state precluding any significant alternative use and development for decades longer than under HDI's DECON Plan."

"The Signatory Parties agree that HDI's DECON Plan-based decommissioning and release of the parcels at Indian Point for future re-use will yield considerable economic and environmental benefits for New Yorkers." **[page 42]**

Source: Fifteen parties Joint Proposal to the State of New York Public Service Commission, April 14, 2021.

Appendix D
New York PSC Order

"Under this arrangement, Holtec projects that it could obtain NRC approval to release the Site, with the exception of the ISFSI, for unrestricted use (known as partial site release in NRC parlance) by 2036, and possibly as early as 2033. If the transaction is not consummated, Entergy has announced that it intends to follow an NRC-approved deferred decommissioning schedule known as "SAFSTOR" that would allow Entergy up to 60 years (i.e., until 2081) to decommission the Site." **[pages 8-9]**

"First, the Commission finds that a prompt decommissioning and site restoration process is unquestionably in the public interest." **[page 33]**

Source: State of New York Public Service Commission, Case 19-E-0730, May 19, 2021.

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"Specifically, the Joint Proposal establishes a series of minimum balances that Holtec must maintain in the decommissioning trust funds over time. First, Holtec has agreed to maintain a minimum balance of no less than $400 million in the trust funds until at least 2031. After 2031, Holtec has further agreed to maintain a minimum balance of no less than $360 million until it has obtained partial site release from the NRC."

Prompt decommissioning and site restoration was determined to be unquestionably in the public interest. It is also in Holtec's interest because the trust fund must contain at least $360 million until NRC approves a partial site release.

Protracted onsite storage of radioactively contaminated water, therefore, is neither in the public's interest nor Holtec's interest.

Source: State of New York Public Service Commission, Case 19-E-0730, May 19, 2021.