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New Mexico's Los Alamos National Laboratory facing increased workload and increased accident risks to package surplus plutonium for WIPP disposal

The Department of Energy's National Nuclear Security Administration (NNSA) has issued, last December 2022, its latest draft Surplus Plutonium Disposition Program Environmental Impact Statement (DOE/EIS-0549). [1] In this draft EIS, the NNSA falsely asserts that adding work scope to the already struggling Los Alamos National Laboratory (LANL) would be done "without impact to other [LANL] programs."

The NNSA in a November 2022 hearing conducted by the Defense Nuclear Facilities Safety Board [2] explained its tardy or cancelled safety upgrades at LANL by saying that in the U.S. it is difficult to get work done, and hiring and retaining workers is extremely difficult at LANL. Read more in the Environmental Defense Institute newsletters for December 2022 and January 2023 "Recap of the egregious safety shortcuts at LANL" at www.Environmental-Defense-Institute.org

At the November hearing, the NNSA explained that it was accepting accident radiological doses to the public from an accident at LANL's PF-4 that far exceeded what Department of Energy requirements would normally allow. Normally, safety class systems would be required to assure that doses to the public remained below 25 rem. A 25-rem inhalation dose to the public would involve an obscenely high release of radioactivity that would remain in the environment basically, forever. **But the DOE and NNSA invoked the "exigent circumstances" processes to allow doses to the offsite public to exceed a whooping 3000 rem.** A radiation inhalation dose exceeding 400 rem is typically considered lethal.

The excuses for accepting such high accident consequences to the public (and also lethal doses to an undetermined number of the 1000 workers at LANL's PF-4) was that the NNSA found it hard to procure a few needed seismically restrained gloveboxes. And NNSA found it

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[1] Department of Energy's National Nuclear Security Administration, Surplus Plutonium Disposition Program Environmental Impact Statement (DOE/EIS-0549), issued December 2022. Public comments accepted until February 14, 2023. See https://www.energy.gov/nepa/articles/doeeis-0549-draft-environmental-impact-statement-december-2022 and https://www.federalregister.gov/documents/2022/12/16/2022-27152/notice-of-availability-of-draft-environmental-impact-statement-for-the-surplus-plutonium-disposition

[2] Defense Nuclear Facilities Safety Review Board website at dnfsb.gov, November 16, 2022 meeting on the Los Alamos National Laboratory, see meeting agenda, videos, exhibits for cleanup and increased pit production and other information on the dnfsb.gov webpage https://www.dnfsb.gov/public-hearings-meetings/november-16-2022-public-hearing.

inconvenient to implement meaningful limits on the material-at-risk (MAR), implement meaningful combustible loading controls, or complete other long-needed safety upgrades.

However, the NNSA excused its lack of safety by assuring the DNFSB and those attending the meeting that the NNSA "was working very closely with the Department of Defense."

The NNSA's latest surplus plutonium disposition draft EIS states that the added work scope for LANL will require additional gloveboxes, additional workers, and scheduling shifts of workers 24 hour a day, 7 days a week. With the already expanding nuclear weapons pit production work, the added plutonium disposition work will most certainly create significantly more safety problems at the already overloaded plutonium facility, PF-4, at LANL.

The draft EIS includes a variety of options, "sub-alternatives," in its "preferred" option. The weapons pit disassembly work could be conducted only at LANL, only at the Savannah River Site, or a combination. Similarly, the non-pit surplus plutonium work could be conducted only at LANL, only at the Savannah River Site, or a combination, even though the non-pit material is already at SRS.

The November 2022 hearing exhibits by the DNFSB pointed out that the public is located only about 0.6 miles from LANL's PF-4 facility while the nearest offsite public is located about 6 miles from the facilities at SRS. There are roughly 690,000 people within 50 miles of SRS and roughly 990,000 people within 60 miles of LANL. The 2022 draft EIS states that there are 343,000 people living within 50 miles of PF-4, which gives a false portrayal of the significance of the size of the communities surrounding LANL.

The draft surplus plutonium disposition EIS preferred option would shove an additional 34 metric tons of plutonium into the Waste Isolation Pilot Plant (WIPP), without any assessment of the existing limits, commitments made to the State of New Mexico or needed analysis for the added waste emplacement. Technical information regarding the WIPP facility was essentially limited to stating the depth underground salt mine, as though the increased criticality risks and higher concentration of plutonium in the brine that flows through the WIPP repository didn't matter.

The draft EIS fails to provide any status of the documented safety analyses which continue to be tardy as well as technically indefensible, or of the status of long-awaited safety upgrades at LANL's PF-4. In fact, the draft EIS simply points to a biased, inadequate and out-of-date 2015 Final Surplus Plutonium Disposition Supplemental EIS, Appendix D. The 2022 draft surplus plutonium disposition EIS simply does not include basic information about the many facility accidents or the assumptions made, but points to the tangled and out-of-date material in the 2015 EIS.

The 2015 EIS had generally found it more reasonable to hack and slash the leak path factor used in the DOE's safety analyses by a factor of ten to reduce the accident consequences. The reality is that the DOE's safety analyses leak path factors would probably be more realistic and appropriate if increased by a factor of 10!

The failure to provide needed accident analysis assumptions in the December 2022 draft EIS creates significant ambiguity when trying to sort out what was assumed by searching in the 2015 EIS. The 2015 EIS Appendix D analysis of human health effects and the accident consequences at LANL and SRS gave DOE's documented safety analysis results from over a decade ago, and also gave the reduced consequence estimates as deemed more appropriate by the 2015 EIS authors. Then the December 2022 EIS appeared to pick and choose sometimes the older DOE consequences and sometimes the reduced 2015 consequence estimates, all without explanation. The adjustment of values in the 2022 EIS makes it all the more difficult to compare to the 2015 EIS. And an up-to-date status of LANL upgrades is simply not provided in the 2022 draft EIS.

Many statements, used by reference to the 2015 EIS, assert that DOE's rigorous safety requirements would be met and would assure low radiation doses to the public. But, in light of NNSA's recent use of the "exigent circumstances" processes at LANL to accept far higher accident risks and to continue to delay or outright cancel needed safety upgrades shows that these statement in the 2022 draft EIS are fiction and simply not true.

The 2022 draft surplus plutonium disposition EIS must explain the actual status of safety upgrades at LANL. The December 2022 EIS has omitted the fact that heat source plutonium, plutonium-238, has a far higher dose consequence than was assumed in the 2015 EIS or this 2022 EIS. The NNSA's December 2022 draft surplus plutonium disposition EIS is fictional and fraudulent to a degree extreme even for DOE.

The 2015 EIS also makes inappropriate and incorrect statements and assumption pertaining to plutonium-241. In fact, it states in its Appendix D that

> *"For plutonium isotopes, the relative inhalation hazard is similar for plutonium-238, -239, -240, and -242.* ***Plutonium-241 is less hazardous.*** *[emphasis added] Plutonium decays with time and americium-241 builds up. The relative inhalation hazard of americium-241 is higher than that of plutonium-239."*

The problem is that plutonium-241 does decay to americium-241, both inside the storage containers of material and inside the human body. And with the higher amount of plutonium-241 in non-pit plutonium, not only is the build up of americium-241 higher in the inhaled material, the plutonium-241 inhaled, is highly retained in the body. The inhaled plutonium-241 decays into americium-241 while inside the body. And so, while the beta decay of Pu-241 to Am-241 isn't as harmful as an alpha decay of Pu-239 or Am-241, the EIS makes a mistake that has long been a mistake made in the estimation of worker radiation doses. Likely the EIS incorrectly underestimated the doses to the public as well.

The error in the radiation dose estimate is higher for plutonium with higher amounts of plutonium-241 and the americium-241 ingrowth can be significant for higher Pu-240 and Pu-241 materials. During the last decade, the Department of Energy has begun to realize the mistake of ignoring the plutonium-241 inhaled in plutonium mixtures but NNSA has ignored this in the 2022 draft EIS. In addition, research has found plutonium to be even more highly retained and recycled in the body than previously thought. Dose conversion factors for plutonium continue to change and have been found to increase.

The 2022 draft EIS assumes, by its use of the 2015 EIS, that surface deposition of plutonium will be controllable through "interdiction" which means food grown in the contaminated soil will not be consumed. Resuspension of plutonium forever blowing in the wind is assumed to not be a problem. The forced evacuation of homes and property and economic losses are ignored.

In the 2022 draft EIS, "disposition" is defined as "disposal" because the Mixed Oxide Fuel fabrication facility was canceled due to spiraling costs.

The 2022 draft EIS "preferred option" increases the risk of a serious accident at the already overburdened facility in New Mexico at the Los Alamos National Laboratory (LANL). It also greatly increases the amount of plutonium to be disposed of at the Waste Isolation Pilot Plant (WIPP), also located in New Mexico. The draft EIS makes terrible assumptions, often tangled and inappropriate and out-of-date assumptions that are not even described within the 2022 document but are simply pointed out as coming from the out-of-date 2015 EIS. The already enormous weapons plutonium and heat source plutonium accident risks at LANL are unacceptable and reckless. The 2022 draft EIS ignores the actual state of accident risks at LANL while claiming to consider all the facility accident risks.

Dismantling pits from Pantex does not mean all of the weapon's material would be disposed of because some material may be used for new weapons. [3] [4] [5] [6] The Arms Control Association December 2022 article [7] reported that modernizing the U.S. nuclear arsenal is expected to cost at least $634 billion over the next decade. "This includes 400 new land-based intercontinental ballistic missiles, a new fleet of nuclear-armed strategic submarines, a new strategic bomber, a new air-launched cruise missile, a newly designed nuclear warhead (the W-93), and the refurbishment of other nuclear warhead types."

Public comment on the Department of Energy's National Nuclear Security Administration (NNSA) latest draft Surplus Plutonium Disposition Environmental Impact Statement (DOE/EIS-0549) will be accepted until February 14, 2023. [8]

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[3] Willian J. Broad, *The New York Times*, "The Surprising Afterlife of Unwanted Atom Bombs," November 17, 2022. https://www.nytimes.com/2022/11/17/science/retired-nuclear-bombs-b83.html The B83 bombs are being retired, as the B93 bombs are planned to be built.

[4] Whitney Spivey, Editor, Los Alamos National Laboratory, "Envisioning the W98," July 26, 2021. https://discover.lanl.gov/publications/national-security-science/2021-summer/w93/. This glitzy government funded article fails to mention the risk and the harm to the public, workers and the environment from nuclear weapons pits disassembly, new pit construction and weapons pit disposal.

[5] Hans Kristensen and Matt Korda, Federation of American Scientists, "The 2022 Nuclear Posture Review: Arms Control Subdued By Military Rivalry," October 27, 2022. https://fas.org/blogs/security/2022/10/2022-nuclear-posture-review/ The latest nuclear posture review moves forward with retiring the B83-1 bomb due to increasing maintenance costs and cancelling the nuclear sea-launched cruise missile (SLCM-N).

[6] Congressional Research Service, 2022 Nuclear Posture Review, December 6, 2022. https://crsreports.congress.gov

[7] Daryl G. Kimball, Arms Control Today, "Biden's Disappointing Nuclear Posture Review," December 2022. https://www.armscontrol.org/act/2022-12/focus/bidens-disappointing-nuclear-posture-review

[8] Department of Energy's National Nuclear Security Administration, Surplus Plutonium Disposition Program Environmental Impact Statement (DOE/EIS-0549), issued December 2022. Public comments accepted until February 14, 2023. See https://www.energy.gov/nepa/articles/doeeis-0549-draft-environmental-impact-statement-december-2022 and https://www.federalregister.gov/documents/2022/12/16/2022-27152/notice-of-availability-of-draft-environmental-impact-statement-for-the-surplus-plutonium-disposition

New Mexico lawmakers are debating whether New Mexico's consent must be required for the Holtec spent nuclear fuel

The State of New Mexico is seeking the requirement that the state can choose whether or not to allow the proposed Holtec spent fuel storage facility to be built in the state. [9] New Mexico lawmakers are debating whether New Mexico's consent must be required. The Holtec facility would hold spent fuel from around the country, generated at various nuclear power plants.

In 2021, the U.S. Nuclear Regulatory Commission approved a license for a similar nuclear spent fuel facility in West Texas and the NRC has plans to grant a license for the Holtec spent fuel storage facility in New Mexico as early as March. The two sites for so-called "interim" storage of spent nuclear fuel would be about 40 miles apart.

The interim storage facilities are not designed for permanent storage, but there is no permanent storage or disposal facility being built in the U.S. In fact, the Department of Energy has no spent nuclear fuel repository program, which is why they had to stop collecting fees from electricity rate payers for a program.

The Department of Energy stated it had collected $28.2 billion from commercial nuclear utilities for the "Nuclear Waste Fund." The U.S. Court of Appeals agreed to end DOE's collection of fees because DOE did not have waste disposal program for spent nuclear fuel and also because the DOE's latest fee assessment covered an enormous range of possible costs, from somewhere between $25 billion and $2 trillion dollars, so there was no way to determine the adequacy of the fees paid. [10]

The court found that the DOE's 2011 plan to somehow find a spent nuclear fuel disposal facility by 2048 was "pie in the sky." [11]

Under the 1982 Nuclear Waste Policy Act, DOE was to have a disposal facility by 1998. And nuclear utility customers would pay one-tenth of a cent for every kilowatt hour of nuclear-generated electricity in to the Nuclear Waste Fund. The collection of the fee ended on what is being called "zero day," May 16, 2014. [12]

The Department of Energy has stated it would begin disposal of commercial spent nuclear fuel in 1998, then 2010, to 2017 to 2020 and now 2048. [13] We know that these dates prior to 2048 have all been empty promises. See the Environmental Defense Institute December 2020

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[9] Susan Montoya Bryan, AP, "US sweetens pot to study siting for spent nuke fuel storage," January 26, 2023. https://apnews.com/article/politics-new-mexico-state-government-texas-united-states-5850006929f541cc5aaac613191417d9

[10] Steven Dolley, Elaine Hiruo, and Annie Siebert, *S&P Global Platts*, "Federal court orders suspension of US DOE nuclear waste fund fee," November 19, 2013. https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/111913-federal-court-orders-suspension-of-us-doe-nuclear-waste-fund-fee

[11] Ibid.

[12] World Nuclear News, Zero day for US nuclear waste fee, May 16, 2014. https://www.world-nuclear-news.org/Articles/Zero-day-for-US-nuclear-waste-fee

[13] Brandi Buchman, *Courthouse News Service*, "Entergy Says Feds Are 50 Years Behind on Nuclear Waste," July 2, 2017. https://www.courthousenews.com/entergy-says-feds-50-years-behind-nuclear-waste/

newsletter article for more details, "The 'Nuclear Waste Fund' fee is no longer being collected from commercial nuclear power utilities – because the Department of Energy has no spent fuel disposal program."

The spent nuclear fuel is radioactive and the decay heat is reduced over time, in a few hundred years, it does not require as much cooling or shielding. However, the radioactive material remaining in the fuel remains very toxic to all living organisms for long over hundreds of thousands of years. The problem of how to keep the radioactive material in the spent fuel contained for millennia has not been solved.

The NRC is granting licenses for a limited time, a few decades – yet it takes many decades to site and build a permanent repository. And the casks of the spent nuclear fuel that will be stored at these interim storage facilities likely won't be safe for storage for decades let alone safe for use for future shipping. No spent fuel repackaging capability has been designed and none is required or available at these interim facilities such as proposed for New Mexico and Texas.

Storing the spent nuclear fuel in NRC-licensed casks was supposed to require that the fuel be able to be repackaged if there was a problem. But the NRC did not comply with its own regulations and granted licenses to the Holtec and other thin-walled canister systems. Other countries use safer technology that involves thick-walled casks and the systems to repackage the fuel.

A study updated in 2019 by the Department of Energy confirms that the NRC had no documented evaluation of the consequences of spent nuclear fuel canister failure. The NRC has prepared the draft Environmental Impact Statement for the proposed Holtec consolidated interim storage facility in New Mexico without having any documented basis for the consequences of an expected event, leakage of a spent nuclear fuel canister. [14]

Instead of using thin-walled welded canisters that cannot be adequately inspected or repaired, the Swiss required the use of bolted thick-walled casks. They store them in a building, away from ocean salt spray air, for example. The Swiss require a hot cell for repackaging a cask if needed. Read more at SanOnofreSafety.org [15] (and also the December 2020 EDI newsletter).

The NRC has also licensed far higher reactor burnup levels and this has meant far higher criticality risk in each canister. The fuel in a canister will go critical if water enters the canister, which, in the past, was not the case, for the lower enriched fuels.

While the criticality risk of the fuel is high in the first 100 hours after shutdown and remains at its highest during the first year, the reactivity, or k-effective, declines during the first 100 years. However, after about 100 years, the k-effective climbs steadily, peaking at about 25,000

[14] U.S. Department of Energy, Spent Fuel and Waste Science and Technology, Gap Analysis to Guide DOE R&D in Supporting Extended Storage and Transportation of Spent Nuclear Fuel: An FY2019 Assessment, SAND2019-15479R, December 23, 2019. https://www.osti.gov/servlets/purl/1592862

[15] SanOnofreSafety.org webpage "Swiss Solution – Swiss nuclear waste storage systems exceed US safety standards" at https://sanonofresafety.org/swiss/

years after its use in a reactor before starting to decline again. [16] See the Environmental Defense Institute December 2020 newsletter article for more details, "The last 10 years of repository research shows that the criticality issues are a problem, especially for 'direct disposal' of spent nuclear fuel canisters."

The spent fuel canisters now prevalently in use in the U.S. are going to fail. And the NRC is keeping any study of the actual range of radiological consequences, under wraps. The airborne leakage of radioactive gases, the NRC can argue, can be maintained below regulatory limits. But this argument may rely on meeting the regulatory limits by evacuation of people living near the interim storage site.

With the unsafe canister designs, once the canisters start failing, and the problem is deemed just a South Texas and New Mexico problem, there will be little incentive for replacing the unsafe storage canister design and little incentive for seeking a permanent disposal solution.

The AP article cites how the San Onofre nuclear plant in California is seeking to move their spent fuel to New Mexico. The San Onofre spent nuclear fuel is stored in Holtec canisters and a storage system, essentially the same as proposed for New Mexico. The San Onofre spent fuel storage facility was licensed by the NRC. Yet, it is on the coastline of the Pacific Ocean and even more susceptible to long-known chloride-induced stress corrosion cracking. The through-wall cracking can occur within twenty years. The NRC licensed outrageously shortsighted and unsafe storage of spent nuclear fuel at San Onofre as well as the other nuclear power plants in the U.S.

The masters of subtlety, a U.S. Nuclear Regulatory Commission basically admits that currently there is no ability to detect cracks in dry spent nuclear fuel canisters.

The transcript of the NRC meeting held October 11, 2018 includes the response to questioning about canister inspection capability. The NRC engineer responds: "Separately, we do have a contract with PNNL, one of the DOE laboratories, to set up a mockup of a cask to collaborate with EPRI to actually see how the robotics, how these tools are resulting in the inspections to actually assess and see, can they detect the flaws, can they understand and characterize the flaws. So, I think it's progressing well, I think we have confidence in the industry and the direction they're going to be able to inspect these in the future." [17]

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[16] Energy Workshops, *2018 SFWST Annual Working Group Meeting, Las Vegas, Nevada May 22 to May 24*, 2018. https://energyworkshops.sandia.gov/nuclear/2018-sfwst-rd-team-meeting/ See presentation #05 on direct disposal of spent nuclear fuel, page 4 the figure of K-effective versus time, and see page 10 for regulations that dismiss fallout effects on groundwater for criticality events after 10,000 years if less than 1.0E-4 annual probability at https://energyworkshops.sandia.gov/wp-content/uploads/2018/05/05-Direct-Disposal-of-Spent-Nuclear-Fuel-in-Dual-Purpose-Canisters-RD-Path-Forward-SAND2018-5437-PE.pdf

[17] SanOnofreSafety.org at https://sanonofresafety.org/ and see the U.S. Nuclear Regulatory Commission transcript for the October 11, 2018 meeting, Strategic Programmatic Overview of the decommissioning and Low-Level Waste and Spent Fuel Storage and Transportation Business Lines (ML18295A698) (pages 104 and 105) at https://www.nrc.gov/docs/ML1829/ML18295A698.pdf

Translation, thanks to Donna Gilmore for SanOnofreSafety.org, is that the nuclear industry has again admitted that they currently have no ability to inspect canisters for cracks. They have no ability to "detect the flaws" or "understand and characterize the flaws." [18]

What this means is that spent nuclear fuel canisters at nuclear plants around the country may start leaking and/or exploding without warning and with no means of repackaging the spent fuel into a new canister.

The NRC hasn't actually included chloride-induced canister cracking in its risk assessments. And they know that through-wall cracking takes less than 20 years from exposure to salt water or other chloride-rich water. See our July 2018 EDI newsletter [19] and our comments regarding Holtec and Interim Storage Partners proposed interim storage facilities. [20] [21] See also the Environmental Defense Institute February 2019 newsletter article, "Despite the U.S. NRC Spin, There is No Ability to Detect Dry Spent Nuclear Fuel Canister Cracks."

In 2010, the U.S. Nuclear Waste Technical Review Board (NWTRB) recommended the "design and demonstration of dry-transfer fuel systems for removing fuel from casks and canisters following extended dry storage." [22] But this still hasn't happened.

In addition to the costs associated with spent nuclear fuel disposal because the industry's welded canisters were not considered suitable for disposal, the U.S. Nuclear Regulatory Commission has not grappled with the safety ramifications of not being able to retrieve spent fuel from these canisters, should one be damaged. [23]

In a dangerous and exceedingly dishonest way, the NRC has stipulated that aging degradation will not be included in its risk assessment of the canisters, despite known high likelihood, ineffective inspection programs and essentially no means for addressing aging degradation of the dry storage canisters predominantly used by the commercial nuclear industry. See the Environmental Defense Institute January 2021 newsletter article for more details, "The

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[18] Donna Gilmore, SanOnofreSafety.org, Press Release, "Regulators consider whether to allow San Onofre nuclear waste to be stored in defective Holtec storage system," January 24, 2019. https://sanonofresafety.files.wordpress.com/2019/01/pressrelease2019.jan24nrc2pm.pdf

[19] Tami Thatcher, Environmental Defense Institute, July 2018 Newsletter article "Spent Nuclear Fuel Dry Storage Safety Issues Largely Ignored," http://www.environmental-defense-institute.org/publications/News.18.July.pdf

[20] Tami Thatcher, "Public Comment Regarding Application to the U.S. Nuclear Regulatory Commission on the "Holtec International HI-STORE Consolidated Interim Storage Facility Project," Docket NRC-2018-0052-0058, July 30, 2018. http://www.environmental-defense-institute.org/publications/NRCHoltec2018.pdf

[21] Tami Thatcher, "Public Comment Regarding Interim Storage Partners LLC's Consolidated Interim Storage Facility," Docket NRC-2016-0231, November 2018. http://www.environmental-defense-institute.org/publications/CommentNRC2018Texas.pdf

[22] U.S. Nuclear Waste Technical Review Board, *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*. Arlington, Virginia, 2010. pp. 14 and 125, (at www.nwtrb.gov) as cited in https://info.ornl.gov/sites/publications/files/Pub60236.pdf

[23] Read the Environmental Defense Institute December 2020 newsletter, including "Devil in the details of the Standard Contract with the Department of Energy under the NWPA" and "The 'Nuclear Waste Fund' fee is no longer being collected from commercial nuclear power utilities – because the Department of Energy has no spent fuel disposal program," at http://www.environmental-defense-institute.org/publications/News.20.Dec.pdf

NRC Required Canistered Spent Nuclear Fuel To Be Retrievable – But It Isn't and Prevalent Canister Storage Poses Huge Safety Risks as Well as Higher Disposal Costs."

What are the canister leak consequences for a leak, even of modest size? The answer is, even using the NRC's fuel release fractions rather than the entire canister radionuclide inventory, the radiation dose within a few miles could be over several hundred rem. In other words, deadly. And if somehow, there is any radiological monitoring being conducted by someone (the NRC doesn't require it), you will be evacuating and not coming back to your home. See the Environmental Defense Institute January 2021 newsletter article for more details, "Spent Nuclear Fuel Canister Breaches – The Potential Radiological Releases are Too Scary for the NRC to Admit."

To gain an idea of the contents of a single spent fuel canister, see Table 1 below. The estimated inhalation dose may be based on out-of-date dose conversion factors.

Table 1. Selected commercial spent nuclear fuel inventory in a canister.

Nuclide [a]	**Inventory per Assembly (Ci)** [b]	**Number of Assemblies**	**Release Fraction** [c]	**Release (Ci)**	**Eff DCF** [d] **(mrem/uCi)**	**Inhalation Dose at 500 m for 30 days (rem)**
Hydrogen-3	5.0E2	36	0.15 (gases)	2700	6.40E-2	0.11
Iodine-129	3.6E-2	36	0.15 (gases)	0.1944	1.74E2	0.02
Krypton-85	5.8E3	36	0.15 (gases)	31320	0	0
Cobalt-60	3.3E1	36	1 (crud)	1188	2.19E2	166.51
Strontium-90	6.5E4	36	3E-5 (volatiles)	70	1.3E3	58.24
Ruthenium-106	1.3E4	36	3E-5 (volatiles)	14	4.77E2	4.27
Cesium-134	4.1E4	36	3E-5 (volatiles)	44	4.6E1	1.29
Cesium-137	1.1E5	36	3E-5 (volatiles)	119	3.19E1	2.43
Barium-137m	9.9E4	36	3E-3 (fines)	10692	?	?
Plutonium-241	8.0E4	36	3E-3 (fines)	8640	8.25E3	45,619
Yttrium-90	6.5E4	36	3E-3 (fines)	7020	8.44	37.9
Promethium-147	2.3E4	36	3E-3 (fines)	2484	39.2E1	623
Europium-154	6.2E3	36	3E-3 (fines)	669.6	2.86E2	122.5
Curium-244	1.4E4	36	3E-3 (fines)	1512	2.48E5	239,985
Plutonium-238	6.8E3	36	3E-3 (fines)	734	3.92E5	184,146
Antimony-125	1.9E3	36	3E-3 (fines)	205.2	1.22E1	1.6
Europium-155	1.8E3	36	3E-3 (fines)	194.4	4.14E1	5.15
Americium-241	8.8E2	36	3E-3 (fines)	95.04	4.44E5	27,007
Plutonium-240	4.0E2	36	3E-3 (fines)	43.2	4.29E5	11,861
Plutonium-239	1.8E2	36	3E-3 (fines)	19.44	4.29E5	5337
					Total (rem)	~400,000

Nuclide [a]	Inventory per Assembly (Ci) [b]	Number of Assemblies	Release Fraction [c]	Release (Ci)	Eff DCF [d] (mrem/uCi)	Inhalation Dose at 500 m for 30 days (rem)
					At 500 m for 30 days, Inhalation dose	rem

a. The list of radionuclides is incomplete and only includes some of the radionuclides typically contributing the most to radiation dose.

b. Inventory per assembly based on Yucca Mountain Supplement 2008, Appendix E at ML081750216. The number of pressurized water reactor assemblies involved was 36 PWR assemblies, at 5 percent enrichment, 80 gigawatt-days/metric ton uranium (GWd/MTU), and decay time of 5 years, per Appendix E of the 2008 YM Supplement.

c. Release fractions based on U.S. NRC, Dry Storage and Transportation of High Burnup Spent Nuclear Fuel, NUREG-2224, November 2020, ML20191A321, Table 3-1, for "accident-fire conditions." There are many variations in the release fractions used in past radiological release evaluations. (The release fraction for gases (0.3), volatiles (2E-3), fuel fines (2E-3) had been assumed for oxidation release in DOE-RW-0573, Rev. 1, for high burnup fuel.)

d. The effective dose conversion factors (mrem/microcurie) are from 1999 and somewhat out of date, from a Private Fuel Storage analysis, ML010330302. Chi/Q for 500 meters is multiplied by breathing rate, 1.94E-3 (s/m^3) * 3.3E-4 (m^3/s) = 6.4E-7 must be multiplied by the curies inhaled and the effective dose conversion factor.

e. The YM Supplement does not reveal the atmospheric dilution factor used for the 11 mile dose (10,200 meters), nor were the documents cited as source documents actually revealing the atmospheric dilution factor, the Chi/Q for the public dose. (ML-90770783 did not include the public and ML090770554 available online was incomplete.) ML092360330 gives the distance to the public but not the atmospheric dilution factor, which the Department of Energy appears to go to great lengths to avoid revealing. The 2007 Bechtel SAIC report, 000-00C-MGR0-02800-000-00B is not found on NRC's Adams database. Also, according to the YM Supplement, the 95th percentile dose for a noninvolved worker for the canister scenario, Table E-11, is inexplicably lower than the 50th percentile dose. This appears to be an error. But for the 50th percentile dose, no exposure time or dilution factor given, the dose was 0.21 rem. Removing the HEPA filters would yield a 2100 rem dose to the noninvolved worker. The doses to the involved workers or workers deemed close to the canister accident are not given. In any case, a 500 rem dose is acknowledged to kill 50 percent of people in short order and based on the experience of SL-1 emergency responders said to have received 20 rem doses, the other 50 percent are not going to live more than a few years.

The dose from Table 1 is for a person standing in the radiological plume 500 meters from the canister for 30 days. Also, the respirable fraction is assumed to be 1.0, consistent with Department of Energy assumptions for high burnup fuel. [24]

An acute radiation dose exceeding 400 rem is considered lethal. The acutely high doses in Table 1 far exceed 400 rem and this perhaps explains why the NRC refuses to admit that a

[24] Department of Energy, Yucca Mountain Repository SAR, Docket No. 63-001, DOE/RW-0573, Rev. 1, https://www.nrc.gov/docs/ML0907/ML090700894.pdf Ch 1.6, Page 1.8-18 [286]

canister leak of significant size is credible. The U.S. NRC has also been eliminating requirements for canister monitoring and capability for emergency response.

The NRC makes statements that a canister leakage would not exceed regulatory requirements. This sophistry doesn't mention that keeping doses below, say, 25 rem, could require permanent evacuation of residents. There is no discussion of the fact that automobiles and homes are not insured for radiological events.

The nuclear industry has a myopic focus on cancer, although cancer is certainly increased by the inhalation or ingestion of radiative particles and/or from "shine" from penetrating radiation. The actual rates of health harm such as infertility, increased birth defects, heart disease, dementia, shortened life span and other adverse health effects are not adequately represented in nuclear industry radiation protection standards, especially for the chronic radiation exposure of far lower radiation doses. It is known that the developing child in utero, children and the elderly are many times more vulnerable to radiation exposure.

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