Public Comment Submittal on the U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS) (DOE/EIS-0542)

Comment submittal (Second Set) by Tami Thatcher, March 1, 2021

Comments Due: March 2, 2021. Sent by email to VTR.EIS@Nuclear.Energy.gov

BACKGROUND

The draft Environmental Impact Statement for the Versatile Test Reactor (VTR) considers the potential environmental impacts for the construction and operation a new Department of Energy regulated test reactor, and associated facilities for post-irradiation evaluation of fuels and other materials, VTR driver fuel production (fuel feedstock and fuel fabrication), and the managing of its spent nuclear fuel. [1] [2] The VTR would be a 300 megawatt (thermal) fast neutron reactor that does not generate electricity and is only used for high neutron bombardment of fuels and other materials. The VTR is a pool-type, sodium-cooled reactor with a fast-neutron spectrum and will use a uranium-plutonium-zirconium metal fuel.

GE Hitachi Nuclear Energy is working with the Idaho National Laboratory on the VTR conceptual design based on its PRISM reactor, which was based on the Experimental Breeder II reactor. [3] The EBR II which was operated by Argonne National Laboratory – West at the Idaho site which is now the Materials and Fuels Complex (MFC) at the INL, although the EBR II has been dismantled. The 60-year-old pyrochemical (or pyroprocessing or electrometallurgical processing) facility at MFC, the Fuel Conditioning Facility (FCF) remains at the former EBR II complex.

OVERALL SUMMARY

The Department of Energy proposes to construct and operate the Versatile Test Reactor at either the Idaho National Laboratory or the Oak Ridge National Laboratory DOE site. DOE's stated preferred site is the INL. DOE would also produce VTR fuel at the INL or the Savannah River Site. I oppose construction of the Versatile Test Reactor at the preferred site (INL) and at ORNL. The cost of the project is going to skyrocket far beyond the several billion dollars currently discussed and the accident risks are unacceptable. Sodium-cooled fast reactors are not

[1] U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS) (DOE/EIS-0542) at https://www.energy.gov/ne/downloads/public-draft-versatile-test-reactor-environmental-impact-statement-doeeis-0542 (Announced December 21, 2020). A copy of the Draft VTR EIS can be downloaded at https://www.energy.gov/nepa or https://www.energy.gov/ne/nuclear-reactor-technologies/versatile-test-reactor. Extended deadline, VTR EIS comments now due: March 2, 2021. Send by email to VTR.EIS@Nuclear.Energy.gov

[2] See Versatile Test Reactor (VTR) draft Environmental Impact Statement comments on our home page at http://www.environmental-defense-institute.org and at http://www.environmental-defense-institute.org/publications/CommentVTRdEIS.pdf

[3] Press Release, GE Hitachi, "GE Hitachi and PRISM Selected for U.S. Department of Energy's Versatile Test Reactor Program," November 13, 2018. https://www.ge.com/news/press-releases/ge-hitachi-and-prism-selected-us-department-energys-versatile-test-reactor-program

economically competitive, are not likely to be as safe as already unsafe light-water reactors and also significantly increase proliferation concerns. [4]

The INL site is said to be preferred due to the lower population near the facility, which yields lower latent cancer fatalities following an accident. But precisely because Idaho has a lower population near the facility, the Department of Energy will take more shortcuts, undercutting safety at the facility.

The accident consequences from a reactor accident such as a "core disruptive accident" at the VTR is enormous. So enormous that the VTR EIS hides the total curie amount. But do the math on 110 fuel assemblies and the reactor holds 1.57 billion curies. A reactor accident at the VTR is on the order of one or more Chernobyl nuclear disasters depending on which estimate of the Chernobyl radiological release is used in the comparison.

Even without a core disruption accident, the fuel handling, and fuel preparation and fabrication impose risks and consequences to the population within 50 miles of the facilities similar to the estimated risk and consequences of a meltdown of a commercial light-water reactor regulated by the U.S. Nuclear Regulatory Commission. The Department of Energy, however, is notorious for cutting safety features without having a technical justification, as happened at the DOE's WIPP facility and at the DOE's Materials and Fuels Complex regarding the plutonium inhalation event in 2011.

The DOE is proposing conducting fuel pyrochemical (or pyroprocessing) in 60-year-old facilities at the INL to remove sodium-bonded material from the VTR fuel and years of outdoor storage of spent nuclear fuel and transuranic waste. The facilities will be too old to treat the material for the proposed added 60 years of VTR operations.

Importation of plutonium from France or the UK is likely to be preferred over U.S. surplus plutonium because of the variety of impurities. The purification processes for the U.S. surplus plutonium have been costly and slow. The VTR EIS will probably not be reducing the U.S. surplus plutonium stock pile. The VTR only exacerbates plutonium disposal issues, all while creating many opportunities for plutonium theft and plutonium release accidents as the material is transported and during storage. The transportation of plutonium from Europe to the US and around the U.S. has not been addressed adequately in the VTR EIS due to the number of shipments, the flexible and lax packaging requirements, and the inadequate emergency response readiness. The VTR EIS must address the plutonium shipment accident consequences and explain whether any compensation program (such as Price-Anderson Act) would apply to radiological releases from transportation of radiological material.

The VTR EIS relies on numerous EISs that are inadequate for many facets of the VTR program including being inadequate to address the unavoidable waste streams including the spent nuclear fuel from the VTR. A Programmatic Environmental Impact Statement (PEIS) is required to address the VTR because it would be adversely impacting waste disposal at the

[4] Thomas B. Cochran, et al., *Fast Breeder Reactor Programs: History and Status*, A research report of the International Panel on Fissile Materials, February 2010. http://large.stanford.edu/courses/2011/ph241/dunn1/docs/rr08.pdf

Waste Isolation Pilot Plant (WIPP), DOE's Greater-Than-Class-C waste disposal, spent fuel continued storage and disposal at the non-existent DOE spent fuel and high-level waste disposal program, and impacting treatment of existing sodium-bonded spent fuel at the INL. The hoped-for off-shoots of the VTR will then greatly add to the spent nuclear fuel problem because we already need two Yucca Mountain repositories and we don't have one Yucca Mountain repository and there has been no program to develop one since 2010.

The high cost of VTR siphons scare money away from real climate change solutions. And any meaningful increase in the use of nuclear energy would mean needing a new Yucca Mountain repository every year. [5]

I am opposed to the Department of Energy's proposed Versatile Test Reactor project and to locating it at the Idaho National Laboratory. And anyone who cares about human health in general and southeast Idaho in particular who understands the costs and risks imposed by the VTR project would be opposed to this project.

Please add these comments to the comments I sent earlier in February [6] just prior to the announced deadline extension. In this second comment submittal, I address more of the errors and misleading portrayals of the accident likelihood and consequences in the VTR EIS.

The VTR EIS addresses the radiation dose to a noninvolved worker at 330 feet from the accident, to a hypothetical member of the public at 3.1 miles from the accident, and the latent cancer fatalities for the population within 50 miles. The harm to human health harm, particularly from cancer incidence rather than cancer fatality, increased illnesses, increased birth defects is not included in the VTR EIS and it must, in order to fulfill the intent of NEPA reguations.

The radioactive waste storage and disposal problems the Idaho National Laboratory already faces are greatly worsened by the VTR project. The extent to which radioactive wastes from the VTR project will be buried over the Snake River aquifer or will languish with no disposal facility are not realistically or transparently addressed in the VTR EIS. The VTR EIS violates NEPA by pretending that previous EISs, many of which have flailing or non-existent programs, cover the issue of waste management. From the DOE's greater-than-class-C low-level radioactive waste that DOE has not ruled out sending to INL, to the over-committed Waste Isolation Pilot Plant (WIPP) in New Mexico, to the non-existent spent nuclear fuel disposal program, the VTR EIS is waiving at fictions to pretend that DOE has the comprehensive planning, research and program implementation to address existing waste or future VTR wastes.

The DOE wants us to believe its many assumptions and assertions about the accident risks posed by the project. Buried in the EIS document it does admit that if the VTR has a bad day,

[5] Edited by Allison M. Macfarlane and Rodney C. Ewing, *Uncertainty Underground Yucca Mountain and the Nation's High-Level Nuclear Waste*, The MIT Press, 2006. Page 4.

[6] See Tami Thatcher's first public comment submittal on the U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (DOE/EIS-0542) at http://www.environmental-defense-institute.org/publications/CommentVTRdEIS.pdf

"the consequences can be in the hundreds or thousands of rem to the public…" [7] But trust us, they say in technojargon, that is "beyond extremely unlikely."

The DOE wants to bet the farm - your farm (or business or home or life or your child's life) that a severe reactor accident won't happen.

And even without a reactor accident, an accident involving making VTR's plutonium fuel or performing the required processing to store the fuel involves significant risk to communities within 50 miles of the facilities.

The project DOE is promoting aims for privatized profits at tax payer expense. It claims to help solve energy poverty by helping to generate electricity in the most expensive and accident-prone way known and by adding to the spent nuclear fuel storage and disposal problems we already have. [8] [9] [10] The Department of Energy has not estimated what the nation's spent nuclear fuel storage, repackaging and disposal costs will ultimately be.

The fees collected from operating commercial nuclear reactors probably won't even pay for the cost of repackaging the waste for disposal, let alone obtaining the two disposal repositories now needed. [11] [12] [13]

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[7] Excerpt from VTR EIS, Appendix D, page D-74, Section D.4.9 Versatile Test Reactor Beyond-Design-Basis Reactor Accidents, "By design, the VTR is able to withstand a wide range of accidents. Most events that could affect safe operation of the VTR are mitigated by the VTR design. This section addresses potential beyond-design-basis accidents that have the potential for high consequences even though the probability is very low (1×10^{-6} to 1×10^{-8} per year). These accidents represent events in which the consequences can be in the hundreds or thousands of rem to the public while probabilities are less than one in a million per year. Consideration of these very low-probability but potentially high-consequence accidents provides valuable insight for the public and decision-makers in understanding the overall risks of operation, siting decisions, and the need for emergency preparedness."

[8] Blue Ribbon Commission of America's Nuclear Future. 2012. (It uses 2010 estimates for spent fuel quantities) www.brc.gov

[9] U.S. Nuclear Waste Technical Review Board (NWTRB), Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel. Arlington, December 2017. See p. 15.

[10] Nuclear Regulatory Commission, 10 CFR 51, Waste Confidence-Continued Storage of Spent Nuclear Fuel, Federal Register, Vol. 78, No. 178, September 13, 2013.

[11] Government Accountability Office, Spent Nuclear Fuel: Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges, GAO-12-797. September 14, 2012. https://www.gao.gov/products/GAO-12-797 The amount of spent nuclear fuel is increasing by about 2,000 metric tons per year and likely more than doubling to about 140,000 metric tons before it can be moved off-site. "At the end of 2012, over 69,000 metric tons is expected to accumulate at 75 sites in 33 states, enough to fill a football field about 17 meters deep." Apparently they converted to metric units by changing feet to meters (?)

[12] Sandia National Laboratories, Spent Fuel and Waste Science and Technology, *Direct Disposal of Spent Nuclear Fuel in Dual Purpose Canisters: R&D Path Forward*, PowerPoint presentation, SAND2018-5437 PE, May 2018. https://www.osti.gov/servlets/purl/1515737 Their study estimated the cost of repackaging spent nuclear fuel canisters at $32.7 billion, see page 9. The criticality concerns for not repackaging were said to need to argue low risk rather than low probability of criticalities in the repository, meaning their argument would have to show criticalities were low consequence.

[13] U.S. Government Accountability Office, *Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned*," GAO-11-229, May 10, 2011. https://www.gao.gov/assets/320/317634.html "Spent nuclear fuel is considered one of the most hazardous substances on earth. Without protective shielding, its intense radioactivity can kill a person exposed directly to it within minutes or cause cancer in those who receive smaller doses. Although some elements of spent nuclear fuel

Other radioactive wastes from the VTR project will either be buried over the Snake River Plain aquifer as it the DOE's current practice or shipped elsewhere. The presumption that the Waste Isolation Pilot Plant (WIPP) in New Mexico can accept any and all waste that the DOE can't dispose of anywhere else continues a long pattern of DOE expecting to undermine the laws that were made to protect New Mexico from an ever-expanding mission.

The VTR project could use surplus plutonium stocks but these proved costly and complicated to purify at the DOE's canceled MOX plant. The VTR EIS says DOE may choose to import the plutonium from France or the UK. Importing the plutonium, however, would simply add to the nation's current plutonium disposal problems.

The DOE has actually stated it hopes the VTR project will "lead to reduced nonproliferation concerns." [14] [15]Translated this means DOE's stated goal is to *increase the proliferation concerns* – which is indeed, what the proposed program will actually do. It will make it easier for nuclear weapons material like plutonium to get into the wrong hands.

The DOE had to cease collecting fees from commercial nuclear power plants in 2014 because a court found that the DOE had no spent nuclear fuel disposal program and hasn't since 2010. [16] [17] [18] The VTR EIS relies on numerous inadequate waste management EISs, hoping we won't

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cool and decay quickly, becoming less radiologically dangerous, others remain dangerous to human health and the environment for tens of thousands of years. The nation's inventory of over 65,000 metric tons of commercial spent nuclear fuel--enough to fill a football field nearly 15 feet deep--consists mostly of spent nuclear fuel removed from commercial power reactors. The volume of commercial spent nuclear fuel is expected to more than double by 2055—assuming currently operating reactors receive license extensions and no new reactors are built--and is currently accumulating at 75 sites in 33 states…"

[14] The Department of Energy's Federal Register notice that is in Appendix A of the VTR EIS actually quotes DOE as having an objective of the VTR to lead to ***reduced nonproliferation concerns***. Most of us would like to reduce the weapons proliferation concerns, however.

[15] Also see Federal Register stating DOE's intent. Specifically, "DOE will continue to explore advanced concepts in nuclear energy that may lead to new types of reactors with further safety improvements and reduced environmental and nonproliferation concerns." https://www.federalregister.gov/documents/2019/08/05/2019-16578/notice-of-intent-to-prepare-an-environmental-impact-statement-for-a-versatile-test-reactor

[16] 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

[17] 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 Collection of the fee ended on what is being called "zero day," May 16, 2014.

[18] 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/

notice the multiple disconnects with reality. There is no spent nuclear fuel disposal facility on the horizon. [19] [20] [21]

The routine emissions from the VTR will be negligible, the VTR EIS assures us. And the routine radiological releases from the INL have been increasing over the last two decades, including releases of americium-241.

In Idaho and elsewhere, thyroid cancer incidence has been rapidly climbing. But curiously, all of the counties surrounding the INL have experienced more than a decade of roughly double the thyroid cancer incidence than the rest of Idaho and the rest of the country. [22] [23] [24] [25]

Americium-241 has been determined to pose a significant risk for thyroid cancer incidence which the VTR EIS ignores because of its focus on cancer fatalities, not incidence. [26]

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[19] See everycrsreport.com from September 16, 2019 on Civilian Nuclear Waste Disposal. By law, the Yucca Mountain repository was capped at 70,000 metric tons. DOE estimated that there was 81,600 metric tons in 2018. And it discusses the projected need to dispose of 130,000 metric tons, citing a 2007 projection. https://www.everycrsreport.com/files/20190916_RL33461_9c53abb93c522f94939ff34d94bba8f2b8c190ef.html#Content

[20] FCRD-UFD-2014-000069, August 2014, reports the Department of Energy already assuming to projected need to dispose of approximately 139,000 metric tons, projected to be produced through shutdown of the last reactor in 2055. (Two repositories were to hold 140,000 metric tons of spent nuclear fuel.) https://www.energy.gov/sites/prod/files/2014/10/f19/7FCRDUFD2014000069R1%20DPC%20DirectDispFeasibility.pdf

[21] Sierra Club, *Guidance on Implementing Sierra Club Policy on the Management of High-Level Nuclear Waste*, Adopted by the Board of Directors September 12, 2020. https://www.sierraclub.org/sites/www.sierraclub.org/files/uploads-wysiwig/sierraclub_guidance_high-level_nuclear_waste_management_2020_08_05.pdf?v=20200805 "Even more problematic, after cancelling the Yucca project, our federal government has not launched a scientific and technical effort to identify the necessary elements for a permanent repository and all the key safeguards. Instead the federal government is now jointly participating in research being conducted by other countries, using Underground Research Laboratories for the studies."

[22] National Cancer Institute, Surveillance, Epidemiology, and End Results Program, Cancer Query System. https://seer.cancer.gov/canques/incidence.html

[23] Hyeyeun Lim et al., JAMA, "Trends in Thyroid Cancer Incidence and Mortality in the United States, 1974-2013," April 4, 2017. https://pubmed.ncbi.nlm.nih.gov/28362912/ or https://jamanetwork.com/journals/jama/fullarticle/2613728

[24] C. J. Johnson, B. M. Morawski, R. K., Rycroft, Cancer Data Registry of Idaho (CDRI), Boise Idaho, Annual Report of the Cancer Data Registry of Idaho, *Cancer in Idaho – 2017*, December 2019. https://www.idcancer.org/ContentFiles/AnnualReports/Cancer%20in%20Idaho%202017.pdf.

[25] Environmental Defense Institute February/March 2020 and July 2020 newsletter articles. "Rate of cancer in Idaho continues to increase, according to Cancer Data Registry of Idaho." As the SEER 9 region thyroid incidence peaked at 15.7 per 100,000, and the State of Idaho thyroid incidence average was 14.2 per 100,000, Bonneville County reached thyroid cancer rates of 30.9 per 100,000. [25] But other counties near the Idaho National Laboratory also have elevated thyroid cancer incidence rates: Madison (29.3 per 100,000), Fremont (27.9 per 100,000), Jefferson (28.9 per 100,000), and Bingham (28.6 per 100,000). But let's not forget Butte county. Butte county's thyroid cancer rate of 45.9 per 100,000 puts it in a class by itself. Much of Butte county is within 20 miles of the INL and nothing says radiation exposure like Butte's leukemia rate at 3 times the state rate and myeloma at 5 times the state average rate.

[26] T.R. Hay and J.P. Rishel, Pacific Northwest National Laboratory, Department of Energy, *Revision of the APGEMS Dose Conversion Factor File Using Revised Factor from Federal Guidance Report 12 and 13*, PNNL-22827, September 2013. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22827.pdf

When I started studying radiological releases from the INL, I never imagined what Idaho citizens would be facing now and in the future. With my years as a nuclear safety analyst at the INL and my years studying accidents, environmental surveillance, worker illness compensation and CERCLA cleanup, and the way the Department of Energy manages its nuclear facilities, I am terrified of the VTR program proposed for the INL. Citizens of southeast Idaho should be, too.

I have compiled a table of the VTR accidents, including the "beyond extremely unlikely" ones not discussed in the main body of the VTR EIS documents, see Table 1. The accidents are ordered by dose to the hypothetical maximally exposed individual located 3.1 miles from the facility during the accident. Many of these accidents would affect the public within 50 miles of the accident, but those figures are more difficult to conceptualize as they depend on population dose.

Table 1. Versatile Test Reactor project accident highlights (includes those deemed "beyond extremely unlikely").

Accident scenario	Material-at-risk of being released	Radiological material released	Dose at 330 ft (rem)	Dose at 3.1 miles (rem) [50-mile population LCF]
VTR core disruption reactor accident – the only reactor accident and the only "beyond-design-basis accident noted in the VTR EIS.	66 fuel assemblies in-core and 44 fuel assemblies decayed 220 days, total of 1.57E9 curies, See Table D-42 for individual fuel assemblies	Use release fractions of Table D-32 for 1,100 C, which range from 1.0 to 0.001 For 1,300 C, the release is stated in the VTR EIS to be several times higher	520,000 rem This uses the release factors for 1100 C. The release fractions for the 1300 C accident would have been several times higher.	790 rem [220]
D.3.1.8 Aircraft Crash into VTR Fuel Fabrication Facility	5000 grams Pu, See Table D-2	1020 grams, Pu-239 equivalent	830 rem	1.1 rem [0.1]
D.3.1.9 Beyond-Design-Basis Earthquake Involving All VTR Fuel Fabrication and Preparation MAR	5000 grams Pu See Table D-2	1020 grams, Pu-239 equivalent	830 rem	1.1 rem [0.1]
D.3.3.5.2.2 Eutectic Fire Involving VTR 6 Fuel Assemblies in the VTR Experiment Hall	3 Fuel Assembles (half of the assemblies)	220-day cooled assemblies. See Table D-42 and see the uniquely chosen release fractions in Table D-10	160 rem	0.24 rem [0.02]
D.3.3.5.2.4 VTR Seismic Event Resulting in Collapse of the Experiment Hall	18 Spent fuel assemblies in experiment hall	220-day cooled assemblies. See Table D-42 and see the uniquely chosen release fractions in Table D-10	58 rem	0.071 rem [8E-9]
D.3.1.4 Spill and Oxidation of Molten Pu-U with Seismically Induced	5,090 grams KIS-grade PuO_2	11.1 grams Pu-239 equivalent	9 rem	0.012 rem [1E-3]

Accident scenario	Material-at-risk of being released	Radiological material released	Dose at 330 ft (rem)	Dose at 3.1 miles (rem) [50-mile population LCF]
Confinement Failure (During Fuel Production)				
D.3.6.1 Seismic event Causes Failure of Spent Fuel Storage Cask	6 spent fuel assemblies	3 spent fuel assemblies, 4-year cooled, See Table D-43 and see Table D-13 for unique and very low release fractions of 4.0E-5 for all but the noble gases	3.1 rem	3.9E-3 rem [4E-10]
D.3.1.6 Beyond-Design-Basis Fire Involving TRU Waste Drum (From Fuel Production)	398 grams KIS-grade Pu	1.96 grams Pu-239 equivalent	1.6 rem	2.2E-3 rem [2E-9]
D.3.4.1 Criticality Involving Melted Spent Fuel (Failed Confinement) (During Spent Fuel Handling and Treatment)	1.0E19 fissions	Noble gases and Iodine, see Table D-44	1.0 rem	3.9E-3 rem [8E-5]
D.3.1.5 Plutonium Oxide-to-Metal Conversion Explosion of 3013 Container of PuO_2 (Fuel Production)	5,090 grams KIS grade PuO_2	97.3 grams Pu-239 equivalent	0.27 rem	0.11 rem [1E-2]

Table sources: See various tables throughout Appendix D of the VTR EIS. The 50-mile population LCF [latent cancer fatality] is the number of expected latent cancer fatalities for the entire population within 50-miles, in order to compare the accident severity presented in the table. But the actual value should not be construed as realistic. The Department of Energy's rate of cancer fatalities per rem low-balls the actual figure, omits cancer incidence, and increased birth defects as well as other health impacts. The VTR EIS does include a long-term figure but appears to do so incorrectly by neglecting the wide spread impact of contaminated food and future generations of people living in the long-lived radioactive contamination. Note that for some accidents, the release is modeled to stay closer to the INL. The explosion of a 3013 can of plutonium oxide, D.3.1.5, however, has a substantial offsite dose, higher than several other accidents that had higher doses at 3.1 miles.

SUMMARY OF VTR EIS INADEQUACY WITH EMPHASIS ON THE ACCIDENT ANALYSIS

The harm from a VTR accident regarding economic impacts from the loss of agriculture, contaminated property, land, homes and vehicles, loss of livelihoods and the many years, more than decades of unacceptable levels of radiological contamination is not adequately conveyed in the VTR EIS.

The VTR EIS has buried in the document, the radionuclides and curie-amounts released by various accidents, in ways that require ferreting the information out from various tables in appendixes. The VTR EIS goes to extreme lengths to avoid saying the total curies released and from which radionuclides for the beyond-design-basis reactor accident. Even the release fraction table, Table D-32 is not specific enough to ascertain precisely which radionuclides the release fraction corresponds to.

Why does the VTR EIS go to these lengths? I think they don't want the public to know that the VTR reactor accident can release 1.57 billion curies. I think they don't want the public to know that the VTR reactor accident can release nearly the amount of cesium-137 that the 1986 nuclear disaster at Chernobyl (based on accepted but probably underestimated release estimates). I think they don't want the public to understand how a VTR accident can release an unusually high amount of long-lived transuranic radionuclides, specifically the americium and curium, which have a high release fraction. These radionuclides decay through a long series of radioactive elements and so the half-life of an individual radionuclide can be misleading.

The story that the VTR EIS emphasizes is that the Department of Energy's estimated accident likelihoods are so low that there's no need to worry. The public won't understand the degree to which the Department of Energy's accident likelihood estimates and the various release factors used to whittle down the radiological releases are **biased, speculative and unreliable.**

The story that the VTR EIS emphasizes is that there are laws and regulations and that the Department of Energy follows these laws and will ensure that its operations are safe. But I have studied the serious accidents over the last decade at Department of Energy facilities: the 2011 plutonium inhalation event at the Idaho National Laboratory's Materials and Fuels Complex, the 2014 underground fire and then drum explosion at WIPP, and the 2018 accident when four waste drums popped their lids and ejected powdery radioactive waste in a fabric enclosure that would usually have unprotected workers present. In each accident, the Department of Energy was found to have serious deficiencies in multiple safety programs. In each case, the Department of Energy was taking shortcuts with maintenance of equipment, shortcuts in emergency response training and planning, and making indefensible safety changes.

The accident analyses in the VTR EIS rely on many assumptions that are unreliable even if sanctioned by the Department of Energy methodologies. The amount of radioactive material that could be released, the "material-at-risk" may be significantly larger than the VTR EIS has estimated. The fraction of the admitted "material-at-risk" to the fire or explosion is then reduced by various factors such as the "airborne-release-fraction," the "respirable faction," the "damage ratio," and the "leak-path-factor" These chosen factors may reduce the radiological release by

several orders of magnitude. This means, for example, that an estimated dose of 3 rem to a noninvolved worker at 330 ft from the accident may actually yield a dose 100 or more times higher — 300 rem rather than the 3 rem. Such differences can be the difference between life and death for the person exposed.

And obscured beyond the focus on hypothetical radiation doses to people is the extensive radiological contamination that will yield years, decades or more, of long-term impact to citizens living in the region. The sometimes modest-appearing radiological doses mean that a significant radiological release, particularly of the long-lived radionuclides released to southeast Idaho, will blow in the wind, contaminate air, soil, water, agricultural land, real estate, homes, businesses, vehicles — and is simply not explained adequately in the VTR EIS.

Even a modest, non-reactor VTR accident would have severe adverse impact to communities near the Idaho National Laboratory. And following a severe reactor accident at the VTR, communities would be devastated, economically and from short-term and long-term radiation health effects. While some radioactive gases would blow away in the winds, other radionuclides like the plutonium and americium would stay in our communities for, basically, millennia.

Radionuclides of various radioactive decay half-lives would be released. The radionuclides would remain pervasive in the environment as fine, invisible and deadly dust that we breathe, that through airborne contamination contaminates our water wells and water tanks, and that contaminates agriculture products, both plant and animal. It would not simply be the misfortune of some workers at the INL — this proposed project creates numerous ways for serious radiological releases to occur that would devastate the lives and livelihoods of many people living in southeast Idaho.

The VTR EIS Must Explain the Curie Amounts and Radionuclides Released

By never stating the curie size of the release, and by asserting, without sound technical basis, that the accidents are "beyond extremely unlikely", if the reader misses one page of an appendix, they would not see the out-of-this-world radiation doses to someone 330 ft from the accident or the deadly dose even 3.1 miles away.

The VTR EIS obscures that fact that a reactor accident involving the Versatile Test Reactor could involve a radiological release larger than released by the 1986 Chernobyl accident. Neither the human health nor the economic devastation from a VTR accident are realistically conveyed in the VTR EIS.

The VTR EIS repeatedly asserts that a reactor accident won't happen and is "beyond-design-basis," at 1.0E-7 accidents per year. But the VTR EIS Tables show that if such an accident does occur, it would involve releasing a significant portion of 1.57 billion curies. But you have to do the math yourself. Even the release fractions are given in a fuzzy way (Table D-32) and the VTR results did not use the higher temperature accident, so they could lower the presented radiological consequences. The VTR EIS must be clear about the total curies released for every radionuclide released by an accident and the release fractions must be given in a less fuzzy way. The VTR EIS must state the total curies released from a VTR accident for both the moderate and the high temperature accidents, not just the moderate temperature accident. The VTR EIS

assumed that the accident would not attain temperatures above 1100 C but noted that if the temperatures do exceed 1100 C, the **releases would be several times higher.**

A VTR accident would involve the 66 fuel assemblies in the core and the 44 fuel assemblies stored out-of-core but in the reactor vessel. The accident would occur rapidly and involve the entire 110 fuel assemblies, but DOE assumes that the accident does not reach temperatures above 1100 C would cause an **estimated radiation dose of 520,000 rem** to the noninvolved worker at 330 ft from the accident and **790 rem to a hypothetical citizen** located 3.1 miles from the accident. Much about the radiological exposures to people within 50 miles is left to the imagination. The VTR EIS only wants to communicate that the higher population near Oak Ridge means that the VTR should be located in the more sparely populated southeast Idaho — because people in a lower population zone are expendable.

The radiological doses would depend on how the wind blows, when it rains, and whether or not contaminated food is consumed. A bad day at the Versatile Test Reactor could be an accident fifteen times larger in terms of total curies than many of the experts had estimated the Chernobyl accident to have released. The experts don't have a consensus on how many curies and of each radionuclide were actually released from Chernobyl. The contamination from the VTR could stay closer to home but much depends on the weather at the time of the accident.

The VTR EIS doesn't state the amount of curies that its limited temperature VTR accident would release, nor the curies released in the event that the accident reaches higher temperatures. The radionuclide inventory of the fuel assemblies in Table D-42 show that for the 110 fuel assemblies, 1.57 billion curies are releasable from the 66 in-core fuel assemblies and additional 44 fuel assemblies stored in the reactor vessel, but it is left for the reader to do the math because the table is in terms of a single fuel assembly.

The VTR EIS includes a large number of potential radiological accidents. I highlighted just a few of them in Table 1 (above). Table 1 includes the material-at-risk and then the material assumed to actually be released, after having been reduced by a number of assumptions pertaining to the airborne-release-factor, respirable fraction, damage ratio and leak-path-factor. The estimated radiological doses to the noninvolved worker at 330 ft from the accident, to the maximally-exposed-individual of the public located 3.1 miles from the accident give an indication of the severity of the accident. Although the releases can also affect the population within 50 miles of the accident, the VTR EIS's lowballed accident frequencies and the dependence on low population, the latent cancer fatality statistics or risk estimates are less easily understood.

The VTR EIS uses language to promote the false impression of more confidence in the overly optimistically low releases and low radiation doses than warranted by the what is really known. If it is science, it must be understood as the "tobacco science" that it is, because of the heavy bias toward reducing radiological release estimates, the associated radiation doses and the human health and economic harm.

The Summary and Chapter 4 of the VTR EIS exclude any mention of what its authors have deemed "beyond extremely unlikely" or "beyond design basis." For that reason, none of the higher radiological dose impacts from VTR's Appendix D are mentioned. But while the DOE

asserts that a VTR accident is so unlikely as to be less than 1.0E-6/yr, it is only a biased assertion and not a estimate based on data. Likewise, the VTR EIS hints at the problem of existing facilities that will not be updated to current seismic standards, yet it pretends those accidents won't happen either (Accident D-3.1.9).

Inadequate seismic analyses for existing INL Materials and Fuels Complex facilities, including the Fuel Conditioning Facility, were long-standing and still not corrected in 2010. [27] It is doubtful that compliance has been achieved other than to accept seismically inadequate structures. The VTR EIS must be forthright about the seismic deficiencies at MFC.

The VTR EIS must admit which facilities at the Materials and Fuels Complex will simply comply with existing seismic standards by the reasoning of the allowed "grandfathering" of existing facilities. The VTR EIS must show (make publicly available) the seismic design analysis of the fragility of these facilities in its VTR EIS.

The VTR EIS states in Appendix D, page D-74, Section D.4.9 Versatile Test Reactor Beyond-Design-Basis Reactor Accidents: **"**By design, the VTR is able to withstand a wide range of accidents. Most events that could affect safe operation of the VTR are mitigated by the VTR design. This section addresses potential beyond-design-basis accidents that have the potential for high consequences even though the probability is very low (1×10-6 to 1×10-8 per year). These accidents represent events in which the consequences can be in the hundreds or thousands of rem to the public while probabilities are less than one in a million per year. Consideration of these very low-probability but potentially high-consequence accidents provides valuable insight for the public and decision-makers in understanding the overall risks of operation, siting decisions, and the need for emergency preparedness."

In the VTR EIS, a VTR reactor accident is presumed to be "beyond-design-basis" and the frequency of a severe accident below 1.0E-7 per year. Given the high number of sodium-cooled reactor core melt accidents (the EBR I and Fermi-1) and very little time in operation, the core accident risk early in the operating life of a sodium-cooled reactor could more appropriately be approximated as 0.1/yr (or 1 accident in 10 years) rather than 1.0E-7/yr (or one accident in 10,000,000 years.)

The radiological consequences of the beyond-design-basis VTR accident are discussed in Appendix D, pages D-78 and D-79. The low number for the probability of latent cancer fatalities was obtained by multiplying by the presumed 1.0E-7/yr accident probability.

A severe VTR accident was estimated to give an early radiation dose to a hypothetical member of the public, the maximally exposure individual (MEI) located 3.1 miles from MFC, of astonishing size, 790 rem (see Table D-33, page D-79 and see page D-8 for distance to MEI).

The VTR EIS doubles down on general Department of Energy ignorance of radiation health by saying, for an individual, that "Unless the exposure is quite high (~ 1000 rem), the

[27] Department of Energy, Office of Health, Safety and Security, *Independent Oversight Review of the Idaho National Laboratory Fuel Conditioning Facility Safety Basis*, April 2010. https://www.energy.gov/sites/prod/files/hss/Enforcement%20and%20Oversight/Oversight/docs/reports/eshevals/2010/2010_INL_FCF_Report%20_final_April_2010.pdf

expected LCF [latent cancer fatalities] would be 0." (See Appendix D, pages D-66 and D-67)

But the VTR EIS statement is ridiculous as well as false because a radiation dose received in an acute dose is known to have an LD50 of 300 to 400 rad, meaning 50 percent of adults receiving this dose would die within weeks. The VTR EIS has made quite a remarkable error and exaggeration as to the nature of a 1000 rem whole body dose. See many sources, including *Radiobiology for the Radiologist*, by Eric J. Hall, 5th ed., 2000, p. 134.

With the predicted 790 rem dose to a hypothetical member of the public 3.1 miles from the reactor, to the MEI, from a VTR accident being so high, the Department of Energy tried to try to give the impression that doses up to 1000 rem have negligible latent cancer fatality risk. This person standing at 3.1 miles (or closer) to the VTR for plume passage from the destroyed reactor is dead within weeks of the accident.

Note in Table D-33, that in addition to the rem dose of 520,000 rem to a person at 330 ft from the reactor and the rem dose of 790 rem to the maximally exposed member of the public, the MEI, at 3.1 miles from the reactor if located at the Idaho National Laboratory's Materials and Fuels Complex, there is also given in Table D-33 the population dose in "person-rem" which cannot be compared to the individual rem doses. The "person-rem" dose is the average dose to the population within 50 miles, multiplied by the total number of people within 50 miles.

The VTR EIS does not say much about how, in addition to the 790-rem dose 3.1 miles from the VTR, every person working at MFC may have faced a deadly radiation exposure. If they were somehow sheltered, the car they drove to work is now too contaminated for anyone to drive. The number of "hot" cars in southeast Idaho would be astonishing and so will the owners be, when they are reminded that their vehicles are not insured for radiation exposure.

The VTR EIS does not point out how a hospital admitting anyone contaminated by the MFC VTR accident is going to severely contaminate the medical facility or be refused admission. The doses to the rest of the population will depend on how the contamination is dispersed and whether or not it rains. And the resuspension of fallout will be contaminating air, soil and water for years. The exclusion zone created by such an accident would be larger than that of Chernobyl. And the areas requiring cessation of agriculture and livestock could extend beyond a 50-mile radius of the VTR.

The 66 fuel assemblies in the core and 44 additional used fuel assemblies in the vessel, a VTR severe accident would release roughly 1570 million curies (or 1.57 billion curies) for VTR's 110 fuel assemblies. (See the 2.35E7 curies per assembly for 66 in-core assemblies and 4.30E5 curies per assembly for 44 fuel assemblies out-of-core but stored in-vessel (aged 220 days) from Table D-42.) The vague way that the release fractions are given in Table D-32 makes identifying which the release fraction corresponds to, very difficult.

VTR EIS Beyond Design Basis Reactor Accident Comparison to Chernobyl

Estimates of the 1986 Chernobyl accident range from 80 million curies to over 3 billion curies. Using the U.S. Nuclear Regulatory Commission estimate from NUREG-1250 of the

Chernobyl release, of 100 million curies, a severe VTR reactor accident would be like 15 Chernobyl accidents.

NUREG-1250, [28] the 1987 NRC report only repeats what the Soviet experts have presented as the radiological release. The NRC quotes the Soviets as saying that an estimated total of about 50 million curies of noble gases (approximately 100 percent of the core inventory) and a total of about 50 million curies of other radionuclides (approximately 3 to 4 percent of the core inventory) were released to the environment over a period of 10 days (from April 26 to May 6). This statement adds 20 million curies to the 80 million curies estimated to be released in the INSAG table. Then the NRC report repeats the same INSAG table of total inventory and release fractions from the Soviets that I have provided above. NUREG-1250 was basically the accepted Chernobyl accident release estimate for perhaps at least a decade.

The Chernobyl release was likely on the order of at least 3 to 7 billion curies. In 1996, Argonne National Laboratory was estimating 30 percent of the core's total inventory of 9 billion curies was released (or about 3 billion curies), and scientists at Lawrence Livermore National Laboratory were estimating that about 80 percent of the core, or 7 billion curies, had been released. [29] [30]

Keep in mind the wide range of radiological release estimates for the Chernobyl accident, from 80 million curies to 7 billion curies. Conditions of the Chernobyl accident created high altitude releases. Lower altitude releases stay closer to home, so to speak, with resultant higher contamination levels locally. The ability to determine an accident's radiological releases and where the fallout occurs, due to weather patterns, is limited. And the desire by the nuclear promotors to underestimate the release is real. This and other difficulties increase the uncertainty of obtaining accident compensation for property damage and damage to human health.

The VTR EIS Economic Costs of an Accident, It Admits are Speculative and This Inadequacy Must Be Addressed

From Appendix D of the VTR EIS, "The economic impacts of the hypothetical beyond-design-basis reactor accident with loss of cooling are speculative. The MACCS2 computer program, which is used for the accident impact evaluations, has the capability to project economic costs, including population-dependent costs, farm dependent costs, decontamination costs, interdiction costs, emergency phase costs, and milk and crop disposal costs. These economic models were developed by Sandia National Laboratory, the MACCS2 model developer, and the NRC. The models have been used for U.S. nuclear power plant evaluations for decades. Evaluations using this MACCS2 model incorporated INL and ORNL-specific regional data developed with the SECPOP companion computer code to MACCS2. The models

[28] U.S. Nuclear Regulatory Commission, Washington, DC, Joint Agency Report, *Report on the Accident at the Chernobyl Nuclear Power Station*, NUREG-1250, January 1987. https://www.nrc.gov/docs/ML0716/ML071690245.pdf

[29] John M. LaForge, Ratical.org, Chernobyl at Ten: Half-lives and Half Truths, (cerca 1996). https://ratical.org/radiation/Chernobyl/Chernobyl@10p2.html#fn8

[30] World Information Service on Energy, Nuclear Monitor Issue #641, How Much Radiation Was Released by Chernobyl? January 27, 2006. https://www.wiseinternational.org/nuclear-monitor/641/how-much-radiation-was-released-chernobyl

projected economic costs within 50 miles for the severe accidents to be 290 and 3,500 million dollars at INL and ORNL, respectively. The models' projected economic costs for the ORNL region are much higher primarily due to the higher population density and the more varied land use in that area."

It is not just the accidents that the VTR EIS optimistically deems "beyond design basis" or "beyond extremely unlikely," the VTR EIS must provide a realistic economic cost analysis to southeast Idaho, for the many potential VTR accidents that may render serious or devastating economic damages to the airport, the hospitals and medical facilities, agriculture sector, automobiles, homes and so forth, even a modestly bad day at the VTR facility could cause damages exceeding $290 million dollars. The economic costs are harder for the Department of Energy to falsify after an accident; but really to easiest to compute prior to an accident. The VTR EIS must include an adequate accident economic cost assessment for southeast Idaho.

Expanding Outdoor Storage of Spent Nuclear Fuel and Radioactive Waste Invites Disaster and Unacceptable Accident Risks

When the VTR EIS proposes storage and handling of various waste streams out-of-doors, outside confinement, while having whittled down the amount of material released with various assumptions pertaining to release factors, it is important to understand that for a release that would cause a 3-rem radiation dose at 330 ft from the accident, it can easily be 100 times higher, and that would mean a 300-rem radiation dose to the noninvolved worker. It is not the DOE's practice to evaluate the level of uncertainty in the predicted doses, but the range of doses is often very large, with the higher doses meaning death or vastly shortened life span.

The VTR EIS uses an 80 PE-Ci (plutonium-239 equivalent) limit for a transuranic (TRU) waste drum, stating the rationale is the limit for remote-handled TRU waste (see D.3.1.6 Beyond-Design-Basis Fire Involving TRU Waste Drum). But the VTR TRU waste could be either contact handled or remote handled waste. The limits for a contact-handled standard waste box (SWB) are 560 PE-Ci; other limits are as high as 1800 PE-Ci. [31] For supposedly solidified waste, aging over time can degrade to solidified waste. Waste drums have been found to have several times the expected level of TRU waste. The predominantly alpha emitters and the low energy gamma from americium-241 make verification of the radiological inventory in a drum difficult or impossible. The VTR EIS assumption of 80 PE-Ci in a waste drum may not be bounding of a single container's PE-Ci inventory and multiple containers may be involved in a release. The VTR EIS must reexamine radioactive waste containers and make sure that their assumptions bound the release. The VTR EIS must use bounding accident inventories in the material-at-risk and has not.

[31] Department of Energy, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, DOE/WIPP-02-3122, Revision 8, July 5, 2016. https://www.wipp.energy.gov/Library/Information_Repository_A/Class_3_Permit_Modifications/TID%20References/U.S.%20DOE.%202016..pdf

The VTR EIS Must Address the Cancer Incidence Risk, Including Accident Release of the Americium-241

The VTR EIS must include in its accident release from a reactor accident, the additional radionuclides from target and test materials.

The VTR EIS currently ignores cancer incidence. Americium and curium releases are enhanced in a sodium-cooled reactor accident. Americium has a known disproportional rate of causing thyroid cancer, not represented by cancer mortality.

What the VTR EIS has addressed as the "lanthanide group" in Table D-32 for the release fractions includes elements that are not lanthanides: americium and curium. These are far more releasable than the plutonium and uranium, according to Table D-32. Both americium and curium decay through a series of radioactive elements and are thus persistent sources of radioactivity for more than thousands of years. For the americium-241, for the modest temperature of 1100 C, the release fraction is 0.3, from Table D-32. From Table D-42, for a single in-core fuel assembly, the amount of americium-241 is 4.91E1. There are 66 fuel assemblies, so this is 3240.6 curies of Am-241 for the in-core fuel. Then there are in addition 44 stored-in-vessel fuel assemblies with 220 days of decay, each assembly having 8.04E1 curies, so times 44 fuel assemblies are 3537.6 curies. Adding the 66 in-core fuel assemblies and the 44 out-of-core but in vessel fuel assemblies, the total for americium-241 is 6778.2 curies. (Note that the ingrowth of americium-241 from the decay of plutonium-241 actually increases the curies of americium-241 in the out-of-core fuel.)

For a release fraction of 0.3, the americium-241 released is 6778.2 curies multiplied by 0.3, to yield 2033.46 curies.

We are already seeing adverse health impacts from annual releases of americium-241 of typically less than 8.0E-3 curies per year. I am referring to the elevated incidence of thyroid cancer in each of the counties surrounding the INL and the well-known to the Department of Energy fact that americium is terrific at causing thyroid cancer, but you don't necessarily die from it. (See additional details on these facts in my previous comment submittal on the VTR [32].) It is understood that the tiny thyroids of the developing embryo and infant are more adversely affected by radiation and can cause a failure to thrive and other adverse health conditions before any cancer is developed.

The amount of cesium-137 released from the VTR accident, assuming a release fraction of 1.0 from Table D-32 and the 110 fuel assemblies is 841,060 curies. This is nearly the amount of cesium-137 that was thought to have been released from the Chernobyl accident. The estimated radiological releases from the Chernobyl nuclear catastrophe have shifted over the years and are still debated. With nuclear accidents, the amount of the radiological release and where it spreads to, can be somewhat characterized but even with environmental monitoring, remains elusive,

[32] See Tami Thatcher's first public comment submittal on the U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (DOE/EIS-0542) at http://www.environmental-defense-institute.org/publications/CommentVTRdEIS.pdf

particularly when the operator of the reactor along with the nuclear industry always seem to be motivated to minimize the appearance of the severity of the release.

The VTR EIS focuses only on cancer fatality risk and not cancer incidence. Radiation-induced hereditary effects are also ignored. And many health conditions are worsened by radiation despite the nuclear industry fixation of only one adverse effect, which is death from cancer.

It is well known that a radiation exposure of 0.5 rem to a developing child in-utero doubles the risk of cancer and/or leukemia. This is a single 500 millirem dose.

It would appear that the Department of Energy, the manner in which it has limited the information in the VTR EIS, does not think that Idahoans care about their health, their children's health, their property, or their livelihoods. This assumption by the DOE is wrong.

The way that the information is hidden within the sprawling EIS document does suggest that DOE does not want the public to grasp what the VTR is gambling on. It is betting the public's life, economic health — it's betting your farm, your baby and your life — in order to conduct research to make nuclear promoter's like Bill Gates richer (he's a partner with TerraPower) and in order for the Department of Energy to irradiate materials in the most expensive, unreliable and unsafe way imaginable.

DEPARTMENT OF ENERGY'S TRACK RECORD ON ACCIDENTS MUST BE INCLUDED IN THE VTR EIS

The VTR EIS argues that its assumptions are reasonable or even conservative. But the fact is that during the last ten years when accidents at Department of Energy facilities have occurred, multiple assumptions made in safety analyses have been wrong and underestimated the likelihood of the accident and the amount of radiological material released.

When the VTR EIS shows low latent cancer fatality risks for a particular accident category, it is because of low-balled estimates of the likelihood of the accident and also the whittling down of the amount of material released during the accident, often reducing the release by a factor of 100 or more, by numerous assumptions regarding the assumed airborne-release-fraction and other factors. Simply put, the VTR EIS radiological risks and consequences from the wide range of possible accidents is in reality far larger than the VTR EIS is claiming.

The accidents for VTR nuclear fuel feedstock processing, for fuel fabrication, for waste handling from these processes, for handling the spent nuclear fuel from the reactor, for storage and pyrochemical processing of the spent nuclear fuel — these yield very large accident risks not only to workers involved directly, but also to noninvolved workers and also to the public.

An accident from the VTR reactor operation itself, while argued to be so rare, as to be "beyond-design-basis" is tucked deeply away in an appendix in the EIS but should be described on the first page of the EIS. If the severity of the radiological consequences of a VTR core disruption accident are comprehended, then no one would support the project.

The amount of radiological material-at-risk can be significantly larger than assumed, as has been the case in waste containers destined for the Department of Energy's defense waste facility,

the Waste Isolation Pilot Plant (WIPP) in New Mexico. Due to the difficulty in estimating and surveying the amount of transuranic material loaded into waste containers such as 55-gallon drums, the amount of alpha emitters present can and has significantly exceeded what was expected to be in a waste drum.

Prohibited materials were in waste drums, actually hundreds of waste drums, such as organic kitty litter the Los Alamos National Laboratory had loaded into waste drums to absorb liquids. The waste drum that exploded at WIPP, the Department of Energy's WIPP defense waste disposal facility, had far higher amounts of transuranic material than were expected in the drum. Materials in prohibited amounts were also the cause of another accident in Department of Energy waste. Beryllium and radioactive metal in pyrophoric form was found in exceedingly high amounts in the debris of the four drums that energetically popped off their lids and forcefully expelled powdery transuranic waste through a fabric enclosure that would have had a dozen workers present had the accident occurred a few hours earlier, at the Idaho National Laboratory in 2018.

The fraction of the radiological material that was released from a drum, in both of these accidents exceeded Department of Energy estimates in its nuclear safety documentation for the airborne-release-fraction (ARF). Therefore, the assumptions key to estimating how much material is released by an accident have often been proven wrong. And seems to be forgotten after an accident occurs. The VTR EIS must include evaluation of DOE's repeated safety failures, including multi-program safety program deficiencies, as found in DOE's 2014 WIPP accidents, the 2011 MFC plutonium inhalation at ZPPR and the 2018 four waste drum overpressurizations. The VTR EIS must explain why anyone would think DOE's nuclear facility oversight and management is going to be adequate and is supportive of the very low accident likelihoods the VTR EIS asserts.

INL MFC's Plutonium Inhalation Event at ZPPR

Anyone familiar with the numerous workers exposed to inhalation of plutonium and americium from ZPPR fuel plates for several minutes from the 2011 accident at the Materials and Fuels Complex knows that the DOE was not conducting and implementing adequate nuclear safety analysis or other safety programs to protect workers. In the 2011 ZPPR facility management refused to address any of the safety oversight chairman's stated worker safety concerns when performing ZPPR plate inspections and directed workers to examine the plates in unsafe conditions caused multiple workers to inhale radionuclides that were still at detectable levels, based on urine and fecal bioassay, months after the event. [33]

According to The Center for Public Integrity investigation in 2017 titled "Nuclear Negligence" [34] that covered bad behavior around the Department of Energy Complex, INL's

[33] Department of Energy, Office of Health, Safety and Security (HSS), Accident Investigation Report, "Plutonium Contamination in Zero Power Physics Reactor Facility (ZPPR) at the Idaho National Laboratory" accident 11/8/11 at the Materials and Fuels Complex (MFC). http://energy.gov/hss/downloads/investigation-november-8-2011-plutonium-contamination-zero-power-physics-reactor.

[34] Patrick Malone, Peter Cary, *The Center for Public Integrity*, "Nuclear Negligence – Part Five: The inhalation of plutonium by 16 workers is preceded and followed by other contamination incidents but the private contractor in

MFC managers overseeing the ZPPR facility were warned 19 times by the Safety Oversight Chairman about worker safety issues concerning plutonium plate inspections but no action was taken. And Public Integrity reported that three legal settlements have resulted from the plutonium plate accident.

The VTR EIS ignores the Department of Energy's egregious record on nuclear facility safety and the finding that in each of three major accidents in the last decade, multiple DOE safety programs were not adequately implemented. The VTR EIS needs to explain why DOE's safety record is being ignored.

DOE Transuranic Waste Accidents at WIPP

Anyone familiar with the two accidents at the Waste Isolation Pilot Plant (WIPP) in New Mexico in 2014 knows that DOE was failing in nearly all programs for safety at WIPP, including 10 CFR 830 requirements.

WIPP's original safety basis under 10 CFR 830 had been extensively reviewed, more than any other DOE facility. Reviews by the Environmental Protection Agency and by the Defense Nuclear Facility Safety Board had been conducted. But subsequent changes to the WIPP safety basis, approved by DOE had reduced safety significantly. They made the assumption that a roof fall would never occur in an open panel and had no accident analysis for this. WIPP experienced a roof fall within a couple months of not bolting the ceiling in the underground mine. The accident investigation report also discovered that far more plutonium/americium was released from a single drum in the February 12, 2014 event than the safety analysis predicted was possible. [35]

INL Four Waste Drum Overpressurization Event in 2018

And anyone familiar with the cause of the four drums that blew their lids off at the INL's Radioactive Waste Management Complex in April 2018 understands that the Department of Energy took egregious shortcuts in each of these accidents, including failure to conduct nuclear safety analysis for a waste stream that they actually knew contained a very reactive form of uranium along with beryllium carbide. The DOE was actively involved with not meeting

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charge suffers only a light penalty," June 28, 2017 https://apps.publicintegrity.org/nuclear-negligence/repeated-warnings/

[35] Department of Energy Office of Environmental Management, Accident Investigation Report, "Phase 2 Radiological Releases Event at the Waste Isolation Pilot Plant February 14,2014," April 2015. http://wipp.energy.gov/Special/AIB_WIPP%20Rad_Event%20Report_Phase%20II.pdf See Sections 7.1 and 7.2. The release was found to have been from a single drum with stated inventory in plutonium-239 equivalent curies of 2.84 PE-Ci. But based on contamination on filters at Station A of 0.1 curies PE-ci far from the exploded drum in Panel 7, using conventional safety analysis assumptions the expected amount of material released to Panel 7 would not have exceeded 2.84E-4 PE-Ci — far less than what was measured downstream at Station A. The inventory in the drum appears to have been much higher than stated for WIPP drum and the release fractions may also be incorrect. This discrepancy in the transuranic inventory of the drum is in addition to the fact that forbidden inorganic "kitty litter" absorbent was placed in the drum which allowed an explosive combination of nitrates and organics. In my view, the extent to which the stated transuranic inventory was understated and actually not known does not appear to be adequately addressed by corrective actions recommended in the report. Alpha is difficult to monitor and easily shielded: DOE does not want you to know the degree that they say is in the drums may not conservatively bound what is actually in the drums.

hazardous waste RCRA requirements required by the State of Idaho and also no conducting required nuclear safety analysis per 10 CFR 830. A causal analysis [36] has been issued for the four transuranic waste drums that blew off their lids last April at the U.S. Department of Energy's Radioactive Waste Management Complex. The causal analysis states that "Management failed to fully understand, characterize, establish and implement adequate process controls for treating waste which lacked documented origin or process information." Specifically, the requirements for meeting 10 CFR 830 were not met.

U.S. Department of Energy cleanup contractor Fluor Idaho has issued a report on the causes of the transuranic waste drums that blew their lids in April 2018 at the Idaho National Laboratory's Radioactive Waste Management Complex. [37] If DOE regulations and hazardous waste laws including the state-issued RCRA permit had been complied with, the accident would not have happened. A fire had occurred last December when a waste container with this form of uranium was opened at the Advanced Mixed Waste Treatment Facility. And despite this, a drum known to contain large amounts of the same form of uranium was sent to the Accelerated Retrieval Project V fabric enclosure despite its RCRA permit forbidding such material.

The drums one by one expelled their powdery radioactive contents throughout the ARP V enclosure just hours after workers had gone home.

The first smoldering drum set off fire alarms. The fire department responded, but because of radiation monitor malfunction they were unaware that radioactive airborne contamination inside the fabric tension membrane enclosure was far above normal. Radiological control personnel came to assist the fire fighters 43 minutes after requested. The responders had inadequate knowledge of the materials in the drums which also hampered their efforts.

The second drum exploded just after emergency responders exited the facility. The integrity of the enclosure could have been compromised by the heat and also by one of the ejected lids which penetrated a layer of the enclosure.

Dozens of possible chemicals were ascribed to this catch-all category for powdery material considered "homogeneous solids" of the kind from Rocky Flats nuclear weapons plant where Portland cement-like material had been added to drums with various chemical and finely divided radionuclide and metal wastes. [38]

No analyses were conducted for chemical compatibility and reactive and pyrophoric materials for the SD-176 waste as required by hazardous waste RCRA laws. On top of that, no nuclear safety analysis was conducted to mitigate the hazards of this new SD-176 waste stream.

The day of the accident, uranium from one drum was mixed with the unknown material in other drums to distribute the uranium among the drums. Now supplied with oxygen from the

[36] Idaho Cleanup Project Core, "Formal Cause Analysis for the ARP V (WFM-1617) Drum Event at the RWMC," October 2018. https://fluor-idaho.com/Portals/0/Documents/04_%20Community/8283498_RPT-1659.pdf

[37] Idaho Cleanup Project Core, "Formal Cause Analysis for the ARP V (WFM-1617) Drum Event at the RWMC," October 2018. https://fluor-idaho.com/Portals/0/Documents/04_%20Community/8283498_RPT-1659.pdf

[38] Idaho Completion Project, Bechtel BWXT Idaho, LLC for the Department of Energy, "Historical Background Report for Rocky Flats Plant Waste Shipped to the INEEL and Buried in the SDA from 1954 to 1971," ICP/EXT-04-00248, Revision 1, March 2005. https://ar.icp.doe.gov/images/pdf/200504/2005040400022KAH.pdf

repackaging, the uranium began oxidizing and heating up the drums. The heat enabled another chemical reaction that rapidly produced methane from the beryllium carbide [39] in the drums.

The DOE also violated its radioactive waste management regulations by not having a plan for disposing of the waste prior to processing it. Current Waste Isolation Pilot Plant (WIPP) waste acceptance criteria were not being applied. [40]

The cause of the accident appears to be the pervasive management culture that ignored DOE regulations and state and federal laws in order to streamline processing of the radioactive and chemically hazardous waste.

The DOE, Fluor Idaho and the Idaho Department of Environmental Quality all pretended that the waste was being treated in accordance with laws and regulations. But it wasn't. [41] [42]

The Department of Energy is reviewing whether to fine Fluor Idaho $580,700 over the four drums that exploded in April 2018 [43] [44] The letter from DOE white-washes the extent of Fluor Idaho's responsibility for the event because Fluor Idaho willfully ignored the actual contents of the drums, which contained beryllium as well as extraordinary amounts of uranium metal. People could easily have lost their lives had the explosions happened a few hours earlier and the containment fabric was very nearly breached which would have released an irremediable amount of powdery radioactive waste to the Idaho skies.

Thousands of repackaged drums of transuranic waste are still stored above ground and awaiting shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico.

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[39] U.S. Nuclear Waste Technical Review Board, "Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel – Report to the United States Congress and the Secretary of Energy," December 2017. http://www.nwtrb.gov/our-work/reports/management-and-disposal-of-u.s.-department-of-energy-spent-nuclear-fuel-(december-2017) On p. 22 of this report, the NWTRB states that "Carbide-containing DOE SNF can create combustible gases such as methane and acetylene when contacted by water …if the coatings on the carbide particles are damaged." While what was in the transuranic (or uranium) waste drums was not spent nuclear fuel, the knowledge of potential reactions with carbide are well-known and yet no identification of this hazard was conducted for the waste being treated which they knew potentially contained beryllium carbide from Rocky Flats weapons production processes — that's likely why the uranium had not be "roasted."

[40] Department of Energy, Carlsbad Field Office, WIPP Waste Acceptance Criteria, DOE/WIPP-02-3122, Revision 8 Effective July 5, 2016. http://www.wipp.energy.gov/library/cra/CRA-2014/references/Others/US_DOE_2002_WIPP_Rev_6_TRU_Waste_Acceptance_Criteria_02_3122.pdf

[41] For more about the April transuranic waste drum ruptures at the Radioactive Waste Management Complex at the Idaho National Laboratory Idaho Cleanup Project, see past EDI newsletters on the April drum ruptures (May through November 2018) and my second Public Comment submittal on October 30 to the Idaho DEQ concerning renewal of the Advanced Mixed Waste Treatment Project RCRA permit renewal at www.environmental-defense-institute.org

[42] DOE Order 435.1, "Radioactive Waste Management," DOE Order 830 "Nuclear Safety Management" (contains hazard identification and Unreviewed Safety Question requirements) and federal and state Resource Conservation and Recovery Act (RCRA) laws.

[43] Exchange Monitor, "Fluor Idaho Has 30 Days to Contest $580K Penalty for Drum Blast," November 24, 2020. https://www.exchangemonitor.com/fluor-idaho-30-days-contest-580k-penalty-drum-blast/?printmode=1

[44] U.S. Department of Energy, Letter to Fred Hughes, Fluor Idaho, LLC, November 20, 2020. https://www.energy.gov/sites/prod/files/2020/11/f80/Preliminary%20Notice%20of%20Violation%20for%20Fluor%20Idaho_0.pdf

DOE Failure to Implement Widely Acknowledged Radiation Accident Protocols

A 2014 event at the Idaho National Laboratory's FMF facility internally contaminated workers but this was not discovered until weeks had elapsed and workers had been exposed again to elevated airborne contamination during special processing in a leaking glovebox. [45] Battelle Energy Alliance failed to discuss why contamination swipes, hand-held alpha monitoring and step-in portal alpha monitors failed to identify the elevated contamination when the inadequately configured constant air monitor failed to identify the contamination. That curious lack of curiosity about why the elevated levels of airborne contamination was not identified until weeks later when contamination was found on constant air monitor filters and the DOE contractor inexplicably decided that no causal analysis was needed.

A 2018 Department of Energy Occurrence Report was issued for the June 5 injury at the Advanced Mixed Waste Treatment Project. A worker cleaning out a Supercompactor Glovebox got a puncture wound involving transuranic radionuclides. [46] At the October 25, 2018 Citizens Advisory Board meeting in Sun Valley, Fred Hughes admitted that chelation was required for the June 5, 2018 puncture wound event, although he had avoided discussing it. [47]

As I was aware of the Oak Ridge REACTS website that emphasized that **chelation of wounds involving transuranic radionuclides needs to be administered within 2 hours in order to limit bone uptake**, and that after 2 hours, the effectiveness of chelation is much less, I asked if chelation was administered within 2 hours of the injury. Fred Hughes said no. He did not address the reasons why. And the corrective actions for the occurrence report didn't address the issue of the tardy medical response.

Chelation following plutonium intake is recommended to commence within one hour of the intake or wound entry. Actinides such as plutonium are rapidly taken up by bone within two hours. [48]

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[45] Department of Energy Occurrence Report NE-ID-BEA - - FMF – 2014- 0001. "MFC-704 FMF Suspect Contamination Found on CAM Filters," Sept 24, 2014. "On October 9, 2014, it was reported that low levels of transuranic contamination were detected on four separate filters, two each taken from a Continuous Air Monitor (CAM) and a Portable Low Volume Air Sampler operating in the Fuel Manufacturing Facility between August 25 through September 2. Multiple workers were found, weeks later, to have internal contamination as determined by bioassay. Battelle Energy Alliance wrote in the occurrence report that no cause analysis of the undetected elevated levels of airborne contamination was needed.

[46] Department of Energy Occurrence Report EM-ID—FID-AMWTF-2018-0004, "Operator Receives Puncture Wound Resulting in Internal Dose." Final report September 18, 2018.

[47] Idaho Cleanup Project Citizens Advisory Board (formerly the Idaho National Laboratory Citizens Advisory Board) meeting schedules and presentations at https://energy.gov/em/icpcab/idaho-cleanup-project-citizens-advisory-board-icp-cab Meeting held October 25, 2018.

[48] Nicholas Dainiak, MD, FACP et al., Radiation Emergency Assistance Center/Training Site, Oak Ridge Associated Universities, "REAC/TS Approach to Rapid Dose Estimation and Decontamination of Plutonium Following a Puncture Wound," Presentation May 10, 2017. https://radiation-medicine.de/fileadmin/user_upload/Praesentationen/Dainiak-ConRad2017.pdf Actinides (plutonium, americium and others) are absorbed through wounds rapidly, within 2 hours. The actinides are taken up strongly by bone and liver. "Early decorporation therapy (1-2 hours) with DTPA is required to reduce rapid translocation of actinides to tissues." In 2018, at a DOE site where a worker had a puncture wound involving 300 disintegrations/minute on an alpha meter, the wound was flushed and treatment with Ca-DTPA was initiated within 1 hour.

At the Idaho National Laboratory, work with radionuclides including glovebox work, was conducted with disregard for lessons learned at other DOE facilities and was conducted without properly trained personnel to provide timely evaluation and treatment of radiologically contaminated skin injuries.

VTR EIS VIOLATES NEPA IN NUMEROUS CRUCIAL AREAS

SRS MOX Plant Through-Put Misrepresented and Violates NEPA

On page D-17, the VTR EIS explains that "The MOX facility was designed (at least initially) to process up to 3.5 metric tons of plutonium annually so its throughput was likely a factor of ~7 times the VTR needs." Despite what the MOX plant at SRS may have promised, the chemical "aqueous polishing" processes to remove impurities from the plutonium feed stock seems to have been a significant bottleneck and part of the reason for the cancellation of the never completed MOX facility, despite assumed low technical risk because MOX fuel is fabricated other countries. The VTR EIS appears to be misleading the reader regarding the costs and difficulties of "aqueous polishing."

VTR EIS Relies on DOE/EIS-0203 Despite It's Inadequacy (DOE's Plan to Send Aluminum-Clad Fuel to SRS Misrepresented and Violates NEPA)

The VTR EIS states that regarding the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement* (SNF PEIS) (DOE/EIS-0203) (DOE 1995), the SNF PEIS analyzed, at a programmatic level, the potential environmental consequences over a 40-year period of alternatives related to the transportation, receipt, processing, and storage of SNF under the responsibility of DOE. It also addressed the site-wide actions anticipated to occur at the INL Site for waste and SNF management.

The VTR EIS must explain why the 40 years addressed beginning in 1997 is adequate for a 60-year VTR program beginning after 2021.

The VTR EIS misportrays DOE-EIS-0203 and ignores the state of complete disarray of the Department of Energy's stated reprocessing and spent nuclear fuel disposal programs.

DOE decided to manage its SNF by type (fuel cladding and matrix material) at the Hanford Site, INL, and SRS. Under this decision, the fuel type distribution would be as follows:

- Hanford production reactor fuel would remain at the Hanford Site.
- Aluminum-clad fuel would be consolidated at SRS.
- Non-aluminum-clad fuels (including Naval SNF) would be transferred to INL.

Multiple problems and inadequacies arise due to reliance on the SNF PEIS. DOE had committed to construct and open Yucca Mountain by 1998. DOE has no program for disposal of spent fuel at Yucca Mountain or anywhere else. The DOE is NOT sending aluminum-clad fuel to SRS.

The VTR EIS must explain why the serious problem that a fuel or high-level waste disposal program does not exist.

Importing Plutonium from Other Countries and Activities to Support VTR Are Not Included in the Surplus Plutonium Disposition EIS and Pretending Otherwise Violates NEPA

The VTR EIS states: *Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE/EIS-0283-S2) (DOE 2015a) – This Supplemental EIS evaluated the potential environmental impacts of alternatives for the disposition of surplus plutonium, which had no previously assigned disposition path.

The importation of plutonium from Europe (France or the UK) for VTR fuel is not addressed in the Surplus Plutonium Disposition EIS and requires a new EIS. Pretending otherwise violates NEPA.

The VTR EIS includes both short-term and long-term latent cancer fatality estimates, but does not say what time duration is evaluated, i.e, 100 years or other, from the exposure by ingestion of contaminated food and inhalation of resuspended radionuclides. The VTR EIS must address the many decades and more of elevated contamination levels and the impact to agriculture, and chronic health issues.

Lax packaging standards for plutonium may be the rule rather than the exception. The VTR EIS must explain the standards for plutonium packaging, Type B or Type C or other standards and what testing has been conducted for accident conditions. [49]

The activities and tradeoffs for the reduction of surplus plutonium in its EIS do not address creation of feedstock and fuel fabrication for the VTR and pretending otherwise violates NEPA. [50]

The VTR EIS Violates the WIPP EIS and DOE Waste EIS (DOE/EIS-0200)

The VTR EIS lists the *"Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement Eddy County, near Carlsbad, New Mexico* (DOE/EIS-0026-S-2) (DOE 1997b), but the VTR EIS fails to address the full extent of additional wastes that DOE plans to or hopes to send to WIPP. The VTR EIS mentions WIPP as the place to send VTR wastes without addressing whether or not WIPP has the capacity for 60 years of VTR operations.

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[49] For example, Issues of packaging are described by Edwin Lyman, Union of Concerned Scientists, *Inadequacy of the IAEA's Air Transport Regulations: The Case of MOX Fuel*, undated, (accessed 2/25/2021) http://www.ccnr.org/lyman_casks.html He writes: "The consequence code MACCS2, developed for the U.S. NRC, was used to assess the consequences of the release of 5 kg of reactor-grade plutonium as a result of an air crash in an area with a population density of 250 persons/km2. For a buoyant release as a result of a hot fire, neutral atmospheric conditions and a light wind, committed effective doses resulting from the passage of the radioactive plume were as high as 52 Sievert (Sv) at 200 meters from the crash site, and remained above 50 mSv for more than 40 km (64 mi) from the crash site. There were more than 4300 cancers committed from the initial passage of the plume. The total number of cancers, including those resulting from resuspension of the ground contamination, exceeded 16,000 over a 100-year period."

[50] U.S. Government Accountability Office, *NNSA's Long-Term Plutonium Oxide Production Plans Are Uncertain*, October 2019. https://www.gao.gov/assets/710/702239.pdf Multiple program changes in strategy between 1997 and 2008.

The VTR EIS violates NEPA regarding transuranic waste disposal and the illusion that WIPP can take future VTR related wastes.

The VTR EIS must disclose all the waste streams DOE has asserted will be sent to WIPP, despite being against the law. DOE has asserted that Hanford vitrification waste will go to WIPP, that INL's treated sodium-bearing waste will go to WIPP, that the nation's surplus plutonium will go to WIPP and even that the naval spent nuclear fuel will go to WIPP.

The VTR EIS Violates the DOE Waste EIS (DOE/EIS-0200) and Other EISs

The DOE/EIS-0200 EIS from 1997 cannot be used for the extended time that the VTR will be operating.

The Department of Energy's Radioactive Waste Manual for 435.1-1 for DOE Order 435.1 allows any concentration of the waste to be called "incidental" and non-HLW. [51] The DOE's Order will not limit the shallow disposal of its waste to Class A, B or C wastes. The DOE Order and its waste manual allows that DOE may authorize "alternate requirements" that exceed Class C concentrations. Very importantly, the radionuclides that the DOE may shallowly bury would exceed Class C concentrations for long-lived radionuclides. There would be no upper limit on the total amount or on the concentrations of long-lived radionuclides.

The methods, assumptions, and standards by which the DOE may use to assess the risk using a performance-based approach are ambiguous and flexible in DOE regulations. Experience shows DOE's performance assessments to be driven to select whatever set of assumptions needed to achieve what they think will give the appearance of acceptably low waste migration rates and acceptably low predicted groundwater contamination. Although not always admitted, the currently accepted state-of-the-art for performance assessments do not accurately or conservatively estimate the rate of contaminant migration or the resulting radiation doses, largely from groundwater ingestion at most disposal sites.

Citizens have no reason to trust DOE to make decisions that will provide reasonable assurance of the protection of human health and the environment, both because of its regulatory ambiguity and because of the DOE's long history of creating contamination that cannot be remediated at its DOE sites and also at sites for mining, milling and processing uranium.

Even if the DOE were to improve its Radioactive Waste Manual, the DOE generously applies interpretation of how to meet its Orders, Standards and Manuals and allows removal of any inconvenient requirement via Secretary approval. The DOE's Radioactive Waste Manual and DOE Order 435.1 was blatantly violated in 2018, without DOE Secretary approval, with regard to waste acceptance criteria for allowing waste to be brought into a DOE facility at the Idaho National Laboratory as reported in a causal analysis conducted for four transuranic waste drums that overpressurized, ejecting their contents. It was business as usual for the DOE.

[51] Department of Energy Radioactive Waste Manual 435.1-1 https://www.directives.doe.gov/directives-documents/400-series/0435.1-DManual-1/@@images/file

The evidence shows that DOE doesn't comply with its regulations or state regulations. The Department of Energy claims it follows its own regulations and for example, "Activities that affect, or may affect, the safety of DOE nuclear facilities must also comply with the requirements of 10 CFR 830, Nuclear Safety Management."

When the Idaho National Laboratory wanted to bring two shipments of commercial spent nuclear fuel to INL for research, a draft supplemental analysis was developed by the DOE. That supplemental analysis relied on the existence of a spent nuclear fuel repository. Specifically, that supplemental analysis cited the Yucca Mountain repository and cited its EIS. [52] [53]

After decades of failed efforts to obtain a repository for spent nuclear fuel and high-level waste, the Department of Energy cannot even claim to have a plan or a program to obtain a repository. The DOE disposed of all the documents and public comment pertaining to last year's "consent-based siting" effort. The political realities are as insurmountable as the scientific difficulties to attempt to predict the concentrations of contaminants that migrate from a repository over thousands of years.

The DOE's failed spent nuclear fuel and high-level waste disposal program failures are not solved by simply omitting the Yucca Mountain EIS from mention in the VTR EIS.

Ramifications of DOE's High-Level Waste Reclassification Remain Unexplained

In November 2018, the Department of Energy issued for public comment its proposal to allow the DOE to unilaterally reclassify its high-level waste (HLW) to non-HLW. [54]

The Idaho Cleanup Project (ICP) Citizens Advisory Board [55] subcommittee on DOE's Proposed High-Level Waste (HLW) Interpretation reviewed the comments describing the multitude of problems with DOE's proposal identified by the State of Idaho, [56] the Natural

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[52] See EDI comments to the Department of Energy on the U.S. Department of Energy Draft Supplement Analysis on Two Proposed Shipments of Commercial Nuclear Fuel to Idaho National Laboratory for Research and Development Purposes 2015 (DOE/EIS-0203-SA-07), July 2015 at our website.

[53] See the Yucca Mountain Environmental Impact Statement including DOE/EIS-0250F and supplement analysis DOE/EIS-0250F-S1.

[54] Federal Register, Request for Public Comment on the U.S. Department of Energy Interpretation of High-Level Radioactive Waste, A Notice by the Energy Department on October 10, 2018, extended to January 9, 2019. https://www.federalregister.gov/documents/2018/10/10/2018-22002/request-for-public-comment-on-the-us-department-of-energy-interpretation-of-high-level-radioactive Summary: "U.S. Department of Energy (DOE or the Department) provides this Notice and request for public comment on its interpretation of the definition of the statutory term "high-level radioactive waste" (HLW) as set forth in the Atomic Energy Act of 1954 and the Nuclear Waste Policy Act of 1982. This statutory term indicates that not all wastes from the reprocessing of spent nuclear fuel ("reprocessing wastes") are HLW, and DOE interprets the statutory term such that some reprocessing wastes may be classified as not HLW (non-HLW) and may be disposed of in accordance with their radiological characteristics." See the docket for the Department of Energy's Proposed Interpretation of High-Level Radioactive Waste ID: DOE_FRDOC_0001-3696, comments due January 9, 2019, on regulations.gov at https://www.regulations.gov/document?D=DOE_FRDOC_0001-3696

[55] Idaho Cleanup Project Citizens Advisory Board (formerly the Idaho National Laboratory Citizens Advisory Board) meeting schedules and presentations at https://energy.gov/em/icpcab/idaho-cleanup-project-citizens-advisory-board-icp-cab Meeting held June 21, 2018.

[56] John H. Tippets, Director, Idaho Department of Environmental Quality, Letter to Anne White, Assistant Secretary, Office of Environmental Management, U.S. Department of Energy, Subject: State of Idaho Comments

Resources Defense Council (NRDC),[57] and others and gave up trying to respond directly on the DOE's problematic proposal. The ICP CAB focused instead on the reclassification of sodium-bearing waste currently managed as HLW at the INL and the hope of sending it to the Waste Isolation Pilot Plant (WIPP) in New Mexico. Another subcommittee plans to review HLW calcine stored at the INL. (The status of HLW at the Idaho National Laboratory's Materials and Fuels Complex remains a mystery.)

The State of Idaho pointed out in its comments about the DOE's HLW proposal that the Department of Energy had actually a defied request for information that Congress had codified into law last year. Specifically, DOE did not comply with Section 3139 of the National Defense Authorization Act for Fiscal Year 2018 (H.R. 2810) that required DOE to prepare and submit a report to Congress by February 1, 2018 on the classification of certain wastes.

Despite the complexity of the DOE's proposed HLW interpretation and the lack of information from the DOE about the ramifications of the HLW proposal on state agreements and current HLW commitments, no presentations were given to the CAB to attempt to explain DOE's proposal.

DOE has continually been prodding the Citizens Advisory Board (CAB) for the Idaho Cleanup Project to ditching the Idaho Settlement Agreement. [58]

For many years now, the Department of Energy has been pretending that they were on track to meet the Idaho Settlement Agreement milestones for removing spent nuclear fuel and high-level waste from the state of Idaho. The CAB has for years been assured, behind the scenes, that a repository would be available when there was a change in the country's political leadership. But despite having a Republican president and Republican majorities in both the House and Senate for the previous two years, funding has not been passed for reopening Yucca Mountain licensing activities. The seriousness of the difficulties of finding a repository for the HLW and spent nuclear fuel at the Idaho National Laboratory seems to be beginning to dawn on the CAB.

Some of the difficulty in understanding the ramifications of DOE's HLW reclassification effort is by design — the DOE does not want citizens or the CAB to understand what its proposed HLW reclassification will actually mean.

There is also a complex history pertaining to high-level waste. It is important to understand that there is a process for accepting some small percentage of radioactive waste remaining in storage tanks when efforts have been made to empty and clean the tanks. In Idaho, this acceptance process is the Section 3116 process that requires state and U.S. Nuclear Regulatory Commission involvement. This issue gets complicated by just how much of the waste is left behind, because even a few percent of the waste being left behind can mean millions of gallons of waste left behind at the DOE site at Hanford, Washington, which has not allowed the Section

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on U.S. Department of Energy Interpretation of High Level Radioactive Waste (83 FR 50909), January 9, 2019. See it on our website at http://www.environmental-defense-institute.org/publications/IDEQHLW.pdf

[57] The Natural Resources Defense Council (NDRC), "NRDC et al. Comments on Energy Department's Request for Public Comment on the Interpretation of High-Level Radioactive Waste," January 9, 2019. https://static1.squarespace.com/static/568adf4125981deb769d96b2/t/5c36635670a6add06a0aa079/1547068277020/NRDC+et+al.+Full+Comments+DOE+HLW+9+Jan+2019.pdf

[58] See more about Idaho's Settlement Agreement at https://www.deq.idaho.gov/inl-oversight/oversight-agreements/1995-settlement-agreement.aspx

3116 process. See our EDI comments on DOE's HLW Reclassification for a discussion of the 3116 process. [59]

In contrast to accepting a small percentage of the waste left behind in tanks after emptying and washing the HLW tanks, the DOE wants to reclassify the bulk of certain HLW streams. When the entire amount of liquid sodium-bearing waste at the INL, now managed as HLW and classified as HLW — when that entire waste stream of 900,000 gallons of waste is reclassified from HLW, it becomes Low-level waste (LLW). If the sodium-bearing waste isn't currently HLW as DOE sometimes postures, then why is DOE having the ICP CAB study the issue of its reclassification from being HLW? Importantly, the DOE has tremendous latitude to dispose of LLW on its DOE sites.

A subset of LLW is of unlimited radioactivity and that is known as waste that is Greater-Than-Class C (GTCC) waste. Low-level waste that is GTCC can include transuranic waste of unlimited concentrations. Only when DOE's transuranic waste meets the criteria as being defense-related and acceptable for disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico can it be disposed of at WIPP. WIPP currently requires state and EPA permitting and has laws that govern what it will accept for disposal. HLW, for example, has been prohibited by law from disposal at WIPP. Reclassified sodium-bearing waste, having been HLW tank waste, is also currently prohibited at WIPP.

The DOE is trying to muddy the water by confusing the tank closure Section 3116 process that applies in Idaho **with the unlawful reclassification of the entire bulk amount of the HLW**, whether sodium-bearing waste or calcine.

The DOE is also refusing to acknowledge to the public and to the ICP CAB — to a degree I consider unethical — the serious cloud over the legality of its proposal to reclassify the bulk of its HLW. The court found that DOE's vague approach using its DOE Order and Manual 435.1 to allow unspecified "alternate requirements" would be unacceptable because it would allow DOE to reclassify waste on whim. For example, the DOE could allow cost savings to be the overriding waste classification criteria, not safety of human health and the environment. The court dismissed the case as unripe because the DOE had not yet reclassified its HLW.

See details of the legal challenges to DOE's HLW reclassification in the State of Idaho's HLW comment submittal, [60] the National Resources Defense Council (NRDC) comment submittal,[61] and also the book *Fuel Cycle to Nowhere*. [62]

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[59] High-level Waste Reclassification comment submittals at http://www.environmental-defense-institute.org/index.html (http://www.environmental-defense-institute.org/publications/CommentDOEHLW.pdf and http://www.environmental-defense-institute.org/publications/EDIComHLW6.pdf)

[60] John H. Tippets, Director, Idaho Department of Environmental Quality, Letter to Anne White, Assistant Secretary, Office of Environmental Management, U.S. Department of Energy, Subject: State of Idaho Comments on U.S. Department of Energy Interpretation of High Level Radioactive Waste (83 FR 50909), January 9, 2019. See it on our website at http://www.environmental-defense-institute.org/publications/IDEQHLW.pdf

[61] The Natural Resources Defense Council (NDRC), "NRDC et al. Comments on Energy Department's Request for Public Comment on the Interpretation of High-Level Radioactive Waste," January 9, 2019. https://static1.squarespace.com/static/568adf4125981deb769d96b2/t/5c36635670a6add06a0aa079/1547068277020/NRDC+et+al.+Full+Comments+DOE+HLW+9+Jan+2019.pdf

[62] Richard Burleson Stewart and Jane Bloom Stewart, *Fuel Cycle to Nowhere – U.S. Law and Policy on Nuclear Waste*, Vanderbilt University Press, 2011, ISBN 978-0-8265-1774-6.

VTR Waste Disposal Violates NEPA and requires a New Programmatic EIS

The VTR EIS is violating NEPA in the VTR EIS by waving at old, inadequate EISs, and by avoiding admitting the true extent to which the Department of Energy recently decided to reclassify any DOE waste, whether spent nuclear fuel or high-level waste resulting from pyrochemical processing, as low-level waste.

The Department of Energy's at-whim regulations can shallowly bury low-level radioactive waste over the Snake River Plain aquifer and has for years.

Waste that is not accepted by any other waste disposal facility such as Greater-Than-Class-C waste is buried over the Snake River Plain aquifer. Waste that would have more stringent disposal requirements, such as "high-level waste" is simply reclassified at-whim to be "low-level radioactive waste."

The waste disposal "performance assessment" requirements and evaluation of adequacy is up to DOE's at-whim criteria. Environmental monitoring is funded and overseen by the Department of Energy. Even the data used by the U.S. Environmental Protection Agency radiological monitoring programs is only available if DOE's handmaiden's deliver the air filters, etc. to the EPA. Hence, months and even years of data blackouts are common from ocean docks to the Columbia River to Hanford and to the INL.

The distance for the waste that the performance assessment criteria must be applied must be stipulated. Otherwise the DOE could select 50 miles or 500 miles or whatever distance it takes for their analysis to dilute the contamination to meet the selected contamination standard. So, the DOE is disposing of and apparently intends to save money by disposal of vast amounts of

extremely long-lived radioactive waste that may be Greater-Than-Class C on the Savannah River Site as well as Hanford and the Idaho site. [63] [64] [65] [66] [67] [68] [69] [70] [71]

This isn't about scrapping a fine layer of radioactive waste off tank walls — this is about the bulk of HLW being diluted, then it's concentration of radioactivity evaluated to "alternate criteria" that allow exceeding Class C concentrations for long-lived radionuclides and then enormous quantities of HLW being shallow buried onsite using Performance Assessments full of inadequately evaluated assumptions and inadequate technical basis.

The approach by the DOE at the Savannah River Site was to ignore the long-lived and highly mobile fission products technetium-99 and iodine-129. But the U.S. Nuclear Regulatory Commission pointed out that this wasn't sound. Later it was determined that these ignored fission products dominate the projected radiation doses. [72]

DOE would have citizens believe that when HLW becomes low-level waste, no matter the quantity, that it doesn't need deep geologic disposal. But low-level Greater-Than-Class C waste and TRU waste have long been recognized to need the kind of isolation from the biosphere provided by deep geologic disposal.

High-level waste is waste from reprocessing spent nuclear fuel and uranium targets for producing plutonium. It contains fission products such as cesium-137 and strontium-90 that

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[63] Department of Energy, Nuclear Energy, Idaho Field Office, "Basis for Section 3116 Determination for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility," DOE/NE-ID-11226, November 2006. https://www.energy.gov/sites/prod/files/em/FinalINTECTFFWDBasisDocument.pdf

[64] DOE-ID, 2003b, Performance Assessment for the Tank Farm Facility at the Idaho National Engineering and Environmental Laboratory, DOE/ID-10966, Rev. 1, April 2003 (Errata December 2, 2003).

[65] C. M. Barnes et al., "Feed Composition for the Sodium-Bearing Waste Treatment Process," INEEL/EXT-2000-01378, Rev. 3, September 2003. https://inldigitallibrary.inl.gov/sites/STI/STI/3156999.pdf#search=INEEL%2FEXT%2D2000%2D01378

[66] B. Jennifer Davis, John S. Contardi, and Lawrence T. Ling, "A Regulatory Analysis of Incidental Waste," January 19, 2001, Available on adams.nrc.gov ML010120200.

[67] Gregory Suber Nuclear Regulatory Commission, NRC Waste Incidental to Reprocessing Program: Overview of Consultation and Monitoring Activities at the Idaho National Laboratory and the Savannah River Site – What We Have Learned – 12470, undated, on NRC Adams database.

[68] U.S. Nuclear Regulatory Commission Technical Evaluation Report for the U.S. Department of Energy Idaho National Laboratory Site Draft Section 3116 Waste Determination for Idaho Nuclear Technology and Engineering Center Tank Farm Facility," October 2006. ML062490142 at https://www.nrc.gov/docs/ML0624/ML062490142.pdf

[69] U.S. Nuclear Regulatory Commission Review of the Idaho National Engineering and Environmental Laboratory Draft Waste Incidental to Reprocessing Determination for Sodium-Bear Waste. (2002) on Adams database, no author and no date.

[70] "Tank Waste retrieval, processing, and On-site Disposal at Three Department of Energy Sites: Final Report, The National Academies Press, 2006. https://www.nap.edu/read/11618/chapter/14

[71] Victor Stello, Jr., U.S. NRC, "NRC Licensing of the Disposal of High-Level Hanford Defense Wastes," SECY-88-238, August 19, 1988. On NRC's Adams database. This policy letter highlights the disagreement between the Department of Energy and the Nuclear Regulatory Commission over what is and is not high level waste. The NRC has regulatory oversight of long-term storage and disposal of HLW. The DOE denied that reprocessing water at Hanford was HLW.

[72] Dr. Christianne Ridge, U.S. Nuclear Regulatory Commission, "NRC Perspective on Science and Technology for the Department of Energy's Defense Environmental Cleanup Program," December 5, 2017. On NRC's Adams Database.

cause about half of the radioactivity of recently reprocessed HLW. The waste from uranium targets may have fewer fission products. However, DOE SNF reprocessing and its target material may include more transuranic radionuclides.

Fission products such as iodine-129 and technetium-99 are a small fraction of the activity in the HLW, yet due to their very long half-life and their high mobility, they can dominate the radiological hazard to groundwater by leaching from the disposal site. The radioactive half-life of iodine-129 is 15.7 million years and the half-life of technetium-99 is 213,000 years. What appears to be a small curie level for I-129 and Tc-99 can pose a large hazard to groundwater from leaching radioactive waste.

In addition to fission products that are created in an operating nuclear reactor, transuranic radionuclides are created in a reactor by the successive absorption of neutrons. The transuranic radionuclides, those having more than the 92 protons that uranium has, include various isotopes of plutonium, americium, curium, neptunium, and others. These transuranic radionuclides either have very long a half-life or decay into progeny that have long half-lives. And they must decay through a long series of radionuclides before finally becoming a stable isotope of lead. For example, plutonium-241 decays to americium-241 that has a 430-year half-life but it decays to neptunium-237, then to protactinium-233 then to uranium-233 with a 160,000-year half-life and so forth. Plutonium-241 is a beta emitter rather than an alpha emitter is so the DOE doesn't count Pu-241 as an alpha emitter when it classifies transuranic waste. The transuranic radionuclides emit not only alpha particles but beta and gamma radiation. The actinides, which are uranium and transuranic radionuclides, pose serious health hazards from exceeding small curie amounts when inhaled or ingested. While DOE argues that the transuranics are easily bound to soil, other experts know that the chemistry of the waste, water and soil can allow leaching of transuranics from the buried waste at higher rates than assumed by the DOE.

Uranium-233 is an entirely man-made fissile material also used to make nuclear weapons. Plutonium-241 decays to Am-241 which decays to Np-237 which decays to U-233. Man-made U-233 has a decay series is similar to that of U-238 and U-235. Radium-225 results from U-233 decay series, while radium-223 results from U-235 decay series, radium-226 results from U-238 decay series, and radium-224 and radium-228 result from thorium-232 decay series. Drinking water monitoring typically only assesses radium-226 and radium-228.

The length of time that some of the radionuclides in the DOE's radioactive waste will be a hazard to human health isn't just 500 years, or 10,000 years. As decay progeny are produced by radioactive decay, radionuclides like plutonium, americium, curium and neptunium as well as uranium and thorium become more radioactive over time, over hundreds of thousands of years and beyond one million years.

The lowest concentration limits for low-level radioactive waste are Class A. When the concentration of a radionuclide's activity per volume or per gram exceeds the U.S. Nuclear Regulatory Commission's Class C as specified in 10 CFR 61.55, the low-level waste is referred to as Greater-Than-Class C (or GTCC). GTCC waste can be as radioactive or more radioactive than spent nuclear fuel. GTCC waste includes no limit to the concentration of radioactivity in the

waste. GTCC waste includes very long-lived radionuclides including I-129, Tc-99, Pu-238, Pu-239, and others.

So, when the DOE wants to say HLW is now “low level waste” or “low activity waste” it is important to understand that this does not mean the waste does not pose a serious long-term hazard to human health and the environment. Levels of alpha-emitters above 100 nanocurie/gram were not expected to be produced by NRC licensees except in spent nuclear fuel and HLW and the NRC’s regulations for surface disposal for Classes A, B and C radioactive waste were not created with Greater-Than-Class C levels of transuranic waste.

DOE’s HLW, even waste it may refer to as “low activity waste” usually has levels of alpha-emitters above 100 nanocurie/gram. Under DOE’s proposal, DOE provides no standards for how DOE will classify or reclassify waste. DOE can reclassify HLW and dispose of it how it chooses on its DOE sites despite the waste exceeding Class C levels of alpha-emitters. DOE provides in its manual for managing radioactive waste that DOE may authorize ***alternative requirements*** for waste classification and characterization.

Under Order 435.1, DOE manages waste incidental to reprocessing as either low-level waste or transuranic waste based on the waste’s specific radioisotopic inventory. DOE defines *transuranic waste*, or TRU, as waste that is contaminated with alpha-emitting radionuclides (greater than uranium on the periodic table) with half-lives greater than 20 years and concentrations greater than 100 nanocuries per gram. If the TRU is not considered as originating from defense programs to make it eligible to be disposed of at the WIPP facility, then the waste is classified by DOE as ***low-level waste***.

According to the NRC’s radioactive waste concentrations for defining classes of low-level waste, the DOE’s transuranic waste would exceed Class C concentrations and be Greater-Than-Class C low-level radioactive waste. The NRC’s definition for alpha-emitting radionuclides is slightly different and more restrictive than the DOE’s. The NRC’s definition in 10 CFR 61.55 includes alpha-emitting transuranics with half-lives greater than 5 years. The NRC also has limits for beta-emitting transuranics, plutonium-241 and curium-242, which decay through many decay progenies before a stable non-radioactive isotope results. The NRC’s 10 CFR 61.55 applies to NRC licensees or NRC licensed facilities; therefore, the DOE does not use 10 CFR 61.55 unless it plans to dispose of its waste at an NRC-licensed disposal facility.

Whenever the DOE disposes of radioactive waste at the Nevada National Security Site, it means that the waste classification exceeded what was allowed at commercial nuclear disposal facilities such as the one in Clive, Utah.

The DOE has used undefined and imprecise terms such as “low activity” waste to try to diminish the appearance that the waste poses a serious hazard and must be isolated from the biosphere for the length of time that the waste is hazardous if in our air, soil or water.

The length of time that the waste is hazardous is usually thought of as at requiring at least 10 half-lives. But this only applies when the radioactive decay results in a stable isotope. When the radionuclide requires many decay progenies before reaching a stable nuclide, the half-life of each of the progeny must be considered and believe it or not, the DOE often ignores this.

The VTR EIS Violates NEPA Regarding Safe Disposal of Spent Nuclear Fuel

The VTR EIS waves at EISs that are already inadequate and completely inadequate for the 60-year VTR operation and the many decades or longer following that, regarding radioactive waste including spent nuclear fuel, which DOE may decide rename as "pixy dust" in the future.

***Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE/EIS-0200) (DOE 1997a)]** This DOE/EIS-0200 is not for spent nuclear fuel, but at MFC, spent nuclear fuel is renamed to high-level waste and then is renamed to low-level radioactive waste. This out-of-date EIS being cited is proof of how poorly the DOE is conducted its planning and its waste storage and disposal, i.e., via non-existent programs.

The VTR EIS must admit when a program relied upon in an EIS it points to, is actually flailing or completely non-existent, as DOE/EIS-0200 and also DOE-EIS-0203, ***Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement* (SNF PEIS) (DOE/EIS-0203) (DOE 1995)** [73]

Although the DOE/EIS-0203 from 1995 was to address spent nuclear fuel for 40 years through 2035, its failures began early and not only did it not obtain one repository, it failed to, by 2010 as required, name the second repository. For the VTR EIS to call out the DOE/EIS-0203 document is laughable were the problem not so deadly for millennia and also such a cost burden on future generations. The Department of Energy has failed to find a way to safely isolate spent fuel from the environment. The State of Nevada fought the DOE's efforts because the state officials saw and took note of the fraudulent metal corrosion studies, the fraudulent water infiltration models and the rapidly shifting strategies for the Yucca Mountain repository design.

When the VTR EIS points to other DOE EIS's to handle the spent nuclear fuel and other wastes the VTR project generates, it ought to have considered the timeframe that the supporting EIS's covered, and whether the economic or technical factors have changed over time, making assumptions and expectations of those supporting EISs highly inadequate to protect the public.

The extensive environmental polluting and health impacts from the isotope production program reveals the inadequacy of the NI PEIS, ***Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (NI PEIS) (DOE/EIS-0310) (DOE 2000b).** The VTR EIS must evaluate the entire environmental monitoring program for the INL, via an independent look at its inadequacies, weeks and months of unexplained gaps, and review technical indefensible explanations which go to any excuse to avoid attributing radiological contamination to the INL.

If the americium in our environment was simply from past weapons testing, counties in Idaho that had more nuclear weapons testing fallout than those surrounding the INL would also be affected. The Department of Energy's environmental surveillance contractor, promotes technical

[73] See https://www.energy.gov/sites/prod/files/2015/05/f22/EIS-0203-FEIS-Summary_0.pdf

indefensible fiction, however, and attributes the elevated levels of americium around the INL to be from past nuclear weapons testing.

The Nuclear Industry Continues to Pretend that the Technology for Confining Long-lived Radioactive Waste for Millenia Exists – It Doesn't and The Fiction Violates NEPA

The DOE has been telling the public that the technology for confining radioactive waste is not a problem — but may be true for the short-term in some cases but it is not true for disposal of radioactive waste in the long term. Unfortunately, the DOE does not have the technology to isolate the radioactive waste past a few decades. DOE does not have the technology to isolate the waste for 500 years. And DOE definitely does not have the technology to isolate the waste adequately for over 1 million years. The waste the DOE wishes to dispose of in shallow land burial has long-lived, mobile and radiotoxic radionuclides that the DOE cannot confine over time and cannot ensure the contrived slow steady trickle out predicted by its technically unjustified performance assessment models.

For light-water reactor (LWR) spent nuclear fuel disposal, a study found that the radiotoxicity of the radionuclides that leach out of buried waste is typically dominated by the actinides, which are the uranium, thorium and transuranic radionuclides. [74] [75] But studies of estimated groundwater contamination from the same repository, Yucca Mountain, have yielded radiation doses ranging from 1 rem/yr to 1000 rem/yr in studies prior to 1995 (dominant contributors have included C-14, Cs-135, Np-237, Tc-99, I-129, Pb-210, U-234, and Ra-226), [76] and doses below 1 rem/yr assuming perfect performance of titanium drip shields (dominated by Tc-99 and I-129). [77]

VTR EIS RADIATION RISKS INADEQUATELY CHARACTERIZED

While the official cancer fatality risk per rem rate used by DOE in the VTR EIS is 6E-4 fatal cancers per rem, underestimates the cancer fatality risk, it ignores the higher cancer fatality risk

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[74] Peter Swift, Sandia National Laboratories, ASTM-26 Workshop on Spent Fuel Disposal, Avignon, France, June 18, 2013, "Impact of Waste Characteristics on Disposal Options for Used Nuclear Fuel and High-Level Radioactive Waste," SAND2013-4208C, 2013. https://www.osti.gov/servlets/purl/1080027

[75] Transuranics are radionuclides often having extremely long half-lives. Many decay progenies may be created before reaching a stable, non-radioactive state. See our factsheet at http://www.environmental-defense-institute.org/publications/decayfact.pdf. See also an ANL factsheet at https://www.remm.nlm.gov/ANL-ContaminationFactSheets-All-070418.pdf

[76] Institute for Energy and Environmental Research, Science for Democratic Action, "Centerfold for Technoweenies," Vol. 4. No. 4, Fall 1995, p. 8-9. https://ieer.org/wp/wp-content/uploads/2012/02/4-4.pdf

[77] U.S. Nuclear Regulatory Commission, "U.S. Department of Energy's Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada – Final Report," NUREG-2184, May 2016. https://www.nrc.gov/docs/ML1612/ML16125A032.pdf "The peak estimated annual individual radiological dose over the one-million-year period at any of the evaluated locations is 1.3 mrem [0.013 mSv]. This maximum dose is associated with pumping and irrigation at the Amargosa Farms area, and the estimated radiological dose at other potential surface discharge locations is lower. The NRC staff concludes that the estimated radiological doses are SMALL because they are a small fraction of the background radiation dose of 300 mrem/yr [3.0 mSv/yr] (including radon), and much less than the NRC annual dose standards for a Yucca Mountain repository in 10 CFR Part 63 {15 mrem [0.15 mSv] for the first 10,000 years, and 100 mrem [1 mSv] for one million years, after permanent closure}."

per rem to women, children and the unborn. The VTR EIS ignores the long known non-fatal cancers and severe hereditary effects associated with radiation exposure and reported by the International Commission on Radiation Protection, i.e., ICRP-60 of 1991. The VTR EIS goes further – and ignores long known acute fatality rates for doses above say, 300 rem.

The dozen SL-1 emergency responders that were honored by DOE and said to have doses less than 25 rem, were noted by various observers to have all died of cancer within about 10 years. Their actual doses were likely higher than admitted to. **Even so, the VTR EIS statement, more than once, to say that 1000 rem would not cause cancer relates to misapplication of their own cancer per rem approach, whether due to sloppiness or deliberate deceptiveness.**

On page D-11, the VTR EIS states that the probability coefficients for determining the likelihood of fatal cancer, given a dose, are taken from the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991) and DOE guidance (DOE 2004b). For low doses or low dose rates, probability coefficients of 6.0×10^{-4} fatal cancers per rem and person-rem are applied for workers and the general public, respectively (DOE 2003). For cases where the individual dose would be equal to or greater than 20 rem, the LCF risk is doubled (NCRP 1993).

So, mathematically, 6.0E-4 fatal cancer per rem times 2 is 12.0E-4 fatal cancers per rem. And 1000 times 12.0E-4 is 1.2 (and the MEI is one person, so this is assumed to be a probability near one). I guess this was the reasoning for **the statement in the VTR EIS that "Unless the exposure is quite high (~ 1000 rem), the expected LCF [latent cancer fatalities] would be 0."** But, again, this neglects the well-known early fatality consequence of impending death for doses above 300 rem and death, within hours, of receiving 1000 rem. The VTR reactor accident dose to the MEI is acknowledged to be mostly the early dose rather than a later chronic ingestion dose.

Also note that the VTR EIS admits that the fuel feedstock and fuel fabrication risks are so high as to be about equivalent to that of a commercial light-water-reactor (LWR) accident, when located at the Oak Ridge National Laboratory, due to the larger nearby population. See Appendix D, page D-80, Table D-35 and fuel feedstock and fabrication accidents summarized in Table D-31. These tables focus on estimated average doses to the overall population and do not reflect that the contamination from these operational accidents would be economically devastating even when the stated population latent-cancer-fatality (LCF) risk is low. There are so many ways to have a significant accident not involving the reactor, which have rather high likelihoods, that at least one significant accident involving VTR fuel feedstock or fuel fabrication can be expected.

Either a severe accident involving the VTR reactor or an accident involving the radiological contamination from any of a variety of VTR fuel feedstock and fuel fabrication accidents may also involve agriculture interdiction, loss of market for agricultural products, loss of tourism, loss of property values, contaminated automobiles, and so forth. This would be true even for accidents with fewer predicted immediate fatalities and fewer predicted cancers than the beyond-design-basis VTR reactor accident.

The VTR EIS ignores the reality of the consequences to citizens of southeast Idaho in order to grease the wheels for hoped-for profits for aspiring reactor builders.

The DOE/EIS-0200 includes estimates of transuranic waste drum accidents, estimating such accidents to be about as frequent as 1 in 10,000 years or 1.0E-4/yr. Yet the Department of Energy has had two accidents in the last 5 years that were supposed to be 1 in 10,000 years or less. Does this say something about the DOE's accident likelihood estimates? (See the WIPP accident and 4-drum expulsion of waste at the INL)

The DOE/EIS-0200 actually includes radiation induced genetic effects in Table 8.4-7. The hazard of radiation induced genetic effects isn't new, yet the VTR EIS excludes them from consideration. In fact, the range of doses that the public will be bathed in over the long term and just how long, how many years were considered in the "long-term" population doses leaves much to the imagination as it is not explained.

Regarding transuranic waste storage outdoors, the accident scenario developed for a remote-handled 55-gallon drum (described in Section D.3.2.2) uses the assumption that the airborne release factor (ARF) can be low, 6.0E-3, and the respirable fraction can be 0.01. There are numerous ways that the TRU waste drum or standard waste box scenario may yield a higher release. The VTR EIS must consider how easily americium-241 is shielded and may not be properly estimated inside a container. The VTR EIS must consider overloading, above stated assumed disposal requirements for WIPP. Americium-241 is rather easily shielded due to its low energy gamma ray and other plutonium and transuranic radionuclides, with primarily alpha emission, are exceedingly difficult to detect once placed in a container. Overloaded containers destined for WIPP as packaged by the Department of Energy may actually be the rule more than the exception. It must explain why it considers that WIPP will accept the waste from this commercial reactor research venture, why only a single remote-handled drum is considered, why an overloaded contact-handled 55-gallon drum or a standard waste box was not considered, why multiple containers were not included in the scenario, why pyrophoric radionuclides or chemicals were assumed to be excluded from the waste, and why nitrates were not assumed to be present in the TRU waste container. It would seem that the number of containers involved, the possibility of higher than regulatory limits of plutonium-americium are present and the presence of materials that increase the radiological release, such as increased airborne-release-factor (ARF) and respirable fraction (RF) have not been considered. It is not justified why the VTR EIS thought the TRU waste drum accident scenario was bounding. The Department of Energy has, in recent years, had multiple instances of loading prohibited materials and incompatible chemicals and higher than allowed amounts of radioactive waste into containers. The Department of Energy has had multiple instances of inadequate fire protection measures, fire protection procedures and fire protection emergency response. See the 2014 WIPP accident and the 2018 INL four waste drum overpressurization event that caused four drums to forcefully pop their lids and expel transuranic waste, due to loading prohibited and incompatible materials into transuranic waste drums destined for the Waste Isolation Pilot Plant (WIPP) in New Mexico.

Infertility and Other Adverse Effects of Neutron Dose Ignored by VTR EIS

Neutron exposures can occur despite the absence of an operating nuclear reactor. Radiation workers who work near radioactive materials such as uranium, plutonium, curium, californium and other fissile or fissionable materials can receive neutron exposures. Hot cell, glove box and

waste containers, as well as fissile material handling can involve neutron doses which are often inadequately monitored and their harm may be underestimated.

Oddly, neutrons ejected from the spontaneous fission of the materials are not shielded by thick metal. To shield fission neutrons, materials rich in hydrogen are used, including water, concrete, and paraffin.

The human body is a great neutron sponge. Each collision with a hydrogen causes the neutron to change direction. This is repeated until the neutron runs out of energy. The damage from neutron exposure is very effective at creating double strand DNA breaks.

Special monitoring is needed in order to estimate neutron exposure. And even if conducted, a worker may not be told what portion of their radiation dose is from neutron exposure. Additionally, the placement of the source of the neutrons in relation to the person's gonads (ovaries or testes) may be causing a larger gonad dose than implied by the whole body averaged dose that is communicated to workers.

Metal jock strap? Lead apron? Sorry. These can lower gamma radiation but they are not effective against densely ionizing high linear-energy transfer (high LET) neutron dose. The double-strand DNA breaks from neutron exposure are more complex and less repairable than from more sparsely ionizing gamma radiation. [78]

How much do these radiation workers know about the non-cancer health effects of neutron exposure? According to a working group considering neutron exposure, "studies of human exposure to neutron radiation are extremely limited" and the neutron radiation component of the A-bomb dose reconstruction for Hiroshima and Nagasaki was at most 1 percent of the total absorbed radiation dose. Using experimental data, it is assumed that the relative biological effectiveness (RBE) of the A-bomb neutrons is 10 times greater than that of gamma radiation. But other experts think the RBE may be higher, in the range of 20-50. [79]

Furthermore, IARC documents that in experiments with mice, neutron exposure clearly increased the incidence in:

- Myeloid leukemia and malignant lymphoma including thymic lymphoma
- Benign and malignant tumors of the lung and the mammary gland
- Benign and malignant tumors of the ovary
- Benign and malignant tumors of the liver
- Benign and malignant tumors of the Harderian gland
- Tumors of the pituitary and adrenal gland.

[78] Agnes Schipler and George Iliakis, Nucleic Acids Res., "DNA double-strand-break complexity levels and their possible contributions to the probability for error-prone processing and repair pathway choice," Published online 2013 Jun 25. doi: 10.1093/nar/gkt556 or https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3763544/

[79] International Agency for Research on Cancer, 2012 https://www.ncbi.nlm.nih.gov/books/NBK304359/

The IARC studies also show that neutrons were also tested for carcinogenicity in mice exposed prenatally, and in mice after male parental exposure. In adult animals, the incidences of leukemia and of ovarian, mammary, lung and liver tumors were increased in a dose-related manner, although the incidence often decreased at high doses. **Prenatal and parental exposure of mice resulted in increased incidences of liver tumors in the offspring** (IARC, 2000).

So, knowing your neutron exposure is important. And both the dose and the harm may be higher than the whole-body dose estimate reported to workers at Department of Energy sites.

Metal does not shield neutrons. To illustrate this point, dose reconstructions showed that spent fuel storage casks at the Idaho National Laboratory in the 1980s at Test Area North had dose rates of about 30 mrem/hr gamma and 40 mrem/hr neutron. [80] The metal cask attenuates the gamma radiation, but does not appreciably affect the neutron field. According to a NIOSH report, neutron radiation levels were discovered in the nearby offices where people were not monitored for neutron dose. Each of three casks were in the area of the offices for two weeks.

The Materials Test Reactor at the Test Reactor Area (now the ATR Complex) had neutron beam ports. There would seem to have been potential for unmonitored neutron dose inside and outside the facility. The Test Reactor Area also had TRA-635 with Californium-252 and the TRA Hot Cell Cave with Cf-252 on filters. (See ORAUT-TKBS-0007-6, Table 6-11 for a listing of some INL areas with potential neutron exposure.)

So, even if you did not work at a glove box or near drums of transuranic waste, you still may have gotten more neutron exposure than you realized.

Spontaneous fission neutron yields for various radionuclides are shown in Table 2 based on N. Ensslin's Table 11-1. [81] The neutrons are emitted at various energies, not shown. Notice the range of neutron spontaneous fission yield is very for californium-252, curium-242 and -244 and plutonium-238, -240 and -242. And note the extraordinarily high curium neutron yields. Curium in the VTR SNF will be more releasable in an accident, according to the VTR EIS. But additional neutron harm VTR operations may impose adverse health impacts beyond cancer fatality, the only health effect the VTR EIS has included.

[80] National Institute for Occupations Safety and Health at cdc.gov, ORAU TEAM Dose Reconstruction Project for NIOSH, "Idaho National Laboratory and Argonne National Laboratory-West Occupational External Dosimetry, ORAUT-TKBS-0007-6, 2011. https://www.cdc.gov/niosh/ocas/pdfs/tbd/inl-anlw6-r3.pdf Section 6.3.4.2.3 Test Area North Fuel Storage Casks.

[81] N. Ensslin, Chapter 11. The Origin of Neutron Radiation, https://fas.org/sgp/othergov/doe/lanl/lib-www/la-pubs/00326406.pdf

Table 2. Spontaneous fission neutron yields.

Isotope A	Number of Protons Z	Number of Neutrons N	Total Half-Life	Spontaneous Fission Half-Life (yr)	Spontaneous Fission Yield (n/s-g)	Spontaneous Fission Multiplicity V	Induced Thermal Fission Multiplicity V
Th-232	**90**	**142**	**1.41 E10yr**	**<1 E21**	**< 6 E-8**	**2.14**	**1.9**
U-232	**92**	**140**	**71.7 yr**	**8 E13**	**1.3**	**1.71**	**3.13**
U-233	**92**	**141**	**1.59 E5 yr**	**1.2 E17**	**8.6 E-4**	**1.76**	**2.4**
U-234	**92**	**142**	**2.45 E5 yr**	**2.1 E16**	**5.02 E-3**	**1.81**	**2.4**
U-235	**92**	**143**	**7.04 E8 yr**	**3.5 E17**	**2.99 E-4**	**1.86**	**2.41**
U-236	**92**	**144**	**2.34 E7 yr**	**1.95 E16**	**5.49 E-3**	**1.91**	**2.2**
U-238	**92**	**146**	**4.47 E9 yr**	**8.20 E15**	**1.36 E-2**	**2.01**	**2.3**
Np-237	**93**	**144**	**2.14 E6 yr**	**1.0 E18**	**1.14 E-4**	**2.05**	**2.70**
Pu-238	**94**	**144**	**87.74 yr**	**4.77 E10**	**2.59 E3**	**2.21**	**2.9**
Pu-239	**94**	**145**	**2.41 E4 yr**	**5.48 E15**	**2.18 E-2**	**2.16**	**2.88**
Pu-240	**94**	**146**	**6.56 E3 yr**	**1.16 E11**	**1.02 E3**	**2.16**	**2.8**
Pu-241	**94**	**147**	**14.35 yr**	**(2.5 E15)**	**(5 E-2)**	**2.25**	**2.8**
Pu-242	**94**	**148**	**3.76 E5 yr**	**6.84 E10**	**1.72 E3**	**2.15**	**2.81**
Am-241	**95**	**146**	**433.6 yr**	**1.05 E14**	**1.18**	**3.22**	**3.09**
Cm-242	**96**	**146**	**163 days**	**6.56 E6**	**2.10 E7**	**2.54**	**3.44**
Cm-244	**96**	**148**	**18.1 yr**	**1.35 E7**	**1.08 E7**	**2.72**	**3.46**
Bk-249	**97**	**152**	**320 days**	**1.90 E9**	**1.0 E5**	**3.40**	**3.7**
Cf-252	**98**	**154**	**2.646 yr**	**85.5**	**2.34 E12**	**3.757**	**4.06**

a. Data source: N. Ensslin, Chapter 11, The Origin of Neutron Radiation, Table 11-1. https://fas.org/sgp/othergov/doe/lanl/lib-www/la-pubs/00326406.pdf
b. Units for fission yield neutron/(second-gram); fission multiplicity Greek letter v, represents the number of neutrons emitted per spontaneous fission.
c. Units for spontaneous fission yield (n/s-g), neutrons/(second – gram).
d. The average energies are from 4 to 6 MeV (mega electron volts) (see Table 11-3 from N. Ensslin.)

VTR EIS IGNORING UPWARD SPIRAL OF INL RADIOLOGICAL EMISSIONS

From new reactors, to high-assay low-enriched fuel processing, to unfettered radiological releases from INL's new test range, radiological emissions have now gone up by a factor of 170, see Table 3.

The EA ignores many the ongoing radiological releases including the decision by the U.S. Department of Energy to allow the DOE to release long-lived radionuclides to air and soil at the Idaho National Laboratory, from the Expanding Capabilities at the National Security Test Range and the Radiological Response Training Range at Idaho National Laboratory (DOE/EA-2063) at

Table 3. Estimated annual air pathway dose (mrem) to Idaho communities from normal operations to the maximally exposed offsite individual from proposed projects, including the estimated dose from expanding capabilities at the Ranges based on DOE/EA-2063.

Current and Reasonably Foreseeable Future Action	Estimated Annual Air Pathway Dose (mrem)
National Security Test Range	0.04[e]
Radiological Response Training Range (North Test Range)	0.048[d]
Radiological Response Training Range (South Test Range)	0.00034[a]
HALEU Fuel Production (DOE-ID, 2019)	1.6[a]
Integrated Waste Treatment Unit (ICP/EXT-05-01116)	0.0746[h]
New DOE Remote-Handled LLW Disposal Facility (DOE/ID 2018)	0.0074[a]
Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling (DOE/EIS 2016)	0.0006[c]
TREAT (DOE/EA 2014)	0.0011[a]
DOE Idaho Spent Fuel Facility (NRC, 2004)	0.000063[a]
Plutonium-238 Production for Radioisotope Power Systems (DOE/EIS 2013)	0.00000026[b]
Total of Reasonably Foreseeable Future Actions on the INL Site	1.77[g]
Current (2018) Annual Estimated INL Emissions (DOE2019a)	0.0102[f]
Total of Current and Reasonably Foreseeable Future Actions on the INL Site [**DOE WOULD INCREASE INL'S AIRBORNE RELEASES BY OVER 170 TIMES**]	1.78[g]

Table notes:

a. Dose calculated at Frenchman's Cabin, typically INL's MEI for annual NESHAP evaluation.

b. Receptor location is not clear. Conservatively assumed at Frenchman's Cabin.

c. Dose calculated at INL boundary northwest of Naval Reactor Facility. Dose at Frenchman' Cabin likely much lower.

d. Dose calculated at INL boundary northeast of Specific Manufacturing Capability. Dose at Frenchman's Cabin likely much lower.

e. Sum of doses from New Explosive Test Area and Radiological Training Pad calculated at separate locations northeast of MFC near Mud Lake. **Dose at Frenchman's Cabin likely much lower. PLEASE NOTE THAT THE PUBLIC AT MUD LAKE IS CLOSER TO THE RELEASE THAN TO FRENCHMAN'S CABIN.**

f. Dose at MEI location (Frenchman's Cabin) from 2018 INL emissions (DOE 2019a). The 10-year (2008 through 2017) average dose is 0.05 mrem/year. **PLEASE NOTE THAT MANY RADIOLOGICAL RELEASES ARE IGNORED AND NOT INCLUDED IN THE RELEASE ESTIMATES IN NESHAPS REPORTING.**

g. This total represents air impact from current and reasonably foreseeable future actions at INL. It conservatively assumes the dose from each facility was calculated at the same location (Frenchman's Cabin), which they were not.

h. Receptor location unknown, according to the Department of Energy, the agency that is supposed to know the receptor location.

The VTR EIS Must Include More Comprehensive Listing of Radionuclides, To Facilitate Environmental Monitoring and for Radionuclide Migration Studies

The VTR EIS has left out of Table D-43, the 4-year cooled VTR fuel, many of the radionuclides that can dominate waste disposal, even if not deemed to dominate accident releases in the near-term. The VTR EIS needs to include these radionuclides, especially because these VTR wastes may never leave Idaho for permanent disposal elsewhere.

Table 4. A list of radionuclides that tend to dominate radioactive waste disposal hazard.

Radionuclide	Half-Life (Primary decay mode)	Typical Decay Progeny	Drinking Water Federal Maximum Contaminant Level (MCL)	Waste Leaching Parameter Kd (m^3/kg): (Possible radionuclide origin)
High activity fission products				
Cesium-137	30.2 year (beta)	Barium-137m	160 pCi/L	Kd: screening value 5 Rood for Hanford
Strontium-90	29.1 year (beta)	Yttrium-90	8 pCi/L	Kd: screening 0.1 by Rood Kd: 0.001 to 0.006 in an NRC review of an INL study
Long-lived fission products				
Iodine-129	17 million yr (beta, gamma)		1 pCi/L	Kd: 0.3 to 15 by Rood Kd: 0.002 to 0.03 NRC review Kd: 0 to 3 in INL study for RHLLW
Technetium-99	213,000 year (beta)		900 pCi/L	Kd: screening 78.1 Rood Kd: 0.001 to 5 depending on concrete or grout mixed with it, NRC Kd: 0 to .1 RHLLW
Selenium-79	65,000 year (beta)		? (Se-75 is 900 pCi/L)	Kd: ?
Cesium-135	2.3 million yr (beta)		900 pCi/L	Kd: ?
Activation Products				

Radionuclide	Half-Life (Primary decay mode)	Typical Decay Progeny	Drinking Water Federal Maximum Contaminant Level (MCL)	Waste Leaching Parameter Kd (m^3/kg): (Possible radionuclide origin)
Tritium	12.3 year (weak beta)		20,000 pCi/L	Kd: 0.0, firm
Carbon-14	5730 year (beta)		2,000 pCi/L	Kd: 0.25 to 5.0 NRC Kd: 0 to 2.0, RHLLW
Chlorine-36	301,000 year (beta, EC)		700 pCi/L	Kd: 0.0, firm
Niobium-94	20,000 year (beta)		?	(RHLLW disposal exceeds Class C for Nb-94)
Nickel-59	76,000 year (beta)		300 pCi/L	(RHLLW disposal exceeds Class C for Ni-59)
Nickel-63	96 year (beta)		50 pCi/L	(RHLLW disposal exceeds Class C for Ni-63)
Zirconium-93	1.5 million yr (beta)		2000 pCi/L	?
Actinides (include thorium, protactinium, uranium, neptunium, plutonium, americium, curium, californium and others)				
Thorium-230	77,000 year (alpha)	Radium-226 Many others	15 pCi/L	Kd: 40 to 2000 Rood (Pu-238 and U-238 parent decay progeny)
Protactinium-231	33,000 year (alpha)	Radium-223 Many others	15 pCi/L	Kd: screening 0.1 Rood (Pu-239 and U-235 parent decay progeny)
Uranium-238	4,470 million yr (alpha)	Uranium-234, Thorium-230, Radium-226 Many others	10 pCi/L Total U 30 microgram/L	Kd: 0.6 to 79 Rood Kd: 1.6 to 10 RHLLW (From ore, or enrichment or reprocessing. Primary constituent of

Radionuclide	Half-Life (Primary decay mode)	Typical Decay Progeny	Drinking Water Federal Maximum Contaminant Level (MCL)	Waste Leaching Parameter Kd (m^3/kg): (Possible radionuclide origin)
				depleted uranium.)
Uranium-234	240,000 year (alpha)	Thorium-230 Many others	Total U 30 microgram/L	Kd: (see U-238) (From ore or Pu-238 parent decay. Contributes significantly to activity despite low mass contribution)
Uranium-235 (Fissile material)	700 million yr (alpha)	Pa-231 Ra-223 Many others	Total U 30 microgram/L	Kd: (See U-238) (From ore or Pu-239 parent decay, or enrichment of fuel in fissile U-235)
Uranium-233 (Fissile material)	160,000 year (alpha)	Radium-225 Many others	Total U 30 microgram/L	Kd: (See U-238) (Reactor-made or from Pu-241, Am-241, or Np-237 parent decay)
Uranium-236	23 million yr (alpha)	Thorium-232 Many other	Total U 30 microgram/L	Kd: (See U-238) (Reactor-made or from Pu-244, Pu-240, Curium-244 (Cm-244) parent decay)
Neptunium-237	2,144 million yr (alpha)	Uranium-233 Radium-225 Many others	15 pCi/L	Kd: ? (Reactor-made or from Pu-241 or Am-241 parent decay)
Plutonium-238	88 year (alpha)	Uranium-234 Thorium-230 Radium-226 Many others	15 pCi/L	Kd: screening 0.1 Rood Kd: 22 to 1480 RHLLW (Reactor-made or from Pu-242, Am-242, Np-238 or

Radionuclide	Half-Life (Primary decay mode)	Typical Decay Progeny	Drinking Water Federal Maximum Contaminant Level (MCL)	Waste Leaching Parameter Kd (m^3/kg): (Possible radionuclide origin)
				Cm-242 parent decay)
Plutonium-239 (Fissile material)	24,000 year (alpha)	Uranium-235 Many others	15 pCi/L	Kd: screening 0.1 Rood Kd: 22 to 1480 RHLLW (Reactor-made or from Curium-237, Pu-243, Am-243, Np-239 or Cm-243 parent decay)
Plutonium-240	6,500 year (alpha)	Uranium-236 Many others	15 pCi/L	Kd: (See Pu-239) Reactor-made or from curium-248 or 244 parent decay)
Plutonium-241	14.4 year (beta)	Americium-241 Neptunium-237 Uranium-233 Many others	300 pCi/L	Kd: (See Pu-239) (Reactor-made) Erroneously ignored in classifying transuranics because it is a beta emitter rather than an alpha emitter.
Plutonium-242	380,000 year (alpha)	Uranium-238 Many others	15 pCi/L	Kd: (See Pu-239) (Reactor-made or from Cm-246 decay)
Curium-242	0.45 year (alpha)	Plutonium-238 Uranium-234 Many others	15 pCi/L	Kd: (See Pu-239) (Reactor-made, target irradiation) Short half-life has been erroneously used to ignore its transuranic decay product, Pu-238.
Curium-244	18 year (alpha)	Plutonium-240 Uranium-236 Many others	15 pCi/L	Kd: (See Pu-239) (Reactor-made, target irradiation)

Radionuclide	Half-Life (Primary decay mode)	Typical Decay Progeny	Drinking Water Federal Maximum Contaminant Level (MCL)	Waste Leaching Parameter Kd (m^3/kg): (Possible radionuclide origin)
				Short half-life has been erroneously used to ignore its transuranic decay product, Pu-240.
Americium-241	430 year (alpha)	Neptunium-237 Uranium-233 Many others	15 pCi/L	Kd: (See Pu-239) (Reactor-made or from Pu-241 parent decay)
Radium-226	1600 year (alpha)	Radon-222 Many others	5 pCi/L for radium-226 and radium-228 combined	Kd: 8 to 173 Rood (From Pu-238, U-238, U-234 parent decay)
Radium-228	5.75 year (beta)	Thorium-228 Radium-224 Many others	5 pCi/L for radium-226 and radium-228 combined	Kd: ? (From Pu-240, U-236, or Th-232 parent decay)

Table notes: Table only highlights the dominant decay mode, selected decay progeny, and selected parent progeny and is not exhaustive. Not all fission products, activation products or actinides have been included in the table. Dominant radionuclides highlighted are from spent nuclear fuel repository studies and from a few DOE low-level waste disposal studies and will differ according to the wastes disposed of and the characteristics that allow migration of radionuclides over time. Picocurie/liter (pCi/L), Kd in milliliter per gram.

The parameter Kd in cubic meters per kilogram strongly influences the prediction of waste migration into groundwater. A wide range of values have been used in various studies for the DOE. Kd values are often not only inconsistent, they are selected without adequate technical basis. Zero (0.0) is the most mobile with water infiltration to groundwater.

Arthur Rood, K-Spar Inc, Scientific Consulting, Submitted to Washington State Health Department, "Final Report Groundwater Concentrations and Drinking Water Doses with Uncertainty for the U.S. Ecology Low-Level Radioactive Waste Disposal Facility, Richland Washington," February 2004. https://www.doh.wa.gov/Portals/1/Documents/Pubs/320-031_appIV_w.pdf

U.S. Nuclear Regulatory Commission Technical Evaluation Report for the U.S. Department of Energy Idaho National Laboratory Site Draft Section 3116 Waste Determination for Idaho Nuclear Technology and Engineering Center Tank Farm Facility, October 2006. https://www.nrc.gov/docs/ML0624/ML062490142.pdf

Idaho National Laboratory, "Evaluation of Groundwater Impacts to Support the Natural Environmental Policy Act Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project," INL/EXT-10-19168, Rev. 3, August 2011. Tables 4 and 9.

Regarding waste classification errors for plutonium-241, curium-242 and curium-244, see IEER.ORG publication, *Science for Democratic Action*, "The Curious Case of Curium-242, Curium-244 and Plutonium-241," Volume 6, Number 1, May 1997.

Understanding the decay series of natural uranium and thorium, as well as for transuranic radionuclides is very important in understanding the hazard. The uranium-238 and uranium-235 decay series are commonly found, but the decay series for plutonium and for man-made uranium-233 are not so commonly found. So frequent are conceptions about these radionuclides that I am including simple tables to show the decay series.

Four decay series are presented in Tables 5 through 8 below:

the uranium-238 decay series known as the uranium series;

the thorium-232 decay series known as the thorium series;

the uranium-235 decay series known as the actinium series, and

the uranium-233 decay series which is man-made and remains officially nameless.

I have included these decay series tables here for three reasons: (1) unless you have a degree in radiochemistry, you need to have the names of the nuclides spelled out along with their short-hand symbol identifier (such as U, Pu, Np), (2) it is difficult to locate decay series that are complete with man-made decay chains feeding in, and (3) it is important to understand the specific decay series that a radionuclide belongs to as you study drinking water, lung count results and environmental radionuclide emissions data.

These decay series show the man-made actinides that may also decay through the same series in grey. The decay series depict alpha decay as progressing downward and reducing the atomic mass by 4. Beta decay by electron emission is depicted as progressing upward diagonally to the right. Beta decay flips a neutron into a proton and stays at the same atomic mass. Isotopes of the same chemical element have the same number of protons but can have variable numbers of neutrons and variable atomic mass. The half-lives of the various radionuclides range from millions or billions of years to milli-seconds.

Along with alpha and beta decays at various energy levels, gamma photon emissions of various energy levels can also occur which can be detected by gamma spectrometry.

So, while uranium, thorium and plutonium are thought of primarily as alpha particle emitters, gamma radiation is also emitted and decay progeny may emit beta particles rather than alpha particles along with gamma radiation at various energy levels measured in kiloelectron volts (keV).

Weak or low energy gamma emissions require less shielding than higher energy gamma emissions. Uranium decay progeny of Th-231, Th-234 and Pa-234, all beta emitters, have high specific activity in curies per gram that require some protection of workers.

Sources of uranium-238 include natural soil and rock sources, mill tailings, depleted uranium, reactor fuel melting from reactor accidents, and spent fuel reprocessing. Sources of uranium-234 decay progeny can include man-made plutonium-238 that is present in various materials and processes at the INL.

Sources of thorium-232 include natural thorium-232 in rock and soil. Sources of thorium-232 can also include man-made plutonium-240 and uranium-236 resulting from neutron capture in a reactor.

Sources of uranium-235 include natural uranium in rock and soil but are typically considered to be of small enough abundance to be ignored. But this decay series should not be ignored where large amounts of depleted, enriched or natural uranium are released to the environment.

of the U-235 decay series also include plutonium-239 which decays to uranium-235. Dispersion of reactor fuel from reactor accidents and spent fuel reprocessing can spread uranium-235 in the environment. Waste water disposal from HEU spent fuel reprocessing has put uranium-236 in the Snake River Plain Aquifer. Fuel reprocessing and calcining and reactor fuel melt tests or accidents spread various radionuclides present in nuclear fuels to air and soil.

Depleted uranium is uranium that is left over after extraction of uranium-235. Enriched uranium includes more than 0.72 percent up to 93.5 percent U-235 enrichment. Commercial nuclear power reactors typically use 3 to 5 percent enrichment. Enriched uranium also includes increased amounts of uranium-234 which cannot be separated from the uranium-235. Most depleted uranium includes between 0.2 and 0.4 percent uranium-235. Depleted uranium composition can vary and can include uranium-236 if it resulted from reactor fuel reprocessing. The health harm caused by inhalation or ingestion of depleted uranium includes illness and increased risk of birth defects. [82] [83]

Uranium-233 is not naturally occurring. This weapons fissile material can only be produced in a reactor or by the higher actinide decays shown including plutonium-241 and americium-241 decay. Uranium-233 has been dispersed by its production, separation and limited use in nuclear weapons testing. Disposal of americium-241 following plutonium purification may be a significant source. It can also result from spent fuel reprocessing particularly of high enriched uranium fuel because of the high buildup of neptunium-237 in HEU reactor operations.

Higher actinides such as californium, curium, americium and neptunium may be produced using target material in nuclear reactors in order to produce weapons related materials or to produce a heat source for radiothermal generators such as plutonium-238 which is used as a power supply in spacecraft. [84] These materials have been disposed of routinely to an open-air evaporation pond at the INL's ATR Complex. These materials have not necessarily been included in required federal reporting under the National Emissions Standards (NESHAPs) because they are not monitored but only estimated. Therefore, whenever unplanned releases are occurring via escaping resin beads, for example, the emissions would be underestimated.

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[82] Rosalie Bertell, International Journal of Health Services, "Depleted Uranium: All the Questions About DU and Gulf War Syndrome Are Not Yet Answered," 2006. p. 514 https://ntp.niehs.nih.gov/ntp/roc/nominations/2012/publiccomm/bertellattachmentohw.pdf

[83] Depleted Uranium Education Project, *Depleted Uranium Metal of Dishonor How the Pentagon Radiates Soldiers & Civilians with DU Weapons*, 1997. ISBN:0-9656916-0-8

[84] Transuranics are radionuclides often having extremely long half-lives. Many decay progenies may be created before reaching a stable, non-radioactive state. See our factsheet at http://www.environmental-defense-institute.org/publications/decayfact.pdf. See also an ANL factsheet at https://www.remm.nlm.gov/ANL-ContaminationFactSheets-All-070418.pdf

Table 5. Uranium-238 decay series.

Californium	Cf-250 *						
Curium	Cm-246 *		Cm-242				
Americium	↓	Am-242 /^	↓				
Plutonium	Pu-242	↓	Pu-238				
Neptunium	↓	Np-238 /^	↓				
Uranium	U-238		U-234				
Protactinium	↓	Pa-234 /^	↓				
Thorium	Th-234 /^		Th-230				
Radium			Ra-226				
Radon			Rn-222				
Polonium			Po-218		Po-214		Po-210
Bismuth			↓	Bi-214 /^	↓	Bi-210 /^	↓
Lead			Pb-214 /^		Pb-210 /^		Pb-206 (stable)

Table notes: Alpha decay downward reduces the atomic mass by 4; beta decay upward diagonally to the right flips a neutron to a proton and stays at the same atomic mass. In the table, arrow symbols downward are used to show the progression of some alpha decays if there was space to show the arrow. Movement upward and to the right is shown by /^ which is a lame keyboard attempt to look like an arrow. Man-made actinides are shown in grey.
* Decay series to Cf-250 and Cm-246 not shown which include Cm-250, Pu-246, Am-236 and Bk-250.
Sources of uranium-238 include natural soil and rock sources, depleted uranium, reactor fuel melting from reactor accidents, and spent fuel reprocessing. Sources of uranium-234 decay progeny can include plutonium-238.

Table 6. Thorium-232 decay series.

Californium	Cm-252		Cf-248				
Curium	Cm-248		Cm-244				
Americium	↓		↓				
Plutonium	Pu-244		Pu-240				
Neptunium	↓	Np-240/^	↓				
Uranium	U-240/^		U-236				
Protactinium			↓				
Thorium			Th-232		Th-228		
Actinium			↓	Ac-228/^	↓		
Radium			Ra-228/^		Ra-224		
Radon					Rn-220		
Polonium					Po-216		Po-212
Bismuth					↓	Bi-212/^	↓
Lead					Pb-212/^	↓	Pb-208 (stable)
Thallium						Tl-208/^	

See table notes for Table 5. Sources of thorium-232 include natural thorium-232 in rock and soil. Plutonium-240 and uranium-236 which results from neutron capture in a reactor also decay to thorium-232. Depleted uranium can include uranium-236. The higher actinides that decay to plutonium-240 are not shown but include californium-252 and -248, curium-248 and -244, plutonium-244, and neptunium-240.

Table 7. Uranium-235 decay series.

Californium	Cf-251						
Berkelium	↓	Bk-247					
Curium	Cm-247	↓	Cm-243				
Americium	↓	Am-243	↓				
Plutonium	Pu-243 /^	↓	Pu-239				
Neptunium		Np-239 /^	↓				
Uranium			U-235				
Protactinium			↓	Pa-231			
Thorium			Th-231 /^	↓	Th-227		
Actinium				Ac-227 /^	↓		
Radium				↓	Ra-223		
Francium				Fr-223 /^	↓		
Radon					Rn-219		
Polonium					Po-215		
Bismuth					↓	Bi-211 /^	
Lead					Pb-211 /^	↓	Pb-207 (stable)
Thallium						Tl-207 /^	

See table notes for Table 5. Sources of uranium-235 include natural uranium in rock and soil. It should not be ignored where enriched uranium is released to the environment. Plutonium-239 also decays to uranium-235 and higher actinides (californium, curium, americium and neptunium) are shown. Dispersion of reactor fuel from reactor accidents and spent fuel reprocessing can spread uranium-235 in the environment.

Table 8. Uranium-233 decay series.

Californium	Cf-241					
Curium	Cm-245					
Americium	↓	Am-241				
Plutonium	Pu-241 /^	↓				
Neptunium		Np-237				
Uranium		↓	U-233			
Protactinium		Pa-233 /^	↓			
Thorium			Th-229			
Actinium			↓	Ac-225		
Radium			Ra-225 /^	↓		
Francium				Fr-221		
Radon				↓		
Astatine				At-217		
Polonium				↓	Po-213	
Bismuth				Bi-213 /^	↓	Bi-209
Lead				↓	Pb-209 /^	↓
Thallium				Tl-209 /^		Tl-205

See table notes for Table 5. Uranium-233 is not naturally occurring. This weapons fissile material can only be produced in a reactor or by the higher actinide decays shown including plutonium-241 and americium-241 decay. Higher actinides (californium, curium, americium and neptunium) are shown. Uranium-233 can and has been used in nuclear weapons testing. Its dispersion can also result from various weapons production and separations processes. Disposal of americium-241 following plutonium purification may be a significant source. It can also result from spent fuel reprocessing particularly of high enriched uranium fuel because of the high buildup of neptunium-237 in HEU reactor operations.

Frankly, the NESHAPs reporting by the INL appears to lack validation and may substantially understate INL's airborne emissions of transuranics and other radionuclides. And these very long-lived radionuclides are continuing to be released and to build up in our air, soil and water.

DOE's Environmental Monitoring Lied About the History and Continues to Hide the Truth about INL Radiological Contamination

The DOE must not be allowed to continue its inadequate radiological monitoring of the Idaho National Laboratory radiological emissions or of its waste disposal sites. DOE's past and ongoing coverup of radiological contamination is not protective of human health and the environment.

DOE has failed to disclose past radiological releases and the DOE continues to coverup ongoing intentional and accidental releases. Extensive americium-241 contamination at the ATR Complex was known long ago but the DOE and the U.S. Geological Survey deliberately withheld the information. The DOE has long given presentations to the public that deliberately withheld information about long-lived radionuclide contamination. Even now, when filters are evaluated and found to have americium-241, plutonium-238 and plutonium-239, for example, the DOE and state pretend to not know the source of the radionuclides.

Monitoring of waste burial sites for CERCLA at INL has often been inadequate and biased to hide contamination findings by reduced monitoring and reduced reporting. Spotty monitoring means "no discernable trend could be found."

At the Idaho National Laboratory, formerly the Idaho National Engineering and Environmental Laboratory, the Idaho National Engineering Laboratory, and the National Reactor Testing Station, historical releases were monitored yet not actually characterized as to what and how many curies were released. When asked by the governor in 1989 to provide an estimate of the radionuclides released from routine operations and accidents, the Department of Energy issued the "INEL Historical Dose Evaluation." [85] [86] It has been found to have underestimated serious releases by sometimes 10-fold. Furthermore, the past environmental monitoring used all along to claim no significant releases had occurred were not used in the INEL Historical Dose Evaluation. The environmental records that could have been used against the Department of Energy were destroyed. Americium and plutonium releases were often omitted from the INEL HDE.

The waste incidental to reprocessing requirements under the Section 3116 law required U.S. Nuclear Regulatory Commission oversight to some degree for closure of DOE's HLW tanks at

[85] US Department of Energy Idaho Operations Office, "Idaho National Engineering Laboratory Historical Dose Evaluation," DOE-ID-12119, August 1991. Volumes 1 and 2 can be found at https://www.iaea.org/inis/inis-collection/index.html

[86] Environmental Defense Institute's comment submittal on the Consent-based Approach for Siting Storage for the nation's Nuclear Waste, July 31, 2016. http://www.environmental-defense-institute.org/publications/EDIXConsentFinal.pdf

INL and SRS. The NRC oversight was publicly available such as an NRC monitoring report from 2007. [87]

INL's Forever Contamination is Already So Obscene, DOE Hides the Data

The CERCLA cleanup at the Idaho National Laboratory is leaving behind roughly 55 "forever" radioactively contaminated sites of various sizes, and about 30 "forever" asbestos, mercury or military ordnance sites. [88] [89] The areas contaminated with long-lived radioisotopes that are not being cleaned up will require institutional controls in order to claim that the "remediation" is protective of human health. People must be prevented from coming into contact with subsurface soil or drinking water near some of these sites — forever.

The Department of Energy downplays the mess and usually doesn't specify how long the controls are required when the time frame is over thousands of years: they just say "indefinite." In some cases, the DOE earlier had claimed that these sites would be available for human contact in a hundred or so years. [90] [91] You can find a summary that includes the "forever" sites at https://cleanup.icp.doe.gov/ics/ic_report.pdf

Institutional control of "forever" contamination means they put up a sign, maybe a fence or a soil cap — and assume it will be maintained for millennia. "Don't worry about the cost. And besides," they always add, "you and I won't be here." The DOE acknowledges that the soil cap they plan to put over the RWMC will require maintenance, basically annually, for millennia.

DOE continues to find more contaminated sites and expectations are not always met by remediation. [92] And the DOE has never stopped burying long-lived radioactive waste over the Snake River Plain aquifer.

Frequently cited stringent EPA standards such as 4 rem/yr in drinking water are emphasized. But cleanup efforts often won't come close to achieving the advertised standards.

DOE argued against digging up meaningful amounts of transuranic and other long-lived radioactive waste at the Radioactive Waste Management Complex. Only the most egregious

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[87] "U.S. Nuclear Regulatory Commission Plan for Monitoring Disposal Actions Taken By The U.S. Department of Energy at the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center Tank Farm Facility in Accordance with the National Defense Authorization Act of Fiscal Year 2005," April 13, 2007. On NRC's Adams Database.

[88] INL Waste Area Group Institutional Controls Report. Dated March 25, 2016. https://cleanup.icp.doe.gov/ics/ic_report.pdf from the EPA page: https://cleanup.icp.doe.gov/ics/

[89] ibid. INL Waste Area Group Institutional Controls Report. I counted the "forever" radioactive sites as those with termination date for institutional controls stated as "indefinite" or as "not specified." I counted the chemical sites for asbestos, PCPs, mercury or ordnance similarly. The size of the mess actually ranges from some small number of curies to the huge waste inventory at the RWMC.

[90] Department of Energy Idaho Operations Office, *Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site*, Fiscal Years 2010-2014, DOE/ID-11513, December 2015.

[91] Federal Facility Agreement and Consent Order New Site Identification (NSI), "TRA-04: TRA-712 Warm Waste Retention Basin System (TRA-712 and TRA-612), NSI-26002. Signed by the Department of Energy in August of 2015. See Idaho National Laboratory Federal CERCLA Cleanup documents at www.ar.icp.doe.gov

[92] US Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011. http://energy.gov/sites/prod/files/EA-1793-FEA-2011.pdf

chemically laden waste is being removed. [93] [94] The DOE hasn't decided how much it will bury at the replacement for the RWMC, the Remote Handled Low-Level Waste disposal facility at the Idaho National Laboratory. The RHLLW facility allows disposal of Greater-Than-Class-C long-lived radionuclides that are expected to migrate into the Snake River Plain aquifer. The concentrations of Nickel-59, Nickel-63 and Niobium-94 are expected to exceed Class C and could not be disposed of at a commercial low-level waste disposal facility. The computations to provide the Performance Assessment for the rate at which the radionuclides will migrate into the aquifer are based on unsupported assumptions regarding optimistic selection of properties to slow the estimated rate of migration, assumption of uniform mixing in the aquifer while ignoring the known presence of "fast paths," the presumed lack of flooding, and stable geology for the need million and more years. The DOE hopes to increase the amount of radionuclides buried over the aquifer without so much as even the pretense of a soil cap to slow the migration of radionuclides into the aquifer. The DOE continues to bury radioactive waste over our Snake River Plain aquifer. [95] The DOE has failed to be truthful about past aquifer contamination migration to the south of the Idaho National Laboratory, as I describe in *Tritium at 800 pCi/L in the Snake River Plain Aquifer in the Magic Valley at Kimama: Why This Matters*. [96]

The INL appears to being ignoring the transport of radionuclides from buried waste to the surface by upward diffusion through the unsaturated soils. In an Environmental Assessment (EA) for shallow burial of the nation's entire GTCC inventory at the Andrews, Texas WCS facility, [97]

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[93] U.S. Department of Energy, 2008. Composite Analysis for the RWMC Active Low-Level Waste Disposal Facility at the Idaho National Laboratory Site. DOE/NE-ID-11244. Idaho National Laboratory, Idaho Falls, ID and U.S. Department of Energy, 2007. Performance Assessment for the RWMC Active Low-Level Waste Disposal Facility at the Idaho National Laboratory Site. DOE/NE-ID-11243. Idaho National Laboratory, Idaho Falls, ID. Available at INL's DOE-ID Public Reading room electronic collection. (Newly released because of Environmental Defense Institute's Freedom of Information Act request.) See https://www.inl.gov/about-inl/general-information/doe-public-reading-room/

[94] See the CERCLA administrative record at www.ar.icp.doe.gov (previously at ar.inel.gov) and see also Parsons, Alva M., James M. McCarthy, M. Kay Adler Flitton, Renee Y. Bowser, and Dale A. Cresap, Annual Performance Assessment and Composite Analysis Review for the Active Low-Level Waste Disposal Facility at the RWMC FY 2013, RPT-1267, 2014, Idaho Cleanup Project. And see Prepared for Department of Energy Idaho Operations Office, Phase 1 Interim Remedial Action Report for Operable Unit 7-13/14 Targeted Waste Retrievals, DOE/ID-11396, Revision 3, October 2014 https://ar.inl.gov/images/pdf/201411/20141103009 60BRU.pdf

[95] US Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011. http://energy.gov/sites/prod/files/EA-1793-FEA-2011.pdf and see EDI's report "Unwarranted Confidence in DOE's Low-Level Waste Facility Performance Assessment – The INL Replacement Facility Will Contaminate Our Aquifer for Thousands of Years" at http://www.environmental-defense-institute.org/publications/rhllwFINALwithFigs4.pdf

[96] Thatcher, T.A., Environmental Defense Special Report, *Tritium at 800 pCi/L in the Snake River Plain Aquifer in the Magic Valley at Kimama: Why This Matters*, 2017. www.environmental-defense-institute.org/publications/kimamareport.pdf

[97] U.S. Department of Energy, Environmental Assessment for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste at Waste Control Specialists, Andrews County, Texas, DOE/EA-2082, October 2018. https://www.energy.gov/sites/prod/files/2018/11/f57/final-ea-2082-disposal-of-gtcc-llw-2018-10.pdf The inventory of GTCC and GTCC-like waste is about 12,000 cubic meters (420,000 cubic feet) in volume and contains about 160 million curies of radioactivity. "Since the site is in a semi-arid environment, most of the transport of radionuclides to the environment is expected to be through upward diffusion of volatile radionuclides, including helium-3, carbon-14, argon-39, krypton-85, iodine-129, and radon-222, to the surface rather than via groundwater." "The peak dose is dominated by upward diffusion of

that EA found that burial of GTCC waste at the WCS facility, at the Andrews County, Texas waste site would be dominated by upward diffusion of volatile radionuclides. This means the estimates of air emissions may be omitting this contribution for INL air emissions.

The DOE uses the excuse that it does not define a category of low-level waste in the way the NRC does — the DOE does not declare it has GTCC waste because it doesn't require that classification but the DOE admits it had "GTCC-like" waste.

According to the Environmental Assessment EA-2082 for disposal of the nation's GTCC waste at Andrews County, Texas, "GTCC-like waste refers to DOE-owned or generated LLW and non-defense transuranic (TRU) waste that is without a disposal path and has characteristics sufficiently similar to those of GTCC LLW such that a common disposal approach has been proposed."

The DOE, however, must determine whether its low-level waste exceeds Class C, and is GTCC, before sending waste to NRC-licensed disposal facilities.

What the DOE rely prefers to obscure is the fact that "up to 87 percent of the current and projected volume of 8800 cubic meters of GTCC wastes cited in DOE EIS [98] has TRU nuclides greater than 100 nanocuries/gram (nCi/gm)." [99]

Therefore, when the DOE proposes reclassification of HLW to low-level waste, which will often be GTCC low-level waste, and the DOE is only performing this reclassification because it does not have a deep geologic repository, it means that the DOE will be using shallow burial of the HLW at DOE sites.

Deep geologic disposal has long been advocated for the disposal of the nation's GTCC waste, and has been advocated in NRC regulations. The DOE's EIS for disposal of GTCC waste has long advocated disposal at WIPP; however, currently WIPP prohibits disposal of this GTCC waste.

Part of the reason the deep geologic disposal has long been advocated for HLW, GTCC and TRU waste is that it was hoped that geological features would isolate that waste and not require active institutional controls for geologic time frames, for over one million years. But what the Department of Energy has been saying at the Idaho National Laboratory is that they are relying on active institutional controls to perform basically annual maintenance on the soil cap that is placed over buried waste at the Radioactive Waste Management Complex. This type of silliness was sought to be avoided in the advocating for deep geologic disposal. But now we know that

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technetium-99." "Because of the geologic conditions at the site, as well as the license mitigation measures, releases would not be expected until well after most of the radionuclides had decayed away. Only very long-live [sic] radionuclides would be expected to remain…Transport of radionuclides from the waste to the surface or underlying groundwater would still be limited by diffusion through the unsaturated soils." The EA provides effective dose after loss of institutional control that increases over time, higher at 100,000 years after closure. Because the radionuclides ingested are not delineated, the effective dose which may appear low may in reality cause serious developmental problems or premature death to children.

[98] Department of Energy, Environmental Impact Statement for Greater-Than-Class C Waste.

[99] U.S. Nuclear Regulatory Commission, Policy Issue Notation Vote, "Historical and Current Issues Related to Disposal of Greater-Than-Class C Low-Level Radioactive Waste," SECY-15-0094, July 17, 2015.

obtaining adequate isolation of waste, such as spent nuclear fuel and HLW, has turned out to be far more difficult that people hoped.

The DOE's Environmental Impact Statement of disposal of GTCC has recommended that it be disposed of at WIPP and found that disposal at DOE sites via shallow burial yielded excessive radiological releases. A single alternate to WIPP for disposal of GTCC has also been proposed at Andrews County, Texas, where arid climate and natural clay deposits are thought to limit the migration of contaminants. But there is a strong profit-motive for owners of the Andrews County waste disposal site to show a favorable disposal analysis.

The DOE has disposed of some of its GTCC "low-level" radioactive waste as well as spent fuel irradiation targets by shallow burial at the Idaho National Laboratory's Radioactive Waste Management Complex as well as at other its other DOE sites. The DOE continues to bury GTCC concentrations of INL wastes at the INL's remote-handled low-level waste disposal facility at the ATR Complex, claiming that the migration of contaminates will limit the groundwater contamination.

The EA allows the careless disposal of spent nuclear fuel over the Snake River Plain aquifer if DOE deems the spent nuclear fuel to be related to research. This artificial definition defies science and is simply to shortcut proper disposal to isolate the material from soil, air and groundwater. The VTR EIS must explain the quantities of material from reactor irradiation programs, including spent nuclear fuel, that it has buried at INL and what amount it plans to bury at INL from the VTR program.

The VTR EIS not only misrepresents various VTR reactor, fuel and waste handling accident risks and consequences, it mispreprents the inevitable waste disposal problems. The VTR EIS must acknowledge the cost of continued and indefinite storage of high-level waste and spent fuel at the INL, particularly for the VTR program. The VTR EIS must address the gyrating, flailing, failed and non-existent disposal and waste disposition programs. The VTR EIS must address the long-term costs, especially now that DOE is on track to miss the 2035 Settlement Agreement milestones because it has no spent nuclear fuel and high-level waste repository. The VTR EIS has avoided the truth because it people understood the truth, they would oppose the VTR project.